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ORDNANCE SUPPLY PROBLEMS IN THE CANADAS: THE QUEST FOR AN IMPROVED MILITARY TRANSPORT SYSTEM, 1814-1828

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During the War of 1812, the greatest difficulty with which the British Army had to contend was the inadequacy of the Saint Lawrence River transport system, the sole artery by which troops, ordnance and supplies could be moved to Upper Canada from the ocean ports of Québec and Montréal in Lower Canada. The difficulties and delays experienced in forwarding up the Saint Lawrence the large quantities of supplies and heavy ordnance needed to support the British forces in Upper Canada had not only hamstrung military operations in that theatre but, by 1814, threatened to render them impossible as the ever-increasing demands being placed on the transport system strained its shipping capacity and manpower to the breaking point. In response to these difficulties, the Ordnance Department began to search for ways in which the system of transport might be improved to make it less laborious, time consuming and costly; but this effort was barely underway when it was learned that the cutting of the highly-vulnerable Saint Lawrence communication was to be the primary objective of the American campaign of 1815. Although the termination of the war early in that year rescued the Ordnance Department from an increasingly-hopeless situation, it did little to relieve the anxieties which had been raised about the security of Upper Canada in view of the vulnerability and inadequacies of the Saint Lawrence transport system. Thus, the close of the war witnessed the commencement of over a decade-long quest to develop a safe, interior line of communications independent of the Saint Lawrence by which troops, ordnance and supplies might be moved to Upper Canada. During the course of that effort, the cost, feasibility and potential utility of a number of alternative media and modes of transport were assessed to determine which would be best able to overcome the military transport problems encountered in the late war. In the following paper, the on-going process by which the practicability of various alternative technologies of transport were assessed has been reconstructed in the context of the transport problems faced by the military in the Canadas during the War of 1812, in order to determine to what extent the then-existing state of Canadian transport technology and the Upper Canadian environment influenced the decisions of the British Ordnance Department.[1]

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In meeting military transport needs in the Canadas prior to the War of 1812, the Ordnance Department had simply made use of the existing mode of transport on the Saint Lawrence where bateaux were employed on the navigable stretches of the river and ox carts and wagons were hired to haul cargoes over the portages at the rapids. The French-Canadian bateau adopted by the military was basically a flat-bottomed skiff with pointed ends and almost perpendicular sides. It measured forty feet long by six feet wide, and was capable of carrying five tons of cargo with a draught of only twenty inches.[2] Each bateau was equipped with oars, setting poles, and a single square sail by which the crew of four and a tillerman worked it across the lakes and upstream against the strong currents of the Saint Lawrence River. The bateau had proved ideally suited to a turbulent river navigation as it was almost impossible to capsize,[3] and had the shallow draught characteristic of the canoe while being able to withstand the hard knocks received in being worked up through rock-strewn rapids.[4]

On the Saint Lawrence transport system, all of the heavy freight going up river had to be carted overland eight miles from Montréal to Lachine to avoid the Lachine Rapids. The bateaux were loaded at Lachine from where they were capable of passing by water all of the way to Kingston on Lake Ontario. However, this was no easy task. On the upper Saint Lawrence there were three relatively long, quiet stretches of water where the bateaux could proceed by oar or sail; but these were separated by two approximately nine-mile-long stretches of rapids where the river narrowed appreciably and the water ran so fast and furiously that the bateaux, despite having a sufficient depth of water to ascend, were unable to make any headway. At the base of each series of rapids the cargoes had to be transhipped by ox carts while the lightened bateaux were slowly and laboriously worked upwards with setting poles and, on occasion, by the crewmen plunging into water up to their armpits to pull on tow ropes. This work was relieved only by the employment of oxen to tow the bateaux where a sufficient depth of water was found close enough to shore to permit their employment. Once clear of the upper rapids, the bateaux were fully loaded to sail the last sixty-seven miles to Kingston where they would arrive anywhere from eleven to fourteen days after leaving Lachine, some 120 miles downstream.[5] On the return voyage, the bateaux were able to shoot the rapids reaching Lachine in three to four days.[6]

The Saint Lawrence transport system had functioned reasonably well in the pre-war period; but with the coming of war, unprecedented heavy transport demands were made which altered the situation dramatically. In wartime, all of the ordnance, munitions, equipment and rations required to maintain an army in Upper Canada had to be imported and conveyed up the Saint Lawrence by bateaux.[7] Upper Canada was but thinly populated, with the bulk of its population living by a subsistence agriculture which was unable to provide much of a food surplus at any time, and with the militia called out on active duty, there was no possibility of supporting the army on local resources as was the case where armies

were deployed in older more settled areas.[8] Moreover, as of 1813, the American and British forces fighting on the Upper Canadian frontiers had commenced a shipbuilding war for naval supremacy on Lake Ontario which required the Ordnance Department to convey up the Saint Lawrence all the heavy long guns, anchors and ship cables required to equip the warships of up to 100 guns that the Royal Navy was constructing at the Kingston dockyard.[9]

Both the Americans and the British experienced severe transport problems in maintaining their respective armies on the frontiers of Upper Canada, so much so that logistics had determined the course of the struggle. As the war progressed, both sides came to recognize the critical importance of logistics, and the shipbuilding race for naval supremacy on Lake Ontario was but a natural response to this factor in an area where through roads were either nonexistent or incapable of transporting heavy ordnance and stores.[10] Where logistics were concerned, the British forces were at a decided disadvantage. Not only did all of their regular troops, ordnance and supplies have to be imported from England by way of the torturously slow, difficult and costly Saint Lawrence communication, but that supply line -- and its Lake Ontario extension -- lay exposed along the whole of the fighting front as opposed to the American supply lines which ran back into the interior.[11]

Faced with increasingly-heavy transport demands on the Saint Lawrence, the Ordnance Department had responded by increasing the capacity of the existing system. The prewar bateaux establishment of twenty-five vessels was increased to the point where, at the height of the war, 200 bateaux a week were proceeding up river, and farmers with their ox carts were being called out on corvée from as far as thirty miles distance from Lachine to man the portages. In 1814, 10,000 men were employed in the transport system, including 3,500 bateauxmen,[12] and the Ordnance Department had to expend £341,215 to keep the system in operation, roughly triple the cost of the system in the first year of the war.[13] Despite such enormous expenditures, manpower shortages developed in 1814 which made it clear that the capacity of the existing system could not be increased further or even sustained at its 1814 level.[14] Consequently, plans were formed to render the transport system more efficient by removing rocks that obstructed the water passage in the rapids close to shore, constructing a shallow bateaux canal between Montréal and Lachine, and employing Durham boats, which had a greater carrying capacity than bateaux, on the long stretches of open water between the rapids of the Saint Lawrence.[15] But when it was learned that the Americans planned to cut the Saint Lawrence communication, the British military authorities immediately began to search for ways in which an alternative supply route to Upper Canada might be developed independent of the Saint Lawrence. The first proposal considered came from Lieut.-Col. Macdonnel, a Canadian serving with the British Army on the Saint Lawrence front.

