# *ANNOTATIONS*

***to accompany***

# *THE MANY SIDES OF ROBERT F. LEGGET*

***Canadian Civil Engineer, Geologist and Historian***

**by Doug VanDine**

**August 2020**

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continued…

[A] International Conference on Soil Mechanics and Foundation Engineering, held at Harvard University, Cambridge, MA, June 22-26, 1936. With subsequent conferences, this became known as the first conference.

[B] The Associate Committee on Soil and Snow Mechanics of the National Research Council. It was renamed the Associate Committee on Geotechnical Research in 1965.

## Annotations Chapter 1: INTRODUCTION

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[1] "Geotechnique," the noun and "geotechnical," the adjective, describe an applied science that combines the principles and techniques of geology and hydrogeology with those of soil and rock mechanics, for construction on or under the ground's surface, for the extraction of the Earth's resources and for the prevention, management and mitigation of natural and environmental hazards.

[2] According to City of Ottawa Archives, "Canadians have to thank Robert Legget for wheelchair ramps, smoke detectors and hard hats for construction sites."

[3] Robert (Bob) Hardy (1905-1985) is considered the other "Father of Canadian Geotechnique." Hardy was a graduate of the University of Manitoba (bachelor's 1929) and McGill University (master's 1930). He started teaching in the Civil Engineering Department at the University of Alberta as a lecturer in 1930. After studying soil mechanics at the post-graduate level at Harvard under Arthur Casagrande in 1939 and 1940, he returned to the University of Alberta, established a soils laboratory and helped develop undergraduate and graduate soil mechanics programs in the department. The graduate program, which started in 1945, is considered the first full-time graduate program in soil mechanics in Canada. He became head of the Civil Engineering Department in 1946 and the following year he added the position of Dean of Engineering. Hardy retired from the university in 1959 to devote most of his time to his consulting practice, Hardy Associates (now a part of the Wood Group), but continued at the university as a part-time professor. In 1971, Hardy was the recipient of the 2nd Robert F. Legget Award. For more on Hardy see Harris 1997.

Whereas Legget and Hardy are considered the "Fathers of Canadian Geotechnique," Ibrahim Morrison should be considered the "Grandfather of Canadian Geotechnique." Morrison (1889-1958) joined the Department of Civil Engineering at the University of Alberta in 1912 and began teaching "Foundations" as a separate undergraduate course in the 1920s. In 1937, he renamed that course "Soil Mechanics and Foundations," the first such course in Canada. For more on Ibrahim Morrison see Harold Morrison 1997.

[4] Besides Jack Clark, Dave Townsend and myself, other members of the editorial committee were Bill Eden and Geoff Meyerhof. These gentlemen will be introduced later.

[5] For a more complete story of the CGS "Canadian Geotechnical Heritage Book Project," see VanDine and Heinz 2020.

## Annotations Chapter 2: THE LEGGET FAMILY

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[1] This chapter was compiled from a family tree (LAC 1-5), the Edinburgh City Archives website, several online England and Wales census and registries and some information from Legget's distant relative Val Whinney.

[2] Port Sunlight was named after the famous Lever Brothers product "Sunlight Soap" (Wikipedia).

## Annotations Chapter 3: EARLY YEARS (1904-1922)

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[1] David Legget, personal communication

[2] Most of this information is from the Merchant Taylors' School Archives. As an adult, Legget kept in touch with Merchant Taylors' School and was a member of its "Old Boys Association in Canada" (known as the "Crossbeans") for many years (LAC 1-25).

[3] LAC 3-9

[4] *The Railway Magazine,* a UK monthly magazine for railway enthusiasts, was first published in 1897 (Wikipedia).

[5] LAC 3-9

## Annotations Chapter 4: SPECIAL NOTE AND APOLOGIA

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[1] The Associate Committee on Soil and Snow Mechanics of the National Research Council. It was renamed the Associate Committee on Geotechnical Research in 1965. These committees led to the formation of the Canadian Geotechnical Society in 1972.

[2] Chalmers Jack Mackenzie (1888-1984) was a civil engineering graduate of “Dalhousie College and University” (as it was known then), in Halifax, NS, in 1909. In 1912, he was hired by the University of Saskatchewan to develop its engineering program. In 1939, Mackenzie moved to Ottawa and served as Acting President of the National Research Council (NRC), filling in for President of the NRC, General Andrew McNaughton, who had rejoined the military. Mackenzie served in that capacity for most of the Second World War, becoming President of the NRC in 1944 and serving until 1952. Later he became the first President of Atomic Energy of Canada Limited, the first President of Atomic Energy Control Board and the second Chancellor of Carleton University (1954-1968) (Wikipedia).

[3] Robert Ferguson Legget often referred to himself as R.F.L. or RFL.

[4] As introduced in Chapter 1, Jack Clark and David Townsend were members of the Canadian Geotechnical Society’s early-1980s heritage book committee.

Jack Clark (1932-2010) was a prominent geotechnical engineer in Canada. He was a CGS President (1979-1980) and the 14th Robert Legget Award winner (1983). See the CGS website (Lives Lived) for more on Clark.

David Townsend (1926-1999) taught in the Department of Civil Engineering, Queen’s University in Kingston, ON, from the mid-1950s to the late 1960s and was very influential in the formation of the CGS in the early 1970s. He later worked with Golder Associates in Mississauga, ON, and with RM Hardy & Associates and Gulf Oil in Calgary, AB. In 1991, he retired to Victoria, BC.

## Annotations Chapter 5: EARLY TRAINING (1922-1929)

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[1] Legget registered in the Faculty of Engineering on September 30, 1922, a day after his 18th birthday. In August of that year, he was awarded the "Lancashire County Scholarship…for Proficiency in Secondary School Subjects," with a value of £60, for each of his three undergraduate years. These amounts covered his entire undergraduate tuition fees which were £50 per year (University of Liverpool Archives). £50 in 1922 would be approximately CDN$5,000 in 2020.

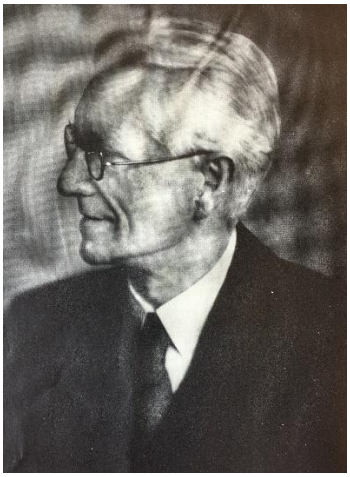
[2] In 1979, Legget recalled thinking he wouldn't be going to university: "I had obtained a job as a bank clerk; I had even bought a bowler hat" (LAC 9-6).

[3] The University of Liverpool was founded as a college in 1881 and became a university in 1903. The Faculty of Engineering was established in 1902 and Civil Engineering became a department in 1908. Currently the university has approximately 33,000 students (University of Liverpool website). In a 1976 letter, Legget describes the Civil Engineering Department in the early 1920s as a "then-small department occupying an old house on Bedford Street." (University of Liverpool Archives)

Oblique air photo of the older central portion of the University of Liverpool (photo source Google Maps 2018)

[4] In another 1976 letter, Legget reminisced that Professor Abell, the Dean of Engineering at the University of Liverpool in the early 1920s, "guided me into civil engineering, in a kindly and wise way, and so I have long been in his debt" (University of Liverpool Archives).

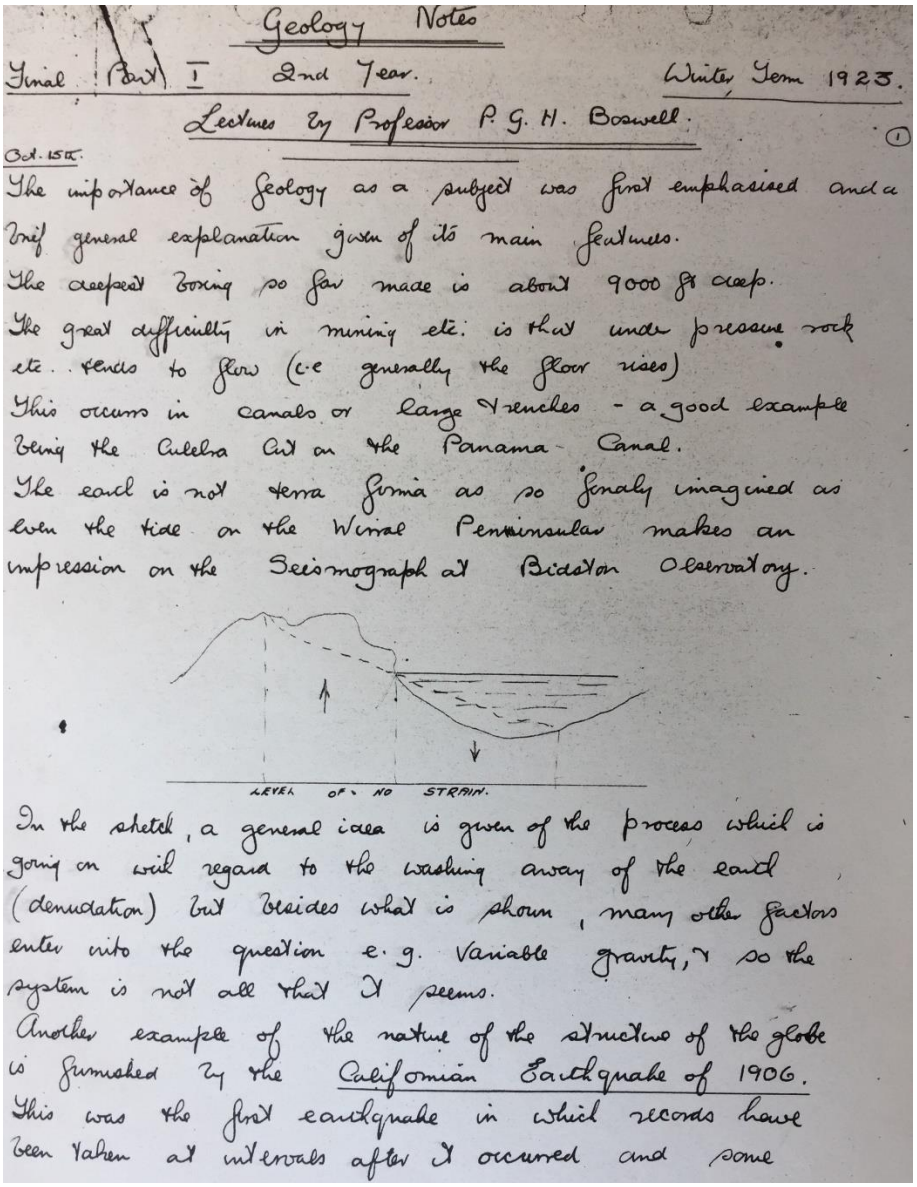
[5] Percy George Hamnall Boswell (1886-1960) became a Fellow of the Geological Society of London (1907), an Officer of the Order of the British Empire (1918) and a Fellow of the Royal Society (1931). He was President of the Geological Society of London during 1941 and 1942 (Geological Society of London website).



A portrait of P.G.H. Boswell from a 1961 Royal Society memoir (LAC 3-22)

An indication of what Legget thought of Boswell is shown by the fact that Legget asked Boswell to write the foreword to Legget's first textbook, *Geology and Engineering*, published in 1939.

[6] A portion of Legget's detailed handwritten geology notes from 1923 (LAC 9-19).



Geology Notes

Final Part I 2nd Year. Winter Term 1923.

Lectures by Professor P. G. H. Boswell.

Oct. 15th.

The importance of Geology as a subject was first emphasised and a brief general explanation given of its main features.

The deepest boring so far made is about 9000 ft deep.

The great difficulty in mining etc. is that under pressure rock etc. tends to flow (i.e generally the floor rises)

This occurs in canals or large trenches - a good example being the Culebra Cut on the Panama Canal.

The earth is not terra firma as so finely imagined as even the tide on the Wirral Peninsular makes an impression on the Seismograph at Bidston Observatory.



In the sketch, a general idea is given of the process which is going on with regard to the washing away of the earth (denudation) but besides what is shown, many other factors enter into the question e.g. Variable gravity, so the system is not all that it seems.

Another example of the nature of the structure of the globe is furnished by the Californian Earthquake of 1906. This was the first earthquake in which records have been taken at intervals after it occurred and some

[7] *Muddy Sediments: Some Geotechnical Studies for Geologists, Engineers and Soil Scientists* by P.G.H. Boswell, 1961, published by W. Heffer & Sons. Founded in Cambridge in 1876, that publisher became part of the Blackwell Group in 1999; however, there still is a Heffers Bookshop in Cambridge (*The Guardian* website).

[8] The Town of Ledbury, between Worchester to the north and Gloucester to the south, is approximately 200 km south of Liverpool.

[9] Kim's Game is named after the hero in Rudyard Kipling's 1901 novel *Kim*. The hero plays the game during his training as a spy. The game helps develop observational and memory skills (Wikipedia).

[10] As mentioned in Chapter 3, Legget was an avid train spotter and had his first photograph of a train published in *The Railway Magazine* in 1919. In 1929, he wrote his first of many articles for the same

magazine. In 1989, he wrote to the editor and offered to write an article on being a contributor for 70 years. His offer wasn't accepted (LAC 16-13). Over the years, Legget also wrote for other railway magazines including *The Railway Gazette, Canadian Rail* and *The Canadian National Railways Magazine.*

In 1949, Legget was the second author, after Charles P. Disney, of an illustrated book titled *Modern Railway Structures*, published by McGraw-Hill (see Chapter 16). In 1973, Legget published *Railways of Canada*. Four years later, he published a 96-page coffee-table book entitled *Canadian Railways in Pictures.*

[11] It is not clear from the text, but Legget is probably referring to his 1925 graduation from the University of Liverpool with a BEng. As he describes in the following paragraphs, he worked in London with C.S. Meik and Buchanan, consulting engineers. He worked with that firm from the fall of 1925 to the spring of 1926, then returned to the University of Liverpool, where he completed his MEng in the early summer of 1927 before returning to London.

[12] The Lochaber Hydroelectric Power Project

[13] It is interesting that Legget says he "was the first member of my family to wander so far afield," because he recorded his travels to "Wilford & London" in 1921 when he was 17 years old (LAC 2-1).

[14] William Halcrow (1883-1958) was a notable English civil engineer. He was knighted in 1944, in part because of his civil engineering contributions during the Second World War. He was elected President of the Institution of Civil Engineers in 1946.

The engineering consulting firm C.S. Meik and Buchanan was established in 1868 under the name Thomas Meik, the father of Charles Scott Meik (Halcrow 1993).

[15] The Forth Bridge is a 2.4 km long railway bridge, completed in 1890, that crosses the Firth of Forth, approximately 25 km west of Edinburgh. It is a UNESCO World Heritage Site (Wikipedia).

Firth of Forth Bridge under construction in the late 1880s (photo source BBC News website)

[16] £300 in 1925 would be approximately CDN$30,000 in 2020.

[17] C.S. Meik and Buchanan's office was at 16 Victoria Street in the Westminster area of London. It was destroyed during the Second World War.

[18] Before working on the Lochaber Hydroelectric Power Project, Legget worked on a number of smaller projects "as personal assistant to Mr. W.T. Halcrow…engaged on calculations and the preparation of contract documents for hydro electric schemes in Scotland, Greece, Italy, Finland, etc., and upon Dock Harbour and general civil engineering work" (Queen's University and NRC Archives).

[19] The firm C.S. Meik and Buchanan was renamed C.S. Meik and Halcrow sometime after Legget left in 1929, although *125 Years of Halcrow*, published by the Halcrow Group in 1993, indicates the name change was in 1923. In a 1993 unpublished note, Legget disputed the 1923 date. In the same note, Legget commented that when he worked with the firm, William Halcrow was known simply as "Bill Halcrow" (LAC 19-12).

An undated photo of William Halcrow (LAC 19-12)

The name of the company was changed in 1941 to W.T. Halcrow & Partners, in 1944 to Sir William Halcrow & Partners and in 1998 to the Halcrow Group. In 2011, the company was acquired by CH2M Hill and in 2017 CH2M was acquired by Jacobs Engineering Group (Wikipedia).

[20] According to Legget's files, he spent a portion of the summer of 1927 and from October 1928 to March 1929 on the Lochaber project site (LAC Spec Coll).

[21] The Lochaber Hydroelectric Power Project, constructed between 1924 and 1929, is located in the western Scottish Highlands. It was constructed to provide electricity to the Lochaber Aluminum Smelter in the adjacent town of Fort William. The Lochaber tunnel is 24 km long and until 1970 it was the longest water tunnel in the world (Wikipedia).


The Lochaber tunnel delivers water from Loch Treig (on the right), beneath Ben Nevis (pinned in the lower left), to the penstocks and the power generating station, located approximately 2.5 km northeast of Fort William. The width of the image shown is approximately 30 km. North is to the top. (modified from Google Earth 2019)

The Lochaber tunnel under construction (LAC Spec Coll)

[22] Benjamin Neeve Peach (1842-1926) became a Fellow of the Royal Society (1892), a Fellow of the Royal Society of Edinburgh (1881) and a Fellow of the Royal Geographical Society (Wikipedia).

[23] (Brock University website).

[24] Sir Edward Battersby Bailey (1881-1965) became a Fellow of the Royal Society (1930) and a Fellow of the Royal Society of Edinburgh. He was Director of the British Geological Survey from 1937 to 1945 (Wikipedia).

[25] Legget summarized his Lochaber experience as (Queen's University and NRC Archives):

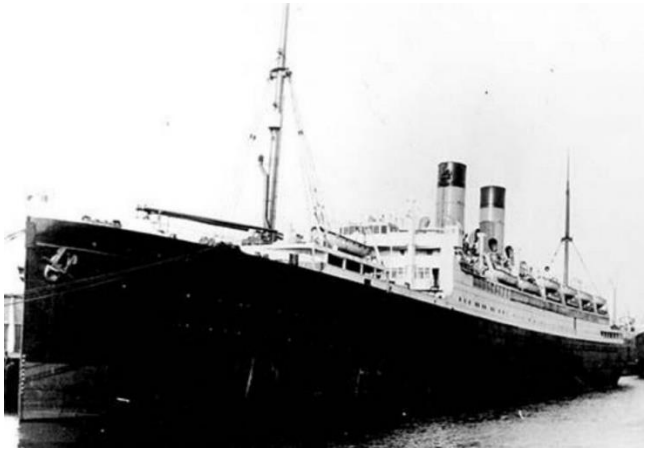
> (120,000 H.P. [approximately 90 Megawatts] under 800 feet head), including the complete design of the Surge Chamber, and high pressure, all welded steel pipe line. Two periods were spent on the construction of this project. For one period as an assistant to the Chief Resident Engineer in charge of the construction of the Surge Chamber and Portal Tunnels. The scheme includes what was then the largest tunnel in the world (15 miles long, 15 1/2 feet diameter) on which much experience was gained.

[26] In 1910, Halcrow worked in Singapore on the King George V Dock (Wikipedia).

[27] As a 24-year-old, Legget left from the Prince's Dock in Liverpool, on board the *SS Albertic* on March 30, 1929 (Canadian Museum of Immigration, Pier 21 website).

Prince's Dock, Liverpool, in 1920 (photo source Vintag website)

*SS Albertic* was built and launched in Germany in 1920; however, she was given to the British government as part of war reparations. She initially sailed as the *SS Ohio* for the Royal Mail Steam Packet Company. In 1927, she was sold to the White Star Line and renamed *SS Albertic*. She served on the trans-Atlantic service between Britain and Canada from April 1927 until August 1930, then anchored in the River Clyde, Scotland, because of the Depression. In 1934, she was broken up for scrap in Japan (Wikipedia).



*SS Albertic* (photo source Canadian Museum of Immigration at Pier 21)

## Annotations Chapter 6: UNIVERSITY AND LONDON YEARS (1922-1929)

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[1] Sometime after the 1920s, 13 Sandringham Road was re-numbered 15A, likely to avoid the superstition around the number 13, a superstition known as triskaidekaphobia.

[2] LAC 4-6, 4-7 and 4-8

[3] LAC 1-8

[4] The *RMS Celtic* was an ocean liner in the White Star Line fleet, the same fleet as the *RMS Titanic*. (The RMS designation means Royal Mail Ship with a contract to carry mail.) She was built and launched in Belfast in 1901 and could carry approximately 2,800 passengers. During the First World War she stuck a mine, 17 people on board were killed but the ship survived. In 1928, she became stranded on rocks near Cobh, Ireland and although freed, was written off due to structural damage. She was finally dismantled for scrap in 1933 (Wikipedia).

[5] University of Liverpool Archives

[6] LAC 1-8

[7] LAC 9-9

[8] *The Kodak Magazine* was published by the Eastman Kodak Company in Rochester, NY, and was first published in 1920 (Wikipedia).

[9] Queen's University Archives

[10] The Geologists' Association was founded in 1858. It is an association for amateur geologists, not to be confused with the professional geologists' Geological Society of London, established in 1807 (Wikipedia).

[11] Toc:H was founded in Belgium during the First World War by a British Army chaplain, Neville Talbot, as a "soldiers' rest and recreation centre." The unusual name is the abbreviation for Talbot House. At that time "Toc" was the British Army's military word for the letter "T" (the word "Tango" is now used). The organization expanded to London in 1920. It is still active in several countries today (Wikipedia).

[12] LAC 20-23

[13] Sir George Buchanan (1865-1940) was knighted for his work in the First World War. He had a very interesting, although somewhat checkered, engineering career (Wikipedia).

[14] LAC 9-9

## Annotations Chapter 7: CANADA PRE-CONFERENCE (1929-1936)

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[1] The International Conference on Soil Mechanics and Foundations Engineering. The name of the International Society for Soil Mechanics and Foundations Engineering was changed to the International Society for Soil Mechanics and Geotechnical Engineering in 1997. The ISSMGE held its 19th conference in South Korea in 2017.

[2] Legget, aboard the *SS Albertic* and after having landfalls in Glasgow and Belfast, arrived at Pier 21 in Halifax, NS, on April 7, 1929, along with 517 other passengers.

Pier 21 was opened in March 1928. Between 1928 and 1971, this Halifax immigration depot was the point of entry into Canada for approximately one million immigrants. It is now a National Historic Site and home of Canada's Museum of Immigration (Canadian Museum of Immigration, Pier 21 website).

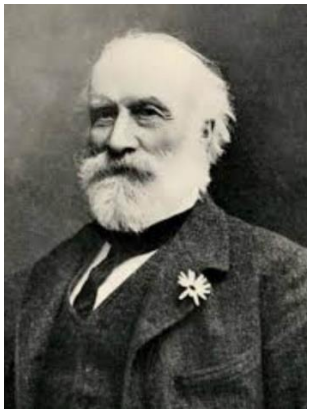
A passenger ship arriving at Pier 21 in Halifax in the late 1920s
(photo source CBC.ca-Seven Wonders of Canada website)

When Legget landed, he was surprised to be met by a member of Toc:H, the organization he had joined in London (see annotation in Chapter 6). Unbeknownst to Legget, that organization had telegraphed the Halifax Toc:H branch with information of Legget's arrival. The Halifax Toc:H member and Legget spent a few hours together in the city before Legget boarded an immigrant train for Montreal (LAC 20-23).

[3] The CNR or Canadian National Railways (the plural is correct) boarded immigrants at a special train station located in the Annex Building connected to Pier 21. In the 1920s, immigrant trains were relatively primitive compared to regular passenger trains. These lower class trains were heated by coal-burning stoves at each end of the car and offered only marginal dining facilities.

The 1,350 km rail line that connects Halifax and Montreal was constructed shortly after the Confederation of Canada in 1867, with Sandford Fleming as the Engineer in Chief. It was part of the Intercolonial Railway until it became part of the CNR in 1919.

Among other things, Sir Sandford Fleming, (1827-1915) went on to help build the Canadian Pacific Railway, promote standard times zones around the world and the use of the 24-hour clock, design Canada's first postage stamp and co-found the Alpine Club of Canada and the Rideau Curling Club, among other things. He was a founding member of the Royal Society of Canada and was Chancellor of Queen's University in Kingston for 35 years. He was knighted in 1897 (Wikipedia and Queen's University Archives websites).



Sir Sandford Fleming, date unknown (photo source Queen's University website)

With Legget's interest in trains and railways, and having seen nothing of Canada, he would have been fascinated by this leg of his trip. In later years he wrote a number of articles about both the Intercolonial Railway and Sir Sandford Fleming.

[4] The Power Corporation of Canada, founded in 1925, started buying existing hydroelectric power companies in Quebec, Ontario, Manitoba and BC and then started building other hydroelectric power plants. By 1929, the parent company and its affiliated companies were operating almost 40 power plants across Canada. The company also established a land development division to encourage new industries to locate near its power plants. In addition, the company opened retail stores to sell electrical goods. Both initiatives were obviously intended to promote power consumption.

In the 1960s, when provincial governments nationalized most hydroelectric companies, Power Corporation diversified into Canadian financial services, insurance, land and water transportation, pulp and paper, newspapers, real estate and even a radio station and a race track. Today, the Power Corporation is a diversified international management and holding company with interests in financial services, asset management, sustainable and renewable energy and other business sectors (Power Corporation website).

[5] The name "Dominion Day," the holiday to commemorate the Confederation of Canada on July 1, 1867, was changed to "Canada Day" in 1982, shortly before Legget wrote his memoir.

[6] There are two Montreal rivers in Ontario (see later annotation). The one to which Legget refers flows into Lake Timiskaming, a widening of the Ottawa River, along the Ontario-Quebec border. The Upper Notch project was located approximately 15 km upstream of the mouth of this Montreal River, approximately halfway between the early-1900s towns of Cobalt and Temagami.

[7] 13,000 horsepower (HP) is approximately 9.7 megawatts (MW).

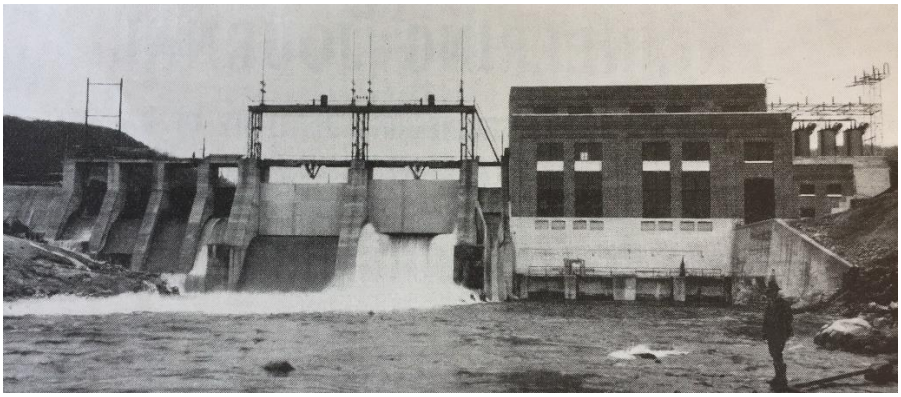


Photo of the completed Upper Notch Power Plant from Legget's 1931 paper in the *Engineering News-Record* (LAC 4-18)

[8]In 1936 and 1947, in statements of qualifications that Legget prepared for his employment at Queen's University and the National Research Council, respectively, he summarized his Upper Notch experience as (Queen's University and NRC Archives):

> Engineer with the Power Corporation of Canada Limited, Construction Division, and for 18 months (i.e. from the start to the finish) Resident Engineer and assistant to the Construction Superintendent, on the construction of the Upper Notch Water Power Plant, the largest automatic plant in Canada (13,000 [HP]) 75% of the concrete on the job being placed under winter conditions with temperatures as low as forty degrees below zero. The job included a 33-mile 110,000 volt transmission line. Work was described in Engineering News-Record for 29th October 1931, and in other publications.

