Newfoundland Labrador

Government of Newfoundland and Labrador
Department of Environment and Conservation
Water Resources Management Division

Technical Memo: Deer Lake Seepage Issue

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Copies: Department of Municipal Affairs, Town of Deer Lake
Date: June 30, 2014
File Number: 533-06

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1. Introduction

In early May of 2014 an issue came to the attention of the Department of Environment and Conservation (ENVC), Water Resources Management Division concerning flooding of a residential area in the Town of Deer Lake due to high groundwater levels. The notification of the issue was originally made to both ENVC and to the Department of Municipal and Intergovernmental Affairs (MIGA) on May 6, 2014 by Mr. Richard Dewey, a resident of Deer Lake. Mr. Dewey has blamed seepage from the Humber Canal for the high groundwater levels that have caused flooding of basements in the area of concern. MIGA's assessment at the time was that they would have no reason for involvement as the town did not see this as an issue requiring capital works funding.

The site in question is indicated in Figures 1-3 and is the residential area bounded by the Humber Canal to the south, Main St. to the north, Deer Lake Power penstocks to the west and the woods in the east. Seepage issues were reported to encompass Garden Rd., Elizabeth Ave., Phillip Dr., Edward St., Canal Rd., Middle Rd., Gate House Rd., Devon Row, and Main Dam Rd. The area in question encompasses approximately 4 km^2. A group of approximately 25 concerned homeowners in this area has formed and presented a petition to the Town of Deer Lake requesting action on this issue.

On May 12, 2014, ENVC staff member Ian Bell (Environmental Scientist) conducted site visit. He met with Mr. Dewey, the Town Manager, the Mayor and the EA for the local MHA. Mr. Bell observed soggy ground conditions in the area of concern and residual snow pack. His conclusion was that the issue of storm drainage/basement flooding in the residential area of concern was a municipal issue to be resolved through normal procedures including the use of municipal own source revenues, and or application to access municipal infrastructure funding. The Town may also wish to explore eligibility under Gas Tax.

On June 13, 2014 ENVC staff member Paula Dawe (Senior Engineer) conducted a site visit of the residential area of concern and Deer Lake Power water control infrastructure including the Humber Canal. She met with the Town Manager, Town Superintendent, four Town Councilors

and separately with the General Manager of Deer Lake Power (DLP). This technical memo summarizes site visit findings.

