**THE PLACE OF SMALL WETLANDS IN
RURAL COUNTRY LOT DEVELOPMENT:
A CASE STUDY IN THE REGIONAL MUNICIPALITY
OF OTTAWA-CARLETON, ONTARIO, CANADA**

**by
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**A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfillment of
the requirements for the degree of**

Master of Arts

Department of Geography

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**THE PLACE OF SMALL WETLANDS IN
RURAL COUNTRY LOT DEVELOPMENT:
A CASE STUDY IN THE REGIONAL MUNICIPALITY
OF OTTAWA-CARLETON, ONTARIO, CANADA**

The influence of country-lot subdivisions on small wetlands in six biophysically different small drainage basins within the Regional Municipality of Ottawa-Carleton was analyzed from the point of development application (as early as 1977) through to present conditions. Although "human scale" wetlands appear to be valued by many of the current residents, their fate is uncertain. Decreases in wetland area appear to result from increases in drainage density, drainage diversions, and disregard for the ecosystems, rather than from the drilled domestic wells. While the landowners recognized many positive attributes of the ecosystems, their perceptions and activities cluster into three groups: an anthropocentric-minded group; one that has acquired its taste for features of the environment; and a third that has a longer term environmental interest.

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LIST OF ACRONYMS

MOEE - Ontario Ministry of Environment and Energy
MVCA - Mississippi Valley Conservation Authority
RMOC - Regional Municipality of Ottawa-Carleton
OMMAL - Oliver, Mangione, McCalla and Associates Limited
OMNR - Ontario Ministry of Natural Resources
WESA - Water and Earth Science Associates Limited

DEFINITIONS

Boundary Condition - where a constant source of water is available to the well after a certain period of pumping

Country lot - development where all lots are a minimum 0.8 hectares in size

Drainage Density (DD) - Length of all channels over the basin area in m/m² (TCL/DA)

Isolated wetland site type - wetlands that have no surface outflow (OMNR, 1993).

Lacustrine wetland site type - wetlands associated with lakes (OMNR, 1993).

Maximum Basin Length - The longest straight line distance from the outlet to the basin perimeter (m)

Nepean Formation - Ordovician or Cambrian, Paleozoic Era, sandstone

Ottawa Formation - Paleozoic Era, a limestone bedrock with some shaly partings; and some sandstone in the basal part.

Oxford Formation - Paleozoic Era, dolomite and limestone

Palustrine wetland site type - generally occur in lands positioned physiographically upslope from lacustrine and riverine wetlands. Palustrine wetlands are defined either by absent or intermittent inflow and either intermittent or permanent outflow. They are often found in headwater areas and may drain in opposite directions into different streams or river basins (OMNR, 1993).

Place of small wetlands - both the part of space occupied by wetlands as well as their position or standing through the subdivision approval process and subsequently in the eyes of landowners (two definitions of "place" from Webster's New World Dictionary)

Relief Ratio - Total Relief (highest elevation minus lowest elevation in the basin) divided by Maximum Basin Length

Riverine wetland site type - include the channel of continuously moving water to the 2 m depth, as well as adjacent wetlands and normal flood plains of rivers and permanent streams (OMNR, 1993).

Total Channel Length (TCL) - Measured length of all channels in the basin (m)

Wetlands - lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case, the presence of abundant water has caused the formation of hydric soils (soils in which there is an abundance of moisture) and has favoured the dominance of either hydrophytic or water tolerant plants (OMNR, 1993).

Chapter 1

Introduction

1.1 Nature of Problem

The health and diversity of the natural environment is fundamental to human wellbeing; we are all dependent upon environmental systems, even if we are not fully aware of how it all works. Nevertheless, the natural environment continues to be degraded and components of it are lost as a result of human activity, thereby creating a problem of intra- and intergenerational inequity. Some individuals deem the degradation as "progress", laud the opportunity to create jobs, and/or believe in their right to make whatever choices they wish. Others recognize the damage as a burden to current and future generations and non-human entities dependent upon the ecosystems taken away.

These diverse attitudes exist towards wetlands, for example. Within the continuum between aquatic and terrestrial environments, wetlands are:

"lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case, the presence of abundant water has caused the formation of hydric soils (soils in which there is an abundance of moisture) and has favoured the dominance of either hydrophytic or water tolerant plants" (OMNR and OMMA, 1992:3).

Currently, wetlands account for about 6 per cent of the land area globally, 25% of which is in Canada (Government of Canada, 1991). Research into their complexity and significance has influenced a growing interest in their protection since the 1970s. Rather than being viewed as wastelands, they are now associated with many positive characteristics at local, regional and global scales. The broad categories of wetland roles

have been variously analyzed at population, ecosystem and global levels (Greeson et.al., 1979) and more recently according to ecological functions and socio-economic values (Government of Canada, 1991). These include: groundwater storage and recharge; flood control; sediment trapping; shoreline protection; natural sinks for pollutants; nutrient cycling and storage; natural storage base for carbon; food web support; preservation of biodiversity and vitality of species; wildlife habitat; commercial outputs (wildlife and energy related); recreational sites; natural heritage areas; and aesthetic qualities related to landscape (Greeson et.al., 1979; Mitsch and Gosselink, 1986; Environment Canada, 1991; Organisation for Economic Cooperation and Development (OECD), 1992). This must be considered a partial list because it is limited to values that are apparent to human beings. As with many other environmental assets, their total ecosystem functions may not be completely known or understood. Norton (cited in Costanza et.al., 1989:338), therefore adds the indirect contributory value of wetlands in "maintaining and accentuating the ecosystem processes which support the direct benefits".

In the late 1980s, grave concern over wetland loss and degradation was being expressed through reports, workshops and consultation processes in Canada. It was estimated that, since early European settlement, up to 75% of the wetlands south of the Canadian Shield had been converted or degraded, with the proportion being as high as 98% in proximity to urban centres (Government of Canada, 1991). In Ontario, past encroachment through land clearance, drainage and filling occurred primarily as a result of the expansion of the agricultural land base. Since the 1970s, however, wetlands have been under increasing pressure from urbanization.

The federal and some provincial governments have responded with policies aimed at wetland protection. In Ontario, the Wetland Policy Statement, under the Authority of the Planning Act (Government of Ontario, 1992), came into effect in June, 1992, and is aimed at the protection of Provincially Significant Wetlands (PSW) (Class 1, 2 or 3 wetlands based on the Ontario Wetland Evaluation System and ranking criteria that underpin the policy's implementation). These PSWs are typically large or have special features, such as rare or endangered species, and some municipalities are having difficulty in adopting the required official plan amendments to protect even these areas. Although the policy states that wetlands that are not provincially significant should also be conserved, this is left to the discretion of the local planning jurisdictions. These smaller, no less functional wetlands which dot the rural landscape continue to be at risk due to competing land use and/or nearby changes to the hydrologic regime upon which they depend.

1.2 Purpose and Objectives

The goal of this research is to examine the place of small wetlands in rural country lot development within the Regional Municipality of Ottawa-Carleton (RMOC), from 1977 to 1995. Six case studies, comprising thirteen plans of subdivision, are reviewed from the point of application through to present conditions. The four objectives are:

1. To survey the similarities and differences in documentation on terrain analysis, hydrogeology and hydrology that have been used in subdivision approval processes in the Regional Municipality of Ottawa-Carleton from 1977-1992.

2. To measure selected characteristics of drainage basins in which a subdivision and wetland areas are found, both before and after the development.
3. To determine whether the country-lot subdivisions or individual residents are altering baseflow to nearby wetland areas.
4. To complete a questionnaire survey to explore the perceptions of country-lot residents towards groundwater, land drainage and wetland ecosystems.

Each case is viewed as a system operating within the rural environment. Therefore, the approaches taken toward groundwater, drainage and wetlands, and the results of the development activity, are integrated with the perceptions of the current residents towards these three topics.

In order to work within the typical information constraints that exist during decision-making processes, this interdisciplinary study is based on existing documentation, except for the questionnaire survey which collected information on the understanding and perceptions of residents towards water-related aspects of the environment. The study sites (Figure 1.1) were selected from a pool of 27 country-lot developments that contained or could affect wetlands. The subdivision criteria for selection were that: each was relatively isolated; had no more than three registered plans of subdivision adjacent to each other; and had clear entrance roadways. Strip developments along a concession, village lot developments and situations where the subdivision and/or wetland was within a golf course development were not considered. The wetlands criteria were that: while being small in area, each had to be clearly visible on the 1991 1:15,000 colour air photos of the RMOC; they were not protected as provincially significant areas in 1992; they were within, adjacent to, or up to 1000 m away from the development (most were in or

downstream from the development); no secondary roadway ran between the subdivision and at least one wetland area; and they were not exclusively riverine, or on major river corridors such as the Ottawa and Rideau Rivers. The size of the catchment area varied with each case, and some sites included more than one wetland area.

1.3 Thesis Context and Structure

The following two pieces of background information about the RMOC provide the context for the study at hand. First, the upper-tier government of the Regional Municipality of Ottawa-Carleton is the approval authority for plans of subdivision within this jurisdiction. Prior to a decision being taken, applications and background documentation are circulated to various provincial, regional and lower-tier municipal government agencies for review and comment. This package typically includes a terrain and hydrogeological investigation report, prepared by the proponent, which 1) depicts the terrain physiography, soils, and the quality and quantity of groundwater, and 2) recommends the configuration of the land subdivision into residential lots with private wells and septic systems. The RMOC Planning Department staff await response from the review agencies and then make recommendations to the Planning Commissioner (Planning Committee, in the early 1980s). This report includes a general description of the proposed development, discussion of the issues raised by the agencies, staff response, and suggested Conditions of Draft Plan Approval. If the Draft Plan is approved, some development may proceed, such as the site preparation, rough grading and laying of lot lines, but this is a risk to the proponent should the plan of subdivision not receive final approval. When all

the conditions of draft plan approval are met, a final agreement which reiterates the draft conditions and details other legal requirements is signed by the proponent and the RMOC, and the Plan is registered in the Land Titles Office. All development works may then proceed.

Secondly, the rural area in the RMOC is defined as "all the land outside of the outer limit of the Greenbelt, excluding land designated Urban Area, which includes urban centres and Stittsville and Leitrim" (RMOC, 1994:3) (Figure 1.1). A study of the rural non-farm development pressure on smaller wetlands, for the period 1970-1994, revealed that approximately three hundred (309) plans of subdivision were registered during the period (Larkin, 1995). (The actual number is slightly higher because prior to 1975, subdivision development data was compiled by individual municipalities and not routinely collected by the Planning and Property Department of the RMOC). These plans created a total 7,266 rural non-farm lots, 3,205 country-lots (outside village limits) and 4,061 village-lots. Ninety-six (96) of the plans of subdivision (31%), with a potential for more than 2800 lots, are likely to have affected a wetland area identified by Environment Canada (1985), based on their abutting (50) or encroaching (46) these ecosystems.

General data about the change in population, change in wetland area and wetland loss per 1000 "wetland subdivision" population are presented in Table 1.1. All percentages are based on the 1995 RMOC area (281,160 hectares). While the number of persons living in the rural area rose by 75% between 1971-1991, from 38,847 to 67,781, the number of hectares of wetland declined for a variety of reasons. Where country-lot subdivisions had the potential to affect a wetland, the loss from 1970-1994 was estimated

at 179 ha/1000 persons (Larkin, 1995).

The next chapter considers why this observation is a concern, based on an outline of the wide-ranging benefits of these ecosystems and the current framework for their protection in Ontario. Chapter 3 then provides an overview of the research methodology, the site descriptions of the pre-development biophysical environment for each case study, and the general profile of the questionnaire participants. The analysis of changes in the hydrogeology, surface drainage and wetland area is completed in Chapter 4, including a review of the approach taken by the reviewing agencies in each case, the physical works of the subdivision development process and the views and activities of the current landowners. Chapter 5 outlines the conclusions of the research project.

Table 1.1: RMOC Development Activity and Wetland Data (from Larkin, 1995)

	1971	1981	1991	% Change
Wetland area (ha) as per sources ¹	35,260 (1967)	34,510 (1982)	24,285 (1994)	-31%
Rural RMOC Population ² (% of RMOC)	38,847 (8.23%)	50,360 (9.21%)	67,781 (9.99%)	+74% (1.76%)
Wetland area (ha) per 1000 rural RMOC population	907	686	358	-61%
	1970-1982	1983-1994	1970-1994	
Wetland affected by subdivisions (ha)	253	722	975	
Increase in "wetland subdivision" population (estimated upper limit ³)	2163	3285	5448	
Ha loss per 1000 "wetland subdivision" population (estimated maximum)	117	339	179	

Note ¹: Environment Canada (1985), Geomatics (1994)

Note ²: RMOC (1994)

Note ³: Result from Mahon (1995), in conjunction with estimated population per dwelling factor.

Chapter 2

Interest in Wetlands Large and Small

Both the World Health Organization and Health Canada have described health since 1986 as not just the absence of disease or infirmity, but a state of complete physical, mental and social wellbeing (McMichael, 1993). These agencies find health to be "... a resource for everyday life that has to be maintained and enhanced, and that good health enable [sic] people to both cope with their circumstances and to take steps to improve them" (Hodge and Taggart, 1992:I-8). As well, both institutions are concerned with the extent to which individuals have access to basic prerequisites to health, among which one should include a healthy and secure environment. Indeed, the basic requirements for sustaining the good physical health of *Homo sapiens* over generations have been listed as: clean air, safe water, adequate food, tolerable temperature, stable climate, biodiversity and protection from solar ultraviolet radiation -- aspects of the natural environment that appear to be taken most for granted (McMichael, 1993). With respect to this research, the following descriptions of wetland ecological functions and socio-economic values point to the particular importance of these ecosystems to ongoing human wellbeing. Some of the reasons for their conversion to other land uses are then discussed, as explained by mainstream economics, followed by a review of past and current interest in small wetlands and the potential for their protection in Ontario.

2.1 Overview of Functions and Values

Wetlands may be lacustrine (lakeside), riverine (river shoreline), palustrine (upland, with an outlet watercourse) or isolated (upland, without an outlet watercourse) (OMNR, 1993) and in Canada, they are classified as a swamp, marsh, bog, fen, or shallow open water, but may also be a combination of these types (Appendix I). They are diverse in terms of their location, type, ecological functions and socio-economic values yet they do not perform equally, nor is each associated with every benefit. Nevertheless, Catallo (1993) notes that wetlands function as nature's kidneys, with respect to their role in sedimentation and filtration; as nature's lungs through biogeochemical gas exchanges; and as nature's womb with respect to breeding and habitat areas. Many of the functions and values will now be described.

To begin, hydrologic functions relate to the wetland's type and location whereby the value of each component of the hydrologic budget (contributions of precipitation, surface or groundwater inflow, and lake and river overflow, as the sources of water; the evapotranspiration, groundwater discharge or surface outflow as water outlets) is site specific and related to the water resources of a region. Indeed, Novitzki developed a classification system that is based on the wetland's relationship to groundwater (Novitzki, 1989). Wetlands may recharge the groundwater system, be an area of groundwater discharge, or flowthrough groundwater (which enters at a higher elevation and exits as streamflow); wetlands may perform two or more of these functions; or they may change functions during the annual cycle (Whiteley and Irwin, 1986; Novitzki, 1989; Gehrels and Mulamoottil, 1990; Roulet, 1990; Shedlock et.al., 1993, Velderman, 1993). In general,

riverine and lacustrine wetlands are discharge areas, where outflow occurs at the transition between the upland and open water. Given that isolated wetlands do not have a surface outflow, they typically recharge groundwater when the maximum possible evapotranspiration rates are below the mean annual precipitation rates. Palustrine wetlands may perform both recharge and discharge functions on a slope.

Along a watercourse, the submerged and emergent wetland vegetation acts as a buffer to incoming wind and waves and thereby protects shorelines from erosion. More controversial is the wetland's role in attenuating the potential for flooding and their contribution to low-flow augmentation during the dry season, both of which relate to their capacity to store water. With respect to flooding, the existence of riverine wetlands clearly provides a larger floodplain during flood events than does a "hard", developed shoreline of retaining walls. Where a wetland exists elsewhere in the drainage basin, water storage that reduces flood risk appears to depend on the moisture content of the wetland prior to the rainfall event. The National Wetlands Working Group (1988) noted that effective water storage may only occur during summer months in Eastern Temperate Canada when the water levels are below maximum at the time of the rainfall. When a wetland is saturated, as is commonly the case during spring runoff, little or no additional precipitation can be held. Whiteley and Irwin (1986) found that where upland wetland areas existed, streamflow during storm periods had smaller peaks and longer recessions than from an equivalent-sized area without wetlands, but that the release of stored water to streamflow at the outlet began within the storm period. They suggested that low-flow augmentation is limited to either a short period after storms, or to later groundwater

discharge to the watercourse.

Wetlands hold, release, or transform nutrients. For example, suspended solids are filtered and accumulate in the sediments because of the hydraulic resistance from the vegetation and soils which decreases the flow velocity. On the other hand, soluble compounds and metals are removed through plant uptake or chemical reaction within the saturated conditions. The forms of nitrogen, iron, manganese, sulphur, phosphorus, heavy metals and carbon have been studied (Gehrels and Mulamootil, 1990; Mitsch and Gosselink, 1993; Reinelt and Horner, 1995). Some of these affect water quality at the local level, while others are linked to global concerns such as climate change. It is believed that the world's wetlands store as much carbon as the South American rainforests.

Maintenance of biodiversity, at the species- through ecosystem-levels, is perhaps the best known ecological function and socio-economic value of wetlands. Wetlands can be highly productive ecosystems, whereby the variety of plants provides food, protection, nesting materials, roosting and loafing areas, and isolation during the breeding seasons for a wide variety of species (OMNR, 1993). As early as 1904, the chief game warden in Ontario recognized the significance of habitat for species survival, when he said of one species:

Shrinkage of its range inspired some of our earliest game laws, and more recently attempts have been made to bring the wild turkey back, but in vain; the environment no longer exists. (Lambert, 1967:463-464).

More recently, the goal of the Wildlife Policy for Canada is to maintain and enhance the health and diversity of Canada's wildlife, for its own sake and for the benefit of present and

future generations of Canadians (Wildlife Ministers' Council of Canada, 1990). The maintenance and restoration of biodiversity is identified as one of three requirements if the goal is to be achieved, and the policy defines biodiversity to include wetland ecosystems.

With respect to the more direct value to people, the importance of habitat was recognized in the *Rideau Valley Conservation Report* of 1968, where planning for the management of fish and wildlife resources was seen as an important branch of land use planning for recreational purposes:

For the hunter and fisherman the opportunity of seeking game and fish with a reasonable chance of success is regarded as a means to healthy pursuits which are an excellent antidote to the stresses of modern life. (Ontario Department of Energy and Resources Management (ODERM), 1968:213)

Today, the total economic impact of such activities is significant. The sport fishing industry in Ontario in 1988 was estimated to be worth one billion dollars annually (Glooshenko and Grondin, 1988:231). While it is difficult to calculate how much of that sum can be attributed to the existence of shoreline wetland ecosystems, fish use wetland habitat for spawning and feeding purposes. More recently, Ducks Unlimited Canada established guidelines for their wetland management decisions based on the projected cost per duck over 40 years (Colley, personal communication). Today, the biologists at this organization calculate the number of ducks that can be supported per marsh, and the engineers calculate the costs of development and long-term management, whereby all data is combined for both production and staging activities. In Ontario and the Prairies, Ducks Unlimited Canada will expend \$21/duck and \$14/duck, respectively. Other commercial values include fruit, energy in the form of peat, wild rice, timber and forage crops,

depending on the region.

On a different tack, wetlands are a resource as a research environment or educational site. For example, studies related to the hydrologic functions of wetlands in Ontario include Whiteley (1975), Taylor and Pierson (1985), Gehrels and Mulamoottil (1990), and Roulet (1990) to name a few. In these cases, the wetlands were about 10.6 ha, 11.75 ha, 18 ha and 157 ha, respectively. A selection of other hydrological studies include research on prairie sloughs in western Canada (Woo and Rowsell, 1993) and a 22 ha Michigan coastal wetland by Shedlock et.al. (1993). The effects of disturbances on wetlands, particularly the effect of changing water levels on vegetation and the cumulative effects on water quality and quantity were reported by Keddy (no date), van der Valk et.al. (1994), Ellison and Bedford (1995), Hemond and Benoit (1988) and Winter (1988).

Wetlands also have aesthetic value. If it was acknowledged in 1968 that "increasing numbers of naturalists and photographers simply enjoyed seeing varied wildlife, vegetation and attractive environments" (ODERM, 1968:213), one might suggest that this value will be of increasing interest, at least in North America, as the population ages into the next century.

Lastly, economists have identified non-use values of wetlands when an individual has a concern for, sympathy with, or respect for the rights or welfare of non-human beings, or the personal preference of knowing that a certain landscape exists (Turner, 1992).

As mentioned earlier, many of these functions and values were not widely recognized prior to the 1970s. Since a growing awareness and this recognition, one may

wonder why these ecosystems continue to be subject to conversion and degradation. The interpretation of some of these issues, with respect to some wetland benefits, is presented in Table 2.1. First, at the level of the private landowner, there is often an incomplete recognition of the full value of wetlands, let alone difficulty in its measurement. This may be particularly true where wetlands are a component of regional ecosystems to which a single landowner does not typically consider the broader scale of concern (Bardecki, 1989) (Table 2.1, column 2 and 4). Moreover, under usual circumstances, the benefits which arise from their existence are not normally capturable by the landowner who is the one who bears the opportunity costs of ownership (Table 2.1, column 3). Bardecki (1984, 1989) estimated that between zero and 27.5% of the total potential ecological and socio-economic benefits of wetlands are capable of being internalized by the private landowner;

Table 2.1: General Characteristics of Wetland Values (Bardecki, 1989)

Value	Extent of Benefit ¹	Primary Focus of Benefit ²	Market-Orientation of Benefit ³
Biological benefits (a) Marketable products (b) Ecological values	P P,R,G	Pr Pu	M SM, NM
Water quantity and quality management	R	Pu	SM
Erosion protection	P,R	Pu	SM
Climatic and atmospheric values	R,G	Pu	NM
Education and Research	P,R	Pu	NM
Recreation	P,R	Pr,Pu	SM
Aesthetic values	P,R	Pr,Pu	NM

Notes:

¹ Extent of benefits: P - Personal (individual), R - Regional, G - Global;

² Primary focus of benefits (who is likely to reap benefits): Pu - Public, Pr - Private;

³ Can monetary values be determined directly (M), imputed easily or partially determinable (SM), or are the values essentially non-market (NM).

decisions, therefore, have been based largely on the private costs and benefits of a change in land use proposal, not including the valuation of the social costs and benefits related to the change. Various government based initiatives have also exacerbated the problem of conversion with poor consideration of the impacts of policies and programs on these resources (such as the Eastern Ontario Subsidiary Agreement Drainage Program (Cecile and Bardecki, 1985)) or through municipal land use policies that do not often identify wetland areas as such (Mosquin, 1993). In this case, the negative effect on these ecosystems has subsequently flowed from zoning through to site plan control. In general, rural subdivision development has the potential to drain or fill a wetland, while paving, house construction, road construction or regrading may change the amount and/or direction of runoff in a local area; the amount of recharge area available to the groundwater system may also be affected (Novitzki, 1989). The findings of this research are presented in Chapter 4.

Moreover, Barendregt et.al. (1995:393) note that "ecological relations within a wetland depend on its hydrology, but that this is determined largely by what happens outside the wetland area". Winter (1988), for instance, suggested that decreasing the hydraulic head by pumping at a well, even some distance away from a wetland, may change the groundwater flow field configuration enough to decrease groundwater discharge to the wetland or even to induce seepage from it. In terms of an ongoing secure groundwater supply, Brinson (1988), Winter (1988) and O'Brien (1988) have noted the potential for wetland discharge of contaminants during groundwater flow reversals. In an attempt to assess the potential for these occurrences, O'Brien and Motts (1980) and

Harbor (1994) have developed hydrogeologic evaluations of wetlands for land use planning purposes.

