

1. *What is the Threat to Drinking Water?*

The vulnerability of an aquifer may be increased by any land use activity or feature that disturbs the surface above the aquifer, or which artificially enhances flow to the aquifer. This implies the existence of preferential flow paths that permit shallow recharge water and contaminants to move through a confining layer. Transport pathways are a land condition resulting from human activity that may increase the vulnerability of a municipal drinking water system's raw water supply (Ontario Regulation 287/07 CWA). Constructed transport pathways can circumvent the natural protection offered by soils and overlying materials. Transport pathways may facilitate the movement of contaminants vertically (a well or a quarry) or laterally (pipes such as water or sewer lines) below the ground and result in faster or more widespread distribution of contaminants.

Transport pathways are not themselves a threat to drinking water and as a result have not been assigned a risk level. They may contribute to an increased risk as a result of an activity near the pathway. Transport pathways are different than activities that are threats and need special consideration in policy discussion. The Clean Water Act (2006) allows for strategic policies to be developed for transport pathways.

2. *What causes this activity to be a drinking water threat?*

Although transport pathways are not themselves considered a threat, in groundwater, transport pathways provide a conduit to an aquifer that bypasses the natural protection of overburden layer resulting in greater potential risk for contamination (See Figure 1 **Error! Reference source not found.**) from nearby threats.

There are many different types of transport pathways:

- Improperly constructed or maintained water wells;
- Unused/abandoned water wells;
- Improperly constructed or maintained oil and gas wells;
- Pits and quarries; construction of underground services or subsurface excavations;
- Sewer pipes and septic systems; and,
- Geothermal wells/earth energy systems.

NOTE TO THE READER

*This document is one of a series of threat policy discussion papers for the Thames- Sydenham and Region in support of Source Protection Plan development. Each discussion paper looks at the nature of one or more types of drinking water threats, describes the local occurrence of those threats, assesses existing policies/programs, and introduces related 'policy concepts' for source protection planning. **While every effort has been made to ensure the accuracy of the information in this document, it should not be construed as legal advice or relied on as a substitute for the legislation.***

*This version is considered to be a **working draft** because it will be revised as the policy development process progresses. This discussion paper represents the best information available to the SPC upon which they will base their policy decisions.*

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Abandoned and improperly maintained wells, wells in urban areas, geothermal wells as well as surface water are further discussed below.

Abandoned and improperly maintained wells (From Water Well Sustainability in Ontario)

Wells deteriorate over time and must be inspected and maintained. Wells, once they reach the end of their life cycle, should be properly decommissioned (Novokowski et.al, 2006). The decommissioning of wells is addressed in Ontario Regulation 903. This legislation indicates that wells are to be decommissioned if they have not been used for more than 2 years. However, this has not been well enforced, which has led to many wells being abandoned (Halton-Hamilton SPC, 2011). Abandoned wells provide a direct conduit to the aquifer. Due to the evolving reporting requirements for wells in Ontario, no one knows exactly how many wells are abandoned. It is speculated



Figure 1: Risk of Abandoned Wells (Source: Novokowski et. al, 2006)

that there are at least 500,000 abandoned wells distributed throughout the province (Novokowski et. al, 2006). Existing programs, such as Well Aware, which will be discussed in Section 4 of this paper, educate people on the importance of maintaining their well and decommissioning it if necessary. Funding programs, such as the Ontario Drinking Water Stewardship Program, are available to assist with decommissioning.

A typical house water well construction is illustrated in Figure 2. A properly constructed well is sealed so that surface water cannot enter the well or migrate along the outside of the well. This reduces the likelihood of the well acting as a transport pathway. A well which was not properly constructed or which has deteriorated can become a pathway.

Due to the increased density of wells and the variety of land uses (e.g. residential, commercial, industrial) within urban areas there is a greater potential for contamination of the municipal water supply. Often wells which are no longer required are left to deteriorate or are simply covered up and forgotten. Generally, there are no regulations in place that would restrict the construction of a well within the urban boundary where municipal services are available and it may not be a requirement to connect to municipal services if they are available.. When connecting to a new municipal service it is often a requirement to sever the connection to the previous well, This is to prevent the possibility of the private water source from contaminating the municipal distribution system. Often the property owner will want to retain the old well for use outside the home or due to the additional cost of properly decommissioning the well.

On rural properties multiple wells could have been installed for various reasons such as providing water to a barn, livestock area or previous home locations. As with the urban example often wells which are no longer needed are left in place to deteriorate or covered over without properly decommissioning. This is common in areas where farms have been consolidated and unneeded residences or farm building have been demolished. With the buildings and possibly the well head removed the current landowner may not even be aware of the existence of the abandoned well.

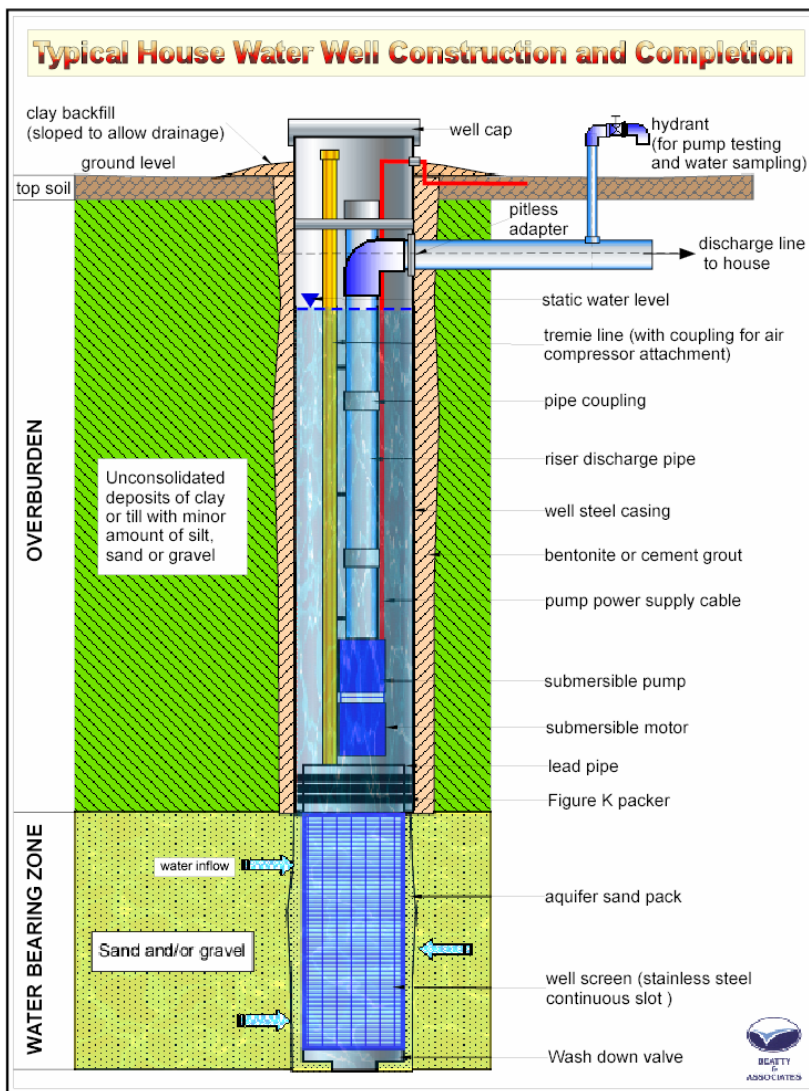


Figure 2: Typical House Water Well Construction and Completion (Source: Novokowski et. al, 2006.)