[9] Legget's first experience with glacial till made an impression on him. In 1976, he was editor of the textbook, *Glacial till; an interdisciplinary study*, published by the Royal Society of Canada.

[10] The Lower Notch (or simply the Notch) was approximately 15 km down river from the Upper Notch.

"The Notch, Montreal River (Timiskaming District), 1906" (photo source *Missions in new Ontario*, 1906 by Rev. James Allen, published by Methodist Church, Toronto)

[11] Diamond drilling was invented in 1863 by Rodolphe Leschot, a French engineer.

[12] Legget took and used a number of similar photos. The photo below was published as Figure 11.10 in Chapter 11, Subsurface Investigations, in *Handbook of Geology in Civil Engineering*, by Legget and Paul Karrow, published in 1983 by McGraw-Hill. The caption reads, "Diamond drilling at the Lower Notch, Montreal River, many years before a dam was constructed at this site."

Photo of drill set up on Montreal River (photo by Legget)

[13] Rigging is a nautical term referring to a system of ropes, cables and/or chains to support the mast (standing rigging) and the sails (running rigging). In Legget's context, he is referring to the use of such a system to support the timber cribs and drilling equipment.

[14] Wash boring is a relatively primitive method of soil drilling that has been used for many hundreds of years.

[15] The Hydro-Electric Power Commission of Ontario was founded in 1906 and changed its name to Ontario Hydro in 1974. In 1999, the power generation side of Ontario Hydro became Ontario Power Generation and the transmission and distribution side became Hydro One Limited (Wikipedia).

[16] The Hydro-Electric Power Commission of Ontario took over operation of the private hydroelectric power plants on the Montreal River in 1944. It carried out subsequent investigations of the Lower Notch site in the early 1960s and constructed the Lower Notch Dam and Generating Station in the late 1960s and early 1970s. The plant was commissioned in 1971 (Ontario Power Generation website).

Lower Notch Dam and Generating Station (photo source Ontario Power Generation website)

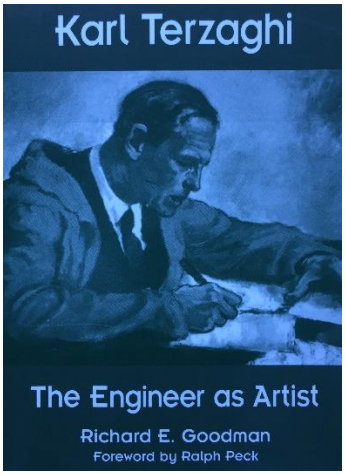
Currently the Lower Notch Generation Station has a capacity of 274 MW, compared to the Upper Notch plant that had a capacity of approximately 9.7 MW.

[17] It is not known to which two "fine UK journals" Legget was referring. In the 1930s, he published articles in three such journals: *Civil Engineering and Public Works Review*; *Concrete and Constructional Engineers* and *Water and Water Engineering*.

The *Engineering News-Record (EN-R)* traces its roots to two publications. The older magazine was first published as *The Engineer and Surveyor* in 1874. It was renamed several times to *The Engineer, Architect and Surveyor*, then *Engineering News and American Railway Journal* and eventually *Engineering News*. The second publication was first known as *The Plumber and Sanitary Engineer*. It was later renamed *The Sanitary Engineer*, then *Engineering and Building Record* and finally *Engineering Record*. In 1917, *Engineering News* and *Engineering Record* merged to become the magazine that is still published today (Wikipedia).

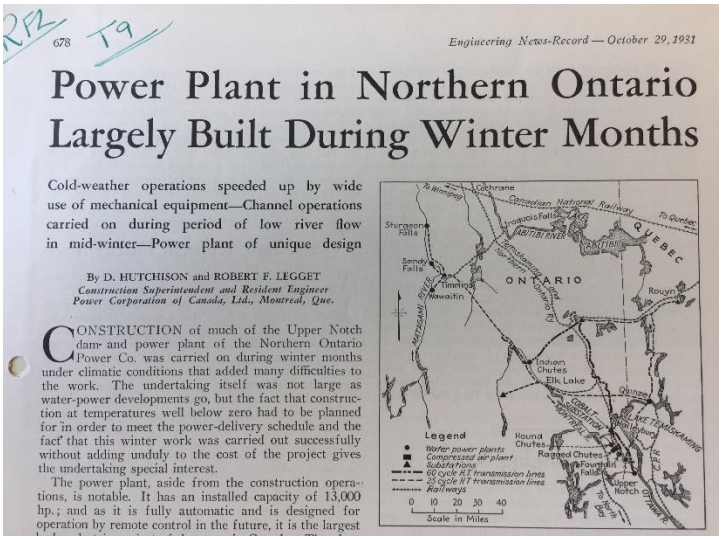
[18] Karl Terzaghi (1883-1963), born in what was then the Austrian Empire, is considered the "Father of Soil Mechanics." The 1925 articles by Terzaghi, to which Legget refers, are a series of eight articles titled "Principles of Soil Mechanics" that appeared in *EN-R*, Volume 95, pages 742-746, 796-800, 832-836, 874-878, 912-915, 987-990, 1026-1029 and 1064-1068. The following year, the articles were published in a 98-page book titled *Principles of Soil Mechanics: a summary of experimental studies of clay and sand*, published by McGraw-Hill.

For more information on Karl Terzaghi see Wikipedia and Goodman 1999.




Terzaghi portrayed on the cover of Goodman 1999

[19] The photo below is of the first page of Legget's five-page *EN-R* article, published on October 29, 1931 (LAC 4-18)



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Engineering News-Record — October 29, 1931

# Power Plant in Northern Ontario Largely Built During Winter Months

**Cold-weather operations speeded up by wide use of mechanical equipment—Channel operations carried on during period of low river flow in mid-winter—Power plant of unique design**

By D. HUTCHISON and ROBERT F. LEGGET
*Construction Superintendent and Resident Engineer Power Corporation of Canada, Ltd., Montreal, Que.*

CONSTRUCTION of much of the Upper Notch dam and power plant of the Northern Ontario Power Co. was carried on during winter months under climatic conditions that added many difficulties to the work. The undertaking itself was not large as water-power developments go, but the fact that construction at temperatures well below zero had to be planned for in order to meet the power-delivery schedule and the fact that this winter work was carried out successfully without adding unduly to the cost of the project gives the undertaking special interest.

The power plant, aside from the construction operations, is notable. It has an installed capacity of 13,000 hp.; and as it is fully automatic and is designed for operation by remote control in the future, it is the largest



Article "By D. Hutchinson and Robert F. Legget, Construction Superintendent and Resident Engineer, Power Corporation of Canada Ltd., Montreal, Que." Legget wrote his initials and "T9" in the upper left corner of this article. He had started to code file his papers; T9 refers to what he considered his 9th published technical paper. (LAC 4 18)

[20] The "other" Montreal River in northern Ontario is in the Algoma and Sudbury districts and flows southwesterly into Lake Superior.

[21] Legget was a "(spare-time) engineering correspondent" and later a special correspondent to the Editor of *EN-R* for exactly 50 years. Over that period he contributed hundreds of relatively short news items about Canadian engineering to the magazine, all without a byline. He cut out most, if not all, of his published contributions and pasted them into two scrap books. His first item, published on December 14, 1933, was entitled "Suit against Quebec engineer dismissed on legal technicality." His last article, published on November 24, 1983, was titled "Canadian rail spending freed up" (LAC 6-66 and 67).

[22] Legget married Lilian Free, the secretary he met at C.S. Meik and Buchanan while working in London, on February 28, 1931. More about their marriage is in Chapter 9.

[23] "Made work" is work that is designed to provide employment, as opposed to work that is necessary. Sometimes it is referred to as "relief work."

[24] The 24-storey Sun Life Building in downtown Montreal was constructed for the Sun Life Insurance Company. It was built in three phases: 1913-1918, 1923-1926 and 1929-1931. When completed, it was the largest building in the British Empire, measured by square footage; however, the neighbouring Royal Bank of Canada office building was taller by several floors (Wikipedia).

Modern photo of the Sun Life Building (photo source Wikipedia)

More about Legget's work at the Sun Life Building is in Chapter 9.

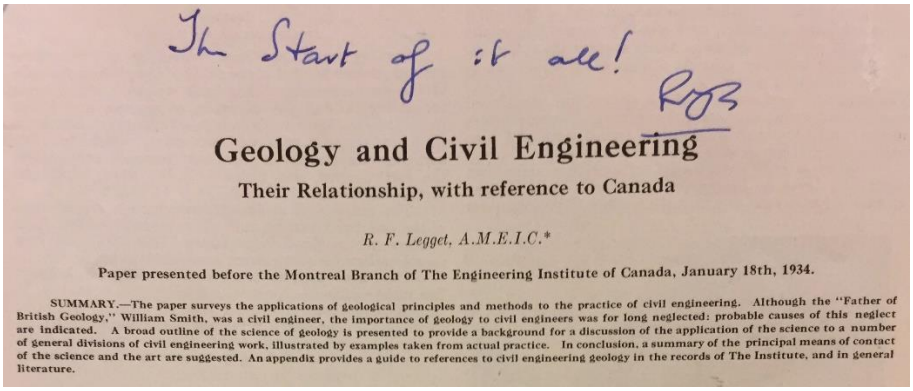
[25] Legget started to work at the Sun Life Building sometime in March 1932 and therefore his meeting with O'Neill occurred at approximately the same time.

[26] John Johnson O'Neill (1886-1966) graduated with a BSc and MSc in geology from McGill University in 1909 and 1910, respectively, and a PhD from Yale in 1912. He joined the faculty of the McGill Geology Department in 1921, became the Chair of the Department in 1929, then Dean of Science in 1935. He took over from Dr. Ernest Brown as Dean of Engineering in 1942 and became Vice Principal in 1948, retiring in 1952 (Wikipedia).

[27] The Engineering Institute of Canada (EIC) was founded in 1887 as the Canadian Society of Civil Engineers (civil, as opposed to military engineers). It changed its name to the Engineering Institute of Canada in 1918 to represent all branches of engineering. It is currently a federation of 12 constituent societies (Engineering Institute of Canada website). There is currently a Canadian Society for Civil Engineering also known by its initials CSCE.

[28] The EIC's *Engineering Journal* was published monthly starting in 1918 and superseded the semi-annual *Transactions of Canadian Society of Civil Engineers* started in 1887. Until the 1960s, when a number of the engineering disciplines left the EIC and started to publish their own journals, the *Engineering Journal* was the prime outlet for publishing engineering papers in Canada. Starting in the mid-1960s, the number of issues per year were reduced until 1987, when it ceased publication (Engineering Institute of Canada website).

[29] The following reprint of Legget's 1934 paper was in the files that he sent to Paul Karrow in 1982. At the time Karrow, a Professor in the Earth Sciences Department at the University of Waterloo, was collaborating with Legget on the textbook *Handbook of Geology in Civil Engineering*, published in 1983.



The Start of it all! RFL

# Geology and Civil Engineering

## Their Relationship, with reference to Canada

*R. F. Legget, A.M.E.I.C.**

Paper presented before the Montreal Branch of The Engineering Institute of Canada, January 18th, 1934.

SUMMARY.—The paper surveys the applications of geological principles and methods to the practice of civil engineering. Although the "Father of British Geology," William Smith, was a civil engineer, the importance of geology to civil engineers was for long neglected: probable causes of this neglect are indicated. A broad outline of the science of geology is presented to provide a background for a discussion of the application of the science to a number of general divisions of civil engineering work, illustrated by examples taken from actual practice. In conclusion, a summary of the principal means of contact of the science and the art are suggested. An appendix provides a guide to references to civil engineering geology in the records of The Institute, and in general literature.

From the first page of the paper. At the top Legget wrote "The Start of it all! RFL" It's not known when he wrote these words. (OUIT Archives)

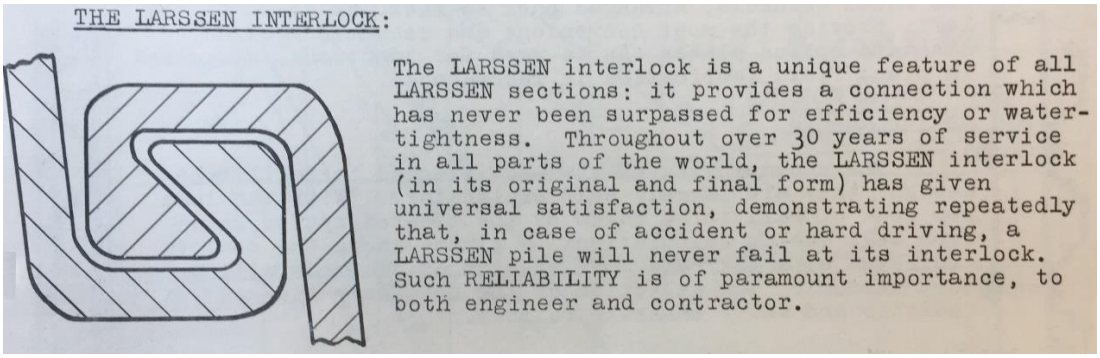
[30] Today the Athenaeum is a five-star hotel in the Piccadilly area of London. It was built as Hope House in the mid-1800s and when Legget visited it in the 1930s, it would have been a distinctive art deco apartment building with its own restaurant (Wikipedia).

[31] McGraw-Hill Publishing Company is a New York-based university and professional book publisher that has roots back to 1888 (Wikipedia). Legget published a number of books with McGraw-Hill.

[32] Legget is referring to his now classic 650-page textbook, *Geology and Engineering,* published by McGraw-Hill in 1939.

[33] The British Steel Piling Company Ltd. was founded in 1905. The company was acquired by Tex Holdings PLC in 1989 and is based in Great Blakenham, near Ipswich, England, where it established its manufacturing centre in 1921 (British Steel Piling Company website).

[34] Larssen sheet piling was developed in 1902 by Tryggve Larssen, a government surveyor in Bremen, Germany, for use in the construction of the waterfront structure in Bremen. It is manufactured from rolled sheets of steel that are bent into a channel-shaped cross-section with a system to interlock the piles together.



THE LARSSEN INTERLOCK:

The LARSSEN interlock is a unique feature of all LARSSEN sections: it provides a connection which has never been surpassed for efficiency or water-tightness. Throughout over 30 years of service in all parts of the world, the LARSSEN interlock (in its original and final form) has given universal satisfaction, demonstrating repeatedly that, in case of accident or hard driving, a LARSSEN pile will never fail at its interlock. Such RELIABILITY is of paramount importance, to both engineer and contractor.

Description of the Larssen interlocking system from a 1935 company publication written by Legget (LAC 9-27)

The design was originally patented, but the product is currently manufactured by many different companies and used throughout the world. It is still referred to as Larrsen sheet piles.

[35] Legget was based in Montreal when he worked with the British Steel Piling Company Ltd. subsidiary, the Canadian Sheet Piling Co. Ltd.

[36] This project is described more fully in two papers by Legget titled "New Coal Dock for Toronto Harbour," published in *Civil Engineering* (New York), August 1937, pp 284-287, and "Construction Methods for 22 Acre Coal Storage Dock in Toronto," published in *Engineering & Contract Record* (Toronto), August 25, 1937, pp 9-15.

Panorama of the coal dock from Legget's article in *Civil Engineering*.
Larssen sheet piling forms the facing of the dock. (LAC 4-60)

[37] There were two magazines called *Civil Engineering*. One was published in the UK with the full name *Civil Engineering and Public Works Review.* It was published between 1906 and 1973. The other was published in New York and was associated with the American Society of Civil Engineers (ASCE). It was called *Civil Engineering* and was first published in 1930. From Legget's references in his memoir, it is sometimes difficult to know to which magazine he is referring. From the subject matter, this *Civil Engineering* is likely the US magazine.

[38] US Steel was founded in 1901 and at one time was the largest steel manufacturer in the world. In 2016, it had dropped to the 24th largest. Bethlehem Steel was founded in 1904 and was at one time the second largest steel manufacturer in the US. In 2003, the company was dissolved. Both companies were based in Pennsylvania (Wikipedia).

[39] Most readers will know of the 80-km Panama Canal that connects the Pacific and Atlantic oceans. The Kiel Canal is a 98-km canal in northern Germany that connects the North and Baltic seas.

[40] In the late 1800s and early 1900s, the Swedish State Railways started railway construction in that country. A number of landslides occurred as a result of constructing railway embankments on clay. The largest, and perhaps best known, is the 1918 Geta landslide in eastern Sweden that resulted in 41 fatalities. These landslides led to the formation of the Swedish State Railway Geotechnical Commission that submitted its report in 1922. The use of the term "geotechnical" in the name of this commission may be the first use of the term anywhere in the world (Massarsch, K.R. and Fellenius, B.H. 2012. "Early Swedish Contributions to Geotechnical Engineering," ASCE Geo-Institute Geo-Congress Oakland, California, Geotechnical Special Publication 227, pp 239-256).

[41] Legget preferred the term "geotechnique," (the noun as used in the title of his memoir, or "geotechnical," the adjective) rather than "soil mechanics" because geotechnique includes the associated disciplines of geology, hydrogeology and rock mechanics along with soil mechanics.

[42] Arthur Casagrande (1902-1981) was another Austrian Empire-born civil engineer and early geotechnical engineering researcher, practitioner and professor. In the early 1930s, he developed the soil mechanics program at Harvard University. Casagrande was the Organizing Chair and Secretary of the 1936 International Conference (Wikipedia).

## Annotations Chapter 8: FIRST INTERNATIONAL CONFERENCE (1936)

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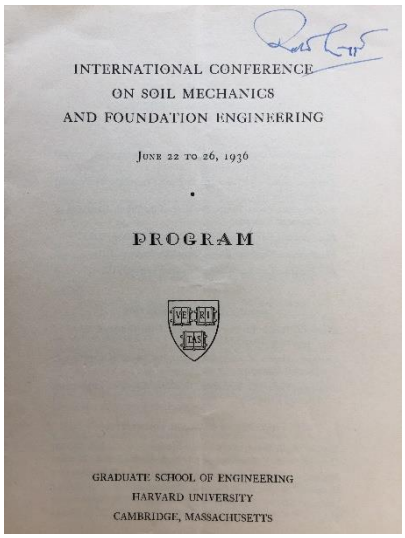
[1] From the 1936 International Conference on Soil Mechanics and Foundation Engineering.

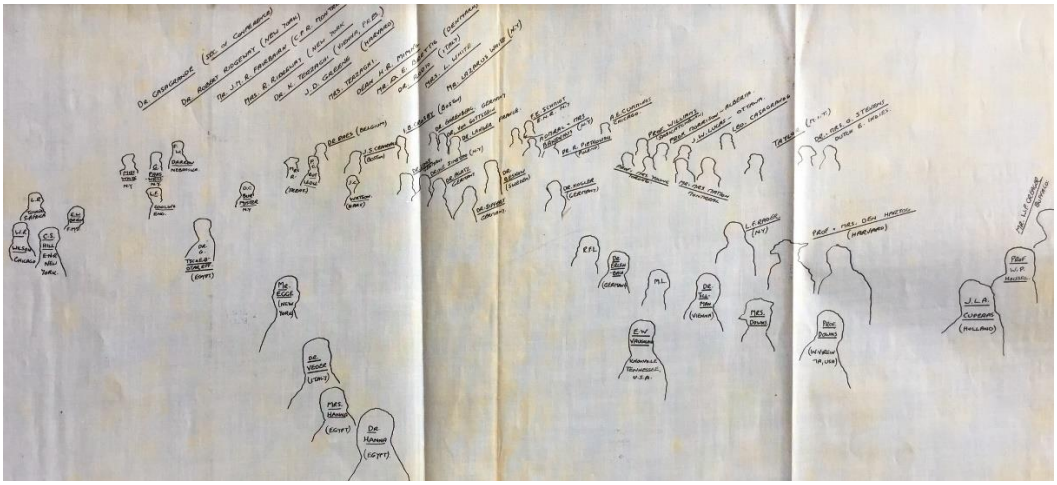




Legget's copy of the program and his name badge (LAC 19-16)

[2] Photo of the "Welcome Dinner, International Conference on Soil Mechanics and Foundation Engineering, Harvard University – June 22-26, 1936."


Legget is near the middle of the photo, on the left side at the far end of the lower series of tables, third table from the left. Mrs. Legget is the second person to his right. (LAC Spec Coll)



A transparency in Legget's files that identifies a number of the delegates at the Welcome Dinner. The organizers and dignitaries, standing at the back of the photo, are identified as: "Dr. Casagrande (Sec. of Conference); Dr. Robert Ridgeway (New York); Mr. J.M.R. Fairbairn (C.P.R. Montreal); Mrs. R. Ridgeway (New York); Dr. K. Terzaghi (Vienna, Pres.); J.D. Greene (Harvard); Mrs. Terzaghi; Dean H.R. Mimno; Mr. A.E. Bretting (Denmark); Dr. Rodio (Italy); Mrs. L. White, Mr. Lazarus White (N.Y.)" (LAC Spec Coll)

[3] Philip Casteen Rutledge (1906-1990) was a civil engineer (BSc, Harvard 1927; MS, MIT 1933 and DSc, Harvard 1939) who helped Arthur Casagrande organize the conference. He taught at Purdue University (1937-1943) and Northwestern University (1943-1952). During the Second World War he helped develop airfield pavements for heavy wartime aircraft. In 1952, he helped establish the New York consulting firm Mueser Rutledge and was known for his foundation designs for buildings, bridges, dams, industrial plants and waterfront structures. He retired in 1977 (US National Academy of Engineering website).

[4] TVA is the Tennessee Valley Authority, a US agency that provides electricity, flood control, navigation and land management for the Tennessee River System (Tennessee Valley Authority website).

[5] The following paragraphs provide a little more information on some of the individuals mentioned in Legget's memoir:

Carlton S. Proctor (1894-1970) worked for the New York-based engineering consulting firm Proctor, Mueser, Rutledge & Johnston. That firm provided the foundation designs for many US dams, bridges and buildings, including the George Washington and Golden Gate bridges, the United Nations building and Yankee Stadium (New York Time Obituaries website).

Carlton Proctor is not the individual who developed the Proctor Compaction Test. The compaction test is named for Ralph R. Proctor.

Reuban Edwin Bakenhus (born 1873) worked as a civil engineer in various US Navy shipyards on the east coast and attained the rank of Rear Admiral. He retired in 1937 (US Navy History website).

Lazarus White (born 1874) worked as a civil engineer for the New York Rapid Transit Commission and Board of Water Supply before becoming a consulting engineer. He was President of Spencer, White and Prentis from 1919-1950 (Prebook website). He and his wife are standing as dignitaries in the Welcome Dinner photo.

Robert Ridgeway (also spelled Ridgway) (1862-1938) was a civil engineer who did not study engineering but worked 49 years for New York City in construction and became Chief Engineer of the New York Transit Commission in 1921. He became President of the American Society of Civil Engineers in 1925 (Wikipedia). He and his wife are standing as dignitaries in the Welcome Dinner photo.

Harry A. Mohr. In the early 1900s, the first soil penetration test was developed in Boston by Gow Construction Co. In the late 1920s and early 1930s, Mohr helped standardize the test and during the 1940s, in conjunction with Terzaghi, he finalized his development of the Standard Penetration Test (SPT) (Wikipedia).

Harry Mohr is not the individual for whom the Mohr Circle is named. That individual is German civil engineer Otto Mohr.

Spencer J. Buchanan (1904-1982) established soil mechanics at Texas A&M, College Station, in 1946. He was also president of the consulting firm Spencer J. Buchanan & Associates (Texas A&M website).

Donald Burmister was a professor at Columbia University, New York, who correlated standard penetration test blow counts with those of other sampler blow counts, using input energy corrections. He is also known for his work on soil classification (Wikipedia).

A.E. Cummings was Director of Research of the Raymond Concrete Pile Company, New York. He was also the author of *Pile Foundations,* a 34-page 1952 reprint of a September 1940 article on concrete pile foundations, originally published in *Proceedings of the Purdue Conference on Soil Mechanics and Its Application*, Purdue University, Lafayette, IN (Amazon.com). Legget attended this 1940 conference.

C.A. Hogentogler was a senior highway engineer with the US Bureau of Public Roads and the first Chairman of ASTM Committee D18 on Soil and Rock for Engineering Purposes. He authored *Engineering Properties of Soils,* published by McGraw-Hill in 1936. The ASTM's C.A. Hogentogler Award is named in his honour. His son formed Hogentogler & Co in 1939, first as an engineering consulting firm. The firm then started manufacturing materials testing equipment to meet the standards developed by his father and others on the ASTM committee.

E.J. Kilcawley was the head of soil mechanics at Rensselaer Polytechnic Institute, Troy, NY, and author of *Weathering Resistance of Concrete* (Amazon.com).

D.P. Krynine was a professor at Yale University, New Haven, CT. He was co-author, with W.R. Judd, of the 1957 textbook, *Principles of Engineering Geology and Geotechnics*, published by McGraw-Hill.

Jorj O. Osterberg (1915-2008) was a 1940 graduate of Harvard University under Arthur Casagrande. He invented the WES (Waterways Experimental Station) pressure cell, the Osterberg piston sampler and the Osterberg drilled shaft load cell (O-cell). He started the soil mechanics laboratory at Northwestern University, Evanston, IL (US National Academy of Engineering website).

Merlin Grant Spangler (1894-1986) was a professor at Iowa State College and author of the 1951 textbook *Soil Engineering*, published by International Textbook Co (Babal Hathitrust website). He is known for his work on culvert theory.

O.L. Stokstad was a soils engineer with the Michigan State Highways Department.

Donald W. Taylor (1900-1955) was a graduate of MIT, Cambridge, MA, where he was on staff, then faculty, from 1936. He authored the 1948 textbook *Fundamentals of Soil Mechanics*, published by John Wiley & Sons. Among other things, Taylor is also known for the Taylor's Stability Charts.

[6] William (Bill) S. Housel (1901-1978) was a professor at University of Michigan, Ann Arbor, research consultant to the Michigan Department of State Highways and private consultant. He made significant contributions to the design and testing of deep foundations and was a founding member of ASTM Committee D18 on Soil and Rock for Engineering Purposes (Google Books).

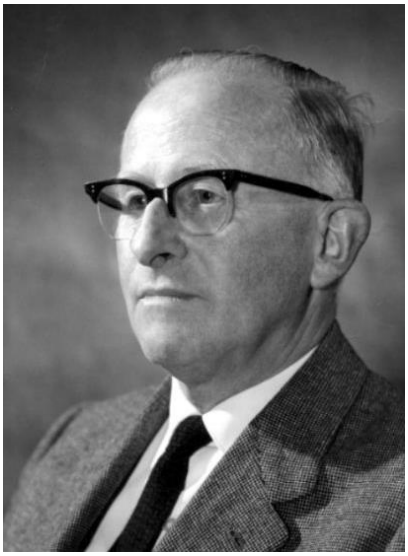
[7] Paul Raes was at the University of Ghent, Belgium. He attended the conference with the financial assistance of the Belgium American Educational Foundation Inc.

[8] William S. Hanna (1896-1980) was an Egyptian-born, long time faculty member of Fouad El-Away University (now Cairo University). In 1933 he established the first soil mechanics laboratory in Egypt and is considered the Father of Egyptian Soil Mechanics (Wikipedia).

Gregory P. Tschebotarioff (1899-1985) was a Russian-born and Russian- and German-trained civil engineer who worked in Germany and Egypt before joining the faculty at Princeton University, Princeton, NJ, in 1938. He started Princeton's soil mechanics program. He was author of, among many other publications, the 1973 textbook *Foundations, Retaining and Earth Structures*, published by McGraw-Hill (Wikipedia).

