Building Tomorrow's Society
Bâtir la Société de Demain

Fredericton, NB Canada
June 13 – June 16, 2018/ *Juin 13 – Juin 16, 2018*

AN HISTORICAL ACCOUNT OF THE 'WILLIAM L. BARRETT WATER TREATMENT PLANT' IN FREDERICTON, NB

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Abstract: Motivated by generations of destructive fires and outbreaks of typhoid fever, the municipality of Fredericton, having a population of approximately 6000, began a water supply system with the construction of a water pumping station in 1883. The plant was designed to supply 400,000 Imp Gallons/day (1820 m^3/d) at a pressure of 35 psi (240 kPa). This became the core of a growing structure to house a water supply and water treatment system and related technological advancements. The original construction provided a solid masonry building and chimney to house steam boilers and a pump to provide a supply of water from the Saint John River. Improvements in 1906 included a building extension, plumbing, pumping, coagulation basins, and storage basins for a rapid-sand filtration system. At the time this advancement was considered to be the most complete filtration plant for a municipal water supply in Canada. In 1912, the structure housed one of the earliest continuous chlorination systems of a public water supply on the continent. The arrival of electricity in 1926 allowed a partial conversion from steam technology, and required a large addition for a 125 kVA diesel generator. The building was repurposed in the 1950s to pump water from groundwater wells. In 1984, the facility was re-engineered and expanded to provide for the removal of manganese from groundwater using pressurized filtration. At that time the manganese removal system was the largest of its kind in North America. The facility was renamed the William L. Barrett Water Treatment Plant in June 2007. The current water treatment plant uses contemporary treatment processes while retaining and repurposing the historic components of the structure. The facility was recognized as a CSCE National Historic Civil Engineering Site in 2018. The paper documents the key historical features of the William L. Barrett Water Treatment Plant from 1883 to the present.

1 INTRODUCTION

Through community leadership and engineering efforts, a water supply system grew from a single building, housing steam-driven pumping equipment to supply water to a community of 6000 to a large and modern water treatment plant serving 50 000. This paper emphasises the developments at the facility from 1883 to 1926. Figure 1 shows the footprint of the original plant and the extensions made over the years.

2 EARLY FIRES AND TYPHOID FEVER

In 1816, the small town of Fredericton suffered from a series of fires of such size and intensity that the town's existence was threatened. Later, in 1822, one fire destroyed 70 buildings, including the Governor's Mansion.