Geothermal Wells (Earth Energy Systems)

Earth Energy Systems (geothermal wells) are a potential concern when it comes to transport pathways. The presence of these wells may serve as conduits for the potential transfer of contaminants from the surface down to aquifers or for the water between aquifers within the ground (MOE, 2009). Installation requires drilling holes or constructing trenches which could intersect aquifers that supply municipal and private drinking water wells. The Canadian Standards Association (CSA) has published Design and Installation of Earth Energy Standards, however these Standards are only applied when there is an application for a building permit (MOE, 2009).

There are two types of earth energy systems, open loop and closed loop. Open loop systems extract water from the environment to use for heating and cooling and then discharge the water back into the environment either directly or indirectly. This would have an affect on water quantity. Closed loop systems circulate a heat transfer fluid (HTF) through pipes installed in the environment to utilize the thermal gradient between the HTF and the environment for heating or cooling (MOE, 2009). Closed loop systems have the potential to affect the quality of source water since HTF could be released into the environment.

The activity of earth energy systems is not a prescribed threat under the current regulations. However, if it were to be added, preliminary analysis suggests that it would only be a significant threat for ethanol and propylene glycol heat transfer fluids in a relatively large volume commercial/industrial system in a vulnerable area with a score of 10. Within a vulnerable area of any lesser score with such a system or any residential system, this activity would not be a significant threat under the current assessment. (MOE, 2009)

Under the current legislation, where a transport pathway is confirmed as a factor in contributing to a significant drinking water threat, addressing the pathway could be part of the risk management plan for addressing such a threat. This could include, but not be limited to:

- requiring or confirming that the construction complies with CSA requirements
- testing the well or boring, where possible, to determine if it provides a conduit for flow
- monitoring the system to determine if there is enhanced flow or if there is any loss of HTF from the system

- providing an emergency contingency plan in the event that there is a leak to minimize the impact on source waters
- restricting the installation or application of earth energy systems
- decommissioning faulty or high risk earth energy systems (MOE, 2009)

Septic Systems

Unlike wells, septic systems can be considered drinking water threats as well as transport pathways. The risk associated with this threat is dependant on the size of the system and the vulnerability of the area in which the system is located. The nature of the drinking water threat is discussed in the Thames-Sydenham and Region Threats Policy Discussion Paper on Septic Systems (Thames-Sydenham and Region, 2011).

In the construction of a standard leaching bed system native soil is removed and aggregate is installed in trenches surrounding the perforated pipes which slowly discharge (leach) the sewage into the permeable aggregate. Where the native soil is not suitable for the installation of a standard leaching bed system, a raised bed may be installed in imported fill which would be significantly more permeable than the native soil. Where the native soil has been replaced with soils which allow water and contaminants to flow more freely through it, the presence of the leaching bed can increase the intrinsic vulnerability of the area. While the bed and this permeable aggregate is where the treatment of the pathogens occurs (after the settling of solids in the tank) this media allows other contaminants which are not treated in the septic system to flow more freely towards the aquifers. This is especially true where the vertical separation between the bottom of the leaching bed and the aquifer providing the drinking water source is minimal. Not only are the pathogens and chemicals of concern being released within the septic system, they are being released closer to the aquifer than a discharge on the surface and into soil which may offer less resistance to the flow of the water than the native soils. The presence of this systems also makes the aquifers more susceptible to the other activities on the site or nearby. Spills may be directed to the septic bed either through the plumbing (floor drain) or overland to the septic bed.

In highly vulnerable areas this difference may be negligible as the native soil and the aggregate used for backfill may have similar properties. In the case of deeper aquifers and bedrock aquifers the impact is also minimal as the modifications have been made only in the top metre or two leaving any meters of natural protection in place.

It is also important to realize that while proper design, construction and maintenance of the septic system would reduce the risk associated with the system it does not reduce the impact of the system as a transport pathway.

Petroleum and Natural Gas Wells

The nature of the potential impact of petroleum and natural gas wells is similar to that of drinking water wells discussed above. The difference is that these wells are often considerably deeper potentially interconnecting many aquifers. This poses the additional potential of contaminating a drinking water source with water from other aquifers which have water quality which is not suitable as a drinking water source. The other obvious potential contaminant is from the oil itself. As such it is important that these wells not only be sealed to prevent surface water from directly reaching the aquifer, but also the cross contamination of aquifers. As with the drinking water wells, these oil and gas wells are not considered a drinking water threat (they are not included in the prescribed activities which can be considered threats). Thus the focus of considering these wells as transport pathways is to prevent contaminants from land use activities (threats). As with the drinking water wells the proper design construction and maintenance reduces the impact that they would have on the vulnerability of the area.

As with the drinking water wells the abandoned oil and gas wells can be a considerable concern. The vulnerability and threats assessment did not identify any WHPA in the region where historical petroleum exploration resulted in a concern that these wells might have an impact on the groundwater systems. The

areas of the region where oil and gas exploration may have been a concern have shifted to surface water sources.

Quarries

Quarries, both aggregate and stone are prevalent in many part of the source protection region. Quarries mine or remove materials which provide some natural protection of the aquifers. This material may be sand and gravel overlying the aquifer or in some cases the actual sand and gravel which contains the water. In many cases the aggregate removal is limited to those areas above the water table. These quarries are often referred to as gravel pits. There are gravel pits in WHPAs in the UTRSPA.

Other quarries in the region produce limestone and related products. These are located in the Ingersoll and St Marys areas. In these operations all the overburden and capstone is removed from the quarry and rock is removed. In these areas it is possible to have direct connection to the aquifers serving as a drinking water source, however it is important to note that hydraulic gradient is steep and results in flow into the quarries rather than from the quarry back into the aquifers (along the rock face). Due to the depths of these excavations significant dewatering is necessary with discharge of the water to surface water features. These quarries are not located in WHPA in the Thames-Sydenham and Region.

The Thames-Sydenham and Region developed local guidance which discussed the various options for adjusting vulnerability to reflect transport pathways (Thames-Sydenham and Region, 2009?). This guidance suggested that as part of the rehabilitation of pits within vulnerable areas the revised vulnerability be calculated based on the post rehabilitation materials overlying the aquifer. This has no impact on the quarry operations; however it will have an impact on the threats assessment for activities proposed for the rehabilitated site.

Construction Activities

Various construction activities could have the potential to alter the vulnerability of a site. Most are associated with the removal of native soils and possibly replacing them with materials such as sands and gravels which allow water and contaminants to move more freely through them. As with most of the other transport pathways discussed in this paper the construction activity is not considered the threat but the increased vulnerability can increase the risk associated with other threats.