In November 1814, Macdonnel had proposed that an alternative

water communication might be opened by linking together a number of rivers and small lakes on the Lake Ontario watershed to the rear of Kingston, with waters flowing into the Rideau River on the Ottawa River watershed so that bateaux, if they ascended the existing Ottawa River navigation to the rear of Montréal, could pass through the interior of Upper Canada to Kingston independent of the Saint Lawrence.[16] Only a handful of settlers was scattered throughout this vast wilderness area about which comparatively little was known; but Macdonnel, after reconnoitering the proposed route in December 1814, reported that a bateaux navigation could be developed by connecting up the headwaters of the Rideau and Cataraqui rivers. What Macdonnel had in mind was the improvement of the natural river navigations in conjunction with haulover portages to connect up the separate bodies of navigable water. These works, he believed, could readily be constructed at a minimal cost to make a workable bateaux communication;[17] but not everyone agreed that a bateaux communication so formed would prove all that viable.

After perusing the Macdonnel plan in January 1815, Robert Nichol, the Quartermaster-General of Militia, noted that the great number and extent of the portages to be traversed would result in intolerable delays and require the employment of such a large and costly working establishment as would prove impossible to sustain in a wilderness. He calculated that the ten portages alone would take eleven days to traverse, exclusive of the time spent on the river navigations between the portages. Furthermore, Nichol felt that if the proposed Rideau navigation were to meet wartime transport demands, it would have to be capable of passing up to sixteen bateaux a day with their lading across each of its portages, and this would require an establishment of as many as 1700 yoke of oxen to make the system work effectively. Such a large establishment would be difficult to procure, even if money were no object; but what rendered the whole system totally impracticable in Nichol's judgment was the lack of forage for draught animals in the heavily-forested Rideau interior.[18] Despite Nichol's objections, the local military authorities faced with the almost hopeless task of keeping the Saint Lawrence open during the coming 1815 campaign were planning to proceed with the development of the proposed Rideau bateaux navigation when news arrived that a peace treaty had been signed.[19]

The termination of the war, although it removed the serious logistical problems facing the Ordnance Department and saved the British forces from the prospect of having to abandon Upper Canada to fall back on a defence of the Saint Lawrence frontier, did not result in the shelving of the proposed Rideau communication. On the contrary, the Colonial Office, as well as the local British military commanders, was convinced that the security of the Canadas in any future war with the United States was dependent, in large measure, upon what steps were taken beforehand to develop and improve water communication with Upper Canada independent of the Saint Lawrence. Lord Bathurst, the Colonial Secretary, was particularly anxious that detailed

plans and estimates be prepared for the proposed Ottawa-Rideau bateaux navigation, as well as for a canal from Montréal to Lachine, so that the British government could determine whether the works should proceed separately or simultaneously.[20] In the interim, discharged soldiers and their families were settled in the wilderness interior of the Rideau at Perth (after 1816), Richmond (after 1818) and Lanark (after 1820), to serve as nuclei for new settlements which would supply the labour, forage, and draught animals required to construct and operate a bateaux navigation, as well as provide trained militia units for its defence. It was hoped that the military settlements would foster an increasing trade which eventually would encourage the provincial government to undertake, or at least contribute substantially towards, the cost of constructing a proper canal through the Rideau interior.[21] The settlers were also encouraged to open roads through the forest to connect the new military settlements with the major water communications of the Ottawa River to the east and with Lake Ontario to the southwest at Kingston.[22] The construction of roads by settlers in Upper Canada, however, was never regarded as a viable alternative to the construction of a canal, and with good reason.

In the early period of settlement in Upper Canada, roads were not used extensively for transport outside of the winter months and, indeed, there was not much demand for heavy transport communications where subsistence farming was the norm and local communities were largely self sufficient. When heavy transport was needed, farmers either resorted to water carriage where that was available or waited until the winter months to do their heavy hauling by sleigh or sled. In winter, a snow-covered road, regardless of its summer condition, provided an excellent highway along which farmers could haul their crops to mill at any distance. In such circumstances, the farmers had little interest in improving roads when all that was necessary to effect a winter road was to clear a right-of-way through the trees.[23] The so-called roads opened by the settlers in the Rideau corridor were, in effect, either mere bridle and bush paths, or roads which, although wide enough for a wagon, were cluttered with stumps, rocks and bogs that rendered them impassable for weeks on end during wet seasons of the year.[24] With the general lack of ditches,[25] and the high trees excluding the wind, these forest roads were seldom dry.[26] Corduroy roads were being constructed in the older, settled areas of the province at this time; but they provided at best a torturously slow and rough passage for horse and wagon, and such roads quickly broke up under heavy use.[27]

Even if good roads could have been constructed, it was well known that heavy goods could be transported by water at one-twenty-fifth the cost of land carriage;[28] and regardless of cost, there was no prospect of securing sufficient carts and wagons to meet military transport needs on a 125-mile-long road through the, as yet, sparcely-settled Rideau interior. In view of the total impracticability of the land transport alternative, the Ordnance Department concentrated

its efforts in the immediate post-war period on determining how the Ottawa and Rideau waterways might be temporarily improved to enable fully-laden bateaux to ascend the various rapids with little, if any, recourse to extensive land carriage with all of the problems that would entail until such time as a proper canal could be built. At the same time, plans were prepared for the construction of a Durham boat canal, sixteen feet wide by three feet deep, between Montréal and Lachine, to eliminate the need for land transport there.[29]

As of 1817, Durham boats were in widespread use as freight carriers on the upper reaches of major North American river navigations.[30] These boats were essentially narrow, nearly flat-bottomed barges sixty feet long and from eight to eleven feet wide with a rounded bow and stern, and an open hatch that extended well over half of the length and almost the full width. Fully loaded, a Durham boat was capable of carrying up to twenty-six tons with a draught of only twenty-eight inches;[31] but on the upper Saint Lawrence, where they were first introduced by New York forwarders in 1809, cargoes rarely exceeded eight tons in ascending the river.[32] Each boat had a crew of five, and was propelled by a single sail or oars on quiet water and by poling when going upstream against a strong current. As with the bateaux, poling was extremely slow and laborious work in the rapids of the upper Saint Lawrence where the Durham boats also had to tranship their cargoes into land carriage.[33] After the war, Durham boats began to supersede the bateaux as the preferred mode of downstream transport for heavy bulk freight as they not only possessed the shallow draught characteristic of the bateaux, but had better sailing qualities on open water and five times the tonnage capacity of a bateaux going downstream.[34] The Ordnance Department realized the advantages to be gained by employing Durham boats on canals, but still considered the bateaux to be the best mode of conveyance on river navigations where extensive rapids would have to be surmounted, hence the post-war decision to develop a temporary bateaux navigation through the Ottawa and Rideau waterways, while planning to construct a Durham boat canal from Montréal to Lachine.[35] It was assumed that Durham boat canals would eventually be constructed around the rapids of the Ottawa and Rideau waterways to complete an uninterrupted canal system from Montréal to Kingston.[36] To that end, in 1819, the military commenced the construction of a short bateaux canal at Grenville to pass the one set of rapids on the Ottawa river navigation that could not be improved sufficiently to enable fully-laden bateaux to ascend,[37] and efforts continued to persuade the government of Lower Canada to construct a Durham boat canal to Lachine.[38] When Lower Canada was about to undertake such a canal, however, the Admiralty insisted that it be constructed on a larger scale than envisaged by the Ordnance Department.