The interest in keeping small wetlands, in particular, has been very limited. On the positive side, conversion of prairie sloughs into agricultural lands has subsided, partly as a result of the North American Waterfowl Management Plan (1986) which is aimed at the maintenance and management of high-quality waterfowl habitat. In broad terms, the Plan should help ensure habitat for 62 million breeding ducks and a fall flight of more than 100 million birds. Habitat is also necessary to support more than 6 million overwintering geese. As well, small wetlands near urban developments are now of interest as an alternative method for stormwater management. According to Mitsch (1995) the construction and restoration of wetlands is "among the most discussed and practiced applications of ecological engineering". Breen et.al. (1994) suggested that where a transition from agricultural to urban land use occurs, the opportunity exists to restore some of the natural values of the catchment, through the creation or enhancement of a wetland area for wildlife habitat and passive recreational activities.

With respect to the Ontario region, the next section describes the implementation of the 1992 Ontario Wetland Policy Statement in order to substantiate the claim that its existence does not change the way country-lot developments affect small wetlands in the study region.

2.2 Wetland Protection in Ontario

In Ontario, wetland protection began in 1984 with a "Guidelines for *Wetland*

Management". By the late 1980s, the government found that this measure had not curbed wetland conversion, and as a consequence, efforts continued on the development of the Wetlands Policy Statement which has the following three objectives (OMNR, 1992):

1. to ensure no loss of *Wetland Function* or *Wetland Area* of *Provincially Significant Wetlands* [Classes 1 to 3] in the *Great Lakes - St. Lawrence Region*;
2. to ensure no loss of *Wetland Function* or *Wetland Area* of *Provincially Significant Wetlands* in the *Boreal Region*;
3. to encourage the conservation of other *Wetlands* (e.g. Classes 4 to 7) throughout Ontario.

It is a prohibitive policy, whereby no development activity is permitted within identified provincially significant wetlands. Planning jurisdictions are also encouraged to protect other wetlands, but the means with which to do this are not prescribed.

A fundamental tool in its implementation is the continued identification and measurement of recognized ecosystem functions and socio-economic values of wetlands through the Ontario Wetland Evaluation System (OMNR, 1984 and 1993), in order to determine their class ranking and status in terms of provincial significance. A combination of field investigations and background data collection is used to evaluate

"the perceived values of characteristics, activities, or expressions of the wetland or its parts that function to maintain ecosystem processes, or that have some utility or amenity value to a segment of society" (OMNR, 1993:3).

The appraised positive attributes fall into four components: the Biological, Hydrological, and Special Features that assess the ecosystem processes, and the Social Component that assesses the utility or amenity value. Points are awarded to subcomponents, attributes, and subattributes to a maximum 250 points per component; these scores are summed, to a maximum 1000 points per individual wetland, a numeric score that rates one wetland

against another. (Over 2000 wetlands were evaluated under the 1984 (2nd) edition of the Manual with the judgement of dozens of people forming the basis of the credibility of the rankings). The wetland class is ultimately based on the Total Score **OR** the Component Score, whichever results in the higher level according to the ordinal ranking scheme (Table 2.2).

Houston (1995) suggested that the critical point in the ranking scheme is the difference between Provincially Significant Wetlands and the others, because of the implications with respect to the Wetlands Policy. A wetland with 600 total points or 200 points in either the biological or special features components is provincially significant (but a wetland with one less point in either criteria is not). The choice in components that can determine provincial significance is noteworthy: the biological and special features can do it, but high scores in the hydrological or social components will not. This distinction was made because many large wetlands attained the Class 3 designation based on their hydrologic values (over 200 points) but the OMNR deemed this to "skew" provincial

Table 2.2: Ontario Wetland Policy Criteria for Class Designations
(Houston, personal communication)

Wetland Class	Total Point Score	Component Point Score
Class 1	700 or more	3 components over 200
Class 2	650 or more	2 components over 200
Class 3	600 or more	1 of Biological or Special Features components over 200
Class 4	550 or more	4 components over 100
Class 5	500 or more	3 components over 100
Class 6	450 or more	2 components over 100
Class 7	less than 450	1 component over 100

significance -- they are more interested in wetlands that are biologically diverse (Houston, 1995).

The policy and its implementation point to little interest in the protection of wetlands that are not Class 1, 2, or 3 for several reasons. First, unevaluated wetlands (which do not have a class ranking) are out of the policy's sphere of influence; the third objective refers to the "conservation of other wetlands", but only those in Classes 4-7, as noted above. Second, the evaluations have focussed on larger areas, and on those with known special features such as rare or endangered flora and fauna. The Evaluation Guide (OMNR, 1993) states that wetlands smaller than two hectares are not to be evaluated unless they are a part of a larger wetland complex. Third, according to Houston (personal communication), the OMNR evaluation of this Region's wetlands is essentially complete, except where their boundaries are adjusted through ongoing updates. About 72% of the wetlands have been evaluated, ranging in size from 19 ha to 3,341.5 ha, the vast majority of which are Provincially Significant (Brownell & Larson, 1995). Only one additional wetland (approximately 500 ha) was studied in the field season of 1995. Lastly, even when the Wetlands Working Group (1995) agreed on the importance of wetland ecosystems in general, the landowner representatives on this group did not allow discussion about the future protection of "Other Wetlands". The focus of this ten-month working group was limited to the implementation questions of the RMOC's Official Plan Amendment which was aimed at designating the Provincially Significant Wetlands in this Region.

With respect to the wetland losses that appear to have resulted from sub-division

development in this Region (as outlined in Chapter 1), and the vacancy rate of these developed lands (estimated as the number of vacant lots created, whereby data for the case studies is included later in Table 3.1), a relatively small percentage of the population appears to benefit from the conversion of wetland ecosystems for development purposes. This is viewed as a moral issue of social inequality because of the unknown implications of the change, as well as its long-lasting nature.

Chapter 3

Setting the Stage: Methodology, Case Descriptions and Respondent Profile

3.1 Methodology

For each case study, the following features of the pre- and post-development catchment areas were noted from existing topographic and base maps (1:10,000, 1:25,000, 1:50,000), geologic maps (1:50,000), soil maps (1:50,000), site specific, local or regional terrain and hydrogeological reports, and pre- and post-development air photos at a nominal scale of 1:7,500-1:10,000 : topography, deep bedrock formation and depth of overburden, soil associations including parent material, hydrography, hydrogeology and land use. The primary interests about the soils are their subgroups classification and textural class: the former because wetland soils outside of permafrost areas fall within the Gleysolic and Organic Orders of the Canadian System of Soil Classification (ACECSS, 1987), and the latter because of its influence on drainage characteristics. The drainage capacity of each soil association is also identified. Based on the dates of the air photos and the precipitation records (information listed in the references), it was concluded that the wetland conditions were fairly represented for the pre- and post-development interpretation. Two field surveys were used to ground-truth air-photo interpretation of the change in wetland area and direction of channelled runoff. The pre-development wetland condition was evaluated with auger-extracted soil samples taken in May and September, 1995. Each was up to 30 cm deep; colour and mottling were observed. The wetland descriptions are based on a preliminary functional assessment with respect to

groundwater recharge and discharge (Larson et.al.,1989), the Ontario Wetland Evaluation System (OMNR, 1993), and easily understood vegetation descriptions (Lyon,1993).

Plan of subdivision files held by the Planning and Environment Department of the RMOC and/or the Planning department of the pertinent lower-tier municipalities were reviewed with respect to groundwater, drainage, and wetlands.

A questionnaire survey was developed and administered by the researcher (Appendix II). A preliminary version was pre-tested on approximately 40 residents of three subdivisions which were similar to those of the case studies, one each in the Townships of Osgoode, Goulbourn and West Carleton (Larkin, Boyce and Dolan, no date). It was determined that additional questions were required for the thesis research purposes, based in part on the information freely given in general discussions with the test group participants as well as upon other review comments. Several questions were therefore added and refined (after a further test effort): Q5, Q6, Q7, Q45, Q46 about the respondent's background; the completion of the base map as well as Q9; the section on the perception about land drainage (Q10-Q15); Q27 about sump pumps; and Q38 and Q41b about wetlands.

For the thesis research, 25% of the residents living in each of the six case study areas were surveyed, for a total sample of 57 respondents. An introductory letter was hand-delivered to each home in a subdivision approximately one week in advance of the scheduled survey days (Appendix III); telephone calls were subsequently made to arrange appointments with every fourth name on the municipal assessment role, as much as possible, in an effort to space the surveys evenly around the development. With unlisted

telephone numbers and rejections, it was necessary to attempt to reach approximately 50% of the residents in order to achieve the 25% response rate.

Information was collected on the understanding and perceptions of residents towards land drainage, the quantity and quality of groundwater, and wetlands. Each section began with general questions and ended more specifically at the subdivision or personal activity level. The overall strategy was to use a combination of closed and open-ended questions in order to obtain greater detail about the respondent's views on particular issues. The survey began with questions about the respondents, including their interests and activities related to the environment. Drainage, groundwater and wetland issues were then dealt with separately, even though these topics are interconnected in physical terms. This is because these subjects are not considered on a day-to-day basis by most individuals; it was therefore decided that these focussed sections would be easier for the respondents to address. The perception about wetlands was the last topic considered because the issue of wetlands can be controversial, especially since the implementation of the Ontario Wetland Policy Statement that prohibits development activity, as noted earlier in Chapter 2.

3.2 Case Descriptions

3.2.1 Background

The six case studies include thirteen plan of subdivision applications which were submitted between 1976 and 1989, and approved between 1978 and 1992. A total of 394 lots were created (a low of 30 and a high of 107 lots per plan). 218 homes (55% of lots)

had been built as of May 1994. With the exception of one application which took almost eight and one-half years to process (because the property changed hands several times), the average time elapsed between application and registration was just over three years. This included three subdivisions for which revised applications were submitted after draft plan approval. Table 3.1 lists development data for each plan, including the timing of the application and its approval, the total hectares, including the portion that was road or open space, where available; and the number of lots approved, compared with the built status in 1995. Hereinafter, where more than one approved subdivision exists within a case study area, each is referred to as a Phase.

The protocol for delineating the drainage basins is as follows: 1) close to 100% of the subdivision lands are included; 2) the outlet is that of the wetland downgradient from the subdivision lands or 3) where such a large wetland did not exist, the outlet is the first confluence of a creek or ditch outside the developed lands. In some cases, more than one basin was delineated in a case study and each is labelled by capitals A-D in subsequent figures and tables. For reference purposes, the selected pre-development characteristics of the basins are presented in Table 3.2. A grid overlay was used to measure the total area of the drainage basin, and the wet area, whereas the built-up area was taken from the plan of subdivision application. The total channel length (TCL) is a linear measurement of all creeks and ditches in the basin and the drainage density is a measure of the length of channel available to drain the sub-basin; the total relief and relief ratio give a sense of the basin topography.

Table 3.1: Basic Subdivision data

Case Study Name and Phases	Application			Area (hectare)		Number lots	
	Year start	Year revised	Year end	Total	Road/ Open Space	Approved	Built (1995)
Dunrobin I	1978		1981	39.9	1/0	33	57 90%
Dunrobin II	1984		1985	36.1	3.2/0	30	
Deerwood I	1976		1978	27.9	0.6/0	18	76 96%
Deerwood II	1981	1983	1984	30.2	na	27	
Deerwood III	1984		1986	35.7	3.3/0	34	
Kanata I	1979	1983	1984	41.72	2.72/0	37	41 54%
Kanata II	1984		1992	10.53	1.32/0	11	
Kanata III	1988		1992	25.5	2.5/81	27	
Lakeland I	1980	1984	1985	47.8	3.28/ 30.22	30	21 52.5%
Lakeland II	1986		1990	6.29	1.253/0	10	
Goulbourn	April 1984	Nov. 1984	1987	29.54	2.39/0	30	14 47%
Deermeadow I	1988	1989	1991	44.29	3.49/ 13.5	51	13 12%
Deermeadow II	1989		1992	61.7	4.04/0	56	

Table 3.2: Selected Pre-Development Drainage Basin Characteristics
(measurements are approximate)

Case	Drainage Area (ha)	Built-up Area (ha) (percent)	Wet Area (ha) (percent)	Total Relief (m)/ Relief Ratio (m/m)	Total Channel Length (m)	Drainage Density TCL/DA (m/m ²)
Dunrobin	A:125.5		9.9 ha 7.9%	34 m 0.0195	6095	0.0046
	B: 13		2.5 ha 19.2%	NA ¹	1040	0.008
	Total: 138.5	76 ha 58%	12.4 ha 9.4 %	NA	NA	NA
Deerwood	A: 71.5	27.9 ha 39%	9.5 ha 13 %	29 m/ 0.016	1241	0.002
	B: 136.5	65.9 ha 33.8%	18.5 ha 13.5 %	26 m/ 0.010	5220	0.004
	C: 58.5		4 ha 7 %	27 m/ 0.016	508	0.0008
	Total: 264.5	93.8 ha 35.5%	32 ha 12 %	NA	NA	NA
Kanata	A:146.5	68.2 ha 46.5%	23.8 ha 16.3%	20.5 m/ 0.0098	4355	0.003
	B:33	9.5 ha 28.8%	0.75 ha 2.3%	NA	990	0.003
	Total: 179.5	78.2 ha 43.5%	24.6 ha 13.7 %	NA	NA	NA
Lakeland	A:26.5	47.8 ha 82%	A:9.3 ha 35%	A:3 m/ 0.0023	1771	0.007
	B:31.5		B:4.6 ha 14.6%	B:3 m/ 0.0023	742	0.002
	C: 48	6.29 ha 13%	C:4.6 ha 9.6a%	3 m/ 0.0010	1308	0.003
	T:106	54.09 ha 51%	T:18.5 ha 17.45%	NA	NA	NA
Goulbourn	56	29.5 ha 53%	42 ha/ 75%	17 m 0.014	2605 m	0.004
Deermeadow	508	106 ha 20.8%	214 ha/ 42%	5.5 m 0.0016	7759 m	0.0015

Notes:¹ NA: Not applicable

3.2.2 Dunrobin

The Dunrobin case includes two adjacent drainage basins, whereby Basin A is significantly larger than Basin B (131.5 ha versus 7 ha) (Figure 3.1). The wetlands are riverine, palustrine and isolated, and the basins were delineated based on the downstream outlet of the creeks which run through the subdivision lands. The eastern half of the site was treed with marked relief and the western half of the basin is flat to gently rolling meadow on a clay plain. The two approved subdivisions cover approximately 58% of the land in the drainage basins and are joined by a common roadway.

Geology and Soils

Outcrops of the Precambrian gneiss bedrock are evident in the east and a clay plain exists in the western half of the basin, with a clay over till in the centre, as depicted by Novaplan (no date) (Figure 3.2). Other deposits include more recently developed soil and alluvium material not mapped by Schut and Wilson (1987) because of scale constraints, particularly areas along the floodplain of the creeks. Table 3.3 presents soil information

Hydrography and Hydrogeology

Within the drainage basins, approximately 12.4 ha palustrine, isolated and riverine marsh and swamp wetlands were identified. The total channel length in Basin A and B was 6095 m and 1040 m; the drainage density was 0.005 m/m² and 0.008 m/m² respectively. The western half of the subdivision lands were flat to gently rolling, and in some areas drainage was slow and ponding occurred after heavy rainfall. In the east, one permanently poorly drained palustrine area was identified in Phase I. Other wetlands are riverine, along the branches of the two creeks that drain the basin. An artificial pond was

Figure 3.1 Dunrobin pre-development basin

Soils*
 Wetlands
 Drainage ———
 Drainage basin ———
 Drainage outlet
 Subdivision lands - - -
 Roads ———
 Contour interval 5 m

* for soil description
 see table 3.3

FIGURE 3.2 DUNROBIN ESTATES

(from Novaplan, no date.)

Table 3.3: Soils in Dunrobin Drainage Basin (from Schut and Wilson, 1987)

Soil Association	Parent Material	Description	Drainage	Recognized Subgroup/ Surface Texture
Clay plain D2.C-RK2/2*-3 Dalhousie dominant (>40%) Rockland significant (20-40%)	Clayey marine material	Gray neutral silty clay or clay marine material Exposures of Precambrian bedrock comprising 25 % or more of area	Imperfect drainage > 40%; poor drainage significant (20-40%)	Gleyed Melanic Brunisols (imperfect) Orthic Humic Gleysols (poor)/ Silty clay loam, silty clay, or clay
Precambrian outcrops RK2-A1/5-S3.4 Rockland dominant (>40%) Anstruther significant (20-40%)	Considerable amount of granitic material	See above 10-50 cm of acidic stony sandy loam, loamy sand or sand undifferentiated drift material over igneous and metamorphic Precambrian bedrock 20 - 40%	Excessive to good	Loamy sand or sandy loam

present on the southern stream in Phase II. Beaver ponds were evident in the south-central area and at the confluence at the downstream boundary of the study area. Small recharge wetlands are located at the base of rock outcrops and the site for Dunrobin II was well-drained overall (Geleta, 1985). Recharge to bedrock may occur through the downward movement of precipitation into fractures in the underlying bedrock. A limited amount of recharge might occur through the thick marine clay plain in the west

(Novaplan, no date). Local groundwater flow was thought to be primarily vertical, with a small horizontal flow between and within geological units controlled by topography and differences in hydraulic conductivity . The water table was at 1 m across most of the site (Novaplan, no date; WESA, 1984).

3.2.3 Deerwood

Deerwood occupies parts of three adjacent drainage basins delineated from the downstream confluence of the outlet drainage creeks (Figure 3.3). The basins, predominantly on an upland, surficial bedrock, forested ridge, measure as follows: Basin A, 71.5 ha; Basin B, 136.5 ha; Basin C, 58.5 ha. A limited area of lowland clay plain, cultivated for agricultural production, is included in the northeast, east and southeast edge. On the ridge, the vegetation was predominantly cedar trees, with some grassy openings, and some mixed areas of conifers and hardwoods. The topography is gently sloping to the northeast. The developed lands exist on both sides of Panmure Road and cover approximately 35.5% of the three sub basins.

Geology and Soils

The bedrock ridge is the limestone Ottawa Formation of the Paleozoic era. A general geology and groundwater flow cross section was included in the Terrain Reports (Figure 3.4). Schut and Wilson (1987) described the soils on the south side of Panmure Road as Grenville association unit 5 (dominant), a moderately coarse to medium textured soil developed on glacial till; and North Gower association (significant), a moderately fine to very fine textured soil developed on marine clay; mainly poorly drained. Later, Schut

Figure 3.3 Deerwood pre-development basin

Soils*
 Wetlands
 Drainage
 Drainage basin
 Drainage outlet
 Subdivision lands - - -
 Roads
 Contour interval 5 m

* for soil description
 see table 3.4

FIGURE 3.4

GEOLOGY AND GROUNDWATER FLOW ALONG SOUTH EDGE OF CARP VALLEY

PROPOSED DEERWOOD SUBDIVISION - PHASE II

WATER AND EARTH SCIENCE ASSOCIATES LTD.

(1981)

and Wilson (1987) reclassified the association as Farmington unit 6 (dominant), coarse to moderately coarse textured soils developed on thin (10-50cm) undifferentiated drift material overlying consolidated bedrock; and Grenville unit 2 (significant). Soils on the north side of Panmure Road were classified as Farmington unit 5 soil association by Schut and Wilson (1981) and later as Farmington unit 6 by Schut and Wilson (1987). Table 3.4 presents further information on the soils.

Table 3.4: Soils in Deerwood Drainage Basins (from Schut and Wilson, 1987)

Soil Association	Parent Material	Description	Drainage	Recognized Subgroup/ Surface Texture
Bedrock Ridge Phase I - F3-G2/S1.2-S2.3 Farmington dominant (>40%) Grenville significant (20-40%)	Paleozoic limestone and dolomite bedrock Glacial till	10-50 cm of neutral to alkaline flaggy sandy loam, fine sandy loam, loamy fine sand, or loamy sand undifferentiated drift material Alkaline stony sandy loam, fine sandy loam, loam, or silt loam glacial till material	Poor Imperfect	Orthic Humic Gleysols / Sandy loam, loam, or silt loam Upwards of 50% sand Loamy sand +70% Gleyed Eluviated Melanic Brunisols/ Fine sandy loam, sandy loam, or loam Broader range of percentage sand especially with respect to loam
Phase II, III - F6/S3.2 Farmington	See above	See above	Dominant drainage (>40%) - Good Significant drainage (20-40%) - Poor	Orthic Melanic Brunisols (well) Orthic Humic Gleysols (poor)/ See above

Hydrography and Hydrogeology

In general, the limestone ridge in Deerwood is a groundwater recharge area from which the flow is down gradient under the Clay Plain towards the Carp River, and subsequently on a regional scale to the Ottawa River. WESA (1981, Section 1.3; 1984:3) also suggested that "a shallow topographic gradient and the presence of more impermeable brown-silty sand over bedrock have caused the poorly drained conditions. It is also likely that the underlying limestone bedrock is more competent in these areas, thereby being less permeable than the surrounding area".

Within the three drainage basins, approximately 32 ha (12%) of mostly isolated wetlands were identified, with approximately 9.5 ha, 18.5 ha and 4 ha in each of Basin A, B and C, respectively. The total channel length and drainage density were as follows: 1241 m/0.002 m/m²; 5220 m/0.004m/m²; and 508 m/0.0008 m/m², respectively.

In Phase I, the application described the position of the water table as "unknown but estimated to vary seasonally between two and ten feet below the surface" (Rampton, 1976). Later, the hydrogeology reports (WESA 1981; 1984) noted that the shallow groundwater flow regime was strongly influenced by gravity drainage, where water movement is towards the topographically lower areas. Generally, the flow path was determined to be from west to east. Adequate ditching along the northern boundary (Panmure Road) of Deerwood I (Basin A) appeared to provide good drainage in that area and a small swale (stream at spring runoff) which crossed the property at its midpoint appeared to facilitate drainage from west to east (Mulligan, 1976). The southern end was poorly drained marshy ground subject to some spring wetness (Mulligan, 1976). An

elongated wetland in the vicinity of the above-mentioned swale also existed and small marshes of one-half to one hectare were noted in the northwestern wooded area away from proposed building sites. Aside from the central swampy area in Basin B, this subdivision property was "very well drained" (Buchanan, 1981) and Geleta (1983) found that the runoff from the surrounding area to the west of the subdivision partly flowed through the subdivision lands. The outlet for the large wetland appeared to be the roadside ditch and WESA (1981) suggested that water from the area is derived from the shallow subsurface flow regime prior to its entering the beaver pond, with further drainage taking place as overland or near-surface flow towards the township road drainage ditch. Basin C wetlands were much smaller in area, and included a dugout on the adjacent lands.

3.2.4 Kanata

The Kanata case includes two adjacent drainage basins (Figure 3.5) with a total drainage area of 179.5 ha. The larger Basin A flows north and the smaller Basin B, along with an area of subdivision land that drains to the Second Line ditch, and a part of the large wetland to the southeast, contribute flow to the Harwood Creek. The basins were typically open in the west, with cedar and deciduous tree cover closer to the large wetland in the east. The developed land is composed of three disconnected subdivisions (77.75 ha or 43.3% of the basins).

Geology and Soils

The Nepean Sandstone formation is the dominant surficial geology, with a small area of the March and Oxford Formations in the northwest (GSC, 1979). The

Figure 3.5 Kanata pre-development basin

Soils*
 Wetlands
 Drainage ————
 Drainage basin ————
 Drainage outlet
 Subdivision lands - - - -
 Roads ————
 Contour interval 5 m

* for soil description
see table 3.5

predominant soil association is the Nepean, unit 1, dominant and Queensway unit 1 significant. The wetland area is classified as Nepean (dominant) with the organic Greely association (significant); the Dalhousie clay is present in the south. Table 3.5 presents further soil information. Where existing within the subdivision lands, the soil varied between 0.5 and 2.0 m in depth (WESA, no date), the latter occurring where clay underlies the Queensway till. The soil in this case is poorly drained, and has a high permanent water table in most places. WESA (no date) also noted the presence of thin black organic soils in this terrain due to the abundance of hydrophytic vegetation.

