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Twenty-fifth anniversary special paper:
Thomas Roy and his "Remarks on road-making" (1841)¹

ROBERT F. LEGGET

531 Echo Drive, Ottawa, Ont., Canada K1S 1N7

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Thomas Roy was a civil engineer and geologist who lived in Toronto from 1834 to 1842; he was probably Canada's first geotechnical engineer. In 1835 he carried out the survey for what would have been Canada's first railway if it had then been constructed. He acted as City Engineer for the fledgling city. Nothing is yet known of his life before 1834 but the search continues. In 1837 he presented to the Geological Society of London a paper on the former, raised water levels of the Great Lakes, based on his field observations while surveying. In 1841 he wrote and had published a remarkable little book on road making, in some ways far ahead of its time; significant extracts are herein presented.

Key words: road building, archival, geology.

Thomas Roy fut un ingénieur civil et géologue qui a vécu à Toronto de 1834 à 1842; il fut probablement le premier ingénieur géotechnicien du Canada. En 1835, il a effectué le relevé pour ce qui aurait été le premier chemin de fer du Canada s'il eût été construit en ce temps-là. Il a agi comme ingénieur municipal pour la ville naissante. L'on ignore encore tout de sa vie avant 1834, mais les recherches se poursuivent. En 1837, il présenta à la Geological Society of London un article sur les anciens rehaussements des niveaux d'eau des Grands Lacs basés sur ses observations accumulées au cours des relevés sur le terrain. En 1841, il écrit et publia un petit livre remarquable sur la construction routière, qui était à plusieurs points de vue bien en avant de son temps; des extraits significatifs sont présentés dans cet article.

Mots clés : construction routière, archives, géologie.

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Part 1. Thomas Roy

Sir Charles Lyell (1797-1875) is widely regarded as the founder of the modern science of geology. The publication in 1830 of the first edition of his *Principles of Geology* was the beginning of the end for the catastrophic theories of the science. It ran to 37 editions and it can still be read with pleasure and profit (Lyell 1830-1833). Although born in England, Lyell belonged to a Scottish family of moderate wealth. Able to travel widely, he paid two extensive visits to North America, the first in 1841-1842 and the second in 1845-1846. And, as was then the custom, he published interesting accounts of his travels, based on his meticulously kept field notebooks. The account of his first visit was published in two volumes in 1845 and is entitled "Travels in North America . . ." (Lyell 1845).

When reading the second of these two interesting volumes, I was stopped in my tracks when I read, on p. 85, that, in Toronto on 14 June 1842, "I found Mr. Roy, the civil engineer, expecting me." A little further on I read about the successive terraces above the level of Lake Ontario "of which he had given an account to the Geological Society of London." A civil engineer and geologist, in Toronto, in 1842! This was clearly something to be investigated. At the time (1966) there was neither time nor opportunity for initiating such a study but a continuing postretirement pleasure has been a search for information about "Mr. Roy, the civil engineer." The results to date, even though still incomplete, are summarized in this paper.

The contribution to the Geological Society of London (estab-

lished, incidentally, before the venerable Institution of Civil Engineers) was easily located (Roy 1837). The unusual title is "On the ancient state of the North American Continent." It was "communicated" to the society by Charles Lyell F.R.S. and read, in part, at a meeting in London on 22 March 1837. The reading was concluded at the next meeting on 5 April.

The summary starts thus: "The author having in the course of his professional duties, discovered in the lake district of Upper Canada terraces or level ridges which agreed in elevation at considerable horizontal distances . . ." and he then proceeds to discuss the origins of, and the reasons for, these ridges, deducing (correctly) that they were old beaches and shorelines. He calculated the volume of water in the Great Lakes due to the higher lake levels, concluding that it must have been discharged through the St. Lawrence, the Mississippi, and the Hudson rivers—in effect giving today's explanation of the variation in the levels of the Great Lakes with the single exception of not recognising that ice sheets were the cause of the higher lake elevations. The summary concludes: "Mr. Roy next details with considerable minuteness, the processes by which he supposes this vast sea was drained; but as his description cannot be successfully followed without the aid of diagrams, they do not admit of being given in the Society's Proceedings." No trace of the diagrams has yet been found.

Just how Thomas Roy met Charles Lyell is not known, only four letters from Roy (apart from some about his work in Toronto) having yet been found. But it is clear that Roy's work had impressed Lyell, since he arranged to meet with him during his 1842 visit to the United Province of Canada. From Lyell's book, it would be assumed that this first meeting was in Toronto, but a study of Lyell's field notebooks suggests that they might have met first in Niagara Falls, since the notes contain a number of references to what "Mr. Roy says" and also to "riding with Mr. Roy" (Lyell 1842). They also contain references to what Mr. Roy had observed in excavations! Lyell's

¹This paper was prepared to mark the 25th anniversary of the first issue of the *Canadian geotechnical journal*. It was written at the invitation of the Editorial Board of the *Journal* and has been subject to the normal review process. It is one of a short series of special papers in Vol. 25 that look back to the early days of geotechnical engineering in Canada, and forward into the future of the profession.

notebooks contain almost exclusively records of field observations, with some notes about discussions with those whom Lyell met, but very little about travel or accommodation.

The discovery of the complete lifetime set of Lyell's notebooks by Canadian-born Dr. Leonard Wilson, now Professor and Head of the Department of the History of Medicine at the University of Minnesota at Minneapolis, is a fascinating story. Dr. Wilson had been studying the life of Darwin but, on finding how much Darwin relied on the field observations and writings of Lyell, he redirected his attention to Lyell. He has already produced the first of two (or more) volumes on Lyell's life, which will clearly be one of the outstanding scientific biographies of this century (Wilson 1972). He was able to have made a complete set of photocopies of all the contents of the field notebooks and gave me the privilege of examining, while I was teaching a graduate course at his University, the three books in which Lyell recorded his 1842 visit to Canada (from 8 to 29 June 1842). The notes are often roughly written, clearly "on the spot," but each book is meticulously indexed in a beautiful feminine hand, probably a labour-of-love on the part of Mrs. Lyell.

In Toronto, Roy took Lyell to see the ridges north of Toronto and seems to have gone with him some distance to the east of the city, before Lyell proceeded on to Kingston, Montreal, and Quebec City, then to the United States through Burlington, Vermont. They were certainly together on 16 June 1842 but, on 28 July 1842, Thomas Roy died "at his residence, Newgate Street." The notice of his death gives no details of the man himself, his family, or his fatal illness, but concludes with these words: "During the late visit of Mr. Lyell, the Geologist, to this city, Mr. Roy was his constant associate whilst examining the country; he warmly entered into Mr. Roy's views, and expressed himself quite astonished at the important and valuable results of his unaided, unheeded, and unrewarded labours."

Small wonder that so little is known about, and that so little attention has been paid in the years between to, Thomas Roy—so clearly the first geotechnical engineer of Canada. It is appropriate, therefore, that in this first special paper marking the 25th anniversary of the founding of the *Canadian geotechnical journal*, the best possible account of Thomas Roy's life and work should be featured, incomplete though it has to be, together with the essential parts of quite a remarkable little book that he wrote. Even what is now known about his life and work can be an inspiration to geotechnical engineers of today, his careful observation of geological features in all the works upon which he was engaged being an example that geotechnical engineers should always follow. The "observational method," so strongly urged by Dr. Ralph Peck and others, has a long history.