[9] Leonard Frank Cooling (1903-1977) was Head of the Soil Mechanics Section of the British Building

Research Station. A soil physics section was established in 1933 and Cooling was put in charge. He then established the first soil mechanics laboratory in Britain. In 1935, the section was renamed the Soil Mechanics Section. Among other accomplishments, Cooling was one of the founders of the journal *Géotechnique* in the late 1940s (Burland, J.B. 2008. "The Founders of *Géotechnique," Géotechnique,* Vol 58, pp 327-341.)



Dr. Leonard Frank Cooling (photo source Burland, 2008)

Legget relates more about Cooling later in his memoir. Two prominent Canadian geotechnical engineers worked under Cooling early in their careers before immigrating to Canada: Geoffrey Meyerhof and Hugh Golder.

[10] The Netherlands East Indies is more commonly referred to as the Dutch East Indies. It was a Dutch colony until the 1949 when it became Indonesia. The entire colony was occupied by the Japanese during the Second World War, from late 1941 to the end of the war in the Pacific, September 2, 1945 (Wikipedia).

[11] The Straits Settlements originally consisted of four individual "settlements," Penang, Singapore, Malacca and Dinding. Christmas Island and the Cocos Islands were added in 1886. The island of Labuan, off the coast of Borneo, joined in 1912. Most of the territories now form part of Malaysia, from which Singapore separated in 1965. The Cocos (or Keeling) Islands were transferred to Australian control in 1955 and Christmas Island was transferred to Australia in 1958 (Wikipedia).

[12] Clarence Richard Young (1879-1964) started teaching structural engineering in the Department of Civil Engineering at the University of Toronto in 1908, was Head of the Municipal and Structural Division of the department from 1929 to 1945 and was Dean of Applied Science and Engineering from 1941 to 1949. He contributed to the Toronto Building Code. After retirement Young wrote about early engineering education at the university (White 2000). Legget relates more about Young later in his memoir.

[13] brahim Folinsbee Morrison (1889-1958) was American-born and MIT-trained. He joined the Civil and Municipal Engineering Department, University of Alberta in 1912. The 1936 conference seems to have been the impetus that accelerated the development of soil mechanics at U of A. See also Morrison 1997.

[14] G.M. Williams, Professor of Civil Engineering at the University of Saskatchewan, should not be confused with G.B. Williams of the Manitoba Department of Public Works who is mentioned later in Legget's memoir.

[15] From 1910 to 1924, this company was a subsidiary of the US firm Foundation Company. In 1929 it became the Foundation Company of Canada, the independence of it having been initiated in 1924.

[16] Richard Ellard Chadwick (1885-1966) was President of the Foundation Company of Canada from 1924 to 1952 (CGS website; Lives Lived).

[17] Here and later in this chapter, Legget is referring to himself and his wife, who also attended the conference.

[18] In 1983, Legget and his wife may not have remembered J.M.R. Fairbairn attending the conference, but Legget's transparency of those who attended the Welcome Dinner identifies Fairbairn. Besides being the Chief Engineer of the Canadian Pacific Railway in the mid-1920s, Fairburn was involved in the founding of the "ritual of the calling of an engineer" (Wikipedia).

Mrs. Mary Legget (centre) flanked by delegate Dr. O. Stevens and his daughter, from the Dutch East Indies. Photo by Legget (LAC 19-16)

[19] Since 2017, all ISSMFE and ISSMGE proceedings have been available online. See Chapter 24.

[20] The "heading" Legget refers to is just below the title of his contribution "(Abstract of a report contributed by R.F. Legget, AMEIC [Associate Member of the Engineering Institute of Canada])." It is difficult to understand why the editors of the Canadian-published *Engineering Journal* would, as Legget suggests, remove the names of the Canadian delegates.

[21] $10 in 1936 would be approximately CDN$200 in 2020.

[22] "The Yard" is Harvard Yard, the oldest part of Harvard University and the location of the dormitories for most freshmen.

[23] The Sheldon Hotel, completed in 1923, was originally a men's residence. At that time, it was considered the tallest hotel in the world. The 31-storey building was designed in the Romanesque Revival style and is thought to have influenced the design of the later-built Empire State Building. Today it is the New York Marriott East Side Hotel and a New York landmark (New York City Archives website).

[24] The Rainbow Grill is located on the 65th floor of what was originally known as the RCA Building, now the Comcast Building, at 30 Rockefeller Plaza. The building was completed and the restaurant opened in 1934 (only two years before Legget's visit) as a "focal point for the city's elite." The building and the restaurant are New York landmarks (Wikipedia).

[25] West Point, established in 1802, is a prestigious US Military Academy located approximately 80 km north of New York City (Wikipedia).

[26] The Quabbin water supply scheme, now referred to as the Quabbin Reservoir, was created between 1930 and 1939 and is the largest inland body of water in Massachusetts. It is the primary water supply for Boston, approximately 100 km to the east (Wikipedia).

[27] Longfellow's Wayside Inn, located approximately 40 km west of Boston, began as Howe's Tavern in 1716. When Henry Wadsworth Longfellow visited it in 1862, he wrote a series of poems that focused on

the tavern. It was given its current name in 1892. As Legget mentions in his memoir, a fire in 1955 destroyed most of the inn, but it was fully restored by 1960, the year it became a US National Historic Site (Wikipedia).

[28] In Legget's files in the Library and Archives Canada, there are copies of approximately 300 papers and articles that he authored or co-authored between 1923 and 1993 (LAC 4-4 to 6-65). His paper in Volume 1 of the *Proceedings of the 1936 International Conference* is not among them, possibly indicating how little he thought of it. A copy of the manuscript of his paper, however, is elsewhere in his files (LAC 9-28).

## Annotations Chapter 9: EARLY YEARS IN CANADA (1929-1936)

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[1] Toc:H; see Chapter 6 and its annotations

[2] *Contractors and Engineers Monthly* was a US publication first published in 1920. In a 1947 issue, it described itself as “A national business paper for the highway and heavy construction industry.”

[3] “The Upper Notch Automatic Hydro-Electric Plant,” *Engineering Journal*, Vol 14, pp 437-444.

[4] LAC 4-14

[5] “C.S. Meik and Buchanan…Reminiscences 1925-1929,” unpublished note (LAC 9-9)

[6] Queen’s University and NRC Archives

[7] Queen’s University and NRC Archives

[8] *Canadian Forum* was a left-leaning literary, cultural and political monthly magazine, published between 1920 and 2000 (Wikipedia).

[9] LAC 8-22. In addition to the start of this book, Legget’s interest in power is demonstrated by his giving a special lecture at McGill University in February 1934 on “Water Power in Canada (Illustrated)” to the Mechanics’ Institute of Montreal. (LAC 20-3).

[10] LAC 4 49

[11] Legget’s *Engineering Journal* article was published in very small print. To make it more readable, it has been reformatted in Chapter 18 with a larger font.

[12] This 1935 trip to England was associated with his work for the Canadian Sheet Piling Co. It was a trip that lasted several weeks and for which he kept another extensive log—this one handwritten (LAC 2-2).

[13] Both these Montreal area residential sites have since been redeveloped.

[14] LAC 19-16

## Annotations Chapter 10: DEVELOPMENTS IN EASTERN CANADA (1936-1939)

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[1] Legget is referring to Professor I.F. Morrison from the University of Alberta. See Chapters 1 and 8 and their annotations.

[2] Legget is referring to Robert Hardy's contribution to the early 1980's CGS Geotechnical Heritage Book Project (see VanDine and Heinz 2020).

[3] In 1940, under "the Chief's" (Richard Chadwick's) leadership, the Foundation Company of Canada formed a Soils Engineering Department to carry out site investigations and to support the company's diverse land and marine construction of projects across Canada. This could be the first private soil engineering group in Canada.

[4] Used in this context, "imprimatur" is a form of approval or endorsement.

[5] Edward Fetherstonhaugh, an electrical engineer, was the first Dean of Engineering of the University of Manitoba (1921 to 1949) (University of Manitoba website).

[6] Founded in 1907, the Nova Scotia Technical College was renamed the Technical University of Nova Scotia in 1980. In 1997, it merged with Dalhousie University. Frederick Sexton was the founding principal (a position renamed president) from 1907 to 1947 (Wikipedia).

[7] John ("Blinky") Stephens was Dean of Engineering of the University of New Brunswick from 1920 to 1945. It is not known why Legget considered him famous.

[8] Although not mentioned in his memoir, in January 1936, Legget applied for a teaching position advertised by the Civil Engineering Department at the University of Liverpool, the John William Hughes Chair of Civil Engineering (LAC 1-7). He was unsuccessful.

[9] Legget was hired as a lecturer to assist Sandy Macphail teach "General Engineering 1". This was a 2nd-year course for all engineering students; two lecture hours per week, both terms (Queen's University calendar).

[10] Robert Charles Wallace (1881-1955) was a Scottish-Canadian geologist. He was President of the University of Alberta from 1928 to 1936 and Principal of Queen's University from 1936 to 1951. He was the first scientist to become Principal of Queen's (Wikipedia).

[11] William McNeill (1876-1959) was a Professor of English who became Registrar and Treasurer of Queen's University in 1920. He is credited with helping Queen's survive the Depression without drastic cutbacks (Queen's University Encyclopedia website).

[12] Professors Alexander (Sandy) Macphail, William Wilgar, Douglas Ellis and Lindsay Malcolm and lecturer R.A. Low (Queen's University calendar). Why Legget considered the Department of Civil Engineering unique and what the historical explanation was are unknown.

[13] Alexander (Sandy) Macphail (1870-1949) became a professor of Civil Engineering at Queen's in 1904 and was department head until 1939. He held the unique position of Professor of General Engineering. During the First World War he was a major in the 5th Field Company Canadian Engineers militia unit comprised mainly of Queen's engineering students. For his work during the war he was awarded the CMG (Companion of the Order of St. Michael and St. George) and the DSO (Distinguished Service Order) for his distinguished service in action (Queen's University Encyclopedia website).

[14] A year after Legget left Queen's, Malcolm left Queen's and joined the faculty at Cornell University.

[15] Port Stanley is a small community on the north shore of Lake Erie, south of London, ON. It is approximately 400 km west of Kingston.

[16] Bermingham Construction Limited was founded in 1897 by William Bermingham and is still a thriving privately owned family business today. Based in Hamilton, ON, its construction arm includes pile foundations, excavations and shoring and marine projects. It also sells, rents and services foundation construction equipment (Bermingham website).

[17] C.R. Young is introduced in Chapter 8 and its annotations.


Clarence Richard Young in 1947 (photo source White 2000)

[18] Here Legget's memory differs somewhat from the University of Toronto 1938-1939 Applied Science and Engineering calendar. In that calendar, "Soil Mechanics" was a 4th-year course (one lecture hour per week, first term) taught by W.L. Sagar. The course was introduced in the 1936-1937 session, immediately after the International Conference held in June 1936, and was taught that year and the next year by Young, who had attended the 1936 conference.

During Legget's first two years at the University of Toronto, he co-taught with Sagar "Foundations, Retaining Walls and Dams." It was a 4th-year course (one lecture hour per week, both terms). This, or a similar course, had been taught since at least the late 1920s.

In the same two years, Legget also taught "Graphical Methods," a 3rd-year course (one lecture hour per week, both terms), and co-taught "Structural Design", a 5th-year course (one lecture hour and three laboratory hours per week, both terms), both structural engineering courses (University of Toronto calendars).

[19] The Electrical Building at the University of Toronto was opened in 1920 to help alleviate the large enrollment of engineering students after the First World War. It was renamed the Roseburgh Building in 1936 but Legget refers to it by its original name. Today its exterior is all but swallowed up by the Donnelly Centre for Cellular and Biomolecular Research (University of Toronto website).

Basement entrance of the Electrical Building (Roseburgh Building). Legget's soil mechanics laboratory was in this basement. The staircase to the left leads to the Donnelly Centre opened in 2005. (photo Doug VanDine 2019)

[20] Henry Girdlestone Acres (1880-1945) was a 1903 civil engineering graduate from the University of Toronto. He pioneered hydroelectric power development in Canada. He was one of the first employees of the Hydro-Electric Power Commission of Ontario, which became Ontario Hydro. He was chief hydraulic engineer for the Niagara Falls Generating Station at Queenston/Chippewa and started the consulting firm H.G. Acres and Company in 1924 (*Canadian Consulting Engineer* website).

In the 1970s, H.G. Acres and Company changed its name to Acres International and in 2004 was purchased by, and now works as a subsidiary of, Hatch Ltd.

[21] The Shand Dam is on the Grand River near Fergus, ON, approximately 35 km north of Kitchener-Waterloo. It was the first dam in Canada to be built for multiple purposes: flood control, water supply and water quality (Grand River Conservation Authority website).

Fig 15.1 in Legget's and Paul Karrow's *Handbook for Geology in Civil Engineering,* published in 1983 by McGraw-Hill. The caption of this photo by Legget reads "The Shand Dam on the Grand River, Ontario, a dam built of glacial till with no core wall". Notice that Legget included a train in the photo.

[22] Today there are 36 conservation authorities in Ontario, 31 in southern Ontario and five in northern Ontario. They "are community-based watershed management agencies, whose mandate is to undertake watershed-based programs to protect people and property from flooding and other natural hazards, and to conserve natural resources for economic, social and environmental benefits and are legislated under the 1946 Conservation Authorities Act" (Conservation Ontario website).

[23] Legget's memoir states "The job was finished in 1939". His portion of the project was completed in 1939; however, dam construction was completed in 1942 (Grand River Conservation Authority website).

[24] Canada entered the Second World War on September 10, 1939.

[25] John Fletcher Caley (1903-1971) was a University of Alberta (BSc) and University of Toronto (MSc and PhD) trained geologist. He joined the Geological Survey of Canada in Ottawa in 1935 and during his career, among other achievements, he either mapped, or directed the mapping of, most of bedrock geology of southern Ontario. (Geological Society of America website) Caley investigated the bedrock geology for the Shand Dam and contributed the geology sections to Legget's 1942 paper on the Shand Dam in *Economic Geology*.

## Annotations Chapter 11: THE WAR YEARS (1939-1945)

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[1] The firm Christiani & Nielsen was founded in Copenhagen, Denmark in 1904 by Rudolf Christiani, a Danish civil engineer and Aage Nielsen, a Royal Danish Navy captain. Throughout the 20th century it extended its geographic base to the United Kingdom, South America, Australia, Africa and Asia. Currently (2020) most of its work is in Thailand and Southeast Asia. In 2011, the GP Group, based in Thailand, was the largest shareholder (Wikipedia).

[2] Germany invaded Denmark on April 9, 1940.

[3] The Royal Canadian Air Force would not consider enlisting an individual from a German-occupied country, because of the possibility of him/her being a spy.

[4] The Northern Aluminum Company Limited was founded in 1902 in Shawinigan, QC and changed its name to the Aluminum Company of Canada in 1925. At that time it was a subsidiary of the Aluminum Company of America. Between 1925 and 1932, the company harnessed the hydroelectric power of the Saguenay River by constructing the Chute-à-Caron dam and the associated 224 MW hydroelectric plant. It also built an aluminum smelter, then the largest in the world. To support these facilities, the company constructed the neighbouring town of Arvida, in addition to a major port on the St Lawrence River and associated railway facilities.

The company town of Arvida in 1933 with the aluminum smelter in the background
(photo source Rio Tinto Alcan website)

In the early 1950s, Alcan (as the company was renamed in 1945) repeated the process near Kitimat, BC. In 2007, Alcan was bought by Rio Tinto. In 2011 Apollo Global Management and FSI (Fonds stratégique d'investissement) purchased 61% of Rio Tinto.

Arvida is approximately 240 km north of Quebec City. The town was named after the then President of the Aluminum Company of America, Arthur Vining Davis. In 1975, Arvida was amalgamated with the Town of Jonquière and in 2002, Jonquière was amalgamated into a larger city, Saguenay (Wikipedia). Geotechnical professionals may remember Arvida because most of the survivors of the nearby 1971 Saint-Jean-Vianney landslide were resettled there.

[5] Some of the Virgin Islands in the Caribbean were colonized by Denmark in the 1800s. In 1917, the Danish islands were sold to the United States, but Danish continued to be the primary language for many years afterward. The Virgin Islands were one of the main sources of bauxite, the prime ingredient in the production of aluminum, for the Aluminum Company of Canada during the Second World War (Wikipedia).

[6] Legget got to know Per Hall and his wife very well. In an unpublished 1983 note Legget wrote that Per Hall was born around 1913. Legget described that the stress caused by Germany's invasion of Denmark

and Per Hall having to look for work in Canada resulted in his pregnant wife going into premature labour. The birth went well and Legget became the godfather of their daughter, Ingrid (LAC 3-17).

In the 1950s, Per Hall went on to become President of the FENCO, the Foundation Company of Canada's engineering subsidiary, before forming his own consultancy based in Montreal. He specialized, as he had with Christiani & Nielsen in Denmark, in constructing underwater tunnels by floating precast sections into place and then sinking them. One project with which he, FENCO and Christiani & Nielsen were associated was the Deas Island (George Massey) Tunnel under the Fraser River in Vancouver, BC. It was opened by Queen Elizabeth II in 1959 and is still in use today (Wikipedia).

[7] In 1940, Per Hall may have been the first graduate student in soil mechanics in Canada. Up until then, all Canadians who wanted to study soil mechanics at the graduate level typically attended Harvard University and studied with Arthur Casagrande. It is not known if Per Hall completed his graduate work with Legget, or if Legget had any other graduate students while at the University of Toronto.

The University of Alberta is considered to have started the first graduate program in soil mechanics in 1945.

[8] The "phoney war" was the eight-month period at the beginning of the Second World War when there was little military action, the period between Germany's invasion of Poland (September 1939) and its invasion of France, the Netherlands, Belgium and Luxembourg (May 1940) (Wikipedia).

[9] Although university engineering staff may not have been able to serve in the armed forces, at times during the Second World War, some of Legget's department colleagues did take multi-year "leaves of absence" from their university duties for "war service." This left more teaching responsibilities for Legget and the remaining colleagues (University of Toronto calendars).

[10] In each of the 1938-1939 and 1939-1940 sessions, Legget taught two courses and co-taught two courses. In the 1940-1941 session he taught three courses and co-taught one course. In the 1941-1942 session, when some of his colleagues went on war leave, Legget taught eight courses and co-taught three courses (his heaviest session of teaching). In the 1942-1943 and 1943-1944 sessions Legget taught six courses and four courses and co-taught three courses and four courses, respectively. Starting with the 1944-1945 session, Legget's teaching load was slightly reduced (University of Toronto calendars). His teaching at U of T is discussed further in Chapter 13.

[11] Mackenzie River Transport used river boats and barges to supply the Hudson's Bay Company trading posts and settlements throughout the Mackenzie River watershed extending to the Arctic Ocean.

A typical Mackenzie River boat and barge in 1963. This boat, operated by the Northern Transportation Company Limited, was the steel hulled *Radium Gilbert* built in 1946. (photo source NWT Timeline website)

[12] The Eldorado mine on Great Bear Lake started mining gold, silver, radium and uranium in the early 1930s. During the Second World War, uranium was secretly mined and used in the US "Manhattan

Project," for the development of atomic bombs. The ore was barged from Great Bear Lake, down the Great Bear River, up the Mackenzie River, across Great Slave Lake, up the Slave River, across Lake Athabasca and up the Athabasca River to Waterways, Alberta (present-day Fort McMurray). After travelling more than 2000 km by water, at Waterways the ore was transferred to the Alberta and Great Waterways Railway (now part of the Canadian National Railways) and railed to its destination in the United States (Wikipedia).

Postcard of Waterways taken in the 1940s by photographer Sutherland
(photo source University of Alberta Libraries, Peel's Prairie Provinces Image PC-005215)

[13] Waterways is now a part of Fort McMurray. What exactly Legget, as a civil engineer, did that summer in Waterways is not known. Based on his summer experience, he wrote an article for the March 1941 issue of *The Beaver* (the Hudson's Bay Company's "Magazine of the North") about barging large machinery to a gold mine in Yellowknife. That issue noted that Legget "was engaged last summer on advisory work for Mackenzie River Transport" (LAC 4-85). Regardless of what he did, this assignment introduced Legget to western and northern Canada.

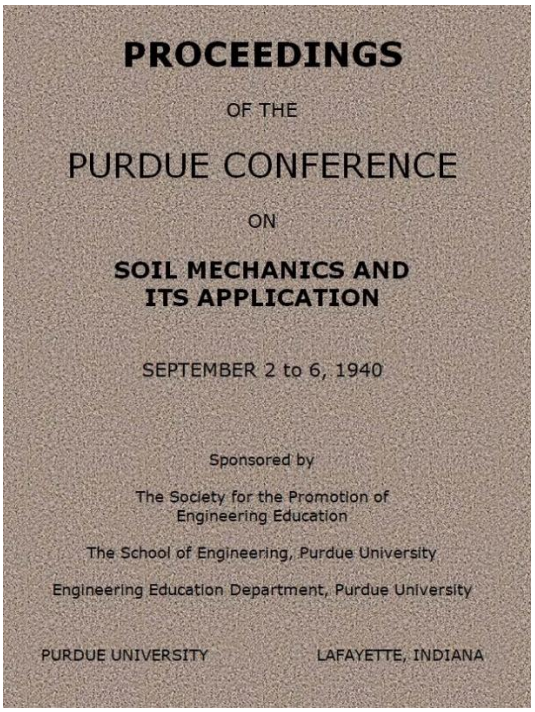
[14] The word "permafrost," a contraction of "perma(nent) + frost," is used to describe permanently frozen ground. The word is attributed to Siemon William Müller, an American geologist, who first used the term in 1943 while researching frozen ground for the US Army during the Second World War (Wikipedia).

[15] Ibrahim Morrison with Legget.

Ibrahim Morrison (left) with Legget, ca 1955 (photo source University of Alberta Archives)

[16] Legget is asking this of Robert (Bob) Hardy, again associated with the CGS Canadian Geotechnical Heritage Project (refer to Chapter 1).

[17] The second soil mechanics conference in North America was the Purdue Conference on “Soil Mechanics and its Applications,” September 2 to 6, 1940. The Proceedings were edited by P.C. Rutledge. The conference was sponsored by the (US) Society for the Promotion of Engineering Education and Purdue University, School of Civil Engineering and Department of Engineering Extension, Lafayette, ID. Philip Rutledge, a Professor at Purdue, was interested in soil mechanics as it related to highway road construction. He is introduced in Chapter 8 and its annotations.




[18] Bill Housel is introduced in Chapter 8 and its annotations.

[19] After he submitted his 1983 manuscript, Legget did not provide any further information about this conference.

[20] See an earlier annotation in this chapter with respect to Legget’s teaching load during the war.

[21] The year was 1941. Charles Mitchell (1872-1941) was Dean of Applied Science and Engineering at the University of Toronto (1919-1941) and died shortly after leaving this position. He was succeeded by C.R. Young (University of Toronto Skulepedia website).

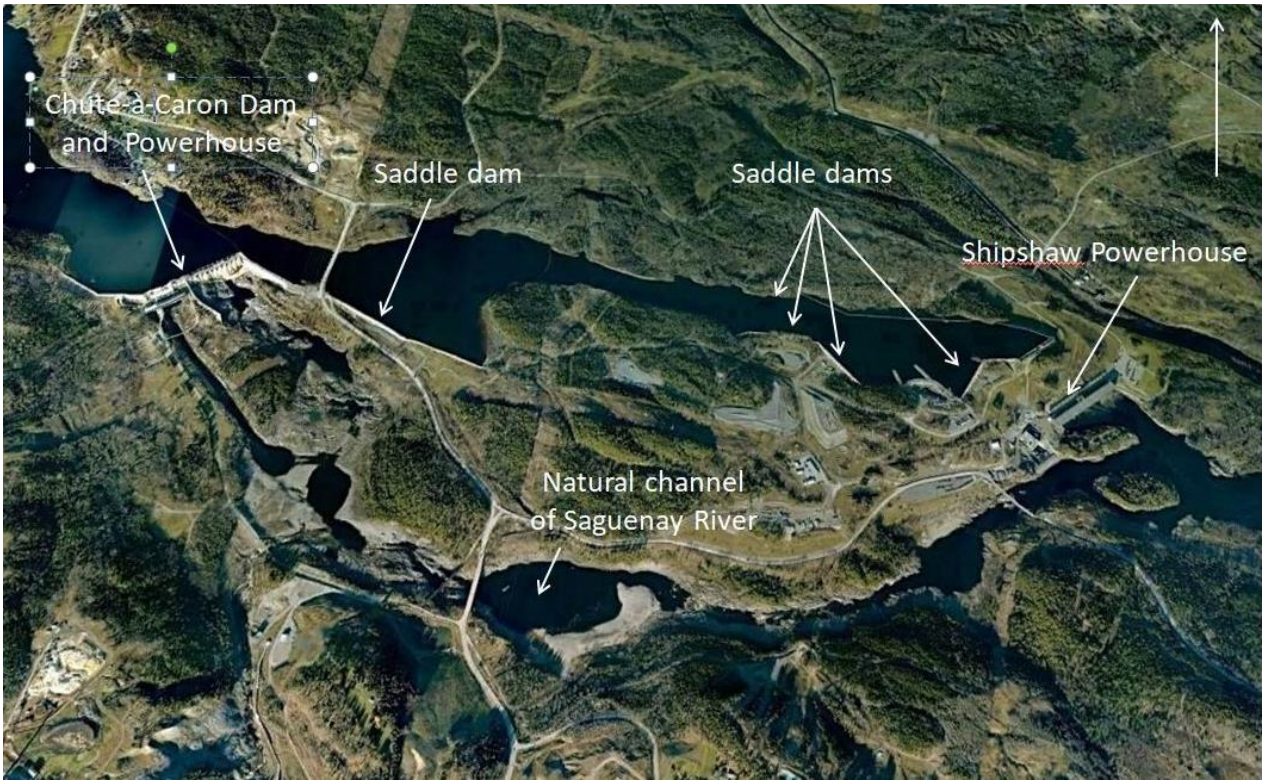
[22] Now referred to as the Lac Saint-Jean area of Quebec, this is the location of what was then known as Arvida and the Shipshaw Hydroelectric Power project. The Shipshaw project was so named because it was located immediately upstream from the confluence of the Saguenay and Shipshaw rivers.

[23] The Aluminum Company of Canada constructed the Chute-à-Caron dam and hydroelectric plant at Arvida in the late 1920s. The Duke Power and the Duke-Price Power companies were both involved in constructing smaller hydroelectric power plants in the area, primarily to service the pulp and paper industry (Cité de l’Aluminium website).

[24] A saddle dam is an auxiliary dam constructed in a low spot, depression or saddle, through which water in a reservoir would otherwise flow (Wikipedia).

[25] 1,200,000 HP is approximately 895 MW. Between 2008 and 2012, the Shipshaw powerhouse was rehabilitated and expanded to produce 1,145 MW of power (Wikipedia).

[26] Overview of the Chute-à-Caron and Shipshaw projects.




View of the Chute-à-Caron (left) and the Shipshaw (right) projects. During construction of the Shipshaw project, the entire Saguenay River flowed eastward through the Chute-à-Caron dam and along its natural channel shown. Therefore, as described by Legget, the five Shipshaw saddle dams and associated powerhouse could be constructed "in the dry," without having to divert the Saguenay River. The width of the image shown is approximately 4 km. North is to the top of the image. (modified from Google Earth 2018)

[27] When the Shipshaw project was completed it was one of the world's largest power generating plants. The project was described in 1943 articles in *MacLean's Magazine* (MacLean's Archives 1943/3/15) and *Popular Mechanics* (Google Books, Popular Mechanics Dec 1943), starting on page 8, past the 56 pages of advertisements!)