The simplest of these concerns is the regarding of lands where considerable earth is removed. In areas where the intrinsic vulnerability is already high the vulnerability cannot be increased. Theoretically the removal of a few meters of fill in shaving a hill to level an area for development could remove a substantial amount of the material protecting a shallow aquifer. As with the septic systems, the regarding of a few meters of fill is not going to have a measurable effect on areas where the aquifers are deep and protected by many meters of impermeable tills and clays. Offsetting the effects of the regarding to some degree is the drainage improvements which make it more likely that contaminants would be removed to the surface water bodies than leaching into the groundwater.

Other construction activities which could affect the vulnerability of an are include subsurface infrastructure like pipes and sewers or road beds. As with the septic beds the concern stems from the replacement of the native soils with materials which are freer draining and allow water and contaminants to more easily travel through them. The additional concern with these is that they may not only allow transmission of contaminants vertically towards the drinking water source they may also serve as a pipe laterally towards the drinking water well. Although these transport pathways did not result in any adjustments to vulnerability scores in the region, municipalities may want to give some consideration to this affect in their design and planning of this infrastructure in those areas where it would be warranted.

Although these activities have not resulted in any adjustments to the vulnerabilities reported in the AR, municipalities may want to give some consideration in their planning and approval of projects in the WHPA where these activities could have an impact on the vulnerability of their drinking water source.

Surface Water Transport Pathways

In the case of surface water, transport pathways act as conduits which can extend the delineation of IPZ-2, WHPA-E or IPZ-3. Transport pathways delineation can be extended to include an area that may contribute to the intake through a pathway that influences travel time to an intake (such as storm sewers). In this case, transport pathways would have an impact on the extent of the vulnerable area rather than the vulnerability and risk within a vulnerable area. Changes to the transport pathways within or near one of these zones may result in the need to revise the delineation of the vulnerable zone. For this reason new or altered transport pathways must be reported to the CA. The effect on the drinking water source should be considered in the design of the transport pathway where possible.

3. *What is the local scale of the drinking water threat?*

Transport pathways may be considered when interpreting the vulnerability score of the surface (IPZ) or groundwater (WHPA) sources of drinking water since these pathways have the ability to facilitate the movement of contaminants vertically or laterally below the ground. The risk level (significant, moderate or low) may be influenced by the presence of transport pathways. Changes in vulnerability scoring to a higher number would raise the risk level of a prescribed drinking water threat and could change some moderate threats to significant and low threats to moderate or high. Although the vulnerability may be increased by 1 or 2 levels resulting in an adjustment in the scoring may of 2 or 4 points, in the Thames-Sydenham and Region an adjustment of one level (2 points) has been made.

Groundwater transport pathways, such as wells and septic beds, have been considered differently within four counties (Perth, Oxford, Middlesex and Chatham-Kent) within the Thames-Sydenham and Region Source Protection Region. In assessing the impact of transport pathways on the vulnerability in the WHPA of the Thames-Sydenham and Region the discussion paper/local guidance on Vulnerability Adjustment due to Transport Pathways (Thames-Sydenham and Region, 2009?) was considered. This discussion paper discussed the various methods of considering the pathways and allowed for different methodologies to be applied. The provincial guidance and specifically the Technical Rules (MOE, 200?) allow for the adjustment but do not identify the criteria or methods to apply to the adjustment, therefore allowing for the most appropriate method/criteria to be applied locally.

The areas of adjustment of vulnerability to reflect transport pathways are indicated in the section 4 maps in the Assessment Reports.

Perth

The majority of private wells and municipal wells in Perth County are deep (generally greater than 25 m). The Perth County Groundwater Study (2002) indicated that the greatest threat to the aquifers in the County was poorly constructed wells. Improperly constructed wells, improperly maintained wells and abandoned wells could provide a rapid transport mechanism for contamination to an otherwise well protected aquifer. Within 30 m of identified well locations, the vulnerability was increased one level (2 points).

Septic beds and sewers are not generally considered transport pathways in Perth due to the deeper aquifers utilized for municipal drinking water sources. In the case of Perth County, there was no adjustment to the risk level.

Oxford

Within Oxford County there are both overburden and bedrock municipal wells. Transport pathways pose an elevated risk level in proximity to municipal wells in areas of higher density of private wells. The areas where there were a higher density of wells were raised one risk level.

Septic beds within Oxford County could represent potential transport pathways in areas where shallow aquifers are used for municipal water especially in areas where there is a higher density of septic systems in WHPA. Areas of higher density have been raised one level of vulnerability (2 points).

Middlesex and Chatham-Kent

Transport pathways in these two areas are not considered to have a significant effect on the vulnerability scores due to the limited density of the transport pathways in the WHPA. No adjustments were made to risk vulnerability.

4. *Applicable Legislation, Policies and Programs*

The following section provides a summary of the applicable legislation, policies and programs (federal, provincial, municipal and other) that address the concept of transport pathways.

Table 1: Applicable Legislation, Policies and Programs

Level of Government	Applicable Legislation/Policies/Programs
Provincial	Clean Water Act 1996 <ul style="list-style-type: none"> • O. Reg. 287/07
	Ontario Water Resources Act 1990 <ul style="list-style-type: none"> • O. Reg. 903 Wells Regulation
	Oil, Gas and Salt Resources Act <ul style="list-style-type: none"> • O. Reg. 245/97
	Municipal Act 2001
	Abandoned Works Program
	Ontario Drinking Water Stewardship Program
	Safe Water Program
Municipal	Well Abandonment Program <ul style="list-style-type: none"> • City of London • Other Jurisdictions: Region of Peel
Other	Canadian Groundwater Association <ul style="list-style-type: none"> • Guidelines for Water Well Construction
	Well Aware Program
	Well Wise Program
	Clean Water Program
	Canadian-Ontario Environmental Farm Plan

a) **Federal**

There is no specific federal legislation, policies or programs aimed at groundwater protection or groundwater transport pathways. Canadian provinces have primary jurisdiction over water resources as a result of their constitutional power to make laws governing natural resources, and their proprietary powers. The Federal government governs water with respect to transboundary waters, navigation, fisheries, and international treaties, and also has proprietary powers. The provinces and the federal government share responsibility for health and agriculture. (http://www.watergovernance.ca/factsheets/pdf/FS_Groundwater_Regs.pdf).

b) **Provincial**

Clean Water Act 2006 O. Reg. 287/07

Section 27 (1) of O. Reg. 287/07 allows policies to be included in Source Protection Plans that are intended to ensure:

- a) that any drinking water threat in the vicinity of a transport pathway ceases to be or will not become a significant drinking water threat; or,
- b) that the transport pathway ceases to endanger the raw water supply of a drinking water system,

Under S.27 (2), the policies associated with transport pathways may establish stewardship programs, specify and promote best management practices, establish pilot programs, govern research or specify the actions to be taken to implement the Source Protection Plan or to achieve the Plan's objectives.

In addition, municipalities are required to notify the Source Protection Authority and the Source Protection Committee if they receive applications to undertake activities within a wellhead protection area or a surface water intake protection zone that may result in the creation of a new pathway or the modification of an existing transport pathway (S.27(3)).

