History of the Loch Lomond Water Supply System

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Structural Engineer/Project Manager
Introduction

- Last November, our firm performed some consulting work at the Loch Lomond Gate House, located at the North East end of Loch Lomond.

- While inspecting the gate house, Mike McLeod and I got into a discussion about the construction and history of the Loch Lomond Water system. Mike suggested: “Why don’t you do a presentation on the topic and that is how it all started.”
Topics of Discussion

- Planning Stage
- Design Phase
- Construction 1906 to 1909
Loch Lomond

- **Loch Lomond** is a large spring fed lake, located 3.7 miles south of Thunder Bay at an elevation of 335 ft above Lake Superior. The natural re-charge level of Loch Lomond from underground spring water is estimated at 12,600,000 Imperial Gallons per day.

- It is approximately 5.6 miles long, has an average width of about 1.0 miles and it averages 75 feet deep with the deepest point at 240 feet deep.
Loch Lomond In Relation to the CTB
Development of a Plan

- Late 1800’s - Loch Lomond was studied and identified as a future permanent source of water but the cost of driving a rock tunnel almost 1,600 meters did not seem feasible for such a small population at that time.
- 1896 – The population had reached 2,500 people and the first water supply system for Fort William was installed. The system consisted of two duplex compound pumps, each with a rated capacity of 520 Imperial GPM that delivered unfiltered water from the Kam River to the water distribution system.
1896 to 1903 – Two brief reports, including cost estimates on the feasibility of supplying water from Loch Lomond to the town were produced. These reports were lost when the old municipal buildings were destroyed by fire.

1904 – Mr. John Galt, a consulting engineer who was involved in the construction of sewers for the City was asked to prepare a report on the Loch Lomond System.
June 24, 1904 – Mr. Galt presented a detailed description and cost estimate on a scheme that could serve the needs of 30,000 people with an estimated price of $215,000.00.

At this time, the population had reached 6,000 people and it was felt that the cost of the project was still prohibitive.
The Loch Lomond Supply Source

- In late 1905 and early 1906, the Town of Fort William was struck by one of Canada’s worst typhoid outbreaks.
- The City Council's response was to construct a pipeline to bring pure water to Fort William from Loch Lomond. A tunnel were drilled through Mount McKay to the Loch and the system was completed in 1910.
- In 2006, the Bare Point Water Treatment Plant was expanded to serve the entire city from a single source and the Loch Lomond source was abandoned.
The water was found to be highly polluted, with the cause attributed to the discharge of several sewers upstream of the intake.

In January, 1906, there were so many typhoid patients that McKellar Hospital could not cope.

Temporary hospitals were set up in the town hall auditorium and in a building on Marks street. Volunteers also built a temporary addition to McKellar Hospital.

Out of a population of 10,032 at the time, 832 people were infected and 98 people died.
Typhoid Epidemic

Nurses, doctors and typhoid patients utilized the temporary hospital created in the Fort William town hall auditorium in the early 1900s.
McKellar Hospital in 1906.
March 5\textsuperscript{th}, 1906 – Mr. Sidney Hancock Jr. was hired as the City Engineer and was immediately asked to report on the proposed Loch Lomond Water Supply system.

Mr. Hancock studied the location adopted by Mr. Galt as well as other locations including a pumping station constructed on the shores of Lake Superior.

These options were rejected for various reasons and Mr. Hancock recommended the Loch Lomond proposal be endorsed.

This was accepted by the board and a request was made to City Council for funding.
H. Sydney Hancock Jr.

- H. Sydney Hancock Jr. was born in Cornwall, England, on July 10, 1879 and received his Engineering training at Cambridge in England.
- He re-located to the United States in 1901 and worked in heavy construction until early 1906.
- From 1906 to 1911 Hancock was Waterworks Engineer for the City of Fort William and was mainly involved in construction of the Loch Lomond water supply system.
- From 1911 to 1913 he worked as a consulting engineer in Vancouver before returning to Fort William in 1913 to develop harbour frontage.
Due to the urgency of an alternate source of safe, clean drinking water, it was decided to utilize Crescent Lake as a temporary supply.

Crescent Lake is a small body of Water, located approximately 3 miles from the City.

This scheme proved to be a failure and it became necessary to construct a permanent system.

Two schemes were considered:

- Pumping water from Lake Superior through a filtration system prior to distribution; or
- Supply Water from Loch Lomond, using gravity to convey the water to the distribution system.
Crescent Lake Location
Temporary Works

- This work consisted of the construction of a temporary supply from Crescent Lake until the tunnel from Loch Lomond could be constructed:
  - Dams at Crescent Lake
  - Intake pipe at crescent lake
  - 8-inch supply main to the reservoir

- Permanent works - These facilities would stay in service after the tunnel from Loch Lomond was constructed.
  - Reservoir
  - Two miles of road construction
  - 18-inch pressure main from the reservoir to the Kam River
  - Kaministiquia River Crossing
  - Connection to the Distribution Pipe
  - Two miles of road construction
Permanent works

It was the intention of those involved that these become part of the permanent system after the tunnel from Loch Lomond was constructed.