As early as 1816, the British Admiralty had recommended that the proposed Lachine Canal should be large enough not only to enable Durham boats to be towed through, but also

the gunboats which had been used to protect convoys of bateaux on the navigable stretches of the Saint Lawrence during the war, and small steam tugs which the Admiralty hoped would eventually be employed on the inland lakes and rivers of the Canadas.[39] Gunboats, propelled by oars and sail, were up to sixty-four feet long, with a sixteen-foot breadth of beam, and a four-feet, nine-inch draught.[40] The steam tugs in contemplation must have been somewhat larger for, by 1819, it was decided to construct the Lachine Canal with locks 108 feet long by twenty feet wide with up to five feet of water on the sills.[41] This scale of canal lock was thereafter adopted for the Grenville Canal already under construction.[42] Where the Rideau waterway was concerned, no decision was taken as to the scale of canal to be constructed pending the completion of an Upper Canadian inquiry.

In 1823-24, the legislature of Upper Canada employed a civil engineer, Samuel Clowes, to survey and report on the potential cost and feasibility of constructing a number of canals in the province, including the proposed Rideau communication. Clowes reported in September 1824 that the construction of an uninterrupted canal from Kingston to the Ottawa River was possible by the Rideau Lake route; but a Durham boat canal, with a depth of five feet to enable the draught of these vessels to be increased, would cost £145,802.[43] This sum ranged far beyond anything that had been contemplated hitherto and, at this juncture, the Colonial Office, which had been assiduously promoting the settlement of the Rideau corridor while trying to induce the provincial legislature to undertake the construction of a canal, turned to consider another mode of transport which appeared potentially less costly to construct.

In December 1824, James George, a forwarder on the Saint Lawrence, patented a novel method of constructing wooden portage railways[44] and tried to form a company to undertake the improvement of the Saint Lawrence navigation. He intended to establish a sloop navigation between Montréal and Kingston by blasting rocks impeding the river channels, constructing portage railways to carry laden sloops around impassable rapids and employing steamboats to tow the vessels on the river and up through the deeper rapids where strong currents had hitherto prevented boats propelled by oar, pole or sail from ascending.[45] When George submitted his invention to the Colonial Office, Lord Bathurst immediately seized upon the idea of completing the desired Rideau military communication by constructing a railway from the head of the Ottawa River navigation to Kingston.[46] At that time, the handful of English tramways in existence averaged about thirteen miles in length;[47] but what Lord Bathurst had in contemplation was a railway of the unprecedented length of up to 125 miles making use of George's wooden railway or a more conventional track.[48]

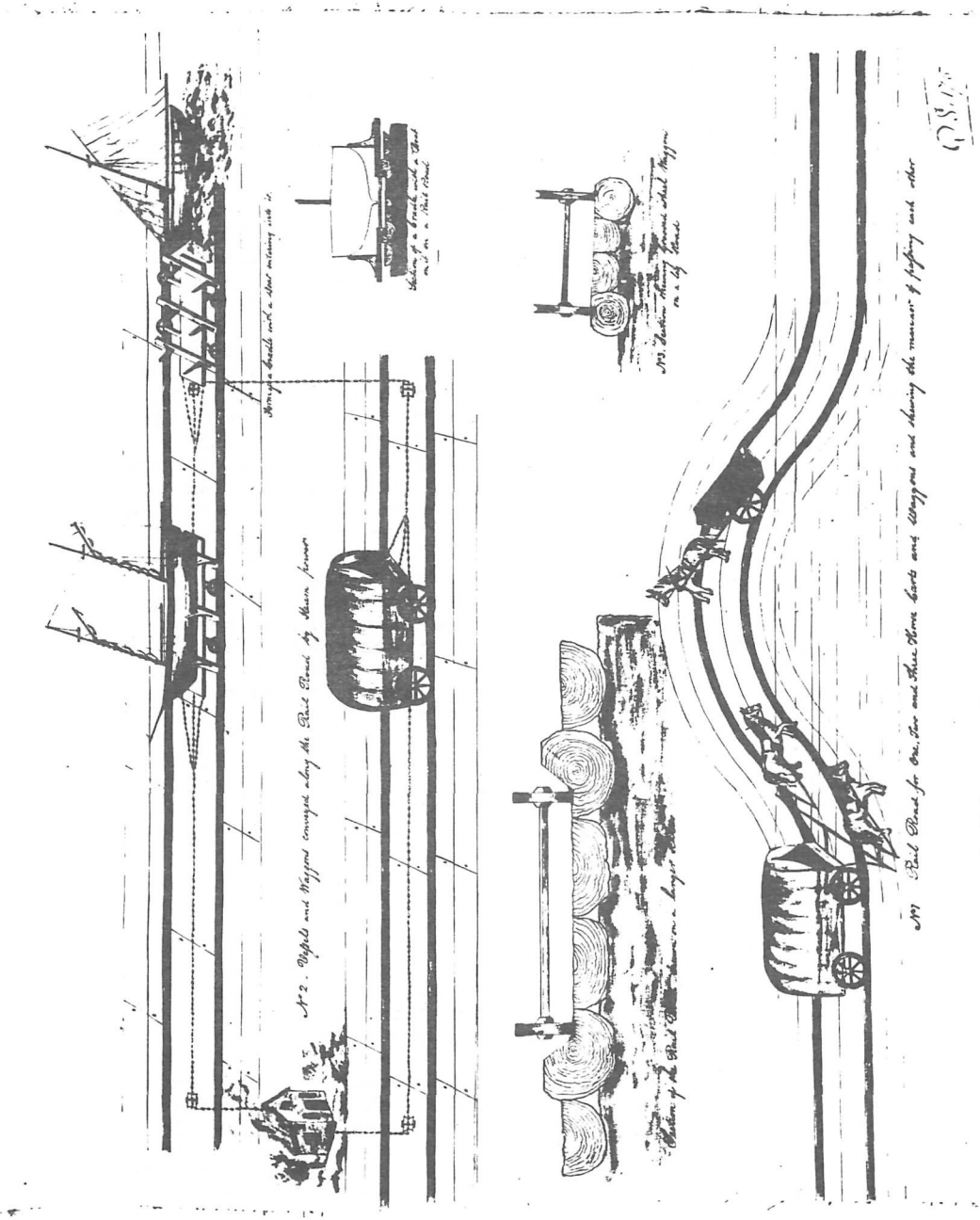
According to George's specifications, the track of his railway was to be formed of grooved, rough-hewn logs with iron strapping on a gauge matching the carts and wagons in

common use, and on which cradles capable of carrying vessels of varying hull dimensions were to be drawn. Horses were to provide the motive power on most of the system, but on steep inclines, a double track was to be constructed with a stationary steam engine positioned at the crest to operate an endless chain by which one cradle or wagon could ascend while another descended.[49] George claimed that his railway could be constructed using materials and tools readily at hand for only £10 per mile which meant, if his cost calculations were correct,[50] that a railway from the Ottawa River to Kingston would cost as little as £1,250 exclusive of the operating equipment.