Ontario Water Resources Act 1990

Water takings in Ontario are governed by the Ontario Water Resources Act (OWRA). The OWRA has included groundwater licensing since 1961. Section 34 of OWRA, the Water Taking and Transfer Regulation, requires anyone taking more than 50,000 Litres of water in a day, with some exceptions, to obtain a permit. The Ministry of Environment (MOE) is the primary regulator, and governs according to the Water Transfer and Taking Regulation. There are approximately 500,000 wells, and a total of 2,800 permits.

Annual water use reports must be submitted to the MOE. Notification of applications to municipalities and conservation authorities is mandatory (s. 7 Water Taking and Transfer Regulation). http://www.watgovernance.ca/factsheets/pdf/FS_Groundwater_Regs.pdf

Ontario Water Resources Act 1990 O. Reg.903 Wells Regulation

Ontario Water Resources Act, Regulation 903 sets out the minimum provincial standards for siting, construction, tagging, reporting, maintaining and decommissioning wells used for drinking water. All wells including public, private, municipal, rural, commercial and industrial as well as test holes, dewatering wells and monitoring wells are covered under this legislation. A Best Practices Manual was developed in 2009 by MOE to accompany the regulation and provide detailed information on Best Practices for well design, construction, maintenance, disinfection and abandonment.

Oil, Gas and Salt Resources Act, O. Reg. 245/97

Under O. Reg. 245/97, a life-cycle well licence was introduced to ensure that a designated operator will always be responsible for a well from drilling until final plugging. O. Reg. 245/97 requires oil and gas well operators to plug wells which are no longer used for the purpose for which they were drilled or that did not produce oil or gas. Where no operator exists, the landowner is responsible for plugging the well. There is a program which funds the decommissioning of priority wells which is described below.

Abandoned Works Program

In 2005, the Ministry of Natural Resources established the Abandoned Works Program. This program was initiated to plug abandoned oil and natural gas wells to protect public health and safety and source water resources (MNR, 2011). Candidate wells are ranked according to their risk to public safety and potential for environmental damage. Sites that represent immediate or significant hazards will be addressed first. Most candidate wells are more than 50 years old and Ministry records are either incomplete or non-existent (MNR, 2011). The Abandoned Works Program relies on landowners to help identify and locate abandoned wells on their property for which no public record exists. All costs are paid by the Ministry provided that written

permission for the contractor is granted to enter the property to do the work. If access to the land is denied the Ministry may order the landowner to plug the well and the landowner pays for the plugging (MNR, 2011)

Municipal Act 2001

Municipalities have the ability to pass by-laws about the economic, social and environmental well-being of the municipality, and about the health, safety and well-being of people under the Municipal Act 2001. Some municipalities have passed bylaws which restrict the construction of wells within their serviced area. In some cases these bylaws may also be applied to certain types of earth energy systems.

Ontario Drinking Water Stewardship Program

Section 97 (1) of the Clean Water Act provides provisions for the development of the Ontario Drinking Water Stewardship Program (ODWSP). The purpose of this program is to provide financial assistance to those that are affected by requirements of the Source Protection Plan developed under the Clean Water Act, 2006 so that plans may be implemented to protect current and future drinking water sources (MOE, 2008). The Early Actions Program was initiated first. Eligibility for this program is based on the location associated to municipal wellheads (100 m radius and/or approved 2 year time of travel) and surface intake protection zones (200 m radius and/or approved IPZ-1 zone). More recently the Early Response Program has replaced the Early Actions Program. This program focuses on activities which have been identified as significant threats and on transport pathways which increase the risks associated with significant threats.

The ODWSP will cover up to 80% of the cost of a project or to a maximum amount. Projects including well decommissioning (e.g. sealing and capping old water wells, connecting to municipal drinking water service line) and septic systems (e.g. replacing septic tanks, connecting to municipal sewer and decommissioning existing septic system) are funded under ODWSP.

Safe Water Program

The Safe Water Program is a program that is offered by the Ministry of Health and Long Term Care. One of the goals of this program is to prevent or reduce the burden of water-borne illness related to drinking water. The Safe Water Program is a stewardship program that provides a no-fee service for testing bacteria (total coliform and E. coli) in samples of private well water that is used for drinking.

c) **Municipal**

Well Abandonment Programs

City of London

In 2006, the City of London established the Abandoned Well Decommissioning Program. This program provides a proactive approach to ensure that groundwater is protected by preventing surface water contamination (City of London, 2010). The Abandoned Well Decommissioning Program is intended to properly decommission city-owned wells and is to be phased in ending in 2016. Initial background work has identified 50 City owned abandoned wells (City of London, 2010).

Other Jurisdictions: Region of Peel

The Region of Peel has developed a Private Well Abandonment Program that decommissions old, unused private wells in Caledon, rural Brampton and Mississauga. Old and unused wells threaten groundwater sources by allowing pollutants such as chemicals and bacteria to contaminate groundwater. The program's purpose is to protect Peel's groundwater sources, which is a drinking water source for most of the Region's residents (Region of Peel, 2011).

Wells are decommissioned by qualified and licensed well contractors in accordance with O. Reg. 903 Standard Well Abandonment requirements. This program is fully funded by the Region and is on a first come first serve basis (Region of Peel, 2011).

d) **Other**

Canadian Groundwater Association Guidelines for Water Well Construction

"Guidelines for Water Well Construction" were first published in January 1992 by the Canadian Groundwater Association. Following an intensive review in 1993/1994, the document was revised and republished in January 1995. The revision reflects current standards of practice and sets forth guidelines for proper water well construction across Canada. The manual can be used as a guide for the drilling and construction of water wells. Primarily, the guidelines apply to water well construction for the purpose of obtaining groundwater supply for human consumption, preparation of food products, livestock watering, public and private utility, and institutional supplies.

The "Guidelines" serve as minimum construction requirements, and any provincial standard or regulation that supersedes the recommendations would apply. The minimum guidelines meet the criteria set out in most of the existing regulations and legislation in effect across Canada. The publication serves to guide drillers, well owners, and legislative agencies in the construction of safe and useable water wells.

Emphasis is that wells should be constructed so that they can be maintained, serviced, and located away from all types of contamination

Well Aware (www.wellaware.ca)

Well Aware is a program provided by Green Communities Canada, a national association of non-profit organizations that offer practical solutions to environmental problems. The Well Aware program encourages Ontario's residential well owners to protect their wells and our common groundwater supplies. Education is a key tool that is used in the Well Aware program. To facilitate the education of well owners, Green Communities Canada has developed "A Guide to Caring for your Well". Within this guide, guidance/education is provided on the overarching topic of protecting well water. Topics include well location, well construction, well upgrading, well decommissioning and well maintenance. Another service offered through the Well Aware program is voluntary site visits. These visits are to assist the landowner to identify and address potential risks.

Well Wise

The Ontario Ground Water Association was created in 1952 as a not-for-profit organization to facilitate the various sectors of the groundwater industry coming together for the delivery of safe and clean water supplies throughout the Province. Well Wise has partnered with the Ontario Ground Water Association to provide a water testing program.