An oblique overview, looking upstream over the Shipshaw powerhouse (foreground) and Chute-à-Caron powerhouse (upper left). Date unknown. (photo source Northern Miner website)

Because of their importance to the Allied war effort, during the Second World War, Arvida, the aluminum plant and the associated dams were protected by anti-aircraft batteries.

[28] Bert Younghusband was not one of the authors. The three authors and their papers in the April 1944 issue of *Engineering Journal*, Vol 27, were:

- McNeely DuBose, MEIC, VP Aluminum Company of Canada, "The Engineering History of Shipshaw," pp 194-220
- H.G. Acres, MEIC, President H.G. Acres and Company, "The Design of the Shipshaw Power Development," pp 221-233, and
- Walter Griesbach, MEIC, Chief Engineer, Foundation Company of Canada, "Construction of the Shipshaw Power Development," p 234-249.

[29] Aluminum Laboratories was the research and development arm of the Aluminum Company of Canada.

[30] This talk may have been the same as one that Legget presented at the "Engineering Conference in Soils for Engineers" held at Michigan State College in Lansing, MI, in March 1941. The titles are identical (LAC 4-86).

[31] The liquid limit is the water content at which the behaviour of a particular clay changes from its plastic state to its liquid state. It is determined by a standard laboratory test that was developed by Arthur Casagrande.

[32] "Leda clay" is now referred to as "Champlain Sea clay." It was deposited during the most recent period of glaciation (13,000 to 10,000 years ago) in the Champlain Sea, a marine environment that extended up the St. Lawrence River lowlands from the Atlantic Ocean to northwest of Ottawa and southward from Montreal to the Lake Champlain region of upper New York State. It is now known that the internal structure of the clay, which was deposited in salt water, can become unstable when exposed to fresh water.

[33] Paleobotany is the branch of botany dealing with the recovery, study and identification of ancient plant remains.

[34] Norman William (Bill) Radforth (1912-1999) was Canada's pioneer muskeg researcher. Throughout his life, he was very involved in Canadian and international committee work and conferences that promoted the study of muskeg. Radforth was on the faculty of McMaster University from the 1940s to 1968. In 1968, he became Head of the Department of Biology and Director of the Muskeg Research Institute at the University of New Brunswick (*Canadian Geotechnical Journal*, 1999, Vol 36, No 2, pp iii.).

[35] The Shipshaw project, completed in approximately 18 months between 1941 and 1943, employed a total of approximately 10,000 workers working in shifts around the clock (Wikipedia).

[36] The *Canadian Journal of Earth Sciences*, Canada's premier outlet for publishing geological papers, was first published in 1964.

[37] The Saint James' Club of Montreal, or as it is known today Club Saint-James, was founded in 1857 and is the oldest private business club in Canada (Saint James Club website).

[38] The Windsor Hotel opened in 1878 and closed in 1981. It is often considered as the first "grand railway hotel" in Canada (Wikipedia).

The Windsor Hotel in 1906 (photo source Wikipedia)

[1] Legget presented the Thirteenth Terzaghi Lecture (named after Karl Terzaghi) in San Francisco in 1977. Terzaghi's challenge to which Legget alludes was to integrate geology with soil mechanics (Legget 1979, p 342).

[1] La Tuque, approximately 150 km north of Trois Rivières, QC and the St. Lawrence River, was named after a neighbouring rock formation that resembles the French-Canadian winter hat of the same name. La Tuque dam and hydroelectric generating station was built on the Saint Maurice River between 1940 and 1955. It is currently the 6th of 11 dams on the river, counting upstream from its confluence with the St. Lawrence River (Wikipedia).

La Tuque dam and hydroelectric generating plant (date unknown) (photo source Hydro-Québec website)

Shawinigan Engineering Company was established in 1919 as a subsidiary of Shawinigan Water and Power Company, founded in 1898. Both had their origins in the town of Shawinigan, QC, also on the Saint Maurice River, approximately 40 km north of Trois Rivières. Most of Shawinigan Engineering's work was associated with developing dams and hydroelectric generating plants. Shawinigan Engineering was bought by Lavalin in the early 1980s (Wikipedia).

[1] Forestville, QC, is located on the north shore of the St. Lawrence River. Here the river is approximately 50 km wide, with Rimouski directly across on the south shore of the river. The project to which Legget refers was likely Anglo-Canadian Pulp & Paper's mill constructed in the mid-1940s (Wikipedia).

[1] Sarnia, ON, is in southwestern Ontario at the south end of Lake Huron. The Polymer Corporation, a war-time-formed federal crown corporation, constructed its plant between 1942 and 1943. Ironically, the artificial rubber was produced using a German patent from an American licensee (Wikipedia).

Sarnia Polymer plant, 1944, (photo source LAC, MIKAN 319646, Ronny Jacques)

[1] Clarence Decatur Howe (1886-1960) was an American born civil engineer who moved to, worked and lived in Canada most of his life. In 1935, he entered politics and became a cabinet minister in the Mackenzie King Liberal government. During the war he was Minister of the Department of Munitions and Supply. The C.D. Howe Institute, an economic think tank, is named after him (Wikipedia).

Although today in Canada, the title "the Right Honourable" is reserved for prime ministers, governors general and chief justices, in the 1940s the title was given to prominent Canadians who were appointed to the British Imperial Privy Council. Howe was so appointed after the Second World War for his war-time efforts. Therefore, in this chapter, Legget perhaps should have referred to the Hon. C.D. Howe.

[1] Styrene, or more precisely Styrene-Butadiene, is a chemical compound that when exposed to air, light or heat transforms into a synthetic rubber. The process was originally developed in Germany in 1929 (Wikipedia).

[1] Richard Lankaster Hearn (1890-1987) was a civil engineer (University of Toronto, 1913) and one of a group that was responsible for the growth of the Hydro-Electric Power Commission of Ontario, the predecessor of Ontario Hydro, now Ontario Power Generation. He was also an early partner in the H.G. Acres and Company. The Hearn Generating Station, located on the Toronto waterfront and operated until 1983, was named after him (Wikipedia).

[1] Soil can be stabilized by adding calcium chloride (CaCl). CaCl was traditionally applied to gravel road surfaces to attract moisture and thereby minimize road dust. It was found, however, that applying the correct amount of CaCl, along with other additives such as fly ash (fine particulate residue of burned coal), would create a stabilized road surface, not as durable as asphalt, but much better than gravel.

[1] Such a reference has not been located. The magazine *The Canadian Engineer* is no longer published. The US-based *Roads & Bridges* trade magazine, first published in the early 1900s, is still being published.

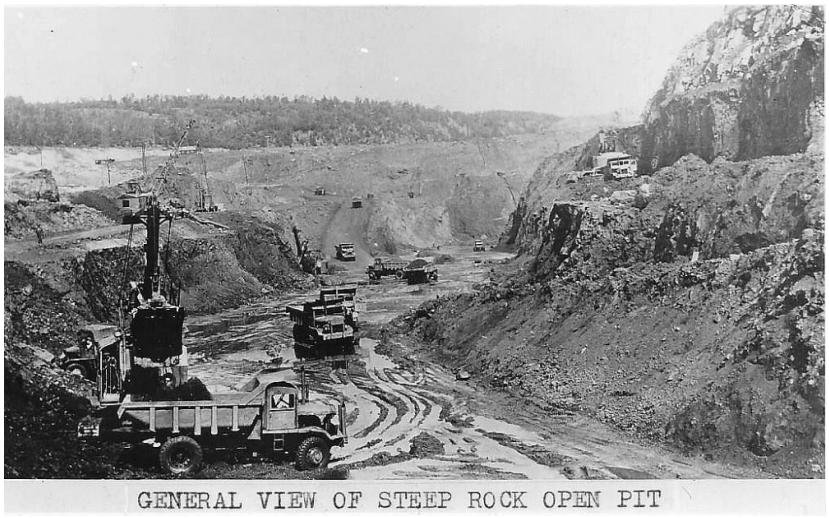
[1] The Aamjiwnaang First Nation, also known as the Chippewas of Sarnia First Nation, is an Ojibwe First Nation located on the Sarnia 45 Indian Reserve. For many years, the approximately 600-700 residents have expressed concern about the proximity of the petrochemical plants that are in the area (Wikipedia).

[1] Hearn, R.L. and Legget, R.F. 1947. "Coal Handling with Earth Moving Equipment," *Transactions of the American Society of Mechanical Engineers*, June, pp 1-5.

[1] Donald Hugh MacDonald (1922-2007) graduated from the University of Toronto in 1945 and was a student of Legget's. He subsequently studied at Cornell University and Imperial College on an Athlone Scholarship, finishing with a PhD from the University of London in 1953. Besides working on the project that Legget describes, he worked with Legget on the early stages of the Toronto subway project. In 1955, he joined H.G. Acres and Company, eventually becoming its president. He was awarded the 9th CGS R.F. Legget Award in 1978 (CGS website; Lives Lived).

[1] Atikokan, ON, is approximately 200 km west of Thunder Bay. In 1938, iron ore was discovered beneath

Steep Rock Lake, a few kilometres west and north of Atikokan. One year later, Steep Rock Iron Mines Limited was formed. Initial underground mining attempts were flooded out. Because of the war, when the demand for iron ore was high, it was decided to divert the Seine River so it wouldn't flow through Steep Rock Lake, then dam and drain the lake, then remove 100 metres thickness of glacial sediment to reach the ore (Sunset Country website).




Mining the iron ore from beneath what was Steep Rock Lake, date unknown

Aerial view of the Steep Rock Iron Mine in 1974
(photo source for both, CGS Canadian Geotechnical Achievements 2017)

[1] The Caland Ore Co Ltd was formed in 1949 as a wholly-owned subsidiary of the Inland Steel Company of Chicago. In 1953, Caland signed a 99-year lease with Steep Rock Iron Mines. Both Steep Rock Iron Mines and Caland had ceased operations by 1980 (Caland Freeservers website).

[1] Varved clay is glacial lake sediment characterized by fine (clayey) sediment, deposited during lower energy winter months, interbedded with coarser (silt and/or sand) sediment and deposited during higher energy summer months.

[1] The paper to which Legget refers is Hardy, R.M. and Legget, R.F. 1960. “Boulder in Varved Clay at Steep Rock Lake, Ontario, Canada,” *Bulletin of the Geological Society of America*, Vol 71, pp 93-94. Not mentioned by Legget is another paper about Steep Rock Lake he coauthored with a Steep Rock Iron Mine geologist, Melville W. Bartley: Legget, R.F. and Bartley, M.W. 1953. “An Engineering Study of the Glacial Deposits at Steep Rock Lake, Ontario, Canada,” *Economic Geology*, Vol 48, pp 513-540.

[1] Although it may have originated as Royal Society of Canada Special Publication #3, it was published by the University of Toronto Press (see Chapter 16).

[1] “Both cases” to which Legget refers are the Steep Rock Iron Mine Limited and the Caland Ore Co ltd.

## Annotations Chapter 12: THE POST-WAR YEARS (1945-1947)

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[1] Canada established the Department of Reconstruction in June 1944, before the end of the Second World War, to help promote industrial output and to maximize employment once the war was over. Howe was appointed the minister of the department, while retaining his war-time position as Minister of Munitions and Supply. In late 1945, after the war, the two departments merged to become the Department of Reconstruction and Supply (War Museum Canada website). Howe is introduced in Chapter 11 and its annotations.

[2] Frank James (1903-1973) was Principal of McGill University from 1939-1962. He was born in London, England and attended the London School of Economics and the University of Pennsylvania, receiving his PhD in 1926 (McGill University website).

[3] Clarence Richard Young was introduced in chapter 8 and 10 and their annotations.

[4] This individual was T.R. Loudon, Professor of Civil Engineering and Aeronautics, who served as Department Head of Civil Engineering (Municipal and Structural) from 1945 to 1954. He was a faculty member from 1907 to 1954. While at U of T, Louden was very involved with athletics and helped design the University of Toronto's Varsity Stadium and Varsity Arena in the 1920s. For three years during the Second World War he was on war leave from the university and served as a RCAF wing commander. After the war, Louden was awarded the British Empire Efficiency Decoration (VD) in recognition of his long and meritorious service as a part-time commissioned officer (University of Toronto website).

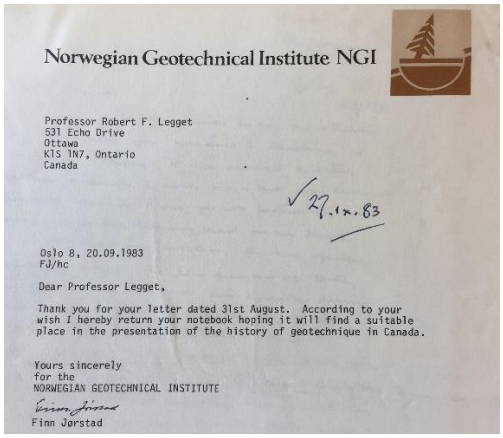
[5] The *Daily Commercial News* was founded in the mid-1930s and is still published in both print and online. According to its website, it "has been the leader in providing essential construction news, project leads and tender information to eastern Canada's construction marketplace."

[6] In 1945, Ontario Hydro would have been known as the Hydro-Electric Power Commission of Ontario. See annotations in Chapter 7 for more information on Ontario Hydro.

[7] In 1945, Otto Holden was the General Manager of the Hydro-Electric Power Commission of Ontario. The Otto Holden Generating Station on the Ottawa River, a short distance north of Mattawa, is named after him (Ontario Power Generation website).

[8] Lyman J. Chapman graduated from Ontario Agricultural College (now affiliated with the University of Guelph) in 1930. From 1932 to 1973, he was a research fellow and Director of the Physiography Department of the Ontario Research Foundation, an Ontario government crown corporation. Chapman was co-author, with D.F. Putnam, of *Physiography of Southern Ontario*. The first edition was published in 1951 and then republished in 1966 and 1984. The Lyman J. Chapman Library at the University of Guelph is named after him (University of Guelph website).

[9] Shortly after Legget wrote his memoir, he did contact the Terzaghi Library at the Norwegian Geotechnical Institute (NGI) and asked for the return of his course notes and associated materials. They returned his "notebook" in September 1983. However, a recent search for this material in the Libraries and Archives Canada, the NRC Archives, the University of Ontario Technical Institute's National Engineering Archives and the University of Alberta Archives turned up nothing.



Norwegian Geotechnical Institute NGI

Professor Robert F. Legget
531 Echo Drive
Ottawa
K1S 1N7, Ontario
Canada

√27.IX.83

Oslo 8, 20.09.1983
FJ/nc

Dear Professor Legget,

Thank you for your letter dated 31st August. According to your wish I hereby return your notebook hoping it will find a suitable place in the presentation of the history of geotechnique in Canada.

Yours sincerely
for the
NORWEGIAN GEOTECHNICAL INSTITUTE
Finn Jørstad

Letter from Finn Jorstad of the NGI to Legget with regards to returning the material associated with his 1945 short course on Soil Mechanics. The numbers/letters “27.IX.83” indicate that Legget responded to this letter on September 27, 1983. (LAC 3-17)

[10] Legget saw this cooperation when he attended the Purdue Conference on “Soil Mechanics and its Applications” in 1940 (see Chapter 11).

K.B. Woods was a professor, then Professor Emeritus of Lyles School of Civil Engineering at Purdue University, Lafayette, IN. He was the 19th Chairman of the (US) Highway Research Board (now known as the Transportation Research Board) and was active in the affairs of the board throughout his career (US Transportation Research Board website).

[11] During the 1950s, Alex Rutka was the Principal Soils Engineer of the Ontario Department of Highways. Under his leadership the department flourished. Rutka was a 1947 civil engineering graduate of Queen’s University then joined the department where he worked his entire career until he retired in the early 1980s. In 1984, he was presented with a Distinguished Service Award by the Transportation Association of Canada.

[12] Harry William Tate (1884-1974) graduated as a civil engineer from the University of Toronto in 1909. He served overseas with the Royal Canadian Engineers during the First World War. During the Second World War he helped select and train engineering officers, for which he was awarded the MBE (Member of the Most Excellent Order of the British Empire) in June 1946 (University of Toronto Alumni website).

Tate worked with the Toronto Transportation Commission (now the Toronto Transit Commission) from 1920 to 1954. As assistant general manager he was instrumental in getting the initial Yonge Street “rapid transit subway” (as it was then known) line constructed between 1949 and 1954 (Toronto Transit Commission website).


Toronto’s Yonge Street subway under construction, using the cut and cover method of construction in the late 1940s (photo source City of Toronto Archives, Series 381, s0381_80015_id6207-3)

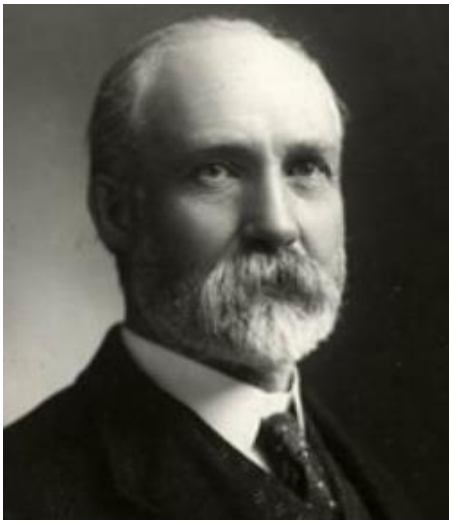
[13] As will be mentioned later, in 1973, Legget published his 624-page textbook *Cities and Geology*.

[14] Arthur Philemon Coleman (1852-1939) studied geology and natural history at Victoria College in Cobourg, ON, then received his PhD from the University of Breslau (a German University in what is now Poland) in 1881. During his long career, he taught at various times at Victoria College, the School of Practical Science in Toronto and the University of Toronto. Between and in parallel with his academic career, he was a geologist with the Ontario government, retiring in 1934 at the age of 82!

Coleman did not limit his work to Ontario. He was a member of numerous European, Arctic and Canadian Rockies geological expeditions. He was a team member of the first ascent of Castle Mountain, AB, and the first attempt to climb Mount Robson, BC. In 1939, the year he died, he had planned to carry out geological work in British Guiana (now Guyana).

Coleman was honoured by many national and international science and geological organizations and received four honorary doctorates. He was the first Canadian to be President of the Geological Society of America (Legget was the second). In his later years, he was recognized as the "Dean of North American Geologists" (Wikipedia).

With regard to Legget's research on the geology of Toronto, he referenced Coleman's 1913 "Map of Toronto and Vicinity," the first comprehensive geological map of Toronto, and the map "The Pleistocene of the Toronto Region" by Coleman and A. MacLean (1933), both prepared for the Ontario Department of Mines.



Dr. A. P Coleman from his February 27, 1939 *Globe and Mail* obituary.
Legget had it in his personal files. (photo source LAC 18-19).

[15] The firm Carruthers & Wallace was a well-known Toronto structural engineering company responsible for, among other Toronto landmarks, the Canadian National Expedition Stadium, the Eaton Centre, the Royal Bank Building and Roy Thompson Hall. In 2005, it joined the Trow Group of Companies, now known as exp Global Inc (exp Global website).

[16] Australian-born Owen L. White (1926-2018) was a prominent Engineering Geology/Geotechnical Engineer in Canada. After teaching at the University of Waterloo in the 1960s and 1970s, he became Chief of the Engineering and Terrain Geology Section of the Ontario Geological Survey in 1977, a position he held until he retired in the early 1990s. White served as President of the International Association of Engineering Geology from 1986-1990. He was awarded the 37th CGS R.F. Legget Medal in 2006 (CGS website; Lives Lived).

Recent correspondence with the Ontario Geological Survey turned up nothing with respect to the document to which Legget refers. However, Figure 9 in the 1998 paper "Urban Geology of Toronto and Surrounding Area" by C.L. Baker, L.R. Lahti and D.C. Roumbanis, is a partial reconstruction of the distribution of historical streams and rivers in the Toronto area and is based on a 1951 City of Toronto

Planning Department unpublished map. This paper is published in the Geological Association of Canada's Special Paper 42, edited by Paul Karrow and Owen White. This 1951 map could be the map to which Legget refers.

There is an interactive map of the disappearing rivers of the Toronto area at www.LostRivers that captures the period from 1807 to 2017. The historical map-base for this interactive map is Coleman and MacLean's 1933 map "The Pleistocene of the Toronto Region."

[17] Quicksand is a saturated loose sand that, when agitated or when the upward flow of the water within the sand is greater than the force of gravity, creates a liquefied soil that cannot support weight.

[18] Until recently, gasoline leakage from underground tanks was a major source of groundwater contamination. In North America, starting in the late 1970s and continuing to the present, this problem and its remediation have resulted in the development of a specialized branch of environmental hydrogeology.

[19] From 1921, when the TTC was formed, until 1957, its head office was in the seven storey Toronto Board of Trade Building on the corner of Front Street East and Yonge Street in downtown Toronto. When this building was constructed in 1892, it was one of the tallest buildings in the city. It was demolished in 1958 causing the TTC to move its head office to The William McBrien Building at Davisville and Yonge streets (Wikipedia).

Early 1900s photo of the Toronto Board of Trade Building, head office of the TTC from 1921 to 1957
(photo source Wikipedia)

[20] Advisory committees or review boards have now become common for most large construction or development projects.

[21] A recent inquiry of the Royal Ontario Museum has not yet determined whether it still has the soil samples to which Legget refers.

[22] William Robert (Bill) Schriever (1921-2018) was a Swiss-trained civil engineer who graduated from Arthur Casagrande's master's program in soil mechanics at Harvard University in 1948. Upon graduation he immigrated to Canada and starting working for Legget at the NRC's Division of Building Research. His first assignment was to represent the NRC/DBR in Toronto during the construction of the TTC's Yonge Street subway. He eventually focused his research on buildings and snow loads and became Head of the Building Structures Section of the NRC/DBR (*Ottawa Citizen* Obituaries website). He is mentioned again later in Legget's memoir.

[23] In 1960, Legget could have published this paper in the EIC's *Engineering Journal*. He had published a number of other geotechnical papers in that journal prior to 1960.

[24] After the Second World War, the Canadian government wanted to encourage more engineering training. With federal support, the military munitions plant at Ajax, ON, approximately 45 km east of the

main University of Toronto campus, was converted into lecture rooms and laboratories. First- and second-year classes were held there from 1946 to 1949 (University of Toronto Alumni website).

[25] James (Jimmy) Govan (1882-1963) was a Scottish-born and trained architect. He moved to Toronto in 1907. During his career he specialized in designing hospitals. His and his partners' designs can be found in every province in Canada except British Columbia, and in some US cities. His firm, Govan, Ferguson and Lindsay, designed Toronto's Hospital for Sick Children and Mount Sinai Hospital among many other hospitals (Dictionary of Architects in Canada website).

[26] Stone & Webster, founded in 1889, was a large Massachusetts-based engineering, construction, environmental and plant operation company. In 2000, it was acquired by the larger Shaw Group based in Baton Rouge, LA (Wikipedia).

[27] Legget has his geography a little confused. The Long Lake Diversion, completed in 1939, diverted water from the headwaters of the Kanogami River (which flowed into the Albany River, then into James Bay) so that it flows into the Aguasabon River, then into Lake Superior. That diversion project, located approximately 130 km north of Lake Superior, is described in a 1980 Canadian Water Resources Journal paper by S.E. Peet and J.C. Day.

[28] A defile is a somewhat archaic word for a narrow passage way, canyon or gorge.

[29] Construction of the Aguasabon Hydroelectric Power project near Terrace Bay, ON, began in 1946 and was completed in 1948. Terrace Bay is located along the north shore of Lake Superior, approximately 200 km east of Thunder Bay, ON (Ontario Power Generation website and Wikipedia).


View of the Terrace Bay area and the Aguasabon Hydroelectric Power project. The dam is located on the Aguasabon River, approximately 1.5 km north-northwest of the community of Terrace Bay. The 'defile' to which Legget refers is the narrow east-west trending body of water that connects the Aguasabon Reservoir and Hays Lake (formerly a lagoon called Blue Jay Lake). The power house is approximately 3.5 km west of the community. The tunnel from Hays Lake to the power house on the shore of Lake Superior is approximately 1 km in length. The width of the image shown is approximately 11 km. North is to the top. (photo modified from Google Earth 2018)

[30] *Géotechnique*, published by the (UK) Institution of Civil Engineers since 1948, is the premier geotechnical journal in the world.

## Annotations Chapter 13: UNIVERSITY YEARS IN CANADA (1936-1947)

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[1] Queen's University and the University of Toronto calendars of that period provided the addresses of the faculty. See Chapter 24 to see how to access these calendars.

[2] *Saturday Night* was Canada's first general interest magazine and was published between 1887 and 2005 (Wikipedia).

[3] University of Liverpool Archives. At the time in the UK, a DEng could be awarded based on either a suite of submitted publications or the more conventional route of course work, research and a thesis.

[4] From a review of U of T calendars, a summary of the courses Legget taught during his tenure at the university is shown below.

| UofT Civil Engineering Course | | | | | Session | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | Name | Level (Yr) | Term(s) | Hrs/week | 38-38 (1) | 39-40 | 40-41 | 41-42 (2) | 42-43 (2) | 43-44 (2) | 44-45 (2) | 45-46 | 46-47 |
| 20 | Applied Mechanics/Statics | 1 | 1+2 | 2 | | | | ● | ● | ○ | | | |
| 23 | Mechanics of Materials | 2 | 1+2 | 2 | | | | ● | ● | ○ | ○ | ○ | ○ |
| 24 | Engineering Mechanics (3) | 2 | 1+2 | 2 | | | | ○ | | | | | |
| 25 | Mechanics of Materials (4) | 2 | 1+2 | 1 | | | | ● | | | | | |
| 26 | Engineering Mechanics (3) | 1 | 1+2 | 2 | | | | ○ | ○ | | | | |
| 32 | Graphical Methods | 3 | 1+2 | 1 | ● | ● | ● | ● | | | | | |
| 39 | Foundations, Retaining Walls and Dams (5) | 4 | 1+2 | 1 | ○ | ○ | ● | ● | ● | ● | ● | ● | ● |
| 40 | Soil Mechanics | 4 | 1 | 1 | | | | ● | ● | ● | ● | ● | ○ |
| 47 | Structural Design (4)(6) | 5 | 1+2 | 4 | ○ | ○ | ○ | ○ | ○ | ○ | | | |
| 50 | Mechanics of Materials: Soils and Highways (7) | 4 | 2 | 3 | | | | | ○ | ○ | ○ | ○ | ○ |
| 315 | Contracts and Specifications | 4 | 2 | 1 | | | | ● | ● | ● | ● | ● | ● |
| 316 | Management | 4 | 1+2 | 1 | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Legget's course load: teaching couse by self (●) + teaching course with others (○ ) | | | | | 2+2 | 2+2 | 3+1 | 8+3 | 6+3 | 4+4 | 4+2 | 4+2 | 3+3 |

Notes:
(1) assumed same as 39-40 session
(2) some faculty on war leave 41-42 to 45-46 sessions
(3) taught to Department of Engineering Physics students
(4) taught to School of Architecture students
(5) "Dams" removed from course title in 46-47 session
(6) 1 hr lecture; 3 hrs lab
(7) new course in 42-43 session

[5] This contribution by Lionel Peckover was attached to Legget's May 1983 Supplement to his March 1983 memoir.

[6] These individuals may have been working in the US, but only some were born in the US.

[7] LAC 3-21

[8] Following is a portion of Victor Polly's August 17, 1942 letter (LAC 4-2).