Although George's projected railway was of a seemingly primitive nature, the materials to be employed in its construction were by no means outmoded in terms of the state of advancement of North American railway building technology. In England, Jessup's cast iron edge rail, in its two-foot, six-inch lengths, had long since been the standard form of track which was only beginning to be superseded by the twenty-foot lengths of wrought iron rail that Birkenshaw, as of 1820, had succeeded in producing by rolling;[51] but iron rails were unknown in North America. The several short tramways constructed in the United States prior to 1825 had solid wooden rails and, in the following year, a three-mile-long Boston tramway was the first in North America to use wooden rails capped with strips of flat iron.[52] Solid iron rails were not to be introduced into American railway construction until 1835, and into Canadian railway construction until still a decade later.[53] In North America, around 1825, wooden rails with iron strapping were, if anything, advanced rather than an archaic form of railway construction and, likewise, George's proposal to use horsepower and stationary steam engines rather than steam traction was in keeping with the most reliable power system developed for railways to that date.

In England, Richard Trevithick had employed a steam locomotive in hauling a ten-ton load over a colliery tramway as early as 1804,[54] but subsequent efforts to employ steam locomotives on tramways had attained only a limited success marred by frequent breakdowns, steaming problems and an inadequate rail-making technology which severely limited their efficiency and effective range of operation.[55] By the 1820s, English railway engineers were, for the most part, convinced that the employment of horsepower on long, level stretches of railways in conjunction with stationary steam engines on short, steep inclines -- where hills could not be readily avoided -- was the most efficient and reliable system of operating a railway.[56] Indeed, by 1825, this had become the standard approach to the construction and operation of English railways.[57] The steam locomotive was not able to establish a marked superiority over horsepower until October 1829 when Robert Stephenson's *Rocket*, equipped with the newly-developed multi-tubular boiler and an exhaust-induced draught, was able to draw a forty-four ton load a total distance of seventy miles back and forth without difficulty.[58] These decisive developments

James George's Original Drawing
(Public Archives of Canada)



in the steam locomotive were, as yet, in the future when, in December 1824, the Colonial Office, and subsequently the Ordnance Department, had their first view of James George's portage railway scheme. At that time the horse-powered railways, employing stationary steam engines on steep gradients, were the most effective and efficient mode of railway transport in existence in England or anywhere.

In response to Bathurst's railway suggestion, the Ordnance, in April 1825, appointed a commission of Royal Engineers to examine into the state of the defences of British North America and, in particular, to provide preliminary cost estimates for the canals and/or railways needed to render Upper Canada defensible.[59] After reconnoitering the river systems of the Canadas, the Smyth Commission reported in September 1825 that uninterrupted canals, on a scale sufficient to enable gunboats to circulate freely through the whole of the military transport system, were, from a military standpoint, superior to railways. Canals were by far the most economical means of transport as one horse could draw twenty-five tons on a canal, but only five tons with ease on a railway, and in the Canadas canals could be used almost year round. In winter, once the ice hardened, sleds loaded with any bulk of weight could be readily drawn along their surface, whereas the operation of railways would be severely restricted, if not prevented altogether, by the severity of the climate and the heavy snowfall.[60] This was a widely-held belief in the Canadas where, as in the Rideau corridor, winter temperatures could range as low as -32°F. for days on end and the snowfall could reach up to fifteen feet in near-record years.[61] By contrast, the potential use of canals as a winter transport system was readily perceived by the Smyth Commission as the transport of heavy bulk freight over the ice of winter 'river roads,' a Canadian tradition. In view of the suspected difficulty, if not impossibility, of operating railways during the long Canadian winter, the commissioners concluded that railways were not suited to serve as major transport arteries in the Canadas and that they should be employed only in situations where great weights had to be transported over very short distances in the absence of sufficient water to construct a canal.[62] In their view, canals were also cheaper to construct than railways.

The Smyth Commission reported that whereas a canal four feet deep by twenty feet wide could be excavated for an expenditure of £1,860 per mile, a railway would cost up to £3,000 to construct. Moreover, a canal could step directly up steep slopes where sufficient water was available, but a railway could not be constructed for horse-drawn wagons with an angle of ascent greater than one degree, or a ninety-two feet rise in a mile. This meant that in hilly country a railway might well have to be routed over three times as great a distance as a canal. Taking this comparative distance factor into account, the commission calculated that the extra distance a railway would have to be constructed to overcome hilly terrain was roughly equal to the cost of constructing locks to overcome the same difference of

elevation on a direct line and, therefore, canals were £1,140 per mile cheaper to construct than railways based on a simple comparison of the cost of excavation versus that of building a railway.[63]

Where railways and canals were concerned, the Smyth Commission based its assessment of construction costs on contemporary British experience. No report was made on the feasibility of James George's novel scheme for building railways nor were his cost calculations taken into account.[64] The Smyth Commission, in calculating railway construction costs, did not even consider what had proven around 1825 to be the most efficient and cheapest mode of construction, viz. the building of railways on a direct line with approximately level gradients but making use of inclines equipped with stationary steam engines to ascend steep hills -- thereby eliminating the need for constructing long detours. Nonetheless, based on the Smyth cost figures for laying tracks, even a direct railway over the 125-mile distance from the Ottawa River to Kingston would have cost £375,000, whereas Samuel Clowes had calculated that by taking advantage of the natural waterways of the Rideau corridor, a Durham boat canal, with locks fifteen feet by eighty-five feet and five feet of water on the sills, could be constructed for £145,802.[65] In keeping with the above assessment, the Smyth Commission recommended that an uninterrupted canal with locks twenty feet by 108 feet to match the locks of the Lachine and Grenville canals should be constructed through the Rideau corridor at an estimated cost of £169,000,[66] and in March 1826, Lieut.-Col. John By of the Royal Engineers was selected by the Board of Ordnance to superintend its construction.[67]

Soon after arriving in Upper Canada, By became convinced that the Rideau Canal should be built with large locks, 150 feet by fifty feet with ten feet of water on the sills. He informed the Ordnance Department that if this were done, in conjunction with the enlargement of the Ottawa River locks and the new Lachine Canal, it would enable the largest of the steamboats then employed on the Saint Lawrence River below Montréal to circulate through to Lake Ontario and thereby provide a system of transport readily adaptable for military purposes in wartime. By believed that the whole system could be constructed for £1,200,000 or roughly double the total cost of operating the old Saint Lawrence transport system during the war, and that once built, an uninterrupted steamboat navigation would enable British forces to be marshalled in strength at any given point on the frontier with a rapidity of movement the Americans could not match on land or on their barge canals.[68]

It is not surprising that By should have been struck by the military potential of steamboats. In the Canadas, commercial steamboat runs had been introduced at a very early date commencing with John Molson's *Accommodation*, launched at Montréal in 1809 to provide a passenger service between that city and Québec.[69] When By arrived in the Canadas, there were more than a dozen sidewheelers employed on the Great Lakes and lower Saint Lawrence River.[70] The largest

class of these steamers was about 145 feet long and had an overall width of forty-eight feet with an eight-foot draught.[71]