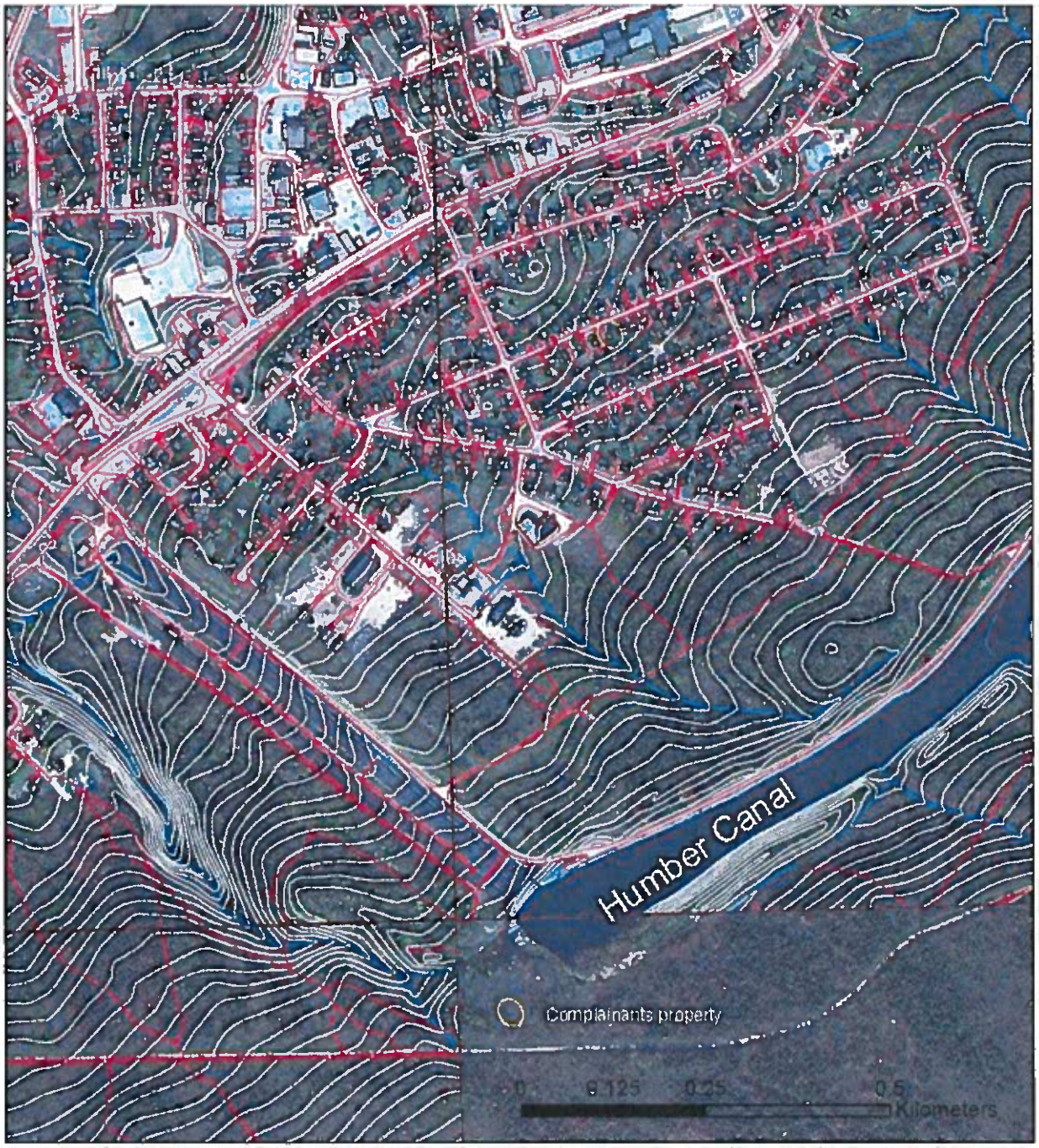

Figure 1: Deer Lake residential area downstream of Humber Canal and affected by high groundwater levels

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Figure 2: Deer Lake residential area downstream of Humber Canal and affected by high groundwater levels including street names

Figure 3: DLP produced map indicating seepage monitoring weirs and natural surface water drainage

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At least 7 articles have appeared in the Western Star concerning this issue. Figure 4 shows a picture taken by Mr. Dewey.

- July 9, 2014 http://www.thewesternstar.com/News/Local/2014-07-09/article-3792206/Residents-talking-legal-action%2C-town-still-waiting-for-information/1
- June 12, 2014 http://www.thewesternstar.com/News/Local/2014-06-12/article-3759653/Deer-Lake-resident-wants-to-see-action-taken-to-stop-flooding/1
- June 10, 2014 http://www.thewesternstar.com/News/Local/2014-06-10/article-3757070/No-overnight-solution-to-Deer-Lake-flooding%3A-Ball/1
- May 29, 2014 http://www.thewesternstar.com/News/Local/2014-05-29/article-3742058/Town-of-Deer-Lake-still-waiting-for-answers-on-flooding-problem/1
- May 27, 2014 http://www.thewesternstar.com/News/Local/2014-05-27/article-3738797/Deer-Lake-council-commits-to-finding-answers-on-flooding-woes/1
- May 14, 2014 http://www.thewesternstar.com/News/Local/2014-05-14/article-3724440/Ball-says-a-lot-of-work-to-be-done-to-determine-cause-of-water-issues/1
- May 13, 2014 http://www.thewesternstar.com/News/Local/2014-05-13/article-3722154/Leaking-canal-causing-trouble-in-Deer-Lake/1

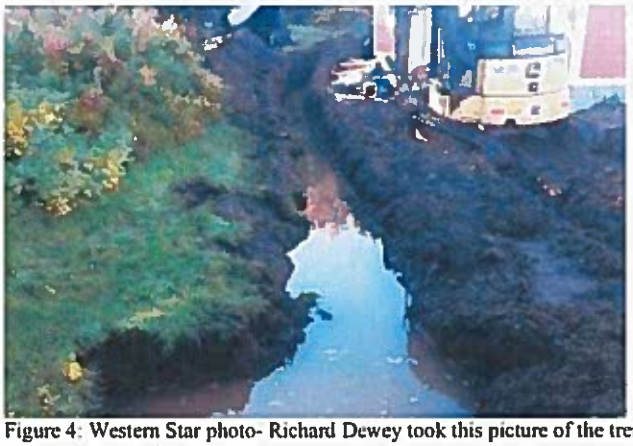

Figure 4: Western Star photo- Richard Dewey took this picture of the trench he dug in his yard to show the town how properties around the Deer Lake canal are being flooded

2. Background Information on the Area

DLP System

As shown in Figure 5, the DLP system of water control structures was originally built in 1923-24 and uses runoff from Grand Lake to generate hydroelectricity at the generating station in the Town of Deer Lake. The DLP system is comprised of:

- Main Dam
- Canal Intake Control Dam
- Long Bank Dam
- Deep Bank Dam
- West Bank Dyke
- Forebay Dam

The Humber Canal is cut through a height of land from Grand Lake a distance of 4 km to a reinforced concrete Intake Control Dam. The Humber Canal continues another 9 km to the

Forbay Dam as a side hill canal created by the construction of embankments on the downhill side. The West Bank Dyke and the Forebay dam are located directly above the Town of Deer Lake. The canal is approximately 6 m deep. The West Bank Dyke crest above the town is located at an elevation of approximately 180 m. The residential area in question is located at elevations between approximately 35 and 60 m. It is unknown at what depth the stormwater collection system in this residential area is buried to.