Clean Water Program

The Clean Water Program (CWP) is a rural water quality initiative that provides technical assistance and financial incentives to improve and protect water quality within Oxford, Middlesex and Perth Counties as well as the City of London, the City of Stratford and the Town of St. Mary's. Funding provided for projects under this program is 50% of the project with a maximum range from \$500 to \$5000. Projects include:

- decommissioning unused wells-to prevent groundwater contamination via improperly abandoned or unused wells by encouraging the proper decommissioning of wells that are dry or unused. Wells must be decommissioned by a licensed contractor and must comply with MOE procedures under O. Reg. 903.

- wellhead protection-to reduce the risk of contamination of well water by implementing proper construction and maintenance practices and safeguards for existing wells. Eligible projects include upgrading or replacing dilapidated casings, extension of well casing and sealing around the well casing. Landowners are encouraged to hire a licensed contractor to complete this work.
- septic systems-to prevent contamination of groundwater and surface water and associated public health risks. The project must show a negative impact on groundwater or surface water and the system must meet design requirements set out in the Ontario Building Code.

All projects require the completion of an Environmental Farm Plan or a CWP Worksheet for septic systems and wells.

The CWP has been the delivery agent for the MOE Ontario Drinking Water Stewardship Program within the Thames-Sydenham and Region Source Protection Region, specifically offering cost-sharing to landowners residing within the 100 m and/or 2 year time of travel zone of municipal wellheads.

Canada-Ontario Environmental Farm Plan

The Environmental Farm Plan (EFP) is a program that is delivered locally through the Ontario Soil and Crop Improvement Association with expertise provided by the Ontario Ministry of Agriculture, Food and Rural Affairs. It is a voluntary educational program for farmers delivered through local workshops. Participants progress through a risk assessment and action plan development for their farm. The risk assessment gives the farmer the opportunity to assess the current level of environmental concern in up to 23 different areas on the farm and access funding to make improvements for areas of identified risk (Ontario Soil and Crop Association, 2005). Information sheet #2 provides information on water wells.

5. *Gaps in existing legislation, policies and programs*

The following table provides the gaps that exist in the legislation, policies and programs that are currently associated with transport pathways.

Table 2: Gaps in Existing Legislation, Policies and Programs

Level of Government	Legislation/Policies/Programs	Gaps
Provincial	O. Reg. 903 Wells Regulations	<ul style="list-style-type: none"> • Regulation provides for decommissioning but enforcement of this provision is not effective. • Inspection to ensure that wells are properly constructed and maintained such that they continue to meet standards is not undertaken • The Regulation is not direct; there are opportunities for individual interpretation
	Safe Water Program	<ul style="list-style-type: none"> • Needs to be made consistently available and accessible to well owners across Ontario • Testing is limited to bacteria only
Other	Well Aware Program	<ul style="list-style-type: none"> • The program needs to be expanded into additional communities in order to maintain consistency
General		<ul style="list-style-type: none"> • Maintenance not enforced as poorly maintained wells remain unknown to

		regulating body <ul style="list-style-type: none"> • Inaccurate and incomplete well records • Decommissioning of inactive wells not <i>actively</i> required • Illegal drilling of wells by unlicensed drillers • Little incentive relative to cost to decommission a well aside from financial programs to assist with cost
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6. Policy Considerations

When developing transport pathways policies, specific considerations need to be taken into account. These considerations can be based on expert panel reports as well as general observations/assumptions.

Expert Panel Reports

Two specific expert reports, the Sustainable Water Well Infrastructure Initiative and the International Joint Commission Report on Groundwater in the Great Lakes Basin, which are further described below, provide insightful recommendations that should be taken into consideration when developing transport pathway policies.

Sustainable Water Well Infrastructure Initiative

In 2002, the MOE funded a project known as the Sustainable Water Well Infrastructure (SWWI) initiative. The main purpose of this initiative was to provide innovative approaches to water well maintenance and monitoring to extend and improve the integrity of water well infrastructure in Ontario. An expert panel of four scientists and engineers, who had experience within the water well industry, was established. The recommendations that were made by this panel through this initiative applicable to Source Water Protection are outlined below:

Table 3: Recommendations from Sustainable Water Well Initiative

Recommendation	Explanation
Province-wide Well Water Quality Survey	A comprehensive province-wide survey of water quality in all private wells should be undertaken immediately. This should include all unregulated wells including rural wells, cottage wells, and private wells in urban areas, in addition to farm wells. This survey should be repeated at least every ten years, allowing for ample time between surveys to investigate trends and findings in more detail. At the SPP scale we could recommend a source protection region survey of water quality.
Public Groundwater/Well Website	The MOE manages the Water Well Information System (WWIS). The MOE should make available to the public a comprehensive, user-friendly, interactive groundwater website containing information such as the results of comprehensive groundwater studies; water taking; groundwater monitoring network data; Water Well records data; and Ministry of Health and Long Term Care well water quality data.
Skilled Groundwater Workforce	Mandatory membership in an accredited professional groundwater

Recommendation	Explanation
	association should be required for all workers engaged in water well activities. This action is needed to facilitate the transfer of knowledge from those on the cutting edge to the broader water well industry and to ensure that a highly skilled workforce is sustained throughout the Province.
Industry Outreach and Education	To ensure due diligence and compliance with Reg. 903, a third party organization should be engaged to develop an outreach and education program for the drilling industry.
Third Party Enforcement of Well Regulation	To support the objectives of Reg. 903, enforcement of the regulation should be provided by a third party organization, who has qualified, experienced staff that are knowledgeable about the water well industry.
Water Well Database Initiative	To build upon MOE's source protection and water taking permit initiatives, a stakeholder group should be established immediately to explore alternatives for managing the Water Well database. This stakeholder group should report to the Minister within 12 months of its formation.
Expand Well Aware Program	The Well Aware program, a provincial government funded province-wide effort to educate rural residents about well safety, is an effective tool for promoting well stewardship and should receive continued funding and support. Indeed, consideration should be given to expansion of this program into additional Ontario communities.
Subsidy Program for Well Upgrades and Decommissioning	The Ontario government should continue to fund a subsidy program similar or equivalent to the Ontario Ministry of Agriculture and Food (OMAF) Healthy Futures Upgrade and Decommissioning program. The Panel recommends that such programs provide greater than two-thirds cost-sharing and include an educational component.
Disclosure of Water Well Status	The MOE should introduce legislation aimed at disclosing the status of all used and unused water wells by the owner at the sale or transfer of property where they are located. The disclosure records should include well performance and quality of all operating water wells and the status and condition of all unused wells. The new legislation should include a phase-in schedule to allow time for trained water-well service companies to develop across the Province.