The Ordnance Department, although in agreement with By as to the immense commercial and military advantages to be gained by such a steamboat navigation, nonetheless turned his recommendation down on the grounds that steamboats would be unable to operate on canals, and that the towing of steamboats through an extensive canal system was of no real advantage. Moreover, the construction of the Rideau Canal with large locks would have little utility if the other canals were not similarly enlarged, and to construct locks of such a size through the whole system would entail enormous costs, probably far beyond what By had in contemplation.[72] Leaving aside the question of cost, which dictated heavily against By's scheme, there was much to be said in favour of the Ordnance's decision based on the situation as it was perceived from England. Despite their unquestioned success on the rivers of the British Isles and North America, steamboats were not used on canals. In Great Britain, a number of experiments had been tried in operating steamboats on canals, but with very discouraging results. In every case the churning of the paddle wheels destroyed the banks, and experience had shown that the only effectual response was either to protect the banks by walling and/or paving -- which was prohibitively expensive -- or to eliminate the source of the problem. Hence, steamboats were banned from British canals.[73]

In response to the arguments cited by the Board of Ordnance, Lieut.-Col. By pointed out that almost 100 miles of the 123-mile-long Rideau waterway would consist of either broad lakes or wide rivers, the banks of which were scoured each spring by floods ranging as high as fifteen feet above the mean level of the river. The other river navigations between Québec and the Rideau were of a similar nature. On the whole of the 324 miles of waterway from Québec to the mouth of the Rideau, there would be only a few miles of canal by-passing the Lachine rapids and some twelve miles of canal passing around the Ottawa River rapids where steamboats would have to be towed.

To overcome the objection of the Ordnance Department to the enormous cost of constructing a large lock steamboat navigation from Québec through to Lake Ontario via the Rideau route, By changed his argument somewhat and argued that if the Rideau alone were built with the 150-by-fifty-foot lock at a reduced depth of five feet, it would still suffice to realize the major commercial and military advantages of a through steamboat navigation. Steamboats could be stationed on the long navigable stretches of the Saint Lawrence and Ottawa Rivers to tow Durham boats, which could also be towed by oxen through the existing Lachine Canal and the Ottawa locks without any need for transhipment. At the head of the Grenville Canal, the cargoes could be transhipped into the large lake steamboats which, if not fully laden, could pass through the whole of the Rideau system to Lake Ontario and beyond.[74] By was convinced that on such a

system, the whole of the 447-mile voyage from Québec to Kingston could be covered in seventy-seven hours of steaming time, and the cost of transporting stores reduced from just over £4 per ton on the Saint Lawrence route to £1 1/3 per ton.[75] These advantages could be realized for an additional expenditure of as little as £50,000 for as long as the depth of the navigation remained the same, the amount of damning and embanking required to construct the Rideau Canal would not change appreciably nor would the thickness of the lock wall masonry estimated for the smaller scale of canal.[76]

Once the survey work on the Rideau was completed, By reported further that if steamboats were not used thereon, vessels would have to rely on oar or sail to effect a passage as towpaths were impracticable for up to seventy miles where the banks consisted of either high rocky cliffs -- which would be too costly to excavate -- or low-lying flood plains and swamps which would require heavy embanking at a prohibitive expense. Furthermore, on the Rideau the canal cuts were being carried for the most part through solid rock which would pose no problem in operating the paddles of steamboats.[77]

In view of the compelling nature of By's arguments, the Board of Ordnance decided to despatch a committee of Royal Engineers to Upper Canada to decide on the scale of lock to be built. The Kempt Committee reported in June 1828 that the critical consideration was the need to secure a dependable means of propulsion for military transport vessels. Although sails and sweeps might well suffice for commercial transport needs where two paths could not be constructed, this was not the case for war operations. Vessels could not tack against the wind on a canalized river, and relying on oars or awaiting a favourable wind would occasion unacceptable delays. Consequently, the committee concluded that the construction of locks of a sufficient size to enable steamboats to circulate through the Rideau Canal was imperative. The committee, however, did not see the advantage of constructing the large lock proposed by By without a proportionably deep canal and correspondingly large locks on the other canals, which would be prohibitively expensive. Accordingly, they decided that the Rideau navigation should be built five feet deep with locks sufficiently large to pass the smallest of the steam towboats that had proved capable of operating on the open waters of the Ottawa River navigation. These sidewheelers were 108 feet long and thirty feet wide across the paddleboxes, with a four-foot draught, and their thirty-two HP engine, it was calculated, could easily tow two fully-laden Durham boats at a speed of four to five miles per hour in quiet water. Moreover, the committee noted there were more than enough Durham boats currently in use on the Saint Lawrence to provide ample transport for military and naval stores in the event of war, and the Durham boats would be able to pass through the whole system from Montréal to Kingston independent of the Saint Lawrence without any recourse to transhipment.[78] Subsequently, the size of lock approved by the Kempt Committee -- 134 feet by thirty-three feet -- was built on the Rideau Canal

which, when it opened for navigation in May 1832, was the first steamboat canal in the Canadas, if not the first to be constructed anywhere.[79]

In the decade-or-more-long quest to determine how an alternative communications system to that in existence on the Saint Lawrence might be best developed and operated in the interior of Upper Canada, the British Ordnance Department had concentrated on determining what was the best medium as well as mode of transport. Whether roads, canals or railways were considered, the inquiry focussed on each medium of transport in terms of its feasibility as well as its construction and maintenance costs, carrying capacity, the availability of the motive power required and its relative speed and ease of operation. Initially, the Ordnance Department had intended to develop a bateaux navigation by way of the Ottawa-Rideau route employing thereon the French-Canadian bateaux, the prevalent mode of river transport on the Saint Lawrence; but when the American Durham boat came into common use on major Canadian rivers, the possibility of employing these vessels in the military transport system was investigated. When it became apparent that a canal through the Rideau corridor would be much more costly to construct than hitherto suspected, the Ordnance Department -- at the prompting of the Colonial Department -- immediately turned to investigate the possibility of a railway. Although the subsequent inquiry focussed on the feasibility of constructing a railway in keeping with English standards, rather than the as-yet unproven invention of James George, the Canadian invention did initiate the inquiry into the railway alternative and railways were ultimately rejected in large part because of their perceived unsuitability to the Canadian environment.

Where a steamboat canal was concerned, the Ordnance was slow to respond to the benefits realized through the early introduction of this mode of transport onto Canadian river navigations. However, this rejection was based on the British experience where all but insuperable difficulties had been encountered in attempting to operate steamboats on canals. Once Lieut.-Colonel By made it clear that the same objections did not apply to a canal constructed on a canalized river system in the Canadian environment, where heavy spring floods scoured river banks, and in particular did not apply to the Rideau Canal where the canal cuts were being carried through the rock of the Canadian shield, the Ordnance quickly came to appreciate the advantage of employing this mode of transport on the Rideau Canal. At all stages of the inquiry into various possible solutions to the military transport problems encountered during the War of 1812, the alternatives were assessed not only in terms of the British experience with which the Ordnance Department was directly familiar, but also in the context of the Canadian setting. The British Ordnance Department showed itself to be acutely aware of the problems posed by the Canadian climate and environment in determining what medium of transport should be utilized, and the latest developments in Canadian transport technology were taken into account in deciding what mode of transport was best suited to meet military transport needs

in the Canadas.

