

# Middlesex-Elgin Groundwater Study

## *Executive Summary*

In Middlesex County and Elgin County, groundwater is a major source of potable water for domestic, industrial and agriculture uses. Approximately 86,000 people in this area rely on a groundwater source for their potable water supply from a groundwater source. Groundwater is also an integral component of the water cycle and water resource ecosystems.

The municipalities within Middlesex and Elgin commissioned a groundwater study to assess existing groundwater conditions and to recommend management and protection practices to maintain the quantity and quality of the groundwater resource. The Ontario Ministry of the Environment has provided funding to complete groundwater studies throughout Ontario. The primary goals of these studies are to examine groundwater resources at a local and regional level, and to identify potential risks to these resources. The studies include delineation of wellhead protection areas for municipal wells, mapping of groundwater recharge and discharge areas, and identification of sensitive groundwater areas.

On a regional level, aquifer recharge and discharge areas are identified. As well, potential contaminant sources are assessed on a regional basis. Groundwater use is researched to provide information on how much water is used, and what it is used for (e.g., agricultural, commercial, industrial or residential purposes).

### **Study Objectives**

The principal objective of this study was to develop a detailed understanding of the groundwater resources in Middlesex and Elgin (Bayham Township in east Elgin, was not part of this study but is part of the Norfolk County Groundwater Study, east of Elgin). From this knowledge, management strategies can be developed to protect groundwater resources both as a safe supply of potable water for current and future generations and to protect the water resource ecosystem. To fulfill this objective, several separate but related work tasks were performed, including:

- i) characterization of regional groundwater flow systems including areas of significant groundwater recharge and discharge;
- ii) assessment of the water resource capabilities of the regional aquifers;
- iii) mapping of areas vulnerable to groundwater contamination;
- iv) compilation of data relating to the existing use of the groundwater resource;
- v) assessment of current long term sustainability of the groundwater resource;
- vi) definition of Wellhead Protection Areas (WHPAs) for the municipal well systems for the

communities where similar studies have not been conducted;

- vii) identification of major existing and potential sources of groundwater contamination and their present/potential impact on both groundwater and surface water; and
- viii) development of recommendations for groundwater management and protection strategies that can be implemented at the County level.

Data generated and compiled during this study was placed into a Geographical Information System (GIS) to facilitate future manipulation and presentation of data.

### **Study Approach**

Implementation of the study task was conducted in the following four parts.

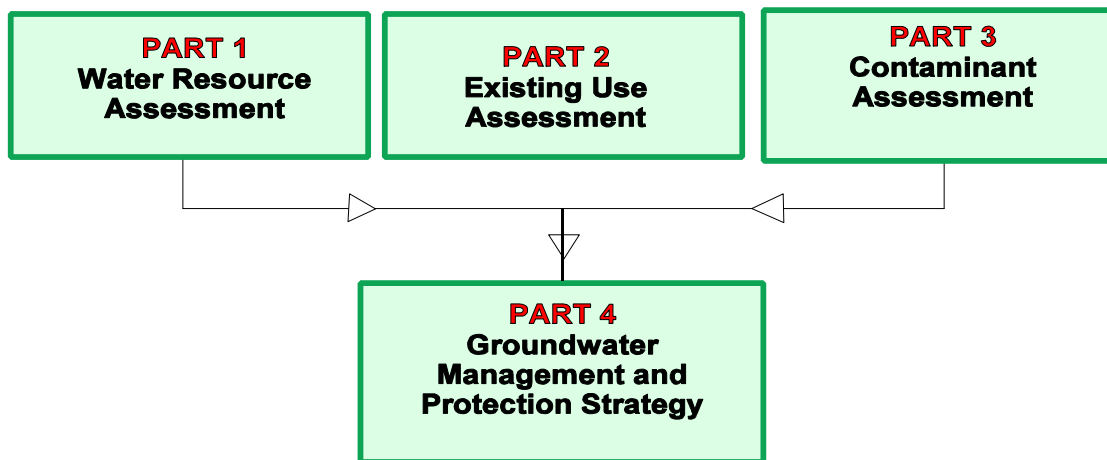
**PART 1:** Understanding and Assessment of the Regional Groundwater Resource

**PART 2:** Assessment of the Existing Use of Groundwater in the Study Area

**PART 3:** Evaluation of Potential Contaminant Sources

**PART 4:** Evaluation of Groundwater Management and Protection Measures

The results from the two three steps were used as input into the evaluation of future groundwater management and protection measures. The relationship among the four parts of the study is presented below.



