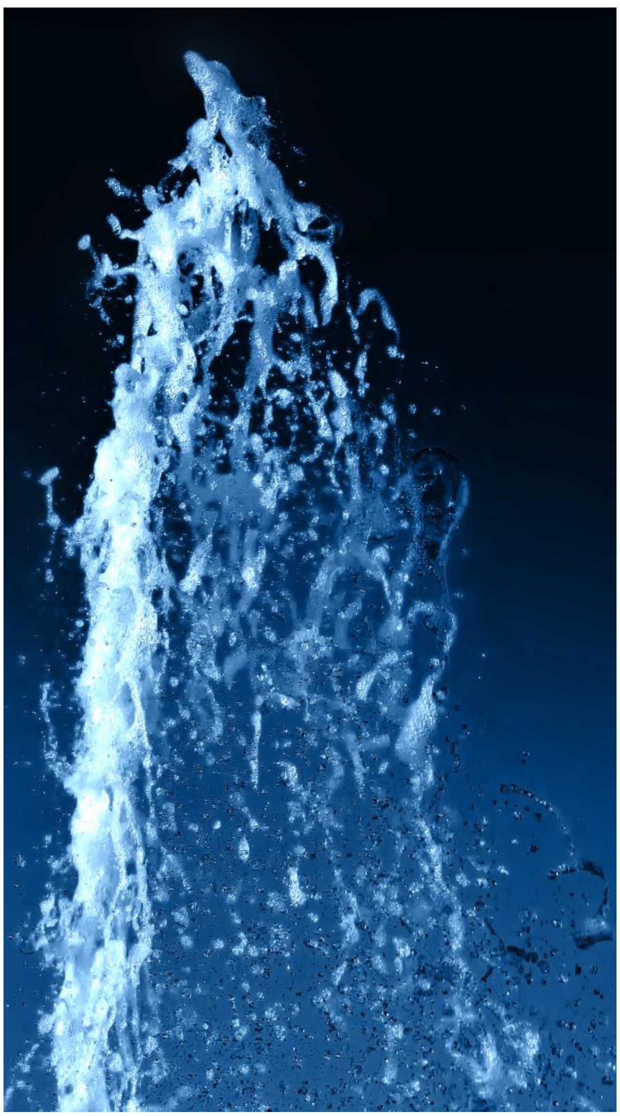
Part Ten

Dowling Drinking Water System



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Chapter 51 - The Dowling Drinking Water System

The Dowling drinking water system consists of two wells located in the community of Dowling, close to the Onaping River, and services approximately 1,850 people. Riverside (Well #1) is located on Riverside Drive and Lionel (Well #2) is located at the end of Lionel Avenue. Construction of the system occurred in two phases; the first well was built in 1975 and the second well in 1983. Map 10.1 illustrates the distribution system for the community of Dowling.

Both wells have been determined to be Groundwater Under the Direct Influence of surface water (GUDI) wells with effective in situ infiltration (Golder 2002). Water taking from the Riverside and Lionel Wells is alternated remotely from the Wanapitei Water Treatment Plant. Treatment consists of disinfection with U.V. treatment, chlorine gas and the addition of fluoride.

Water use figures are presented in Table 10.1. An elevated storage tank with a holding capacity of 1,360 m^3 is included in the system and is operated by staff at the Wanapitei Water Treatment Plant. It takes approximately 9 hours to fill the tank and, based on current usage rates, the tank could sustain the community for approximately 2.4 days.

Table 10.1 – Summary of water usage in the Dowling drinking water system for 2002-2007

	Lionel	Riverside
Daily Permitted Amount (m^3/day)	3,600	3,600
Monthly Permitted Amount (m^3/month)	109,500	109,500
Average Actual Monthly Volume (m^3/month)	6,272	9,361
Percentage of Monthly Permitted Volume	6%	9%
Maximum Actual Monthly Volume (m^3)	12,524	16,517
Percentage of Monthly Permitted Volume	11%	15%
95^{th} Percentile (m^3)	11,229	14,052
Percentage of Monthly Permitted Volume	10%	13%

Chapter 52 - The Dowling Contributing Area

The Dowling drinking water system, as described in the previous chapter, is subject to the influence of surface water and is thus deemed to be a Groundwater Under the Direct Influence of surface water (GUDI) well. The delineation of the contributing area for the wells includes the surface water system upstream from the two wells and is truncated at the point where the Vale wells begin in Levack[1].