NOTES

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1. The Ordnance Department was headed by a Master-General and Board of Ordnance. The Master-General commanded the Royal Artillery and the Royal Engineers, held a seat in cabinet and, with the support of the Board of Ordnance, was responsible for the manufacture, procurement and transport of all war supplies for the army and navy, the education and support of the Royal Artillery and Royal Engineers, the topographical survey of the United Kingdom and the construction and maintenance of fortifications, storehouses and military buildings.

2. Captain Basil Hall, RN, *Travels in North America in the years 1827 and 1828*, vol. I (Edinburgh, 1829), 360-1; Edward A. Talbot, *Five Years' Residence in the Canadas, including a Tour through Part of the United States of America in the year 1823*, vol. I (London, 1824), 83-4; and Edwin C. Guillet, *Early Life in Upper Canada* (Toronto, 1969), 416-18.

3. *Ibid.*; and M.J. Patton, 'Shipping and Canals,' *Canada and Its Provinces*, Adam Shortt and Arthur G. Doughty, eds., vol. X (Toronto, 1913), 489.

4. Peter Kalm, *Travels into North America; containing its Natural History and a Circumstantial account of its Plantations and Agriculture in general with the Civil, Ecclesiastical and Commercial state of the Country*, vol. II translated by J.R. Forster (London, 1771), 242.

5. Talbot, *Op. Cit.*, I, 83-4, and Guillet, *Op. Cit.*, 420-9.

6. John M. Duncan, *Travels through Part of the United States and Canada in 1818 and 1819*, vol. II (Glasgow, 1823), 125-45; and Hall, *Op. Cit.*, I, 370-80.

7. Glenn A. Steppler, *A Duty Troublesome Beyond Measure: Logistical Considerations in the Canadian War of 1812*, M.A. Thesis: McGill University, 1974, 109.

8. *Ibid.*, 235-6 and 241.

9. C.P. Stacey, 'Naval Power on the Lakes,' in Philip P. Mason, ed., *After Tippecanoe* (Toronto, 1963), 52; and Brig.-General E.A. Cruikshank, 'The Contest for the Command of Lake Ontario in 1814,' *OHS Papers and Records* XXI (Toronto, 1924), 148-52.

10. Steppler, *Op. Cit.*, 144, and 242-4; and Stacey, *Op. Cit.*, 49-50.

11. *Ibid.*, 51.

12. Steppler, *Op. Cit.*, 145, 240; and J. Mackay Hitsman, *The Incredible War of 1812, A Military History* (Toronto, 1965).

13. Great Britain, Parliamentary Papers, Colonies, Canada, vol. VI, Sessions 1825-32, Hardinge Testimony, 24 March 1828.

14. Public Archives of Canada (PAC), RG 8, Series C, British Military and Naval Records, reel C02616, vol. 38, 88-93. Commissary General Robinson to Prevost, 14 November 1814.

15. *Ibid.*; and Steppler, *Op. Cit.*, 143.

16. George Raudzens, '"Red George" Macdonnel, Military Saviour of Upper Canada,' *Ontario History* LXII: 4 (December 1970), 199-212.

17. Macdonnel's report has not been found. There are, however, a number of references to it, and its contents have been deduced from a critique prepared by Robert Nichol, the Quartermaster-General of Militia. See below, and also PAC, MG 12, A, Admiralty, Secretary's Department, reel B-2942, vol. 2738, 85. Commodore James Yeo to Melville, 30 May 1815.

18. PAC, RG 8, C, reel C-2616, vol. 38, 97-100. Robert Nichol (Quartermaster-General of Militia to Lieut.-General Drummond, 7 January 1815.

19. *Ibid.*, 101-2, Colonel Myers (Deputy Quartermaster-General)to Captain Sherwood ; and *ibid.*, 104-6, General Drummond to Sir George Prevost, 17 January 1815. Reuben Sherwood, a surveyor who had accompanied Macdonnel through the Rideau route, was selected to prepare a report on where portage roads and locks would be required to complete the bateaux navigation proposed by Macdonnel. Sherwood's report, completed long after the war ended, can be found in *ibid.*, 118. R. Sherwood to Col. Myers, 13 July 1815.

20. PAC, MG 13, WO 44, War Office, Department of Ordnance, Canada, B-1294, vol. 19, 9-11. Henry Goulburn to George Harrison, 23 March 1819; and PAC, RG 8, Series C, C-2616, vol. 38, 129. Earl Bathurst to Sir G. Drummond, 20 October 1815.

21. PAC, MG 24, A12, Dalhousie Muniments, reel A-525, 123. Memorandum Relative to the Water Communication between Upper Canada and Lower Canada; PAC, MG 13, WO 44, B-1294, vol. 19, 9, Henry Goulburn to George Harrison, 20 November 1817; and Eric Jarvis, 'Military Land Granting in Upper Canada following the War of 1812,' *Ontario History*, LXVII (1975), 122-34.

22. PAC, WO 44, B-1294, vol. 19, 12. Lieut.-Colonel Cockburn (Deputy Quartermaster-General), Report on the Military Settlements in the Neighbourhood of the Rideau, 26 November 1818; and MG 24, A12, reel A-525, 20-25, Cockburn to Earl Dalhousie, 20 May 1821.

23. W.H. Breipthaupt, 'Dundas Street and Other Early Upper Canada Roads,' *OHS Papers and Records* XXI (1924), 5-10; and Thomas F. McIlwraith, 'The Adequacy of Rural Roads in the Era Before Railways: An Illustration from Upper Canada,' *The Canadian Geographer* XIV: 4 (1970), 344-60.

24. Jean S. McGill, *A Pioneer History of the County of Lanark* (Toronto, 1970), 14, 22, 29 and 118.

25. Guillet, *Op. Cit.*, 537.

26. John Mactaggart, *Three Years in Canada: An Account of the Actual State of the Country in 1826-7-8 comprehending its resources, productions, Improvements, and Capabilities and including Sketches of the State of Society, Advice to Emigrants, etc.* (London, 1829), vol. I, 282.

27. Guillet, *Op. Cit.*, 526-7. The military occasionally constructed corduroy roads, but they were expensive. Their use and cost is discussed in PAC, WO 55, War Office, Ordnance Miscellanea, Engineer Papers, vol. 1551, 86-89. North American Commissioners Report, 1825. At least one civil engineer, John Mactaggart, held that in heavily forested areas canals, making use of existing river systems, were much easier to construct and would require far less maintenance than roads (Mactaggart, *Op. Cit.*, II, 104).

28. PAC, MG 13, WO 55, vol. 863, B-2809, 237. The Welland Canal Company, *Directors' Report*, (Montreal, 1826).

29. PAC, MG 13, WO 44, B-1294, vol. 19, 10f: Captain Romilly, Estimate for a Canal from Upper La Chine to Montreal to be navigated by Durham Boats, 1817.

30. William A. Baker, *Sloops & Shallops* (Barre, Massachusetts, 1966), 129; and Gerald J.J. Tulchinsky, *The Construction of the First Lachine Canal, 1815-1826*, M.A. Thesis: McGill University, June 1960, 20.