Overall management of the study was provided by the Upper Thames River Conservation Authority and direction for the study was provided by a Steering Committee, made up of political, technical and municipal staff representatives and from several stakeholder groups. The purpose of the Steering Committee was to provide input and direction to the consultants during the undertaking of the study.

## **Summary of Findings**

The findings of the main four study tasks are as follows:

Groundwater in Middlesex and Elgin is highly influenced by the glacial geology of the area. The sand plains, clay plains and moraines in the Study Area all effect groundwater resource in terms of recharge, protection of underlying aquifers or discharge to surface water.

Within Middlesex and Elgin, there are three main types of potable water aquifers: shallow unconfined overburden aquifers, intermediate to deep overburden aquifers that are protected by overlying low permeability clay and till soils, and bedrock aquifers. Approximately 75 percent of all water wells pump from overburden aquifers.

The two major bedrock aquifers include a limestone aquifer located in the north-central part of Middlesex County and a shale aquifer located near the western border of Middlesex. The limestone aquifer produces adequate quantities of groundwater and generally has good quality (with elevated water hardness). The shale aquifer is more marginal and produces less water with poorer water quality.

The overburden aquifer can be divided into three aquifer types: surficial unconfined sand and gravel aquifers associated with sand plains (glacial lake origin) or former glacier meltwater streams. There are also aquifers found below low permeability soils like clay and till referred to as intermediate depth confined overburden aquifers and deeper overburden confined aquifers. These aquifers tend to be very local in nature and cannot be mapped on a regional basis.

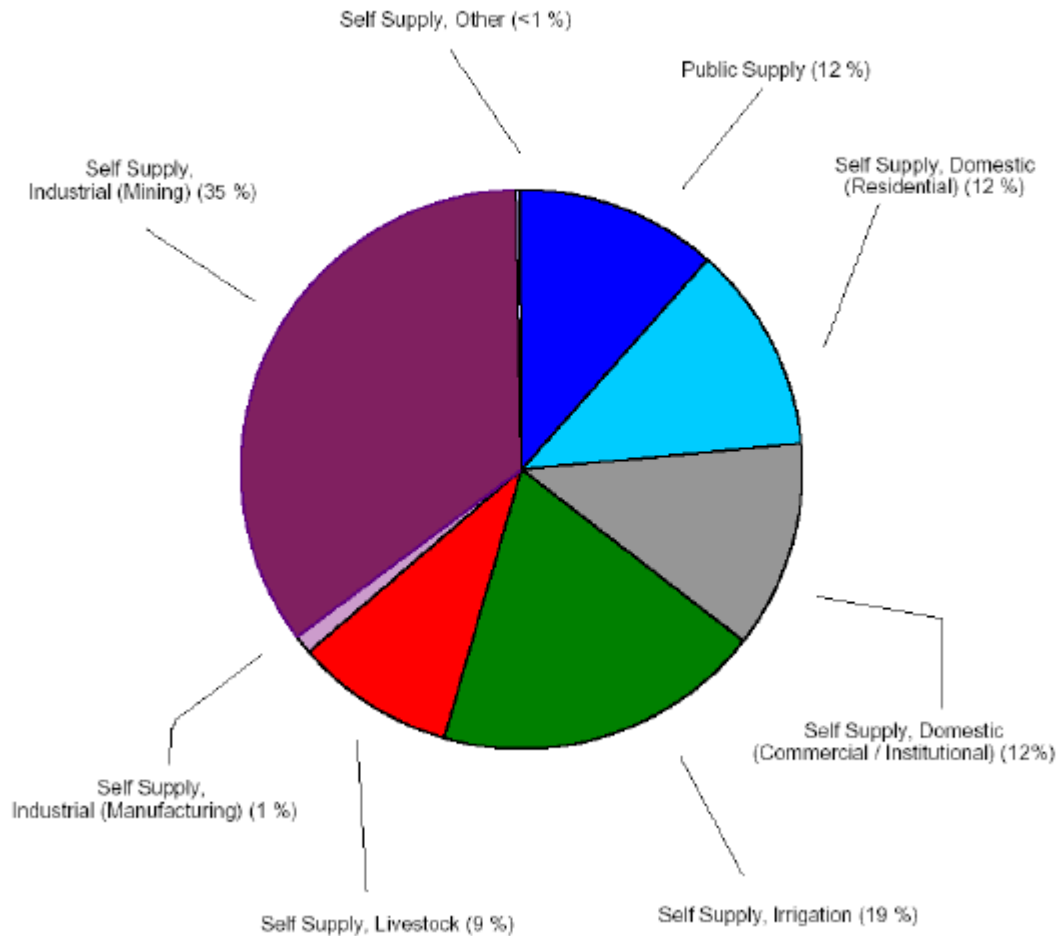
Groundwater flow is influenced by topography and the surface water drainage system, but regional flow is generally from northeast to southwest in the bedrock. The bedrock flow system is similar to the overburden system with the exception in north Middlesex, mainly in Lucan-Biddulph, where water in bedrock wells are quite low, below the overburden/bedrock interface. This is a regional condition also identified in Perth County and Huron County, north of Lucan-Biddulph.