Source: Novokowski et. al, 2006

Groundwater in the Great Lakes Basin: A Report of the Great Lakes Science Advisory Board to the International Joint Commission

The chief transboundary water co-operation agency is the International Joint Commission (IJC) which highlighted that groundwater is an important component of the Great Lakes Basin in its report on Groundwater in the Great Lakes Basin. Groundwater is essential within the Great Lakes Basin because it not only supports significant ecosystem functions (i.e. maintaining stream flows and wetlands during dry periods) but also provides an important drinking water source. The IJC have identified within their report on Groundwater in the Great Lakes Basin threats to groundwater quality from abandoned wells. Improperly decommissioned and abandoned wells provide direct routes for contaminants to reach groundwater. This expert report outlined a variety of recommended actions to help prevent contamination. These recommendations include:

- Implementing measures to alleviate the stresses and dangers that improperly abandoned wells place on groundwater in the Great Lakes Basin;
- Development of a targeted program to monitor high-risk private single family well water systems;
- Mandate stricter and more encompassing well testing for bacterial and viral contamination;

- More trained employees need to be provided to ensure the enforcement of proper well closing;
- Licensed well drillers and pump installers need to be employed to properly close abandoned wells;
- Enforcement and regular inspections of private drinking water well construction and maintenance needs to occur;
- Ontario Wells Regulation needs to be amended to be more direct leaving fewer opportunities for individual interpretation;
- Inventories should be completed to determine accurate numbers of functional and abandoned wells; and,
- Programs to help properly educate well owners regarding construction, maintenance and decommissioning need to be implemented (Great Lakes, 2010).

General Observations/Assumptions

- In addition to policies that address specific threats to drinking water sources, policies that are more strategic in effect also included. Transport pathways are incorporated to ensure that their presence does not increase risk to drinking water protection.
- Policies will be “Strategic” in their legal effect
- Policies may use S. 26 CWA tools
 - Stewardship
 - Pilot programs
 - Promote Best Management Practices
 - Govern research
 - Specify action
- Hydrogeological study prepared and submitted with development application in WHPA
 - Study must document potential impact of proposed transport pathways on vulnerability of municipal drinking water source and supply, could also identify potential threats within proposed development
- Discussions between SP staff and municipality to identify which activities create a transport pathway and should be listed within the SPP as activities requiring notification
- O. Reg. 903 requires wells to be properly decommissioned when not in use for longer than 2 years
 - Consider enforcement as a component of policy in vulnerable areas
- Improperly constructed or maintained wells can be transport pathways
- Policies should focus on helping individuals understand the potential danger of old wells and offer support through education and funding
- Many times property owners do not know about the existence of old wells on their property especially if there is no MOE well record.

7. *Proposed Policy Ideas*

For discussion purposes, this section of the report provides policy ideas that could be applicable to the subject threat in the Thames-Sydenham and Region. It is not an exhaustive list. Each policy tool is discussed separately in the table below.

Threat: Transport Pathways
Sub- Threat N/A
Circumstances N/A

Policy Tool	Policy ideas
Education and Outreach	<ul style="list-style-type: none"> • Build on existing programs such as the Well Aware program • Incorporate Source Water Protection messaging into programs • Focus on WHPA where threats can be significant • Increased focus on areas where vulnerability adjustments were made due to transport pathways • Involve well drillers in programs • Involve licensing authorities (MOE-drinking water wells; MNR-oil wells) • Promote education of earth energy systems • Promote overall environmental awareness with regards to other connections to groundwater (e.g. low water recharge areas) • Promote or develop programs specifically targeted at landowners where transport pathways would cause an increase risk
Incentive Programs	<ul style="list-style-type: none"> • Continuation of current programs (i.e. Clean Water Stewardship, Ontario Drinking Water Stewardship) • Encouragement of funding programs from federal, provincial, municipal governments (First Nations and agriculture as examples) • Municipality should consider paying for inspections and basic tests (i.e. water quality tests) • Incentives for: <ul style="list-style-type: none"> ○ Well decommissioning ○ Upgrades to meet standards ○ Septic inspection and upgrades ○ Well and septic maintenance • Consider including insurers and mortgage holders since not all incentives need to be monetary (e.g. reduced insurance rates) • Develop incentive programs for current employers (e.g. well drillers) to maintain a professional standard when constructing and decommissioning wells
Prescribed Instruments	<ul style="list-style-type: none"> • Not relevant as there is no instrument with which risk can be managed-consider specify action policy • Things to think about <ul style="list-style-type: none"> ○ Permit to Take Water (PTTW) <ul style="list-style-type: none"> ▪ Could a PTTW include a condition that a well be maintained to standards ▪ Could a well without a permit or that was not used for a period of

	<p>time be required to be decommissioned (does not apply to residential wells) thereby enforcing the provision in O. Reg. 903</p> <ul style="list-style-type: none"> ○ Septic Approval by MOE for large systems <ul style="list-style-type: none"> ▪ Should consider whether system is a transport pathway which affects vulnerability
S. 26 p.1 Specify Action	<ul style="list-style-type: none"> • Municipal bylaws restricting new transport pathways in vulnerable areas where activities could be significant • Municipal bylaws requiring decommissioning of unused wells • Municipal bylaws requiring hookup where services are available • Notification of SPA of new transport pathways-required • Encourage municipalities to enumerate all transport pathways • Encourage municipalities to prohibit construction of new private drinking water wells where municipal services are available • Where transport pathways as a result of Earth Energy Systems have been identified, municipalities should be encouraged to develop a risk management plan • MOE (or Municipal) well inspection in areas where significant threats can occur
S. 26 p.1 Stewardship	<ul style="list-style-type: none"> • Encourage support for ongoing stewardship programs for decommissioning wells as per O. Reg. 903 • Focus stewardship efforts on where transport pathways could become significant threats to drinking water.
S. 26 p. 1 Specify and Promote Best Management Practices	<ul style="list-style-type: none"> • Support current Best Management Practices offered. Guidance can be found in documents such as OMAFRA Water Wells Best Management Practices Book and MOE Water Supply Wells Requirements and Best Management Practices • Municipalities to be encouraged to ensure that wells are properly decommissioned under O. Reg. 903 in vulnerable areas • Qualified professional to consider the effect of municipal infrastructure (i.e. sewers, SWM ponds) and development servicing (re-grading) on vulnerability of the WHPA • Encourage the use of the Canadian Standards Association Design and Installation Guidelines with regards to Earth Energy Systems

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Well Wise ([web site](#))

Appendix A –Transport Pathways Estimates

County	Municipality	WHPA	Vulnerability	Vuln Adj?	Mun Serv Available?	Number of Pathways

DRAFT

Appendix B-Policy Examples

Appendix B will be added when the SPC gets to the appropriate stage in the policy discussions. The draft policies presented in appendix B are placeholder policies based on the policy ideas noted above. They are presented in this document to facilitate policy discussion at the upcoming SPC meeting. And subsequent review and comment by the Municipal Source Protection Policy Advisory committee.