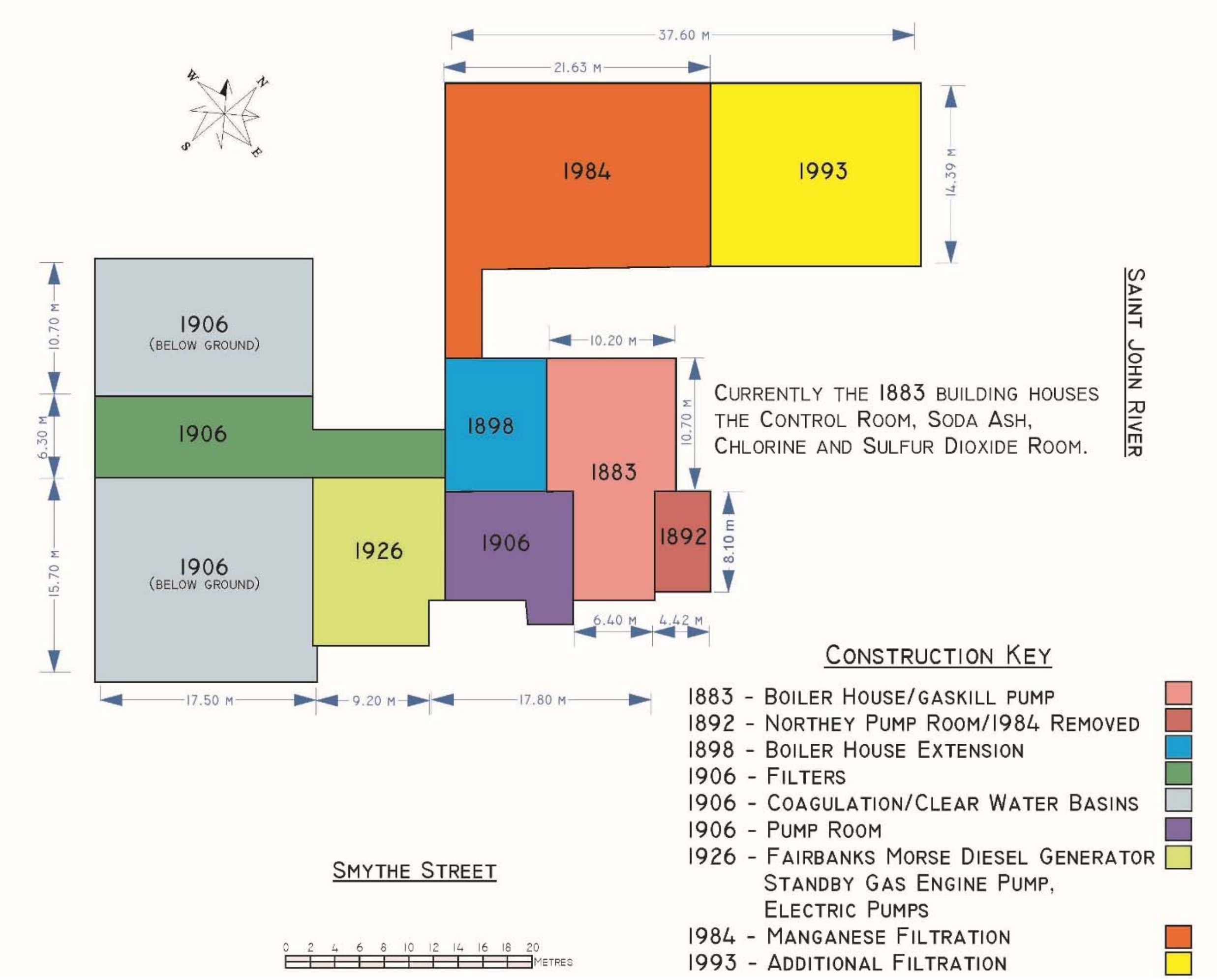

Figure 1: Footprint of the 1883 water treatment plant and extensions between 1883 and 1993

In 1825, embers from the Great Miramichi Fire again set several fires in the town. In 1849, twenty buildings were lost, and in 1850, a fire left 2000 people homeless and destroyed the town merchants' winter stock (Squires 1980).

Water for domestic purposes before and throughout this period was obtained from private shallow wells, usually dug in the front or rear of the residences. Outdoor toilets were located in the rear of the houses, often not far from the wells. Typhoid fever, a common ailment in Fredericton's past, is thought to be the result of this arrangement. In 1880, the Fredericton Board of Health recommended to City Council that positive action be taken to provide a proper water supply for the City.

3 EARLY PROPOSALS AND THE INITIAL CONSTRUCTION

An 1867 plan exists at the UNB Archives, signed by Chas. C. Gregory, Civil Engineer, in which a pipeline with filters was proposed from Tower Lake, about 8 km out the Hanwell Road, to the city. In 1876 Henry George Clopper Ketchum presented a report to City Council that reviewed six proposals for a water supply for Fredericton, including a critical review of and enhancements to the Tower Lake proposal by Gregory. Ketchum's recommendation was a 4 km pipeline from Mill Creek (now Corbett Brook) to the city (Ketchum

1876). Ketchum was a prominent engineer who in 1888-1891 promoted and oversaw the Chignecto Ship Railway project which for various reasons was never completed (Ircha, 1992).

In 1882, the consulting firm of Crafts and Forbes from Boston was appointed by the Fredericton Water Committee to explore and survey the vicinity of the City and report on a plan for an economical and thorough system of water supply and sewerage. The consulting firm's report was received in July of the same year. It described an investigation of all possible options for the City but recommended a direct pumping station with the Saint John River as a supply. The pumping station was to be located at the lower end of Smythe Street near the river.