Groundwater recharge areas were identified mainly associated with the moraines in the area, which tend to be topographical highs. The Lucan-Biddulph area was also identified as a recharge area caused by the low water level in the bedrock. Recharge areas are in the stream and river valleys, notably the Thames River and the incised creeks that feed into Lake Erie (Catfish Creek, Kettle Creek and Talbot Creek) as well as the Ausable River along the western border of North Middlesex.

Aquifers vulnerable to contamination have been identified using the Ministry of the Environment Intrinsic Susceptibility Index (ISI) method. Aquifers that are most vulnerable to impacts are the

surficial sand and gravel aquifers. These cover a large part of south Malahide and Central Elgin, almost all of Strathroy-Caradoc as well as significant part do the City of London, and the Dorchester area. Deeper aquifers are much better protected than shallow aquifers.

Over 86,000 people in Middlesex and Elgin depend on groundwater as their potable water supply. Of this number, over 26,000 people receive water from a municipal groundwater supply system. The following chart summarizes the different uses of groundwater in Middlesex and Elgin.



Potential sources of contamination were assessed by developing an inventory of potential contaminant sources across the study area, and assigning a geographic coordinate to each source where possible. A detailed methodology was developed and documented when conducting this inventory, such that the procedure can be repeated when newer or more accurate data become available. The distribution of potential contaminant sources across the study area indicate, not surprisingly, the majority of the point contaminant sources such as gas stations, PCB storage sites,

dry cleaners and manufacturing facilities are located in and around the urban areas, particularly London and St. Thomas. Landfill sites are more broadly distributed, with both active and closed landfills in all area municipalities. A detailed assessment of spreading agricultural and non-agricultural (biosolids) nutrients, road salting practices, landfills and industrial and commercial chemical usage is provided.

Wellhead protection areas around six municipal groundwater supply systems. Three of these systems, Thorndale, Birr and Melrose, and relatively small systems and more importantly, their aquifer, are protected by an aquitard consisting of a thick layer of clay and silt soils. Protection planning for these systems should centre on maintaining the integrity of the aquitard with the decommissioning of unused water wells and the proper construction of new wells being the major issues. The Dorchester aquifer is an unconfined aquifer which receives water from Dorchester Creek in a relatively short time period. Protection planning for this system should centre on land uses along the margins of the Dorchester swamp and also maintaining the good ecosystem of the Swamp. Komoka-Kilworth has an aquifer that is mainly protected from surface contaminants but is in an area of complex geology. Protection planning for this area should include both land use considerations as well as maintaining the integrity of the clay soils overlying the aquifer.

Groundwater management and protection in Middlesex and Elgin is the responsibility of several levels of government, public organizations and the general public. The groundwater resource management measures for Middlesex and Elgin were developed according to these two areas of consideration. First, land uses and activities that could affect groundwater resources within the study area were considered. Secondly, specific groundwater resource features were defined and described including wellhead protection areas, water recharge areas, and ISI areas. The table at the end of this Executive Summary provides a detailed summary of the groundwater management issues evaluated and the associated protection measures developed. The following “first principles” were used developing this strategy:

- C **Utilize planning tools for smart growth:** The existing land use planning regime in Ontario provides both the policy direction and mechanisms for a “multiple barrier” approach to groundwater protection. The Provincial Policy Statement issued under the Planning Act promotes wisely managed growth resulting in communities which are environmentally and economically sound, and specifically refers to the need to protect or enhance the quality and quantity of groundwater and surface waters. Municipal Official Plans, secondary plans, subwatershed plans, and stormwater management master plans can provide or contribute to overall policies for the management, wise use and protection of water resources. Zoning By-laws, development controls, site plans and by-laws for property standards, water use, and tree-cutting can play a key role at the issue or site-specific level. This can include directing growth to urban areas and rural settlement areas, to lands that are suitable for development. It would also involve implementation of servicing policies that encourage development on full or communal services, and discourage multi-lot development on individual services. Some municipalities, such as Halton and Peel, prohibit communal services because they are concerned that they will be forced to assume control and ownership of the systems.