Roy's work in Toronto

The obituary notice about Thomas Roy, an unusual feature in a newspaper of that time, was unsigned. It contains this statement, as well as that just quoted: "The death of this gentleman will prove a public loss, as he not only planned and carried into execution the various public improvements which have raised this city to its present state of prosperity, but he has for years employed himself in examining into geological features of the Province, and sometime since presented to government a geological section of the country passing from the coal field of Pennsylvania through the Niagara District and the Home District to the Granite Rocks beyond Lake Simcoe."

And all this was after a residence of only eight years in the small city, the change from the village of York having taken place just before Roy's arrival.

Even if the statement were written by a friend of Roy, it yet remains a remarkable tribute to his activity in Toronto, with the reference to the great geological section suggesting that he had done a good deal of travelling outside the Toronto area. The geological section was seen and admired by William (later Sir William) Logan soon after his arrival to be the first Director of the Geological Survey of Canada, since it is mentioned in one of his notebooks.

Diligent search has been made for the section in all the possible repositories available today, but without success. The consensus of those consulted is that since it was "presented to government" it must have been placed in the safekeeping of the legislative library. One of the great tragedies of the story of the records of early Canada is the number of fires that have affected the main legislative libraries. Bad fires occurred in 1849 (Montreal), 1854 (Quebec), and 1909 (Toronto). It can only be assumed that this unique geological record was destroyed in one of these fires, with no copy elsewhere.

The first reference to Roy's life in Toronto is contained in a letter that he wrote to the mayor of the city on 6 March 1835, applying for the position of engineer to report on Toronto Harbour and the possibility of a cut through the peninsula. In this letter he says that "when I came here in July last [i.e., 1834] I was desired to inspect the Harbour Bay . . . I spent upwards of a week in investigating Ashbridge's Bay." He is not listed in the directory for Little York for 1833–1834, nor in that for Toronto for 1843–1844, but he is listed in the city directory for 1837 as living on Peter Street. It therefore seems clear that he resided in Toronto from July 1834 until the time of his death in July 1842.

The original of Roy's first report on the state of Toronto Harbour was found almost by chance in the map library of the (former) Department of Lands and Forests of Ontario.² The report is dated 12 August 1834 and is headed "Remarks on Mr. Richardson's pamphlet on the improvement of York Harbour." (A photocopy of this early report was sent to the Metropolitan Toronto Reference Library, which did not then have a copy, and to the Chief Engineer of Toronto Harbour Commission.) It is an interesting review, concerned mainly with the discharge of the Don River into the harbour and the silting up, which was then giving cause for concern. It does touch upon the idea of making a cut through the peninsula near Ashbridge's Bay but, strangely, Roy did not realise that the peninsula had been formed by littoral drift coming from the east along the shore of Lake Ontario.

He was appointed by the city in March 1835 to report again on the Harbour, this time with Captain R. H. Bonnycastle "appointed by the Governor." His 23-page report is dated 31 March 1835, so he had clearly lost no time in carrying out his study. He refers to "Mr. Bonnycastle's excellent chart" in his clear and well written report. He gave a more extended review of his ideas on the Harbour and its formation in the second of two lectures he delivered to the Toronto Mechanics Institute. This was published in 1841 in the first volume of a very rare publication, the *Monthly review* of the Mechanics Institute, "devoted to the civil government of Canada." The lecture

²Instead of attempting to give individual references for unpublished material mentioned herein, the Appendix to this paper summarizes the depositories in which it may be found.

contains many references to Roy's geological studies in the Toronto area but still fails to account for the formation of the peninsula, now Toronto Island.

The "Mr. Bonnycastle" to whom reference is made was Captain Richard Henry Bonnycastle, an officer in the (British) Corps of Royal Engineers, who gave distinguished service to Canada, for which he was knighted in 1837. He was clearly attracted by the new country that he served so well and in 1846 (when he was a Lieutenant Colonel) he published a two-volume work entitled *Canada and the Canadians—in 1846*. This is a delightfully discursive review of the Province of Canada and its people (in 1846), including such exotic diversions as a recipe for a sherry cobbler! (Bonnycastle 1846) He, too, formed a high opinion of Thomas Roy, since on pp. 1–6 of his first volume he has this to say: "Lyell visited these (ridges) with the late Mr. Roy, a person little appreciated and less understood by the great ones of the earth at Toronto, who made an excellent geological survey of this part of the province . . . and no one has done him even a shadow of justice, but Mr. Lyell, who, having no colonial dependence, had no fears in so doing." He refers also to Mrs. Roy's difficulties after her husband's death in obtaining recompense for work that he had done.

Between his two surveys of Toronto Harbour, Thomas Roy carried out the survey of the route for what would have been, had it been constructed, Canada's first railway. On 23 September 1834, Roy was engaged by a group of Toronto business men to "make a survey of the line of country between Toronto and Lake Simcoe . . . for a Canal or Railway between the above-named places." The letter of instructions then proceeds to give in detail (certainly too much detail) what the committee hoped that the survey would reveal. One instruction is significant—Roy was "to note the soils." He was to consult with the committee on various parts of the work and he was saddled with the services of D. Gibson as an assistant, a young man who proved to be most unreliable.

This is the only project carried out by Roy of which a reasonably complete record exists. He was meticulous in reporting to Mr. James Newbiggin, for the committee, and some of his letters, as well as the original letter of instruction, have been preserved in the Allan papers in the Metropolitan Toronto Reference Library. The story has been well summarized by Professor F. H. Armstrong (Armstrong 1966) and more briefly by the present writer (Legget 1979). And Roy was to be paid the sum of £50 for the entire survey!

The letters report the progress being made, very rapidly considering the virgin country through which the line was run, after a quick start before the end of September. The letters gradually decrease in their interest, however, as Roy's financial problems with the committee became more serious. As early as 13 October, he had to report that "he had not quite sufficient to pay the men." Later, when the survey was substantially complete, he reported that the total expenditure from 9 November to 25 December amounted to £65-12-6, his own fee being £1-5-0 per day for 31 days. The total amount paid to Roy appears to have been £72-12-5 but the committee had been able to raise only £75-12-5 in subscriptions!

This is not the place for any further detailed account of the railway survey nor of Roy's subsequent altercation with the committee, the last sad letter being dated 18 July 1836. It is to be remembered, however, that it was this survey that probably introduced Roy to the raised beaches above the present level of Lake Ontario, to which he then proceeded to devote such wide-

ranging study. Long before the date of the last letter, he had been engaged by the city, presumably on contract, to supervise work on roads and sewers, and this work, apparently, occupied much of his time for the rest of his life. There were interruptions. In September 1835, for example, he handed in his resignation to the Commissioner of Paving and Drainage because of political interference, his letter being one of the few such records that still exist. It is to be found in the early city council records, now in the safekeeping of the Archives of Ontario. These contain just a few interesting details such as an estimate for macadamizing Bay Street south of King Street, but the records close with a letter from R. L. Mainguy, Civil Engineer, written in Kingston on 3 August 1842, applying for the position "left vacant by the death of Mr. Roy."

This suggests, rather definitely, that Roy had the position of City Engineer. The records in the City's own archives are, unfortunately, sadly lacking on such matters. Thomas Young, an architect, is listed as being at one time first City Surveyor but it is known, from other sources, that Thomas Roy did all the work. Much of the writing in his "Remarks on road making" (see Part 2 of this paper) were clearly based on his own practical experience but few written records have yet been found to show just what he did to "raise this city (Toronto) to its present state of prosperity," as his obituary notice stated.

