Significant Groundwater Recharge Areas

Under the Clean Water Act (2006), Technical Rules for development of an Assessment Report have been established. These rules outline the delineation of four types of vulnerable areas within which policies will be developed and implemented to protect water, namely: Well Head Protection Areas, Intake Protection Zones, Highly Vulnerable Aquifers and Significant Groundwater Recharge Areas.

Significant Recharge areas are to be developed using existing models and data from Tier I water budgets, and the Technical Rules allow for the use of Professional Judgment in the form of a technical Peer Review Committee. Specifically, the rules state:

> 44. Subject to rule 45, an area is a significant groundwater recharge area if,
>
> (1) the area annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more; or
>
> (2) the area annually recharges a volume of water to the underlying aquifer that is 55% or more of the volume determined by subtracting the annual evapotranspiration for the whole of the related groundwater recharge area from the annual precipitation for the whole of the related groundwater recharge area.
>
> 45. Despite rule 44, an area shall not be delineated as a significant groundwater recharge area unless the area has a hydrological connection to a surface water body or aquifer that is a source of drinking water for a drinking water system.
>
> 46. The areas described in rule 44 shall be delineated using the models developed for the purposes of Part III of these rules and with consideration of the topography, surficial geology, and how land cover affects groundwater and surface water.
>
> (Technical Rules: Assessment Report, December, 2008)
> *Clean Water Act, 2006*

Further guidance was provided by the Ministry of Natural Resources on the development of Significant Groundwater Recharge Areas (SGRA) in the form of a Technical Bulletin (dated April, 2009). This bulletin highlighted what aspects of the methodology require Professional Judgment. Specifically, key decisions which require Professional Judgment are:

1. Which methodology is to be used in order to determine SGRA (i.e. rule 44 (1) or (2))

2. The scale at which these methodologies will be applied

3. Incorporation of local geological and hydrological knowledge into the SGRA delineation process

This bulletin is intended to provide an overview of the SGRA methodology developed for the Ausable Bayfield Maitland Source Protection Region in coordination with Peer Review Committee.

Karst and Sinkhole Drainage Areas

The Ausable Bayfield Maitland Source Protection Region is host to a unique category of geological features related to Karst topography and, more specifically sinkhole development. Large sinkholes, located in several areas in the Region have had natural and agricultural drainage directed into them under the Drainage Act. These features allow for direct recharge of the bedrock aquifers (WHI, 2003).

Under the guidance of the Clean water act, the areas which drain into these sinkholes are considered herein to be Significant Groundwater Recharge Areas under rule 44(2) as approximately 100% of water remaining after subtracting the annual evapotranspiration from the annual precipitation. In accordance with Rule 45, these areas are known to have influence on local private water wells, though the extent of that influence has not been adequately determined (WHI, 2005). Drainage areas which are connected to sinkholes that have direct connections to the underlying bedrock aquifers are shown on Map 1, attached.

Hydrologic Response Units

In order to determine SGRAs at a finer sclae than the Tier 1 Subwatersheds, it was decided by the Peer Review Committee for this process that another approach be implemented. This approach was designed to account for the geology, soils, land cover and topography of the Region. In order to do this, a series of unique Hydrologic Response Units (HRUs) were created using available geology, landcover and topographical mapping. HRUs were developed following a similar methodology to that of the abutting Saugeen Grey Sauble Northern Bruce Peninsula and Lake Erie Source Water Protection Regions (see for example, AquaResource, 2008). Once HRUs have been developed for the entire region specific recharge values can be approximated for the Region.

Hydrologic Response Units were created by reclassifying and intersecting a number of data sets. The details of which are described below.

Surficial Geology

Surficial geological units were reclassified according to the texture of the materials of which they are composed. It should be noted that the surficial geological classifications also account, to a large extent, for the soil texture distribution and topography of the Region and are therefore considered redundant with respect to determining SGRAs. The reclassification of the surficial geological units are listed below in Table 1.

Land Cover

Land Cover datasets were created by overlaying the following existing datasets: forested areas (Ministry of Natural Resources (MNR) Forest Resource Inventory); wetland areas (MNR wetlands); and urban areas identified on the municipal parcel fabric. Land areas that did not fall into one of the three categories (forest, wetland or urban) are assigned as agricultural. Initial attempts at creating this synthetic landcover layer were reviewed and stream beds were poorly represented (i.e. they were reclassified as agricultural) as they have no unique land cover category. However, these stream beds are typically represented by the geological unit “alluvium” and, as such, it was deemed appropriate to

reclassify these types of deposits as impervious within the new geological classifications for the purpose of SGRA delineation (see Table 1) rather than attempt to extract them manually from the Land Cover data set.