- C **Adopt a watershed approach with Conservation Authority leadership:** Water resources - both surface and groundwater - are best understood, monitored, managed, protected and enhanced from a watershed ecosystem perspective. This allows comprehensive consideration of water balance, water quantity, and water quality, as well as water-related natural features, terrestrial resources, aquatic life, and other key ecosystem indicators. Groundwater resource management plans and activities should be undertaken within a watershed framework. The 36 Conservation Authorities in Ontario were founded on the watershed approach to resource management and, with local municipal support, they have provided leadership in water resource management for more than half a century. Their established structure and base of expertise provides a foundation for a continued leadership role in water resource management and, with appropriate funding and resources, they would be well placed to lead the development and implementation of a watershed-based approach to groundwater protection.
- C **Better enforcement of existing rules:** An extensive array of laws and regulations already exist that specify requirements relevant to the protection of water resources. Additional resources for and improved enforcement of the existing regulatory requirements would be very beneficial in achieving groundwater resource management goals.
- C **Coordination of activities among government and agencies:** Various federal and provincial government departments, municipalities, conservation authorities, and health units have responsibilities related to water resource management and protection. Improved communication and coordination of effort among these responsible parties, including working agreements, partnerships, and data and resource sharing, would result in more efficient use of available resources and greater effectiveness in management of the groundwater resources.
- C **Encourage a “living strategy” with continuous improvement:** A groundwater resource management strategy will, at any point in time, be the product of the technical data available, the environmental context, and the laws and regulations in place during its development. Updates and improvements will be needed through further studies and ongoing monitoring to allow for appropriate refinements and improvements. Establishment of a regional Groundwater Strategy Implementation Committee would assist in the continuous improvement process.
- C **Build upon and expand non-regulatory programs:** Regulation and enforcement have a role to play in providing safeguards for the environment and in ensuring the remediation of negative effects. However, non-regulatory initiatives are often more influential in raising awareness of environmentally sound practices and behaviours, and in encouraging such practices to become part of day-to-day activities. There are many non-regulatory programs in Ontario aimed at improving practices that have the potential to impact on water resources. These include the educational programs, stewardship activities, and funding initiatives that have been or are being undertaken by conservation authorities, agricultural associations, health units, and community groups, either individually or in partnership with provincial or

municipal organizations. With appropriate funding and resources, these groups have the depth of experience and local knowledge needed to continue to develop and deliver these important non-regulatory components of groundwater protection and management.

**Middlesex-Elgin Groundwater Study:  
General Principles for Groundwater Management**

<b>General Principle</b>	<b>Description</b>
Utilize planning tools for smart growth	The existing land use planning regime in Ontario provides both the policy direction and mechanisms for a “multiple barrier” approach to groundwater protection. The Provincial Policy Statement issued under the Planning Act promotes wisely managed growth resulting in communities which are environmentally and economically sound, and specifically refers to the need to protect or enhance the quality and quantity of groundwater and surface waters. Municipal Official Plans, secondary plans, subwatershed plans, and stormwater management master plans can provide or contribute to overall policies for the management, wise use and protection of water resources. Zoning by-laws, development controls, site plans and by-laws for property standards, water use, and tree-cutting can play a key role at the issue or site-specific level. This can include directing growth to urban areas and rural settlement areas, to lands that are suitable for development. It would also involve implementation of servicing policies that encourage development on full or communal services, and discourage multi-lot development on individual services.
Adopt a watershed approach with Conservation Authority leadership	Water resources - both surface and groundwater - are best understood, monitored, managed, protected and enhanced from a watershed ecosystem perspective. This allows comprehensive consideration of water balance, water quantity, and water quality, as well as water-related natural features, terrestrial resources, aquatic life, and other key ecosystem indicators. Groundwater resource management plans and activities should be undertaken within a watershed framework. The 36 Conservation Authorities in Ontario were founded on the watershed approach to resource management and, with local municipal support, they have provided leadership in water resource management for more than half a century. Their established structure and base of expertise provides a foundation for a continued leadership role in water resource management and, with appropriate funding and resources, they would be well placed to lead the development and implementation of a watershed-based approach to groundwater protection.