> We have to do more to beat Germany. When Germany is beaten, we shall have to fight battles at home, and in world politics, if this world is to be a place worthy of the bloodshed which will take place. I feel keenly that something must be done to win these battles.
>
> Someone must lead the world into the path of peace and order. The men who must do this are the thinking men—men who have hitherto been content to vote, and otherwise do nothing. These men

> are the engineers, doctors, and all the other professional men in the country. I realize my own responsibility very keenly, and I intend to do everything in my power to help achieve these things, when the war is over. But my effort is useless if others do not think seriously of this problem. If every Engineer and all the thinking people in the country make up their minds, as I have made up mine, to do everything they can (even at the cost of sacrifice) to build a better world, then natural leaders will arise from their ranks to carry these things into the realm of reality. Even an active fearless engineering society or association, conscious of its responsibility to the people, could do a lot to improve conditions. They have the power, the latent power, and if they use that power to the last unit in doing something for the betterment of this world, then they are only fulfilling their moral duty to mankind.
>
> This is not the talk of a young college student grasping at new ideas. These are the things I know to be right, to be my duty. I don't think about them all the time, I realize their truth and acceptance. Unfortunately I do not think the majority of engineers have given much deep thought to the subject.

[9] A listing of Legget's publications associated with geotechnique is in Chapter 23.

[10] At the conference held in Guelph, ON, conservationists from across Ontario met to discuss the extensive damage to southern Ontario's environment as a result of poor land, water and forestry practices that led to extensive soil loss and flooding (Wikipedia).

[11] Legget's association with the ASTM would culminate with him becoming the President in 1965 and 1966.

[12] LAC 1-26

[13] LAC 3-10

[14] Grand Manan, NB, located just north of the Canada/US border, is the largest island in the Bay of Fundy.

## Annotations Chapter 14: OTTAWA (1947 AND ON)

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[1] As mentioned in the annotations in Chapter 8, Leonard Cooling was Head of the Soil Mechanics Section of the UK Building Research Station and Legget first met him at the 1936 International Conference.

[2] The British Building Research Station was established in 1921 as a government funded laboratory to conduct research for the Building Research Board and thereby help improve the quality of housing in the UK. It is now known as the Building Research Establishment and was privatized in 1997 (Building Research Establishment website).

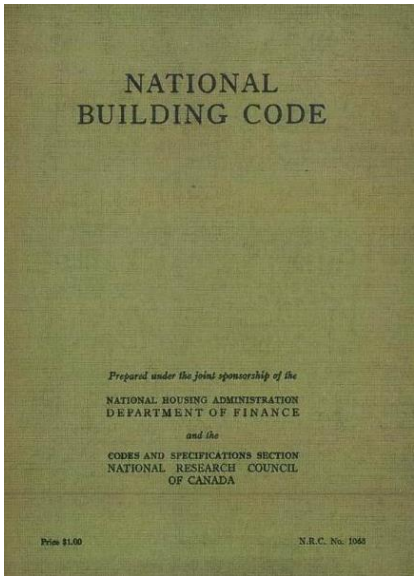
[3] Reginald Stradling (1891-1952) was trained as a civil engineer at Bristol University. He worked as a consultant and in academia until 1924 when he was appointed Director of the UK Building Research Station. He was knighted in 1945. He stepped down as Director in 1946. In 1949, Stradling was appointed Dean of the (UK) Military College of Science, now the Royal Military College of Science (GracesGuide website).

[4] The National Research Council of Canada (NRC) was formed in 1916 to advise the government on both military and civilian scientific and industrial research. It became a more formal government body in 1928. In 1932, the NRC research laboratories were opened at 100 Sussex Drive in Ottawa. During the Second World War, much of its research was of a military nature.

General Andrew McNaughton served as President of the NRC between 1935 and 1944, although C.J. Mackenzie served as Acting President during much of the war (Wikipedia).

Andrew McNaughton (1887-1966) was born in Saskatchewan (then part of the Northwest Territories) and was a 1910 electrical engineering graduate of McGill University. He had distinguished military careers during both the First and Second world wars (Wikipedia).

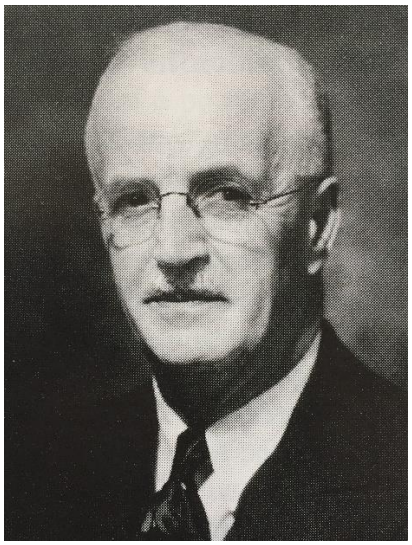
[5] Prior to the National Building Code, the responsibility for building regulations belonged to the provinces and territories and this responsibility was typically delegated to municipalities. Because each municipality tried to deal with its own needs and issues, these regulations often varied from one municipality to the next. This situation frequently made it very difficult for architects, designers, engineers, product manufacturers and contractors, as well as for national programs that supported construction. In the late 1930s, to help alleviate the difficulties associated with the multitude of municipal building regulations across the country, the federal Department of Finance asked the NRC to develop a building code that could be adopted by all municipalities in Canada. The result was the first edition of the *National Building Code of Canada*, published in 1941.




First Edition of the *National Building Code [of Canada]* 1941

[6] Legget will say more about his trip to Switzerland in Chapter 15.

[7] C.J. Mackenzie was introduced in the annotations in Chapter 4. He became President of the NRC in 1944. Therefore, Legget's reference to Mackenzie being Acting President in 1946 is incorrect.



C.J. Mackenzie (photo source University of Saskatchewan Archives)

[8] This should read "twenty-five years", the BRS being established in 1921.

[9] In 1946, the Mines Branch was a branch of the federal Department of Mines and Resources, and is currently a branch of the Natural Resources Canada.

The Canadian Forest Products Laboratories were established in Montreal in 1913, in co-operation with McGill University, as a part of the Forest Service of what was then the federal Department of the Interior. The research is now carried out at three locations: the main laboratory in Ottawa (established 1927), the Vancouver Laboratory in Vancouver (1918) and the Pulp and Paper Research Institute of Canada, which is still in Montreal (Food and Agriculture Organization of the UN website).

[10] As explained later in Legget's memoir, "track research" was the first area of research to which the Associate Committee turned its attention.

[11] This was the same C.D. Howe who was the Minister of the federal Department of Reconstruction and Supply.

[12] The Central Mortgage and Housing Corporation was created by the federal government in 1946 to help house returning war veterans. Until 1979 known as Central Mortgage and Housing, its current mandate is to help Canadians access a variety of affordable housing options. It also provides housing and real estate trend research to consumers, businesses and government (CMHC website).

[13] As mentioned in Chapter 13, C.R. Young was the University of Toronto Civil Engineering Department Head (Municipal and Structural) from 1929 to 1945 and the Dean of Applied Science and Engineering from 1941 to 1949.

[14]A copy of this letter is in Legget's files in the Library and Archives Canada (LAC 3-10) and is quoted in Chapter 13.

[15] The Toronto residence to which Legget refers is 64 Castle Frank Crescent. Refer to Chapter 13.

[16] Frederick Lea (1900-1984) was the Director of the British Building Research Station from 1946 to 1965.

[17] The photo below, taken in 1945, shows the NRC laboratories at 100 Sussex Drive in Ottawa, which were opened in 1932.

The NRC laboratories at 100 Sussex Drive in Ottawa in 1945 (NRC Archives)

[18] It is not known what "foundation problem" Legget was investigating in Chalk River; however, it was likely related to the NRC's Chalk River nuclear research laboratory, located on the Ottawa River, approximately 200 km northwest of Ottawa.

Initially established by the British and Canadian governments in Montreal in 1942, the Chalk River facility was opened in 1944. In September 1945, this facility became the first nuclear reactor outside the US. The following year, the NRC closed its Montreal facility and focused on its Chalk River facility. Atomic Energy of Canada Limited (AECL) was formed in 1952, with C.J. Mackenzie as president, and took over the facility from the NRC. The Chalk River reactor was shut down in 2018 and is currently awaiting decommissioning (Wikipedia).

Chalk River nuclear research facilities in 1945 (photo source Wikipedia)

[19] The Montreal Road laboratories of the NRC are located on an approximately 50-hectare site that straddles Montreal Road, approximately 6 km east of the original NRC laboratories at 100 Sussex Drive, in Ottawa. The area was part of the former RCAF Station Rockcliffe. The first of the Montreal Road laboratories was constructed in the late 1930s. The area is now known as the Montreal Road Campus. (NRC Archives).

[20] The US Division of Building Research is now the Building and Fire Research Laboratory of the (US) National Institute of Standards and Technology, administered by the US Department of Commerce (US Department of Commerce website).

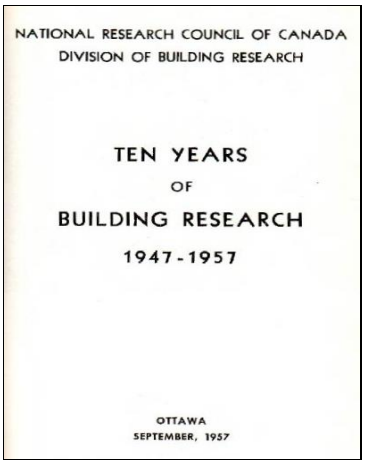
[21] Conseil international du bâtiment (CIB):

> …was established in 1953 as an association whose objectives were to stimulate and facilitate international cooperation and information exchange between governmental research institutes in the building and construction sector, with an emphasis on those institutes engaged in technical fields of research.

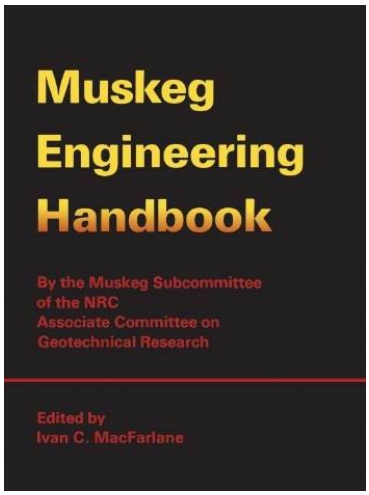
> The CIB has since developed into a world-wide network of over 5,000 experts from about 500 member organisations with a research, university, industry or government background, who collectively are active in all aspects of research and innovation for building and construction.

In 1998, the name was changed to International Council for Research and Innovation in Building and Construction, but the acronym, CIB, has stayed the same (CIB website).

[22] The 120-page *Ten Years of Building Research, 1947-1957* was published by the NRC/DBR. This publication started a series of annual or bi-annual reports on Canadian Building Research.




[23] Ivan Coleman MacFarlane (1929-2018) started working at the NRC/DBR in 1954 and continued working there until he retired in 1989. Among the many other publications he contributed to, MacFarlane edited *Muskeg Engineering Handbook*, a 297-page textbook published by the University of Toronto Press in 1969. For many years it was the standard Canadian reference on the topic.




[24] The cold-room facilities were constructed as part of the Building Research Centre, as one of the NRC's Montreal Road laboratories. See later annotation.

[25] Marcel R. de Quervain (1915-2007; Encyclopedia Britannica website) came to Canada as a guest of the NRC/DBR for one year. The main purpose of his visit in the late 1940s was to examine the problems of snow and ice in relation to the Canadian economy. D.C. Pearce, then Head of the Snow and Ice Section, accompanied de Quervain on his visits to snow and ice research institutions in Canada and the US, including an ice reconnaissance flight in 1949 "which revealed most strikingly the extent of the ice cover on Hudson Bay". They covered approximately 24,000 km in two and a half months (NRC/DBR Technical Report 5, 1950).

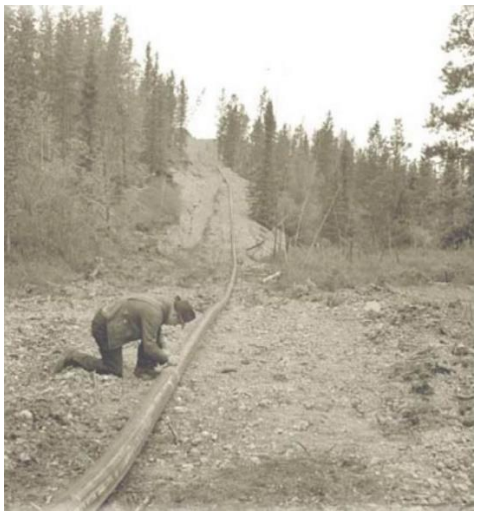
[26] Lorne Gold (1928-2018) joined the NRC/DBR in 1950 shortly after graduating from the University of Saskatchewan. He retired from the same organization in 1986. Gold pioneered ice and snow studies applied to ice pressures on dams and bridge piers. In 1969, after serving as Head of the Snow and Ice Section for many years, he became Head of the Geotechnical Section and in 1974 became Assistant Director, and then Associate Director of the Division of Building Research (CGS website; Lives Lived).

[27] Legget says more about “Exercise Muskox” in Chapter 15.

[28] John Pihlainen (1925-1964) pioneered the NRC/DBR’s investigations of permafrost and associated construction problems. He left the DBR in 1960 and established his own consulting practice. Pihlainen died suddenly of a heart attack in his 38th year (CGS website; Lives Lived).

[29] Norman Wells, NWT, (population 809 in 2017) is located along the Mackenzie River at latitude 65° N. It is approximately 1,500 km north of Edmonton and 145 km south of the Arctic Circle. The explorer Alexander Mackenzie noted oil along the river when he passed by the area in 1789. The oil-bearing formation was discovered in 1911, Imperial Oil started drilling in 1919 and built a small refinery that operated until 1925. Imperial Oil started to develop the area and the town in earnest in 1937 and a much larger refinery was completed in 1939. This refinery was closed in 1996, but the area still produces approximately 120,000 barrels of crude oil per year which is transported to Edmonton by an Enbridge pipeline, completed in 1985. (Wikipedia and Canadian Encyclopedia online)

During the Second World War, the approximately 950 km Canol (short for Canadian Oil) Road and associated 10 cm diameter oil pipelines were constructed by the US Army to move crude oil from Norman Wells to Whitehorse, YT, and then to Alaskan tidewater. Oil started flowing in late 1943 but was stopped shortly after the war. The 355-km Canol Heritage Trail is all that remains of the Canol Road in the NWT. In the Yukon there is a 449-km stretch of the road, some of which can be driven. Both sections are now a part of the Trans-Canada (Great) Trail (Wikipedia).



The 10 cm diameter Canol Pipeline (photo source Wikipedia)

[30] Edgar William Richard Steacie (1900-1962) was a physical chemist who joined NRC’s Chemistry Division in 1939 and became NRC President in 1952, succeeding C.J. Mackenzie. Stacie died while president. The Natural Sciences and Engineering Research Council of Canada annually awards up to six EWR Steacie Memorial Fellowships to young Canadian scientists (Wikipedia).

[31] The humorous story is that the refrigerator in the brand new NRC Norman Wells Station, although reputed to hold permafrost, when opened during the opening ceremonies, was full of home-made beer (CGS website; Lives Lived, John Pihlainen).

[32] F. Lionel (“Peck”) Peckover (1921-2015) graduated as a civil engineer from the University of Toronto in 1944. According to a note he prepared in 1983, he took seven courses from Legget while at university: Statics; Strength of Materials; Highway Engineering; Soil Mechanics; Foundations, Dams and Retaining

Walls; Contracts and Specifications; and Management. Legget has more to say about “Peck” later in this chapter.

[33] The Hydraulics Building was constructed as part of the Montreal Road laboratories in 1942. According to *War History of Division of Mechanical Engineering, National Research Council of Canada,* published in 1946, “Besides the laboratory space mentioned above, the [Hydraulics and Fire Hazard Laboratory] building houses four offices, drafting room and space for a soil mechanics laboratory” (NRC Publications Archive website). Therefore, Legget was correct in remembering that J.H. Parkin was thinking of starting soil mechanics research in the NRC’s Division of Mechanical Engineering.

[34] While Peckover was working with the NRC/DBR, Legget encouraged him to pursue graduate studies in geotechnical engineering under the supervision of Arthur Casagrande at Harvard University. Peckover graduated from Harvard in 1947 and returned to the DBR where he worked closely with Legget until 1953. He then worked as the Chief Soils Engineer of the St. Lawrence Seaway Authority from 1953-1959. After that he joined Canadian National Railways and became its Engineer of Geotechnical Services from coast-to-coast. Many consider Lionel Peckover to be the “Father of Geotechnical Engineering for Canadian Railways.” Upon retiring from the CNR in 1976, he joined Canac Consulting, where he carried out studies for a proposed high-speed rail line from Montreal to Windsor. Peckover fully retired in 1984 (CGS website; Lives Lived).

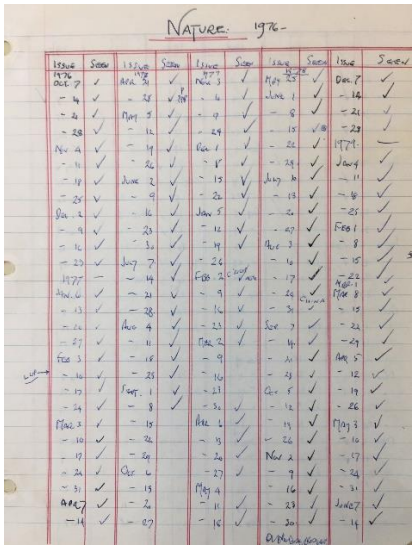
[35] Carl Benson Crawford (1923-2010) graduated as a civil engineer from Queen’s University in Kingston in 1949, followed by postgraduate degrees from Northwestern University in Illinois and Imperial College in London. While a student at Queen’s, Crawford attended a lecture by Legget and was so impressed that he decided to join the DBR’s Soil Mechanics Section, becoming its head in 1953. He became Director of the Division of Building Research in 1974, a position he held until his retirement in 1985. Crawford was the recipient of the 6th CGS R.F. Legget Award in 1975.

After his retirement, Crawford continued to pursue his research interests at Cambridge University (England), the Norwegian Geotechnical Institute (Oslo), the Centre for Cold Oceans Research (St. John’s, NL) and the University of British Columbia (Vancouver, BC) (CGS website; Lives Lived).

In retirement, Crawford also compiled all the “Historical Notes” that Legget prepared for the *Canadian Consulting Engineer*. See Chapter 23.

[36] Legget was a voracious reader. In his files in the Library and Archives Canada, there are records of him reading or reviewing: *The Engineering-News Record, Engineering & Contract Record, Canadian Engineer, Engineer Journal, (UK) Civil Engineering, (US) Civil Engineering, New Civil Engineer, Transactions/Proceedings of the American Society for Civil Engineers, Transactions of the Canadian Society of Civil Engineer, Canadian Geotechnical Journal, Canadian Journal of Earth Sciences, Economic Geology, Engineering Geology, Nature, Science, New Scientist, Scientific American, American Journal of Science,* and *Transactions of the Royal Society of Canada* (LAC 20-4).

In the same files, there is evidence of Legget keeping a record of which issues of which journals he had reviewed. The following photo is of Legget’s record with respect to *Nature,* the internationally acclaimed British scientific journal, first published in 1869.




Legget's record of which issues of *Nature* for 1976 he reviewed (LAC 20-4)

[37] Construction of the Building Research Centre began in 1951 and the building opened on October 23, 1953.

Legget is second from the left. Although not obvious, the words "Building Research" are worked into the metal artwork at the top of the glass above the entrance way. (photo source NRC Archives)


Legget and C.D. Howe at the opening ceremonies. (photo source NRC Archives) The plaque reads:

National Research Council Division of Building Research
This Building Research Centre
was dedicated to serve the research needs
of building throughout Canada
by
The Right Honourable C.D. Howe, M.P., B.Sc.
Chairman of the Committee of the Privy Council on Scientific & Industrial Research
on the 23rd day of October 1953
J.C. Meadowcroft, F.R.A.I.C, Architect, Montreal
Robertson Construction and Engineering Co. Ltd.
Contractor, Niagara Falls.

## Annotations Chapter 15: THE ASSOCIATE COMMITTEE

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[1] The Associate Committee on Soil and Snow Mechanics was renamed the Associate Committee on Geotechnical Research in 1965.

[2] V-E Day (Victory in Europe Day) was on May 8, 1945; V-J Day (Victory over Japan Day) was still several months away (see later annotation).

[3] The Library and Archives Canada has most of the records of the Associate Committee on Soil and Snow Mechanics (1945-1965) and the Associate Committee on Geotechnical Research (1965-1990), including the minutes of all the meetings. The contents of the LAC files are listed on the CGS website (Virtual Archives). See Chapter 24.

[4] Peckover did review Legget's memoir and did make a few changes and corrections. These are incorporated into this book.

[5] Neil Barron Hutcheon (1911-1989) received his bachelor's and master's degrees in mechanical engineering from the University of Saskatchewan and his PhD from the University of London. He joined the faculty of U of S in 1937 and remained there until 1953, when he was appointed Assistant Director of the NRC/DBR. Hutcheon worked at the DBR for 24 years. When Legget retired in 1969, Hutcheon succeeded him as Director. His technical interest was associated with heat and moisture problems in buildings (University of Saskatchewan website).

[6] Legget did find a copy of Hutcheon's note of appreciation of the Associate Committee and included it as Appendix B in his memoir (see Chapter 18).

[7] This counter-offensive was known both as the Ardennes Counter-offensive and the Battle of the Bulge. It was the last major German offensive campaign on the Western Front during the Second World War, taking place from 16 December 1944 to 25 January 1945. The offensive was intended to stop Allied use of the port of Antwerp, Belgium, and to split the Allied forces. Eventually unsuccessful, it resulted in over 100,000 casualties on both sides (Wikipedia).

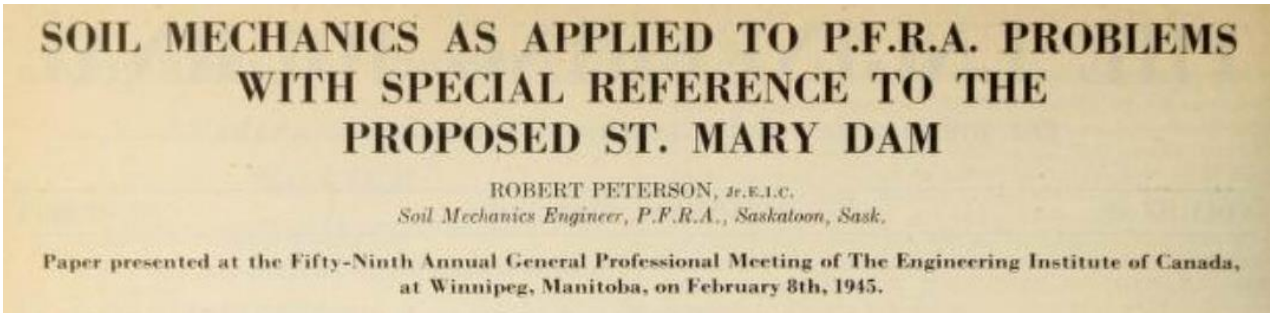
[8] Albert Edward Macdonald (1900-1963), a structural engineer, joined the Civil Engineering Department at the University of Manitoba in 1923, became department head in 1936 and was the second dean of engineering (1949-1963). He died in office. An engineering building on campus is named after him (University of Manitoba website).

[9] Robert (Bob) Peterson (1918-1969) was a 1939 civil engineering graduate of the University of Saskatchewan. He joined the Prairie Farm Rehabilitation Administration (PFRA) and developed a great interest in soil mechanics. Following up on his interest, Peterson took graduate studies under Karl Terzaghi and Arthur Casagrande at Harvard University, earning a master's degree in civil engineering in 1941. Upon returning to PFRA he became chief soil mechanics and materials engineer responsible for all investigations and research in soils and concrete and for the design of earthworks for numerous projects. Peterson was awarded, posthumously, the 1st Robert F. Legget Award in 1970 (CGS website; Lives Lived).

The PFRA was established by the federal government in 1935 in response to the widespread drought, farm abandonment and land degradation of the 1930s. Its purpose was to promote sustainable development on the prairies, in part by developing water supply and soil conservation projects. The PFRA was phased out in the early 2010s (Wikipedia).

Gerry Williams was a materials engineer with the Highways Branch of the Manitoba Department of Public Works.

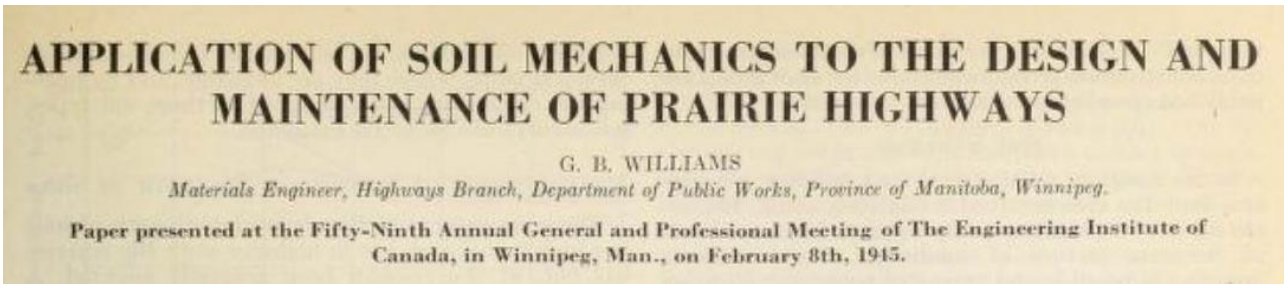
[10] Both papers were published in Volume 28, the May 1945 issue of the *Engineering Journal* (pp 274 and 288, respectively).



SOIL MECHANICS AS APPLIED TO P.F.R.A. PROBLEMS WITH SPECIAL REFERENCE TO THE PROPOSED ST. MARY DAM

ROBERT PETERSON, Jr.E.I.C.
*Soil Mechanics Engineer, P.F.R.A., Saskatoon, Sask.*

Paper presented at the Fifty-Ninth Annual General Professional Meeting of The Engineering Institute of Canada, at Winnipeg, Manitoba, on February 8th, 1945.



APPLICATION OF SOIL MECHANICS TO THE DESIGN AND MAINTENANCE OF PRAIRIE HIGHWAYS

G. B. WILLIAMS
*Materials Engineer, Highways Branch, Department of Public Works, Province of Manitoba, Winnipeg.*

Paper presented at the Fifty-Ninth Annual General and Professional Meeting of The Engineering Institute of Canada, in Winnipeg, Man., on February 8th, 1945.

[11] Legget describes his involvement with the Steep Rock Iron Ore Mine in Chapter 11.

[12] Don C. Rose worked with the NRC Physics Division from the 1920s to 1966. At the time to which Legget refers, Rose was the Special Assistant to C.J. Mackenzie, NRC President. Among other achievements, Rose initiated Canada's space research and was the Chair of the Canadian Organizational Committee for the International Geophysical Year in 1957 (NRC Archives).

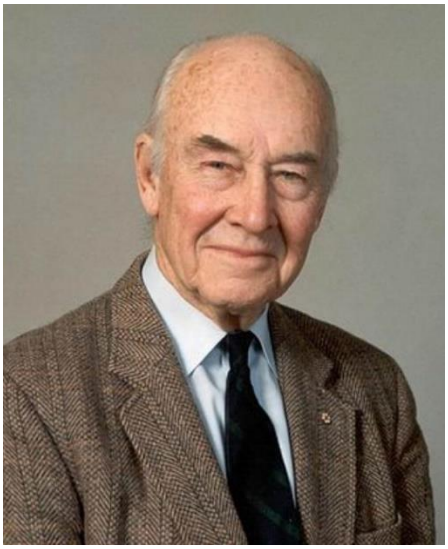
[13] Robert (Bert) Edward Jamison (1891-1970) graduated from McGill University in applied science in 1914. After the First World War he joined the faculty of McGill's Department of Civil Engineering in 1920. During the Second World War, Jamieson was Director-General of Army Engineering for the supply branch of the Department of Munitions and Supply. He served as Dean of Engineering of McGill from 1952 until 1957 (McGill University website).