Hydrography and Hydrogeology

Within the drainage basin, a total of 24.6 ha (13.7%) palustrine and isolated marsh and swamp wetlands were identified. For Basin A and B, the total channel length was 4355 m and 990 m; and the drainage density was 0.003 m/m² in both cases. Within the subdivision land, the water table was found at 1 m depth in most areas, and this was reduced to 0.5 m where the land was poorly drained (WESA, no date; 1989).

In Phase I, Geleta (1983b) found that the runoff flowed from west to east, directly to the swamp located east of the subdivision. A system of drainage ditches which had been excavated in the past in the middle of the subdivision were filled with debris, trees and beaver dams, creating some water ponding most of the year. A drainage divide split Kanata II, such that one third drained to the northwest (Second Line ditch) and two thirds to the southeast. Lastly, the Terrain Report for Kanata III noted that drainage across the site was good, "though some seasonal ponding of water may be expected in some of the low lying areas" (WESA, 1989, pg.2). Surface runoff direction was to the northwest and

Table 3.5: Soils in Kanata Drainage Basins (from Schut and Wilson, 1987)

Soil Association	Parent Material	Description	Drainage	Recognized Subgroup/ Surface Texture
Surficial Bedrock N1-Q1/R2.3-S2.3 Nepean dominant (>40%)	Differentiation of parent material from weathered subsoil difficult	10-50 cm of acidic stony or flaggy fine sandy loam, sandy loam, or loamy sand undifferentiated drift material, over Paleozoic sandstone bedrock	Good	Orthic Melanic Brunisols/ Sandy loam, loam
	Queensway significant (20-40%) Paleozoic sandstone bedrock Stony glacial till (morainal) material	Acidic stony sandy loam or loamy sand glacial till material	Good	Orthic Melanic Brunisols Eluviated Melanic Brunisols/ Sandy loam or loamy sand
Large Wetland N3-GY1 Nepean dominant (>40%)	See above	See above	Poor	Orthic Humic Gleysols / See above
	Greely significant (20-40%) No parent material - derived from forest vegetation	40-160 cm of moderately to well decomposed forest peat, over loamy or sandy material and Paleozoic bedrock	Poor to very poor	Typic Humisols Typic Mesisols/ Organic
Clay D3/2 Dalhousie	Clayey marine material	Gray neutral silty clay or clay marine material	Poor	Orthic Humic Gleysols / Silty clay loam, silty clay, or clay
Rockland RK4		Exposures of Sandstone Paleozoic bedrock comprising 25% or more of area		

northeast, in the northern part of the property, and towards the east in the central part, into the ditch created by Kanata I. Both flows contribute to the same ditch which runs

north as the outlet for the delineated drainage Basin A.

3.2.5 Lakeland

In Lakeland, three drainage basins exist for a total 106 ha, based on the outflow of ditches (Figure 3.6). The development was made as a sequential land use of a mineral resource property and the two adjacent plans of subdivision (54 ha) share a single roadway.

Geology and Soils

The bedrock geology is the Oxford Formation. WESA (1987) noted that the upper layer of rock was usually weathered for a thickness of about a metre and well records show that the bedrock surface lies between 5 m and 25 m below the ground surface within 1 km radius of the site. Most of the basin is classified as the Kars soil association, poorly graded sands and gravelly sands with little or no fines. The wetland in the southwest corner is the organic soil Goulbourn association, with poor to very poor drainage. Table 3.6 presents additional information.

Hydrography and Hydrogeology

Three groundwater-fed ponds, resulting from the gravel pit operations, dominate Basins A and B. The water table was estimated to be between 1.0-2.6 m below the ground elevation. A total 18.5 ha palustrine marsh and swamp wetlands were also identified and the total channel length was 1771m, 742m and 1308 m for Basin A, B and C, with a 0.007 m/m^2 , 0.002 m/m^2 and 0.003 m/m^2 drainage density, respectively.

The treed swamp in the southwest corner is part of a larger wet area which was

Figure 3.6 Lakeland pre-development basin

- Soils*
- Wetlands
- Lakes
- Drainage
- Drainage basin
- Drainage outlet
- Subdivision lands - - - - -
- Roads
- Contour interval 5 m

* for soil description
see table 3.6

Table 3.6: Soils in Lakeland Drainage Basins (from Schut and Wilson, 1987)

Soil Association	Parent Material	Description	Drainage	Recognized Subgroup/ Surface Texture
Gravel pit K1/S2.3 Kars	Coarse sand and loamy coarse sand matrix material	Neutral to alkaline gravelly coarse sand or loamy coarse sand glacio-fluvial material containing cobbles	Excessive to good	Eluviated Melanic Brunisols/ Gravelly sandy loam or coarse sandy loam
Wetland GB1/1 Goulbourn	No parent material - Derived from forest vegetation	40-160 cm of moderately to well decomposed forest peat, over loamy or sandy mineral material	Poor to very poor	Terric Mesisols/ Organic
Wetland ML Marshland		Vegetated wetlands that remain inundated year round		

cut in two with the earlier development of Regional Road 25. The water table was at the surface in May and September. Both an open water/marsh wetland (south end) and swamp wetland (east wetland) existed in Basin B. In Lakeland I, two drainage courses existed and it was anticipated that drainage would be to a creek along the southern boundary of the site, with some drainage directly into the lakes (Buchanan, 1980 and Faintuck, 1984) (Figure 3.6). Later, the Plan found that part of the subdivision lands actually drain east and north to the Cedar Acres Municipal Drain. A smaller portion of the subdivision lands drained into Regional Road No. 25 reaching a sub-basin of the Grey's Creek Municipal Drain (Basin A). Drainage in Lakeland II was described as excellent.

3.2.6 Goulbourn

The drainage basin is approximately 56 ha (Figure 3.7). A hydro line was cut

through the middle of the basin in 1985-86. Only one plan of subdivision was built, the north end of which was developed as sequential land use of a mineral resource property, similar to the Lakeland case. In the southwest and southeast, the vegetative cover was reforested conifers and mixed deciduous trees, respectively.

Geology and Soils

The basin is underlain by the limestone Ottawa Formation. Water well records indicate that the overburden was between 9.8 m and 16.5 m in the vicinity (OMMAL, 1985). The gravel pit is classified as the Kars soil association and the Terrain Report noted that the sand became increasingly finer and loamier from west to east (OMMAL, 1985). The Reevecraig soil was mapped in the past as Muck (Dominion Department of Agriculture, no date). The small area of Manotick soil adjacent to Fallowfield Road, extends south into the provincially evaluated Stanley's Corners wetland. Table 3.7 presents further soil information.

Hydrography and Hydrogeology

Within the basin, a total 42 ha palustrine wetland was identified. On a regional scale, the wetland was located in the middle of the drainage slope to the Jock River and is a relatively large percentage (75%) of the pre-development basin. A soil map had previously identified the area as muck, as noted above. The wetland was not dependent on streamflow from higher ground and outflow was in two directions: through a ditch across the centre of the basin, draining eastward, and by the roadside ditch in the south, along Fallowfield Road. The wetland could function in groundwater recharge, and possibly support baseflow to the Flowing Creek. The total channel length and drainage

Figure 3.7 Goulbourn pre-development basin

- Soils*
- Wetlands
- Pond
- Drainage
- Drainage basin
- Drainage outlet
- Subdivision lands
- Roads
- Gravel pit
- Contour interval 5 m

* for soil description
see table 3.7

Table 3.7: Soils in Goulbourn Drainage Basin (from Schut and Wilson, 1987)

Association	Parent Material	Description	Drainage	Recognized Subgroup/ Surface Texture
Gravel Pit K1/S3.3 Kars	Coarse sand and loamy coarse sand matrix material	Neutral to alkaline gravelly coarse sand or loamy coarse sand glacio-fluvial material containing cobbles	Excessive to good drainage	Eluviated Melanic Brunisols/ Gravelly sandy loam or coarse sandy loam or sandy loam
Wetland M7/1 Manotick	Clayey marine material (North Gower, Rideau, Bearbrook soil association)	40-100 cm of acidic loamy fine sand, fine sand, or sand marine or fluvial material, over neutral to alkaline clay loam, silty clay loam, silty clay, or clay marine material	Very poor drainage	Rego Gleysols / Fine sandy loam or loamy fine sand
Wetland RE3/1 Reevecraig	Marine or fluvial material	Alkaline very fine sand, loamy very fine sand, fine sand, or loamy fine sand over finer textured loamy or clayery material at depths of 1-2 m.	Poor drainage	Orthic Humic Gleysols Rego Humic Gleysols / Very fine sandy loam or fine sandy loam

density was 2605 m and 0.004 m/m², respectively.

With respect to the subdivision lands, runoff from the property had two main exit points along the eastern boundary, a low point swale at the centre of the eastern border which drained eastward into the adjacent lands and a ditch at the southeast corner beside Regional Road 12 (Fallowfield Road). A permanent groundwater-fed pond was preserved in the north end of the development land. The water table was deemed to be difficult to predict due to the steepness of the terrain (OMMAL, 1985), although it was noted that "the groundwater appears to flow easterly in keeping with the topography" (OMMAL, 1985, pg15). Based on a pond elevation at 104.1 metres and the static level at the CBC

well (on the adjacent property to the east) at 1.5 metres, it was surmized that the water table was below the MOEE 0.6 m required depth for septic system installation.

3.2.7 Deermeadow

The drainage basin is approximately 508 ha, and is delineated to include the subdivision lands and the organic soils that straddle Grey Creek (Figure 3.8), with a mixture of agricultural and forest cover. In low-lying areas, OMMAL (1989) found that the vegetation types reflect past high water levels: immature mixed forest and mature coniferous forest dominated, below and above 98 metres in elevation, respectively. The development land includes two plans of subdivision (106 ha, or 20.8% of the basin) which are joined by the road network.

Geology and Soils

The basin is underlain by dolomite and limestone bedrock of the Oxford Formation. The general depth to bedrock is less than 10 m, and across the subdivision lands it was encountered at between 0.60 and 3.20 metres below the ground surface. Several soil associations are identified across the basin: within the development land, the higher lands in the east is Grenville, unit 4, dominant, and Ironside unit 1, significant, both with good drainage. The area that includes the Middle Castor Creek is the organic Goulbourn association, with poor to very poor drainage. A small strip adjacent to the Third Line is also Grenville. Table 3.8 presents further soil information.

Hydrography and Hydrogeology

The subdivision applications (Princiotta, 1988,1989; O'Brien, 1989) and the Terrain

Figure 3.8 Deermeadow pre-development basin

Soils*
 Wetlands
 Drainage —————
 Drainage basin —————
 Drainage outlet
 Subdivision lands - - - -
 Roads —————
 Contour interval 5 m

*for soil description
 see table 3.8

Table 3.8: Soils in Deermeadow Drainage Basin (from Schut and Wilson, 1987)

Soil Association	Parent Material	Description	Drainage	Recognized Subgroup/ Surface Texture
Upland G4-I1/S3.3 Grenville dominant (>40%)	Stony glacial till	Alkaline stony sandy loam, fine sandy loam, loam or silt loam glacial till material	Good	Eluviated Melanic Brunisols (well) Orthic Melanic Brunisols (well)/ Sandy loam, loam or silt loam
Ironside significant (20-40%)	Glacial till material	40-100 cm of neutral to acid fine sand or loamy fine sand marine material	Good	Orthic Melanic Brunisols/ Fine sandy loam, loamy fine sand, or fine sand
Wetland GB1/1 Goulbourn	No parent material - Derived from forest vegetation	40-160 cm of moderately to well decomposed forest peat, over loamy or sandy material	Poor to very poor	Terric Mesisol/ Organic
Wetland J5 Jockvale	Undifferentiated marine or fluvial material	Neutral to medium acid fine sand or loamy fine sand	Poor	Orthic Humic Gleysols/ Fine sandy loam, loamy fine sand or fine sand
Wetland H1 Huntley	No parent material - derived from forest and sedge vegetation	160 cm or more of moderately to well decomposed forest peat, over loamy or sandy material	Poor to very poor	Typic Mesisols Mesic Humisols Humic Mesisols/ Organic
M14 Milles Isle	Noncalcareous coarse sands	Acidic coarse sand marine or fluvial material	Imperfect	Gleyed Sombric Brunisols Gleyed Dystric Brunisols Loamy sand or sand

Analysis and Hydrogeological Reports (Golder Associates Limited (GAL), 1989; Oliver, Mangione, McCalla and Associates Limited (OMMAL), 1989), noted that the properties

were rolling, with drainage following the contours into Grey's Creek with some existing ditches outleting to the Grey's Creek Municipal Drain. The total channel length and drainage density was 7759 m and 0.0015 m/m², respectively.

A total 214 ha wetlands were identified as the organic and gleysolic soil associations (42% of the basin). Within the subdivision lands, the hydrogeologic report by Golder Associates Limited (GAL, 1989) noted that the western part of the site was relatively low lying and covered by a cedar swamp. The water table was from 0.11 to 0.37 metres below surface in the western fine to coarse sand, with some silt. It was noted that somewhat higher groundwater levels could exist during the spring of the year or following a lengthy period of wet weather. In the east, one pit terminated at 1.55 metres due to rapid caving of the pit walls. Groundwater inflow occurred at depths between 1.1 m and 1.43 m in the fine to medium sand with minimal silt soil. In the central, topographically higher portion of the site, no groundwater inflow was experienced with the exception of one site. The thickness of organic material identified in the OMMAL report for Deermeadow II (1989) ranged from 0.20 to 0.70 metres. No standing water was observed in June, 1989, except in the drainage ditches.

Hydrostatic equipotentials constructed from water well record information, which connect points of equal recorded piezometric head, indicated that the regional groundwater flow direction was from east to west, towards the Rideau River (OMMLA, 1989).

3.3 Respondent Profile

As mentioned previously, the survey was conducted with one (and sometimes two) members of approximately 25% of the households living in each of the six subdivision developments. However, the percent of the sample of 57 questionnaires that each case represents ranges from 7-32% because of the variable built-status figures (Table 3.9). In the analysis, all percentages are rounded up or down to the nearest full point.

Twenty-seven men (47%), twenty women (35%) and ten couples (18%) agreed to participate. Other basic data about the number of respondents for various criteria are presented in Table 3.10. With the small sample size under 25 and over 55 years of age, age group analysis focussed on respondents less than 41 and greater than 41 years old, unless responses clearly reflected the less than 25 or greater than 55 year old age groups to be distinctive. In total, 52.5% of the sample was younger than 41 years of age. For 65% of the respondents, their only experience of rural living was at their current location.

Table 3.9: Number and Percent of Respondents from each study area.

	Dunrobin	Deerwood	Kanata	Lakeland	Goulbourn	Deermeadow
Homes Built	57	76	41	21	14	13
Surveys Completed	14	18	10	7	4	4
Percent of 57 Surveys	25%	32%	18%	12%	7%	7%

Table 3.10: Questionnaire Survey Respondent Profile

	Criteria (Frequency of Response)			
Background	Less than 3 years	4-9 years	10 years or more	Over 21 years
Time in subdivision	16 (28%)	33 (58%)	8 (14%)	NA
Time in rural area	7 (12%)	24 (42%)	18 (31.5%)	8 (14%)
Age Bracket	Under 25	25-40	41-55	Over 55
	2 (3.5%)	28 (49%)	24 (42%)	3 (5%)
Education	High School	University	Graduate	Other
	10 (17.5%)	36 (63%)	11 (19%)	0

Chapter 4

Groundwater, Drainage and Wetlands: Changes and Interests

4.1 General

The changes to the groundwater and drainage regimes in the six basins and their impact on identified wetland areas were analyzed. The first section considers the effects of subdivision wells and sump pumps on the water table; second, the drainage system is examined; and lastly, the approach to the wetlands within the subdivision approval process and evidence of impacts on these ecosystems is presented. For each topic area, the analysis includes the perceptions of the residents, and describes the information provided for the subdivision approval process. The interests of the respondents in the environment are reported first.

4.2 Respondents' Motivation

In order to appreciate the location of water-related features of the environment known to the respondents, each survey participant identified surface water (channels, open water), groundwater (springs, wells) and perceived wet areas on a basemap which included lands inside and outside their subdivision development (an example of a basemap is included in Appendix II).

Selected results of this portion of the questionnaire are as follows: at the two extremes, features found only within the bounds of the subdivision lands were noted by 11

respondents while 15 others identified one or more features located on the edge or outside of the mapped area; 33 respondents identified features on their own property. Overall, 51 respondents (90%) were correct in marking wetlands that were also known to the author. Additional observations about the completed maps are provided throughout this chapter.

Although no specific questions attempted to assess the respondents' environmental awareness or commitment, a sense of these was also obtained through questions about their participation in environment-related activities; their reasons for locating in the subdivision and for choosing their particular lot; their interest in the environment; the extent to which their decisions about their property take into consideration impacts on the natural environment; their top two aspects of the environment considered when an activity on the property is undertaken; and whether or not they have thought about water related aspects of the environment left for future generations (Appendix II).

The frequency of responses to these questions are as follows: the most attended events were a clean-up day (24%), and attendance at a planning meeting or information session (20%); 18% of respondents participated in 'Other' activities not specifically listed in the questionnaire, which were mostly employment related. 9.5% of respondents had not participated in any of the choice activities, 22 % had attended two events, and 8% had attended three events. It is suggested that the respondents' past activity level is fairly low unless a specific proposal is subject to debate, such as a proposed dump in proximity to the residences.

The respondents' initial interest in their own location was most often some aspect of the natural environment (37 times, 65%), with location (32 times, 56%) and lot size (23

times, 40 %) other frequent responses. The particular interest in the natural environment was labelled as the quality of life (8%), nature (16%), water (35% - primarily from Lakeland) or more generally the country and rural setting (49%). This larger group possibly represents individuals who had a positive perception about the "package" that came with their location, but who did not have a clear view, when moving into the area, as to what that might actually include.

Most had a primary reason for choosing their lot (53 respondents), and in some cases, more than one reason was provided. Overall, aesthetic reasons (vegetation, layout) were given by 57% of this group, an economic factor (price, availability) by 43%, a note about the topography (height of their land) by 25%, and other criteria given by 26%. These responses reflect fairly pragmatic reasons for their lot selection - with one quarter reflecting on an interest to not locate in a lowland.

Almost half the respondents (47%) stated that they considered the impacts on the environment "a great deal" in their decisions about their property and another 32% said "quite a bit". Only one individual said not at all. The top two aspects of the environment considered when an activity is undertaken on their property were found to be the natural features (35%) and landscape appearance (39%), with groundwater quality and forests mentioned 25% each. 14% of respondents stated that they thought about all the features provided in the survey. Half the respondents reported a high commitment to environmental protection (35% plus 14%), with at least one third also focussing on the look of their property.

Three quarters of respondents (77%) have thought about water related aspects of

the environment left for future generations. The primary interest of this group is related to surface water (48% of these respondents), groundwater quality for consumption (34%) and with a view to preserve or improve the water (34%). These responses show a substantial interest in the future environment that will exist.

In the analysis that follows in Sections 4.3-4.5, responses to the three survey issues of groundwater, drainage and wetlands are related to the responses outlined above. It becomes apparent that three groups of residents can be identified: those with a long standing interest in the environment; a somewhat larger group who have developed their interest in the environment over time; and a third group that has a somewhat reduced interest in water related aspects of the environment in which they reside.

4.3 Groundwater

4.3.1 General

Hydrogeologic investigations for each subdivision application focussed on whether or not adequate groundwater quantity and quality could be found to supply private wells. In early applications, consultants made this determination based on a review of the Water Well Records in proximity to the development site, which are available from the Ontario Ministry of the Environment. Typically, these Records include a log of the overburden and bedrock materials, the depth and kind of water found, the casing and open hole specifications, and results of a 2-hour pump test completed by the driller. More recently, this information is augmented by aquifer pump tests such as those performed in four of the most recently approved subdivisions.

With respect to the topic in general, all respondents recognized that they all rely on groundwater, but only four also mentioned the natural environment as a groundwater user. Seventy-five percent felt that the groundwater resource was shared, mostly with respect to the subdivision wells all tapping the same water source (mentioned in terms of a vein or pool). When asked what they thought might affect the quantity of groundwater generally, 35% of respondents noted precipitation, 22% suggested the number of users, and 11% noted human-related land use. Furthermore, 61% felt precipitation was the most important factor that affects groundwater quantity and 16% did not know what the most important factor might be. For the most part, this group suggested that not enough was known about the environment to make this sort of determination.

4.3.2 Potential Effects

A survey of the well drilling records for the subdivisions (GAL, 1989, 1991; Novaplan Group, no date; OMMAL, 1984, 1985, 1989; Rampton, 1976; WESA, no date (a), no date (b), 1981, 1984a, 1984b, 1984c, 1987, 1989) and questionnaire responses found that all but one domestic water well, for all the subdivisions, are drilled into the underlying bedrock (Table 4.1). One, in Dunrobin, was completed in the overburden. The dominant water-bearing zones in bedrock occur in fractured intervals between partial confining layers (Allen, personal communication).

The static water level recorded on drillers' records is not necessarily an indication of the location of the water table, as suggested in some hydrogeologic reports; rather, it is a measure of the aquifer's potentiometric head. As the depth of a

Table 4.1: Depths of Overburden and Drilled Wells

Subdivision	Depth to Bedrock ¹	Respondent's Well Depths
Dunrobin	Exposed at surface; 12 m in clay plain	3 @ 6-30 m - 1 in clay 6 @ 31-65 m 5 @ over 65 m
Kanata	Exposed at surface	7 @ 6 - 30 m 3 @ 31 - 65 m
Deerwood	Exposed at surface	2 @ 6-30 m 11 @ 31-65 m 4 @ over 65 m 1 no response
Lakeland	5 m - 25 m	4 @ 6-30 m 3 @ 31-65 m
Goulbourn	9.8 m - 16.5 m	3 @ 31-65 m 1 @ over 65 m
Deermeadow	< 10 m	1 @ 6-30 m 2 @ 31-65 m 1 @ over 65 m

Notes ¹: From GAL (1989, 1991); Novaplan Group (no date); OMMAL (1984, 1985, 1989); Rampton (1976); WESA (no date (a), no date (b), 1981, 1984a, 1984b, 1984c, 1987, 1989)

well increases, the static head will vary depending on the hydraulic head present within the aquifer. Pumping, unless from an unconfined aquifer, will have little to no effect on the water table unless surface leakage takes place which contributes a water supply to the deep drilled well.

A pump test in Goulbourn was conducted by OMMAL (1985b). It was confirmed that the pond was self-replenishing and would therefore maintain a constant surface elevation throughout the year. In order to ensure that the pond would not be affected by local wells, OMMAL recommended in their report (1985b) that they be placed somewhat below the 104 metre geodetic elevation (which is not very helpful, as the ground elevation is approximately the same). Aquifer pump tests were completed in just four subdivisions. In these cases, the data analysis pointed to a boundary condition, where a constant source

of water is available to the well after a certain period of pumping, in four of five tests in Kanata II and III, and in three of five pump tests in Deermeadow (Table 4.2). In these circumstances, the possibility that the wetlands were the source of recharge was considered further. Allen (personal communication) noted that the change in the slope observed on a semi-log plot of drawdown measured during pump tests versus time does not necessarily reflect surface leakage (Figure 4.1) and that these aquifer test results display a behaviour consistent with confined conditions in which fault boundaries are present. Indeed, one fault line mapped by the Ontario Geological Survey (Williams et.al., 1984) runs through the Kanata subdivision lands and another is within 1000 m to the east of it; in Deermeadow, the generalized line of the Hazeldean fault is approximately 6000 m to the north (GSC, 1979) and it may be that associated fractures extend further south. Unfortunately, this information was not available from existing maps.