Records indicate that N. Henry Crafts was the attending engineer. Crafts was the Engineer in Charge of Works for the City of Boston, MA, from 1863 to 1872. He was elected a member of the Boston Society of Civil Engineers in 1886, and was a principal in consulting firms with A.W. Forbes and Thomas Doane. He was the principal engineer in the construction of the Stonybrook Dam in Cambridge, MA., in 1885-87 and in the initial water supply project for Woodstock, NB, in 1884.

The completed works of 1883 consisted of the intake crib and piping to the building, a well located along that piping for storage, and the building itself which housed coal-fired boilers, a steam-driven pump to draw the river water and deliver it directly to the then built-up area of the City. The population of the City in 1883 was approximately 6000 people. The new system gave good fire protection and provided a reliable supply for domestic consumption, but it did not entirely stop the yearly outbreaks of typhoid fever.

The equipment specified for the pump house required that it be able to pump the water on a constant basis without the assistance of a standpipe or reservoir, and when required, to "perform a fire service equivalent to three steam fire engines." It had to deliver the estimated daily requirement of 400 000 Imperial gallons per day (1.8 ML/d) at a pressure of 35 psi (240 kPa); and deliver a fire flow of 850 Imperial gallons per minute (64 L/s) at a pressure of 80 psi (550 kPa). Further, it had to be capable of lifting 1 500 000 gallons per day (6.8 ML/d) 80 feet (24 m) high, and show a duty of 50 000 000 pounds raised one foot (68 MN·m) by the consumption of 100 pounds (45 kg) of coal.

The original steam engine, a Gaskill horizontal compound pumping engine, was acquired from and installed by the Holly Manufacturing Company, Lockport, NY, under the supervision of the consulting engineer, N. Henry Crafts.

This waterworks also included the installation of over 14 km of water piping and 80 hydrants. It can be presumed that such an undertaking and its results would have had significant impacts on the small city’s treasury and its economic and social fabric. Records reflected improved fire protection and that was credited to the new water supply.

In 1892, a small room was added to the north side of the engine room of the water works and a new steam-driven Northey pump was installed. It was unable to draw water directly from the river, but drew it from the well which received water piped from the river. Its efficiency was less than the Gaskill pump and engine, and therefore provided backup service to it.

In 1898, a portion of the boiler house, the westerly section of the works, was removed and rebuilt to a size double its initial capacity (see Figure 2). As well, the old boilers were removed and a new "Leonard" boiler was installed and connected to both engines.

4 THE ADDITION OF FILTRATION

In 1904 the Water Committee requested that Mr. E. Brydone-Jack, the City Engineer, investigate all aspects of the purity of the City's water supply.

Figure 2: Fredericton Pumping Station with the new boiler house at the left and the pump house at the right (c1898).
[Source: Public Archives of New Brunswick Image: P32-128]

Ernest Edmund Brydone-Jack was a graduate of the University of New Brunswick (BA 1891) and Rensselaer Polytechnic Institute (C.E. 1894). In 1901, he became the first dean of engineering at the University of New Brunswick, Fredericton, while he served as City Engineer. He held these positions until 1905. He then served as professor at Dalhousie University (1905-1907) before becoming the first dean of civil engineering at the University of Manitoba (1907-1917). He was a councillor (1911-1913), then vice president (1915) of the Canadian Society of Civil Engineers (renamed Engineering Institute of Canada, 1918), and president of the Association of Professional Engineers of British Columbia (1924). He was also a member of the American Society of Civil Engineers, the Society for the Promotion of Engineering Education and the Institution of Civil Engineers of Great Britain. In 1926 the University of New Brunswick awarded him an honorary Doctor of Science. He died in 1960. (Willard 2013)

After receiving reports and recommendations, the Water Committee hired Mr. Frank A. Barbour, an engineer from Boston, to further investigate the problem. Barbour was recommended by Mayor McNally who learned during a hearing of the Provincial Board of Health that Mr. Barbour was "...known as one of the very best sanitary engineers on the continent and is a man with an international reputation." Barbour served as Section President of the Boston Society of Civil Engineers in 1920, and was prominent in the American Water Works Association. He authored numerous published works, served on committees, and became the president of the Association for the term 1935-36.