Still less is known about his personal life. His letters from the railway survey contain a reference to Mrs. Roy, and also to "his family," so presumably they had children. His relatively sudden death may possibly explain why no record of his will is to be found in the early listings of the Surrogate Court (now also with the Archives of Ontario). Even stranger is the fact that no record has yet been found of his burial place, despite enquiries to all known holders of records of burials in Toronto at the time of his death. The excellence of his work makes this absence of personal information the more tantalizing. Having exhausted all available Toronto records known to me, I was led somewhat naturally to follow up leads elsewhere. A very brief summary of the results of this further, and continuing, search may be usefully included in this paper in case it may come to the attention of someone who does have further information about Roy, or who can suggest other lines of inquiry.

The continuing search

The few examples of Thomas Roy's writings that have so far been found, as well as the small book on "Road-making," shortly to be described, show that he was a gifted and fluent writer. The widespread geographical references in his geological writings suggest that he must have kept careful notes, so that possibly there may be somewhere a set of his field notebooks awaiting discovery just as did those of Charles Lyell, stored in the Lyell ancestral home until discovered by Dr. Wilson.

A clue for a start at inquiring about Roy's further writings was provided by an almost passing reference in one of his geological writings to James Hall, the distinguished founding Director of the New York State Geological Survey. Inquiry was therefore made of the state archives in Albany. The staff there were most helpful and clearly went to some trouble before having to advise me that no letters from Thomas Roy to James Hall could be found. By chance, I mentioned this further disappointment to Dr. Donald Fisher, the State Paleontologist of New York when, also by chance, we were joint chairmen at a geological meeting. Dr. Fisher did not forget my passing comment and, when back in Albany, paid a special visit to the

state library to search the records himself. He found the originals of four letters from Roy to Hall, photocopies of which he was good enough to send to me. They were treasures indeed.

Their interest is mainly geological, somewhat naturally. It is hoped that eventually they may be published in full in an appropriate geological journal. They contain, however, a few clues with regard to Roy's life and work and so will be briefly reviewed. All written in a firm, clear hand, their fluency confirming, yet again, what a singularly articulate man was their writer. All were written from Toronto, the first from Bishop's Buildings, and sent to James Hall at Albany, or to Gorham, New York, by the pioneer postal service then in operation, the markings of which would be of interest to philatelists.

In the first letter, written on 24 August 1838 (about 2500 words long), Roy introduces himself to Hall and comments most favourably upon reports from the *New York survey* published in 1837. He indicates his personal interest in many of the matters therein discussed and asks, most politely, if he may comment upon them. ("I might state several other shades of difference, but I am too well satisfied to become a critic, especially as my own observations are far from being perfect.")

Hall must have replied to this letter equally cordially, since Roy's second letter, dated 6 May 1839, is considerably longer (about 3300 words) and is accompanied by an appendix consisting of extracts from a paper by Roy about the probability of there being "extensive fields of bituminous coal in Upper Canada." In his opening paragraph he says that "... I thought it better to refer to what I had recorded for during the past year the distractions caused by the fooleries which have been acting produced so much derangement that I may say I had no opportunity for further observation." This is his only comment on the turbulent political times through which he was then living, his expression "fooleries" being in itself an interesting commentary. He refers to the area where the St. John and Connecticut rivers have their sources, the inference being that he had been there, although later he says, "You may be surprised that I am not better informed concerning that opening at the Headwaters of the Connecticut and St. John's rivers but the fact is that Major Yule of the Royal Engineers conducted the survey for the New Brunswick and St. Lawrence Railway [which was to pass through this opening] under the auspices of the British Government; his operations were carried out until late in the season; he was thus compelled to proceed to England before he had time to make up his report. Copies of the report were sent to the provincial governments but the section, etc., are in England and I had no opportunity of procuring any information from himself..."

This is all in connection with the upper reaches of the Chemung Valley, of importance in connection with the draining of the early Great Lakes. (The railway had been proposed as a defence measure in the Carmichael-Smythe report of 1825.) This letter also contains references to "polished rocks" but both the United States and Canadian observers still believed that the polishing was the result not of ice action but of the abrasive action of rocks carried along by floodwaters. The letter concludes with a gracious offer to guide Hall over "our scenery" but he could not "enter upon any arrangements for it is extremely probable that I shall be ordered to Halifax to make preparations for an overland communication in connection with the line of steam packets established by the British Government." This most significant statement appears to be a reference to the proposal for a railway between Halifax and

Montreal, the survey for which was finally carried out (in accordance with the promise included in the British North America Act of 1867) by Sandford Fleming 30 years later, leading to the building of the Intercolonial Railway.

The third letter is shorter (being only about 1500 words long), written on 2 May 1840, in response to one from Hall, but in some ways it is the most interesting. Roy refers in it to the geology of Mexico City and to the work of the "Azteque's." He wants to come down and take levels along the line of the projected railway between Albany and Boston. He is determined to visit the Mississippi River to take levels there, just as he had already done along the south shore of Lake Erie. He had a paragraph on experiments he has been conducting on making cement from local limestone. Then he says, "I am perfectly acquainted with travelling in England," proceeding to give precise advice as to how best to see British geology, giving a route that will "carry you over every outcrop of the English formations." And he concludes by saying that he has been just "ordered upon a tour of inspection where I shall have many opportunities of observation in parts which I have not yet visited." One wonders where? And he sends his regards to Mrs. Hall, so they must have met.

The fourth and final letter is quite short (about 600 words) dated 13 January 1842 and is mainly about his concern at not having heard anything about the visit of Charles Lyell, being arranged presumably by James Hall. But, typically, he includes hastily written notes on some new observations, such as, "Last summer in making an extensive excavation through the blue clay and into the secondary shale underneath I was surprised to find the surface of the shale water worn and as closely covered with large boulders as any ridge or hill top you ever visited... every one of which was of the primary or protruded class of rocks and of Northern origin." And again, "In making an excavation not far from the Lake where the blue clay was reduced to 10 or 12 feet in thickness and the Brown surface clay 12 or 15 feet thick regularly stratified over the blue clay, we found several organic remains deposited in the broken strata of the blue clay, amongst other things a piece of wood cut into shape by a stone hatchet or some other blunt instrument. It had the marks of a withe twisted round its middle and no doubt was used as a mallet. It was found 23 feet below the present surface of regularly stratified clay." One wonders where it is now!

The reason for making this extended reference to the four letters will now be clear. They give some indication of Roy's travels, especially in England (could Bonnycastle have been responsible?); of his wide reading (that reference to the Aztecs); and of his astute observations even in excavations carried out in the course of his engineering work in Toronto. And they reinforce the hope that one day more of his writings will be found.

What of the man himself, and his life before 1834? This was a complete blank and so one had to write him off as a "mystery man." I used this expression when once talking with Mrs. Zena Cherry, writer of a well-known social column in the *Globe and mail* of Toronto. She kindly offered to mention Roy in one of her regular columns and did so on 1 February 1978. Six letters were received as a result. Five expressed interest but nothing more. The sixth letter was from Mrs. Susan Hubbard of Fort Erie, who told me that on p. 668 of the *Winslow papers A.D. 1776-1826*, published by the New Brunswick Historical Society in 1901, there was a reference to land having been surveyed in 1814 by "Mr. Thomas Roy." The population of

British North America was then so small that the possibility of there being two surveyors of the same name, even in such widely separated parts of the country, seemed somewhat remote. So anxious was I to leave no stone unturned in my search for Thomas Roy's origins that, on my next visit to New Brunswick, I arranged to see the originals of the Winslow papers in Fredericton.