The Dowling watershed is estimated to be approximately 1,567 km^2 and includes a number of points of interest. Onaping Falls, or A.Y. Jackson lookout, is a major attraction offering walking trails and lookouts for fall colour viewing. The watershed includes the towns of Onaping and Levack and continues to the headwater area of Moose Lake. The majority of the watershed is forested with bedrock dominating the geology of the area. Map 10.2 illustrates the contributing area for the Dowling wells.

[1] The Levack wells were part of the municipal drinking water system for the Town of Levack until November 2009. The Hardy wells in Onaping currently serve as the Levack drinking water supply and the original Levack wells are in operation for mining purposes only.

Chapter 53 - Water Budget and Quantity Assessment

The Dowling drinking water system lies within the Vermilion watershed. As previously described in Chapter 28, the Vermilion watershed was given a water quantity stress level of low and therefore did not need to progress to the next level of a water quantity assessment. Given the isolated nature of the municipal wells, it was decided by the Greater Sudbury Source Protection Area technical team that a Tier 1 water budget should be completed for each drinking water system. The methodology applied is described in greater detail in Chapter 3 and in Appendix 2.

53.1 The Dowling Wells Contributing Area Water Budget

The water balance for the Dowling drinking water system was based on the delineated watershed described in the previous chapter. Table 10.2 summarizes the elements of the water balance estimate. The soil water holding capacity was weighted over this delineated watershed and streamflow was measured at the closest gauging station located on the Onaping River (02CF010) and prorated to the outlet of the watershed.

As described in Table 10.2, the average annual recharge was calculated to be 188 mm, and the annual water surplus was calculated to be 410 mm. Estimated annual recharge was greater than estimated baseflow, which may be a result of processes such as interflow, which move water to surface water sources (e.g. wetlands) prior to releasing to rivers.

Table 10.2 – Water budget for the Dowling watershed

	Water Balance Element (mm)										
Month	Rainfall	Snow-fall	Snow-melt	Total Input	PET*	AET**	Stream-flow	Base-flow	Runoff	Water Surplus	Water Deficit
January	2.3	61.2	5.8	8.1	0.0	0.0	10.3	5.2	5.2	0.0	-2.2
February	2.9	48.5	13.5	16.4	0.0	0.0	8.1	4.0	4.0	8.3	0.0
March	20.0	46.7	67.2	87.1	0.0	0.0	10.8	3.2	7.5	76.4	0.0
April	52.0	13.4	129.2	181.1	19.2	19.2	50.0	10.0	40.0	112.0	0.0
May	80.8	1.0	8.8	89.6	74.5	73.2	47.9	7.2	40.7	0.0	-31.5
June	77.1	0.0	0.0	77.1	110.5	102.0	20.3	4.1	16.2	0.0	-45.1
July	78.0	0.0	0.0	78.0	130.3	108.5	9.4	4.2	5.2	0.0	-39.9
August	84.9	0.0	0.0	84.9	112.7	92.2	5.7	2.6	3.1	0.0	-12.9
September	106.4	0.0	0.0	106.4	69.0	67.0	7.5	3.0	4.5	32.0	0.0
October	82.3	2.5	2.5	84.8	30.2	30.2	16.4	5.7	10.6	38.2	0.0
November	45.4	33.3	19.0	64.4	0.7	0.7	20.0	7.0	13.0	43.7	0.0
December	9.3	55.5	15.2	24.6	0.0	0.0	15.6	6.2	9.4	9.0	0.0
Annual Total	641.5	262.1	261.2	902.7	547.0	493.0	221.8	62.4	159.4	319.5	-131.6
Annual Recharge										**187.9**	

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

53.2 The Dowling Wells Water Quantity Stress Assessment

The water quantity stress assessment results are provided in Table 10.3. For the Lionel and Riverside wells, it was assumed that the permitted pumping rates were 100% consumed from the groundwater system. Municipal demand calculated for this contributing catchment included the municipal demand in the community of Levack. The calculated water removed by the Dowling groundwater wells was approximately 0.8 mm, which represented 14% of the permitted pumping rate. In addition, there are several other groundwater removals in the Dowling watershed including the industrial water use in Levack.