[14] Gordon McIntosh Letson (1901-1999) was a 1926 mechanical engineering graduate of the University of British Columbia. In the late 1800s, his father started Letson and Burpee, an engineering and machinery manufacturing company. Except when he served in the army during the Second World War, G.M. Letson worked for Letson and Burpee, serving as president from 1950 until he retired in 1975 (Legacy Obituaries website).

[15] Franklin Delano Roosevelt (1882-1945) was the 32nd US President. Earlier in his life, he contracted a paralytic illness, believed at the time to be polio, and his legs became permanently paralyzed. A heavy smoker his entire life, his health started to deteriorate in 1940, got worse in 1944 and he died on April 12, 1945 (Wikipedia).

[16] Roosevelt's Vice President and successor was Harry S. Truman, who served as the 33rd US President from 1945 to 1953.

[17] John Tuzo Wilson (1908-1993) was a geophysics and geology graduate from the University of Toronto, University of Cambridge and Princeton University. During the Second World War, he served in Canada and Europe as a colonel with the Royal Canadian Engineers. After the war, Wilson was the University of Toronto's first Professor of Geophysics and became president of that university from 1967 to 1974. In 1974, he became the Director General of the Ontario Science Centre and in 1983 the Chancellor of York University. He contributed significantly to the geological theory of plate tectonics (Wikipedia).



J. Tuzo Wilson in 1992 (photo source Wikipedia)

[18] George Johann Klein (1904-1992) was a mechanical engineering graduate of the University of Toronto. He worked for forty years (1929-1969) in the NRC Mechanical Engineering Division in Ottawa. He invented, or made significant contributions to, the first electric wheelchair for quadriplegics, the first microsurgical staple gun, the ZEEP nuclear reactor (the precursor to the CANDU reactor), the international system for classifying ground-cover snow, aircraft skis, the Weasel all-terrain vehicle, the STEM antenna for the space program and the Canadarm (Wikipedia). Lionel Peckover remembers Klein designing the first modern kamitik (traditional Inuit sled) for the RCMP.

[19] Peckover is introduced in Chapter 14 and its annotations.

[20] The Rideau Club is a private social club in downtown Ottawa. It was founded in 1865 by John A. Macdonald, soon to be the first Prime Minster of Canada. The original club building burned down in 1979 (Wikipedia).

[21] $15,000 in 1945 would be approximately CDN$200,000 in 2020.

[22] In 1987, Legget wrote about the name that Mackenzie suggested, “and so he used the name as a ‘disguise’ (for want of a better word) for a smaller group of six, with me as Chairman, charged with a top-secret wartime research task” (Letter to *Geotechnical News*, 27 June 1987).

[23] For a first-hand description of this “lamentable disastrous twenty-fifth anniversary dinner … that awful evening” see “The ‘Lamentable Disastrous’ Canadian Geotechnical Conference 25th Anniversary Banquet, ” by Don Shields *Canadian Geotechnique/Géotechnique canadienne*, Vol 1, No 2, pp 18.

[24] C.J. Mackenzie died in 1984.

[25] This course taught by Legget is described in Chapter 12.

[26] Up to this point in time (1945) all Legget’s Canadian travel was by train, his preferred mode of travel.

[27] The Vehicle Proving Grounds, part of the Department of National Defence, were located west of the town of Orleans, ON, approximately 10 km east of Ottawa. Among other things, the grounds were used to test tanks and other tracked vehicles. The site is no longer the responsibility of DND and is currently used by the RCMP as a Technical and Protective Operations Facility (TPOF) (Wikipedia).

[28] Alfred Leahey (1900-1981) was a soil scientist, a lecturer and research assistant with the Alberta Department of Soil Science from 1930 to 1936. He subsequently joined the federal Department of Agriculture and held supervisory positions in pedology with the Experimental Farm Service (1936-1959) and the Research Branch (1959-1966), both in Ottawa. For many years he served as Chair of the National Soil Survey Committee (University of Alberta website).

[29] Many war historians now regard August 14, 1945 as V-J Day, the day Japan initially surrendered. September 2, 1945 was the day Japan signed the surrender documents.

[30] Two nuclear weapon tests were conducted near the Bikini Atoll, one on the Marshall Islands, in mid-1946. These were the first peacetime nuclear tests. Twenty-one additional tests were carried out up until 1958. Before testing began, all residents were removed, could not return and have not returned to the atoll (Wikipedia).

[31] Legget expands on the concept of the "spaced-link track" later in this chapter.

[32] Don Nazzer (1918- 2005) was a 1941 mechanical engineering graduate of the University of British Columbia. He spent the early part of his career with the NRC and was a close associate of George Klein. Among other projects, Nazzer was involved with Canada's nuclear program and the wind tunnel for the Avro Arrow project (NRC Archives).

[33] More will be said about M.G. Bekker later in this chapter.

[34] Norman William McLeod (1904-1989) was a chemistry graduate of the University of Alberta (bachelor's 1930), University of Saskatchewan (master's 1936) and the University of Michigan (ScD 1938). Most of his career was associated with the geotechnical design of asphalt paving mixtures for roads and airfields. He worked with the Saskatchewan Department of Highways, Imperial Oil and McAsphalt Industries. McLeod was the recipient of the 3rd CGS Robert F. Legget Award in 1972 (CGS website; Lives Lived).

[35] Norman William Radforth is introduced in Chapter 11 and its annotations. Lionel Peckover, Secretary to the ACSSM at the time, remembers that his most difficult task as secretary was "translating Norman's writings into a less academic style. I once ran a 'fog index' on one of his pieces …. It scored 22!" (The fog index is a readability test for English writing. It estimates the years of formal education a person needs to understand the text on the first reading. A score of 17 is as high as the index goes and, therefore, Peckover's comment was likely tongue-in-cheek).

[36] In 1947, P.O. Ripley was the Director of the Division of Field, Husbandry, Soils and Agricultural Engineering at the Experimental Farms Services of the federal Department of Agriculture in Ottawa. One of his areas of research was the association of agriculture with climate (Wikipedia).

[37] The minutes of the prior 17 meetings were "classified" for military purposes. This classification was not removed until the late 1940s or early 1950s.

[38] William J. Eden (1926-1994) was a civil engineering graduate of the University of Toronto. He had taken a few courses from Legget before Legget left U of T in 1947. Eden spent his entire career with the NRC/DBR. Technically he was involved with landslides, shrinking and swelling clays and shales, varved clays and in situ testing techniques. In addition to his many years associated with the Associate Committee, for many years he was editor of the *CGS News* and its predecessors. CGS website; Lives Lived).

[39] Lorne Gold was introduced in Chapter 14 and its annotations. In 1982, Gold was Chair of the Associate Committee and his colleague Carl Crawford was Director of the NRC/DBR. Legget likely made this statement tongue-in-cheek.

[40] It is not known what Legget's "ace of spades" was, except that he knew he was retiring in 1969.

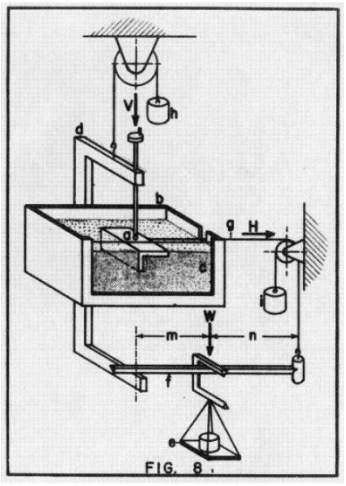
[41] Carl Crawford was introduced in Chapter 14 and its annotations.

**Track Studies**

[42] Grousers, also called lugs, are protrusions on the steel plates (track shoes) of a tracked vehicle. They increase traction in loose or soft soil or snow.

Grousers on the track of a bulldozer (photo source Duratuff Products)

[43] This figure is a sketch of the soil box apparatus used to test grousers in Legget's University of Toronto soils laboratory.




The grouser being tested is the inverted L-shaped metal bar in the soil box. From *Fundamentals of Soil Action Under Vehicles (Part One)* by R.F. Legget and M.G. Bekker, November 1946, NRC/DBR TM #6.

[44] A "conventional track" is made up of steel plates (track shoes) attached to track links. Track links are similar to the links of a bicycle chain. Grousers can be attached to the steel plates for more traction. A "spaced-link track" is made up of steel bars attached at a regular spacing to the track links. The steel bars can either be flat, or more commonly 'L'-shaped, to form grousers for more traction. A "spaced-link track" typically has only 30% of the contact with the ground compared to a "convention track" (Wikipedia). Legget is referring to the critical spacing between the steel 'L'-shaped bars, or grousers.

[45] These technical memoranda were all related, in some way, to track studies. Notes on each follow.

TM #1: *Proposed Field Soil Testing Device* – August 1945. Although the testing device was designed by Bekker, Legget prepared this memorandum and it was checked by Bekker.

TM #2: *Ground Failure Under the Action of a Track Grouser* – September 1945. Prepared by Bekker and checked by Legget.

TM #3: *The Interrelation of Soil Mechanics and the Design and Operation of Vehicles* – November 1945. Prepared by Captain "Jake" Kastner and checked by Legget.

TM #4: *Soil Survey of Vehicle Proving Establishment, Ottawa* – October 1945. Prepared by D.L.B. Hamlin and R.B. Belford (two of Legget's U of T students) and checked by Legget

TM #5: *Method of Measuring the Significant Characteristics of a Snow-Cover* – November 1946. Prepared by G.L. Klein of the NRC Division of Mechanical Engineering.

TM #6: *Fundamentals of Soil Action Under Vehicles (Part One)* by Legget and Bekker – November 1946. Legget refers to this as "the vital document."

TM #7: *Preliminary Notes on 'Muskeg' from Churchill* by Norman W. Radforth – March 1947. Contains a foreword by Legget.
TM #8: *Fundamentals of Soil Action Under Vehicles (Part Two)* by M.G. Bekker, Directorate of Vehicle Development, Department of National Defence – June 1947.

[46] Legget thought quite highly of TM #6. When he applied to the University of Liverpool for a merit-based DEng in January 1947 (see Chapter 13), he submitted TM #6, along with a copy of his 1939 textbook *Geology and Engineering* and one other unidentified publication with his application. As noted below, TM #6 was a classified document until the late 1950s. It is not known how Legget got permission to send TM #6 to the University of Liverpool in 1947.

[47] TMs #2, #3, #6, #7, and #8 were considered either as "wartime-restricted" or "classified documents" and were not made available to the public until the late 1950s. See Chapter 24.

[48] The Society of Automotive Engineers was established in New York, with the original name Society of Automobile Engineers. It is now is called SAE International and has approximately 140,000 members world-wide (Wikipedia).

[49] Bekker spent time at both General Motors in Detroit, MI and the US Army's Aberdeen Proving Ground near Aberdeen, MD (Wikipedia).

[50] The paper was written by Legget in August 1951 and titled "Soil Action Under an Anchored Plate." In 1959, Legget wrote an explanatory note that he attached to his draft of this paper (NRC Archives). The note reads:

> It has been decided not to proceed further with the idea of publishing this paper, the history of which is a very chequered one. It is the revised version of Technical Memorandum No. 6 of the Associate Committee on Soil and Snow Mechanics which we could never get declassified by the military authorities. By agreement with Major Bekker, I therefore wrote this paper in 1951 cutting out the classified material in the T.M. The paper in this revised form was cleared for publication on 29 October 1951.
>
> By this time, however, Colonel Bekker had developed his queer ideas regarding publication and letters on file show his violent objection he took to the paper being published in this form. It was therefore held up until he cooled down.
>
> By this time various publications in the States, including some from Colonel Bekker himself, had used information contained in this original paper and this made the question of publication more difficult. …
>
> This brief record is therefore made so that if, in the future, anyone should ever refer to this paper they may know the strange and chequered history of its non-publication. 13 May 1959. R.F.L.

It appears that for at least 8 years (1951-1959), the reasons for the non- publication of this paper bothered Legget.

[51] Mieczyslaw G. Bekker (1905-1989) graduated from Warsaw Technical University (Poland) in 1929, worked in Poland on tracked vehicle research until 1939, then moved to France. In 1942, he moved to Ottawa to work in armoured tracked vehicle research. He joined the Canadian Army in 1943, attained the rank of lieutenant colonel and was decommissioned in 1956 when he moved permanently to the US.

After leaving Canada, he taught at several US universities, worked for General Motors and did contract work for the US Army. He was a leading specialist in theory and design of military and off-road vehicles and was an originator of the engineering discipline called "terramechanics"—the interaction of wheeled or tracked vehicles on various surfaces. Later in his career, Bekker contributed to the design and construction of the Lunar Roving Vehicle used by missions Apollo 15 to 17 (Wikipedia).

The book to which Legget refers is *Theory of Land Locomotion, the Mechanics of Vehicle Mobility*, University of Michigan Press, 1956. A 2nd edition was published in 1962.

**Snow Studies**

[52] Jean-Frederic Lugeon (1898-1976) was Director of the Swiss Meteorological Services from 1945 to 1963. In addition to this position, he was the author of approximately 180 books and scientific papers and conceived numerous methods of weather forecasting. He was also the leader of several Swiss scientific expeditions, including those to Spitsbergen (an island in northern Norway), the Sahara Desert and Argentina (*The NY Times* Obituary website).

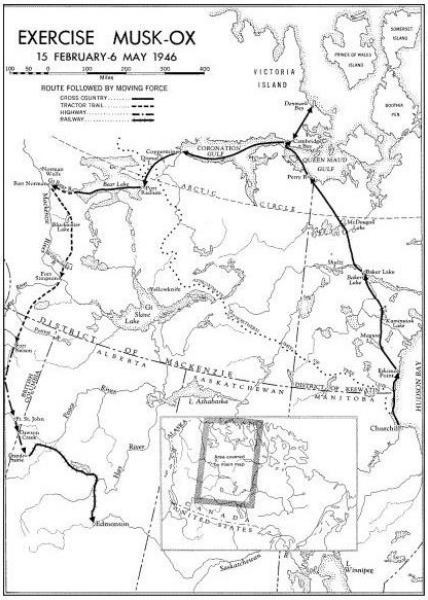
[53] Weissfluhjoch (2,693 m) is a summit in Switzerland. Since 1932 it has been connected to Davos by a funicular (inclined) railway (Wikipedia).

[54] For his research trip to Switzerland, Legget was given the military rank of a colonel.

Legget (wearing sunglasses) testing a carrying seat for wounded soldiers in Switzerland in 1946.
He is wearing a Canadian Army uniform. (photo source NRC Archives courtesy Michael Bozozuk)

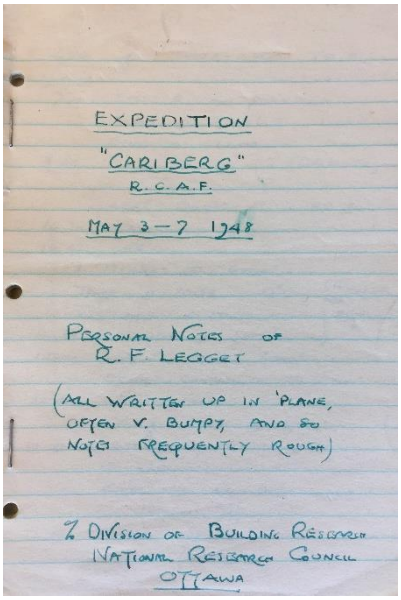
[55] Marcel De Quervain is introduced in Chapter 14 and its annotations.

[56] Exercise Musk Ox involved 48 members of the Canadian Army, one observer from the Canadian Navy, several scientists and three US observers. In 81 days, the participants drove eleven, 4½-ton Canadian-designed snowmobiles, called “Penguins” and one smaller US-designed snowmobile, called a “Weasel,” across the Northwest Territories from Churchill, MB, to Baker Lake, to Denmark Bay on Victoria Island, then south to Kugluktuk, Port Radium, Norman Wells, Fort Simpson (all in the NWT), Fort Nelson, BC, and finally to Grande Prairie, AB. The mission demonstrated that it was highly unlikely that Soviet forces would attempt an overland invasion of North America (Wikipedia). For film footage, see the Youtube Muskox Operation. (The term “Musk Ox” is, in other places, spelt “Muskox” and “Musk-Ox”, and both “Exercise” and an “Operation” are used.)



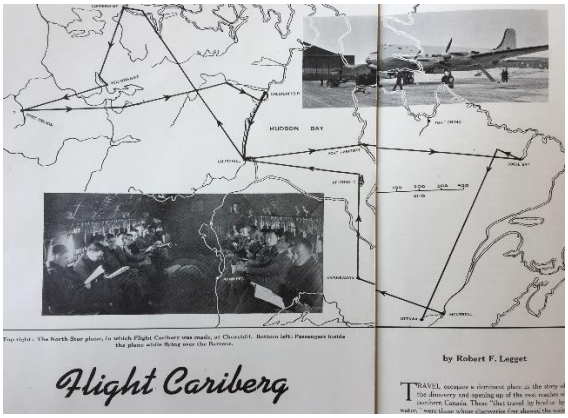

Route of Exercise Musk-Ox. (from C.S. Beals and D.A. Shenstone. 1968. *Science, History and Hudson Bay,* Volume 2, Queen's Printer, Ottawa)

[57] Legget was a member of Flight Cariberg (a contraction of the words 'caribou' and 'iceberg') and kept a journal of this May 1948 trip.




Cover of Legget's Cariberg journal. It states "All written up in 'plane, often v. bumpy, and so notes frequently rough." (LAC 2-6)

The purpose was to make the first Arctic flight of the Canadian-built North Star airplane and to make scientific observations. The 13,000 km-long expedition included 21 passengers, 8 crew and 5 maintenance personnel. Passengers included RCAF personnel, one British and US representative and Canadian scientists—biologists, geologists and meteorologists. One was female. From Legget's 1950 *The Beaver* article: "In 1848, Sir George Simpson travelled from Montreal to the end of Lake Winnipeg and back, and spent 2½ months doing it. In 1948, twenty-one scientists and service officers travelled from Montreal to the Alaska Highway and back, via the Arctic and Labrador coasts, and spent 4½ days doing it."



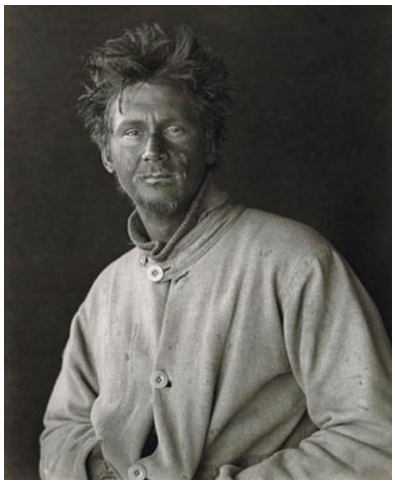

Map from Legget's 1950 *The Beaver* article.

[58] Gerald Seligman (1886-1973) was a British born and educated glaciologist. He founded, in 1936, and was first President of the Association for the Study of Snow and Ice. In 1962, that association changed its name to the International Glaciology Society and the following year Seligman stepped down as president. The Seligman Crystal is awarded by the society in recognition of outstanding scientific contributions to glaciology. He launched the *Journal of Glaciology* in the late 1940s (International Glaciology Society website).

The book to which Legget refers is the 555-page *Snow Structure and Ski Fields—being an account of snow and ice forms met with in nature and a study on avalanches and snowcraft*, published by Macmillan & Co Ltd, London, 1936.

[59] Sir Charles Wright (1887-1975) was born and educated in Toronto (Upper Canada College and University of Toronto) and in England. He was a member of Robert Scott's 1910-1913 expedition to Antarctica as a glaciologist and physicist. He served the British during the First and Second world wars and was knighted after the Second World War for his work on the development of radar and mine and torpedo detection. After the war he moved to the US, where he became Director of the Marine Physical Laboratory of the Scripps Institution of Oceanography at La Jolla, CA in 1951. He joined the Defence Research Board of Canada's Pacific Naval Laboratory in 1955 and in 1967 joined the Institute of Earth Sciences at the University of British Columbia and then Royal Roads Military College in Victoria, BC (Wikipedia).

Wright and Legget became personal friends. Legget visited Wright just before Wright died on Salt Spring Island, BC, where he had retired.



A photo of C.S. Wright taken in 1912 during the Scott expedition
by expedition photographer Herbert Ponting (photo source Wikipedia)

[60] *Glaciology* by C.S. Wright and R.E. Priestley was published in 1922 by Harrison and Sons, London. It was for many years considered the definitive work on the glaciers in Antarctica and was based on the authors' participation in the 1910-1913 Scott expedition. Priestly became Wright's brother-in-law shortly after the expedition.

**Muskeg Studies**

[61] Radforth is introduced in Chapter 11 and its annotations.

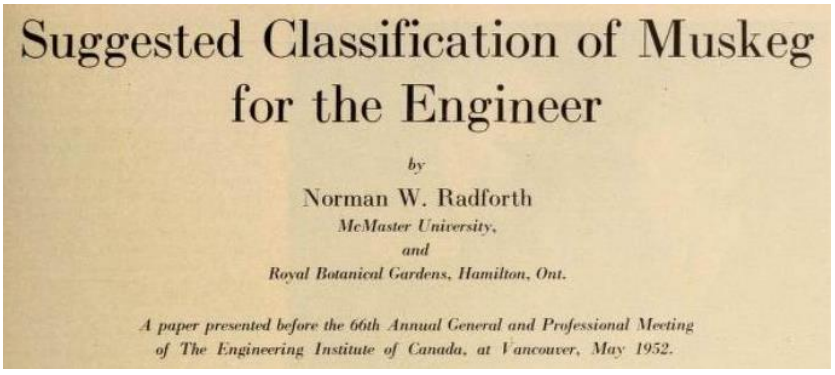
[62] When Legget wrote his memoir in 1983, the 1982 ten-week Falklands War between the UK and Argentina was still fresh in people's minds.

In 1983, Ivan MacFarlane recorded his recollection of Radforth's journey to the Falkland Islands in his interview for the Canadian Geotechnical Heritage Book project. The following is a summary.

> Radforth's trip was in the late 1950s or early 1960s and was funded by an NRC grant, through the Associate Committee of which Legget was the chair. At that time, the Falkland Islands were a British possession and the only means of getting there was by a British Royal Navy supply ship from Uruguay. Radforth decided to take his wife, a noted ichthyologist who was working with the Royal Ontario Museum at the time and who wanted to study fish unique to the Falkland Islands.
>
> They arrived in Montevideo, Uruguay, but were not allowed to board ship because, at that time, women were not allowed on Royal Navy ships. The only exception was if Queen Elizabeth II, the Commander-in-Chief of the British Armed Forces, sanctioned it. Radforth, being the man he was, sent a telegram to the Queen asking for her permission. It turns out that the telegram was directed from the Queen's office to that of the Governor General of Canada. Legget was awoken in the middle of the night by the Governor General's office asking what Radforth's telegram was all about. Legget did not support Radforth's opinion that the regulation should be waived for Mrs. Radforth and, therefore, Radforth went to the Falkland Islands on his own.

[63] The Defence Research Board was established in 1947 and is now known as Defence Research and Development Canada (Wikipedia).

[64] The EIC meeting was held in Vancouver, BC and Radforth's paper was published in the *Engineering Journal* in 1952—"Suggested Classification of Muskeg for the Engineer," Vol 35, pp 1199-1210.



Suggested Classification of Muskeg for the Engineer

*by*

Norman W. Radforth

*McMaster University,*
*and*
*Royal Botanical Gardens, Hamilton, Ont.*

*A paper presented before the 66th Annual General and Professional Meeting of The Engineering Institute of Canada, at Vancouver, May 1952.*

[65] Here Legget's memory may have failed him. Within a year of Radforth publishing his first paper in the *Engineering Journal* in 1952, he published a paper in the *Transactions of the Royal Society of Canada*. Radforth did not publish a paper in *Nature* until 1965—a paper titled "Muskeg in North America."

**Permafrost Studies**

[66] Ivan MacFarlane is introduced in Chapter 14 and its annotations.

**Soil Mechanics Studies**

[67] The Division of Building Research did not exist at that time.

[68] George Geoffrey Meyerhof (1916-2003) was born in Germany and educated in the UK. He worked with the UK Building Research Station from 1946 to 1953. Meyerhof immigrated to Canada in 1953 and initially worked for FENCO before joining the faculty of the Technical University of Nova Scotia, where he also served as Civil Engineering department head and dean of engineering. He was the first President of the Canadian Geotechnical Society in 1972. In 1974, he was awarded the 5th CGS Robert F. Legget Award. In 1995, the CGS Soil Mechanics and Foundation Engineering Division named its annual award in Meyerhof's honour (CGS website; Lives Lived).

[69] The Canadian Soil Mechanics Conference is now the Canadian Geotechnical Society's annual "Canadian Geotechnical Conference." In 2020, the 73rd conference was held "virtually" because of the COVID-19 pandemic. For more information on the first conference see "The First Canadian Geotechnical Conference (1947)," *Geotechnical News,* September 2019, pp 15-19 by Doug VanDine.

[70] The 2nd Canadian conference, held in Lethbridge, AB, included a field trip to see the construction of PFRA's St. Mary's Dam, approximately 60 km southwest of Lethbridge.

[71] The NRC/DBR published the proceedings of the first 16 annual conferences. They are available online at (see Chapter 24). The proceedings of almost all the annual Canadian Geotechnical Conferences are on the CGS website and available to CGS members for viewing and downloading.

**Associate Committee: Operations**

[72] James Merritt Harrison (1915-1990) was a geology graduate of the University of Manitoba (bachelor's) and Queen's University (master's and PhD). His field work was primarily in northern Manitoba and Labrador. He worked for the Geological Survey of Canada as a summer student during the late 1930s, then joined the GSC full time in 1943. He was Director of the GSC from 1956 to 1964, then served as assistant deputy ministry in the federal Department of Mines and Technical Surveys from 1964 to 1972. Yves Fourtier succeeded Harrison as Director of the GSC from 1964 to 1973 (*Reading the Rocks, the Story of the Geological Survey of Canada*, by Morris Zaslow, MacMillan Company of Canada, 1975).

[73] Robert Hardy is introduced in Chapter 1 and its annotations.

[74] The 2nd International Conference on Soil Mechanics and Foundation Engineering was held in Rotterdam, the Netherlands, in 1948. Because of the Second World War, there were no conferences held between 1936 and 1948.

[75] The federal Department of Mines was initially established in 1907. Its name was changed to Department of Mines and Resources in 1936, then Department of Mines and Technical Surveys in 1949. This is likely the department name to which Legget is referring. In 1966, the department became Energy, Mines and Resources and in 1993 it became the Department of Natural Resources, as it is known today (Government of Canada website).

[76] For many years, the Canadian Rock Mechanics Association (CARMA) has been composed of two bodies: the Rock Mechanics Division of the Canadian Institute of Mining and Metallurgy and the Rock Mechanics Division of the Canadian Geotechnical Society. CARMA is the Canadian representative body of the International Society of Rock Mechanics.

[77] There are currently 20 CGS local sections across the country. Some local sections are more active than others.

[78] The Association of Engineering Geologists is now the Association of Environmental and Engineering Geologists, but it still uses the acronym AEG (AEG website).

[79] The IEEE is the Institute of Electrical and Electronics Engineers and was established in 1884. The IEEE is no longer limited to only electric and electronic engineers and is open to many other engineering, scientific and even medical professionals. Its mission is to advance innovation and technological

excellence for the benefit of humanity and is the world's largest technical professional society (IEEE website).

[80]The American Society of Civil Engineers, established in 1852, does not keep a list of its past presidents, making it difficult to determine the number of Canadian presidents of the society. As of 2020, the Geological Society of America, founded in 1888 and which does have a list of presidents, has had 13 presidents identified as being Canadian, one being Legget in 1966 (Geological Society of America website).