Barbour submitted a report dated February 1, 1906 to the Mayor and Council. The opening paragraph describes the pressures which brought about the study and its results:

> "The water supply of Fredericton, whether deservedly or not, has been under suspicion for some years, and has been held responsible, in the minds of many people, for the development, from time to time, of typhoid above normal. That this feeling of uneasiness exists and that it lessens the desirability of Fredericton as a place of residence, particularly in the minds of strangers, cannot be denied. The removal of this suspicion and the restoration

> of confidence in the municipal supply is, therefore, an undertaking which must appeal to the mind of any citizen interested in the growth and prosperity of the City." (Barbour 1906)

Barbour proposed the construction of a filtration plant at the site which would incorporate the existing water pumping station. The technology of the rapid sand or mechanical filtration system which was proposed and constructed is also well described in the report. Low lift pumps would lift the water to a coagulating basin from which it would flow to any of three filters, each filter having an area of 13.5 m^2. The treated water would flow to a clear water basin, which would supply the new steam driven pump which maintained flow and pressure for the distribution system. As before, the pump would supply water at 35 psi (240 kPa) for domestic flows and 80 psi (550 kPa) for firefighting. No elevated reservoir would be required except an elevated tank for backwashing. The completed structure is shown in Figure 3 and the piping to and from the three filters is shown in Figure 4. It is noted that three additional filters were installed at a later date. One of the original control panels for the system is shown in Figure 5.

Figure 3: Fredericton Pumping Station and Water Treatment Facility (c. 1906). The tall tower houses the constant head tank for the rapid sand filters in the lower portion of the building. [Source: Provincial Archives of New Brunswick Image: P657-25]

The plans were available in March 1906, but were revised by April to include the purchase and installation of a much larger high lift pump. The new Allis-Chalmers compound Corliss pumping steam engine (Figure 6) was justified by a pending need for more capacity and with the savings of both efficiency and a longer life. (Barbour 1906)

In 1907, the Fredericton Water Committee reported:

> "Through contracts let to Messrs. Mooney & Sons, Saint John, and the New York Continental Jewell Filtration Company of New York, in May 1906, the City has now the most complete filtration plant for municipal water supply in Canada".

The 1908 City Engineer's Report to Council provides:

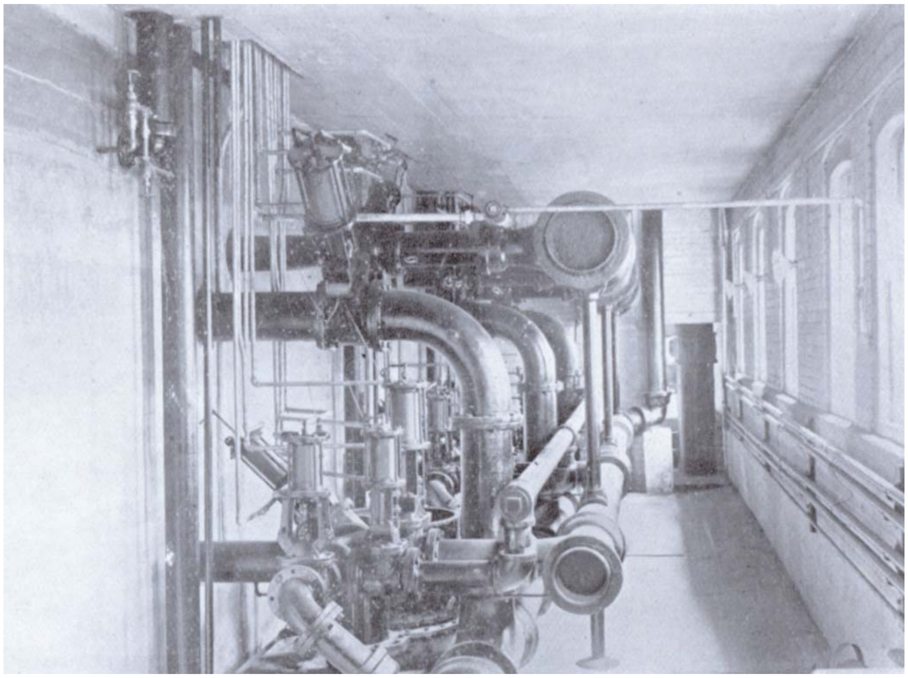

Figure 4: Piping to and from the three rapid sand filters at the Fredericton Pumping Station and Water Treatment Plant (c. 1906).
[Source: Provincial Archives of New Brunswick   Image: P657-27]

Figure 5. An original control panel for the rapid sand filter for the 1906 plant.