Figure 5: Deer Lake Power System

In 2013, Deer Lake Power engaged the engineering consultant firm Hatch Mott MacDonald to undertake a Dam Safety Review of all structures that comprise the DLP system. This report was finalized in May 2014 and provided to ENVC for review. The report included a number of recommendations and DLP is currently working on developing an Action Plan to address these recommendations. Recommendations that are related to some degree to the issue of groundwater seepage in areas of the Town of Deer Lake include:

- Vegetation control/maintenance of earth embankments and dykes
- Verify crest elevations of earth embankments
- Continue to maintain and monitor weirs at seepage locations of embankments and dykes
- Inspect embankment dams and dykes for seepage (once vegetation is cleared), install additional seepage monitoring devices where required
- Repair erosion/beaching at West Bank Dyke
- Monitor areas of settlement of upstream crest at West Bank Dyke
- Survey embankment dam and dyke cross sections and undertake stability analysis of structures

There are 18 monitoring weirs located along the downstream toe of the Humber Canal to monitor seepage, as indicated in Figure 3. Figure 6 shows weir # 2 and weir # 4. The review indicated that it is wet at most locations along the downstream toe of the West Bank Dyke, immediately

above the Town of Deer Lake. Identification of seepage, however, is impeded by the thick trees, brush and grass allowed to grow up along the downstream slope of the dyke. The downstream face of the West Bank Dyke is particularly overgrown along the section between Weirs 1 & 4. Weirs 1-4 are the closest in proximity and directly upstream of the neighbourhood of interest. Sediment was observed deposited upstream of Weirs 3 and 4.

Figure 6. Weir 2 (left) and Weir 4 with accumulated sediment (right) monitoring seepage from the toe of the West Bank Dyke

As shown in Figure 7, recent repairs to the upstream face of the West Bank Dyke were observed in a couple of locations including in the vicinity of Weirs 7 & 8. Locations of repairs coincide with the outlet of streams into the Canal from the opposite south bank. Weirs 3 & 4 also coincide with the location of stream outlets from the opposite south bank. These locations should be monitored carefully for seepage from the canal, sediment in the seepage, and any deterioration in the upstream or downstream face of the dyke. DLP lowers the water level in the Humber Canal twice a year in order to do an inspection by boat. Figure 6 shows repair work to the upstream face of the west bank dyke.

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Figure 7: Repair of upstream face of West Bank Dyke opposite of natural stream in the vicinity of Weirs 7 & 8

DLP is currently working on compiling weir flow data. According to the General Manager there is data from 1935, from 1997-2005, and 2011-13. Flow is currently measured using a bucket and stopwatch and is collected once a month, except in winter.

The Humber Canal was not constructed to be waterproof. The canal does not contain any seepage control measures such as foundation cutoffs. A certain amount of seepage is normal and expected. What is important to monitor is any significant change in the quantity or quality of the seepage from the canal. Weir monitoring flow data to be provided by DLP will help in this evaluation.

Deer Lake Neighbourhood Affected by High Groundwater Levels

The neighbourhood in Deer Lake affected by high groundwater levels includes homes from the 1920-80s. The majority of properties probably date from the 50s, 60s and 70s. Many of the older homes did not originally have basements, only crawl spaces underneath the house. Issues have arisen with seepage when some of these older houses have been retrofitted with basements. Anecdotal evidence indicates that there have been drainage issues in this area from the beginning linked to seasonal high water tables typically in the spring and fall.

As indicated in Figure 1 (produced by ENVC) and Figure 3 (produced by DLP), there are two surface water streams running directly through this neighbourhood. These streams appear to be the continuation of original stream channels that drained into Deer Lake prior to development of the town and canal. You can see how the Humber Canal appears to cut across these streams, interrupting the original flow pattern. As this residential area developed there were efforts to partially channelize and redirect flows from these streams through the town's stormwater system, however, it appears homes were build over or very near the original streambed. Properties in closest proximity to these original stream channels tend to be experiencing more flooding issues.

The establishment of no development buffers around these original streambeds should be considered as an option. These old stream beds are located in areas of lower elevation and are natural points of collection for surface water runoff including rainfall and snowmelt and subsurface groundwater flow.

According to town officials, not all houses in the area are affected by high groundwater levels and seepage. One house may have an issue and four houses along on the same road, homeowners experience no problems. There is also unequal application of measures taken by individual homeowners to deal with drainage issues. Properties that have installed sump pumps, drainage ditches and tile drains experience fewer issues. Figure 8 shows South Stream running through backyard of homes on the Main Dam Road.