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Coordination of Activities among government and agencies	Various federal and provincial government departments, municipalities, conservation authorities, and health units have responsibilities related to water resource management and protection. Improved communication and coordination of effort among these responsible parties, including working agreements, partnerships, and data and resource sharing, would result in more efficient use of available resources and greater effectiveness in management of the groundwater resources.
Encourage a “living strategy” with continuous improvement	A groundwater resource management strategy will, at any point in time, be the product of the technical data available, the environmental context, and the laws and regulations in place during its development. Updates and improvements will be needed through further studies and ongoing monitoring to allow for appropriate refinements and improvements. Establishment of a regional Groundwater Strategy Implementation Committee would assist in the continuous improvement process.
Build upon and expand non-regulatory programs	Regulation and enforcement have a role to play in providing safeguards for the environment and in ensuring the remediation of negative effects. However, non-regulatory initiatives are often more influential in raising awareness of environmentally sound practices and behaviours, and in encouraging such practices to become part of day-to-day activities. There are many non-regulatory programs in Ontario aimed at improving practices that have the potential to impact on water resources. These include the educational programs, stewardship activities, and funding initiatives that have been or are being undertaken by conservation authorities, agricultural associations, health units, and community groups, either individually or in partnership with provincial or municipal organizations. With appropriate funding and resources, these groups have the depth of experience and local knowledge needed to continue to develop and deliver these important non-regulatory components of groundwater protection and management.

**Middlesex-Elgin Groundwater Study:  
Summary of Groundwater Management Issues and Measures**

Category/Issue	Provincial Role	Municipal Regulatory Options	Non-Regulatory Initiatives
<b>Wells, Septic Systems and Tanks</b>			
<i>Water Well Construction, Maintenance and Decommissioning</i>	Regulation 903	municipalities could use their powers related to development approvals and servicing to ensure that the requirements of Regulation 903 are being followed within the municipality	develop a closer working relationship with MOE to focus their efforts on particularly troublesome local areas
	Healthy Futures for Ontario funding	municipalities could require proof of proper abandonment of unused water wells, monitoring wells or boreholes as a condition of development approval (i.e. for demolition permits, applications for consent, site plan approvals and subdivision approvals)	identify a group member to act as a local education and liaison representative regarding well drilling and decommissioning programs within the region

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Summary of Groundwater Management Issues and Measures**

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	It is recommended that the Provincial role with respect to well construction, maintenance and decommissioning be improved by:	municipalities could require proof of proper abandonment of unused water wells, monitoring wells or boreholes as a precondition for hook-up to a municipal water system; for hook-up of an existing hamlet this would require proof of decommissioning of all the individual wells; grants for municipal water hook-ups could include funding for well decommissioning, with provision to amortize the cost over several years	develop an abandoned well identification and location program in conjunction with MOE to identify specific wells which require decommissioning
<b><i>Water Well Construction, Maintenance and Decommissioning (cont'd)</i></b>	allocating more staff and resources to the inspection of well drilling activities	a deposit system could be introduced whereby a deposit is paid prior to the drilling of investigative wells or boreholes on municipal lands or for municipal projects; the deposit would be returned once proper decommissioning has occurred	provide educational forums on the need for and methods of well construction and decommissioning
	providing funding to identify wells which need to be decommissioned	municipal inspection duties for septic systems could be extended to/coordinated with inspection of wells	develop working relationships with water suppliers, municipalities, and other groups to educate residents and industries on well decommissioning needs and programs, and on the vulnerabilities of shallow wells

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	continue funding programs for upgrades and decommissioning under the Clean Water Program and the OFA through the Healthy Futures for Ontario program	municipalities could request to be given the responsibility of inspecting wells under Regulation 903; for example, the Township of North Grenville in eastern Ontario	initiate a mechanism whereby well test data collected by the Health Unit can be provided to the municipality for monitoring purposes.
	providing educational materials to well drilling firms, residents, municipalities, organizations, and industries regarding the MOE role and the needs and advantages inherent in proper well construction		
	developing an education program which details the vulnerabilities of shallow wells		
	developing closer ties and communication with municipal water systems to notify residents and industries which connect to public water supplies of the decommissioning requirements		
	instituting requirements for proper plugging of test holes similar to the rules for wells		