The originals of these most valuable records are in the safe-keeping of the Archives and Special Collections section of the Harriet Irvine Library of the University of New Brunswick. Miss Mary Flagg, who was in charge of this fine collection, had kindly looked up for me references to Thomas Roy, three in number. The first is a two-page report to Edward Winslow (the Deputy Surveyor General of the Woods in the province of New Brunswick) from Wm. Ferguson, dated 30 May 1814, containing the reference given me by Mrs. Hubbard. Mr. Munro had been Ferguson's informant; he is identified as of St. Peter's (now Bathurst). The second is a permit, signed by Winslow, issued to Matthew Stewart, a merchant of Nouvelle, Quebec, allowing him to export wood from New Brunswick "when surveyed and inspected by Thomas Roy, Deputy Surveyor of Woods in that district." The third is a two-page letter to Winslow from St. Peter's, dated 8 May 1810 and signed by Thomas Roy, signing himself as above. It was not possible to compare directly the writing of this letter and its signature with the letters written to James Hall, but the signature certainly appeared to me to be very similar, if not identical to those of which I had copies. This suggested that Thomas Roy might have been a native of the northern part of New Brunswick and started his career as surveyor of woods, a possibility reinforced when a study of a surveyor's record and letter book (another treasure of the University of New Brunswick Library) gave the names and land holdings of two Scottish immigrants named George and James Roy.

This in turn led to me to Mrs. Mary McAllister, of Newcastle, New Brunswick, widely known as the local historian of the Miramichi, and she, in turn, was most helpful and directed me to Miss Deborah Frost, the Registrar of Deeds for Northumberland County, which includes the mouth of the Miramichi River—for this is the Miramichi country. While other old records had usually been incomplete, the land deeds for Northumberland County were a joy to examine, so complete and well indexed are they. It was, therefore, easy to find that George Roy's land grant was made on 13 September 1785 when he had just arrived from Scotland; and that James Roy had also received a grant of 150 acres, having also come from Scotland but in 1786. There were other Roys named in the land grants but internal evidence showed that they were probably Acadians, the use of the same surname in French and English complicating the search to some degree. George Roy is variously described as a "fisherman" and "Mariner." Then came a sudden end to this line of inquiry, since George Roy died intestate and his widow, Jean Findlay, residing at "Boat Bridge" in Scotland, appointed James Roy as the executor of the estate, the only son and daughter of George Roy being "William and Isobel."

Attention was then turned to James Roy, who, in one entry, is said to have had a large family. In the records for 1824 there is a long document regarding the executors of James Roy of the parish of Newcastle, one of them being James Thompson of Chatham, the minister of the Scottish Presbyterian Church. This has now become the United Church of Chatham. Since many early records were held by churches, there seemed to be

a hope that old records might still be in the possession of the present-day United Church but the minister, the Reverend Mr. Miller, had to tell me that he knew of no records of that early period.

A number of historians of New Brunswick have since been consulted but no new "leads" have been uncovered. Examining the old documents in Fredericton and in Newcastle combined to give me a strange, but perhaps irrational, feeling that I was finally on the trail of Thomas Roy's origin but this had yet to be confirmed. The search is being pursued in Scotland but with rather slim hopes of finding that Thomas Roy was one of the sons of James Roy, of the Miramichi. This finding would be entirely fitting in that men of the Miramichi have made their mark in many walks of Canadian life, while the Scottish emphasis on education for children would readily explain the remarkable career of Thomas Roy, as so briefly recorded in this paper. But all this is mere surmise; the final proof has yet to be found.

What has been found, however, are two or possibly three copies of a small book written by Roy and published in 1841. It is such a significant geotechnical publication that Part 2 of this paper consists of a series of extracts from its text, so that they may speak for themselves, linked together by only the briefest of explanatory comment.

Part 2. The treatise on "Road-making"

Thomas Roy's *Remarks on the principles and practice of road-making, as applicable to Canada* was published in 1841 as a small pocket-sized pamphlet of 42 pages. It was printed and published by H. & W. Rowsell of Toronto on fairly thin paper, for the time, with the result that the few remaining copies are frail indeed. Quite the best is that in the Special Library of the Public Archives of Canada, not the National Library of Canada, although both are in the same building.

As can be seen from Figs. 1 and 2, it was dedicated, in the manner usual at that time, to the Governor General of British North America. It is significant that this was Lord Sydenham. Coming here as Charles Poulett Thompson, this fine man would have been an inspiring leader for the union, in 1841, of the two provinces of Lower and Upper Canada had he not been killed in a fall from a horse when in Kingston in that same year. Prior to this, however, he had been assisted in the start of his work by a large Imperial loan with which he was able to sponsor a new round of public works, including road building. It was probably in this way that Thomas Roy had met him.

The pamphlet is about 13 000 words long, too long to be quoted in full in these pages. By arrangement with the Editor, therefore, all the more significant parts of the contents are here given, with only such linking comments as seem to be desirable. The booklet starts with this resounding declaration:

One of the first objects which occupies the attention of an energetic people, when they are striving to advance in the march of improvement, and to take a higher standing amongst the nations of the earth, is the forming and establishing of roads and other mediums of communication, in order to promote the development of the resources of their own country, and to enable them to maintain a commercial and social intercourse with foreign nations.

After explaining that almost the whole of the population of Upper Canada (this was written before 1841) were "natives or descendents of natives of countries where such lines of communication are established," he proceeds:

REMARKS

ON THE

PRINCIPLES AND PRACTICE

OF

ROAD-MAKING,

AS APPLICABLE TO CANADA.

BY **THOMAS ROY,**
CIVIL ENGINEER.

TORONTO:

H. & W. ROWSELL, PRINTERS, KING-STREET.

1841.

FIG. 1. Title page, from the original "Remarks on road-making" by Thomas Roy.

Upon the first laying out of the Townships in the Upper Province, even a superabundance of reserves was left for roads; but these concession lines and side-lines run straight on, across ravines and rivers, over hills, through swamps, lakes and other hindrances, and could never have been intended to serve as leading lines of communication when the Province became settled and good roads became necessary for the conveyance of produce and goods to and from distant markets. Their intention is to serve the same purpose as the parish roads of England, or to connect the various parts of the Townships with leading roads, to be constructed upon proper locations, and in proper directions, as circumstances may require.

The purpose of the booklet is:

... to draw attention to the best and most economical methods of constructing leading lines of roads throughout the Province, in such locations as shall most effectually open up every part of it, and progressively develop its vast resources. One objection to forming a general system of common roads in this Province may as well be met here. It is often said, why lay out large sums upon common roads; they will soon be superseded by railways? Those who raise this objection, do not appear to have taken a very

TO HIS EXCELLENCY

The Right Honourable Charles, Baron Sydenham,

OF SYDENHAM, IN THE COUNTY OF KENT, AND OF TORONTO, IN CANADA,

ONE OF HER MAJESTY'S

MOST HONOURABLE PRIVY COUNCIL,

GOVERNOR-GENERAL OF BRITISH NORTH AMERICA,

AND

CAPTAIN-GENERAL AND COMMANDER-IN-CHIEF

IN AND OVER THE PROVINCES OF

CANADA, NOVA-SCOTIA, NEW-BRUNSWICK, AND THE ISLAND OF PRINCE EDWARD,

AND VICE-ADMIRAL OF THE SAME:

THESE REMARKS,

ON THE

PRINCIPLES AND PRACTICE OF ROAD-MAKING,

AS APPLICABLE TO CANADA,

ARE, BY PERMISSION,

MOST RESPECTFULLY DEDICATED,

BY HIS EXCELLENCY'S

VERY OBEDIENT SERVANT,

THOMAS ROY.