[81] Legget was awarded an AEG Honorary Membership in 1971.

[82] Reginald Hugh Grice was a professor in the Department of Geological Sciences at McGill University. He was a 1964 PhD graduate of the University of Illinois at Urbana-Champaign, supervised by the well-known engineering geologist Don Deere (University of Illinois website).

[83] Legget is referring to Luc Boyer, not Marc Boyer. Luc Boyer was an engineering geologist who for many years worked with Roctest Ltée, a monitoring and instrumentation developer, manufacturer and supplier founded in Montreal in 1967. He rose to the position of vice-president in that firm. As indicated by Legget, Boyer was the driving force behind the AEG Montreal Section.

[84] Gilbertian refers to a characteristic of the works of English playwright W.S. Gilbert (as in Gilbert and Sullivan), involving ludicrous or paradoxical situations (Wikipedia).

[85] According to the AEG website there are currently no chapters of the association outside the US; however, there is a category of “International Membership.” The Canadian Geotechnical Society currently has an affiliation with the AEG and jointly awards the Robert L. Schuster Medal in the field of geohazards.

[86] Don MacDonald is introduced in Chapter 11 and its annotations.

[87] *Tunnels and Geology in Canada* was published jointly by the CGS Tunnelling Technical Committee and the Tunnelling Association of Canada in 1985.

[88] The Tunnelling Association of Canada was established in 1980 and is the Canadian representative body of the International Tunnelling Association. The CGS no longer has a Tunnelling Committee. The CGS and the Tunnelling Association of Canada have a formal affiliation.

[89] The 4th International Symposium on Landslides was held in Toronto in 1984, in conjunction with the 37th Canadian Geotechnical Conference. The 11th International Symposium on Landslides was held in Banff, AB in 2012 and was organized, in part, by the CGS Landslides Committee.

[90] Most NRC Technical Memoranda are available online (see Chapter 24).

[91] Larry Soderman (1928-1969) was a 1952 civil engineering graduate of the University of Manitoba and did post-graduate work as an Athlone Fellow at Imperial College in London. Upon returning to Canada, he first worked with the consulting firms Racy McCallum, then Trow-Soderman and in 1959 became Chief Geotechnical Engineer of the Ontario Department of Highways. In 1961, Soderman became an associate professor at the University of Western Ontario where he introduced and taught its first soil mechanics courses. He was an associate editor of the *Canadian Geotechnical Journal* from 1965 until his early death at the age of 42. He is credited with helping instigate the formation of the consulting firm Golder Associates in 1960 (CGS website; Lives Lived).

Victor Milligan (1929-2009) was born and raised in Northern Ireland. He obtained a bachelor’s and master’s from Queen’s University, Belfast, in 1951 and 1952, respectively. Coming to Canada after a short time at Purdue University, Milligan worked for the consulting firm Geocon before starting Golder Associates with Hugh Golder in 1960. He worked with Golder Associates for the rest of his stellar career. Milligan was the first Editor of the *Canadian Geotechnical Journal,* from 1963 to 1968 (CGS website; Lives Lived).

[92] Legget helped establish the *Canadian Geotechnical Journal* by also soliciting financial guarantees for the journal’s first two issues from 20 prominent Canadian geotechnical professionals (Crawford 1997).

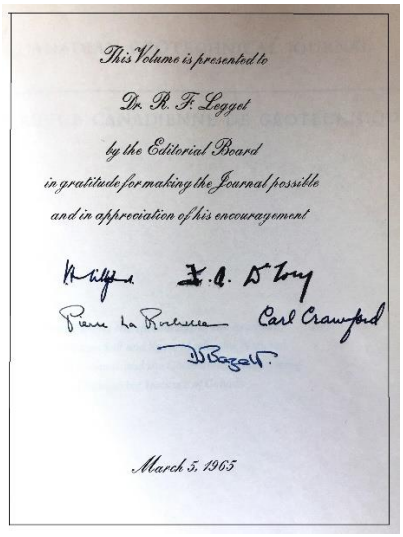
[93] In 1963, Karl Terzaghi was the Honorary President of the International Society of Soil Mechanics and Foundation Engineering. Before his foreword to the journal, there is a full-page photograph of Terzaghi and his handwritten signed note, “To my Canadian colleagues in appreciation of their splendid work.” Terzaghi died a month after the first issue was published.

Legget, as Chairman of the Associate Committee, wrote an introduction to the first issue. From his introduction:

> The journal is intended to provide a medium for the publication of papers in the applied geotechnical field. It is anticipated that most of the papers presented will deal with soil mechanics. In keeping, however, with the liaison with allied fields that has always characterized Canadian soil mechanics work, papers dealing with associated subjects such as engineering geology, pedology, muskeg, hydrology, and the mechanics of snow and ice will always be welcomed by the Editorial Board.

[94] Legget is correct. Milligan was the founding editor from 1963 to 1968, followed by Fred DeLory, who served as editor from 1969 to 1970.

Fred DeLory was a professor at the University of Toronto, Pierre LaRochelle was a professor at Laval University, Carl Crawford worked with Legget at the NRC/DBR and Don Bazett was working with the consulting firm CBA Engineering in Vancouver. Don Bazett became the fourth Editor, serving from 1975 to 1980.




Signed inside cover page of Legget’s specially bound copy of the first volume of the *Canadian Geotechnical Journal.* It reads ”This Volume is presented to Dr. R.F. Legget by the Editorial Board in gratitude for making the Journal possible and in appreciation of his encouragement.” (LAC 18-24)

[85] The *Canadian Journal of Earth Sciences* was first published in August 1964. Since 2010, both the *Canadian Geotechnical Journal* and the *Canadian Journal of Earth Sciences* have been published by Canadian Science Publishing, a private, not-for-profit company that was formerly NRC Research Press, the publishing arm of the National Research Council (Wikipedia).

[96] As far as it is known, Legget did not follow up on this.

[97] The French title is *Revue canadienne de géotechnique.*

[98] Hugh Golder (1911-1990) was a civil engineering graduate of the University of Liverpool (1932). He worked with the UK Building Research Station from 1937 to 1944, then moved to the newly formed UK consulting firm Soil Mechanics Ltd. He was one of the founders of the international journal *Géotechnique*. He immigrated to Canada in 1959 and formed Golder Associates, a consulting geotechnical engineering company, in 1960. Golder was a very highly regarded geotechnical consultant both in Canada and internationally (CGS website; Lives Lived).

[99] Legget's wish has come true. The *Canadian Geotechnical Journal* initially published four issues/year from 1963 to 1989. That increased to six issues/year between 1990 and 2005 and since 2006 it has published 12 issues/year. In the past several years, the journal has typically been ranked second or third by 'impact factor' of all geotechnical journals internationally, and the first or second of Canadian technical journals.

[100] Robert Henry Winters (1910-1969) was a Nova Scotian electrical engineer. He was elected as a Liberal Member of Parliament in 1945 and served as Minister of Public Works, among other portfolios, under Prime Minister Louis St. Laurent (Wikipedia).

[101] Henri Gaudefroy (1909-1992) graduated in civil engineering from École Polytechnique de Montréal in 1933 and later from MIT. He joined the faculty of École Polytechnique in 1939 and served as dean of engineering between 1953 and 1966 (Université de Sherbrooke website).

[102] Photo of some of the individuals Legget mentions.

From left to right: Legget, Robert Winters, Karl Terzaghi, E.W.R Steacie and Henri Gaudefroy
103at the 10th Canadian Geotechnical Conference, Ottawa, 1956 (NRC Archives)

[1] The Aswan High Dam, built between 1960 and 1970, dams the Nile River in Egypt and drowned the Aswan Low Dam that was completed in 1902. It was first envisioned in 1952 to better control flooding, provide increased water storage and generate hydroelectricity. It has had a colourful technical and political history (Wikipedia).

The reservoir is five times the size of that of Lake Mead behind the Hoover Dam in the US. Terzaghi was a consultant on the Aswan High Dam project and the chair of the associated consulting board starting in July 1954, until the Russians took over the project in 1960 (Goodman 1998).

A summary of the dinner address was published in the "Proceeding of the Tenth Canadian Soil Mechanics Conference," published by the NRC/DBR as TM #46. It was republished in 1983 in the *Canadian Geotechnical Journal, Vol 20*, pp 169-172.

[104] E.W.R Steacie is introduced in Chapter 14 and its annotations. Steacie was educated as a physical chemist, hence Legget's reference to "a pure scientist of the pure scientists."

[105] The Canadian Geotechnical Society was formed in 1972. It developed out of the Engineering Institute of Canada's Geotechnical Engineering Division that was established in 1960 and was encouraged by the NRC's Associate Committee on Geotechnical Research.

[106] The two-year period to which Legget refers was 1961 to 1962.

Between the 16th Canadian Geotechnical Conference in 1962 (organized by, and the proceedings published by, the NRC/DBR) and 1972 when the CGS was formed and assumed the responsibility for organizing the annual conferences, the Engineering Institute of Canada's Geotechnical Engineering Division organized the annual conferences. The proceedings of these annual conferences, from 1963 to 1971, were not published as single, stand-alone documents. Some papers were published as preprints that were given to the delegates at the conferences. At some conferences only abstracts were provided and some of the associated papers were printed in subsequent issues of the *Canadian Geotechnical Journal* and in other journals.

[107] Until the 1960s, the Engineering Institute of Canada was the premier learned society for all fields of engineering in Canada. Starting in the late 1960s, various fields of engineering within the EIC started to form their own organizations and their members left the EIC. This weakened its status considerably and in 1986 the EIC officially became a federation of constituent member societies, currently numbering twelve and representing approximately 25,000 Canadian engineers. In 1987, the EIC ceased publishing the *Engineering Journal* (EIC website).

**Associate Committees in General**

[108] The Associate Committee on Soil and Snow Mechanics, established in 1945, changed its name to the Associate Committee on Geotechnical Research in 1965. In 1990, the ACGR was disbanded and turned its mandate over to the Geotechnical Research Board of the CGS.

Past ACGR chairmen and technical advisors honoured at a special dinner hosted by Golder Associates at the Rideau Club in Ottawa on August 23, 1991. The photo includes many of the individuals mentioned in Chapters 14 and 15.

From left to right, with years of ACSSM/ACGR involvement: Carl Crawford (1967-76), Victor Milligan (1983-88), Legget (1945-67), Bill Eden (1951-85), Michael Bozozuk (1985-91), Don Shields (1988-91) and Lorne Gold (1976-83; 1988) (photo source Michael Bozozuk)

## Annotations Chapter 16: DIVISION OF BUILDING RESEARCH YEARS (1947-1969)

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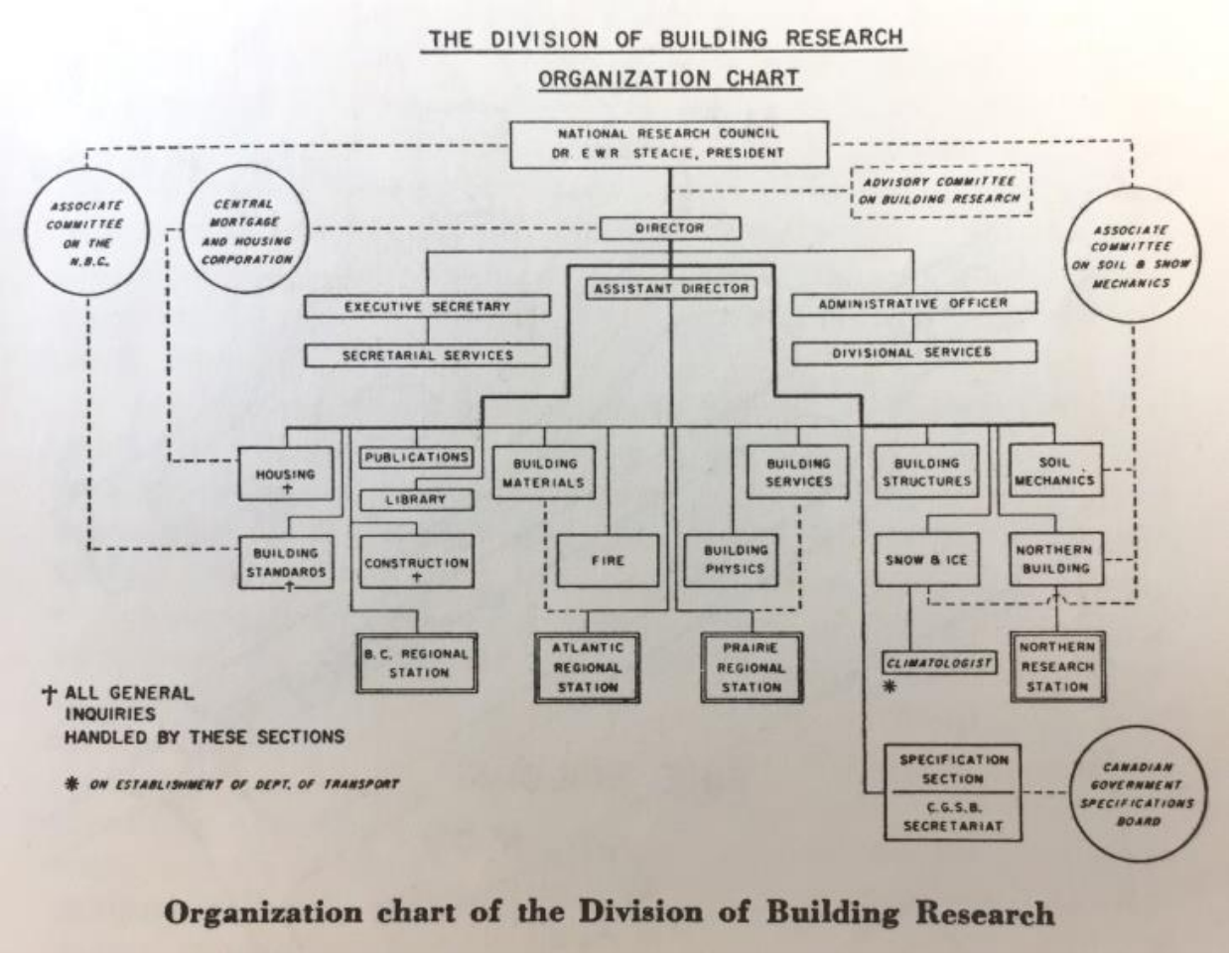
[1] NRC documents indicate that Legget's "Date of commencement … with NRC," was June 2, 1947 (NRC Archives).

[2] The following figure is an organizational chart of the DBR in the late 1950s or early 1960s. Although the organization evolved somewhat over the years, the figure presents a picture of what Legget developed over his first decade as director.




**Organization chart of the Division of Building Research**

From an undated NRC publication, likely published in the late 1950s/early 1960s (LAC 20-10)

The Associate Committee on Soil and Snow Mechanics and the Soil Mechanics, Snow & Ice and Northern Building sections are shown on the extreme right of the chart. Other technical sections, from left to right, include Housing (and the Central Mortgage and Housing Corporation), Building Standards (and the Associate Committee on the National Building Code), Construction, Building Materials, Fire, Building Physics, Building Services, Specifications (and the Canadian Government Specification Board) and Building Structures. In addition, there were three "regional stations" listed from left to right: British Columbia, Atlantic and Prairie, and the Northern Research Station.

Non-technical departments on the chart include the Library, Publications, Secretarial Services and Administration, which included Drafting and Photography, Personnel and Travel, Supply and Office, Shop Services and Building Services. The latter non-technical department was added after the "Building Research Centre" was opened in October 1953.

[3] Hutcheon is introduced in Chapter 15 and its annotations.

[4] As related by Mike Bozozuk.

[5] Friends of the Pleistocene is an informal group of (predominantly) geologists who are interested in the Pleistocene Epoch, the period of geological time between 2.5 million years and 10,000 years ago, during which recent glaciation occurred. It was founded in 1934 in the northeast US and has organized field trips in the northeast US and eastern Canada almost annually ever since (Friends of the Pleistocene website).

[6] Organizations which Legget was a member of and contributed to in 1957 were (from *Ten Years of Building Research in Canada: 1947-1957,* NRC/DBR):

- American Society for Testing Materials (ASTM), general representative of the NRC
- Canadian Construction Association, a member on four committees: Business and Contractor Relations; Housing; Management and Research and Education
- Canadian Standards Association (CSA), a member of the Board of Directors and the Technical Council
- Geological Society of America, a member of the Council (he helped organize its Engineering Geology Division in 1947)
- International Union of Testing and Research Laboratories for Materials and Testing, a Canadian co-representative (with Hutcheon), and
- (UK) Institution of Civil Engineers, the Councillor representing Canada.

[7] The CIB is introduced in Chapter 14 and its annotations.

[8] The proceedings of this conference and all ISSMGE conferences are available on the ISSMGE website (see Chapter 24).

[9] Terzaghi had consulted extensively for BC Hydro and designed the Mission Dam in the early 1950s. Construction started in 1955 and the reservoir was first filled in 1960 (BC Hydro website).

[10] With financial assistance from the Canadian Foundation for Geotechnique, this tour has continued. There are currently two tours a year: one with a Canadian lecturer and the other with an international lecturer. See also *Geotechnical News*, March 2017 (CGS website).

[11] The Rapides-des-Quinze Hydroelectric Power project began with a single dam in the early 1900s and three more dams were constructed in the late 1940s/early 1950s.

[12] G.H. Klein is introduced in Chapter 15 and its annotations.

[13] The Nazis first invaded Prague in March 1939. Legget's unpublished document is titled "Czechoslovakia: 20-24 August 1968" (LAC 8-32).

[14] A listing of Legget's geotechnical and geological publications are listed in Chapter 23.

[15] The *Canadian Consulting Engineer*, a magazine for professional engineers involved with the construction industry, was first published in 1960.

[16] The titles of almost all of Legget's 108 "Historical Notes" are listed in Chapter 23.

[17] Established in the 1950s, Inuvik provided a resettlement location for the largely Inuit population of Aklavik. Aklavik, located centrally in the Mackenzie River delta was being threaten by flooding, erosion, thawing permafrost conditions and access issues.

[18] Canadian conversion to the metric system started in 1970 and continued through the 1970s but has never been completed or fully embraced by the country (or Canadians of a certain age!).

[19] The following is the abstract from the paper by Legget and T.D. Northwood titled "Noise Surveys of Cocktail Parties:"

> This paper discusses and enlarges on a recent theoretical paper by W.R. MacLean on the acoustics of cocktail parties. The discussion is supported by experimental evidence accumulated during the past two years. MacLean's analysis suggests that there is a critical density of participants above which a "quiet" cocktail party becomes abruptly "noisy." It would appear that one might actually plan a quiet or noisy party as required (assuming control over the number of participants). Unfortunately, the cases studied experimentally do not show this quiet-noisy transition, and it is

believed that factors not considered in the theory result in a blurring of the distinction. Indications are that there is a gradual increase in sound level to a saturation value that is independent of the properties of the room, the beverages served, and the number of participants. There is, however, dependence on the sex of the participants.

[20] *Modern Railway Structures* was an illustrated record of some of the advances in the design and construction of the more important structures required for railroads, such as grading, bridges, masonry walls and turntables. The text was mostly on types of bridges. Charles Disney (no relation to Walt) was an American railroad engineer who, in 1934, wrote *New Developments in Grade Separation Structures*. He died in Baltimore, MD in 1950. How Legget and Disney met is not known.

[21] Legget "discovered" the Rideau Canal when he was teaching at Queen's University—Kingston being at the southern end of the canal. He started researching the history of the canal in 1943 when he was teaching at U of T. As mentioned earlier, Legget's home on Echo Drive in Ottawa overlooked the Rideau Canal.

[22] Legget also wrote the preface and introduction to *Soils in Canada* and co-wrote with Robert Hardy a paper on the "Engineering Significance of Soils in Canada."

[23] There are now 22 volumes in this Geological Society of America series.

[24] The Spanish translation is *Geology for Engineers*.

[25] Legget's honours during this period included:

- 1953: Honorary Fellow of the Royal Architectural Institute of Canada
- 1959: Fellow of the Royal Society of Canada
- 1960: Honorary Member of the Ontario Association of Architects
- 1965: Fellow of the Engineering Institute of Canada. Fittingly, this was same year that Robert Hardy was also made an EIC Fellow. They were the first two Canadian geotechnical engineers to be so recognized.
- 1965: Fellow of the Geological Society of America; Legget served as President of the GSA the following year.
- 1967: Foreign Fellow of the Geological Society of London
- 1968: Honorary Member of the Canadian Construction Association, and
- 1968: Honorary Member of the American Society of Testing Materials, Committee D-18 on Soil and Rock for Engineering Purposes. Legget joined this committee in 1940.

[26] The honorary degrees Legget received between 1961 and 1969 were:

- 1961: LLD (Doctor of Laws) from McMaster University
- 1963: DSc (Doctor of Science) from the University of Waterloo
- 1966: LLD from Queen's University, Kingston
- 1969: DSc from the University of Western Ontario (now Western University)
- 1969: LLD from the University of Toronto
- 1969: LLD from the University of New Brunswick, and
- 1969: DGS (Doctor of Geological Sciences) from Charles University, Prague, Czechoslovakia (now the Czech Republic).

Legget receiving his honorary Doctor of Geological Sciences from Charles University in 1969 (LAC Spec Coll)

[27] Yousuf Karsh (1908-2002), an Armenian-Canadian and long-time Ottawa resident, was one of the greatest portrait photographers of the 20th century. Notable subjects included Winston Churchill (1941), George Bernard Shaw (1943), Dwight Eisenhower (1946), Albert Einstein (1948), Audrey Hepburn (1956), Ernest Hemingway (1957) and Nikita Khrushchev (1963).

[28] Henry Gunning served as UBC Dean of Engineering from 1954 to 1959. He resigned to become a consulting geologist for the Anglo-American Corporation in Africa. The position, offered to Legget, was filled by David M. Myers, Head of the Department of Electrical Engineering at the University of Sydney, Australia (UBC Website).

[29] The National Capital Commission is a federal Crown corporation created in 1959 “to ensure that Canada’s Capital is a dynamic and inspiring source of pride for all Canadians and a legacy for generations to come.” Its predecessors were the Ottawa Improvement Commission, created in 1899, and the Federal District Commission, created in 1927. Legget would have replaced Major General Howard Kennedy as Chairman. Alan Hay filled the position that Legget declined (NCC website).

[30] David became a reporter for the *Carleton Place Canadian*—Carleton Place is approximately 50 km southwest of Ottawa—and then eventually a photojournalist for the *Montreal Star*. He married and had two children. In his early 30s, David became disenchanted with the newspaper business and with his father’s assistance he returned to school as a mature student, obtained a teaching degree and became a successful music teacher in the Toronto public school system. David and his wife still live in Toronto (David Legget, personal communication).

## Annotations Chapter 17: L'ENVOI

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[1] "L'envoi" is literally translated from the French as "the sending off." At the end of piece of writing it is used to indicate concluding remarks.

[2] It is not known to which "Soil Mechanics meeting" Legget is referring. The 8th Canadian Soil Mechanics (Geotechnical) Conference in 1954 was held in Ottawa in December of that year. The first Canadian Geotechnical Conference held in the Maritimes was the 13th conference, held in Halifax in 1959. The first Canadian Geotechnical Conference held in Fredericton was the 34th conference in 1981.

[3] John Hugh Flemming (1899-1982) was the 24th Premier of New Brunswick from 1952 to 1960. He later served as a federal Member of Parliament from 1960 to 1972 and served as minister in two portfolios in Prime Minister John Diefenbaker's Conservative cabinet (Wikipedia).

[4] The 6th International Conference on Soil Mechanics and Foundation Engineering was held in Montreal in 1965.

[5] In 1998, the name of the Conseil international du bâtiment was changed to the International Council for Research and Innovation in Building and Construction but the acronym, CIB, has remained in use. This organization was introduced and described in Chapter 14 and its annotations.

[6] In 1983, when Legget wrote his memoir, Carl Crawford was Director of the Division of Building Research and would have represented Canada on the CIB.

[7] The Mayor of Montreal in 1965 was Jean Drapeau, who served as mayor from 1954 to 1957 and from 1960 to 1986 (Wikipedia).

[8] The 21st Canadian Geotechnical Conference was held in Winnipeg in September 1968. Legget's attendance at the International Geological Congress in Prague in August 1968 is described in Chapter 16.

[9] It was during the annual dinner of the 22nd Canadian Geotechnical Conference held in Kingston, ON, that the idea of the Robert F. Legget Award was announced. The award was first presented in 1970 at the 23rd Canadian Geotechnical Conference held in Banff, AB. It was presented, posthumously, to Robert (Bob) Peterson.

The table below lists all the Robert F Legget Award and Medal recipients to 2019. The "award" was changed to a "medal" in 2000. Many of those listed have been mentioned in this book.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1970 | R Peterson | 1971 | RM Hardy | 1972 | NW McLeod | 1973 | V Milligan |
| 1974 | GG Meyerhof | 1975 | CB Crawford | 1976 | AG Stermac | 1977 | P LaRochelle |
| 1978 | DH MacDonald | 1979 | NR Morgenstern | 1980 | RJE Brown | 1981 | B Ladanyi |
| 1982 | DJ Bazett | 1983 | JI Clark | 1984 | L Samson | 1985 | JI Adams |
| 1986 | MAJ Matich | 1987 | CF Ripley | 1988 | WA Trow | 1989 | KY Lo |
| 1990 | EJ Klohn | 1991 | RM Quigley | 1992 | JD Mollard | 1993 | RN Yong |
| 1994 | M Bozozuk | 1995 | FA Tavenas | 1996 | JL Seychuk | 1997 | GC McRostie |
| 1998 | DG Fredlund | 1999 | CO Brawner | 2000 | DH Shields | 2001 | J Graham |
| 2002 | RP Benson | 2003 | RK Rowe | 2004 | G Lefebvre | 2005 | J Krahn |
| 2006 | OL White | 2007 | S Lacasse | 2008 | JF Gartner | 2009 | DM Cruden |
| 2010 | DE Becker | 2011 | WDL Finn | 2012 | E McRoberts | 2013 | S Leroueil |
| 2014 | PM Byrne | 2015 | J Locat | 2016 | RJ Bathurst | 2017 | D Stead |
| 2018 | M Aubertin | 2019 | A Valsangkar | | | | |

[10] What Legget accomplished between the time he wrote his memoir in 1983 and when he died in 1994 is described in Chapter 20.

## Annotations Chapter 18: APPENDICES

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[1] Actually Hutcheon was referring to the 1969 publication by T.A. Harwood and R.J.E. Brown, "A Report on Permafrost, Part III," in *Report on the Geotechnical Sciences to the Solid-Earth Science Study Group of the Science Council of Canada*, National Research Council, Associate Committee on Geotechnical Research, TM 95, 17 p plus appendices.

[2] Legget, R.F. and Peckover, F.L. 1973. "Foundation Performance of a 100-year-old Bridge," *Canadian Geotechnical Journal*, Vol 10, pp 504-519 and
Peckover, F.L. and Legget, R.F. 1973. "Canadian Soil Penetration Tests of 1892., *Canadian Geotechnical Journal*, Vol 10, pp 528-531.

[3] Legget, R.F. 1970. "Dr. Samuel Fortier pioneered basics of soil mechanics," *Canadian Consulting Engineer*, December.

[4] Legget, R.F. 1979. "CNR Tunnel under St. Clair River still in use," *Canadian Consulting Engineer*, September. and
Legget, R.F. 1982. "Joseph Hobson—another name to add to our list of engineering greats," *Canadian Consulting Engineer*, March.

[5] Legget, R.F. 1980. "Sub-surface conditions determine route of Ontario's Murray Canal," *Canadian Consulting Engineer*, January.

[6] This publication is actually Sessional Paper 19A.