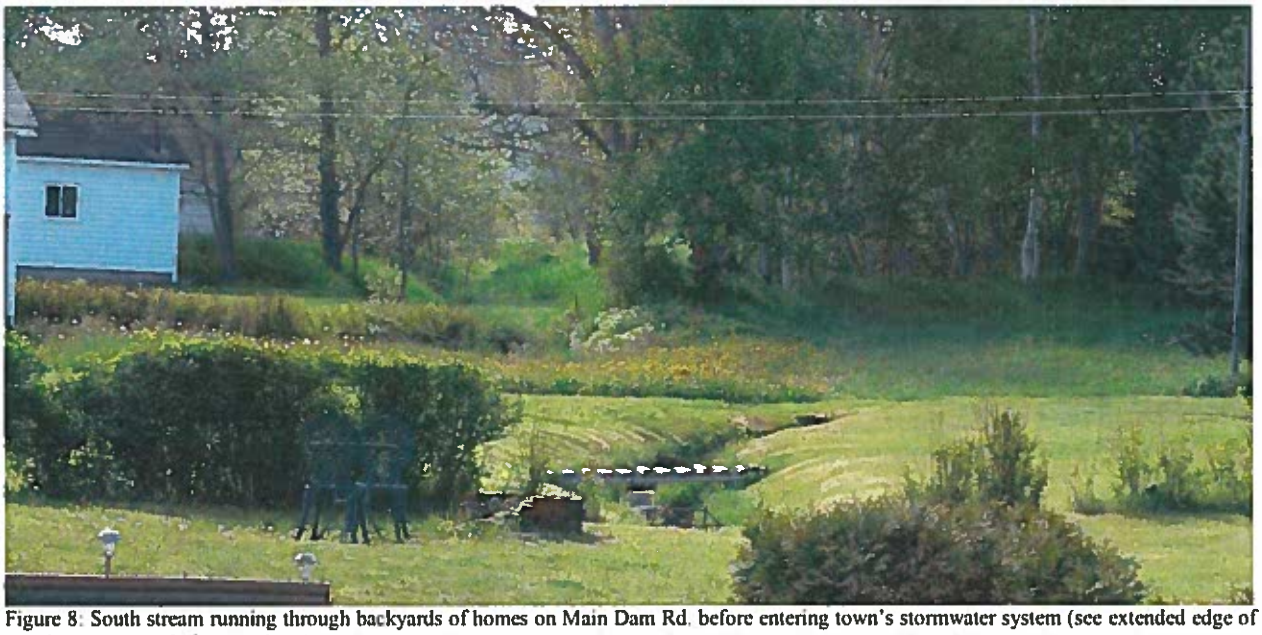

Figure 8: South stream running through backyards of homes on Main Dam Rd. before entering town's stormwater system (see extended edge of metal grate across drainage culvert)

The property on Garden Rd. owned by Mr. Dewey is situated at a lower elevation than the two houses on either side of the property. There are no roof gutters and downspouts installed on the house to redirect runoff away from the home. The North stream has been redirected from its natural flow path once it hits Elizabeth Ave. where it is redirected into the town's stormwater system (a combination of ditches, culverts, storm sewer pipe and catch basins). Flow is directed west along Elizabeth Ave., then north along Edward St., and then west along Garden Rd. passing in front of Mr. Dewey's property. There is a storm drain on the east corner of Mr. Dewey's frontage on Garden Rd. It is believed the storm drain crosses Garden Rd. at this location and continues on behind properties on the other side of the road. Mr. Dewey's property is shown in Figure 9.

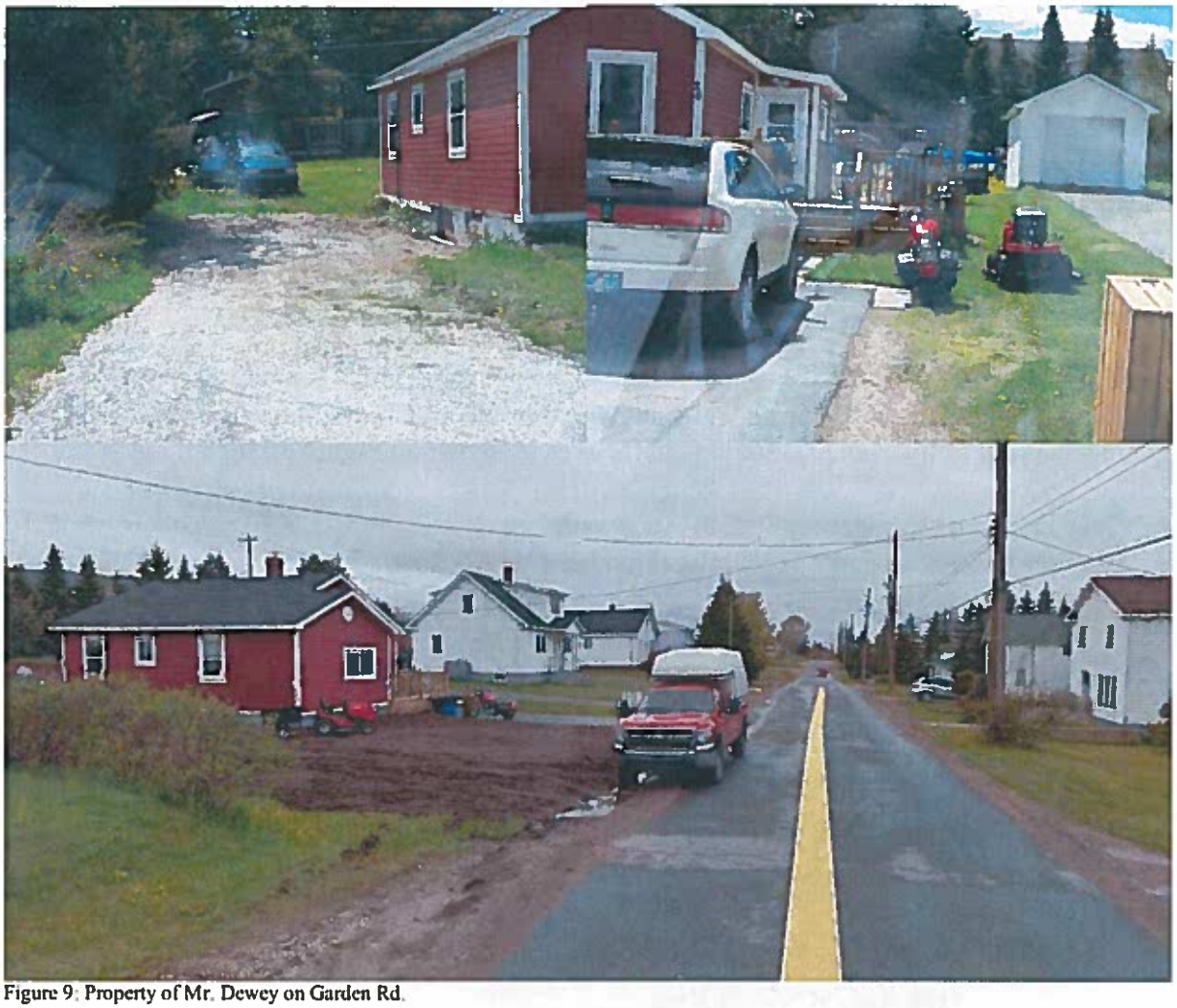

Figure 9: Property of Mr. Dewey on Garden Rd.