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	requiring pump installers to report pump locations and old wells to the Ministry, and to ensure that pump replacement and well retrofits are done properly.		
<i>Septic System Construction and Maintenance</i>	Part 8 of the Building Code, Building Code Act; Ontario Water Resources Act	A primary role for municipalities in minimizing septic system risks to groundwater is to use municipal planning tools, including Official Plans, zoning by-laws and development controls, to implement the “smart growth” principle noted earlier in this report. This would facilitate “doing things right in the first place” by directing growth to serviced areas or areas with optimum subsurface conditions.	development and funding of a program to evaluate and repair existing non-functional septic tanks
		Municipalities can require both a minimum lot size and minimum lot frontage	coordination with existing septic tank education programs
		Municipality to require additional study prior to authorizing septic system permits or approvals to address local geology or water quality issues.	developing studies to evaluate the impact of closely spaced septic tanks on groundwater and surface water quality
			public education on the proper maintenance and safe utilization of septic tanks, and regarding the disposal of hazardous materials into septic systems

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<i>Underground Storage Tanks</i>	Transportation of Dangerous Goods Act (Canada)	municipal regulatory option would be to use municipal powers related to development approvals and servicing to ensure that the provincial requirements are being followed within the municipality	develop a working relationship with the TSSA to assist in the process of identification of underground tank owners and registration of the tanks
	Dangerous Goods Transportation Act (Provincial)	municipalities could require proof of proper installation, registration, upgrading or removal of any underground storage tanks as a condition of development approval (i.e. for applications for consent, site plan approvals and subdivision approvals), or as a precondition for hook-up to a municipal water system.	identify a staff or group member to act as a local education and liaison representative regarding existing requirements, in particular the rules under the <i>Technical Standards and Safety Act</i> and the Fire Code
	Technical Standards and Safety Act, 2000		provide educational forums on the need for and methods of proper underground storage tank installation, maintenance and removal.
	Fire Protection and Prevention Act, 1997		
<i>Oil and Gas Wells</i>	<i>Oil, Gas and Salt Resources Act</i> administered by the Ministry of Natural Resources	regulatory options for municipalities vis a vis oil and gas wells are similar to those mentioned in previous sections	maintenance of an ongoing liaison with local Ministry of Natural Resources staff for the exchange of information
	Ontario Regulation 245/97 titled “Exploration, Drilling and Production”, issued under the <i>Oil, Gas and Salt Resources Act</i>	ensure that the provincial requirements are being followed within the municipality via use of municipal powers related to development approvals and servicing	maintenance of a database regarding both old and active oil and gas wells.

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Summary of Groundwater Management Issues and Measures**

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	R.R.O. 1990, Regulation 341 titled “Deep Well Disposal”, issued under the Environmental Protection Act		
	the <i>Ontario Energy Board Act, 1998</i> administered by the Ministry of Energy, and		
	Ontario Regulation 210/01 titled “Oil and Gas Pipeline Systems”, issued under the <i>Technical Standards and Safety Act, 2000</i> .		
<b>Use of Nutrients and Chemicals</b>			
<b><i>Land Application and Storage of Nutrients</i></b>	Bill 81, Nutrient Management Act	Powers under the <i>Planning Act</i> to regulate where agricultural and related activities take place, subject to provincial policy statements and the <i>Farming and Food Production Protection Act 1998</i>	develop working relationships and, where appropriate, agreements with landowners, OMAF, and MOE to focus their efforts on locally important issues and areas of local concern
		Powers to regulate with respect to operations or activities not addressed by the regulations (e.g. smaller operations)	identify a local education and liaison representative for nutrient management programs to be a point of contact for information, education, or potential violations

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Summary of Groundwater Management Issues and Measures**

Category/Issue	Provincial Role	Municipal Regulatory Options	Non-Regulatory Initiatives
		It is recommended that municipalities be involved in implementation duties such as review and approval of nutrient management plans and the maintenance of registries of nutrient management plans and strategies. At a minimum, municipalities should have ongoing access to this data.	provide educational forums for organization members, farmers, industries, and the general public on effective nutrient management practices
<i>Application of Pesticides and Herbicides</i>	Pest Control Products Act (Federal)	eliminate use of pesticides for certain uses through by-laws	additional financial resources for Best Management Practices (BMPs) could be established at the municipal level to encourage and achieve environmental responsibility in agricultural production.
	Ontario's Pesticides Act	institute requirements for all property owners who apply pesticides to complete education and testing regarding pesticide use comparable to that required of farmers.	Environmental Farm Plan was developed by OFEC to help farmers assess the environmental risk associated with their current farm practices, and to reduce this risk through the adoption of BMPs.
	Environmental Protection Act (the EPA)		municipalities, conservation authorities and other groups could continue to support the existing urban area programs that promote "pesticide free" lawns and alternative ground covers, in conjunction with water conservation measures.
	Ontario Water Resources Act (the OWRA)		