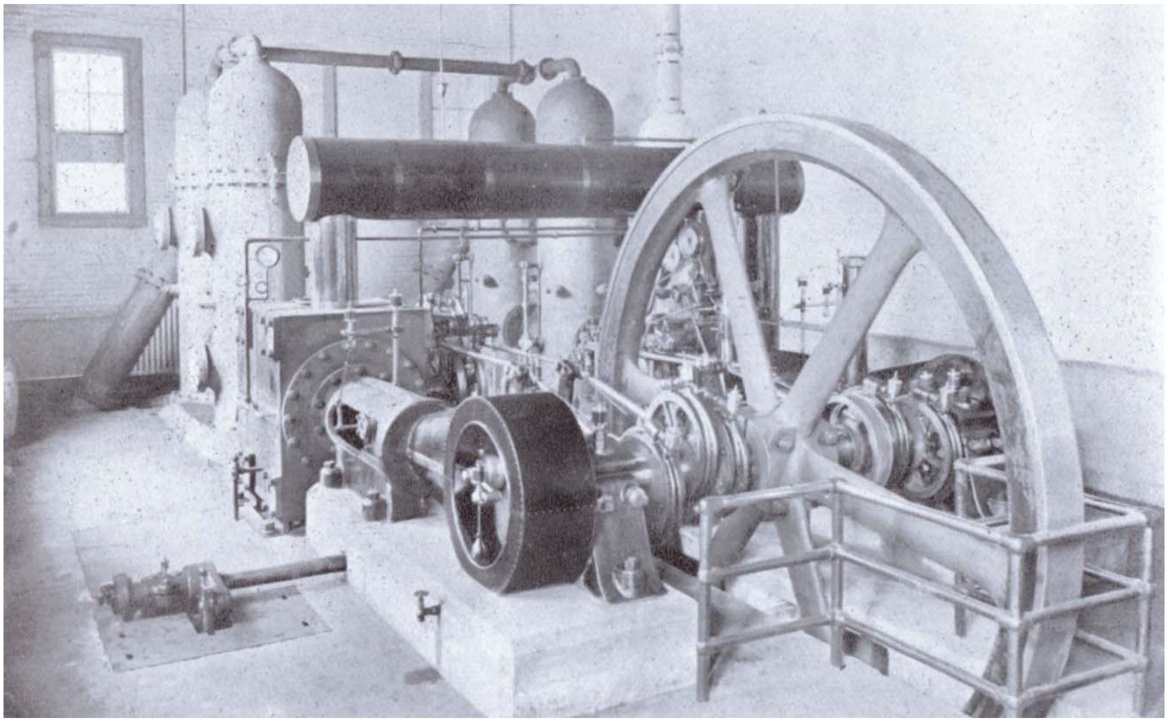

Figure 6. Allis-Chalmers compound Corliss pumping steam engine at the Fredericton Pumping Station and Water Treatment Plant (c. 1906). Installed in 1906 and removed in 1955.
[Source: Provincial Archives of New Brunswick Image: P657-28]

> "The water is drawn from the river through a 15 inch (152 mm) riveted steel suction, this taking the water from a crib pier 150 yards (137 m) from the shore, conveys it by gravity to a pump well located adjacent to the water works station. From the pump well the water is raised by two six inch (152 mm) centrifugal pumps direct connected to reciprocating engines with capacity of 1400 gallons per minute (106 L/s). These pumps raise the water to the coagulating basin, (54 ft. by 22 ft. 3 in.) (16.5 m by 6.8 m) capacity 90 000 gallons (410 m^3), divided completely into two chambers to allow for the alteration of the river. From the coagulating basin the water flows by gravity through the filter beds [each of the three beds being (10 ft. by 15 ft.) (3.0 m by 4.6 m)] at the rate of 125 million gallons per acre per day (140 $m^3/m^2/d$) to the clear water reservoir situated below the filter building. The clear water basin has a storage of 470 000 gallons (2140 m^3).
>
> The coagulating basin, filter tanks and clear water basin are constructed of concrete. The supply and effluent are controlled by hydraulic gates as are also the connections for cleaning the filter beds.
>
> The water supply for the City is lifted from the clear water basin and supplied directly to the City by a cross compound Corliss Engine, manufactured by Allis-Chalmers-Bullock Limited, which has a capacity of 3 000 gallons per minute (227 L/s). There is also a Gaskill Engine connected to the reservoir for emergencies. Both of these engines are also arranged to pump directly from the river."