FIG. 2. Dedication to the Governor General of British North America, from "Remarks on road-making."

accurate view of the subject. Railways are of great and paramount advantage to densely populated countries, where there is great travel, and a constant transit of goods; especially between shipping ports and manufacturing towns, or, in mining districts from the mines to the works, or to the shipping ports; but it is doubtful if there are more than three or four locations in the Province of Canada where railways are really required, and where the returns would pay a dividend upon the cost of construction, for at least twenty years to come.

Two pages follow discussing the geographical aspects of transportation in Upper and Lower Canada, including this perceptive comment:

Above Montreal, the Ottawa River will (when locks are constructed at the rapids) afford four hundred miles of inland navigation. These locks, common roads, and a few branch canals to the small lakes, would most entirely open up the Ottawa Valley to the ocean. Again, were common roads constructed, the whole of the country between Montreal and Kingston would be rendered accessible to the ocean by the St. Lawrence River and the Rideau Canal.

Roy must have read some of the early publicity about the Georgian Bay Ship Canal! Typical of his own advanced thinking is his next section:

But there is another aspect, equally important, in which the subject ought to be viewed, that is, the probability that railways may

be rivalled by steam-carriages upon common roads. This is no chimerical idea. Great exertions are making at this present time to bring these carriages into use, and every season produces some further improvement. The chief hindrance has been the steep activities still to be found on many of the old roads in England. It is however allowed, by the ablest Engineers who have studied the subject, that steam-carriages could work well on common roads, provided there were no activities exceeding one in thirty, and that there were no sharp turns upon the roads. Upon such roads they grant that steam-carriages could convey goods and passengers at a velocity of sixteen miles an hour. This fact ought not to be lost sight of when laying out new lines of road in Canada, for, owing to the general levelness of the country, there are few situations where a skillful Engineer would fail in obtaining lines of road with activities even less than one in thirty, without materially increasing the expense, provided he had full liberty to choose the location.

He then divides his main subject as follows:

- First—The laying out of a road.
- Secondly—The formation of a road.
- Thirdly—The materials for making a road and the methods of applying them.
- Fourthly—The causes which have produced constant failures in attempts at road-making in this Province.
- Fifthly—the means by which failures may in future be prevented.

His remarks on laying out of roads are all based on common sense, such as,

In selecting a line of road where two lines present nearly equal advantages and disadvantages, the cheapest road ought to be preferred, but in making the selection reference ought to be had, not only to the original cost of construction and the future repairs, but also to the relative expense of animal strength required to draw carriages upon each line . . . [and] . . . Roads ought to be carried along a level line as nearly as possible, and having only gentle activities and declivities, for a greater distance on a road nearly level, is productive of less expense of animal strength, than a lesser distance passing over considerable elevations. Hence the necessity of carefully selecting, examining and levelling every proposed line of road.

Platitudes? But this was written in 1841! To support his contentions about the use of animal strength he gives four tables. The tables are of little interest today, but Roy's explanations of them are:

Tables Nos. 1 and 2 are drawn from a series of experiments made on the Holyhead Road by order of the Parliamentary Commissioners. No. 1 was on a well formed and well consolidated part of the road. No. 2 was on a portion of the road made with limestone but less perfectly formed and not so well consolidated. It may be added that the results agree very nearly with the results of the theoretical formula, 'That the required force of traction is inversely as the cosecant of the angle of inclination'. The table No. 3 is calculated from Professor Leslie's formula for the force of traction exerted by horses—which has also been verified by numerous experiments. The table No. 4 was calculated by Mr. McNeil, Assistant Engineer on the Holyhead road, from data obtained in the course of making the experiments from which tables Nos. 1 and 2 are drawn.

In support of the value of the tables, Roy quotes from "the late Mr. Telford's" evidence to the Parliamentary Commissioners, indicative of his wide reading. He next deals with "The formation of a road":

The width of the road in this Province appears to be established at 66 feet. This width (except in the vicinity of towns) we con-

sider to be too much, for it requires too great a rise in the middle to keep the road dry, and consequently increases the cost of formation and repair, without producing any equivalent advantage. We would propose 48 feet as the width of the road, that is, 5 feet for a ditch on one side of the road, 38 feet for the carriageway, and 5 feet for a footpath on the other side of the road. This width will be found adequate for every purpose required.

After describing the preparation of the ground surface for grading, he urges very logically that deep cuttings be avoided. Then comes one of the most significant passages in the booklet:

Drainage is an affair of primary importance in road-making, and requires much skill to execute it in a proper manner. The ditch ought to be on that side of the road whence the flood water flows toward the road. Its capacity should be regulated by the quantity of water which it has to convey, and the distance to which it has to carry it before reaching a lateral outlet. Lateral outlets should be capacious, and, if possible, frequent. The strata of the soil should be carefully studied, and means used to convey all water from springs, however small, into the ditch. It may even be necessary to carry the process of drainage far beyond the area of the road, but no general rules will apply to such a case.

He describes how the cross section of the road surface should be shaped "in the form of the segment of an ellipsis," how a footpath should be formed "at the same elevation as the centre of the road," how culverts should be installed deep enough to avoid interference with the road surface, and how "road metal" should be placed, concluding thus:

The cost of so forming a mile of road in the forest, — taking out the roots of trees, etc., etc., (exclusive of deep cutting and embankment) will be from £220 to £280, — varying according to the nature of the soil, the strength of the timber, etc., etc.,

Roy turns next to "The materials for making a road," this being a discussion of the preparation and placement of "road metal," the term then used to describe broken stone for road use. He urges the use of thin layers (4-6 in) and proper compaction of each layer, using the word "compaction" in the generally accepted usage of today, as illustrated by this passing comment:

The broken stone should never be shot out in cart-loads, or even in wheelbarrow loads, and then be spread out upon the road. In every case, it should be taken out of the cart, or wheelbarrow, by shovels and spread evenly and regularly upon the road, so as to promote an equal consolidation.

After again describing the essential curvature of the cross section of the finished road surface, so as to ensure good drainage, he says:

This curve is quite sufficient to drain off the water, and it is strictly in accordance with the required strength of the road at the centre and the side, for, by observation, it is found that on a road much used by waggons, the waste is in the following proportions: —

Action of the atmosphere	20 per cent.
Carriage wheels	35 per cent.
Horses' feet	45 per cent.

Therefore, if the atmospheric action and the action of the wheels be diffused in a nearly equal degree over the breadth of the road, and the action of the horses' feet be most frequently be on, or near the centre, it follows that the centre ought to be stronger than the edges in the proportion of 7 to 9.

His continuing appreciation of the importance of drainage is again indicated by:

Hollow arching of the materials ought to be carefully guarded against, for a percolation of water from the surface will take place wherever it exists. This hollow arching cannot be avoided when the full thickness of the metal is put on at once, therefore it ought never to be done . . . [and] . . . In this country, the roads sustain much injury from heaving up by the frost. This would be, in a great measure, prevented by adopting a better system of drainage and it would be still further remedied if, when forming the metal-bed on a clay soil, a few inches of vegetable mould were placed over the clay, and the broken stone placed upon the vegetable mould.

Here his recognition of frost action in soils is the significant aspect of his writing, even though his proposed solution would be less than adequate. He then gives some details about the wear of road surfaces in England:

In Canada, so far as our experience guides us, it would appear that the wear of materials upon a firm, well-formed road is even less than the wear of materials in England. This no doubt arises from the transitions from wet to dry, being less frequent. It is only during a few weeks in the autumn, and at the going off of the frost in spring, that roads in Canada suffer much from atmospheric influence. We may instance the streets of Toronto, which are constructed upon the same principle as the best English roads. King Street was paved on the sides and formed with broken stone in the centre in 1836. During the previous year, a common sewer had been constructed under the centre of this street, and the earth over the sewer imperfectly consolidated. For almost the distance of one third of a mile, in the most frequented part of the street, the thickness of broken stone averaged nine inches. At this present, time after five years wear, the average thickness exceeds seven inches; or, the wear on this much frequented road has been about one third of an inch per annum. This street has been much broken up by putting drains from new buildings to the common sewer and in a few places by the subsid-ing of the earth over the common sewer. Had it not been for these causes it is probable that up to this time, it would not have required any repairs. Nearly another one half mile of the same street was constructed during the same season, with an average thickness of eleven inches of broken stone; the wear upon this portion does not appear to exceed 1 inch, and the only apparent injury arises from the causes above mentioned.