[7] Howard Turner (1873-1950) obtained a bachelor's degree in physics (1893), a master's degree in applied science (1896) and a DSc (1900), all from McGill University. He taught and did research at McGill from 1900 to 1933. Turner wrote two books on ice: *Ice Formation, with Special Reference to Anchor-ice and Frazil* (1906) and *Ice Engineering* (1928) (Wikipedia).

[8] E. Brown and Clark, G.S. 1932. "Ice Thrust in Connection with Hydro-Electric Plant Design (with Special Reference to the Plant at Island Falls on the Churchill River, Saskatchewan)," *Engineering Journal*, Vol 15, pp 18-??.

## Annotations Chapter 19: SUPPLEMENT TO GEOTECHNIQUE IN CANADA

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[1] Now the Ordre des ingénieurs du Québec (OIQ).

[2] Louis St. Laurent (1882-1973) subsequently became the 12th Prime Minister of Canada (1948-1957), preceded by WL Mackenzie King and succeeded by John Diefenbaker (Wikipedia).

[3] Leatherhead is approximately 30 km southwest of London.

[4] Franki piles were developed in the early 1900s by Belgian engineer Edgard Frankignoul. The method, still widely used, is used to install cast-in-place concrete piles with an expanded base (Wikipedia). Franki piles are sometimes referred to as “compacto piles” or “expanded base piles or footings.”

[5] The National Academy of Sciences document to which Legget refers is “Report of the Committee of the NAS on Panama Canal Slides,” Memoirs Vol 18, published in 1924.

Legget had a fascination with canals. Sir William Smith, the “Father of British Geology” (1769-1839) and a civil engineer, was noted for his work on the canals of England in the late 1700s. Legget refers to Smith in a number of his publications and includes Smith’s photograph as a frontispiece in his 1939 textbook *Geology and Engineering*. Legget wrote two books on canals: the 320-page *Rideau Waterway* (1955) and 261-page *Canals of Canada* (1976). In 1989 he treated himself to a cruise through the Panama Canal. The last paper Legget had published (1993) was on the Panama Canal. It was published in the *Canadian Geotechnical Journal.*

[6] As described in his memoir, Legget was a lecturer at Queen’s University from 1936 to 1938.

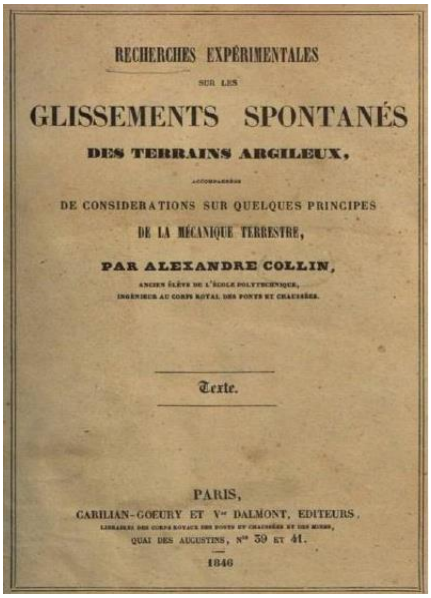
[7] Cornell University in Ithaca, New York, is approximately 300 km south of Queen’s University in Kingston.

[8] Professor Lindsay Malcolm is introduced in Chapter 10 and its annotations.

[9] Legget moved from Queen’s University to the University of Toronto in 1938.

[10] Paris fell to Nazi Germany on June 14, 1940.

[11] The cover of Collin’s 1846 book.


RECHERCHES EXPÉRIMENTALES

SUR LES

GLISSEMENTS SPONTANÉS

DES TERRAINS ARGILEUX,

ACCOMPAGNÉES

DE CONSIDERATIONS SUR QUELQUES PRINCIPES

DE LA MÉCANIQUE TERRESTRE,

PAR ALEXANDRE COLLIN,

ANCIEN ÉLÈVE DE L'ÉCOLE POLYTECHNIQUE,

INGÉNIEUR AU CORPS ROYAL DES PONTS ET CHAUSSÉES.

Texte.

PARIS,

CARILIAN-GOEURY ET Ve DALMONT, EDITEURS,

LIBRAIRES DES CORPS ROYAUX DES PONTS ET CHAUSSÉES ET DES MINES,

QUAI DES AUGUSTINS, Nos 39 ET 41.

1846

Collin, A. 1846. *Recherches Expérimentales sur les Glissements Spontanés des Terrains Argileux, Accompangées de Considerations sur Quelques Principes de la Méchanique Terrestre,* Carilian-Goeury and Dalmont, Paris.

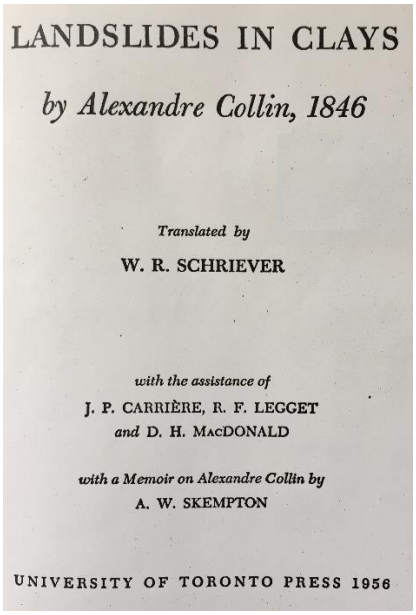
[12] Legget moved to Ottawa in 1947 to become the founding Director of the National Research Council’s Division of Building Research. See Chapters 14 and 15.

[13] L.F. Cooling is introduced in Chapter 8 and its annotations.

[14] Sir Alec W. Skempton (1914-2001) was an English civil engineer and, along with Karl Terzaghi, is considered one of the pioneers of soil mechanics. He established the soil mechanics program at Imperial College, London. He is also noted for his contributions to the history of civil engineering. He was knighted in 2000 (Wikipedia),

[15] Bill Schriever was a Swiss engineer who worked for the NRC/DBR on the construction of the Toronto subway in the early 1950s. He is introduced in Chapter 12 and its annotations.

[16] Photo of the title page of *Landslides in Clays*.


LANDSLIDES IN CLAYS

*by Alexandre Collin, 1846*

*Translated by*

W. R. SCHRIEVER

*with the assistance of*

J. P. CARRIÈRE, R. F. LEGGET

*and* D. H. MACDONALD

*with a Memoir on Alexandre Collin by*

A. W. SKEMPTON

UNIVERSITY OF TORONTO PRESS 1956

"Translated by W.R. Schriever with the assistance of J.P. Carrière, R.F. Legget and D.H. MacDonald, with a Memoir on Alexandre Collin by A.W. Skempton." D.H. (Don) MacDonald was a student of Legget's at the University of Toronto who, along with Bill Schriever, worked on the Toronto subway in the early 1950s.

## Annotations Chapter 20: "RETIREMENT" YEARS (1969-1994)

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[1] For both the 1st (1939) and 2nd (1962) editions of *Geology and Engineering* and for *Cities and Geology* (1973), Legget did his own subject indexing at the back of his books. Today, subject indexing has become somewhat of a science and is typically done by professional subject indexers.

[2] Legget's geotechnical contributions are listed in Chapter 23.

[3] The titles of almost all of Legget's 108 "Historical Notes" and his six "Historical Geological Notes" are listed in Chapter 23.

[4] LAC 3-6

[5] The awards and honours that Legget received between 1970 and 1976 were as follows:

- 1970: Engineering Institute of Canada's inaugural Julian C. Smith Medal for "achievement in the development of Canada."
- 1970: American Society for Testing Materials Walter C. Voss Award for "outstanding contributions in the fields of geology, engineering and building materials" and for "dedicated service in advancing the cause of standardization."
- 1970: Association of Professional Engineers of Ontario's (now Professional Engineers Ontario) inaugural Gold Medal.
- 1971: Canadian Fire Safety Association Life Member.
- 1971: Association of Engineering Geologists Honorary Member.
- 1972: Canadian Council of Professional Engineers (now Engineers Canada) inaugural Gold Medal.
- 1972: Geological Association of Canada Logan Gold Medal.
- 1974: Association of Engineering Geologists Claire P. Holdridge Award.
- 1974: Standards Engineering Society Leo B. Moore Medal for being "one of the most persistent and vigorous contributors to the field of standards, both nationally and internationally."
- 1976: Geological Society of Belgium Dumont Gold Medal.

[6] Between 1970 and 1976, Legget received the following honorary degrees:

- 1971: Doctor of Laws (LLD) from University of Glasgow
- 1971: Doctor of Engineering (DEng) from University of Liverpool
- 1972: Doctor of Science (DSc) from Thomas S. Clarkson College of Technology (now Clarkson University), Potsdam, NY
- 1972: DSc from Sir George William University (now part of Concordia University), Montreal
- 1972: DEng from the Technical University of Nova Scotia (now part of Dalhousie University), Halifax, NS, and
- 1974: DEng from Carleton University, Ottawa.

[7] The Canadian Geotechnical Society, formed in 1972, was the offspring of:

- the Associate Committee on Geotechnical Research (and its predecessor the Associate Committee on Soil and Snow Mechanics) that Legget chaired from 1945 to 1967 and
- the Geotechnical Engineering Division of the Engineering Institute of Canada which Legget helped co-found in the early 1960s.

[8] "Robert F. Legget award and medal" recipients are listed in the annotations in Chapter 17.

[9] Sandford Fleming is introduced in Chapter 7 and in its annotations.

[10] William Smith is introduced in Chapter 13 and mentioned in the annotations of Chapter 19.

[11] Paul Karrow (born 1930) obtained his bachelor's degree from Queen's University in Kingston (1954) and his PhD from University of Illinois—Urbana (1957). After working with the Ontario Geological Survey for several years, he helped established the Earth Sciences Department at the University of Waterloo in the early 1960s. Karrow also has an interest in archeology and was President of the Ontario Archeological Society in 1963 (Canadian Quaternary Association website).

[12] For comparison, the 2nd edition of *Geology and Engineering* had 884 pages and 315 illustrations.

$94.50 in 1983 would be equivalent to approximately CAD$240 in 2020.

[13] *Musk-Ox* was a journal published by the University of Saskatchewan's Institute of Northern Studies.

[14] The topic of Legget's last news item for *EN-R* was the Government of Canada giving support to CP Rail for its 15-km tunnel beneath Rogers Pass in BC. Excavation for that tunnel, now known as the Mount MacDonald Tunnel, began in 1984 and the tunnel was completed and opened in 1988.

[15] In a 1983 Christmas letter, Legget mentioned the writing of his 1983 geotechnical memoir, "…it finished up as an essay of 35,000 words and almost all from memory which worked like a charm once I got started" (LAC 3-7).

[16] LAC 9-6

[17] LAC 9-8

[18] LAC 9-9

[19] LAC 9-4 and 9-5

[20] The awards and honours Legget received between 1977 and 1984 were:

- 1977: Honorary Member of the American Society of Civil Engineers
- 1977: Engineering Institute of Canada's most prestigious Sir John Kennedy Medal
- 1977: The inaugural William Smith Medal from the Geological Society of London
- 1978: Honorary Member of the International Committee on Large Dams
- 1979: The inaugural John Jenkins Award from the Canadian Standards Association
- 1980: Honorary Fellow of the (UK) Institution of Civil Engineers, which he joined as a Student Member in 1925 and became an Associate of in 1930
- 1983: Honorary Fellow of the Royal Society of Edinburgh
- 1983: Fellow of the Canadian Society for Civil Engineering, and
- 1983: Centenary Medal of the Royal Society of Canada.

[21] The items stolen were, as listed by Legget (LAC 1-11):

- Medaille d'Or of the Canadian Council of Professional Engineers, gold or gold alloy
- Dumont Gold Medal of the Geological Society on Belgium, solid gold
- Logan Gold Metal of the Geological Association of Canada, solid gold
- John Kennedy Medal of the Engineering Institute of Canada, dark alloy
- Julian C. Smith Medal of the Engineering Institute of Canada, dark alloy
- William Smith Medal of the Geological Society of London, silver
- Centenary Medal of the Royal Society of Canada, bronze
- Past President lapel pin from the ASTM, gold with a diamond
- Honorary Member lapel from the American Society of Civil Engineers, solid silver, and
- Watch fob, gold, for evening wear (a family treasure, over 50 years old).

(A watch fob is an ornamental chain that attaches a pocket watch to a pocket in a man's dress coat.)

In 2012, the Logan Gold Medal was found in La Vérendrye Park, approximately 10 km east of Ottawa.

[22] The *Canadian Encyclopedia* was an initiative of Random House Publishers and Mel Hurtig, an independent Canadian publisher. When first published in 1985, the three-volume set sold for $125 and sold out within days of publication (Wikipedia). Legget's contributions were put online in the late 2000s Canadian Encyclopedia-Legget and the short articles have since been revised.

The seven Canadian engineers of the 1800s and early 1900s were: Colonel John By, Simon James Dawson, Richard Hearn, Joseph Hobson, Sir John Kennedy and the Shanley brothers Walter and Francis. The six topics related to construction were: bridges, canals and inland waterways, history of the construction industry, tunnels, the Rideau Canal and the Trent-Severn Waterway.

[23] The *Dictionary of Canadian Biography* began in 1959 and is a collaboration between the University of Toronto and Université Laval. It is arranged chronologically by year of death or last known activity and

currently extends up to 1930 (Wikipedia). It is now available online.

The four biographies contributed by Legget were: Colonel John By, Henry Abraham Duvernet, Thomas Roy and Nathanial Hazard Tredwell.

[24] LAC 10-9

[25] C.J. Mackenzie, Legget’s former NRC colleague and boss, was Chancellor of Carleton University from 1954 to 1968.

[26] In 1983, Legget was scheduled to present a lecture to the Manitoba Section of the Canadian Geotechnical Society on the 1880s construction of the Canadian Pacific Railway. Ken Skaftfeld, a young engineering student at the time who knew little of Legget, helped organize the event. Ken recalls phoning Legget in Ottawa and asking him to confirm his audio-visual requirements. Legget politely replied that he didn’t need anything at all and that if he couldn’t present his lecture without slides, he wasn’t much of a lecturer.

Ken was a little anxious as to how the lecture without slides (“just plain talking”) would go over with the audience—that is, until Legget started to talk. Ken recalls that, “You could have heard a pin drop” the entire time Legget presented his lecture on “The Last Spike.” It’s something Ken has never forgotten. Nor has he forgotten the letter of thanks he received from Legget, addressed to “Mr. Ken Skaftfeld, Esquire.”

[27] The formal founding of engineering in Canada is considered to be the formation of the Canadian Society of Civil Engineers in 1887. In 1918, it was renamed the Engineering Institute of Canada.

[28] Legget’s honours between 1985 and 1994 included:

- 1986: ASCE’s Can-Am Civil Engineering Amity Award “in recognition of his career achievements in research, education and as a consultant to the Canadian and United States governments …. for exemplary career activity which has added to the amity between Canada and the US.”
- 1988: (US) National Academy of Engineering Foreign Associate, the designation given to non-US citizens. The academy was established in 1964 as part of the National Academy of Sciences. Election to the NAE is among the highest recognitions in engineering-related fields.
- 1989: Canadian Public Works Association Honorary Member (Legget was a member of its National Editorial Committee).
- 1989: Royal Bank Award.
- 1989: promotion to a Companion of the Order of Canada, and
- 1992: (US) Public Works Historical Society Honorary Member.

Sometime during this period, Legget also became an Honorary Member of the American Underground Construction Association and an Honorary Life Member of the Rideau Valley Conservation Authority.

[29] Other recipients of the Royal Bank Award included Cardinal Paul-Émile Léger, novelist and playwright Morley Callaghan, architect Arthur Erickson, literary writer Northrop Frye, writer Hugh MacLennan, athlete and philanthropist Rick Hansen, opera singer Maureen Forrester, geneticist and environmentalist David Suzuki, and the previously introduced C.J. Mackenzie.

In 2000, the Royal Bank redirected the award to honour innovative organizations and forward-thinking projects. The following year was the last year the award was presented.

[30] Governor General of Canada’s website

[31] Of the $90,000, Legget gave approximately 30% to religious organizations, 20% to hospitals and care facilities, 20% to schools and universities, 20% to museums and historical organizations and 10% to professional and technical organizations (LAC 1-19 and 1-20).

[32] Several of Legget’s obituaries refer to him writing a book on Sir Alexander Mackenzie, or on “Mackenzie’s River,” near the end of his life. If he did, it appears that the book was not published. His obituary writers may have confused Legget’s manuscript on C.J. Mackenzie with a book on Alexander Mackenzie.

[33] David Legget, personal communication

[34] Legget did not agree with the date given in *125 Years of Halcrow* for changing the name of the firm from

"C.S. Meik and Buchanan" to "C.E. Meik and Halcrow." He thought that the book stated it at least seven years early.

> More serious, however, is the fact that I just can not see for whom the publication is intended! I see that it was prepared by 'Halcrow Group Marketing' (whatever that is). If I were a prospective client, I would not be impressed by the illustrated reference to the failure of the first Tay Bridge, or to the quite tragic career of Sir George Buchanan. If I were a member of staff, past or present, I would expect to see an accurate record of accommodation, and of the chief executive officers. Neither is there.

Legget also regretted the book not having a photo of the firm's original office at 16 Victoria Street in London, a photo that Legget had provided in 1984. In addition, "Some of the illustrations are outstanding but the captions are not up to the same standard… And the use of a copy of a newspaper photo of a locomotive on p 7 is a sad blemish! Some of the 'arty' non-engineering illustrations are merely tedious" (LAC 19-12).

[35] Alexander Mackenzie was the first European to cross the continent of North America.

[36] Alexander Mackenzie's headstone reads, "In memory of Sir Alexander Mackenzie of Avoch. The explorer of the North West of America and discoverer of the Mackenzie River. Died 12 March 1820."

[37] LAC 20-7. The documentary, produced by Josephine MacFadden, is on the CGS website under Virtual Archives at CGS John By Documentary.

[38] It is worth reading Legget's story in his own words, written in March 1994, when he was 89 years old, a month before his death (LAC 9-16).

A GOOD SAMARITAN…1993

> Travel by way of Boston was desirable for my second visit of 1993 to the United Kingdom in October 1993 (to attend the 175th anniversary dinner of Honorary Fellows at the Institution of Civil Engineers, which I joined as a student in 1925!) since I had to come back to attend the annual meeting of the Geological Society of America, in Boston. Accordingly, I flew by Delta Airlines from Ottawa to Boston. Boston Airport had been fogged in and closed for most of the day and so we were much delayed, my plane reaching Boston after my connecting plane to London had departed at 7:00 pm. (We arrived at 7:40 pm.)
>
> Despite the extreme inconvenience of the enlarged Logan Airport at Boston, I finally managed to get to the American Airlines counter at 8:40 pm where I received quite wonderful service, despite the chaotic day that the attendants were then just finishing. Although she must have been tired out, the young lady who served me could not have been more helpful. She first contacted British Airways and found that they had a seat available on their 9:00 pm flight to London. Then she looked at her watch and told me that I could not reach the British Airways counter in one of the other buildings in time to catch the flight! "But I've kept the worst news to the last—there isn't a single hotel room available in Boston tonight." "What shall I do? Spend the night in the Airport?"… "I wouldn't; I'd go to New York."
>
> New York! And in no more than five minutes she had it all arranged—a seat on the last flight out of Boston that night; a room booked at the Midway Motel near Kennedy Airport; and a seat on the American morning flight to London. Her final instructions were, "Now at Kennedy go to the lower level and you will find a shuttle bus and driver waiting for you from the Motel". Most fortunately I had my bag so I was soon in the air en route to New York. Arriving there about 10:30, I followed instructions and went to the lower level but no driver or shuttle bus! "Oh! yes, he was here earlier in the evening but he left long ago." I walked outside and stood on the curb wondering what to do—no room, no US funds! As I stood there metaphorically "scratching my head," a small man got out of a vast car waiting there, Chinese in appearance in a leather cap and windbreaker. He walked over and asked, "Are you in trouble, Sir?"
>
> "Well, not trouble exactly"… "but you look worried"… "I am." When I told him why he wanted to know who booked me at the Midway. "They must be crazy; it's ten miles or more away. We have lots of places round the Airport; I have a little list." …and he took out a small notebook with a dozen

motels listed with telephone numbers. “Now shall I try the first? It’s Chinese, but very clean, nice people and only $65 a night.” When I told him I had no US money *[to make the phone call]*, he said not to worry, he had and would call, which he did. They were full up. “Let’s try the second one, Travelodge.” Back he went to the telephones, coming back to say that they did have a room…” but it’s terribly expensive, $125 a night!” I told him that the airline would be paying for it so let’s book it, which he did, with yet another call. [He came] back to say that all was well; they would radio to their shuttle bus driver who was at the Airport, telling him to wait until I got there “… and I know exactly where he stands so I can show you where he is” which he then proceeded to do. I tried to express my gratitude for this wonderful help, explaining that I had no US funds but asking him if he would accept a Canadian $2 bill to pay at least for the telephone calls. “Certainly not, Sir” was his reply with a broad smile, “if we can’t help a visitor to New York when he’s in trouble, there is something wrong with the world.”

I then said “Well at least tell me your name”… “Wilson”… “And where do you work?” He pulled his windbreaker open, revealing a sweatshirt with the AIRPORT HILTON printed across it. “But, why didn’t you send me there?”… “Oh!, they are far too expensive!”

…all this in New York, in 1993.

The driver of the shuttle bus was equally kind, a rotund, jolly Anglo-Saxon, lifting my bag on to and off the bus, assuring me that my room would be all right and was being held (as it was) and saying that he’d see me in the morning since this was his swing shift, this he did, still jovial, again most helpful, refusing very graciously any tip (I had changed some Canadian money). “Not at all, Sir, it has been a privilege to serve you.” Wonderful day-flight, getting to Heathrow as it was closing for the night but got the last bus to Marble Arch and to my hotel by 11:30 pm that Sunday evening.

[39] These obituaries were in files obtained from Michael Bozozuk and Elizabeth White, in addition to those that are online.

## Annotations Chapter 21: THE LEGGET LEGACY

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[1] Ibrahim Morrison established a rudimentary soils laboratory at the University of Alberta in 1930 (Morrison 1997).

[2] Following are some of Legget's U of T students who went on to have illustrious careers in the geotechnical field.

- Per Hall, Legget's graduate student, went on to become President of FENCO, a subsidiary of the Foundation Engineering Company of Canada, before forming his own consulting firm specializing in underwater tunnels.
- Lionel Peckover: U of T 1944, worked with Legget at DBR and went on to become Chief Soils Engineers with the St Lawrence Seaway Authority, then Engineer of Geotechnical Services for CN and is considered the "Father of Canadian Railway Geotechnique."
- Gordon McRostie: U of T 1944, in 1950 formed the first independent geotechnical consulting company in eastern Canada and continued practicing in the field until he died in 2018.
- Don MacDonald: U of T 1945, worked with Legget on the early Toronto subway system and eventually became President of H.G. Acres and Company.
- Bill Eden: U of T 1949, worked closely with Legget at the DBR and on the Associate Committee on Soil and Snow Mechanics and Associate Committee on Geotechnical Research, and
- Don Bazett: U of T 1949, had a stellar geotechnical career, both with Ontario Hydro and in geotechnical consulting in British Columbia. He served as Editor of the *Canadian Geotechnical Journal* from 1975 to 1980.

Short memoirs of the latter five individuals are on the CGS website (see Chapter 24).

[3] The 73rd Canadian Geotechnical Conference is being held in September 2020 as a virtual conference because of the COVID-19 pandemic.

[4] This research grants program is now known as the Natural Sciences and Engineering Research Council of Canada's (NSERC's) Earth Sciences Research Grants.

[5] In the early 1980s, when the CGS Engineering Geology Division decided to present an annual award for an outstanding contribution to engineering geology, Legget suggested that the award be named after Thomas Roy, an early 1800s British-born geologist who spent much of his career working in Canada and may have been North America's first engineering geologist.

[6] See CGS News in *Geotechnical News* (September 2017) for more on the history of the Cross Canada Lecture Tour. A list of all past Cross Canada Lectures from 1965 to the present are listed on the CGS website. The history of the Canadian Foundation for Geotechnique is on the CGS website under Virtual Archives.

[7] The Associate Committee of Geotechnical Research was disbanded in 1990 and evolved into the CGS's Geotechnical Research Board.

[8] Robert Hardy from the University of Alberta is considered the other "Father", while Ibrahim Morrison, an earlier colleague of Robert Hardy at the U of A, is considered the "Grandfather of Canadian Geotechnique".

[9] See Chapter 23

[10] Eventually Legget found John By's birthplace—across the Thames River from the British Houses of Parliament—and started to arrange for a plaque. Shortly after Legget's death, a plaque was erected at John By's birthplace, paid for by Legget's son, David.

[11] The other streets in the areas are named for: Clarence Farrar, an influential psychiatrist and first Director of the Toronto Psychiatric Hospital/Clark Institute; Omond Solandt, a medical doctor who became the first Chairman of the Canadian Defense Research Board; William Schneider, a chemist who became President of the National Research Council (1967-1980); Gerhard Herzberg, a German-Canadian physical chemist who won the Nobel Prize for Chemistry (1971) and Terry Fox, a Canadian athlete and cancer research activist. Solandt, Schneider and Herzberg were NRC colleagues of Legget.

[12] In the foyer of the R.F. Legget Building there is a display case dedicated to Legget. It contains several pieces of memorabilia including his slide rule, his 1939 textbook *Geology and Engineering*, his (UK) Institution of Civil Engineers member certificate (1944); his Architectural Institute of Canada honorary fellow certificate (1953), his honorary DEng certificate from the University of Liverpool (1971) and his Companion of Canada certificate and medal (1989).

The R.F. Legget Building currently houses the Federal Research Centre for Applied Chemistry. In 2009, the building became a "Recognized Federal Heritage Building." See Canada's Historic Places NRC M-20.

[13] See CGS Heritage Committee. 2020. "Legget Memorial Monument," *Canadian Geotechnique/ Géotechnique canadienne*, Vol 1, No 2, pp 30.

[14] In 2004, the association was renamed the Association of Environmental and Engineering Geology.

[15] The Robert F. Legget award and medal recipients, up to 2019, are listed in the annotations to Chapter 17.

## ABOUT THE BOOK

"What a pleasure it has been to read Doug VanDine's *The Many Sides of Robert F. Legget.* Hours just flew by and I kept reading past my bedtime on a number of occasions. This must have been a labour of love. The attention to detail and the determination with which Doug tracked down additional information convince me of this.

We have Doug to thank for bringing Robert Legget's 1983 unpublished memoir to light and for providing us with a lot of additional interesting information about Legget's life. Legget, one of Canada's fathers of geotechnique, was indeed amazing in so many ways; ways that I did not appreciate those nine years I taught at the University of Ottawa and Legget lived on the other side of the Rideau Canal from me.

*The Many Sides of Robert F. Legget* is a winner!"

*Don Shields, Victoria, BC*
Retired geotechnical consultant, professor and Dean of Engineering, University of Manitoba, Don was the president of the Canadian Geotechnical Society in 1977 and 1978.

## ABOUT THE AUTHOR

Doug VanDine is both a geological and geotechnical engineer, having graduated from Queen's University in Kingston in 1972 (BSc. Eng.) and 1975 (MSc. Eng.). Throughout his career, Doug's primary field of interest has been associated with all aspects of landslides. British Columbia's Drynoch landslide was the subject of his master's thesis and the history of that landslide piqued his long-held interest in the history of the profession of geotechnique in Canada. Doug, a past president of both the Canadian Foundation for Geotechnique and the Canadian Geotechnical Society, is currently Features Editor of *Canadian Geotechnique / Géotechnique canadienne*. He and his wife, Donna, live in Victoria, BC.