Table 4.2: Evidence of Boundary Condition, Kanata and Deermeadow (Adapted from Golder (1989, 1991) and WESA (1989))

Characteristic	Kanata Phase II ¹	Kanata Phase III ²			Deermeadow Phase I	Deermeadow Phase II	
	Test Well 2	Test Well 1	Test Well 2	Test Well 3	Test Well 2	Test Well 1	Test Well 2
Static Level (in metres below ground level)	2.3 m	3.58	2.37	3.75	7.44	3.3 m	7.7 m
Maximum Drawdown (m)	7.98	5.86	4.76	1.42	11.37	7.2 m	11.2 m
Approximate Time to Recharge Boundary	30 minutes	30 minutes	8 minutes	NA ³	40 minutes	20 minutes	60 minutes

Notes: ¹ Golder (1991); ² WESA (1989); ³ Statement in text only; time not clearly discernible from pump test plot; ⁴ Golder (1989).

DRAWDOWN DATA TEST WELL TW-2

FIGURE 4.1

Arrow indicates approximate point of change in slope.

Another reason why domestic wells are unlikely to affect the water table is that they are not typically pumped at the relatively high rates and long durations of aquifer pump tests. These wells are drilled to a depth where well yield is sufficient to meet the domestic requirement (approximately 5 imperial gallons per minute). In most cases, the well yield was estimated to be much more than that (GAL, 1989, 1991; Novaplan Group, no date; OMMAL, 1984, 1985, 1989; Rampton, 1976; WESA, no date (a), no date (b), 1981, 1984a, 1984b, 1984c, 1987, 1989) and lengthy pumping might only occur when residents fill their swimming pools from their drilled well. A total of 22 pools exist across all sites.

Fully 88% of respondents had either a very good or excellent overall level of confidence in their wellwater quantity. With respect to their own activities, the respondents were split on their perception of whether or not their activities in the home and on their property had an effect on groundwater quantity: one couple felt they had no impact, 26 respondents thought they had a negligible impact and the rest (52%) thought they did have an impact, most (80%) naming usage as their effect. This perception was related to the respondent's "environmental awareness". Of those who perceived a personal effect, 76% had also thought about water-related aspects of the environment left for future generations. On the flip side, many of those who felt they had a negligible effect on groundwater (23%) had not thought about water for future generations.

With respect to surface leakage from wetlands to the well water supply, it is concluded that the wetland ecosystems are not connected hydrogeologically to the aquifers that supply the drilled wells and they would therefore not be affected measurably

by the number of wells drilled in the estate lot subdivisions. The wetlands may, however, be dependent on groundwater inflow at the local and shallow scale that may be affected by development activities through reduced surface water infiltration, which ultimately leads to a lower water table. Where respondents identified the infiltration capacity or natural environment as affecting groundwater quantity generally (26%) (with no respondent having lived in the rural area less than 3 years) the prevalent reasons (60%) provided were changes in the water holding capacity of a wetland and changes in drainage. With respect to the sample, 85% of respondents who identified the natural environment as having an effect on water quantity had lived in the rural area over 10 years. At the personal level, only two of the 30 respondents who thought they had an impact on groundwater quantity attributed this to a changing environment due to development. One such activity is the requirement for a sump pump in a home (Nuttall, personal communication).

Sump pumps located in the basement of houses will affect the shallow groundwater flow regime because they extract shallow groundwater from around the foundation and discharge it into the subdivision ditches to be carried away as surface flow. Fully 79% of respondents indicated that they have a sump pump, 20% of which were reported to never turn on. Only residences in Deerwood, Kanata and Dunrobin, three subdivisions with surficial bedrock environments and the potential for homeowners to build on grade rather than blast a hole for their basement, did not have sump pumps. Some respondents mentioned that their neighbours had up to three or four sump pumps discharging to the ditch. Where sump pumps are operating, their operation is not limited to the spring runoff season in 60% of the cases: 15% run very frequently, 7% after any

rain event, and 19% after a heavy rain.

Complete details about the drainage systems in the study basins are discussed next.

4.4 Drainage Systems

All plans of subdivision require a lot and road drainage plan prior to their final approval, variously labelled a Drainage Plan, Grade and Drainage Plan and Stormwater Design Plan since 1975, and hereinafter referred to as the "Plan". The Plan typically outlines the drainage system specifications for the development proposal, including plans for roadside ditches and drainage easements required to move internal flows away from the subdivision lands. Some had relatively minor site development, with only minor disruption to the existing drainage pattern (Dunrobin); on the other hand, Deermeadow was developed simultaneously with major "improvements" to the Grey's Creek Municipal Drain and a 50% modification to the hydraulic conditions (van Gaal, 1991; Buchanan, 1992).

The purpose of this section is to: provide background about drainage system specifications; outline the interest of the various agencies in reviewing the Plan; and for each case study, describe the site specific objectives of the Plan and the works completed. The respondent's perceptions about drainage and examples of their activities is also discussed.

4.4.1 Methodology Used to Calculate Drainage System Specifications

In all cases, the objective of the drainage system specifications was to channel and

concentrate the surface runoff in a system of excavated ditches and swales that are large enough to handle a calculated storm flow event. Runoff upgradient from proposed roadways is collected in roadside ditches, passing under the road in designed culverts where required, and draining away from the internal subdivision lands through an outlet ditch that joins into existing ditches outside the subdivision lands. The potential point flow and the required ditch and culvert sizes at various locations within the drainage system were calculated in all cases by the Rational Method (Appendix IV), based on area (internal and external lands), a runoff coefficient (based on the slope of the land, vegetation and permeability of the ground) and the rainfall intensity (based on historical records). Values for the first two of these inputs are detailed below. In Goulbourn, OMMAL (1985) also used the computer based OTTHYMO model, and compared the results with those calculated by the Rational Method for 1 in 5 year and 1 in 100 year storm flows.

Area calculations (internal and external lands)

Area calculations for both internal and external lands to be drained by the subdivision ditches are of interest because the total area potentially affected by subdivision works may be larger than the subdivision property. Table 4.3 presents these figures as listed in the Plan, as well as the External Area as a Percent of the Total Plan Area and the percent Built-up Area of the drainage basin as a whole (from Table 3.2). As the cases are discussed individually, it becomes apparent that the extended effects of a rural development may be quite large and a relatively small percent built-up area does not necessarily equate to a relatively small impact on the drainage basin as a whole. In

Deerwood III, Kanata I, Goulbourn and both phases of Deermeadow, for example, one or more perimeter ditches were excavated to divert surface runoff from its pre-development direction. When the ditch is upgradient, such as in the first three cases, flow no longer enters the subdivision lands; when the ditch is downgradient, in Kanata I, Goulbourn and Lakeland (to a lesser extent), flows are pulled within the subdivision boundary and do not cross into an adjacent property. In Deermeadow, where the land was especially wet, perimeter ditches were used to assist with lowering the water table.

Table 4.3: Drainage Area Used in Rational Method Calculations

Case Study	Internal Area (ha)	External Area (ha)	Total Area (ha)	External Area as a Percent of Total Area	Percent Built-up Area
Dunrobin I ¹	31	58.4	89	65%	58%
Dunrobin II ²	21.7	58.4	80.1	73%	
Deerwood I ³	9.6	42.6	52.2	82%	37.6%
Deerwood II ⁴	30.4	10	40.4	25%	35%
Deerwood III ⁵	35.7	15	50.7	30%	
Kanata I ⁶	41.72	Not Available	Not Available	Not Available	28.5%
Kanata II ⁷	5.8	0 ¹²	5.8	0%	28.8%
Kanata III ⁸	25.5	4.5	30	15%	17.4%
Lakeland I	Not Available	Not Available	Not Available	Not Available	82.4%
Lakeland II	Not Available	Not Available	Not Available	Not Available	13%
Goulbourn ⁹	30.7	0 ¹³	30.7	0%	53%
Deermeadow I ¹⁰	44	330	374	88%	8.7%
Deermeadow II ¹¹	61.7	441	503	88%	12%

Notes: ¹ Anon (1980); ² Geleta (1985); ³ Geleta (1978); ⁴ Geleta (1983c); ⁵ Geleta (1986); ⁶ Geleta (1983b); ⁷ Connelly (1988); ⁸ Connelly (1990); ⁹ OMMAL (1985); ¹⁰ van Gaal (1991); ¹¹ Buchanan, 1992.

¹² Flow previously diverted into Kanata I ditch; ¹³ High point.

Runoff coefficients

Runoff coefficients varied, depending on the vegetation and soils of the subdivision lands. These figures were not provided in the Plan for Deermeadow I, Lakeland I and Goulbourn, but in all other cases, they were balanced within the Rational Method equations to reflect the percentage land that would be pervious and impervious after development. Table 4.4 lists the range of coefficients used, where the higher the value, the more impervious is the condition and the greater the potential for storm flow runoff. These figures and the percent area indicate how conservatively the point flow is calculated for a given storm event; that is, the engineer would prefer to err by calculating a larger runoff than might actually occur during a storm event so that the ditches and culverts are sure to be large enough for actual runoff events.

The potential flow to be carried by the ditch and culvert system was also estimated (and provided in the Drainage Report, in some cases) on a volume basis, from as little as 25.1 L/s at the north intersection in Lakeland, to as much as 4,111 L/sec for the Grey's Creek in Deermeadow, where the contributing area is approximately 457 ha (differing from the area recorded in Table 4.3 because the latter is the total for the Deermeadow Phase II Subdivision which has sub-basins other than the Grey's Creek). The total design outflow into the wetland in Kanata I discussed below was not provided.

In all the subdivisions, the prescribed drainage plan and ditch sizing prescribed therein appears to have been adequate, to date, to carry the estimated flows away from the subdivision lands. All the respondents indicated that the subdivision ditches had not flooded onto the roadway or lawn, except in a few isolated instances of ice build-up

Table 4.4: Runoff coefficients used in Rational Method Calculations, all subdivisions

Subdivision	Impervious		Pervious	
	Runoff coefficient	ha or percent area, as provided ¹	Runoff coefficient	Percent area
Dunrobin I ²	Not used	Not used	C=0.20	43.7 ha
Dunrobin II	C=0.95	1.24 ha	C=0.20 Grass	107.1 ha
Deerwood I	C=0.5 Gravel road	2.59 ha	C=0.12 Predominantly forest, sandy, silty till, flat	52.2 ha
Deerwood II	C=0.9	0.99 ha	C=0.12 Predominantly forest, sandy, flat	92 ha
Deerwood III	C=0.4	14.22 ha (road and portion of lot draining to road)	C=0.25	53.877 ha
Kanata I	NA	NA	C=0.30	NA
Kanata II	C=1.0	12%	C=0.25	88%
Kanata III	C=1.0 Asphalt surfaces, roofs	7.5%	C=0.30 Rolling woodland on silt loam soil	92.5%
Lakeland I	NA	NA	NA	NA
Lakeland II	NA	NA	NA	NA
Goulbourn	NA	10%	NA Grass	90%
Deermeadow I ³	C=0.9	20%	For proposed 0.4 ha lots, C=0.15	80%
Deermeadow II	C=0.9	5%	For proposed 2 ha lots, C=0.10 Pasture	95%

Notes ¹ - From Anon, 1980, 1985, 1990; Buchanan, 1992; Geleta, 1978, 1983a, 1983b, 1985, 1986; OMMAL, 1985; Connelly, 1988, 1990; van Gaal, 1991).

² - may be composite runoff coefficient, for both pervious and impervious lands.

³ - it was proposed that surplus sand material from the higher areas would be used to fill the Goulbourn Organic soil, thus making the entire site a Grenville Sand.

during spring runoff.

Outlet Ditch

As mentioned above, the Plan must identify an outlet for the flows downstream of the subdivision lands. Some drainage reports simply mentioned the name or location of the outlet ditch and others detailed whether the outlet could accommodate increased flows. In some cases, works were undertaken on the outlet ditch, as discussed in each case. The knowledge and perception of the residents with respect to where the ditch water exits from their subdivision varied. Out of all the responses provided (85), 15% reflected knowledge about what was planned within subdivision lands; 25% noted planning within and outside the subdivision lands; 36% indicated a general direction for the outlet, without reference to specific drainage works; 11% remarked that ditch water seeped into the ground; and 8% mentioned a link with a municipal drain. 2% did not know where the ditch water exits and 2% had other views.

4.4.2 Agency review

Having explained the components of the Drainage Plan, the next section summarizes the interests of the Plan Input and Review Agencies in its evaluation and approval. Excerpts from the text of the registered subdivision agreements are provided in Appendix V in order to give a sense of how these requirements are included in the legal document.

With respect to the provincial ministries, the Ontario Ministry of Environment (and Energy, as currently named) reviewed all the Plans of Subdivision with respect to their

interest in the site's capability to support private services. A 1 metre (three foot) separation between the septic tile field and the water table is required. In Deerwood I, for instance, the field inspection report (Mulligan, 1976), led to a recommendation that drainage patterns be established throughout the proposed subdivision to "facilitate sufficient runoff relief and to maintain ground water tables at present levels or less". In Lakeland and Goulbourn, the MOE interest in surface water quality resulted in the requirement that storm water be directed away from the groundwater-sourced ponds to ensure little or no effect; rear lot drainage of the properties is, however, directly into the water bodies.

The Ontario Ministry of Natural Resources reviewed the drainage plans with respect to establishing zero increase in runoff relative to the rates of runoff on the undeveloped site. Where ponds or creeks were present, such as Dunrobin, Lakeland and Deermeadow, they suggested that no habitable dwellings or sewage disposal should be located within 30 metres of the shoreline. Since 1983, the applicable Conservation Authority also reviews the Plan because of their mandate in flood protection and their regulations with respect to fill, construction and alteration to waterways.

A limited number of regional and lower-tier municipal agencies also reviewed the Plans. The RMOC Transportation Department need to establish whether or not the subdivision abuts a regional road, as is the case in Goulbourn and Lakeland, where, in Lakeland, they required that the internal ditching be graded away from the Regional Road. The RMOC Planning Department also reviewed the Plan in just one subdivision (Kanata II) where there was concern for potential adverse effects on the environment from storm

water runoff. The Township of Goulbourn and the City of Kanata were the only lower tier municipalities to get involved, based on their explicit requirement for storage of storm flow prior to its exiting the subdivision lands. In Kanata III, the Plan was also relevant to the approval of Country Estate Lot development in the March Rural Community, ultimately considered a non-standard condition of Draft Plan Approval by the RMOC Planning Department.

4.4.3 Drainage Activity

The pre-development drainage network and site specific drainage objectives and works varied among subdivisions and are described on a case by case basis in the same order as the site descriptions (Chapter 3). The reader is referred again to Figures 3.1, 3.3, and 3.5-3.8 which illustrate the pre-development hydrography. Figures 4.2- 4.7 depict the post-development basin. Activity that occurred in every case is described first and a summary concludes the section. In order to get a sense of the cost of these works, Appendix VI gives these cost estimates and the total development cost for each plan of subdivision, as provided in the registered agreement.

As alluded to, general runoff direction was maintained in all cases, but the flow was concentrated and sometimes diverted within the subdivision lands. Existing drainage networks were used in the early applications (Dunrobin I, II; Deerwood I, II) and modified into a "drainage easement" or ditch. In other cases, interior and perimeter ditches and drainage swales (a wider and shallower channel compared with a ditch) were developed. Ditches run alongside all subdivision roadways to drain the runoff from the

impervious surface and the lands between the house and the road. Typically, the ditches have a 3:1 side slope and a minimum horizontal slope of 0.46 percent. In Deermeadow, however, the width of the bottom of Grey's Creek is 1 m, with a 1.5:1 sideslope, except in peat where the width is 2.0 m, with vertical sideslopes. In rock, such as in Kanata III, the bottom cut is 0.3 metres.

4.4.3.1 Dunrobin

In Dunrobin I and II, it was proposed that the general drainage direction of west to east be maintained in the natural stage with some alterations of depth and direction of flow in existing ditches (Figure 4.2). Hobby (1978) suggested that lot and road drainage was essential throughout the western section and central sections of the site to eliminate many small poorly drained pockets in the thick clay terrain unit. Water that ponded temporarily in isolated areas during spring snowmelt, such as along the east boundary of the property near its mid-point, was drained during road construction. Both Plans included cleaning of the creeks and ditches inside the subdivision from all debris and obstructions, and lot owners were to keep the ditches clean in the future.

4.4.3.2 Deerwood

In Deerwood I, aside from the above-mentioned roadside ditches and culvert under the roadway, only work on the outlet ditch to the south of the property was prescribed in the Plan (Figure 4.3). Approximately 183 m (600 feet) of existing ditch was regraded and

Figure 4.2 Dunrobin post-development basin

- Wetlands
- Drainage
- Drainage basin
- Drainage outlet
- Subdivision lands
- Roads

Figure 4.3 Deerwood post-development basin

- Wetlands
- Drainage
- Drainage basin
- Drainage outlet
- Subdivision lands
- Roads

cleaned from the east boundary of the subdivision to the road. In Deerwood II, the drainage divide changed with the development of the road because the overland flow that once reached the large wetland was thereby diverted to the east. Furthermore, an outlet for the wetland was created. In Deerwood III, post-development runoff was channelled and directed towards two existing watercourses in the east end of the subdivision land and a side and rear drainage easement along the western edges direct the flow from the outside contributing area (15 ha, Table 4.2) to the existing outlet in the northeast corner. This appears to have resulted in redirecting the flow that formerly crossed subdivision lands, as mentioned previously, with the ultimate effect of increasing the surface inflow to the dugout in the corner of the adjacent property, an area that 5 of the 18 respondents in Deerwood now consider a local wetland.

Residences in Basins C and D were assessed as benefitting from the works on the Jack Shaw Municipal Drain undertaken in 1991, located north and east of the subdivision lands.

4.4.3.3 Kanata

In Kanata I, the western half of the subdivision lands drain northwesterly in a series of excavated ditches that ultimately lead into the previously existing swamp (Figure 4.4). Indeed, this wetland was used explicitly as the drainage outlet. In Kanata II, the first application proposed that roadside drainage east of the divide near the Concession Road join the drainage system of Phase I which was still being approved. When the two Phases were not joined by a common road, the next proposed outlet was from the property line,

Figure 4.4 Kanata post-development basin

- Wetlands
- Drainage
- Drainage basin
- Drainage outlet
- Subdivision lands
- Roads

"through neighbouring lands to an existing swamp (i.e. the same swamp that provides an outlet for Stonegate Subdivision (Kanata I))" (Connelly, 1988, p.2). This did not occur either because a drainage easement was not obtained. Instead, the outlet ditch is to the southeast directly to Harwood Creek, thereby creating a different Sub-basin B compared with Figure 3.5. A swale was created in the outlet ditch to reduce the potential impacts of the storm flow downstream.

The internal drainage in Kanata III was made to run into the roadside ditches and flow to an outlet swale at the northern corner of the site; it was surmised that the flow that entered the perimeter ditch for Kanata I would thereby be reduced (Connelly, 1990). It was also noted that "flow problems occasionally arise in the existing ditches due to beaver activity" and Connelly (1990) recommended that these ditches be cleared of any existing beaver dams from the subdivision up to Murphy Side Road (the outlet of the delineated Basin A), a distance of approximately 900 m. Lastly, bedrock was shattered to provide positive drainage for water in the subgrade because it was found that "along some stretches, test pitting indicated that there may be pockets [of air] in the bedrock [which] could potentially cause accumulation of water in the subgrade and result in frost heaving" (Connelly, 1990:3).

The Harwood Creek sub-basin was also part of a Water Management Study done for the Mississippi Valley Conservation Authority in 1989 because of a concern that individual drainage reports and neighbourhood draft plans of subdivision were not sufficient for solving drainage related problems that have both upstream and downstream repercussions" (AJR, 1989). At the time of the study, the basin was said to be in an

"undeveloped state" and it was suggested that under future land use (estate lot) conditions, there would be a small increase in peak flow but no increase in the volume of runoff.

4.4.3.4 Lakeland

The northern lands of Phase I and all of Phase II were drained into the Cedar Acres Municipal Drain (Basin C, Figure 4.5), where an existing offtake ditch was accommodated to drain the central part of the subdivision and a section of the drain was relocated along a fenceline. Most of the properties drain into Basin A, ultimately a sub-basin of the Grey's Creek. The RMOC Transportation Department required that the easterly ditchline of Regional Road 25 which abutted the subdivision lands be cleaned and regraded on a 0.28 percent grade from the southerly intersection with Lakeshore Drive for a distance of 350 m. The rear of all lots drain into the ponds.

4.4.3.5 Goulbourn

In this case, the stated purpose of the drainage analysis was to review the storage volume requirements for the proposed stormwater management pond (to be created in the southeast corner) that would restrict post-development flows to pre-development levels. Storage volume was also achieved through the available east boundary drainage ditch (Figure 4.6). The construction of this perimeter ditch resulted in the closure of the central outlet of the flows from the pre-development lands into the adjacent lands, instead now re-directed south to the detention pond. In their report, OMMAL (1985) suggested that the

Figure 4.5 Lakeland post-development basin 77

- Wetlands
- Lake
- Drainage
- Drainage basin
- Drainage outlet
- Subdivision lands
- Roads

Figure 4.6 Goulbourn post-development basin 78

- Wetlands
- Pond
- Drainage
- Drainage basin
- Subdivision lands
- Roads
- Hydro corridor

sandy and porous soils in the area would not retain water the majority of the time. This area, however, was not part of the terrain analysis study and so the true nature of the soils may have been mis-represented. Furthermore, respondents in Goulbourn noted that ponding is occurring at the newly created right angle in the drainage system.

In June, 1993, maintenance on the Faulkner Municipal Drain was completed, which included sediment removal on the Seabrooke and CBC Branches, to which the delineated basin outlets in the southeast corner.

4.4.3.6 Deermeadow

The most intensive drainage works occurred in Deermeadow. As early as 1989, the Township of Osgoode Subdivision Committee Report to Council (Robinson, 1989), found that the Grey's Creek Municipal Drain would probably have to be relocated within the subdivision lands, and that this would be determined when the Engineer's Report on the Grey's Creek was complete. Ultimately, the Connelly Report (Connelly, 1990) did recommend a realignment of the Main Drain through the O'Brien (Deermeadow II) property to provide the appropriate alignment for the future subdivision. This drain was improved in 1990 from its headwaters at Manotick Station south to its crossing at Highway 31 (approximately 13 km south and east of Deermeadow II). Indeed, the site for Deermeadow I was one of two areas mentioned specifically as requiring drainage. Connelly (1990:3) noted under the heading "Development Potential" that the "clean-out of the Main Drain would allow the collected water in the drain to flow freely to final outlet ... thus allowing farmers earlier access to the fields...". This is in contrast to the description

of the upper reaches of the drainage basin provided in the same document, namely the land was predominantly poorly drained bush, with sparsely farmed areas and country estate lots.

Flows were found to be restricted in the vicinity of Deermeadow I because of insufficient capacity of the drain; intermittent flows were found in areas of beaver activity and sediment buildup. Approximately 0.5 - 1.5 m of hardpan was removed to deepen the creek through the subdivision lands and the drain was lined with a 50 mm clear stone bedding through Deermeadow I and II to both stabilize the bottom of the drain and reduce the maintenance in the area. The cost of the realignment, clear stone and topsoil, seed and mulch, minus the cost of a cleanout, was assessed to Messrs. Princiotta and O'Brien (the applicants for Deermeadow I and II), as follows: Princiotta Ditch Lining \$3,500.; O'Brien Ditch Lining \$6,500.; O'Brien Realignment \$11,000; for a total \$21,000. As prescribed in the Ontario Drainage Act (OMAF, 1980), damages paid to land owners to compensate for the disposal of material removed as a result of the drainage works were assessed for portions of these two properties, for a total \$670; as well agricultural land grants were paid by the Province for one-third the total cost of the assessed benefit, for a total \$12,868.59. In these ways, the special assessment noted above for the same (subdivision) properties was offset by more than 60%, but for which agricultural land use was not to occur.