Then comes a somewhat detailed discussion of the rock types suitable for use as "road metal," with a warning that if gravel be used it must first be screened and all pebbles broken "for consolidation." His estimates of cost per mile of road have historic interest only—£1491 exclusive of deep cuttings, bridges, etc., or only £879-15-0 if limestone is used as the road metal. Next come 12 pages (by far the longest section) on the construction, maintenance, and questionable economics of plank roads, introduced thus:

There is a system of road-making that has lately been pushed into notice, and which has excited considerable attention in this Province, namely, laying down stringer pieces on the central part of the road, and covering them with 3 or 4 inch planks. This system deserves serious consideration, for a benefit will arise to the country from it, should it prove to be useful, but a great and certain loss to the finances of the Province must be the result if it is over-rated, and is placed in the way to divert funds and attention from better, and even more economical systems of road-making.

Despite, or more probably because of, his basic objections to plank roads in comparison with well-constructed "metalled" roads, Roy presents a most detailed analysis of the advantages and disadvantages of plank roads, starting with a discussion of the strength of timber, with this conclusion:

These results are important, for they show us that, in order to obtain a road which will be firm under ordinary pressure, it must be laid with 4-inch plank, — that 3-inch plank will vibrate and soon become loose, — that 2-inch plank will vibrate so much that it cannot be kept firm in its position, — and that 1-inch plank is unsafe, and may break under an ordinary load. Now, it may be objected, that 1-inch plank, or 2-inch plank, will not be used for road-making. We grant that: but it does not change our position, for 4-inch and 3-inch planks will soon wear down to these thicknesses. — These results fix the ultimatum of useful wear in a 4-inch plank to be 2 inches, and in 3-inch plank to be 1 inch . . . The action of hammering or rolling, as is well known to the Indians, separates the fibres of timber, and causes the annual rings to loosen the one from the other. This will be one cause of wear upon plank roads, and thus, the rolling action of the wheels will not a little aid the action of the horses' feet, the greatest cause of wear upon any kind of road. Upon planks, horses' feet act with a most powerful effect; indeed this is the reason why about wharfs and other places, in European cities, iron railways, and other expensive expedients, are adapted to convey goods to such places as the carts can reach, without allowing the horses' feet to tread upon the wooden platforms.

One can so readily imagine Roy "leaning over backwards" to present all the favourable evidence available to him on this subject; he proceeds:

But it may be well to give some further experimental proofs upon this subject, although scientific persons will hold them to be quite unnecessary. We shall draw them from the city of Toronto, where, although the general traffic is not heavy, yet the horses are all shod, and consequently it affords a better proof of what the action of horses' feet will be upon plank roads. In the spring of 1837, Mr. Brown covered his new wharf with 3-inch plank; by last winter it was entirely worn out, and he had to cover it again. This gives an endurance of three seasons, under the traffic to and from the wharf. In 1836, when Yonge Street was paved, several of the inhabitants expressed a wish to have wooden crossings placed in the pavement, — it was unfortunately agreed to, and three planks, 6 inches thick, were placed at each crossing. During the third summer, they were cut through by the horses' feet. Showing a still shorter endurance in this busy street. Several other instances might be given, but these may suffice.

He then presents a very detailed estimate of the cost of maintaining plank roads in comparison with the corresponding costs for roads perfectly constructed with "broken boulders" (his preferred "metal"). He has a somewhat unorthodox way of estimating total costs, adding the total expenditure for maintenance throughout a period of 24 years to the original cost of construction. Using the same method for both types of construction, however, he arrives at these comparable figures: £1947-10-0 for a metaled road; £4450 for a 3-in. plank road and £3450 for a 4-in. plank road, the latter difference caused by six renewals in 24 years for a 3-in. plank road, but only three renewals if 4-in. plank is used. Then:

These results are extremely different from the results which have lately been so industriously handed about. It may be proper to exhibit a few of the errors upon which these statements are founded. The cost of road formation, for a road covered with broken stone, is given as £400, whilst the road formation for a plank road is given as £200. We deny that there will be any difference, if each is to be reduced to true levels and moderate activities. Again, the repairs of a road of broken stone are over-rated. We deny that a well-formed, well consolidated road, will ever require what has been called lifting. And, farther, we have rather under-rated the endurance of such a road at 12 years,

under any traffic in Canada: provided the sun and air are not excluded from it.

So his argument continues, a further statement being:

In arriving at all these conclusions, we have assumed that pine plank will be obtained 16 or 20 years at present prices. We believe, however, that a proposal to contract for a supply of pine plank for the use of the Kingston road, during the ensuing 24 years, at present prices, would startle any of the commissioners of the road, even if the plank were to be delivered to their own saw-mills.

The idea of beautiful pine lumber being used up in this way will strike many younger readers, who may not have heard of plank roads, with horror, but such was the bountiful supply of some of the best lumber in the world at that time that it could be used in this way. Roy's familiarity with English road-building practice is shown again by this comment:

We might quote largely from the evidence of those eminent Engineers under whose management the roads of England have reached their present degree of perfection, to prove that ill-made roads are most expensive in their first formation—that it is all but impossible to keep them in repair—and that, in order to obtain good roads, scientific adaptations must be resorted to—and that where these are properly applied and adhered to, the cost of construction will be lessened, and the expense of repairs will be inconsiderable.

Roy anticipated the possible reaction of readers of his own time, and certainly of ours, by concluding:

It may be deemed superfluous to have said so much concerning plank roads, as there can be no difference of opinion amongst scientific persons upon the subject. But we have before us a publication of Reports, Letters, etc., by the Legislature of 1825 wherein the utility of wooden locks for canals is enforced by arguments sadly at variance with chemical and hydrostatical laws; yet we know that the mania for wooden locks has produced direful effects upon the Province. Let us hope that the present mania for plank roads may be arrested, before it produces so much evil.

The reference to wooden canal locks probably refers to those for the first Welland Canal, all of which had to be replaced with masonry in 1841. Then, surprisingly, he suggests that timber can be successfully used for road construction if used in the form of blocks, another of his farsighted predictions, since I can remember seeing wooden paving blocks for roads used in my lifetime! He quotes from a specification "sent to Sir John Colborne in 1833" (by Roy? he does not say), Sir John being then the Governor of Upper Canada, which concludes with a suggestion of grouting between blocks. And this section of the book ends with this resounding declaration:

We would close this division of the subject by remarking that in order to construct the roads, and other public works of this Province, in an economical, useful, and durable manner, a much higher standard of education and training for Civil Engineers must be required than heretofore. To have passed through a course of Mathematical, Physical, and Chemical instruction is not sufficient. This must be followed up by a practical application of these sciences to the arts of construction, and other useful purposes. In England, the Civil Engineers who are selected to do Government works have all first become eminent in their private professional practice. It would be well if the same system were adopted here.