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Category/Issue	Provincial Role	Municipal Regulatory Options	Non-Regulatory Initiatives
	Nutrient Management Act		
<i>Use of Road Salt on Highways</i>	MTO guidelines	municipalities could consider alternatives to road salting	A review of County road salting activities to ensure optimum road salt application rates are used, however, safety of the travelling public should be paramount.
		use of these control mechanisms to minimize road salt impacts to water supplies could provide a foundation for future management plans.	Reductions in salting rates and transitions to the use of road-salt alternatives (e.g. sand) should only be undertaken where safety permits. This review should include the overall objectives of road maintenance, including the appropriateness of “bare pavement” objectives.
		appropriate separation distance between major salt applications areas (e.g. Highway 401) and new development based on groundwater supply	Water quality monitoring sites could be established near major roads and highways.
		in the absence of an appropriate separation distance between a development and a major salt application area, a satisfactory supporting groundwater quality study should accompany the development application.	

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<i>Spills</i>	MOE and owner of material are primarily responsible in the event of a spill	Municipalities could use development approval powers to ensure that emergency response teams and protocols will be in place for any new development with the potential for chemical spills.	special spill management protocols may be required in WHPAs vs non-WHPA areas. A spill responder group, consisting of the County Fire Co-ordinator, Local Fire Departments, and County and Township Officials could be established to discuss spill response in WHPAs.
	Fire department may be called upon if property or lives are endangered	Municipal response teams and protocols should be developed in conjunction with fire departments and other emergency service personnel.	review response scenarios involving first responders (such as local fire department, police etc) to ensure that response protocols are clearly understood, and the response system is a streamlined as possible.
	Environmental Protection Act, 1990, administered by the MOE		
	Ontario Water Resources Act, 1990, administered by the MOE		

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Summary of Groundwater Management Issues and Measures**

Category/Issue	Provincial Role	Municipal Regulatory Options	Non-Regulatory Initiatives
<b>Large Agricultural and Industrial Operations</b>			
<i>Aggregate Extraction and Reclamation</i>	Aggregate Resources Act - R.S.O. 1990, c.A8., Ministry of Natural Resources (MNR)	Municipalities have a role that is subsidiary to the provincial role in that the zoning by-laws, growth management strategies, and official plans for the municipality are reviewed by the provincial MNR in granting permits and licences.	initiatives that can be employed by aggregate operations may include consulting local environmental or conservation groups in the region before or during aggregate extraction activities.
<i>Intensive Livestock Operations</i>	Bill 81, Nutrient Management Act	same as for “Land Application and Storage of Nutrients”	same as for “Land Application and Storage of Nutrients”
	Farming and Food Production Act, 1998		
	Provincial Policy Statement under the Planning Act		
<i>Solid Waste Landfills</i>	Environmental Assessment Act	Official Plan, zoning, site plan approvals	Landfill liaison committees
	Environmental Protection Act		Financial compensation to host community and/or property owners
	Planning Act		

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	other requirements as applicable under Building Code, Fire Code, Ontario Water Resources Act and Occupational Health and Safety Act		
<b>Drainage and Water Taking</b>			
<i>Field Tile Drains</i>	Drainage Act - R.S.O. 1990, c. D. 17	current role of municipalities in construction or alteration of field tile drainage systems is to ensure that the system follows the approved design before connecting the drainage systems to the municipal drain system.	create a simple effective drainage system that permits the required work to be completed in the fields, while minimize the inhibition of natural recharge.
	Tile Drainage Act - R.S.O. 1990, c. T.8	water from municipal drains that discharge to surface water bodies must meet the Provincial Water Quality Objectives (PWQO's), and as a result, the water quality of the water from field drains must be considered.	A well engineered drainage system could include a simple valving system that allows the amount of water and period of drainage to be controlled by shutting off or controlling the flow through the drainage system.
	Agricultural Tile Drainage Installation Act - R.S.O. 1990, c. A.14.		drainage system could discharge to an irrigation pond, minimizing the amount of water needed to be pumped from an external source in the summer months, while allowing for some groundwater recharge.