With respect to the drainage plans for the subdivision lands, (Figure 4.7) Golder (GAL, 1989:19) found that it was important for the site grading design to incorporate a surface water drainage system which will lower the water table and control storm

Figure 4.7 Deermeadow post-development basin

- Changing wetlands
- Drainage
- Drainage basin
- Drainage outlet
- Subdivision lands
- Roads

water/spring thaw runoff ... and that this was essential in the wetland area to the west, prior to development. A system of roadside and possibly perimeter ditching, extending down to/near the bedrock surface, was thought to be effective in this regard. Van Gaal (1991) also suggested that the deepening and relocation of the existing Grey's Creek Municipal Drain would result in a deeper, more efficient outlet for the entire watershed runoff. The works realigned drainage courses along proposed lot lines based on a preference for rear lot location, considered desirable because 1) excessively deep roadside ditches were avoided, therefore providing greater safety; 2) excessively large driveway culverts were avoided, thus a cost savings; and 3) they were aesthetically more pleasing (van Gaal, 1991).

When the application was made for Deermeadow II in June, 1989, the existing drainage network for Phase I was found to be effective and no standing surface water was observed on the site. Activity to relocate the drainage network was noted to form part of a routine drainage plan (whether this was with respect to the Municipal Drain or Phase I works is unclear) and it was specifically noted that this would not adversely affect the design and location of any proposed septic tank systems (Maybury, 1989). The drainage report for Deermeadow II also included recommendations on subdrainage and erosion protection requirements in swales judged susceptible to nuisance ponding problems (i.e. because of minimum grades or high water table areas).

4.4.4 Respondent views

Having described the objectives of the drainage plans and their results in each case

study, this section highlights the perspective of the residents towards drainage systems. A total of 98 responses were given for the perceived positive aspects of a drainage ditch: 52% of the responses were related to their role in reducing flooding, draining the land, water accumulation and more rapid dissipation of surface water generally; 40% of respondents mentioned their role in decreasing the amount of water in a basement or around a property; 14% thought of a ditch positively with respect to being a site for wildlife, with all such responses coming from residents in Dunrobin, Deerwood and Kanata. Selected negative perceptions about drainage ditches were that they disturb wildlife and wetlands (19%), all such respondents having stated that they had located in the subdivision because of some aspect of the natural environment; the resulting change in plant growth (8%), none of whom also mentioned the ditch as a site for wildlife; and other negative concerns (29%), such as the difficulty in maintaining the ditch by the homeowner, or the lack of maintenance by the municipality. 15 respondents did not mention any negative aspect of ditches, a large majority of which (13) were from just two subdivisions, Deerwood and Kanata. 40% of these respondents did not mention some aspect of the natural environment as a reason for locating in the subdivision and 47% had chosen their lot for primarily economic reasons.

At the homeowner level, over half the respondents (56%) stated that they had changed the way precipitation runs off their own property (with some mentioning more than one activity). 60% of the work was completed by those who had lived in the subdivisions between 4-9 years and another 30% by those in the subdivision over 10 years, suggesting that changes are made after the home and the residents are "settled". 10

respondents (17%) reported that they had put in a ditch or drain pipe on their property, the result of which has been decreased flooding and improved flow 85% of the time. Only residents in Dunrobin, Deerwood and Kanata had undertaken this activity and 50% (5 respondents) had chosen their lot for primarily economic reasons, suggesting that the less expensive lots are wetter and necessitate subsequent drainage activities by the landowner.

Another group of respondents (23) recognized that they had changed the way precipitation runs off their property by the use of fill (67%) or by a change in slope (33%). As mentioned above, the building site (house) typically sits at a higher elevation than the surrounding land, which slopes down and away on all sides. 65% of respondents who recognized the fill/slope change were under 40 years old, although this age group represent only 52% of the sample. Some stated how much fill was brought in -- whether it be 100 truck loads, or \$10,000 worth. Other ways in which changes were made to runoff include eavestroughing (7 respondents).

4.4.5 Summary and Conclusions

Several observations and conclusions can be made about the objectives of the Drainage Plan generally and the results of its manifestation in each case study. The variety of works undertaken are classified into six categories: 1) interior ditches and swales, 2) perimeter works, 3) cleaning and regrading of existing outlets, 4) use of wetlands, 5) major works, and 6) other considerations. Table 4.5 is a summary of where these took place.

In all cases, general runoff direction was maintained, but the roadways created new

Table 4.5: Summary of drainage works undertaken, all subdivisions

Subdivision	Ditches/ Swales	Perimeter Ditches	Cleaning/ Regrading Outlet	Use of wetlands	Major works	Other considerations
Dunrobin I	✓		✓			
Dunrobin II	✓		✓			
Deerwood I	✓/✓		✓			✓
Deerwood II	✓/✓					✓
Deerwood III	✓/✓	✓				
Kanata I	✓/✓	✓		✓		
Kanata II	✓/✓					
Kanata III	✓/✓		✓			✓
Lakeland I	✓		✓			
Lakeland II	✓					
Goulbourn	✓/✓	✓				
Deermeadow I	✓	✓	✓		✓	
Deermeadow II	✓	✓	✓		✓	

drainage divides, and the ditches increased the total channel length and the drainage density in the watershed, that is, the length of channel that is available to drain the entire basin, by as much as 775% (taking into consideration the change in basin area in some cases) (Table 4.6). Prior to discussing the subdivision ditches explicitly, a seemingly low 54% of respondents had identified them as a water-related aspect of the environment on the base map. In order to get a sense of the flows being experienced, the questionnaire survey included questions about the timing and amount of water seen by the respondents in these ditches: 53 respondents (93%) had noticed water in the subdivision ditches since they moved in (half of those who had not were from the newest subdivision, Deermeadow). In 9 cases (16%), the least rain that would result in water flowing in the

ditch was identified as "moderate rain, less than a half-day long". A "daylong rainstorm" or a "thunderstorm" was thought to cause water flowing in 40% of the cases. Five respondents (9%) suggested that there was always water flowing in the ditch and these people live near the outlets in Deerwood I, Deerwood III; Kanata I; and the western end of Dunrobin.

The measure of drainage density is an independent (permanent) variable in the hydrologic cycle that dictates the probable dominance of either surface or ground water runoff: a high drainage density removes the surface water faster, decreases the lag time and increases the mean annual flood level of the drainage course. Although the new

Table 4.6: Change in Total Channel Length and Drainage Density, all basins

Case	Post Drainage Area (ha)	Total Channel Length (m)			Drainage Density TCL/DA (m/m ²)		
		Pre	Post	Change	Pre	Post	Change
Dunrobin	A: 131.5	6095	12249	101%	0.0046	0.009	96%
	B: 13	1040	1720	65.4%	0.008	0.013	62.5%
Deerwood	A: 73	1241	3949	218%	0.002	0.0054	170%
	B: 112.5	5220	7054	35%	0.004	0.006	50%
	C: 71	508	4750	835%	0.0008	0.007	775%
	D: 24.5	NA	2880	NA	NA	0.012	NA
Kanata	A: 146.5	4355	10020	130	0.003	0.007	133
	B: 10	990	1475	49%	0.003	0.015	400%
Lakeland	A: 39.5	1771	3285	85.5%	0.007	0.008	14%
	B: 42	742	964	30%	0.002	0.002	0%
	C: 44	1308	3049.5	133%	0.003	0.007	133%
Goulbourn	56	2605	5879	126%	0.004	0.01	150%
Deermeadow	508	7759	28895	272%	0.0015	0.0057	280%

values are relatively low compared with twenty-eight other Ontario drainage basins, which ranged from 0.004 to 3.98 m/m², with an average 0.95 m/m² (Collier, 1982), the effect of increasing density is nevertheless a faster removal of surface water and a relative decrease in the percentage of water that contributes to subsurface groundwater flows. Increasing the drainage density therefore reduces the potential for precipitation to infiltrate and contribute to the shallow groundwater baseflow a wetland may require. Indeed, channelling runoff for this purpose is a stated objective of a drainage system, as represented by Geleta (1983b:2) for Kanata I:

"(The) proposed system of drainage swales and ditches have 2 purposes. One is to drain surface run-off from the subdivision and second is to keep water level for underground water [sic] down so all the lots could be used as designed".

The extent to which a drainage ditch can lower groundwater levels, in terms of both area and depth, can be determined as presented by OMAFRA (no date) for agricultural purposes and has been determined with respect to a provincially significant wetland in Beckwith Township, just outside of the RMOC, by Golder (GAL, 1991).

With respect to the external area measurement, only lands that are upgradient from the subdivision are of interest. Aside from the two known sites that identified no external lands, a high of 88% of the total area was external in Deermeadow and a low of 15% was tabulated in Kanata III. In order to control the flows that once crossed the subdivision lands, the effect of perimeter ditches was to divert flow away and in so doing, small wetlands within the subdivision boundary now receive less surface water and potentially less groundwater because its flow is also intercepted by the ditch cut. On the other hand, a flat area or depression that may be on the receiving end of the ditch will gain increased

flow, such as in Deerwood III. In Goulbourn, however, these ditches diverted flow that once entered adjacent wetlands.

Only the wetland in close proximity but down gradient from Kanata I was identified explicitly for receiving the subdivision flows in 1983. In Goulbourn by 1985, this was not proposed, and instead, a stormwater detention pond was "created" in the last lot of the subdivision prior to the outlet. With these few examples, and the growing interest in wetlands as an alternative method in stormwater management as outlined previously in Chapter 2, the location of the development within the basin and with respect to a nearby wetland could determine the future of the small wetlands, considerations that are discussed next.

4.5 The Wetlands

An analysis of the changes in the groundwater and drainage systems was presented in Sections 4.2 and 4.3. The last issue to consider in this research is the change in wetland areas in the study basins and the views of the respondents towards these resources. The general perception towards wetlands is discussed first, followed by a case by case analysis of the approach taken in the plan of subdivision approval process and the current views of the respondents towards their local wetland areas. The particularly small survey size in Lakeland (7), Goulbourn (4) and Deermeadow (4) is acknowledged, and unless all respondents had the same perceptions, more limited analysis is presented in these cases. Furthermore, specific drainage or fill activities noted by the respondents for their own properties are not analyzed against the change in wetland area, in an effort to maintain

anonymity. A summary and conclusions on the place of small wetlands in country-lot developments completes this section.

4.5.1 General Perceptions About Wetlands

The participants in the questionnaire survey identified many benefits of wetland ecosystems and a few negative attributes. Those with a frequency rate over 10% are listed in Table 4.7 (For a complete list of responses with respect to wetland functions and values, see Appendix II, question 39a). The roles in wildlife habitat and species diversity were mentioned most often; filtration and ecosystem diversity also "scored" highly. With respect to the perceived negative attributes, over half of respondents did not like the mosquitos, beavers or snakes and one-fifth thought wetlands were a property with limitations, (although 41% of these individuals qualified their remark by saying it would depend on an individual's point of view, not necessarily their own). Overall, all respondents identified at least one wetland benefit and 23% did not think of a negative aspect of wetland areas, suggesting that they are all aware of wetlands, with approximately one quarter of the group especially at ease with these ecosystems.

Given the focus of this research, information about why an attribute was considered important was obtained from respondents who mentioned the role of wetlands in groundwater, filtration, habitat and ecosystem diversity (84% of the cases). The reason for the benefit in groundwater was explained by the respondents as these areas being both a source of water and an indication of a "healthy" water table. The importance of what respondents described as the role of wetlands in the "circle of life" or "balance of nature"

Table 4.7: Response Rates for Benefits and Negative Attributes of Wetlands

Benefits	Response Rate (%)	Negative Attributes	Response Rate (%)
Wildlife habitat	75.5%	Mosquitos/Beaver/Snakes	54%
Species diversity	65%	Property with limitations (depending on one's point of view)	21% (41%)
Sink for pollutants/filter	30%	Other	14%
Ecosystem diversity	28%	None	23%
Recreation	23%		
Store/recharge groundwater	21%		
Good for environment Need them generally	19%		
Aesthetics	17.5%		
Other	12%		

was provided for the habitat function (35%), ecosystem diversity (20%) and species diversity (20%). Habitat was also often related to the needs of the wildlife (35% of the time, and thereby recognizing non-human interests) and the diversity of species that can be found in these ecosystems. With respect to what might be described as a more explicit self interest, 21% of respondents related habitat to their own interest in nature and of the 28% who noted the benefit in ecosystem diversity, one-third related this to human enrichment.

At the general level, all respondents indicated an interest in knowing if wetlands in the area stored contaminants. As a whole, this was because of a perceived potential effect on drinking water (mentioned 40% of the time) and a general effect on health (22% of the time). Where respondents gave more than one answer, the effects on flora and fauna were mentioned often (44%) as well as a stated interest in cleaning up the wetland.

4.5.1.1 The Respondents' Local Wetlands

After a respondent had completed the basemap described previously, he/she was asked to identify whether an area had become wetter or dryer than at the time of their arrival in the community. 23 respondents thought an area on the map had changed in character: 50% deemed it to be wetter and 50% deemed it to be dryer than when they moved in. The dryer conditions were often attributed to activities on their own or neighbouring properties. For instance:

- * respondents noticed when upstream damming had reduced the water in their own pond;
- * a 60 foot waterfall in the Dunrobin basin was said to be a summertime trickle;
- * the position of a home was thought to have changed the flow pattern;
- * in Kanata, a resident found that after the filling of a wet area on an adjacent property, his sump pump ran less frequently;
- * reduced flow in a subdivision ditch was noticed after the development of a nearby lot;
- * the corner wetland in Lakeland was perceived as dryer, likely as a result of the walking path developed by the community association;
- * in another case, the change was attributed to the activity in the surrounding area, such as dewatering at a neighbouring gravel pit.

A series of questions then focussed on the wetland the participants identified as the closest to the subdivision. In order to compare these views, Table 4.8 presents selected results that are discussed generally in this section, and on a case by case basis in Section 4.4.

The respondent's perception about the location of the wetland closest to the subdivision was often correct, thereby shedding additional light on their environmental understanding: 49% identified a wetland within or close enough to the subdivision lands that they could walk to it and 12% identified a "backyard" wetland within the respondent's

Table 4.8: Selected Results of Respondent Survey, by Case Study

Question	Dunrobin Total 14	Deerwood Total 18	Kanata Total 10	Lakeland Total 7	Goulbourn Total 4	Deermeadow Total 4
Location of local wetlands						
Backyard/Subdivision lands	7	12	6	4	1	4
Provincially Evaluated	5	2	0	0	1	0
Other roadside	1	4	4	2	1	0
List of attributes attached to local wetland						
All	6	6	3	3	1	1
Specific	7	10	7	3	2	3
Level of Care						
Quite a bit/A great deal	12	7	5	5	1	3
None/A little	0	5	2	0	1	0
Reason for caring about loss of local wetland						
quality of life/location/scenic	8	2	2	4	1	1
wildlife requirement	3	2	2	0	0	1
part of nature/balance of nature	3	3	2	2	0	2
no need/other land available	2	3	2	1	1	1
concern for loss of more wetland	3	4	1	1	0	0
Effort to keep wetland						
physical labour	6	6	1	3	1	2
lobbying for action by others	8	10	2	6	1	4
change homeowner habits	9	7	1	5	2	3
contribute financially	6	5	3	5	2	3
none	1	4	5	0	2	0

own lot, which indeed was a wetland identified by the researcher in a number of cases. Just over half of the backyard wetlands (4 of 7) were on lots chosen for primarily economic reasons, suggesting a relationship between price and the condition of the lot, as mentioned in Section 4.3.4; 2 backyard wetlands were on lots chosen for topographic reasons, where the respondents knew they wanted the house high and dry, but also identified a wetland below the home. Approximately 35% of respondents were incorrect about the location of the closest wetland, although they were correct about the area being a wetland: 21% of respondents identified 'Other' wetlands located adjacent to a roadway outside the subdivision lands and approximately 14% identified a provincially evaluated wetland as the closest to the subdivision, these instances in all cases except Lakeland, and Deermeadow.

The respondents described their local wetland in a variety of ways, often including a note about water, whether it be soggy ground, or water at the surface (40 respondents); the hydrology of scrub/shrub wetlands was mentioned less often. Where residents indicated an interest in a wetland storing contaminants because of perceived potential effects on drinking water (33 times) and health in general (18 times), just 10 and 4 participants, respectfully, described their local wetland in hydrologic terms. The lowest response in connecting the wetland to the drinking water was in Dunrobin (35%), possibly reflecting a sense of security because of their deep well depths (Table 4.1); in Lakeland, on the other hand, all the respondents identified a concern for the impact on drinking water, possibly because they see surface water on a day to day basis. In most other subdivisions, the percent was over 50%.

Other statements were also made about the flora (38 times), fauna (34 times), seasonal changes (8 times), specifically as a pond (9 times, perhaps not surprisingly 5 of these were from Dunrobin where the ponds were prevalent along the creeks that flowed through the subdivision land). In over half the cases (32), not all the positive or negative features of wetlands identified generally (Table 4.7) were attached to the local wetland, regardless of its proximity to the home. This would suggest that a majority of the respondents perceive that not all wetlands function similarly. The reason for this was not probed further.

Several questions concerned how much the respondent's would care if a local wetland was lost, as well as their potential level of effort to keep a local wetland. 56% of respondents would care "quite a bit" and "a great deal" if their wetland was lost and another 26% would care moderately. The reasons given for this concern were: the loss would affect their quality of life (38%); perceived wildlife requirements (17%); the balance of nature or the natural system (25%); that there is no need and other land is available (21%); or a concern for a more general loss (19%). The 8 respondents who identified lesser levels of interest identified such perceptions as too much attention being paid to these ecosystems; too much regulation; that the wetland could be used for something else; or that the backyard wetland was really causing problems in their basement or on their property. The hydrology of the local wetland was not mentioned often where the respondent did not care highly about its continued existence.

With respect to the level of effort respondents would be willing to put into keeping their local wetland, 33% said yes to doing some physical labour, 54% would lobby for

action by others; 47% would change their own habits; 42% would make a financial contribution to another group; 10% named another type of activity; 21% would do nothing; and 12% identified a willingness to do whatever it would take to keep the wetland.

4.5.2 Approach and Views towards Wetlands

The way in which the plan of subdivision application, agencies and the RMOC Planning Department approached the existing wetlands, and the subsequent requirements towards these areas are described first, followed by the views of the respondents towards their local wetlands. The reader is again referred to Table 4.8 for comparative purposes.

4.5.2.1 Dunrobin

The two plan-of-subdivision applications were submitted with a Terrain Report, which, in the case of Dunrobin I, included a section on Social and Vegetation Impact. This was the only Report which noted that "An analysis of the natural ecology revealed the important factors to be taken into consideration to protect and enhance the natural environment of the site" (Novaplan Group, no date: 1). Twenty-three test pits were dug across the Phase I lands, and where possible, the holes determined the depth to bedrock and they were kept open for several hours to approximately establish the equilibrium water table. In Phase II, twenty-one test pits were dug by backhoe and twenty shallow pits were dug by hand.

The MOE found in Dunrobin I that lot and road drainage was essential throughout

the western and central sections of the site to eliminate many small poorly drained pockets on the thick clay terrain unit (Hobby, 1978) and in Dunrobin II, the drainage of an artificial pond on the southern stream was proposed explicitly (but does not appear to have occurred). Other poorly drained depressions were evident, but were deemed to be of such small area that they did not constitute a development constraint. Most wetlands, which were located across the basins, were essentially protected through the development process, for two reasons: 1) both terrain reports stated that the developments were designed to avoid the floodplain and poorly drained areas in the Rockland/Anstruther soil association (Figure 3.1); and 2) a 30 m development setback was required from the pre-existing creeks. Furthermore, an MOE condition of draft approval required that the owner (developer) enter into an agreement with the Township of West Carleton to inform all prospective (lot) purchasers that no construction or tile bed installation shall occur within the floodplain of the streams which occur throughout the site (Wright, 1978). Overall, a small decrease in wetland area was measured, estimated at 1.9 ha or 1.4%.

Small-scale activities by the homeowners have also occurred. Three respondents have dug a ditch or installed a drain pipe on their property, one of whom may have been reacting to the effects of an adjacent lot development where that homeowner mentioned that their home had "pushed the (ground)water over". With respect to the pre-existing creeks, the area of the floodplain appears to have declined, possibly because residents find the ditch maintenance difficult and proceed to change the cut or the slope to allow earlier and easier access for grass cutting. This issue also came up in Kanata.

The "local wetlands" for Dunrobin respondents were in their backyard or

subdivision lands 50% of the time (7 times); another 5 respondents named the Carp Hills provincially significant wetland complex. Each of the above 7 respondents would care quite a bit or a great deal if their local wetland was lost, and in each of these cases, this was because of a concern for their quality of life. In five cases, the respondents attached their whole list of wetland attributes to the local wetland area. In this instance, quality of life was described as "the type of thing we moved here for". However, this may be an acquired taste, because only 2 respondents identified some aspect of the natural environment as a reason for locating in the subdivision.

Regardless of the wetland's location, the kind of effort these residents would put into keeping their local wetland was as follows: 57% would do some lobbying for action by others; 64% would change their own habits (roughly half having identified a backyard or subdivision wetland); and 43% would do some physical labour.

4.5.2.2 Deerwood

Deerwood I is the oldest and least well documented plan of subdivision. No terrain analysis was undertaken and the information contained in the application (Rampton, 1976) and the MOE site assessment report (Mulligan, 1976) varied. For example, Rampton wrote that soil thickness was greater than 20 feet on the north to less than 3 feet in places along the southern extreme. In contrast, the MOE field evaluation found soil depths to vary from 7 to over 10 feet, with the overburden consisting of a layer of silty clay in varying depths (4' to 8'), underlain by a bed of saturated gravel above bedrock. This contrasts with soil information from available maps, especially the revised

Farmington soil association which has a depth of only 10-50 cm over bedrock (Table 3.4). On another point, the application noted that "[T]he Subdivision is situated adjacent to the northern edge of the recharge area (which is) flat and underlain by rubbly till and bedrock" (Rampton, 1976); in fact, the entire ridge is likely the recharge area, as eventually identified by WESA (1984b) for Deerwood III.

Wetlands exist within the subdivision lands, and up- and down-gradient from them (Figures 3.3, 4.3). Approximately one-fifth (5.6 ha) of the Deerwood I site in the south corner (Figure 3.2) was designated hazard land in the RMOC Official Plan at the time of application. In 1976, the Mississippi Valley Conservation Authority recommended to the OMNR (for transmittal to the RMOC) that "[M]arshy areas (as denoted on the plan) be subject to no filling" (Maher, 1976) and the resulting MNR condition of draft plan approval stated, in part, that "[T]his heavily wooded area has some marshy areas as shown on the Plan that should not be filled without permission of the Mississippi Valley Conservation Authority" (Maslen, 1976). The Ontario Ministry of Housing submitted that the hazard lands be excluded from the development, and that the MNR should "delineate the extent of the hazard land affecting this proposal" (Wright, 1977). This suggestion was not adopted and instead, the Report to Planning Committee stated that

"[T]hough these lands do have some drainage problems, the limited extent of the problem does not seem to preclude the development of the site. This problem can be overcome by ensuring the lots in the vicinity of the wet areas are of sufficient size, as per the policies governing 'hazard lands' in the Regional Official Plan to ensure that sufficient non-hazardous lands form part of the proposed subdivision to permit all buildings used for human occupancy and all wells and septic tank fields to be located outside the hazard lands" (Wright, 1977:2).