31. Duncan, *Op. Cit.*, II, 118.

32. Patton, 'Shipping and Canals,' 134; H.Y. Hind and T.C. Keefer *et. al.*, *The Dominion of Canada, containing a Historical Sketch of the Preliminaries and Organization of Confederation; also the Vast Improvements in Agriculture, Commerce and Trade, Modes of Travel and Transportation, Mining, and Educational Interests, Etc. Etc. for the past Eighty Years under the Provincial names* (Toronto, 1868), 134; and William Caniff, *History of the Settlement of Upper Canada with special reference to the Bay of Quinte* (Toronto, 1869), 142. The first

Durham boats were constructed as early as 1750 by Robert Durham, a Pennsylvania boatbuilder. See Seymour Dunbar, *A History of Travel in America* (New York, 1937), 282.

33. Guillet, *op. cit.*, 431.

34. Hind, *op. cit.*, 134; and Duncan, *op. cit.*, II, 118-9. Commencing in 1822-23, Durham boats on the Saint Lawrence were lengthened, deepened and widened until they were capable of carrying up to fifty tons of freight downstream to Montréal, returning empty to Kingston. At that date, the Lachine boatbuilders began to abandon the bateau in favour of constructing the enlarged Durham boat (PAC, RG 8, Series C, C-2617, vol. 40, 118. John Simpson to Colonel Darling, 7 January 1823; and *ibid.*, vol. 41, 118. John Finlay to Colonel Darling, 8 March 1825).

35. The plans prepared by the Royal Engineers are in the following: PAC, WO 44, B-1294, vol. 19, 13f. Captain J.W. Mann, Report on the Navigation of the Ottawa or Grand River ascending from Point Fortune to the head of the Long Sault; with Observations on the means of improving it, or rendering it practicable for loaded bateaux, Gun boats, etc., October 1818; and *ibid.*, 10f. Captain Romilly, Estimate for a Canal from Upper La Chine to Montréal to be navigated by Durham boats, 1817.

    The plans for the Rideau bateaux navigation, prepared by Lieut. Joshua Jebb, are in PAC, RG 8, Series C, C-2616, vol. 38, 162-6. Lieut. Jebb to Colonel Nicol; and *ibid.*, C-2617, vol. 40, 165-9. Lieut. Jebb to Colonel Durnford, 22 June 1816. Jebb proposed to construct wing walls to narrow and deepen the water flowing through the shallow rapids of the Rideau River, with winches to haul up fully-laden bateaux. Larger obstacles were to be overcome by constructing several portage roads, including possibly a short portage tramway, and a small number of wooden locks.

36. *Kingston Gazette*, VI, 29 March 1817, Lieut.-Governor's Office, York, Notice Tenders.

37. *Ibid.*, Captain Mann, Report on the Navigation of the Ottawa, October 1818; and PAC, RG 8, Series C, C-2617, vol. 40, 29. Captain DuVernet, Report on the Grenville Canal, 18 December 1820.

38. PAC, MG 13, WO 44, B-1294, vol. 19, 14. Richmond to Bathurst, 20 May 1819.

39. PAC, MG 11, CO 42, Colonial Office, B-137, vol. 171, 3-7. John Croker (Admiralty Office) to Henry Goulborn, 6 July 1816.

40. *Ibid.*, 148. Sir Edward Owen to Lieut.-General Drummond, 15 November 1815. On the use of gunboats during the War of 1812 and their armaments, see Judith A. Beattie,

Gunboats on the St. Lawrence River 1763-1839, Parks Canada, Manuscript Report Series, Number 15, 1967.

41. See Tulchinsky, *op. cit.*, and PAC, RG 11, Department of Public Works, Series I, C-4243, vol. 2, 20f. Commissioners for the Lachine Canal, Reports 1821-41. As early as the fall of 1815, the Admiralty was informed of a proposal by Kingston merchants to place a forty HP steam towboat on the Saint Lawrence River, but no dimensions were given for the vessel (PAC, MG 11, CO 42, B-137, vol. 171, 80. Sir Edward Owen to John Croker, 28 October 1815). The first steamboat on the Saint Lawrence River, the *Accommodation*, was eighty-five feet long by twenty-one feet wide clear of the paddles. Early English steam tugs on the Thames River were approximately seventy-six feet long by twenty-five feet wide over the paddle boxes with a four-foot draught. See H.P. Spratt, *The Birth of the Steamboat* (London, 1958), 85, and 95-7.

42. PAC, RG 8, Series C, C-2617, vol. 39, 64. Captain Mann to Major Bowles, 30 September 1819; and *ibid.*, vol. 40, 24. Captain DuVernet letter of 30 November 1820.

43. PAC, RG 5, A1, Civil Secretary's Correspondence, Upper Canada Sundries, C-4614, vol. 70, D37269f. Commissioners of Internal Navigation, *Third General Report*, York, 5 February 1825.

44. Canada, Bureau of Agriculture and Statistics, *Patents of Canada, from 1824-49* (Toronto, 1860), vol. I, 13, Patent No. 3, AD 1824, Lower Canada, Letters Patent to James George, for the Invention of an 'Improvement in the Construction of Wooden Railroads.'

45. PAC, MG 11, Q Series, vol. 170, Part II, James George to Earl Bathurst, 20 December 1824; and *ibid.*, WO 55, vol. 1551, North American Commissioners' Report, 1825, 76.

46. PAC, MG 24, A12, 8, R.W. Horton to Earl Dalhousie, 18 February 1825; *ibid.*, 12, Earl Bathurst to Earl Dalhousie, 5 March 1825; and *ibid.*, 56-7, Dalhousie to Lord Bathurst, 27 March 1825.

47. John Geise, 'What is a Railway,' *Technology and Culture*, I: 1 (1959), 70.

48. PAC, MG 24, A12, A-525, 56-7, Earl Bathurst to My Lord, 27 March 1825. The Ordnance had previously considered the construction of a portage tramway across the summit of the proposed Rideau bateaux navigation system, if sufficient water were not found to make a canal cut practicable, but that tramway would have been only five miles long (RG 8, Series C, C-2617, vol. 40, 176, Jebb Report, 14 July 1816; and Arthur R. Wellesley, second Duke, *Despatches, Correspondence, and Memoranda of Field*

Marshall, Arthur Duke of Wellington, K.G. (London, 1867), vol. I, 40, Wellington to Bathurst, 1 March 1819.

50. PAC, MG 11, Q Series, vol. 170, Part II, 359, James George to Earl Bathurst, 20 December 1824. This figure appears to be remarkably low, but George was counting on free access to timber on Crown Reserves and free labour being provided by the settlers who would benefit immeasurably from the establishment of such a communication on the Saint Lawrence.

51. O.S. Nock, *Railways Then and Now, A World History* (New York, 1975), 8-11; and Great Britain, Army, Corps of Royal Engineers, *Aide-Memoire to the Military Sciences*, vol. III (March 1851), 176, Lieut. D. Galton, RE, 'Railways.'