DRAFT

Policy Number	TP-1
Sub- Threat(s)	N/A
Circumstance	N/A
Vulnerable Area	WHPA-A, B, C, D
Risk	N/A
Body Responsible for Implementing	Municipal Watershed Partnership with Conservation Authority to lead. The implementation of this policy in this manner builds on the strengths and efficiencies of the Conservation Authorities as a partnership of the municipalities in the watershed.
Threat Status	Existing and Future
Land Use	All
Legal Effect	Strategic
Policy Tool	Education and Outreach
Policy Idea	<p>Due to the evolving reporting requirements for wells no one knows exactly how many wells or abandoned wells are in Ontario. Landowners need to take the time to investigate and identify improperly abandoned wells that may exist on their property. Enhance existing education and outreach programs and if they do not exist develop new programs to promote BMP. This would include:</p> <ul style="list-style-type: none"> • An improper abandoned well is one that has not been plugged or sealed properly. Water well drillers shall be encouraged to participate in educating land owners about abandoned wells through assisting in identifying improperly abandoned wells and informing landowners of their responsibilities under O. Reg. 903. • Incorporation of source water messaging into existing education and outreach or establish new materials to be provided to landowners who may contribute to transport pathways • Education programs shall be encouraged that build upon and promote the Well Aware Program. This program encourages Ontario residential well owners to voluntarily protect their wells and common groundwater supplies. • Promote the use of Canadian Standards Guidelines for the Design and Installation of Earth Energy Systems through the education of municipal staff and industry representatives. • Education programs shall be encouraged to be focused on WHPA where threats can be significant. However areas where vulnerability adjustments were made due to transport pathways shall be made a priority. • Promotion of overall environmental awareness with regards to other connections to groundwater (e.g. low water recharge areas) to the general public; • Promotion of partnerships between licensing authorities (i.e. MOE- drinking water, MNR-oil wells) and landowners.

Appendix B – Policy Examples

	<ul style="list-style-type: none"> • Promote or develop municipal programs where transport pathways would cause an increase risk that would provide guidance for land owners. • The implementation of this policy through the existing municipal partnership of the Conservation Authority will allow these programs to be built on existing watershed education and outreach in an efficient manner. The municipalities can be involved in the program development and delivery depending on their individual needs; however the program (s) would be developed in a consistent manner across the region.
Implementation schedule	Within 2 years of the approval of the Source Protection Plan
Monitoring Policy	The implementing body shall be encouraged to report to the SPA the number of educational packages offered as well as a description of the actions/measures they have taken to implement the education/outreach in the previous year. Measures of tracking of the uptake by the target audience will also be included in this report.

Policy Number	TP-2
Sub- Threat(s)	N/A
Circumstance	N/A
Vulnerable Area	WHPA-A, B, C, D
Risk	N/A
Body Responsible for Implementing	Conservation Authority, Municipality, MOE, others
Threat Status	Existing and Future
Land Use	All
Legal Effect	Strategic
Policy Tool	Incentives
Policy Idea	<p>The province, municipalities and conservation authorities shall be encouraged to continue to invest in existing incentive programs (i.e. Clean Water Stewardship, Ontario Drinking Water Stewardship) that contribute to the protection of drinking water threats over the long term.</p> <p>Municipalities shall be encouraged to consider paying for well and septic system inspections as well as basic tests (i.e. water quality tests) in vulnerable areas through the Risk Management Office or other acceptable programs.</p> <p>The province, municipalities and conservation authorities shall be encouraged to develop and implement new incentive programs to assist with the implementation costs of risk mitigation practices such as:</p> <ul style="list-style-type: none"> • Well decommissioning • Upgrades to meet standards • Septic inspection and upgrades • Well and septic maintenance <p>The province and municipalities shall be encouraged to provide incentives for current employers (e.g. well drillers) to maintain a professional standard when constructing and decommissioning wells.</p> <p>As incentives are focused on encouraging someone to act before they have to, other industries such as insurers and mortgage holders shall be encouraged to consider providing incentives (i.e. reduced insurance rates) for well decommissioning and well and septic maintenance and upgrades.</p>
Implementation schedule	Ongoing implementation for existing programs or within 2 years of the approval of the SPP for new programs.
Monitoring Policy	The implementing bodies shall report to the CA annually on the implementation of this policy. The report shall include the funding available, the uptake of the incentives, the areas where the incentives were used and a description of the efforts to promote the incentives. The report shall report on each type of incentive separately.

Policy Example Number	TP-3a
Sub- Threat(s)	N/A
Circumstance	N/A
Vulnerable Area	WHPA-A, B, C, D
Risk	N/A
Body Responsible for Implementing	Municipality
Threat Status	Existing and Future
Land Use	All
Legal Effect	Strategic
Policy Tool	S.26 p.1 Other-Specify action
Policy Idea	<p>Municipalities shall be encouraged to develop by-laws restricting new transport pathways in vulnerable areas where activities could be significant.</p> <p>Municipalities shall be encouraged to develop by-laws to require the decommissioning of unused wells and the maintenance of current wells in vulnerable areas.</p> <p>Municipalities are encouraged to work collaboratively with the CA and the province to develop a program to identify specified transport pathways within WHPA-A, B, C, D.. This information will be used to update the Assessment Report which will inform future policy development.</p> <p>Municipalities shall be encouraged to prohibit construction of new private drinking water wells within vulnerable areas where municipal services are available.</p> <p>Municipalities shall be encouraged to develop by-laws requiring that landowners within the urban boundary that currently use wells as a water supply to hookup to municipal utilities where available.</p> <p>Municipalities shall be encouraged to include conditions of approval for development applications to ensure the decommissioning of wells in accordance with O. Reg. 903.</p> <p>Municipalities shall be encouraged to use the Risk Management Inspector to complete inspections of wells in areas where significant threats can occur. The risk management official would encourage the land owner to improve the well to meet standards including making them aware of any financial incentives which may be available to assist the landowner. If the landowner fails to take appropriate action, the risk management official shall consider drawing this deficiency to the attention of the MOE to enforce the standards under O.Reg. 903</p> <p>Where a transport pathway as a result of a Earth Energy system has been identified as contributing to a significant drinking water threat, municipalities shall be encouraged to develop a risk management</p>

Appendix B – Policy Examples

	plan
Implementation schedule	Within 1 year of effective date of the SPP
Monitoring Policy	<p>Municipalities shall submit an annual report to the CA indicating:</p> <ul style="list-style-type: none"> • Number, location and details of new transport pathways that have been identified; • Number location and details of wells that have been inspected where significant threats could occur; • Number location and details of unused wells with vulnerable areas that have been decommissioned; • Number location and details of currently in use wells in vulnerable areas that have been maintained; • Number of landowners within that have been changed from private wells to the municipal drinking water supply

Policy Example Number	TP-3b
Sub- Threat(s)	N/A
Circumstance	N/A
Vulnerable Area	WHPA-A, B, C, D; IPZ1, 2,3 and WHPA-E
Risk	N/A
Body Responsible for Implementing	Municipality
Threat Status	Existing and Future
Land Use	All
Legal Effect	Conform
Policy Tool	S.26 p.1 Other-Specify action
Policy Idea	<p>Under S.27 (3) of CWA, O. Reg. 287/07, municipalities shall notify the SPA and the SPC if a person applies to the municipality for approval of a proposal to engage in any activity in a WHPA or IPZ that may result in the creation of a new transport pathway or the modification of an existing transport pathway. This notice shall include a description of the proposal, the identity of the person responsible for the proposal and a description of approvals that are required to engage in the proposed activity.</p> <p>Conservation Authorities in collaboration with municipalities shall be encouraged to identify which activities will create a transport pathway so that municipalities are aware of what they need to report on.</p> <p>The notification shall be included as part of existing planning processes where possible.</p>
Implementation schedule	This policy shall be implemented immediately after the SPP comes into effect.
Monitoring Policy	The municipality shall submit an annual report to CA which would include the number, location and details of appropriate details related to proposals within WHPA or IPZ which create new or modifying existing pathways. The report shall summarize those notifications which were made in the previous year and indicate the current status of the proposal.