In the 1970's, there was a motion approved by the town council of Deer Lake, originally proposed by DLP, to build a diversion ditch between the Humber Canal and the neighbourhood in question that would connect to Glide Brook in the northeast. Such a diversion ditch would be over 2.5 km long. The proposed ditch was never constructed and it is doubtful any engineering work was done for the project. The design of any such diversion ditch would have to be carefully evaluated as it could affect the stability of the Humber Canal and result in increased seepage from the canal.

Capital Works Projects for Town of Deer Lake

In recent years, the following capital works projects have been approved for the Town of Deer Lake:

- 2011- Birch & Colbourne- Water & Sewer Upgrades ($1,345,000)
- 2012- Middle Rd.- Water & Sewer Upgrades ($550,000)
- 2012- Wight's Rd.- Water & Sewer Upgrades ($230,000)
- 2013- Lakeside Dr.- Lift Station Upgrade ($217,000)

There has been no work relating to stormwater or in the residential area of interest.

It is not known whether the Town of Deer Lake allows the connection of private residential storm drainage systems to the public municipal stormwater system.

ENVC does not issue approvals for municipal stormwater systems. Management of stormwater is the responsibility of the municipality or LSD. ENVC recommends that stormwater management should focus on ensuring that the post-development stormwater runoff rate will be equal to or less than the pre-development runoff rate. Any stormwater runoff has the potential to contribute to flooding downstream which may have liability issues for the municipality or LSD if not managed properly.

3. Available Data

There are no groundwater monitoring wells anywhere in the area to monitor groundwater levels. There are a handful of hydrometric stations in the area as shown in Figure 10 including:

- Deer Lake near Generating Station- stage only
- Humber River at Grand Lake Outlet (Humber Canal)- flow

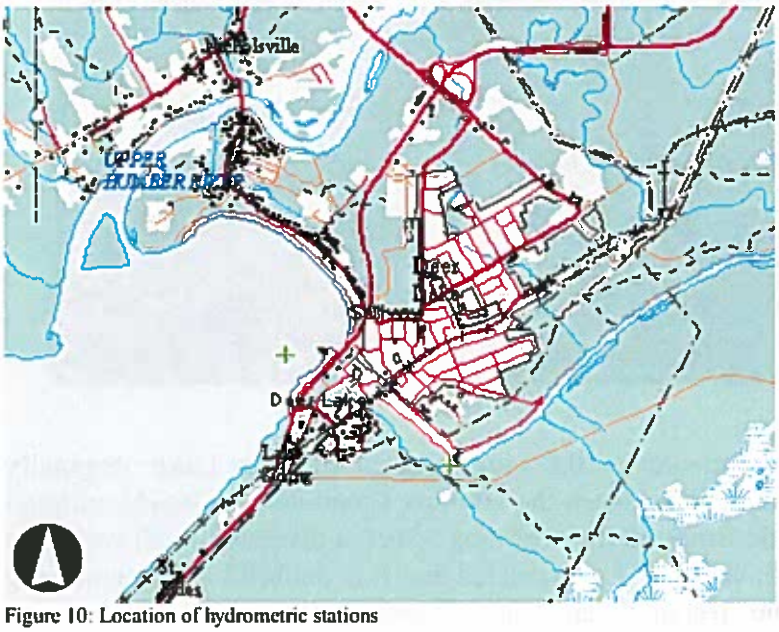

Figure 10: Location of hydrometric stations

As can be seen in the following graphs in Figures 11 and 12, water levels in Deer Lake tend to peak in May, but are otherwise relatively steady throughout the year. Flow from the Humber Canal also displays maximum levels in May with typically little variation throughout the year. The Humber Canal is a highly regulated system controlled by the Intake Control Dam and Forebay Dam. According to town staff, who visit the Humber Canal at least once per week (once per day in summer), the canal water level is steady only varying by approximately a foot. This uniform water level maintained in the Humber Canal would likely be mirrored by relatively uniform amounts of seepage from the dam as monitored by weirs 1-18. This will be confirmed once weir flow data is supplied by DLP.