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			Establishing natural recharge areas such as re-creation of historic wetland areas by the province, municipalities, as well as privately could reduce the stress placed on the groundwater environment from the unnatural inhibition of recharge.
<i>Stormwater Retention/Detention Facilities</i>	Stormwater Quality Best Management Policies, 1991, MOE	Land use regulations imposed by the municipality under the Planning Act is a regulatory control on stormwater management issues.	diligence on the part of the engineering team and those responsible for approving the designs of stormwater management systems is important in creating a system that minimizes, or potentially benefits the local environment.
		The municipality should be actively involved in conjunction with the MOE in granting permits for completing stormwater management works.	Incentives potentially put forth by municipal or provincial authorities to encourage “wise” stormwater management is a possible non-regulatory initiative.
<i>Irrigation Pits and Ponds</i>	Ontario Water Resources Act - O.Reg.285/99 Permit to Take Water	Municipalities are concerned with the implementation of irrigation systems as they can pose environmental damage, as well as damage to public and private property.	Owners of irrigation systems can employ a number of strategies to make efficient use of the water used for irrigation

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	MTO - Permit to Construct	Policies could be imposed in the future by municipalities, that would be consistent with the Best Management Practices put forth by the Provincial Government.	The <i>Best Management Practices</i> provided by the Ministry of Agriculture and Food should be consulted and considered when implementing and operating an irrigation system.
	Conservation Authorities Act - R.S.O. 1990, c.27		Development of irrigation schedules and rural peer groups could benefit farmers and minimize environmental impacts associated with irrigation practices.
	Ministry of Agriculture - Best Management Practices		
<b><i>Groundwater Mining</i></b>	No official regulatory mechanisms present, Ontario Water Resources Act - O.Reg. 185/99 broadly addresses use of groundwater and its conservation	No official municipal regulatory mechanisms in place that deal directly with the issue of groundwater mining.	High volume water users should consider their choice of facility location and water supply in order to avoid long term water supply issues such as diminished yield as a result of groundwater mining.
		Planning Act gives municipalities the authority to use official plans and zoning by-laws to regulate water use.	Established water users can also help to avoid groundwater mining issues by becoming familiar with their water supply system, their consumption, and learn to monitor water levels.

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Category/Issue	Provincial Role	Municipal Regulatory Options	Non-Regulatory Initiatives
		Careful land use and growth management plans are essential in curbing over consumption of groundwater thus preventing groundwater mining.	Diligence in monitoring groundwater supplies can identify problems in the early stages and prevent significant damage by altering water use appropriately.
		Facilities that use high volumes of water should be located in areas designated to be used industrially or commercially by zoning by-laws and official plans with appropriate long term water supply and treatment capacity.	Education programs to encourage the conservation and wise use of water should also be implemented to discourage groundwater mining and other forms of overuse.
<i>Water Use During Periods of Drought</i>	There are no provincial controls on water use during periods of drought.	Lawn watering bans are often imposed by municipal bodies when it becomes apparent that the rate of consumption is going to exceed the capacity of the municipal system to supply water to their residents	initiatives can be taken by the general public, farmers, commercial operations, and industry. During periods of drought, the onus should be placed on all water users to limit unnecessary water use to a minimum.
			Use of simple water conservation measures such as rain barrels, cisterns for lawn irrigation, trickle irrigation systems, and the use of grey water for cosmetic watering should be encouraged on the municipal scale possibly with incentives.

**Middlesex-Elgin Groundwater Study:  
Summary of Groundwater Management Issues and Measures**

Category/Issue	Provincial Role	Municipal Regulatory Options	Non-Regulatory Initiatives
			Fact sheets could be distributed with an emphasis on saving the consumer money, while stressing efficient and proper watering practices.
<i>Groundwater Resource Features: Wellhead Protection Areas, Significant Recharge Areas, ISI Areas</i>		Conventional zoning approach: Control or prohibit higher-risk land uses in wellhead capture zones, sensitive groundwater resource areas	Provide signage in wellhead protection areas to raise awareness
		Performance zoning approach: Require site-specific studies for higher-risk land uses in wellhead capture zones, sensitive groundwater resource areas	Include information about local groundwater resource features as part of education programs.
		Install sentry wells in wellhead protection areas	
		Prepare contingency plans for alternative drinking water supplies, and spill response plans	
		Purchase lands in sensitive groundwater resource areas	
		Provide compensation to land owners where land use restrictions are imposed.	