52. Dunbar, *A History of Travel in America*, 922.

53. Gerald J.J. Tulchinsky, *The River Barons: Montreal Businessmen and the Growth of Industry and Transportation 1837-53* (Toronto, 1977), 107-12; and Oscar D. Skelton, *The Railway Builders, A Chronicle of Overland Highways* (Toronto, 1916), 36. The first public railway in British North America, the fourteen-mile-long Champlain and Saint Lawrence Railway constructed in 1835-36, had wooden rails with a flat iron running surface. Iron rails were first introduced in 1845 when the Champlain and Saint Lawrence was rebuilt and extended in length.

54. Nock, *Railways, Then and Now*, 9; and Skelton, *The Railway Builders*, 10.

55. C. Hamilton Ellis, *Railway History* (London, 1966), 13; Nock, *Railways, Then and Now*, 10-17; and J.B. Snell, *Early Railways* (London, 1964), 11-12.

56. William Strickland, *Report on Canals, Railways, Roads and other Subjects made to "The Pennsylvania Society for the Promotion of Internal Improvement"* (Philadelphia, 1826), 31-2; and below.

57. In September 1825, Stephenson's locomotive, *Locomotion*, was introduced on a twenty-mile section of the new Stockton and Darlington Railway to haul freight. The introduction of a steam locomotive in place of horses was regarded as a novel experiment, and marked the first time a steam locomotive was employed anywhere on a public railway. Horses, however, continued to be used for hauling passengers on the same section of the line, and fixed steam engines were used on inclines in the hilly country. Moreover, the steam locomotive proved to be very troublesome and difficult to keep in operation (Snell, *Early Railways*, 22-3).

58. Ellis, *Railway History*, 17ff.; and Skelton, *The Railway*

Builders, 2-4. The first railway to use steam propulsion exclusively was the Liverpool and Manchester, opened in September 1830. Steam locomotives ran on the level stretches and fixed steam engines were used on steep gradients (Nock, *Railways, Then and Now*, 16).

59. Wellington, *Despatches*, vol. II, 436-7, Wellington to Griffin, 11 April 1825.

60. PAC, WO 55, vol. 1551, 84-5, North American Commissioners Report, 1825.

61. G.P. de T. Glazebrook, *A History of Transportation in Canada*, (Toronto, 1964), vol. I, 141; and Robert Legget, *Railroads of Canada* (Vancouver, 1973), 15. The Champlain and Saint Lawrence operated only during the spring-to-autumn period for a number of years. Early problems, associated with operating railways in the snows of winter were eventually solved and, by 1847, railway engineers were convinced that snow, although still a serious problem, was not an insurmountable obstacle to running trains during the winter. See A.C. Morton, Chief Engineer, *Report on the Gauge for the St. Lawrence and Atlantic Rail-Road* (Montreal, 1847), 32.

62. PAC, WO 55, vol. 1551, 85, North American Commissioners Report, 1825.

63. *Ibid.*, 84-5.

64. *Ibid.*, 76-7. The Smyth report did comment on George's portage railway scheme with respect to its proposed use on the Saint Lawrence. The report opposed any improvement of the Saint Lawrence navigation which would facilitate an American descent on Montreal during wartime, and stated that the proposed Rideau Canal would negate any need for improving the Saint Lawrence communication.

65. PAC, RG 5, A1, C-4614, vol. 70, D37271 and D37309, Commissioners of Internal Navigation, *Third General Report*, 5 February 1825.

66. PAC, WO 55, vol. 1551, 56-7, and 71-2, North American Commissioners Report, 1825.

67. PAC, MG 13, WO 55, B-2809, vol. 863, 209, Lieut.-Col. Ellicombe, Ordnance Department, to Lieut.-Col. By, 14 March 1826. In 1804-05, Lieut. John By had superintended the construction of a small bateaux canal, the Cascades Canal, on the Saint Lawrence. His then commanding officer, Captain Mann, was the same General Gother Mann who, as Inspector General of Fortifications, selected By to superintend the Rideau Canal project in 1826.

68. *Ibid.*, 242-3, Lieut.-Col. By to General Mann, 13 July 1826. As related herein, the Lachine Canal had been

constructed large enough to admit steam tugs being towed through in future, but thereafter the size of steamboats had increased greatly as powerful engines were required to overcome the strong currents of the Saint Lawrence River. The idea of a steamboat passage through the Lachine and Ottawa canals was forgotten. The Ordnance, in planning the Rideau Canal, made no mention of steamboats, and By appears to have conceived of their potential use only after coming to the Canadas.

A total of £638,326 was expended on the transport of military and naval stores from Québec to Kingston during the three years of the 1812 war.

69. Glazebrook, *A History of Transportation*, 67. During the late 18th century, various attempts were made in Britain, France and the United States to apply steam propulsion to boats. All met with indifferent success until 1807 when Robert Fulton launched the *North River Steamboat of Clermont*, and succeeded in establishing a viable commercial steamboat operation on the Hudson River. For a brief history of early experiments with steamboats and their subsequent introduction into the United States, Britain and elsewhere, see Louis C. Hunter, *Steamboats on Western Rivers, An Economic and Technological History* (New York, 1969), and Spratt, *The Birth of the Steamboat*.

70. Glazebrook, *A History of Transportation*, I, 69; and Patton, 'Shipping and Canals,' 496-8.

71. *Ibid.*, and Mactaggart, *Three Years in Canada*, II, 85.

72. PAC, RG 8, Series C, C-2617, vol. 43, 43-8, Major General Smyth to General Mann, 23 August 1826; and *ibid.*, 50-2, Lord Fitzroy Somerset, Office of the Ordnance, to General Mann, 1 September 1826.

73. Jean Lindsay, *The Canals of Scotland* (Newton Abbot, England, 1968), 35-41; and Strickland, *Report on Canals*, 2.

74. PAC, RG 8, Series C, C-2617, vol. 42, 145-54, By to General Mann, 6 December 1826.

75. PAC, MG 24, A12, A-534, Colonel By to Lord Dalhousie, 12 November 1827.

76. PAC, RG 8, Series C, C-2617, vol. 42, 151-2, By to General Mann, 6 December 1826.

77. *Ibid.*, C-2618, vol. 44, 81-2, Colonel By to General Mann, 6 July 1827; and *ibid.*, 203, By to General Mann, 1 November 1827.

78. PAC, MG 13, WO 44, B-1294, vol. 19, 26f., James Kempt, Kingston, Upper Canada, Despatch to the Rt. Hon. William Huskisson, with enclosed Report of the Committee appointed to assemble in Canada upon matters relating to the

Rideau Canal, 28 June 1828; and *ibid.*, 29-30, Lieut.-General Kempt *et. al.* to Lieut.-Col. By, 28 June 1828.

79. In Britain, steam tugs were used on several canal tunnels, where the sides would be either of solid rock or of masonry construction, but steamboats were not employed successfully on canals until the late 1840s and early 1850s when screw propellers came into use. On the narrow canals, steam lighters did not begin to supersede horse drawn vessels until as late as the 1870s (Lindsay, *The Canals of Scotland*, 46; and Charles Hadfield, *British Canals, An Illustrated History* (Newton Abbot, England, 1966), 57, 126, 132 and 245).