Later, in their letter of final approval, the MNR wrote to the RMOC and stated "... that

condition 10 (no filling of wetlands) be deleted" (Maslen, 1978). The MVCA has no documentation on file to suggest this was their idea but Price (personal communication) explained that they had no jurisdiction with respect to fill on private lands in this location. Notwithstanding the recommendation to delete it, the condition is included in the final agreement. Unfortunately, if a resident did apply to the MVCA for permission to fill, this would not have been documented because landowners would have been told verbally that MVCA permission was not in fact required. In this particular area, respondents indicated that they have completed some ditch works, and some believe that the township has taken over responsibility for drainage in this wet area.

In Deerwood II and III, nineteen and twenty-three test pits were excavated, respectively, a number of which were observations of bedrock outcrops. In Phase II, WESA (1981) noted "that the land is well drained with exception of a low lying swampy area and shallow beaver pond in the western and west-central portions of the property, having a seasonally high water table". In Deerwood III, WESA (1984b) noted good drainage, "with exception of two small ponds in the very centre of the property". In both cases, they proposed for both phases that adequate drainage could easily be achieved through proper construction of a lot and road drainage system in the required areas (WESA, 1981, Section 1.3; 1984b:3). The subsequent RMOC comments for Deerwood II found that "Although there is [sic] some limitations to the site i.e., ... the wetness of part of the site ..., these concerns can be adequately met if the applicant fulfils the requirements as stipulated by the MOE and MNR" with respect to the Drainage Plan (as outlined in Section 4.3.3.2) (Wright, 1981). The wetlands in Deerwood III were not mentioned

further during the approval process.

Overall, the decrease in wetland area is approximately 21.5 ha, or 8.3% across the three sub-basins (Figure 4.3). However, the dugout in the northeast corner has enlarged, likely through the outflow of the subdivision ditches. This area was recognized as the "local wetland" for five of the Deerwood respondents. Half the respondents in Deerwood (9) responded that they had changed the way water ran off their property; 5 had brought in fill and 5 had dug a ditch.

Backyard wetlands or those within walking distance of the subdivision lands were identified by 66% (12 respondents) as their local wetland, and five of these attached their whole list of wetland attributes to it. In contrast to Dunrobin, only 2 of the 7 respondents who would care quite a bit or a great deal if the local wetland was lost, related this, in part, to their quality of life and 3 noted the requirement for the balance of nature. On the other hand, 11 respondents (61% of the Deerwood sample) did not care more than moderately if their local wetland was lost. In 6 of these cases, these wetlands were causing problems in respondent's backyards or they were "drive-by" wetlands. Indeed, one such wetland exists at the juncture of Panmure Road and Highway 17 to the west, an intersection slated as an overpass when the next phase of the four lane highway extension is completed. Today, the respondents find this intersection dangerous.

In terms of the kind of effort these residents would put into keeping their local wetland, 5 said they would do physical labour for their backyard or subdivision wetland; 10 would do some lobbying for action by others (8 times for subdivision wetlands) and 7 would change their own habits (5 for backyard or subdivision areas).

4.5.2.3 Kanata

A Terrain Analysis Report was completed for all Phases in Kanata, however no test pits were dug in Phase II. Twenty and twenty-six test pits were dug across the properties for Phase I and III, respectively (WESA, no date; WESA, 1989) and the characteristics and thickness of the surficial materials were discussed. In the latter case, approximately one quarter of the property in the northeast was not subject to test pit observation because of tree cover.

The wetlands in Kanata I, some of which are within the subdivision land and a large area down-gradient from it, were evident to all the agencies. The RMOC found that, within the subdivision lands, a substantial pocket of organic soils and/or restricted drainage covered most of lots 17 and 18 (Tunnacliffe, 1979). A site inspection was recommended to take place but no further correspondence was on file to detail the findings. Secondly, the wetland located immediately to the east of the subdivision lands was identified as a useful storm water detention facility. While it was the MVCA's position that runoff control measures should be maintained within the limits of the proposed development, they noted, in correspondence exchanged prior to final approval (Lehman, 1984), that the City of Kanata "was concerned with the increased maintenance costs which would be incurred through construction of a storm water detention facility when sufficient control could be achieved in the downstream swamp area", and the MVCA agreed that there would be no adverse downstream impacts through implementation of the proposed Drainage Plan that would use the swamp, as outlined in Section 4.3.3.3, above. The corner lot (pond wetland) at the entrance to Kanata III

(Figure 3.3) was designated open space for the subdivision lands and the City of Kanata required that this area be filled (Appendix V, Article Five). It is now an open field.

The change in wetland area is approximately 15.6 ha, or a decrease of 8% across the two sub-basins (Figure 4.4). The drainage works have helped to reduce the level of the water table and improve the rate of runoff from the basin lands. In terms of respondents activity, 2 have put in a ditch and 6 have brought in fill. The wetland adjacent to the swale outlet in Kanata II appears to be unchanged, likely because it was not drained directly by the outlet from that property. The cedar forest in the northeast corner of Phase III appears to be drying up and was not delineated on the post-development map.

The local wetland identified by the respondents in Kanata was the large wetland behind the subdivision (6 times) and other roadside wetlands (4 times), 3 of which identified a wet area directly across the concession road from the subdivision lands. Three respondents attached their whole list of wetland attributes to the local wetland. The reasons why the respondents would care quite a bit or a great deal if the local wetland was lost, was spread over all classified answers, whether it be quality of life, the wildlife requirement, role in balance of nature, or a concern for the loss generally. 50% of the respondents in Kanata indicated that they would not do any of the activities proposed in the questionnaire in an effort to keep the local wetland; but one individual would do all the activities.

4.5.2.4 Lakeland

In Lakeland I, the terrain conditions and proposed guidelines for private services

and maintenance of lake quality were detailed by WESA (1984c). No test pits were excavated and there was no mention of the on-site wetland/Goulbourn soil association (Table 3.7). The latter omission possibly relates to the focus of the report on what the residents need to do to maintain water quality in the ponds. Test pits were dug in Lakeland II which was exclusively on the former gravel pit. The agencies did not make any comment with respect to the wetlands in or adjacent to Lakeland and it is concluded that the wetlands were disregarded.

The delineation of the three sub-basins changed since the development of the subdivision lands (Figure 4.5), and overall, 5.6 ha wetland were gained, or 1.75%. For some reason, the wet area to the south of the subdivision lands is larger than before. 5 respondents noted the use of fill, but most were located outside the wetland area.

With respect to the identification of the "local wetlands", just one respondent recognized the subdivision corner where a walking path has been developed by the community association, and three named the open water wetland, part of the area to the south of the subdivision lands in Basin B. It is interesting to note that the approximately 33 ha "South Highway 25" wetland, provincially evaluated as Class 7, exists just 600 m southeast of the development, but none of the residents identified it on their map. Three of the seven respondents attached their whole list of general wetland attributes to the local wetland; where the respondent would care quite a bit or a great deal about the loss of their local wetland (5 times), this was most often related to the effects on their quality of life (4 times). 5 respondents of the seven indicated that they would lobby for action by others, change their own habits and/or contribute financially in an effort to keep the wetland.

4.5.2.5 Goulbourn

No test pits were dug to verify the conditions in the forested south end of the Goulbourn subdivision property. Hansen (1985) suggested that all lots would require fill because of the water table but the word wetland or swamp did not appear in the documentation; wetlands were essentially disregarded. Moreover, three Goulbourn respondents have brought in fill, costing up to \$10,000.

In Goulbourn, it must be stated that a major hydro corridor was cut through the wetland in the eastern half of the basin in 1985-86. The choice of the corridor in fact delayed the approval of the subdivision development because an alternative proposed route was through the south half of the subdivision property. The loss of wetlands, by over 53%, is therefore not totally related to the approved development, which makes this case an anomaly in terms of the original criteria outlined in Chapter 1. Nevertheless, the subdivision did divert the drainage, as discussed in Section 4.3.3.5. This is also a different case because the provincially evaluated Class 7 Stanley's Corners wetland exists directly across Fallowfield Road (Figure 3.7 and 4.6).

Each of the 4 respondents identified a different "local wetland": for one person, it was the Stanley's Corners wetland; for another, it was the pond that was preserved in the northern part of the site; a third was unsure of the location of the closest wetland to the subdivision. The pond was very important to the respondent who identified it, for it was a reason for purchasing the property; it was felt that something about water gives peace. This individual would get involved in all the described activities to keep the local wetland, whereas the others indicated that they would do none of the activities. Perhaps these

responses are the epitome of the relationship between the proximity of the wetland, the interest in its existence, and the effort potentially expended to ensure its ongoing existence.

4.5.2.6 Deermeadow

Deermeadow is the most recently approved plan of subdivision (dated 1992). In Phase I, eighteen test pits were excavated in November, 1988, except in the swamp in the northwest which was not accessible due to the high water table (Figure 3.8). Nine test pits and twelve auger holes were used to investigate the subsurface conditions of Phase II.

In addition to the drainage works described in Section 4.3.3.6, re-zoning of the organic soils in the subdivision lands was required for subdivision approval.

Correspondence between the RMOC Planning Department and the developer dealt with policy issues, which were formerly designated "Environmental Constraints", related to these areas. Development was not permitted in these areas at the time the applications were received in 1988, but by the time of registration in June, 1991, the region's new Official Plan (approved by the Minister of Municipal Affairs in September, 1989), permitted development on organic soils provided that, among other things, the site could be made suitable for development (Hope, 1988). In both phases, Hope (1989) from the Planning Department's Policy Group, noted his concern that sufficient attention had not been paid to these soils. At the lower tier level, the Township of Osgoode official plan designated the lands "Rural Marginal" and "Hazard", with "rural" and "hazard" zoning. The process to amend the official plan to permit development of a country-estate

subdivision in an area so designated began shortly after the application was circulated.

The RMOC and the MNR suggested that to avoid any conflict with the Regional Official Plan, it was preferable for the Township to defer approval of the by-law until after the Regional Official Plan was approved.

At the same time, the MNR stated that it had not yet evaluated the wetland on the site and the Ministry reserved comment regarding the lots proposed in wet areas until after further site assessment scheduled for June, 1990 (Sellers, 1990). The MNR also requested, through copy of that letter, that the Township of Osgoode and RMOC refrain from re-zoning the land for subdivisions until the issues of hazard lands, wetlands and fisheries concerns were resolved. The MNR's further study resulted in a note on file that "nothing was found" (Houston, personal communication). In Deermeadow I, the end result was a requirement by the Township of Osgoode Subdivision Committee (1989) that lots 1 to 4 and 42 to 46 (inclusive), the swampy lands in the northwest corner, be filled prior to building permits being issued

In Deermeadow II, Kumapley (1990) provided a map to the developer indicating the extent of the organic soils across the south end of the property, as delineated on Schedule G of the Official Plan. In response, Hay (1990) wrote to the RMOC with respect to a proposed additional condition of draft approval that would require proof from the developer that the potential soil constraint could be overcome. He indicated that the proposed subdivision was laid out on the basis of an adequate setback from the drain and associated organic soils such that a sufficient building envelope exists on each lot". McKay (1990) then requested a map showing these envelopes under the rubric of Policy

12 of Section 7.2.2 (page 7-3) of the Regional Official Plan, which states that:

where it is not possible to determine immediately whether a lot to be created by plan of subdivision or severance lies in an area affected by organic soils or unstable slopes, Council may require applicants to provide sufficient information to establish whether the policies of this section are met.

It appears that this request was not fulfilled because no other correspondence related to this issue was on file and the Plan was subsequently registered. The re-zoning of the hazard land for residential development was completed.

With respect to the drainage works of the Grey's Creek discussed in Section 4.3.3.6, only the Provincially Significant Class 1 Osgoode Complex Wetland located south of the study area was mentioned as a potential design constraint in the Engineer's Report (Connelly, 1990). The effect on other organic soils, including those within the subdivision lands, was not mentioned in that report.

Given the relatively recent activity in Deermeadow, the change in wetland area is not assessed and at this point in time, it would be premature to suggest that the wetland is gone (Figure 4.7). The area wetland that appears to be changing most rapidly, however, is approximately 45 ha, or 21% of the wetland delineated by the Schut and Wilson (1987) soil associations. As at Kanata, the drainage works have helped to reduce the level of the water table and improve the rate of runoff from the basin lands; some lots will be filled, as described above. During a drive-through of the subdivision lands, one notices that none of the "wetland" lots have been built upon and most of the homes are in the highland ridge. All four respondents noted parts of the subdivision as the closest wetland, particularly the north end. Three of the respondents attached specific wetland functions and values to the

local wetland. All the respondents would lobby for action to keep the wetland.

4.5.3 Summary and Conclusions

The approach to the wetlands through the plan of subdivision approval process are classified into seven activities: re-zoning, fill, change in inflow, change in outflow, protection, use, and disregard. Table 4.9 presents the change in wetland in each case study, with an indication of which of these applied. The wetland area in Dunrobin and Lakeland is essentially the same as the pre-development environment; in Deerwood and Kanata, approximately 8% of the wetlands have been lost; in Goulbourn and Deermeadow, where the figures are much higher, major works have been initiated for a hydro corridor and municipal drain projects, respectively. Some of the changes may also be attributed to the people who moved into these communities.

It appears as though respondents fall into at least three camps with respect to their perceptions about drainage, groundwater and wetlands: a smaller, more anthropocentric-minded group [1], a group that seems to have acquired its taste for features of the environment [2], and a relatively consistently environmentally-aware group [3]. This is illustrated in the following ways, where the subsequent square brackets ([1], [2], [3]) distinguish which group appears to come through in the analysis.

Respondents recognized many positive attributes of these ecosystems and 56% would care quite a bit or a great deal about the loss of their perceived local wetland, based on such interests as their quality of life, the requirement for wildlife, the balance of nature, and the perception that other areas are available for development. On the other hand,

Table 4.9: Approximate Change in Wetland area, all basins

Case/ Activity	Basin Area (ha)	Wetland Area (ha)			Percent Wetland Area in Drainage Basin (%)		
		Pre	Post	Change	Pre	Post	Approach/ Change
Dunrobin	A:131.5	9.9	10.25	+0.35	7.5	7.8	Drain Protect -1.4%
	B: 13	2.5	0.25	-2.25	19.2	1.9	
	T:144.5	12.4	10.5	-1.9	9.4	8	
Deerwood	A: 73	9.5	4	-5.5	13	5.5	Rezone Drain -8.3%
	B:112.5	18.5	3.9	-14.6	13.5	3.5	
	C: 71	4	2.6	-1.4	7	3.7	
	D: 24.5	NA	0	NA	NA	0	
	T: 281	32	10.5	-21.5	12	3.7	
Kanata	A:146.5	23.8	8	-15.8	16.3	5.11	Fill Use Disregard -7.95%
	B:10	0.75	1	+0.25	2.3	10	
	T:156.5	24.6	9	-15.6	13.7	5.75	
Lakeland	A:39.5	9.3	3.8	-5.5	35	9.6	Disregard +1.75%
	B:42	4.6	15.9	+11.3	14.6	37.8	
	C:44	4.6	4.4	-0.2	9.6	10	
	T:125.5	18.5	24.1	+5.6	17.45	19.2	
Goulbourn	56 ha	42	12	-30	75	21.4	Fill/Disregard 53.6%
Deermeadow	508 ha	109	45 changing	NA	21.4	NA	Re-zone, Fill Drain - 41% changing

21% would do nothing to keep a local wetland, especially if it was not close to the subdivision lands [1]. Their reasons for a lack of interest was related to the perception of abundance, or that there was too much fuss and/or government intervention over these ecosystems. Of this group, 5 were from Kanata.

The activity of respondents in changing the way precipitation runs off their property was compared with their interest in the environment generally, and wetlands in particular: a relatively high 78% of those who have dug a ditch, brought in fill, or changed the slope of their land (activities described in Section 4.3) did not mention that the natural environment was a reason for locating in the subdivision [2]; 28% had a relatively low consideration of the impact of their activities on the environment ("somewhat") [1] and somewhat more drainage activities were done by those who had not thought about water related aspects of the environment left for future generations: 32% of the respondents compared with the 23% general response rate for this outlook. Of the 10 reported cases of ditching, only one respondent noted that ditches change plant growth; and not one person mentioned the negative effect of ditches on wildlife or wetlands [1]. However, another 50% indicated that they would care quite a bit or a great deal about the loss of their local wetland [2]. On the other hand, 42% of all respondents recognized that they had changed the way precipitation runs off their property through the use of fill or change in slope [2,3]. Of this group, 74% indicated that they considered their impacts on the environment "quite a bit" or "a great deal" [3]. Furthermore, of the 9 respondents who thought that a change in drainage would affect a wetland area, none had put in a ditch [3].

With respect to their local wetland, 32 respondents had a high level of interest (quite a bit or a great deal of concern if it was lost) [2,3], and of these, 23 (72%) identified that local wetland as one in their backyard or in the subdivision lands; 12 of these respondents described their reason for the interest in terms of losing a part of their quality of life (a reason given 18 times overall) [2,3], but this appears to be an acquired taste: as

many of these respondents indicated that they chose to live in the subdivision for its location (9) [2], as for some aspect of the natural environment (9) [3]. On the other hand, of those who did mention some aspect of the natural environment as the reason for locating in the subdivision (37 total respondents), their interest in their local wetland was moderate (11 times), quite a lot (8 times) and a great deal (13 times)[3]. No single reason for the interest was dominant. Only 3 said their interest in the local wetland was because of their quality of life.

In many cases, the respondents relate to the smaller, local areas favourably, ones that may be called "human scale" wetlands. They would care more if they were lost and they would do more to keep them. Of the 35 cases where the wetland was in the backyard or subdivision lands, 9 respondents would do whatever it took to keep the wetland, and 8 would do up to 3 of the listed activities (Appendix II, Q42). Of the 20 respondents who identified provincially evaluated wetlands or other roadside wetlands, 9 would not undertake an activity [1,2].

This compares positively with the fate of small wetlands in country-lot developments which may not only be based on the location but also the size and type. Wetlands within subdivision lands that are not well defined will be drained or filled, either by the developer or the landowner who has subsequent water problems on the property. In other cases, subdivision drainage systems will not consider adjacent lands and the wetland will receive less water because ditches may divert water that once flowed into the wetland area. More defined wetlands could be used in stormwater management, but scrub/shrub wetlands which may be somewhat less defined, are more likely to be disregarded.

Chapter 5

Conclusion

The place of small wetlands in rural development in the Regional Municipality of Ottawa-Carleton was considered through the review and analysis of six case studies, based on small drainage basins that included one or more country-lot subdivisions and a number of wetland areas, from the point of application through to present conditions.

The first objective was to identify the similarities and differences in documentation on terrain analysis, hydrogeology, and hydrology used in the subdivision approval process. While all but one plan of subdivision application included a terrain and hydrogeological report prepared by an engineering consultant, the detail of the reports varied. The reports did not consider conditions outside the subdivision lands and in several cases, parts of the subdivision land were not assessed. Until the mid-1980s, test well pump tests were not performed and the hydrogeologic investigation was based on a survey of existing well drilling records in the vicinity of the proposed development. Each plan of subdivision did include a drainage plan aimed at lowering the water table and ensuring a more rapid drainage of the subdivision lands through a system of excavated ditches.

Second, selected characteristics of the study basins, which were in a variety of biophysical settings, were measured both before and after the development, leading to a number of conclusions with respect to the third objective, consideration of whether subdivision works or individual landowners are altering baseflow to wetland areas. Overall, it was determined that the extended effects of a rural development may be quite

large because a relatively small percent built-up area does not necessarily equate to a relatively small impact on the drainage basin as a whole. The clearest effect of the subdivision development has been an increase in drainage density which increases the removal of surface water and thereby decreases the percentage of groundwater runoff. Although the general runoff direction was maintained in all cases, the flow was concentrated and diverted away from the wetlands on the subdivision lands, and both into and away from wetlands on adjacent properties. The variety of drainage works were classified into six types: interior ditches and swales, perimeter works, cleaning and regrading of existing outlets, use of wetlands as the outlet, major works, and other minor considerations. The drainage density increased up to 775%. Residents have also altered the surface flow regime, particularly where perceived water problems have been experienced on their property or in their basement. Over half the respondents (56%) stated that they had changed the way precipitation runs off their land (with some mentioning more than one activity). 60% of the work was completed by those who had lived in the subdivisions between 4-9 years and another 30% by those in the subdivision over 10 years, suggesting that changes are made after the home and the residents were settled. It appears that the lots bought for primarily economic reasons (presumably because they were less expensive than other lots available at the time) are wetter and undergo additional drainage activities by the homeowner; it is possible that up to 20% of subdivision residents alter drainage systems directly through additional ditch work.

The change in wetland area is not, however, resulting from surface leakage from the wetlands to the domestic well water supply. It was concluded that these ecosystems

are not connected hydrogeologically to the aquifers that supply the wells and therefore would not be affected measurably by their increased concentration in the case basins. Groundwater inflow at the local and shallow scale, however, may be affected by development activities that reduce surface water infiltration, which leads to a lower water table. For instance, the use of one or more sump pumps in the basement of 56% of the respondents will affect the shallow groundwater flow regime because they extract groundwater from around the foundation and discharge it into the subdivision ditches, water which is then carried away as surface runoff.

The particular wetland areas were dealt with differently during the plan of subdivision approval process and the approach was classified into seven types: re-zoning, fill, change in inflow, change in outflow, protection, use, and disregard. The result in two cases is a wetland area that is essentially unchanged, and this is where the highest percentage of respondents indicated that they would care a lot if their local wetland was lost, namely in Lakeland (swamp and open water wetlands) and Dunrobin (mixture of riverine ponds and isolated wetlands). In Deerwood and Kanata, there was an approximate decrease in wetland area of 8%. Both cases are dominantly surficial limestone bedrock with larger wetland areas and in some locations, residents have experienced perceived water problems on their property; the views towards these resources was somewhat mixed. In Goulbourn (relatively flat, mixture of former gravel pit and larger wetland area), a large decrease in wetland area appears to have occurred (53%) but this is also attributed to the installation of a high voltage hydro transmission line

through the basin. Again, the most interest was in the smaller pond on the property. In the most recently developed Deermeadow, the loss of organic wetland area is less clear, although a change appears to be underway for about 40% of the pre-development wetland area. The relatively recent landowners seem to be aware of their surroundings.

Based on results of an exploratory questionnaire survey on the perceptions of country-lot residents about groundwater, land drainage and wetland ecosystems, it appears as though respondents fall into at least three camps: a smaller, more anthropocentric-minded group, a group that seems to have acquired its taste for features of the environment, and a relatively consistently environmentally-aware group. The residents recognize many positive attributes of wetland ecosystems in general and 56% would care quite a bit or a great deal about the loss of their perceived local wetland area, based on such interests as their quality of life, the requirement for wildlife, the balance of nature, and the perception that other areas are available for development. Many also recognize the need for infiltration of precipitation to replenish groundwater supplies; but, the systems used to reduce water near human development increase drainage density, thereby relieving the surface of water more quickly and reducing the opportunity for infiltration. In contrast, a relatively high 78% of those who have dug a ditch, brought in fill, or recognized that a change in the slope of their land might have changed the way precipitation runs off their property, did not mention that the natural environment was a reason for locating in the subdivision. Furthermore, of the 10 reported cases of ditching, not one person mentioned the negative effect of ditches on wildlife or wetlands. This last

group is not homogeneous, however, because 50% indicated that they would care quite a bit or a great deal about the loss of their local wetland. A seemingly more consistent group is the 42% of respondents who recognized that they had changed the way precipitation runs off their property through the use of fill or change in slope, 74% of whom indicated that they considered their impacts on the environment "quite a bit" or "a great deal".