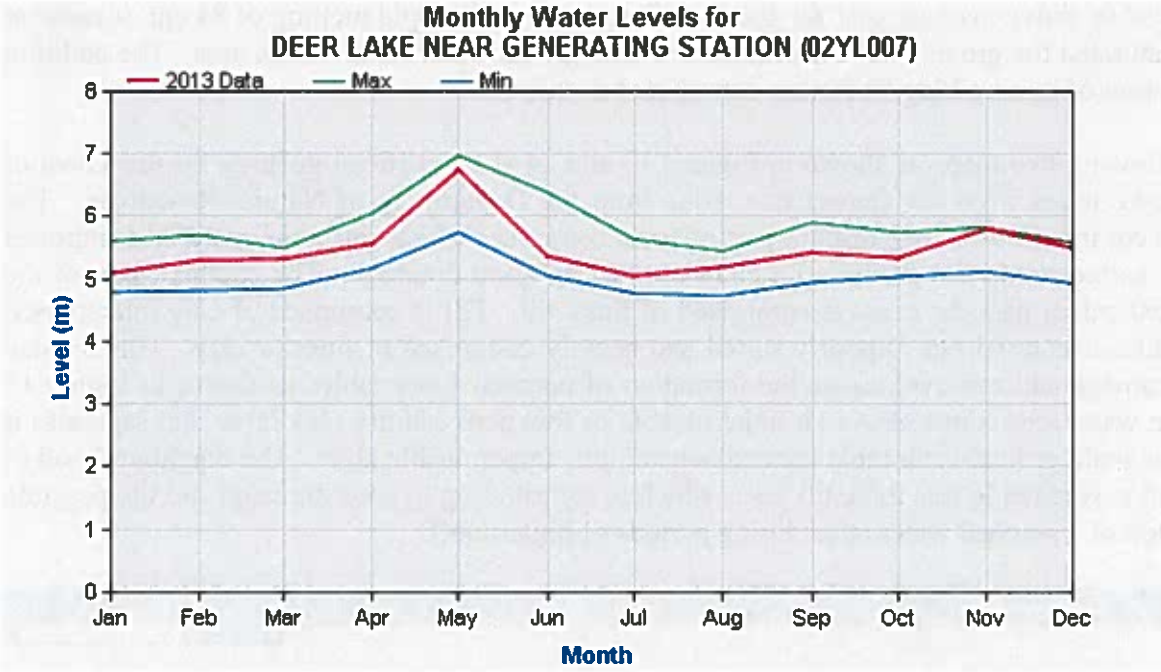

Figure 11: Monthly water levels in Deer Lake, statistics for 86 years of data

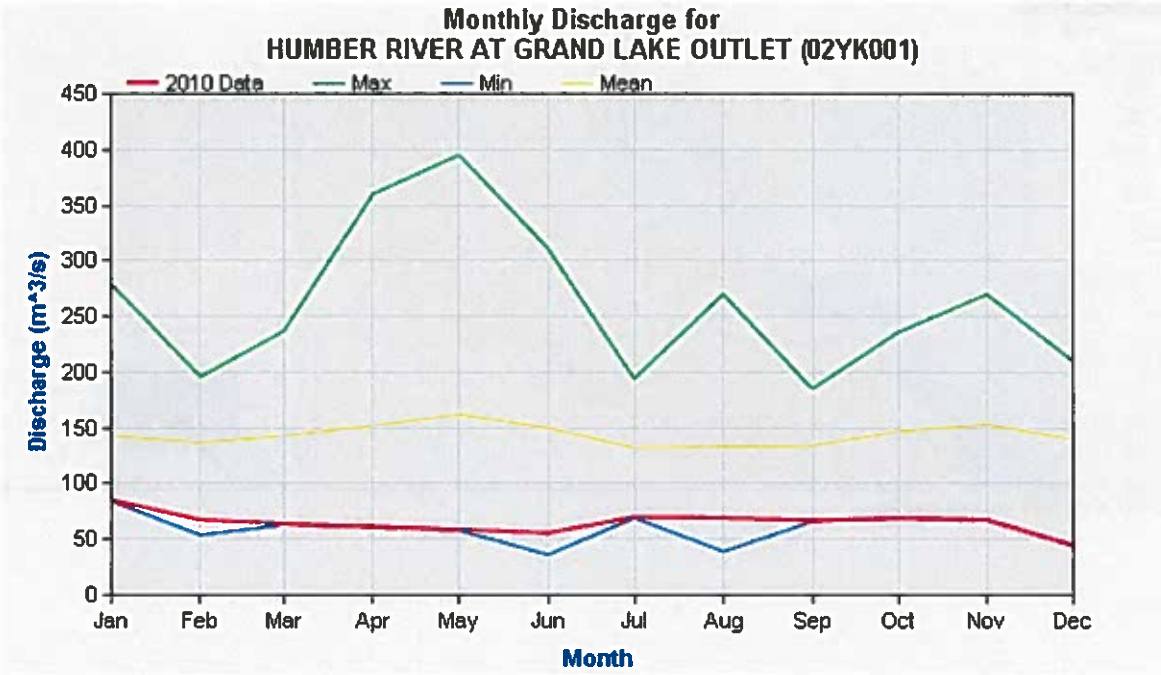

Figure 12: Monthly Discharge at the Humber Canal, statistics for 86 years of data

The nearest climate station is located at Deer Lake Airport. March 6, 2014 saw a maximum level of snow on the ground of 125 cm. By the beginning of May, 2014, this level had been reduced to trace amounts. The month of April saw the melting and consequent surface runoff of 84 cm of snow. There was just over 5 mm of rain the entire month of April. On May 10, 2014, 16.4 mm of rain fell. During the site visit conducted by ENVC staff on May 12, residual snow pack was observed in the area. In 2013, the maximum level of snow on the ground was 82 cm, all gone by April 9. In 2012, all snow was gone by April 17.

2014 was an above average year for snow on the ground. The rapid melting of 84 cm of snow in April saturated the ground and contributed to rising groundwater levels in the area. The addition of 16.4 mm of rain on May 10 further contributed to this effect.