Table 1. – Surficial Geology Reclassification

Geologic Grouping	Quaternary Geology Description
Impervious	Open Water, Alluvium
Clay Tills	St. Joseph Till, Glaciolacustrine Deep Water Deposits, Lacustrine Clay and Silt, Man-Made Deposits, Tavistock Till Fluvial Deposits, Modern Fluvial Deposits, Flood Plain Deposits[1]
Silt Tills	Bruce Till, Dunkeld Till, Elma Till, Rannoch Till, Newmarket Till, Tavistock Till
Sand Tills	Catfish Creek, Wentworth Till
Sand and Gravels	Eolian Deposits, Fan or Cone Deposits, Aeolian Deposits, Glacial-outwash Sand, Glaciofluvial ice-contact Deposits, Glaciofluvial Outwash Deposits, Glaciolacustrine Deposits Beach Bar, Glaciolacustrine Deposits Shallow Water, Glaciolacustrine Shoreline Deposits, Modern Beach Deposits, Ice-contact deposits
Bedrock	Exposed Bedrock or Bedrock with Thin Drift.

Hummocky Topography

Hummocky topography is those areas typified by highly variable, gentle slopes which have high depressional storage and closed depressions with no outlets. They are commonly associated with moraines in the Region. These areas typically have enhanced recharge rates due to the lack of outlet and increase depressional storage. Areas of hummocky topography were identified in the Grey Bruce Groundwater Study (WHI, 2003). These areas were then overlain on the land cover data set to create unique HRUs. All areas of identified hummocky topography were given the hummocky land cover designation. Final land cover categories are listed below in Table 2.

Table 2. Land Cover Reclassification for HRU development

Land Cover Reclassification
Wetland
Forested
Urban
Agricultural
Hummocky

Hydrologic Response Unit Creation

Hydrologic Response Units (HRUs) were then created by combining all 4 reclassified datasets: Quaternary geology, land cover, karst and hummocky topography into 16 HRUs, as shown in Table 3, below.

Table 3. HRU classifications

HRU	Description
1	Impervious
2	Wetland
3	Clay / Clay Till Agricultural
4	Silt Till Agricultural
5	Sand Till Agricultural
6	Sand & Gravel Agricultural
7	Low Permeability Forest
8	High Permeability Forest
9	Low Permeability Hummocky
10	High Permeability Hummocky Vegetation
11	Clay / Clay Till Urban
12	Silt Till Urban
13	Sand Till Urban
14	Sand & Gravel Urban
15	Bedrock
16	Karst

It should be noted that clay till and silt till were grouped together into the "Low Permeability" category , while sand till and sand and gravel grouped into the "High Permeability" category for forested and hummocky land cover groups. This was done to be consistent with HRU development methodologies in abutting Regions.

Assigning Recharge Values to HRUs

Recharge values for individual HRUs are typically derived from a surface water model calibration exercise using the GAWSER modeling package (see for example, AquaResource, 2008). As no GAWSER model was available for the Ausable Bayfield Maitland Region, a different approach was developed.

Initial Recahrge values were assigned to each individual category of HRU based on calibrated modeling of the Otter Creek watershed within the Saugeen Grey Sauble Northern Bruce Peninsula Region. This watershed directly abuts the Ausable Bayfield Maitland Region. Assigned values are listed below in Table 4.

Adjustment of Recharge Values

In order to develop unique recharge values for each HRU in the region, and adjustment exercise was undertaken. Existing SWAT models, created as part of the Tier I water budget for the Region, provided calibrated recharge estimates at a subwatershed scale (approximately 460 subwatersheds). For each of these subwatersheds, an estimate of recharge was developed by summing the initial assigned recharge values for all of the HRUs in that specific subwatershed. This value was then compared to the SWAT-developed recharge estimate and a scalar determined to adjust this value. This scalar was then applied to all the HRU recharge values in that subwatershed, such that each category of HRU had an unique recharge value within each subwatershed.

It should be noted that the relative value of recharge rates between different HRUs was maintained, but actual estimated recharge values were adjusted on a subwatershed scale.