There follows, in somewhat strange juxtaposition, that part of

the treatise entitled "The causes which have produced constant failures in attempts at road-making in this Province." It demands extensive citation if only to show the conditions under which engineers had to work in Canada a century and a half ago:

"Hitherto it has been the practice to apply to the Legislature for a loan of money to make such a given portion of road. When the application has been successful several Commissioners have been appointed, in some instances by the Legislature, in other instances the appointment has been vested in the Governor. At this point the errors commenced, and the bad working of the system began to develop itself. There was no unity of design. The management of the roads was vested in a number of small trusts. A general system of roads for the Province was not even thought of, and every separate road was considered as a local affair. The Commissioners in general were totally ignorant of the duties they were appointed to perform... [who] actually directed the whole operations, with the assistance of a foreman frequently as incompetent to the task as themselves.

"The first source from whence much of the evil arose was the difficulty of selecting suitable Commissioners. Along with others, store-keepers, millers, tavern-keepers, and tradesmen of various descriptions, were appointed... These numerous small trusts, prevented the Commissioners had they been so inclined, from availing themselves of the services of persons fully competent to conduct the necessary operations, because the sphere of action was too limited to afford the expense. Hence in some measure have arisen the very objectionable and expensive proceedings so much to be regretted.

"... The Legislature ought to have provided for a general Inspector of Roads, whose duty it ought to have been to lay out, or at least to inspect, and approve or disapprove, of all lines of road for which grants were made, and also occasionally to have inspected these works in progress and the manner in which the funds granted were applied and to have reported annually to Parliament upon all these matters. The multiplying of trusts also prevented the essentially necessary separation between the deliberative of Commissioners' department, and the Executive, or Engineer's department. In effect the Commissioners acted in both departments to the manifest injury of the work, and the loss of those salutary checks upon expenditure—an Engineer's superintendence and an Engineer's inspection and certificate previous to payments being made.

"Hence no efficient, well-instructed staff of superintendents and foremen could be formed, and the benefits of those scientific adaptations and appliances so essentially necessary in an economical, useful, and durable system of road-making, were totally neglected, and the work was left to be done by what are here called practical men, who are generally the slaves of custom, and follow some form, good or bad, from which they cannot change, and the results of which they are incapable of calculating."

Comment would be superfluous. Roy next gives "a review of the working of the system" necessarily involving some repetition of the ills he has already described. He gives actual examples, the first being:

Yonge Street road. The grants were made "to macadamize Yonge Street road from Toronto to Holland Landing near Lake Simcoe". Now Yonge Street road was so located that it was extremely difficult and expensive to form it into a tolerably good road. On that portion which has already been done, nearly as much money has been expended in cutting hills, building bridges, etc., etc., as in road-making; yet several of the inclinations are as steep as 1 in 14. That portion which remains to be done is still more difficult, and will be more expensive. Now, if, previously to commencing the work, an experienced Engineer had been instructed to examine the country, and to lay out a road

upon the best ground which he could find between "Toronto and Holland Landing", he would have discovered that between 3 and 5 miles west of Yonge Street road, a line of road could have been got from Toronto to the base of the Ridges (about 25 miles) without crossing one ravine, or meeting any difficulty, except the hill to the northward of Toronto; and, farther, that the Ridges could have been crossed in that direction without involving any considerable difficulty. The result is, that the same amount which has been expended in making about fourteen miles of a very indifferent road, would have made almost thirty miles of excellent road, leaving no inclinations steeper than 1 in 40 . . .

All this is a reflection of Roy's own knowledge of the country involved gained while he did the earlier railway survey; it is, at the same time, an interesting foreshadowing of Highway 400! His next example is the proposed road from Oakville to Garafraxa but this is of rather localized interest. He finishes this section by saying:

"We shall not proceed farther with these illustrations of the importance of properly locating and laying out roads, and of the waste of money which is produced where this is improperly done, although instances might be adduced from almost every road hitherto made in this Province. In fact it is the first laying out of a road, that the main objects are secured or lost. These are, cheapness of construction, and the capability of doing the greatest possibility of labour upon the road at the least possible expense of animal strength; and it cannot be disputed but that this important consideration in road-making "The amount of animal strength required to draw a given weight upon various inclinations" has hitherto been entirely lost sight of in this Province. The Act of last Parliament in consolidating the trusts in each district, apparently remedied some of the above errors. Many of its enactments are good, especially those in which provision is made for separating the duties of the deliberative from the executive departments but the benefits expected from it are in a great measure lost by continuing all the former Commissioners as Trustees under the Act, and even adding to their number. It was only in the Home District that it was put to the test; it did not work well and matters went on much the same as before. In the matter of choosing an Engineer, it was proved that neither the choice nor the standing of the Engineer ought to rest implicitly with the Trustees, but that the same test of qualification should be required, and that a negative should rest somewhere."

His concluding section on "The means by which failures may in future be prevented" is essentially a clarion call for a reduction in the number of road trusts and the appointment of an experienced engineer as Inspector of Roads:

"In order to remedy the first, it would be necessary to divide the country into trusts larger than the present districts, or in fact as large as one Engineer's exertions could extend over, to lay out, construct, and attend to the whole of the roads, exclusive of concession and township lines . . .

"Each of the trusts to be under the direction of a board of twelve or fifteen Trustees. The Trustees might be either appointed by the Governor and Council, or the trust might be divided into twelve or fifteen electoral districts, each of these districts to choose a Trustee . . .

"This form of election would give the people an interest in the management of roads . . . It would also afford a guarantee that they would not, as a body, be influenced by local interest and prejudices . . . [and] . . .

"In order to secure unity in design, and a general superintendence, an Inspector of roads ought to be appointed by Government. His duties should be . . . He ought also to have a general superintendence of the Engineers of the several trusts . . . [He] ought to possess high scientific achievements and much practical experience, to enable him to perform his important duties with

advantage to the country, and to secure to himself that respect and influence with the Engineers of the several trusts, which will cause them to act cheerfully upon his suggestions . . . [and] . . .

"It is indispensable that an Engineer of scientific acquirements and practical experience be appointed for each trust, to act under the direction of the Trustees, in laying out new roads . . . directing and examining all work done by contractors and certifying that it is done according to contract before payment, etc., etc. . . . [and, finally] . . .

"In order to prevent disputes about responsibility all instructions from the Board of Trustees to the Engineer should be given in writing and should be duly certified and recorded; and all reports from the Engineer to the Trustees also should be in writing, and should be recorded."

And the little book is brought to a close with these words:

Such is a general outline of the machinery which we would propose to put into operation for the construction and management of roads in this Province. But we would close these remarks by observing, that although a knowledge of the principles of road-making may be conveyed by writing, the practice of road-making is subject to so many contingencies, that nothing but experience can produce any degree of perfection. Therefore, the degree of perfection to which a road can be brought will ever depend upon the talents, scientific knowledge, and practical experience of the person conducting the work.

All spelling and punctuation—with its plethora of commas—are exactly as in the original work, wherein the word Engineer is always capitalized.

In early studies of this remarkable little book, the impression was gained that possibly Thomas Roy had written it with a view to his obtaining the appointment he advocates, that of Inspector of Roads for the Province. But the more one studies what is known of his life, and his increasing responsibilities (as shown, for example, in the quotations from his letters to James Hall) this possibility diminishes. I am now convinced that Roy wrote his book not with any personal gain in view but as a contribution, based on his experience, to the public good, yet another of the examples he has left of fine professional service.