- Concrete Reservoir
- Two miles of road construction
- 18-inch pressure main from the reservoir to the Kam River
- Kaministiquia River Crossing
- Connection to the Distribution Pipe
- Two miles of road construction
Phase 1 Construction

- June 6, 1906 – Contract awarded to Wm. Newman & Co., of Winnipeg for a price of $118,126.50
- June 6, 1906 to November 8, 1906
  - Temporary Works completed
  - Reservoir completed
- July 1, 1906 - Pressure Main (Wood Stave) Installation started
- October 20, 1906 – Pipe laying completed.
Problems With The Pressure Main

- November 8, 1906 – System was filled with water
- November 16, 1906 – It was determined that the pipe was “full of leaks”.
- Over 3,000 leaks were repaired over a period of almost 2 years
- Most of the leaks were located at a coupling with the pipe itself holding up reasonably well.
- Leakage tests on the pipeline revealed that 15,400 imperial gallons of water per hour was being lost
- Someone was quoted as saying “under these circumstances, I do not think the pipeline can be said to be “fairly efficient”.”
In June, 1908, a law suit was filed against the City by the pipe supplier for recovery of unpaid invoices totalling $4,500.

In February 1909, judgement was rendered in favour of the City and it was determined that every joint in the pipe would be repaired at an estimated cost of $7,384.00.
In September, 1906, Mr. Hancock was instructed to prepare plans and specifications for completing the system from Loch Lomond to the Reservoir. Tenders were called in late November based on the following scope of work:

- **Tunnel Work**
  - Construction of the tunnel and tunnel shaft
  - Excavation outside the tunnel
  - Concrete work outside the tunnel

- **General Work**
  - Masonry gate house
  - 500 feet of 36-inch steel intake pipe
  - 3 miles of road construction
Approximate Tunnel/ Pipeline Route
Shaft Construction started before the tunnel

- Sunk at Sta. 9 + 68, (the gate house was Sta. 0 + 00) 60 feet in depth and 12 feet by 8 feet inside dimensions
- Divided into 2 compartments
  - A hoisting compartment, 8’-0” x 8’-0”
  - Ladder, pipe & wire compartment, 3’-9” x 8’-0”

Work on the tunnel was carried out at three faces, two working north and south from the shaft and one working south from the north portal.

Excavation of the tunnel was performed by drilling and blasting the full face in 5’0” to 5”-6” increments
Typical Drill Patterns

Sketch showing arrangement of drill holes.
Tunnel Construction (Continued)

- The minimum finished cross section of the tunnel was intended to be 4’-0” wide by 5’-3” at a grade of 0.10%.
- The original intention was to line the whole tunnel with concrete but eventually, only those portions that indicated signs of weakness were lined.
- Work on the tunnel commenced on June 4th, 1907 and the two long headings met at Station 27 + 56 on the May 24th, 1909.
- The tunnel was then cleaned out and lined with concrete where required; the shaft was covered 8 feet above grade with 2’-0” of reinforced concrete and backfilled to the surface with earth.
Tunnel Profile

Progress Chart of Tunnel Operations

- Date
- Elevation
- Data Entry

Horizontal: 1 foot = 24 inch
Vertical: 1 do = 36 inch

Dates:
- 1st Jan 00
- 1st Feb 00
- 1st Mar 00
- 1st Apr 00
- 1st May 00
- 1st Jun 00
- 1st Jul 00
- 1st Aug 00
- 1st Sep 00
- 1st Oct 00
- 1st Nov 00
- 1st Dec 00
# Yearly Progress Of The Drifts

<table>
<thead>
<tr>
<th>Year</th>
<th>North Portal Drift</th>
<th>North Shaft Drift</th>
<th>South Shaft Drift</th>
<th>Total</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ft.</td>
<td>ft.</td>
<td>ft.</td>
<td>ft.</td>
<td></td>
</tr>
<tr>
<td>1907</td>
<td>1130</td>
<td>601</td>
<td>526</td>
<td>2257</td>
<td>Work on tunnels commenced, June 1907</td>
</tr>
<tr>
<td>1908</td>
<td>812</td>
<td>859</td>
<td>240</td>
<td>1911</td>
<td>South shaft drift completed, April, 1908</td>
</tr>
<tr>
<td>1909</td>
<td>313</td>
<td>338</td>
<td>0</td>
<td>651</td>
<td>Tunneling completed, May 1909</td>
</tr>
<tr>
<td>TOTALS</td>
<td>2255</td>
<td>1798</td>
<td>766</td>
<td>4819</td>
<td></td>
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</tbody>
</table>
## Wages For Tunnel Employees