The report concludes with an excerpt from a report of the Provincial Board of Health, which states that "typhoid statistics have already reflected the great improvement to the water supply."

With Professor H.H. Hagerman's help, a table of performance of the Filtration Plant was provided to Council for 1912. The table provided an average bacterial efficiency of only 79 percent, which was lower than expected. The City Engineer also provided a table of typhoid statistics from 1895 to 1912. He summarized:

> "Previous to filtration the typhoid fever death rate was 64 per 100 000; since filtration the death rate has been 16 per 100 000"

Although the statistics suggested that things were improving, the low bacterial efficiency was probably the reason that Mr. Barbour was requested to return to Fredericton. His report was made to Council in 1913, and pulled no punches in criticizing the management of the filtration and pumping equipment. He stated that bacterial efficiencies of at least 95 percent was appropriate and attainable, and suggested that a much higher level of supervision would be required. Maintenance of the equipment was also terribly lacking, with the Allis-Chalmers pumping system requiring an assessment by the manufacturer. He further explained that the improved supervision and maintenance would save the City considerably in both chemical and coal, besides providing the water that the population deserved.

Records suggest that Council was listening. The new Chief Engineer for the pumping station, C.J. Bowers, made his first report to council in 1913, providing a review of maintenance done since he took up his duties in June of that year.

5 EARLY CHLORINATION

In 1912 J. L. Feeney, a young recent engineering graduate from the University of New Brunswick, designed and installed a "home-made" chlorinating apparatus, using calcium hypochlorite for effective sterilization of the City's water supply; possibly bringing about the end of the typhoid fever outbreaks. This was only four years after the first effective demonstration on the continent of the use of calcium hypochlorite in water purification in Chicago, and only three years after Jersey City became the first City to incorporate large scale continuous chlorination. The system developed by Feeney was used until 1950 when bell-jar gas chlorinating equipment was installed.

H.H. Hagerman was the City's Chemist. In his 1923 report to the City Engineer, he describes the chlorination system, including Mr. Feeney's device as consisting of an orifice box, float valve, dosing tank and mixing vat. Commercial bleaching powder, calcium hypochlorite, was mixed at the appropriate dosage and allowed to stand until clear, then added to the dosing vat. The valve allowed flow from the tank to maintain a constant head over the orifice thus providing a uniform dosing.

John (Jack) Feeney graduated from the University of New Brunswick in 1910 with a degree in Civil Engineering. From 1951 to 1957 he was Chief Engineer of the New Brunswick Electric Power Commission, and later sat on the International Joint Commission for International Water Ways, the Advisory Committee of Atomic Energy Commission for Canada, and the Energy Commission of Canada. He died in 1976.

Harrison Hammond Hagerman was one of the first to be granted a Diploma in Civil Engineering by the University of New Brunswick. He graduated in 1893 and delivered the Valedictory Address that year. He received an honorary doctorate from the University in 1925. He was a science professor at the Normal School in Fredericton, serving as Principal from 1933 to 1940. The 1912 Report of the Board of Health of the City of Fredericton lists Professor H.H. Hagerman as a member, and reported that he served as the Board's Official Analyst. Records reflect that Dr. Hagerman undertook many studies and research for the benefit of the City besides his regular work to assess the efficiency of the treatment systems. Mr. Hagerman's son, Ed Hagerman, became a Mechanical Engineer and instructor at the University of New Brunswick. He took over the responsibility of analysing the municipal water supply from his father, and he was still doing the job in 1979, well after his own professional retirement.