The following two maps as shown in Figures 13 and 14 show surficial geology for the Town of Deer Lake taken from the Geoscience Atlas from the Department of Natural Resources. The town is cut in half with the northern part of town comprised of glacialfluvial material comprised of well sorted sands and gravels and characterized by good drainage. The southern part of the town, extending past the canal is comprised of thick till. Till is comprised of clay interspersed with courser material that is poorly sorted and heavily comprised of fines or clay. Tills display poor drainage and can even cause the formation of perched water tables as shown in Figure 15 where a water lens forms above an impermeable or low permeability clay layer that separates it from the main groundwater table located beneath this impermeable layer. The neighbourhood in question is situated in this thick till layer which is contributing to poor drainage and the possible formation of a perched water table during periods of high runoff.

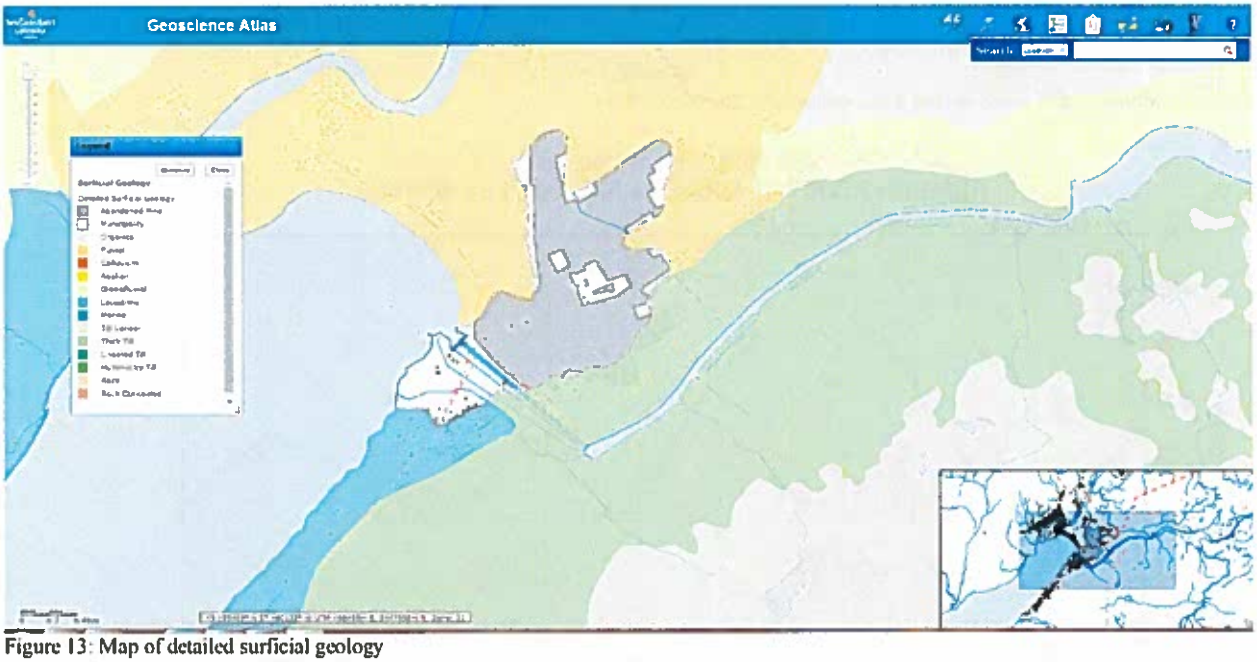

Figure 13: Map of detailed surficial geology

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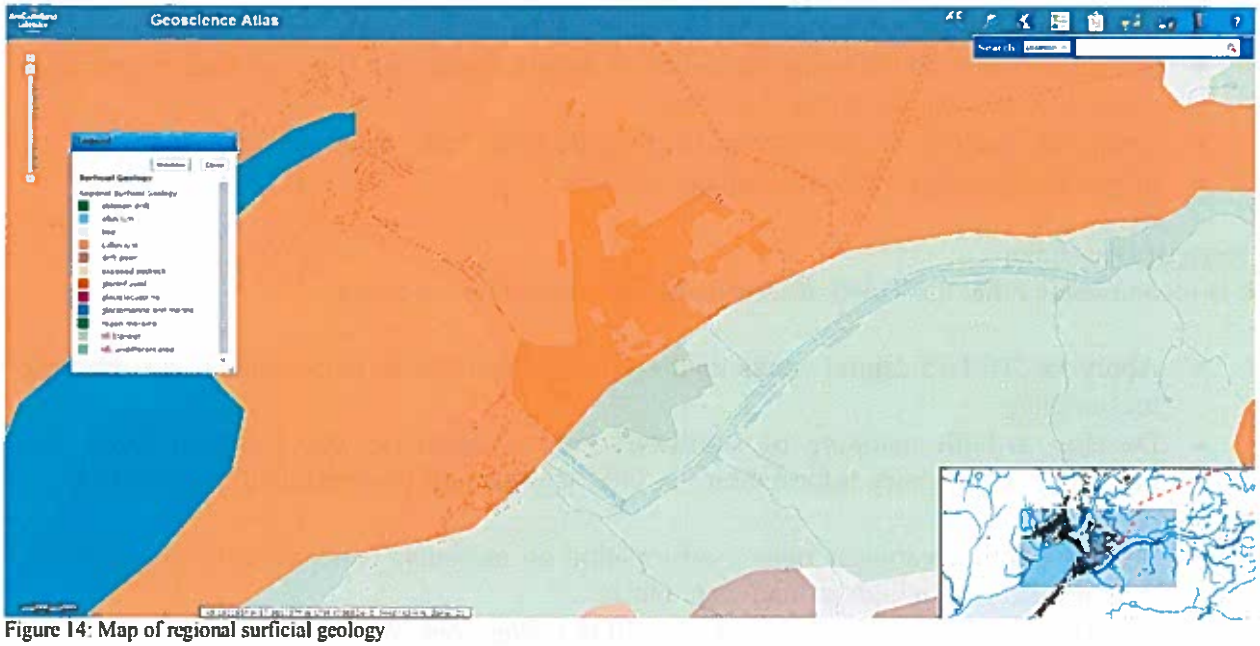