Groundwater recharge was assumed as equal throughout the year. Recharge rates were two orders of magnitude above demand, and monthly stress did not exceed 2% in this watershed. Stress level was calculated to be just below 2% under the current and future municipal demand forecast. On an annual basis, calculated groundwater stress levels were about 1.7% at present and future scenarios, respectively. Therefore, the Dowling watershed was characterized as ‘low’ stress level under all monthly and annual scenarios.

Table 10.3 – Water quantity stress assessment for the Dowling watershed

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Recharge	Reserve	Municipal	Other	Total	Forecast	Present	Forecast
January	9.4	0.94	0.02	0.11	0.13	0.13	1.52	1.54
February	9.4	0.94	0.02	0.11	0.13	0.13	1.51	1.53
March	9.4	0.94	0.02	0.11	0.13	0.13	1.54	1.56
April	9.4	0.94	0.02	0.12	0.13	0.13	1.57	1.58
May	9.4	0.94	0.02	0.12	0.13	0.13	1.57	1.59
June	9.4	0.94	0.02	0.13	0.15	0.15	1.78	1.80
July	9.4	0.94	0.02	0.14	0.16	0.16	1.87	1.89
August	9.4	0.94	0.02	0.15	0.17	0.17	1.96	1.98
September	9.4	0.94	0.02	0.14	0.16	0.16	1.85	1.87
October	9.4	0.94	0.02	0.12	0.14	0.14	1.61	1.63
November	9.4	0.94	0.02	0.12	0.13	0.14	1.58	1.60
December	9.4	0.94	0.02	0.12	0.13	0.14	1.59	1.60
Annual	**9.4**	**0.94**	**0.02**	**0.12**	**0.14**	**0.14**	**1.66**	**1.68**

53.3 Water Budget and Stress Assessment Uncertainty

Uncertainty in the Tier 1 process takes into account the quality of the available data. Municipal water removals and water use trends were obtained from the City of Greater Sudbury and from industry, and large volume permits to take water were checked for actual use and active status. For each Tier 1 water budget, the water surplus was in the range of that reported in the literature (e.g. Richards 2002). For all groundwater sources the estimated uncertainty is low.

Chapter 54 - Dowling Water Quality Risk Assessment

The following sections provide the results for the water quality risk assessment process for the Dowling drinking water system.

54.1 Dowling Wellhead Protection Areas and Vulnerability Scoring

The wellhead protection areas were delineated according to Rules 47 through 50 and followed the methodology outlined in Chapter 2. The resulting vulnerable areas are illustrated on Map 10.3 for each well in the Dowling drinking water system. The maximum time of travel for the Dowling wells is less than five years, therefore there is no WHPA-D.

Both Dowling wells are considered Groundwater Under the Influence of Surface Water (or GUDI) which requires the delineation of a WHPA-E (Rule 49). A WHPA-F was not delineated as no water quality issues are present at the well. The WHPA-E was delineated using HEC-RAS to model a one in two year storm event on the Onaping River. Appendix 2 details the methodology.

Vulnerability scoring for the wellhead protection areas followed Rules 82 through 85 and the methodology outlined in Chapter 2. Map 10.4 illustrates the vulnerability scoring for the Dowling drinking water system.

The vulnerability scoring for the WHPA-E follows the same methodology for an IPZ-2 for a Type C intake. For the Dowling wells, the source vulnerability factor was given a score of 0.9 (out of a possible 0.9 or 1.0) as the wells are not vulnerable to exposure. The area vulnerability factor was given a score of 8 (out of a range of 7-9) as land cover in the area is mostly forested, but the lower reaches are urban residential, and due to the distance and time water must travel to enter the well. The overall vulnerability score for WHPA-E is 7.2, or moderate.