Conclusion or "What's past is prologue"

This paper, in one way, raises almost as many questions as it attempts to answer. How, for example, did Thomas Roy achieve his standing as a Civil Engineer; how did he develop such a proper professional pride in being an Engineer, as typified by the capitalization just mentioned? It would be the middle of the (nineteenth) century before the term "civil engineer" (as distinct from the military engineers) began to gain acceptance in North America. It would be 45 years after Roy's death before Canadian engineers saw the need for establishing the Canadian Society of Civil Engineers (the term again meaning nonmilitary). On the other hand, the Institution of Civil Engineers had been established in London in 1818 with Thomas Telford as its first president. Roy was familiar with Telford and his work, as well as British practice in road making. The conclusion is inescapable that he had spent some time in England, possibly engaged on engineering work. This raises the possibility that he might have been a native of Great Britain, as were other early engineers in Canada, but his wide knowledge of this country has led me to the conclusion that he was a native-born Canadian. If he did come from the Miramichi, time spent in England would account for some of the years between 1810 and 1834. Appropriate inquiries are being made to relevant authorities in London, so far without

success. This part of the search also still continues.

Not only was Roy a Civil Engineer, one of Canada's first, but he was also a Geotechnical Engineer, assuredly the first in Canada. In all the records of his works that remain, soil is given its proper pride of place, something almost unknown in other early engineering writing in English. It was not only soil that Roy appreciated so well, but soil in its geological context. He had a sound concept of the idea of compaction and, although in the few examples of his writing that we have the concept is applied to broken stone and gravel in road building, it is almost a certainty that he related compaction to soils.

It is, perhaps, his understanding of the vital importance of drainage that is today so surprising. He knew that good drainage is essential for the good performance of well-constructed roads. He knew that drainage must often be carried "far beyond the area of the road." And he knew that drainage was related to frost action in soils. All this was a century and a half ago and yet, throughout the long years between, drainage has probably been the most neglected feature of civil engineering design. In recent years a prominent United States consulting engineer, Harry Cedergren, has done much to awaken the awareness of civil engineers to the importance of drainage in all their works, but especially in road building, demonstrating the billions of dollars lost because of its neglect (Cedergren 1976). Thomas Roy said all this, in effect, in 1841.

In my own experience, in the late 1930's I had a long discussion with a senior official of the Ontario government, who was directly involved with the new provincial road building programme then starting, about the need for cooperative research in soil mechanics in relation to road building, and especially into problems of drainage. I was told quite plainly that he had better things to do than to waste his time "messaging about with mud" (his very words). How I now wish that I could then have had in my hands a copy of Thomas Roy's little book containing such sound advice for roads in Ontario, published a century before that talk.

Are there lessons to be drawn from Roy's life and work that would be helpful to geotechnical engineers of today? There are indeed. Rarely have I ever come across anything in the history of engineering in Canada to which Shakespeare's famous words, from *The tempest*, so truly apply: "What's past is prologue." For this reason alone, it is a privilege to present this paper in celebration of the first quarter century of the *Canadian geotechnical journal*. Let me point out just some of what seem to me to be the more important lessons that Thomas Roy has for geotechnical engineers of today:

—First, across the years comes his full appreciation of the privilege of being an engineer, something that today is so easily taken for granted.

—Even a century and a half ago, he realised that fully to be an engineer means having a proper combination of sound theoretical scientific training and good practical experience; this essential combination is vital in all branches of engineering work but nowhere is it more important, nor so difficult to attain, than in the selection of teaching staff for universities, as students are the first to realise.

—Roy took nothing for granted, asking particularly searching questions about even the simplest aspects of the works with which he was concerned, an essential attribute which it is so easy to forget.

—Not only did Roy appreciate the vital importance of soil in all his work but it was soil as a geological material, in its geological setting, and this when his knowledge of geology was

far removed from what is so readily available for all geotechnical engineers of today.

—He realised in a very special way that his engineering work might reveal geological information that was new and often unobtainable in any other way; his pioneer paper to the Geological Society in London, for example, had its origin in his acute observation of the "Ridges" north of Toronto, not just accepted as "hills" but looked at with questioning eyes and inquiring mind.

—Although he would never have heard the word, Roy was a master of serendipity (the art of finding something for which you are not looking), a characteristic that should be one of the hallmarks of all geotechnical engineers.

—The 1837 paper and his other writings showed that not only was Thomas Roy a good observer but also that he wrote up his observations, and his thinking about them, when he was ready with something to say that might help others, a lesson that still has to be learned by so many today.

—Roy's writings that remain to us are so clear and informative that they suggest most definitely that he must have been a good notetaker and recorder, another important attribute that all geotechnical engineers should strive to develop, even though it may not always be accorded the importance it deserves.

One day, perhaps, his notebooks may be found; one day, perhaps, some reader of this paper may be able to find out more about Roy's life and work and present this to the geotechnical community of Canada. How appropriate it would be if such a more rounded and far more complete record of Canada's first geotechnical engineer could be published prior to 28 July 1992 to mark the sesquicentennial of his death.

Finally, so much of the foregoing has such a modern ring to it that it may be difficult, especially when reading some of Roy's own words, to realise that all this comes to us from the years 1834 to 1842. Younger workers in the geotechnical field may therefore usefully be reminded by this record that much in geotechnical engineering happened before the 10-year period now so helpfully covered by computer retrieval in libraries. There is a very real danger that this wonderful new facility will have, all too often, the result of "rediscovering the wheel"—or of the elements of drainage!—so that, in my view, emblazoned across the top of every computer screen should be the words "Newness is not a criterion for Truth."

Acknowledgements

The many names mentioned, in somewhat unorthodox fashion, throughout Part 1 of this paper are some indication of the help I have received, in my "Roy search" over the years, from friends, some known personally, some only through correspondence. To one and all I record my indebtedness for their help and encouragement, encouragement often badly needed as yet another trail of inquiry ran out.

I must make special mention of my gratitude to Dr. Leonard Wilson of the University of Minnesota, particularly for kindly allowing me access to, and the use of, some of Lyell's notebooks before he himself had cited them in his own publications.

Most of the Roy papers still existent are in the safekeeping of the Metropolitan Toronto Reference Library, and the Archives of Ontario. To Miss Edith Fowke (now retired) of the former and to Dr. Ian Wilson of the latter, and to the most helpful members of their staffs who have helped me, I am most grateful.

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Appendix

The locations of several miscellaneous papers in which useful information about Thomas Roy has been found are mentioned in the text of this paper in a general way. For convenience and in the hope that some readers may be able to locate other repositories that may contain information about Roy, the sources examined are here summarized:

- Papers relating to Roy's employment by the city of Toronto (including the letter from Mr. Mainguy) are to be found in the Archives of Ontario, 77 Grenville Street, Toronto, Ontario.
- Correspondence regarding the railway survey of 1835 is to be found in the Allen papers in the Baldwin Room of the Metropolitan Toronto Reference Library (MTRL), Yonge Street at Asquith, Toronto, Ontario.
- Roy's 1834 report on Toronto Harbour was found in the map library of the former Department of Lands and Forests, now the Ministry of Natural Resources, Queen's Park, Toronto, Ontario.
- Roy's second report on the Harbour and the volumes containing his two lectures are held in the Baldwin Room, MTRL.
- The original of Roy's four letters to James Hall are held in the geological section of the State Library of New York in Albany, New York; the writer has photocopies and hopes to be able to publish them eventually in a suitable medium.
- The 1825 report of Sir James Carmichael Smythe and his two colleagues was a secret document of which only 25 copies were made; one of these is held in the Baldwin Room of the MTRL.
- The original Winslow papers are in the Archives and Special Collection of the Harriet Irving Library of the University of New Brunswick in Fredericton, New Brunswick.
- The early legal lands records of the "Miramichi country" are to be found in the Northumberland County Records Office in Newcastle, New Brunswick.