Figure 14: Map of regional surficial geology

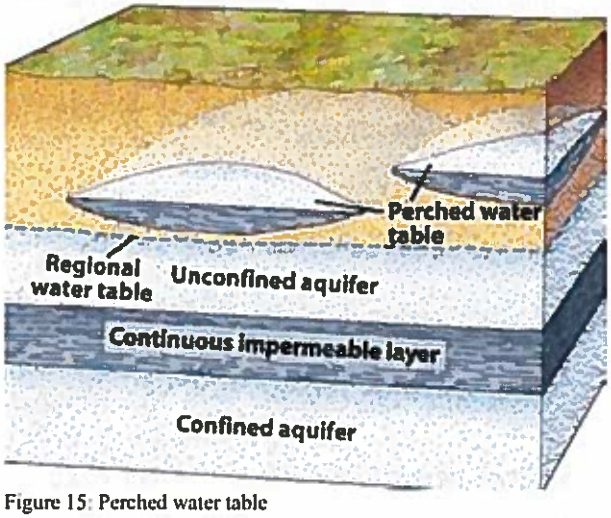

Figure 15: Perched water table

4. Corrective Actions

Homeowners

Homeowners bear responsibility in taking measures to prevent groundwater intrusion from high water tables seeping into their homes. Measures that can be taken by homeowners include:

- subsurface perimeter drains around foundation walls,
- use of sump pumps to remove water,
- use of subsurface drains or tile lines to remove water from the property,
- backup power for sump pumps,
- building basement floors above the seasonal high water table,
- use of a moisture barrier and high quality concrete to reduce water migration through the basement floor and walls,
- use of small diversions or ditches to channel water away from your lot,

- grade yards so that surface water drains away from the house,
- soil directly around the house should be of slow permeability (i.e., not rock or gravel) so water does not penetrate near the house,
- install roof gutters and downspouts to carry the water away from the house, and
- proper maintenance of home drainage systems.

Town of Deer Lake

It is recommended that the Town of Deer Lake take the following actions:

- Apply for 2014-15 capital works funding from MIGA for the completion of a stormwater master plan.
- Develop as-built mapping of stormwater infrastructure in the Town of Deer Lake including dept of bury information. A GIS layer should be developed from this as-built map.
- Provide public awareness raising information on measures residents can take to protect their property from high groundwater tables.
- The Town of Deer Lake should place a 30 m buffer zone on either side of the North and South Stream (and any other streams originating from across the canal) restricting any further future development.
- If the Town of Deer Lake does not allow the connection of private residential storm drainage systems to the public municipal stormwater system, consideration should be given to allowing this and how it might be managed. Evaluation of stormwater system capacity would need to be undertaken.

Deer Lake Power

It is recommended that DLP take the following actions:

- DLP must provide flow data from weirs 1-18 to both the town and ENVC for evaluation and must continue to monitor and record this seepage information from the Humber Canal on a regular basis.
- DLP should provide a copy of the 2013 Dam Safety Review to the Town of Deer Lake.
- DLP must develop an action plan for the implementation of recommendations made in the 2013 Dam Safety Review.
- DLP must continue to work cooperatively with the Town of Deer Lake for the long-term solution to this issue.
- DLP to provide a copy of their Operation, Maintenance and Surveillance Manual to ENVC.
- DLP to fill out Dam Inventory Forms for Canal Intake Control Dam, Long Bank Dam, Deep Bank Dam, West Bank Dyke and Forebay Dam.
- DLP to include in its planning a phased approach to hydrometric station upgrades.

Other

Other possible corrective actions include:

- Hiring of an engineering/hydrogeologic consultant to evaluate the causes of the high groundwater table in the area of interest, identify and evaluate possible corrective

measures, determine cost of possible corrective actions, and evaluate long-term monitoring options.

5. Summary

The issue of seepage into homes from high groundwater table levels in the residential area north of the Humber Canal and east of the DLP penstocks is a long-standing one dating back to the construction of the Humber Canal and the first homes built in the area. The issue is chronic in nature due to the surficial geology of the area which results in poor drainage; the location, situation and construction of homes; the existence of original stream channels in the area; the diversion of these natural streams; and seepage from the canal. The degree of the problem was intensified in the spring of 2014 due to the above average snow pack and the timing of rainfall.

There are steps that can be taken by residents, the Town of Deer Lake, and DLP to help alleviate this issue in both the short and long-term. Joint action by residents, the Town of Deer Lake and DLP may be required for a permanent engineered solution.

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