Vulnerable Area Delineation Uncertainty

Vulnerable area delineation for wellhead protection areas A – D was completed together, while wellhead protection area E was delineated separately.

Wellhead Protection Areas A – D

Modeling groundwater flow is complex and requires good information and adequate data to be certain of the model results. The groundwater model represents a first step in providing a general understanding of groundwater flow conditions. A degree of uncertainty is always present when using a model to interpret real world situations. In general, geological, hydrogeological and methodological factors contribute to the level of uncertainty within a model. Table 10.4 summarizes the uncertainty in these factors for the Dowling drinking water system. For a detailed description of each factor, refer to Appendix 2.

Table 10.4 – Summary of wellhead protection area delineation uncertainty for the Dowling system

Geological Factors	Depth to aquifer, thickness of overburden	Sufficient data from MOECC, MNDM databases
	Soil and Rock Characteristics	Data entry estimations, reporting inconsistencies, averaging by assigning Geologic Survey of Canada codes, very few grain size analyses
Hydrogeological Factors	Hydraulic Parameters	Difference between calculated hydraulic conductivity and value assigned in the model, low density of data, very few porosity data
	Hydraulic Head Measurements	Questionable accuracy of values in WWIS, no data from some areas
	Recharge	Recharge assigned according to top layer
	Boundary Conditions	Rivers assigned constant head; no sensitivity analyses
Methodological Factors	Model Used for WHPA Delineation	MODFLOW /MODPATH are industry standards. Only saturated zone flow considered. Natural attenuation not considered.
	Model Calibration and Sensitivity Analysis	Calibrated hydraulic conductivity and recharge only; no sensitivity analyses
	Pump Rate Used for Model	95th percentile of monthly pumping rate is considered a conservative estimate
	Capture Zones Delineation	High uncertainty due to long, narrow WHPAs

Uncertainty Level

High Uncertainty | Moderate Uncertainty | Low Uncertainty

As described in Table 10.4, there is generally a moderate to high level of uncertainty related to the various components of the groundwater modeling process. The uncertainty in the WHPA-A delineations is lower because they are defined by the Technical Rules as a fixed radius. Generally, the uncertainty in delineating the non-fixed WHPAs decreases closer to the wellhead as there is less compounding of errors. The overall uncertainty for the WHPA-B and WHPA-C delineations is assessed to be high.

Wellhead Protection Area-E

The level of uncertainty associated with the WHPA-E delineation can be assessed by defining the quantity and quality of data as well as the methodology employed. Data can be divided into the following categories: topographic and bathymetric data, hydrometric data and roughness data. Methodological factors can be categorized as the following: model used, boundary conditions, calibration and sensitivity analysis, and capture zone delineation. Table 10.5 summarizes the level of uncertainty assigned to each of these categories and the rationale behind the assessment. Appendix 2 provides additional detail.

Table 10.5 – Summary of WHPA-E uncertainty analysis for the Dowling drinking water system

Data Factors	Topographic and Bathymetric Data	Detailed topography available: bathymetric data based on visual interpretation of aerial photography
	Hydrometric Data	No hydrometric data available within modeled section. HYDAT station with 26 years of data is located 1.8 km upstream
	Roughness Data	Based on interpretation of aerial photography
Methodological Factors	Model Used for Protection Zones Delineation	HEC-RAS is industry standard code for modeling flow in rivers
	Boundary Conditions	Critical depth appropriate for river
	Model Calibration and Sensitivity Analysis	No calibration or sensitivity analysis could be conducted
	Capture Zones Delineation	High uncertainty due to lack of bathymetry data and field observed Manning's data

Uncertainty Level

High Uncertainty | Moderate Uncertainty | Low Uncertainty

The surface water flow model simulations provide a general understanding of the surface water flow conditions in the Onaping River. As explained in Table 10.5, uncertainty related to the various components of the surface water modeling process ranges from low to high. Due to the lack of bathymetry data and the lack of field testing, the overall uncertainty is high.