The type of environment in which the rural developments are situated may play a role in the perceptions held by the residents. Respondents appear to relate to the smaller, closer wetland areas most favourably, where the ecosystem was of a human scale; it seems that these were areas that are "good looking" ponds, where respondents could "see the other side". They would care more if they were lost and they would do more to keep them. Of the 35 cases where the wetland was in the backyard or subdivision lands, 9 respondents would do whatever it took to keep the wetland, and 8 would do three suggested activities such as physical labour, lobbying for action by others or changing homeowner habits. Of the 20 respondents who identified provincially evaluated wetlands or other roadside wetlands as their "local" wetland, 9 would not undertake an activity. The place of wetlands as part of the rural resident's quality of life could be identified as an acquired taste: as many respondents who identified this interest indicated that they chose to live in the subdivision for its location, as for some aspect of the natural environment. Moreover, of those who did mention some aspect of the natural environment as the reason for locating in the subdivision (37 responses) their interest in their local wetland was

moderate (11), quite a lot (8 times) and a great deal (13 times).

In the past, the place of small wetlands in country-lot developments, defined as their position or standing through the subdivision approval process, however, may not only be based on their location but also their size and type. Wetlands within subdivision lands that are scrub/shrub environments will likely be drained or filled, either by the developer or the landowner who has subsequent water problems on the property. These areas on adjacent lands are more likely to be disregarded if water is not at the surface and the wetland is not recognized for what it is. They may receive less water because ditches will divert water that once flowed in.

Their standing (which affects their place in terms of space) should be improved in light of both long-term ecosystem health and diversity and the short to medium term human interest, as reflected in the attitudes of the current landowners. They could be left accessible to property owners within subdivision lands rather than drained or filled during the subdivision development process. Unfortunately, there is no foreseeable interest in these areas from the approval process point of view. The current provincial wetland policy does not address these areas and the recently adopted Evaluation Framework for Natural Areas in the RMOC limits the assessment to wetlands greater than 10 ha in size (Brownell and Larson, 1995). The repercussions with respect to sustainability are not promising. While there is a need for the protection of significant natural areas, there is also the opportunity to bring the environment "home" at the subdivision scale, by preserving smaller wetlands, not only for the benefit of the environment, but for the benefit

of society: property owners may walk to these diverse areas, with the inherent benefits of this activity; they may see the environment in action more often; and they may leave a more complete ecosystem, in all its diversity, for the generations to come.

APPENDIX I

Wetland Types

(from *Wetlands of Canada* (1988:417-424))

A bog is a peatland, generally with the water table at or near the surface. The bog surface, which may be raised or level with the surrounding terrain, is virtually unaffected by the nutrient-rich groundwaters from the surrounding mineral soils and is thus generally acid and low in nutrients. The dominant materials are weakly to moderately decomposed *Sphagnum* and woody peat, underlain at times by sedge peat. The soils are mainly Fibrisols, Mesisols and Organic Cryosols. Bogs may be treed or treeless, and they are usually covered with *Sphagnum* spp. and ericaceous shrubs.

A fen is also a peatland with the water table usually at or just above the surface. The waters are mainly nutrient-rich and minerotrophic from mineral soils. The dominant materials are moderately to well decomposed sedge and or brown moss peat of variable thickness. The soils are mainly Mesisols, Humisols and Organic Cryosols. The vegetation consists predominantly of sedges, grasses, reeds and brown mosses with some shrubs and, at times, a sparse tree layer.

A marsh is a mineral wetland or a peatland that is periodically inundated by standing or slowly moving water. Surface water levels may fluctuate seasonally, with declining levels exposing drawdown zones of matted vegetation or mudflats. The waters are rich in nutrients, varying from fresh to highly saline. The substratum usually consists of mineral material, although occasionally it consists of well-decomposed peat. The soils are predominantly Gleysols, with some Humisols and Mesisols. Marshes characteristically show zonal or mosaic surface patterns composed of pools or channels interspersed with clumps of emergent sedges, grasses, rushes and reeds, bordering grassy meadows and peripheral bands of shrubs or trees. Submerged and floating aquatics flourish where open water areas occur.

A swamp is also a mineral wetland or a peatland with standing water or water gently flowing through pools or channels. The water table is usually at or near the surface. There is pronounced internal water movement from the margin or other mineral sources; hence the waters are rich in nutrients. If peat is present, it is mainly well-decomposed wood, underlain at times by sedge peat. The associated soils are Mesisols, Humisols and Gleysols. The vegetation is characterized by a dense cover of deciduous or coniferous trees or shrubs, herbs and some mosses.

Shallow water is characteristic of intermittently or permanently flooded or seasonally stable water regimes, featuring open expanses of standing or flowing water which are variously called ponds, pools, shallow lakes, oxbows, reaches, channels or impoundments. Shallow water is distinguished from deep water by mid-summer water depths of less than 2 m. and from other wetlands by summer open water zones occupying 75% or more of the wetland surface area. Periodic flooding may increase water depths, but during droughts, low flows, drainage or intertidal periods, drawdown flats may be exposed. Shallow water is distinguished from uplands and bordering wetland complexes by water-eroded shorelines, or by the landward margins of mudflats, floating mats, emergents, or shrubs. In the open water zone, living vegetation, if present, is confined to submerged and floating aquatic plant forms.

APPENDIX II

Questionnaire Survey

Note: Where numbers differ between text and appendix, text is correct.
[data] is frequency count.

1. Background of respondents:

Q1. How long have you lived in the subdivision?

0-3 yrs [16]

4-9 yrs [33]

10+ yrs [8]

Q2. How long have you lived in the rural area?

0-3 yrs [7]

4-9 yrs [24]

10-20 [18]

21+ yrs [8]

Q3. What is your age bracket?

Under 25 [2]

25-40 [28]

41-55 [24]

Over 55 [3]

Q4. What is your highest level of education completed?

high school [10]

college or university [36]

graduate/professional designation [11]

other [0]

Q5. With respect to the environment, which of the following types of events have you attended?

- a a planning meeting to organize a response to an environmental issue
[y] - 21 [n] - 36 Issue:
- b public information session
[y] - 23 [n] - 34 Issue:
- c member attendance at a regularly scheduled meeting of an environmental organization
[y] - 4 [n] - 53 Issue:
- d environment-related activity day
[y] - 27 [n] - 30 Issue:
- e Council meeting with environment issue on the agenda
[y] - 17 [n] - 40 Issue:
- f other
[y] - 22 [n] - 35 Issue:

Q6a. Please list the reasons for locating in this subdivision?

affordability	[11]
general location	[32]
some aspect of natural environment	[37]
recreation	[2]
lot size	[23]
other	[29]

Q6b. Please could you tell me a little bit more about your interest in the natural environment?

country	[11]
rural	[7]
water	[13]
quality of life	[3]
nature/beauty	[6]
recreation	[3]
other	[4]

Q7a. Was there a primary reason for choosing this lot?

yes	[53]
no	[4]
NR	[0]

Q7b. If yes: What was primary interest in lot? (more than one recorded if choice not made)

economic (house, price, availability)	[23]
topographic (height of land)	[13]
aesthetic (vegetation, layout)	[30]
other	[14]

Q45. Generally, to what extent do your decisions about your property take into consideration impacts on the natural environment?

Not at all	[1]	Quite a bit	[17]
Somewhat	[11]	A great deal	[27]
		DK/NR	[0]

Q46. Please identify the top two aspects of the environment you consider when you decide to undertake an activity on this property. All [8]

Groundwater quality	[14]	Landscape appearance	[22]
Soil conservation	[4]	Fish and wildlife	[7]
Groundwater quantity	[9]	Other	[2]
Natural features	[20]	Wetlands	[1]
Surface water quality (lakes and rivers)	[5]	Forests	[14]

Q47a. Have you thought about water related aspects of the environment left for future generations?

Q47a. Have you thought about water related aspects of the environment left for future generations?

yes [44]

no [13]

DK/NR [0]

Q47b. If yes: In what ways?

water table dropping [7]

water quality for consumption [15]

to preserve or improve [15]

surface water [21]

other [12]

2. General overview of environs:

Q8. Please identify water-related features of the natural environment on this base map - surface water, groundwater, wet areas

features edge/off map [15]

subdivision only [11]

property feature [33]

wetland identified prior to survey [51]

subdivision ditch [31]

Q9a. Have you noticed any area on the map that is wetter or drier than when you moved in?

yes [23]

no [32]

DK/NR [2]

Q9b. If yes, please describe the change:

ponding [11]

fill in wetland [3]

dryer [7]

3. Perception about Land Drainage

Q10. What do you perceive are the positive aspects of a drainage ditch?

water accumulation [11]

more rapid dissipation of surface water generally [14]

rid water out of basement/property [23]

reduce flooding [11]

drains land [15]

site for wildlife [8]

other [16]

none [1] DK/NR [1]

Q11. What do you perceive are the negative aspects of a drainage ditch?

stagnant water [6]
 aesthetic (sight, smell) [10]
 changes plant growth [7]
 hazard/safety [10]
 changes wetland/takes away wildlife [11]
 Groundwater related/reduce infiltration [1]
 other [25] none [15]

Q12a. Have you noticed water in the drainage ditches in this subdivision since you moved here?

yes [50]
 no [4]
 DK [3]

Q12b. If yes to Q9a: Which of the following weather conditions result in water flowing in the subdivision ditches? (Least weather required.)

always water in the ditch [5]
 spring snowmelt [9]
 steady, daylong rainstorm [14]
 thunderstorm [15]
 moderate rain less than 1/2 day long [9]
 light rain/drizzle on and off during the day [1]

Q12c. If yes: In terms of the four seasons

a When are the ditches usually dry?

Spring	[0]	Winter	[2]
Summer	[19]	Never	[2]
Fall	[17]	DK/NR	[13]

When is there usually shallow water flowing? (up to 10cm/4 in)

b Spring	[16]	Winter	[0]
Summer	[5]	Never	[1]
Fall	[5]	DK/NR	[25]
		any rain event	[1]

c When are they usually half full? (10-30 cm/4-12 in)

Spring	[26]	Winter	[0]
Summer	[2]	Never	[1]
Fall	[0]	DK/NR	[26]
		Any rain event	[0]

- d When are the ditches usually full? (over 30 cm/12 in)
Spring	[22]	Winter	[0]
Summer	[1]	Never	[1]
Fall	[1]	DK/NR	[29]
		any rain event	[0]

Q12e Have the ditches flooded onto the roadway or lawn?

yes [18]

no [33]

DK/NR [3]

If yes: In what circumstances?

Typically ice jam at spring runoff

Q13. Where do you think the ditch water exits from the subdivision?

as planned within boundary of subdivision [13]

as planned and further [21]

general direction [31]

seepage into ground [9]

to municipal drain [7]

DK [2]

other [2]

Q14a. Have you changed the way precipitation runs off your property?

yes [32]

no [22]

DK/NR [3]

Q14b. If yes: How?

ditch [10]

fill [22]

change slope [13]

other [7]

Q14c. What was the result?

less water/flooding [10]

access [1]

change/improve flow [11]

other/no result [10]

DK [3]

Q15a. When you were considering buying this property, do you recall being shown a grading and drainage plan for each lot?

yes [17]

no [39]

DK [1]

Q15b. Are you the original owner?

yes [37]
no [14]
NR [6]

3. What is perception about groundwater supply?

Q16a. Who uses groundwater around here?

Everyone [58]
Golf course [4]
Aspect of the natural environment [4]
Industry - from farming to construction [3]
Other [2]

Q16b. If c. Please describe:

Q17a. Do you think groundwater is shared?

yes [43]
no [12]
DK [2]

Q17b. If yes: How is it shared?

tap same source - vein/pool [30]
not all same depth [3]
percolate, seepage elsewhere [4]
other [14]

Q18a. What might affect the quantity of groundwater supply?

seasons/precipitation levels [46]
infiltration capacity - may use words such as seepage/runoff [6]
human-related land use - any industry from farming to quarries [15]
number of users [28]
usage [21]
depth of well [3]
feature of natural environment [7]
other [3]
DK [0]

Q18b. If b or f checked off: Please explain b,f:

source - rock [3]
swamp supply seasonal - role in holding water [3]
change drainage with respect to swamp [6]
other [3]
Not applicable [42]

Q19. Of these, what do you think is the most important factor that determines groundwater quantity?

seasons/precipitation levels	[32]
infiltration capacity - may use words such as seepage/runoff	[0]
human-related land use - any industry from farming to quarries	[3]
number of users	[6]
usage	[8]
depth of well	[1]
feature of natural environment	[7]
other	[0]
DK	[3]

Q20. Please explain what you believe happens underground when a water pump goes on:

Don't know [13]

Explanation: variable

Q21a. In the context of groundwater, do you know what the term "drawdown" refers to?

yes [17]

no [36]

NR [4]

Q21b. If yes: Please explain. Variable responses, often incorrect.

Q22. Do you have a water sourced heat pump/water furnace?

yes [11]

no [45]

NR [1]

Q23. Where is your well and septic system?

side/front/back

Q24. How deep is/are the well(s)?

less than 6m (20 feet) [0]

6-30 m (20-97 feet) [17]

31-65m (98-200 feet) [28]

65-97m (201-300 feet) [11]

over 98 m (300 feet) [0]

DK [1]

Q25. When you were considering buying this property, do you recall being shown a report with proposed locations for your well and septic system on this lot?

yes [19]

no [27]

DK/NR [11]

Q26. How far away do you think your wellwater comes from when your pump goes on?

Less than 50m (150 feet)	[16]	1-5 km (1/2-3 miles)	[2]
50 - 250 m (150 feet-1/4 mile)	[10]	5-25 km (3-15 miles)	[2]
251-1000 m (1/4-1/2 mile)	[1]	over 25km away (over 15 miles)	[1]
		DK	[27]

Q27a. Do you have a sump pump?

yes	[44]
no	[13]

Q27b. If yes: When does it go on? - frequency represents least precipitation required.

constant	[0]
any rain event	[4]
spring snowmelt	[28]
very frequently	[4]
heavy rainfall event	[11]
never	[9]
other	[8]

Q28a. As a rural resident, do any of your activities in the home and on your property have an impact on the quantity of groundwater?

yes	[30]
negligeable	[26]
no	[1]

Q28b. If yes: Please list

usage	[24]
changing environment because of development	[2]
other	[5]

Q29. What is your overall level of confidence in your wellwater quantity on a scale of 1 to 5

1 (not good)	[1]
2 (limited quantity)	[2]
3 (satisfactory)	[4]
4 (very good)	[17]
5 (excellent)	[33]

Q30a. What might affect the quality of groundwater?

human activity in general	[33]
agriculture	[18]
little, because of well depth	[2]
septic	[17]
some aspect of the natural environment	[31]
other	[19]

Q30b. If e checked off: Please explain:

mineral deposits	[17]
gases	[13]
other/source area	[12]

Q31a. Have you had any water quality problems at this location?

yes	[35]
no	[22]

Q31b. If yes, what have they been?

Health-related parameter (bacteria)	[1]
Iron	[14]
Sulphur	[26]
Calcium	[8]
Hardness	[18]
other	[2]

Q32. How often have you had your well tested in the last five years?

1 time	[27]	4 times	[2]
2 times	[9]	5 times	[1]
3 times	[4]	over 5 times	[6]
		none	[8]

Q33a. As a rural resident, do you think your activities in the home and on your property have an effect on groundwater quality?

yes	[20]
negligeable	[18]
no	[19]

Q33b. If yes: How?

discharge from softener	[1]
lawn application	[5]
home activities, including septic and pool, if applicable	[12]
consideration of improvement by being environmentally conscious	[4]

Q34. What is your overall level of confidence in your wellwater quality (with the water treatment system, if applicable):

treatment in place	[11]
no treatment	[42]
NR	[4]

Confidence:

1 (not good)	[0]	
2 (limited)	[5]	
3 (satisfactory)		[13]
4 (very good)	[22]	
5 (excellent)	[17]	

Q35a. Do you have any ongoing general concerns about your wellwater supply?

yes [28]

no [29]

Q35b. If yes: What are they?

effects of heat pumps [0]

effects of surrounding land use [4]

ongoing quantity [12]

ongoing general quality [12]

source [5]

contents [3]

4. What is the perception of wetland ecosystems?

Q36. What do you call a wet part of the landscape that is not a lake?

swamp [27]

bog [5]

marsh [28]

fen [0]

wetland [18]

Q39a. What do you think are good things/negative attributes of wetlands.

Positive

store and cycle nutrients	[4]
store and/or recharge groundwater	[12]
control flooding	[3]
causes flooding	[0]
trap sediment	[4]
protect shorelines	[1]
sink for pollutants	[13]
store carbon	[0]
source of ecosystem biodiversity	[13]
support for species biodiversity	[37]
area requiring human/nature interface	[1]
aesthetic area - sight, sound, smell	[10]
damages flora or fauna	[0]
source of commercial output	[1]
recreation site	[12]
wildlife habitat area	[43]
mosquito breeding area	[2]
natural heritage area	[0]
property with limitations	[2]
property with advantages	[2]
other	[26]

Negative

store and cycle nutrients	[0]
store and/or recharge groundwater	[2]
control flooding	[0]
causes flooding	[5]
trap sediment	[0]
protect shorelines	[1]
sink for pollutants	[1]
store carbon	[0]
source of ecosystem biodiversity	[0]
support for species biodiversity	[1]
area requiring human/nature interface	[1]
aesthetic area - sight, sound, smell	[5]
damages flora or fauna	[3]
source of commercial output	[0]
recreation site	[0]
wildlife habitat area	[0]
mosquito breeding area	[26]
natural heritage area	[0]
property with limitations	[12]
property with advantages	[0]
safety	[3]
other	[15]
none	[13]

Q39c. If answered b, g, i, p, s, t:

Please tell me more about these: - Not applicable to [9]

With respect to groundwater

surface water [4]

runoff/walkoff [1]

sign of water table [7]

source of water [8]

With respect to filtration

purify water [5]

With respect to ecosystem

affect on usenrichment [6]

With respect to habitat

diversity [19]

need for species [20]

circle of life/role/interconnected/balance of nature [20]

interest in nature [10]

concern for loss [3]

other [3]

Disadvantages

property with limitations depends on point of view [5]

Other

privacy/green space [1]

Q37. Where is the closest wetland to the subdivision?

backyard [7]

provincially evaluated [8]

ditch [1]

other roadside visible [12]

study identified [28]

other [3]

DK [1]

Q38. What is it like? Mentioned some aspect of:

flora [28] pond [9]

fauna [34] values [2]

hydrology [40] size [8]

changes seasonal [8] other [21]

Q40. Which of positive and negative characteristics you mentioned do you attach to the wetland closest to your home?

all [21]

identify specific [32]

DK [4]

Q41a. On a scale of 1-5, how much would you care if a local wetland was lost?

not at all	[4]
a little	[4]
moderately	[16]
quite a bit	[15]
a great deal	[18]

Q41b. Why?

quality of life/location/scenic	[18]
wildlife requirement	[8]
part of nature/balance of nature	[12]
no need/other land available	[10]
concern for loss of more wetland	[9]
other reasons for moderate concern	[13]
other reasons for low level of concern	[18]

Q42. What kind of effort would you be willing to put into keeping a local wetland?

physical labour	[19]
lobbying for action by others	[31]
change homeowner habits	[27]
contribute financially	[24]
other activity	[6]
none	[8]
all	[7]

Q43a. Would you be interested to know if wetlands in this area store contaminants?

yes	[57]
no	[0]

Q43b. If yes: Why?

general interest	[7]
impact drinking water	[33]
impact flora/fauna	[13]
to clean up	[3]
general effect on health	[18]
other	[2]
none given	[6]

Q44a. In what ways, if any, do you think human activity might have an impact on the local wetland?

changes due to created building site	[8]
changes due to created subdivision	[22]
changes in drainage	[9]
changes to water table	[1]
source of pollution	[19]
other	[28]
none	[3]

Example of Question 8 basemap - Kanata case study: "Please identify water-related features of the natural environment on this base map - surface water, groundwater, and wet areas". The location of the particular residence was marked for orientation purposes.

APPENDIX III
Sample Introductory Letter

Carleton
UNIVERSITY

Department of Geography
B-349 Loeb Building
1125 Colonel By Drive
Ottawa, K1S 5B6
Tel:(613)788-2600 ext.1837

Dear Resident,

Please let me introduce myself.

I am currently a graduate student in geography at Carleton University and have embarked upon thesis research within the boundaries of the Regional Municipality of Ottawa-Carleton. In particular, I am studying water-related aspects of selected country lot/estate lot developments and their surrounding local environment.

In this regard, I am very interested in talking with homeowners who live in or adjacent to the selected sub-divisions about groundwater, drainage patterns and wetlands. Our exchange would take approximately thirty minutes.

To this end, I will be in contact in the next ten days to determine your availability. In the meantime, please call me if you have any questions at 788-2600, Extension 1837.

Thank you very much for your consideration of this request.

Yours sincerely,

Patricia Larkin

APPENDIX IV

Rational Method

(from Pilgrim and Cordery (1993))

Traditional Approach

The rational method formula is

$$q = F C i A$$

where: q is the peak discharge,

C is the runoff coefficient which is dimensionless and loosely defined as the ratio of runoff to rainfall,

i is the rainfall intensity, and

A is the drainage basin area.

F is a units conversion factor, equal to 0.278 with SI units.

The rational method is widely used around the world for flood estimation on small rural drainage basins and is the most widely used method for urban drainage design. It is generally considered to be an approximate deterministic model representing the flood peak that results from a given rainfall, with the runoff coefficient being the ratio of the peak rate of runoff to the rainfall intensity.

APPENDIX V

Registered Plan of Subdivision Clauses

The following excerpts of the Final Agreements illustrate how these discussions at the draft approval stage translated into the legal subdivision agreement between the proponent and lower tier municipality. Minor revisions to the text are not identified, but major new requirements are indicated.

Drainage concerns were typically in Section 7, Conditions of the Regional Municipality of Ottawa-Carleton were included in Section 39, the Drainage Specifications were included as Schedule H, the Terrain Report as Schedule J, and Special conditions were listed in Schedule P.

Article Five - Public Land Development

5.20 The Owner shall provide the required landscaping and drainage plans, clear all Public Lands of dead trees and underbrush and provide grading, topsoil and seeding or sodding and any other work shown on the plans to the satisfaction of the Township in accordance with Schedule "F" and the timing in Schedule "L".

5.22 The Owner, at its expense, shall fill in low areas of the Public Lands and provide adequate drainage to the satisfaction of the Township in accordance with the Grade Control Plan in Schedule "G" and the Landscaping and Drainage Plan for Parks and Public Lands required by Schedule "F".

Article Seven - Drainage System

The following text was typical in each agreement. Deerwood I only included Sections 7.01 and 7.03, and a number of schedules.

- 7.00 Attached hereto as Schedule "H" is a Drainage Report, accepted in principle by the Township Engineer, which sets out generally all matters which may require consideration with respect to drainage in the drainage area of which the subdivision forms part.
- 7.01 The owner shall construct in accordance with Schedule "H" all works which are necessary to provide proper drainage of all land included in the subdivision and adjacent lands which drain through the subdivision, and including any works necessary for drainage to an outlet outside the subdivision in accordance with Schedule H.
- 7.03 The storm drainage system shall be of sufficient size, depth, and at locations within the limits of the subdivision or on adjacent road allowances, to service lands outside the subdivision which will, in the opinion of the Township Engineer, require the use of the subdivision system.
- 7.04 Such works shall be constructed according to plans approved by the Township and Township Engineer, and before the agreement is executed and commencing construction of any of the works the owner will submit to the Township Engineer for his approval a grade control plan containing the following information:
 - (a) the existing and final elevation of all lot corners.
 - (b) the existing and final elevations at the centre line of each road at a spacing of 100

- feet (30 metres) or less at all street intersections.
- (c) the finished ground elevation at the building line.
- (d) the finished elevation of all critical points beyond the street line.
- (e) arrows indicating direction of flow of all surface water.
- (f) the location and details of all swales.
- (g) the locations and details of all surface water outlets.

The Grade Control Plan may be amended from time to time by the Owner with the written approval of the Township Engineer and such approval shall not be withheld except for sound Engineering reasons.