7 ELECTRIC POWER

Major additions made to the works plant in 1926 provided electric motor driven pumps with a diesel generator unit and gasoline engine-driven standby pumps. The diesel Generator, a three piston Fairbanks-Morse, had the following specifications: 3 cycles, 257 rpm, 125 kVa, 2300 Volts, 27 litres per hour fuel consumption. The generator provided emergency power for both the plant and the nearby Victoria Public Hospital. The addition required an extension of the building once again, primarily for this generator, on the southeast corner of the structure.

To oversee the installation of the equipment and to ensure that the City was getting what it expected, the City hired Dr. A. Foster Baird, who was then a professor of physics and electrical engineering at the University of New Brunswick. Dr. Baird believed that the engine was not new, but possibly had done previous duty. Although he devised a test for the engine, the supplier/installer appeared not to be available whenever the test was scheduled. Ultimately, the engine was accepted during Dr. Baird's absence and against his advice by City officials without any testing. The bearings failed one month later.

Before his retirement in 1951, Dr. Baird served as the Dean of Applied Science, Vice Chairman of the Board of Deans, and as Acting President of the University. He was also well known for his electrical consulting work. He died in 1986. Dr. Baird’s son, Ron Baird, served as the Water & Sewer Superintendent from 1967 until 1984.

8 THE CALL FOR FURTHER IMPROVEMENTS LEADS TO A CHANGE IN DIRECTION

In June 1949, J.D. MacKay, City Engineer, empowered the Toronto based firm of Gore & Storrie to make a survey and report relating to water supply and the water works system. This was presumably prompted by the inability of the existing system to provide the City with acceptable quantities of water during the extreme high and low stages of the river.

James F. MacLaren, who at the time was working for Gore & Storrie, suggested a three-stage programme of construction: first, provide a 2 million gallon (9090 m^3) reservoir at the top of the pressure system and large diameter supply and feeder mains; second, a new 24" (610 mm) intake, with a new intake well and low and high lift pumps; and third, alterations and extensions to the plant to improve quality and increase capacity to 3 million gallons per day (13,600 m^3/d).

The construction of the reservoir part way up Smythe Street with an 18" (457 mm) supply main was completed in 1951, while a 12” (305 mm) cross-town feeder main on Charlotte Street was completed in 1952. However, in 1952, before bids were opened for the improvements to the intake and plant, prominent citizens and representatives of International Water Supply Ltd. appeared before Council and petitioned for a preliminary investigation for a groundwater supply.

In 1955 development of Well #1 Wilmot Park was completed, providing 850 imperial gallons per minute (64 L/s), 24 hours per day, piped directly to the plant's clear-water basin for repumping. By 1968, five wells were developed, with one soon being mothballed due to high levels of dissolved manganese ions.

9 CONTINUED DEVELOPMENT AND MODERN TREATMENT

In 1982, increasing levels of dissolved manganese ions were recorded in the well water. At the same time technological advances provided for treatment of manganese rich waters. A new addition was completed in 1984 to incorporate pressurized filtration equipment and allow the facility to deliver water meeting the Canadian Drinking Water Guidelines for manganese. The new water treatment system not only removed the manganese but also provided a free and stable chlorine residual to the community. The site was designated as a Canadian Water Landmark by the American Water Works Association and a brass plaque commemorating the event was installed prior to opening ceremonies in 1984.

In June 2007, the name of the facility was changed to the William L. Barrett Water Treatment Plant to honour Mr. Barrett who served as City Engineer from 1953 to 1979. In November 2017, the Board of Directors of the Canadian Society for Civil Engineering (CSCE) approved the recommendation of the CSCE National History Committee that the facility be a CSCE National Historic Civil Engineering Site. A plaque is to be installed at the site in June 2018. The current building is shown in Figure 7. Visitors to the plant can view water pumping and treatment technology spanning over a century.

Figure 7. The William L. Barrett Water Treatment Plant in 2017.

Acknowledgements

The City of Fredericton has provided documents related to the developments at the site of the water treatment plant. Some of these documents are presently on file at the Provincial Archives of New Brunswick. Historic photographs have been made available through the Provincial Archives of New Brunswick. Figure 1 was prepared by the City of Fredericton through Neil Thomas, Senior Water & Sewer Engineer.

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