Policy Example Number	TP-3c
Sub- Threat(s)	N/A
Circumstance	N/A
Vulnerable Area	WHPA-A, B, C, D
Risk	N/A
Body Responsible for Implementing	MOE
Threat Status	Existing
Land Use	All
Legal Effect	Strategic
Policy Tool	S.26 p.1 Other-Specify action
Policy Idea	MOE shall be encouraged to enforce O. Reg. 903 through well inspection. At a minimum the MOE would be expected to act upon notification of deficient wells (from Risk management officials or others). A more proactive well inspection program focused in the areas where the risk associated with significant drinking water threats can be affected by transport pathways is encouraged.
Implementation schedule	MOE shall respond as soon as reasonably possible to any notification of a deficiency, should it be brought to their attention. A proactive inspection program is encouraged within 2 year of the effective date of the SPP.
Monitoring Policy	MOE shall submit an annual report to the CA indicating: <ul style="list-style-type: none"> • Number location and details of wells identified within an area where significant threats could occur; • Number location and details of wells that have been inspected; • Number location and details of unused wells with vulnerable areas that have been decommissioned or require maintainence. <p>It is suggested that this reporting could be accomplished through annual updates to the Water Well database.</p>

Policy Example Number	TP-4
Sub- Threat(s)	N/A
Circumstance	N/A
Vulnerable Area	WHPA-A,B,C,D
Risk	N/A
Body Responsible for Implementing	Municipality
Threat Status	Existing and Future
Land Use	All
Legal Effect	Strategic
Policy Tool	Specify and Promote Best Management Practices
Policy Idea	<p>Municipalities shall be encouraged to support the use of Best Management Practices which may include guidance from the following documents:</p> <ul style="list-style-type: none"> • OMAFRA Water Wells Best Management Practices Book (provides BMP for construction, maintenance and abandonment of drilled, dug/bored and sand point wells) • MOE Water Supply Wells Requirements and Best Management Practices (provides guidance on when and how to properly abandon a well) • MOE Ontario Water Resources Act Reg. 903 Best Practices Manual <p>When municipalities are presented with an opportunity to decommission wells through development proposals or infrastructure planning they are encouraged to ensure the proper decommissioning of the well (as per O. Reg. 903) .</p> <p>Municipalities shall be encouraged to use qualified professionals to consider the effect of municipal infrastructure (i.e. sewer, SWM, re-grading) and development servicing on the vulnerability of WHPA.</p> <p>Municipalities shall be encouraged to require all Earth Energy systems be designed in accordance to Canadian Standards Association Design and Installation Guidelines or other relevant standards.</p>
Implementation schedule	This policy shall be implemented immediately after the SPP comes into effect
Monitoring Policy	Municipalities shall submit an annual report to the CA that would outline the Best Management Practices that have been undertaken with regards to the construction, maintenance and abandonment of wells as well as the results of studies that have been undertaken considering the effect of municipal infrastructure and development servicing on the vulnerability of WHPA.

Appendix C-Definitions

Aquifer: A geologic formation or structure that transmits water in sufficient quantity to supply the needs for a water development. The term water-bearing is sometimes used synonymously with aquifer when a stratum furnishes water for a specific use. Aquifers are usually saturated sands, gravel, fractures, or cavernous and vesicular rock.

Bedrock: Solid rock below a soil profile from which parent material is derived by weathering.

Closed Loop System: This system circulates Heat Transfer Fluid (HTF) through pipes installed in the ground to utilize the thermal gradient between the HTF and the environment for heating and cooling.

Drinking Water Threat: An activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water and includes an activity or condition that is prescribed by the regulation as a drinking water threat (Clean Water Act, 2006₁).

Earth Energy System (also called Geothermal Systems, Ground Source Heat Pump Systems or Geexchange Systems): Earth energy systems are defined under the Ground Source Heat Pump Regulation as a heating and cooling system for buildings that uses a fluid to exchange heat with the ground or groundwater.

Groundwater: Subsurface water occupying the saturation zone from which wells and springs are fed. In a strict sense the term applies only to water below the water table.

Heat Transfer Fluid: The Heat Transfer Fluid used in closed loop system is ethanol or propylene glycol.

Intake Protection Zone (IPZ): Refers to a surface water intake protection zone, which is an area related to a surface water intake and within which it is desirable to regulate or monitor drinking water threats (General Regulation 287/07₂). Intake Protection Zones are further delineated as:

- Intake Protection Zone 1 (IPZ-1), which is the immediate zone of 1 kilometer radius for a Great Lakes intake, drawn around the intake, until it touches the shore where it extends to a certain setback into the land;
- Intake Protection Zone 2 (IPZ-2), is delineated based on a 2 hour travel time to the intake under tributaries and creeks that drain into the lake within a 2 hour time of travel to the intake.

Moderate and Low Drinking Water Threats: Generally refer to prescribed activities deemed moderate or low drinking water threats based on the risk score.

Open Loop System: An open looped system is one type of earth energy heat pump systems. In these systems groundwater pumped from a well or a series of wells is circulated through a heat pump located inside the building. This system also cools by extracting heat from the air inside the building and transferring it to the water circulating through the system. The system then injects the water back into the aquifer through a well or discharges it to a stream, river, lake or pond.

Overburden: Unconsolidated material overlying bedrock.

Sewershed: The area of a municipality served by a given sewer network. For example, the area tributary to a given combined sewer overflow or a given Water Pollution Control Plant (WPCP) would be termed the sewershed tributary to the overflow or WPCP.

Significant Threat: A significant drinking water threat means a drinking water threat that according to a risk assessment, poses or has the potential to pose a significant risk (Clean Water Act, 2006₁)

Threat: Refers to an activity (land use) that poses a threat to drinking water quality or quantity.

Vulnerability Score: A score assigned to a vulnerable area with a higher score indicating a higher vulnerability.

Appendix C – Definitions

Wellhead Protection Area (WHPA): Refers to an area that is related to a wellhead and within which it is desirable to regulate or monitor drinking water threats (General Regulation 297/07₂). Wellhead Protection Zones can be further delineated into:

- WHPA-A: 100 m fixed radius around each well;
- WHPA-B: 2 year time of travel to the well, excluding the area of WHPA-A
- WHPA-C: 2 to 5 year time of travel to the well;
- WHPA-D: 5 to 25 year time of travel to the well;
- WHPA-E: delineated if it is shown that a surface water system influence effectively bypass the aquifer's protection; and,
- WHPA-F: delineated if the well is subject to issues, which originate from outside the other parts of the Wellhead Protection Area.

Well: A well is defined in Section 1 of Ontario Water Resources Act as a hole made in the ground to locate or obtain groundwater or to test or to obtain information in respect of groundwater or an aquifer, and includes a spring around or in which works are made or equipment is installed for collection or transmission of water and that is or is likely to be used as a source of water for human consumption.

¹Clean Water Act, 2006 (http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_06c22_e.htm)

²Clean Water Act Ontario Regulation 287/07-General (http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_070287_e.htm)