- 7.05 The Owner shall maintain the drainage system in accordance with Schedule "P" hereto annexed. 7.05

At the time of **Lakeland I**, this text was added:

and on completion of the period during which the Owner shall carry out such maintenance, the Owner or its heirs, executors, administrators, successors and assigns, being the owner or owners for the time being of a lot or lots within the Plan of Subdivision shall reimburse the Township for the cost of the future maintenance of the drainage system by the Township as set out in Schedule "P" hereto annexed.

- 7.06 The Owner agrees not to interfere in any way with any existing drain or water course, without the written permission of the Township Engineer, which shall be deemed to be given on approval of the plans of the works by the Township Engineer. The granting of such permission shall not relieve the Owner of the responsibility for any damage caused by such interference...

Lakeland II addition

- 7.06 (Addition) ... The Owner will indemnify the Township against any claims against the Township relating to damage, provided that the Township will give the Owner at its cost, opportunity to defend such claim.
- 7.07 All contracts of sale and Transfers by the Owner of any lot within the subdivision shall contain the provisions relating to drainage set out in Schedule "Q" hereto annexed.

Kanata I included:

- B(8) The Owner shall prevent the water run-off and soil erosion from any part of the Subdivision under development from entering public water courses or storm drainage facilities at a rate in excess of that consistent with sound engineering practice.
- B(9) The Owner shall carry out such grading or drainage works as may be necessary to prevent or eliminate the ponding of surface water, other than designed or controlled ponding approved by the City.

Kanata II added:

and for all lots, upon completion of rough grading prior to the placement of topsoil and sod, contact the City Engineer to inspect the grading.

Kanata II-**New Section G - Building Permits and Restrictions**

- G(7) (g) Lot grades and slopes shall be maintained in accordance with the drainage plan approved by the MOE and the City and as amended from time to time by the Owner with the written approval of the City Engineer.

The Region's Conditions and Covenants Arising Therefrom:**Deerwood I:**

- 39.01 owner shall inform the prospective purchaser of each lot ... that the purchaser will be responsible for making the lots suitable for septic tank systems by the placing of sufficient granular fill in the locations and standards required by the MOE, to maintain a 3 foot separation between a disposal bed and groundwater.
- 39.03 submit to MOE and MNR a drainage plan indicating both the main ditch levels in relation to the elevations of individual lots and a proposal for adequately carrying surface run-off from each lot and that any improvements to the natural drainage shall be to the satisfaction of the above agencies.
- 39.04 owner shall not fill any of the marsh areas on the site without permission of the MVCA, and further the owner shall include a clause in agreement of purchase and sale indicating that marshy areas will not be filled without permission of the MVCA. This shall be done to the satisfaction of MNR.

Dunrobin I:

- 38.01 That the owner enters into an agreement with the Township of West Carleton to inform all prospective purchasers that no construction or tile bed installation shall occur within the floodplain of the streams which occur throughout the site.
- 38.04 That such easements as may be required for utility or drainage purposes be granted to the appropriate authority.

Deerwood II -

- 39.01 Schedule S - Water and Earth Sciences Associates Limited Report - water well and sewage system design, construction and location.
- 39.02 raised tile beds may be required

Dunrobin II -**New**

Section 39.00 The conditions of the Regional Municipality of Ottawa-Carleton to draft plan approval of the subdivision are hereto annexed as Schedule "F". The Owner shall perform all of the conditions so imposed by the Regional Municipality of Ottawa-Carleton. Certain specific covenants relating to such performance may be set out below but shall not limit the generality of the foregoing.

Deermeadow I -

- 39.00 The Owner shall submit a site drainage and grading plan, showing the intended treatment of the calculated stormwater run-off for review and approval of the Ministry of the Environment and South Nation Conservation Authority. The Owner shall implement the approved drainage and grading plan.
- 41.00 The Owner shall submit an overall grade plan for Lots 1 to 4 inclusive and Lots 48-51 inclusive for review and approval to the Township of Osgoode.
- 43.00 The Owner shall receive the approval of the Ministry of Natural Resources prior to any infilling or alteration of the Middle Castor River.
- 44.00 The Owner shall pay to the Township the drainage assessment under By-Law 77-1990 for the Grey's Creek Municipal Drain at such time as the costs are assessed. Security held by the Township for works required by the Subdivision Agreement will not be released until such assessment is paid in full by the Owner.

Deermeadow II -

- 43.00 The Owner is hereby notified that no buildings, structures or sewage systems shall be located within 30 metres of the top of the bank of Grey's Creek Municipal Drain.
- 43.10 The Owner shall obtain the approval of the Ministry of Natural Resources prior to any filling, dredging or alterations of the shoreline of Grey's Creek Municipal Drain and including the crossing of the Grey's Creek Municipal Drain for access to Lots 5, 6 and 7.

Schedule E**Deerwood I -**

Land Dedications and Easements listed drainage easements included in the plan of subdivision across Parts of Lot 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17.

Deerwood II -

Schedule E - Land Dedications and Easements - as per Figure 7

2. Drainage Easements

- (a) on the subject lands - 1) Part of Lot 8, 9, 12, 13, 14, 15, 16
- (b) on the adjoining lands - Part of the South half of Lot 1, concession 6, designated as Part 1, Plan 5R-8028

Deerwood III:**Schedule E - Land Dedications and Easements**

Future road extensions - Blocks 39 and 43

2. Drainage Easements

- (a) on the subject lands - over parts 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 - Schedule R
- (b) on the adjoining lands - Part of the south half of Lot 2, concession 6, designated as Part 1, Plan 5R-9808; Part of the north half of Lot 1, Concession 6, designated as part 3, plan 4R-5320

Schedule F**Deerwood I -**

Region's Conditions repeated text noted above in Section 39.

In Goulboun, Schedule "F" is Standard Engineering Specifications - Estate Lot Subdivisions

Part 1 Drainage System

Part 3 Roads

Part 9 Public Land Development
 Part 12 Overall Grade Control Plan Requirements

Kanata I -

New Schedule F - Part 2 Engineering Plans Requirements

A. Submission of Plans and Documents

Step 1 A drainage and erosion control report must be prepared and submitted by the Owner regarding drainage outlets, land uses, densities, erosion control measures, etc. Approval of the report by the City Engineer is required before designs are submitted and construction is commenced.

Step 2 Submit three complete sets of the following for examination and approval

c) Grade Control Plan (based on the plan to be registered) Schedule G as described later

d) Storm Drainage Plan showing drainage within the subdivision and the limits of areas outside the plan draining into the proposed storm system. The runoff co-efficient and area shall be shown for the areas outside the plan and for each section of the open ditch storm drainage system in the Subdivision. The directions of drainage from all design section areas must be shown.

C. The Overall Grade Control Plan Requirements

Before commencing construction of any of the works the Owner shall submit to the City for approval a grade control plan(s) containing the following information:

2. Existing contours established from elevations taken in the field for the area under consideration, including a sufficient area of the adjacent lands outside the Subdivision to establish the overall drainage pattern. The contours are to be to geodetic datum and bench mark description shown on the drawing.

4. Existing and proposed drainage Works including drainage depressions and open channels, including proposed drainage provisions along lot lines.

5. For each individual lot or block:

e) Arrows indicating direction of flow of all surface water

f) The locations and details of all swales.

g) The locations and details of all surface water outlets.

6. The grade control plan(s) for each individual lot shall be developed using the following minimum standards.

(a) Yard surfaces shall have a minimum slope of 1.5%

(b) Drainage flows shall be directed away from structures

(c) Drainage flows which are carried around structures are to be confined in defined swales located as far from the structure as possible.

(d) Desirable swale depth to be 250 mm. Minimum swale depth to be 150 mm.

Maximum swale depth to be variable, dependent on location and safety considerations, but in no event shall swale depth exceed 0.6 m.

(e) Grades:

i) Swales minimum grade shall be 1.5 %

ii) The maximum flow allowable in the side yard swale shall be that from 6 backyards

f) The maximum flow in rear yard swales where an open drainage system is used shall be that from 10 to 20 backyards, depending on lot size and grade, but maximum length of a rear yard swale without outlet shall be 150 m, and the maximum area to the rear

yard swale shall be 1.0 ha. The maximum flow in yard swales which may be discharged directly onto the road allowance is that from 6 backyards.

g) The maximum flow to a back yard catchbasin shall be that from 8 back yards of lots equivalent in size to lots with an average frontage of 20m, unless the natural or regraded topography provides grades which permit flow from a larger number of lots without increasing the risk of ponding or flooding, and then only with the approval of the City.

- ii) The transferee shall not alter the slope of the lands described herein or interfere with any drains established on the lands except in accordance with the established final grade control plan of the City unless authorized to do so in writing by the City.

Kanata III -

New Schedule F - Standard Engineering Specifications

Rural Residential Subdivision

Part 10 - The Overall Grade Control Plan Requirements

Before commencing construction of any of the works the Owner shall submit to the City for approval a grade control plan(s) containing the following information:

2. Existing contours established from elevations taken in the field for the area under consideration, including a sufficient area of the adjacent lands outside the Subdivision to establish the overall drainage pattern. The contours are to be to geodetic datum and bench mark description shown on the drawing.

4. Existing and proposed drainage works including drainage depressions and open channels including proposed drainage provisions along lot lines.

6. The grade control plan(s) for each individual lot shall be developed using the following minimum standards.

(a) Yard surfaces shall have a minimum slope of 2% for a minimum distance of 7.6 metres (25 ft)

(b) Drainage flows shall be directed away from structures

(c) Drainage flows which are carried around structures are to be confined in defined swales located as far from the structure as possible.

(d) Desirable swale depth to be 250 mm. Minimum swale depth to be 150 mm.

Maximum swale depth to be variable, dependent on location and safety considerations, but in no event shall swale depth exceed 0.6 m.

(e) the maximum side slope on swales shall be three horizontal to one vertical.

(f) A flat area (original ground) having a width of 1 m shall be provided at the boundary limits of the Subdivision in order that the existing boundary elevations shall be maintained.

Part 11 - Requirements for Submission of Plans and other documents for Engineering works.

A Submission of plans

Step 1 A drainage and erosion control report must be prepared and submitted by the Owner regarding drainage outlets, land uses, densities, erosion control measures, etc. Approval of the report by the City Engineer is required before designs are submitted and construction is commenced.

Step 2 Submit three complete sets of the following for examination and approval

c) Grade Control Plan (based on the plan to be registered) Schedule G as described later

d) Storm Drainage Plan showing drainage within the subdivision and the limits of areas outside the plan draining into the proposed storm system. The runoff co-efficient and area shall be shown for the areas outside the plan and for each section of the open ditch storm drainage system in the Subdivision. The directions of drainage from all design section areas must be shown.

Schedule "I" - Standard Roadway Specifications

Deermeadow only -

8. Subdrains

(a) Subsurface drainage shall be provided below all roadside ditches and shall consist of minimum 100 mm diameter corrugated perforated heavy duty plastic tubing with filter cloth covering; "Big O" or approved equal. The top of the pipe shall be placed 300 mm minimum below the ditch bottom elevation and shall be backfilled with 19 mm clear stone except for 80 mm topsoil in the ditch bottom. Where runs of pipe exceed 1,000 metres the size shall be increased to 150 mm in diameter.

In areas where steep grades are available in excess of two percent or where very pervious native soil exists without a high watertable, the Township Engineer may approve roadside ditches without subdrains.

(b) Subdrains - Estate Lot Subdivision

Subsurface drainage in accordance with the specifications for "Subdrains Residential" shall be provided in areas susceptible to poor drainage when directed by the Township Engineer.

Schedule P - Special Conditions

Kanata I -

4. The Owner acknowledges the following and agrees to advise prospective lot purchasers of the following:

- a. that lots shall be made suitable for the installation of sewage systems prior to or at the building permit stage, to the satisfaction of the MOE, ... and in accordance with the recommendations contained in Section 4.2(a)(b)(c) of the Terrain and Hydrogeological Analysis of the site prepared by Water and Earth Sciences Associates, Ltd.;
- c. that raised tile beds may be required on each lot.

6. The Owner acknowledges the following and agrees to advise prospective lot purchasers of the following:

- e. that lot grades and slopes shall be maintained in accordance with the drainage plan for the whole subdivision as approved by the MOE and the City of Kanata ...

23. That the owner ensure, to the satisfaction of the MVCA, that there by "zero" increase in runoff relative to the existing rates of runoff.

Kanata II -

1. The Owner shall attach to all Offers of Purchase and Sale Agreements with prospective purchasers of the lots in this Subdivision, a copy of the Schedule "P" Special Conditions of the Subdivision Agreement.

General Information for Purchasers

The Purchaser of any lot or block within the Plan of Subdivision are advised of the following (emphasis in original):

- a) **That** the Owner is to provide in all Offers of Purchase and Sale Agreements with prospective pruchasers of lots or blocks within the Subdivision an actual size copy of the approved lot grading and drainage plan as well as a copy of the recommendations from the approved terrain analysis and hydrogeology report for this Subdivision.
- b) **That** the location of all sewage systems and water wells within each lot shall be in accordance with the approved terrain analysis and hydrogeology report recommendations and to the satisfaction of the Ministry of the Environment.
- e) **That** all lot grades and slopes shall be maintained in accordance with the drainage plan for the whole subdivision as approved by the MOE and the City ...

2. Storm Drainage

The owner shall prepare and submit to the City and the RMOC Works Department for approval a report dealing with the control measures required to prevent the adverse affects on the environment from stormwater runoff. Any proposed control measures shall be to the satisfaction of the MOE. Approval of related storm drainage facilities will depend upon the resolution of stormwater management concerns for the subject lands. In addition, should stormwater treatment dams be required, application must be made under the Lakes and Rivers Improvement Act, 1980 to the MNR, Kemptville.

3. Before final approval is given to this plan, a Storm Water Design Plan for the subject lands and proposed roads will be prepared by/for the Owner and approved by the MNR, the MOE, the MVCA and the City of Kanata. This storm water design plan shall be complementary to the lands adjacent to this subdivision and shall include lot grades, ditch bottom elevations, location of swales and outlets from the property, cross section of ditches or swales to be used as collectors and an indication of off-site disposal with details of outfall to existing municipal drains or other waterways. Lot grades and slopes shall be maintained in accordance with the approved Storm Water Design Plan.
4. The owner shall, prior to registration of this Agreement, contribute \$100.00 per lot towards the cost of a Master Drainage Area Study for rural Kanata and a further contribution of up to \$500.00 per lot for remedial work required on the drainage channel downstream of this property as determined by the said study.
13. The Owner shall include statements in the Subdivision Agreement with the City of Kanata and in the Offer of Purchase and Sale Agreements with prospective lot purchasers, in wording acceptable to the MOE, advising:

- a) that raised tile beds may be required and that the lots shall be made suitable for the installation of sewage systems prior to or at the building permit stage to the satisfaction of the Ministry of the Environment in accordance with Ontario Regulation 374/81 made under the Environmental Protection Act, 1980; and
- j) that the Storm Water Design Plan be made available to lot purchasers as a guide to development;

Kanata III -

- 13. The Owner agrees to undertake the following works on Lot 1 of the Plan, the park lot, within 12 months of registration:
 - vi) Fill in any low or depressed areas to ensure positive drainage of the entire park site to the approval of the City of Kanata Landscape Architect.

Schedule "Q" - Building Restrictions and Transfer Covenants

Lakeland I -

2. Transfer Covenants

- (1) The following covenants shall be incorporated in all contracts for sale and in all Transfers from the Owner with the express intent that they shall be binding upon the heirs, executors ...

(a) "The Transferor for himself, his heirs, executors, administrators, successors and assigns covenants and agrees that he will not alter the slope of the lands described herein nor interfere with any drains established on the said lands, except in accordance with the established grade control plan, without the written consent of the Township Engineer of the Township of Osgoode.

(b) The Transferee for himself, his heirs, executors, administrators, successors and assigns covenants and agrees that he will not fill in any ditches or swales on the lands described herein or in any road ditch adjacent to the said lands nor install any storm sewer in any such ditches or swales including road ditches adjacent to the said lands without the prior written consent of the Township Engineer of the Township of Osgoode.

Dunrobin I -

Addition

- 1. (a) ... written consent of the Township Engineer of the Township of West Carleton. In addition, the transferee agrees to maintain that part of its lands subject to a drainage easement free of buildings or other structures or new shade or ornamental trees.

Lakeland II, Deermeadow I -

Same as listed in Lakeland Phase I except:

2. Transfer Covenants

- (e) The Transferee for himself, his heirs, executors, administrators, successors and assigns covenants and agrees that he shall not cause or permit the discharge of water from a sump pump on his lands directly into any ditch or drain located on any public highway adjacent to his lands. However, sump pump outlets may discharge into entrance pipes provided the sump pump pipe is inserted into the pipe a minimum length of one metre and the Transferee provides a check valve on the sump pumps.

(j) The Transferee for himself, his heirs, executors, administrators, successors and assigns covenants and agrees to protect and repair any damage caused to subdrain pipes which are located under roadside ditches.

(k) The Transferee acknowledges that the lands are subject to a drainage report for the Grey's Creek Municipal Drain prepared pursuant to the Drainage Act, R.S.O. 1980 c. 126 which may result in assessment for drainage works against the lands of the Transferee.

Deermeadow II -

Same text as Phase I, except:

2. Transfer Covenants

(k) Revised - The Transferee for himself, his heirs, executors, administrators, successors and assigns acknowledges that the lands of this subdivision are within the watershed of the Grey's Creek Municipal Drain and therefore subject to a drainage report prepared pursuant to the Drainage Act, R.S.O. 1990 c. D.17 which may result in assessment for drainage works against the lands of the Transferee.

Schedule "R" - Phasing Requirements (for lands described as Phase I in this Report)

General

1. The lands described in Schedule "A" shall be developed in 2 phases, in numerical sequence, the phases to be known as Phase I and Phase II. The following lots shall be included in Phases listed below:

Phase	Lots
1	7 to 46 inclusive
2	1 to 6 inclusive and 47 to 51 inclusive

Requirements to Proceed to next Phase

3. Before the Regional Municipality of Ottawa-Carleton authorizes the Owner to proceed with any work in Phase II and before the Region retransfers the 0.3 metre reserves [referred to above), the operation of wells and private sewage disposal systems in the previous phase of development shall be shown to be satisfactory based on direction from the Ministry of the Environment.

Schedule "R" - Phasing Requirements

Deermeadow II - for lands described as Phase II in this Report

General

1. The lands described in Schedule "A" shall be developed in 2 phases, in numerical sequence, the phases to be known as Phase I and Phase II. The following lots shall be included in Phases listed below:

Phase	Lots
1	1 to 11 inclusive and 28 to 56 inclusive
2	12 to 27 inclusive

Requirements to Proceed to next Phase

3. Before the Regional Municipality of Ottawa-Carleton authorizes the Owner to proceed with any work in Phase II and before the Region retransfers the 0.3 metre reserves [referred to

above), the operation of wells and private sewage disposal systems in the previous phase of development shall be shown to be satisfactory based on direction from the Ministry of the Environment.

APPENDIX VI

Selected Costs of Subdivision Works

**According to Schedule C or D, in each Registered Plan of Subdivision:
Estimated Cost of the Works/Works to be Constructed by Owner.
Total is cost for all works, of which those listed are only a part.**

Dunrobin I	Cost
Road Construction	\$136,500
Ditch Cleaning	\$3,500
Total	\$179,000

Dunrobin II Estimates are based on 1985 dollars.

(a) Excavation and Fill up to Subgrade	\$21,200
(e) Road ditches	\$26,600
(g) Drainage Ditches and Swales	\$4,700
Total	\$227,000

Deerwood I

A. Roadways	
1. Roadside Ditching	\$2,500
2. Culverts, Subdrains, Rip Rap	\$ 51,200
B. Storm Drainage (Excluding Internal Roads)	
1. Offtake ditches and swales	\$ 14,550
2. Municipal Drain Improvements	\$2,700
Total	\$443,350

Deerwood II Estimates are based on 1984 dollars

Excavation and Fill up to Subgrade	\$12,000
Road Ditches	\$8,000
Drainage Ditches and Swales	\$2,000
Total	\$125,000

Deerwood III

Clearing and Grubbing	\$26,000
Excavation and Fill up to Subgrade	\$38,000
Road Ditches and Culverts	\$67,000
Drainage Ditches and Swales	\$20,000
Rip Rap Erosion Protection	\$3,000
Rock Removal	\$5,000
Total	\$377,000

Kanata I

	Cost
A1 Open ditch storm drainage system	\$8,000
Culverts	\$2,000
A6 Lot Grading	NA
A7 Trees and Lands	\$8,000
A8 Seeding	\$15,000
Total	\$187,500

Kanata II

A1 Open ditch stormwater drainage system	\$10,000
A6 Grading, sodding and seeding	\$17,000
A8 Gree Planting, Landscaping	\$13,000
Total	\$141,125

Kanata III

A1 Open ditch stormwater drainage system	\$9,400
A2 Culverts, Erosion protection works	\$8,120
A6 Lot Grading, sodding and seeding	\$nil
Fill as per grading plan	
A10 Fences and park	\$5,000
Total (all works)	\$214,750

Lakeland I

Storm drainage	\$5,500
Roads	\$213,500
Total	\$219,000

Lakeland II

A. Roadways	
1. Grading and Drainage	\$45,000
B. Storm Drainage (Exclusive of Roadways)	
Outlet Drainage Ditches	\$3,000
Total estimated costs	\$122,000

Estimates are based on 1990 dollars.

Goulbourn (Schedule D)

3. Storm drainage system	\$20,000
9. Park Development	\$9,000
12. Lot Grading and Landscaping	See below*
13. Major Grading of Lots	\$10,000
Total	\$263,600

*Note: No specific deposit is required for lot grading and landscaping, however, a sum of \$500.00 per lot will be retained as part of the security deposit until the landscaping and grading is completed.

Deermeadow I	Cost
A. Roadways	
1. Roadside Ditching	\$2,500
2. Culverts, Subdrains, Rip Rap	\$51,200
B. Storm Drainage (Excluding Internal Roads)	
1. Offtake ditches and swales	\$14,550
2. Municipal Drain Improvements	\$2,700
Total	\$443,350

Deermeadow II	
B. Storm Drainage	
1. Ditches within Subdivision	\$17,500
2. Outlet Ditches	\$20,800
3. Culverts	\$20,000
Total	\$600,000

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Dunrobin: 10 18 4150 50250

Deerwood: 10 18 4050 50200, 10 18 4100 50200

Kanata: 10 18 4200 50200, 10 18 4200 50250

Lakeland: 10 18 4500 50050, 10 18 4500 50100, 10 18 4550 50100,

10 18 4550 50050

Goulbourn: 10 18 4250 50050, 10 18 4300 50050

Deermeadow: 10 18 4500 50050

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AIR PHOTO REFERENCES

Air Photos from the National Air Photo Library, Natural Resources Canada

Case Study	Pre-development Air Photo	Post-development Air Photo
Dunrobin	A23967-156 May 13, 1975 1:9440	A28048-104 May 3, 1994 1:10000
Deerwood	A23968-28 May 13, 1975 1:9160	A28048-104 May 3, 1994 1:9100
Kanata	A23967-203 May 13, 1975 1:7290	A28048-103 May 3, 1994 1:7820
Lakeland	A26472-29 May 21, 1984 1:9760	A28051-23 May 4, 1994 1:9640
Goulbourn	A26482-76 June 2, 1984 1:9370	May 4, 1994 A28051-28 1:9750
Deermeadow	A26472-29 May 21, 1984 1:9760	A28051-23 May 4, 1994 1:9640

Precipitation records:

30 year average: 422.3 mm, November 1- May 1.
 1994 423.1 mm (average)
 1984 550 mm (30% above average) Goulbourn, Deermeadow, Lakeland,
 where pre-development wetlands taken predominantly from soil maps,
 so effect of air photo delineation reduced.
 1975 435.9 mm (17.16 in) (3% above average)