Table 4. Assigned Initial Recharge Values for the Region

(HRU)	Name	Recharge – SVCA
1	Open Water	
2	Wetland	59.56
3	Clay-till Ag	65.50
4	Silt-till Ag	138.91
6	Sand and Gravel Ag	398.90
7	Low Permeability Forest	268.18
8	High Permeability Forest	493.10
9	Low Permeability Hummocky	369.18
10	High Permeability Hummocky	526.78
11	Clay-till Urban	42.57
12	Silt-till Urban	90.29
14	Sand and Gravel Urban	259.28
15	Bedrock	239.41
16	Karst Areas	

Recharge in mm/yr
SVCA data developed form GAWSER model for the Otter Creek Sub watershed (Saugeen, Grey Sauble, Northern Bruce Peninsula Source Protection Region Tier 1 and Tier 2 water budget, 2009)

Determination of Groundwater Recharge Areas

In order to determine the which HRUs would be considered Significant Groundwater Recharge Areas the Peer Review Committee recommended the approach outlined in Rule 44 (1); whereby any HRU with an annual recharge rate more than 1.15 times the average for the surrounding area would be considered an SGRA. In order to develop an average for the "surrounding area", it was decided that the Region would be split into the Maitland Source Protection Area (Jurisdiction of the Maitland valley Conservation Authority) and the Ausable Bayfield Source Protection Area (Jurisdiction of the Ausable Bayfield Conservation Authority).

Accordingly, mean annual adjusted recharge values for all HRUs in each of the Source Protection Areas (SPAs) was developed, and all HRUs with values more than 1.15 times this mean were identified as potential SGRAs. Table 5, below, shows the total number of HRUs identified for the Region and the mean annual recharge values for each SPA.

Determination of Significance

In order to determine significance, under rule 45 the identified SGRA must have a drinking water system located within it. In order to assess this, the HRUs identified as having annual adjusted recharge rates greater than 1.15 times the SPA mean were assembled into new, larger polygons. These polygons were then intersected with the Water Well Information System database in a GIS environment. Only those polygons within which a known well or other drinking water system exists were determined to be SGRAs.

Table 5. Significant Groundwater Recharge Areas by Hydrologic Response Unit for the Ausable Bayfield Maitland Region, based on 1.15 times the annual recharge value for each of the Maitland and Ausable Bayfield

HRU	# HRUs	# HRUs Below 1.15 X mean	# HRUs Above 1.15 X mean	%above	%below
Open Water	428	428	0	0.00	100.00
Wetland	14499	14499	0	0.00	100.00
Clay-till Ag	10280	10280	0	0.00	100.00
Silt-till Ag	7589	7589	0	0.00	100.00
Sand and Gravel Ag	9064	886	8178	**90.23**	**9.77**
Low Permeability Forest	16675	5422	11253	**67.48**	**32.52**
High Permeability Forest	9535	219	9316	**97.70**	**2.30**
Low Permeability Hummocky	3605	444	3161	**87.68**	**12.32**
High Permeability Hummocky	1043	1	1042	**99.90**	**0.10**
Clay-till Urban	3641	3641	0	0.00	100.00
Silt-till Urban	3369	3369	0	0.00	100.00
Sand and Gravel Urban	2949	2145	804	**27.26**	**72.74**
Bedrock	61	40	21	**34.43**	**65.57**
Karst Areas	36	36	0	**100.00**	**0.00**

Maitland SPA Mean	181.71
Mean X 1.15	208.97

Ausable Bayfield SPA Mean	215.95
Mean X 1.15	248.34

Recharge in mm/year
Mean calculation did not include Open Water or Karst HRUs

Peer Review Process

SGRAs in the Ausable Bayfield Maitland Region were developed in concert with the Water Budget Peer Review Committee. Accordingly, the following decisions were vetted through the committee:

1. HRU Methodology. The Peer Review Committee endorsed the usage of the methodology described above.

2. Usage of Rule 44 (1). The Peer Review Committee endorsed the usage of the 1.15 times the mean annual recharge value as the methodology for determining significance.

3. Scale of "surrounding area". The Peer Review Committee endorsed the usage of the Maitland and Ausable Bayfield SPAs as the surrounding area for determining the mean to be consistent with Rule 44 (1)

4. Inclusion of karst drainage areas as SGRAs. The Peer Review Committee endorsed the inclusion of these areas as per Rule 44 (2) in that more than 55% of remaining water is recharged after subtracting annual evapotranspiration from annual precipitation

5. Determination of Significance. The Peer Review Committee endorsed the decision that, consistent with Rule 45, only those recharge areas which have a water system or well will be considered a Significant Groundwater Recharge Area.