<table>
<thead>
<tr>
<th>Position</th>
<th>Wages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunnel Superintendent</td>
<td>$150.00 per month</td>
</tr>
<tr>
<td>Drillers</td>
<td>$3.50 to $4.00 per shift</td>
</tr>
<tr>
<td>Helpers</td>
<td>$3.00 to $3.50 per shift</td>
</tr>
<tr>
<td>Muckers</td>
<td>$2.50 to $2.75 per shift</td>
</tr>
<tr>
<td>Landers</td>
<td>$2.50 per shift</td>
</tr>
<tr>
<td>Hoistmen</td>
<td>$0.25 per hour</td>
</tr>
<tr>
<td>Blacksmiths</td>
<td>$0.35 to $0.40 per hour</td>
</tr>
<tr>
<td>Blacksmiths Helpers</td>
<td>$0.25 per hour</td>
</tr>
<tr>
<td>Compressor Men</td>
<td>$0.25 per hour</td>
</tr>
<tr>
<td>First Mechanic</td>
<td>$0.40 per hour</td>
</tr>
<tr>
<td>Mechanics Helper</td>
<td>$0.30 per hour</td>
</tr>
</tbody>
</table>
Road Construction

- Approximately 4.5 miles of road was constructed for access to the work areas, transportation of manpower, supplies and materials, equipment, etc.
- The route traveled through difficult terrain including bedrock, swamps, muskeg and steep side hill work.
Concrete Culvert

- The south portal was located at Station 1 + 90.
- From the portal, an open trench was excavated to the Gate house, located at Station 0 +00.
- The Gate House was situated approximately 50 feet from the shore of Loch Lomond.
- A reinforced concrete culvert with the dimensions conforming to the tunnel was constructed to connect the tunnel to the gate house.
Culvert Cross Section

Section thru Culvert

Scale = Half an Inch to a Foot
Looking Downstream (North) From Gatehouse
Typical Culvert Dimensions

Water Depth = ± 55 mm

FLOW

1500 mm

245 mm

1190 mm
Gate House

- The Gate House was constructed to a height of 14 feet above the invert of the concrete culvert.
- Inside dimensions were 7’-0” by 9’-0”
- Although provisions were made for two 36-inch intake pipes, only one intake pipe was installed and it protruded 4 inches from the interior wall
- A 36-inch “coffin” sluice gate was bolted to its flange
- The invert was set 6 inches above the floor and 9 feet below the normal level of Loch Lomond
- The structure was constructed to a height of 18’-6” above grade and it took on the appearance of an “embattlement tower”
Gate House, General Arrangement

Scale: 8 feet to an inch
Plaque Commemorating the Work Of Sidney Hancock Jr.
Gatehouse Looking North West

Plaque Mounted on South Wall
Gate House During Construction

Gate House and West Shore Line of Loch Lomond.
Intake Line and Coffer Dam

- The intake pipe with a total length of 750 feet was installed to a depth of 42 feet of water at the intake.
- The pipe was manufactured from a “soft open-hearth” steel with an Fu of 60,000 psi.
- In order to ensure the pipe invert was installed to a minimum of 9 feet in depth, a cofferdam was constructed to a point 277 feet from the gate house.
- The remaining 473 feet was lowered in one piece from the ice.
- This work commenced in January, 2008 and was completed prior to the spring thaw.
Looking South West From the Shore of Loch Lomond
Construction of the Cofferdam

Driving Cofferdam Piles for Intake Pipe. Tunnel Survey Line showing over the Hill.
Cross Section Through Cofferdam

Transverse Section thro' Coffer Dam
Scale ~ 16 feet to an Inch
Forebay

- At the North Portal of the tunnel, a 20 foot long concrete culvert that lead to the forebay was constructed.
- The forebay was segmental with an inside diameter of 39 feet and a height of 24 feet.
Sections & Elevations
Sections

DETAILS OF CONCRETE PIER AND WALLS
REINFORCEMENT TO THE REINFORCEMENT FENCE.

Longitudinal Section through Beam and Slab

Section through Slab  Section through Beam and Slab

SKETCH SHOWING REINFORCED CONCRETE COVER TO FOREBAY.
Second Pressure Main

- While the tunnel was being constructed, the population was growing rapidly and it became apparent that a second line would be required.
- There was also concern with the unsatisfactory condition of the wood pipe.
- The second line basically followed closely that of the wood line.
- The material for this pipeline was cast iron.
Conclusions

- Water started flowing through the tunnel on June 21, 1909.
- Considering the fact the work was carried out in the early 1900’s, this was an amazing feat of engineering and construction.
- The construction costs were in the range of $500,000 but I have no idea what that would equate to in today’s dollars.
Thank You

- NWOWWC Directors for choosing my topic for presentation at this conference
- The City of Thunder Bay
- Brodie Street Library
- The late Sydney Hancock. His paper on the Loch Lomond system proved to be a very valuable resource for my presentation
- Mike McLeod
- Conference Delegates
- My employer