Vulnerability Assessment Uncertainty

The vulnerability scores are based on the Intrinsic Susceptibility Index (ISI) and the wellhead protection area. Therefore, the uncertainty associated with each score is a function of these two variables. The uncertainty of the wellhead protection areas has been described above.

The ISI score is in part based on the presence or absence of an aquitard or confining layer above the aquifer. In the Dowling contributing area, there is no, or a very thin, aquitard, therefore, the ISI score is highly vulnerable. There is a great amount of reliability in this information; therefore, the uncertainty of this score is low.

54.2 Dowling Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed Technical Rules 118 to 125 and the methodology is outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Map 10.4. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater has the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater has the potential for a moderate or low threat to occur.*
- Areas with a vulnerability score of 4 or greater has the potential for a low threat to occur.*
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.*

*DNAPLs are an exception because they are always a significant threat in WHPA-A, B, C/C1 regardless of the vulnerability score.

The MOECC has established an online tool that incorporates the Provincial Tables of Circumstances into an interactive mapping tool, accessible via http://swpip.ca/. With the address search function, this tool lets you identify what vulnerable area(s) a property is located in and what the vulnerability score is at that location. It also identifies a list of circumstances of all is or would be significant, moderate or low drinking water threats. For more detailed instructions on how to use the above mentioned website refer to Appendix 5.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in the vulnerable areas is described in Chapter 2.

The percentage of managed lands in the Dowling wellhead protection areas was assessed to be under 40% (low) and is illustrated on Map 10.5.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. According to these calculations, the area immediately around Riverside Well has a 8-80% impervious area, while the area immediately around Lionel Well has a 1-8% impervious area.

It is noted in Section 54.4 that both the Lionel and Riverside wells consistently have sodium levels in the range from 20 – 30 mg/L, but there is insufficient data to determine if there is a significant increasing trend. The percentage of impervious area is illustrated on Map 10.6.

The methodology used to calculate percentage of impervious surfaces in the vulnerable areas is described in Chapter 2.

The impervious surface calculations result in the application of road salt being designated as a moderate threat in WHPA A, B and C, and a low threat in WHPA-E, as shown in Table 10.7.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. There are no agricultural lands in the Dowling wellhead protection area, therefore the area has a score of under 0.5 nutrient units per acre. The results are illustrated on Map 10.7.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer. The results show that the application of commercial fertilizer is a moderate threat in WHPA A, B and C, and a low threat in WHPA-E, as illustrated in Table 10.6.

Enumeration of Threats

Table 10.6 lists an estimate of the number of significant, moderate and low drinking water quality threats in the Dowling drinking water system in accordance with the Drinking Water Threats Tables.

Table 10.6 – Drinking water quality threats for the Dowling drinking water system

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
WHPA A, B & C			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.		1	
The handling and storage of fuel.		1	
The application of commercial fertilizer to land.		2	
The application of road salt.		2	
Local threat: Transportation of hazardous substances along transportation corridors.	1	1	
WHPA E			
The application of commercial fertilizer to land.			2
The application of road salt.			2
Local threat: Transportation of hazardous substances along transportation corridors.		1	3

54.3 Dowling Drinking Water Threats Conditions

A drinking water condition is a situation that results from a past activity and meets the criteria laid out in Chapter 2. For a more detailed review of methodology for identifying drinking water conditions, please refer to Part 1, Chapter 2.

The areas where a significant, moderate or low threat condition could exist are the same as the areas where a potential threat could occur. For an illustration, please see Map 10.4. Currently, there are no known significant conditions present in the Dowling vulnerable areas.

54.4 Dowling Drinking Water Quality Issues

Drinking water quality issues were assessed based on the methodology outlined in Chapter 2 and Rules 114 and 115.

The Lionel and Riverside wells have sodium levels in the range from 20 – 30 mg/L. Currently, there is insufficient data to determine if there is a significant increasing trend.

Chapter 55 - Data Availability

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data and overall outcome. As new information arises, either from increased or continuous monitoring, improved models or a change in methodology, the results from this report will have to be updated to reflect the additional information.

The assessment report is an ever evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity.