DEPARTMENT OF RAILWAYS AND CANALS
OF CANADA

REPORT

TO THE

HONOURABLE FRANK COCHRANE
Minister of Railways and Canals

ON

HALIFAX HARBOUR

1913

305''

DEPARTMENT OF RAILWAYS AND CANALS
OF CANADA.

CANADIAN GOVERNMENT RAILWAYS

REPORT

TO

THE HONOURABLE FRANK COCHRANE
Minister of Railways and Canals

ON

HALIFAX HARBOUR

AND

THE DEVELOPMENT OF A PROJECT

OF

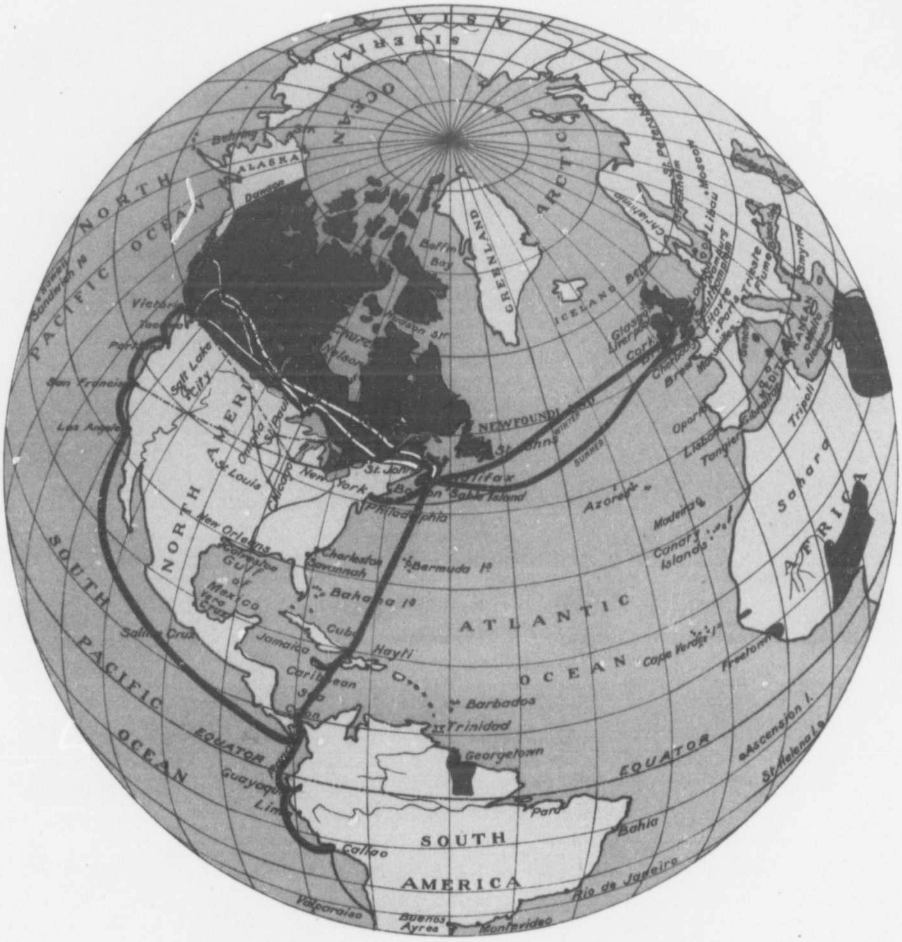
MODERN OCEAN TERMINALS

BY

FREDERICK W. COWIE, B. A. Sc., M. Inst. C. E.

Dated July 1st, 1913.

THE NORTH ATLANTIC OCEAN



NORTH AMERICA TO EUROPE
SUMMER AND WINTER ROUTES
VIA
HALIFAX

HALIFAX OCEAN TERMINALS

1913

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MINISTER OF RAILWAYS AND CANALS

by

FREDERICK W. COWIE, Consulting Engineer

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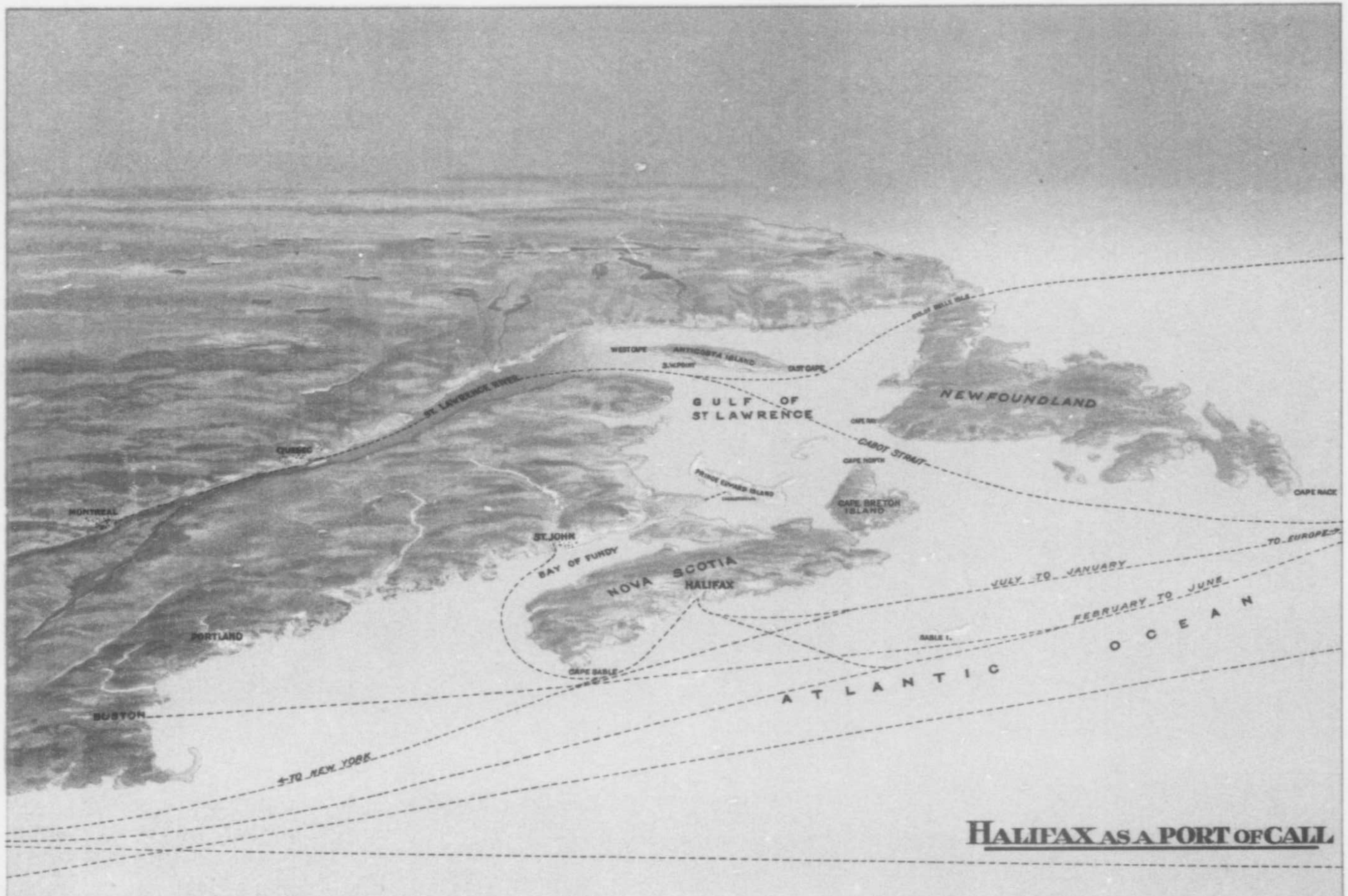

HALIFAX AS A PORT OF CALL

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DEPARTMENT OF RAILWAYS AND CANALS

HALIFAX OCEAN TERMINALS

REPORT

OF

FREDERICK W. COWIE, B. A. Sc., M. Inst. C.E.

INTRODUCTION

MONTREAL, Canada,
July 1st, 1913.

To the Honourable Frank Cochrane,
Minister,
Department of Railways and Canals,
Ottawa, Can.

Sir:—

I have the honour to submit herewith, Report on the various subjects in connection with your instructions that a study of Halifax Harbour should be made with a view to a comprehensive Scheme of proposed extensions being developed to meet the "present requirements of transportation conditions in Canada."

In May, 1912, you did me the honour to request that I should undertake this important work, after you had obtained the consent of the Harbour Com-

missioners of Montreal, for the work to be done in conjunction with my duties as Chief Engineer of Montreal Harbour.

Mr. F. P. Gutelius, M. Can. Soc. C.E., M. Am. Soc. C.E., in his advisory capacity to the Minister, and later as General Manager, Canadian Government Railways, supervised and directed every step in the work from the first consideration of the type and scope of the Scheme until the completion of the contract drawings for the Docks.

To Mr. Gutelius is due the bringing to such early completion of the Scheme which by your direction was to provide facilities at least equal to the best, for combined Railway and Steamship accommodation on the Atlantic Coast of North America.

With your approval a staff of Engineers was organized, with Mr. James McGregor, A.M. Inst. C.E., A.M. Can. Soc. C.E., at its head. Mr. McGregor, having worked with me in 1907 on important harbour designs, was known as fully competent and having the necessary experience to undertake the surveys and details of designing. He was engaged on important bridge foundation work on the Grand Trunk Pacific Railway in British Columbia, and could only reach Montreal in June, 1912, and after a full consultation as to the phases to be considered and the survey work to be undertaken, he took charge at Halifax.

Naturally, the survey work had to be done most discreetly, and the good work of Mr. McGregor and his staff may be judged by the exceptionally speedy way in which the necessary information was obtained and the outlines of the proposed Scheme developed.

After a final personal inspection on Labour Day in September, 1912, it was decided that the advantages of the proposed George's Island site had been demonstrated beyond argument, and after a Preliminary Report and full consideration and study by Mr. F. P. Gutelius, as a Railway Engineer and Traffic Expert, you, after consultation, approved of the Scheme.

Certain necessary and characteristic areas of land were immediately purchased on the Right-of-Way for the Railway and Terminal site, and the public announcement of the scheme was made by you as Minister of Railways and Canals in November, 1912, at Halifax.

The surveys were then most carefully completed, and the test borings made, and I have the honour, with every confidence, to recommend the Scheme of Ocean Terminals, to be known as the George's Island Extensions, as designed to give the best scheme for combined Railway Terminals and Harbour accommodation which Halifax Harbour, so well adapted naturally, can be made to provide.

While subscribing to this Report, I have to cheerfully note that the Project

is, in a very great measure, the result of the carefully worked out Policy of the Minister and Mr. F. P. Gutelius for the adaptation of the Intercolonial Railway and its magnificent natural Terminal Port in Nova Scotia to take the share in the Canadian Transportation Problem which their situation and natural advantages warrant.

I have also had the great advantage of being associated in the exhaustive study and work required, not only in the surveys, the choice of site and the type and design of the proposed constructions, but in the preparation of the Plans and Specifications, with a staff of exceptionally well trained and earnest workers. I refer particularly to Mr. James McGregor, Mr. A. C. Brown, A.M. Inst. C.E., and Mr. J. J. McDonald, B.Sc., A.M. Can. Soc. C.E.

To the Board of Trade of Halifax and its energetic Secretary, Mr. E. A. Saunders, I am greatly indebted for the local facts and statistics which they have so generously obtained and furnished.

Trusting that the merits of the case, as given in the Report herewith respectfully submitted, may be borne out by the future success of the Harbour of Halifax.

I am, Mr. Minister,

Yours obediently,

FREDERICK W. COWIE.

HALIFAX

HISTORICAL NOTES

Champlain's Map of Nouvelle France, dated 1632, correctly locates on the coast of what is now Nova Scotia "Se Sambre" and adjoining to the eastward "Port de Ste. Helaine." These are without doubt what are now Cape Sambro and the Port of Halifax.

In the early seventeenth century, however, the more important theatres of romance and history were Port Royal, now Annapolis; Le Heve; Port Rossignol, now Liverpool; and Port aux Anglais, later named Louisbourg.

It appears to be certain that some sort of a trading post must have been established at the present site of Halifax, at least one hundred years before the recorded foundation of the city in 1749. De Razilly, who founded a post at Le Heve, or his successor Charnisay or that born colonizer, Nicholas Denys, who started a shore fishery at Port Rossignol and later established posts at many places in Cape Breton, could not have overlooked such an advantageous site. Denys established his posts with great skill and, judging by the map of 1850, it is manifest that

the site chosen the year before must have been previously located by some one who had a thorough acquaintance with the country.

Immediately following its foundation in 1749, Halifax took a first place, owing to its many natural advantages and its unrivalled Harbour, and to this day it remains the chief city and harbour in Nova Scotia.

Bouchette, in "British Dominions of North America," 1832, gives the following historical sketch of Nova Scotia:—

> "Nova Scotia was under that name ceded to England by the treaty of Utrecht, 1713; from which period to 1745, from the disaffection and hostility of the neutral French, and the consequent indifference and occasional severity of the English, little or no improvement in the condition of the colony took place. The cession of Nova Scotia to England was again confirmed by the treaty of Aix-la-Chapelle in 1748; and the peace having left a great number of military out of employment, the idea was formed of settling the disbanded troops in this part of America. Land was also offered to civil settlers according to their means, with the advantage of being conveyed with their families to the colony, maintained there one year after their arrival, supplied with arms and ammunition for their defence, and with materials and utensils proper for clearing their land, erecting houses, and prosecuting the fishery, all at the expense of the British government. Nearly 4,000 adventurers arrived in the colony in June, 1749, under the command of Governor Cornwallis. They landed at Chebucto Harbour, and laid the foundation of a town, which was called Halifax, in honour of the Marquis of Halifax, then secretary of state, who had the greatest share in the founding of the colony. Here, on July 14th, 1749, Governor Cornwallis founded the first regular British government established in Nova Scotia."

This valuable chart is remarkable for its accuracy and as an indication of the foresight of the Founders in their choice of the site for the Town and Harbour.

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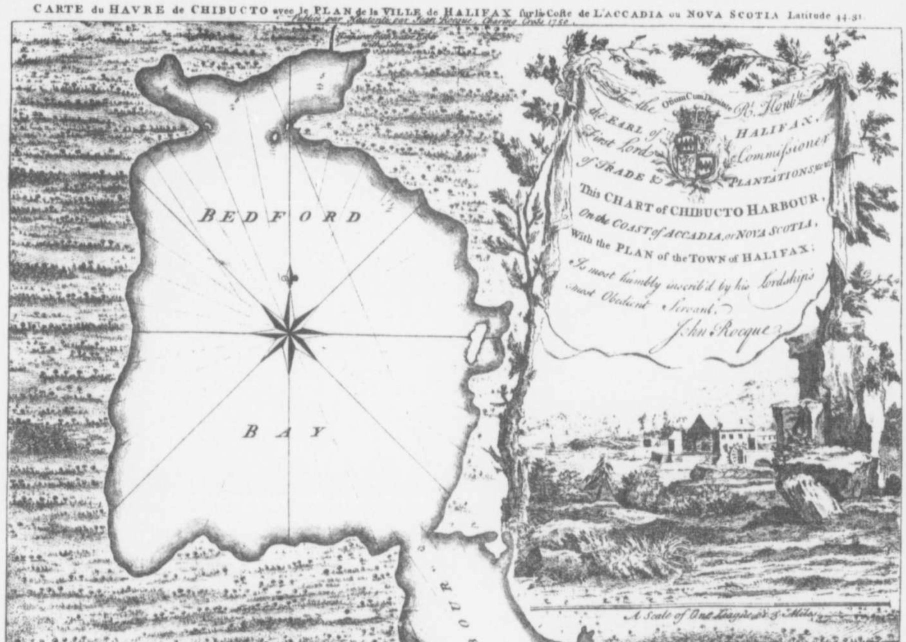
CARTE du HAVRE de CHIBUCTO avec le PLAN de la VILLE de HALIFAX sur la Coste de L'ACCADIA ou NOVA SCOTIA Latitude 44.31



Published by Authority by John Rocque at Charing Cross 1750.

It also shows the care taken within a year in the laying out of the fortifications, and surrounding residential districts.

The Harbour Development, Ives Wharf, must have been the very first, and it apparently was merely a landing place for small boats.

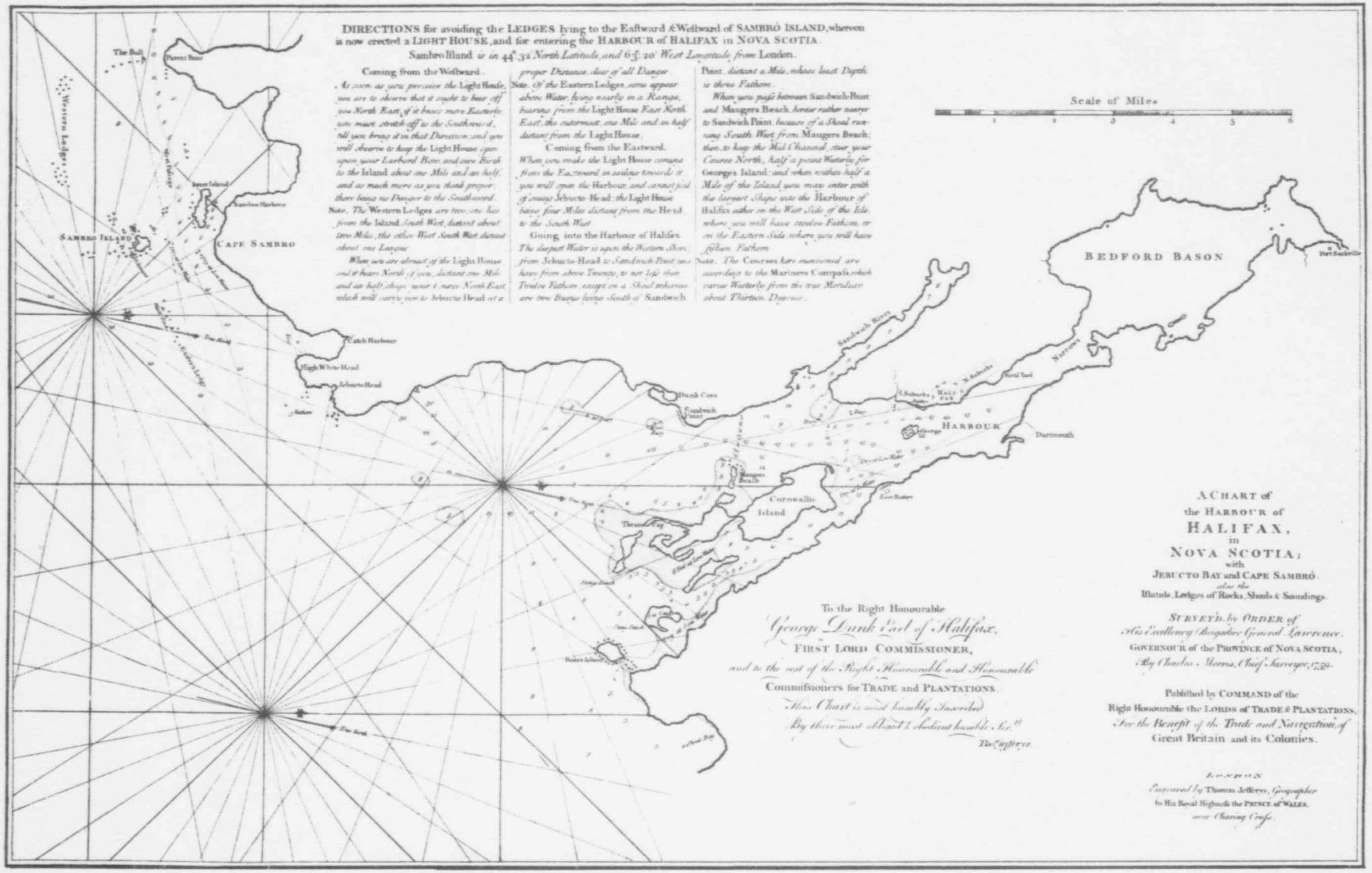
Georges Island is shown as well as the various anchorages. The site for the Harbour and the landing with its easy channel approach from the ocean cannot fail to cause a comparison to be made between the skill of the founders in 1749, and the circuitous railway approach as laid out a century later.

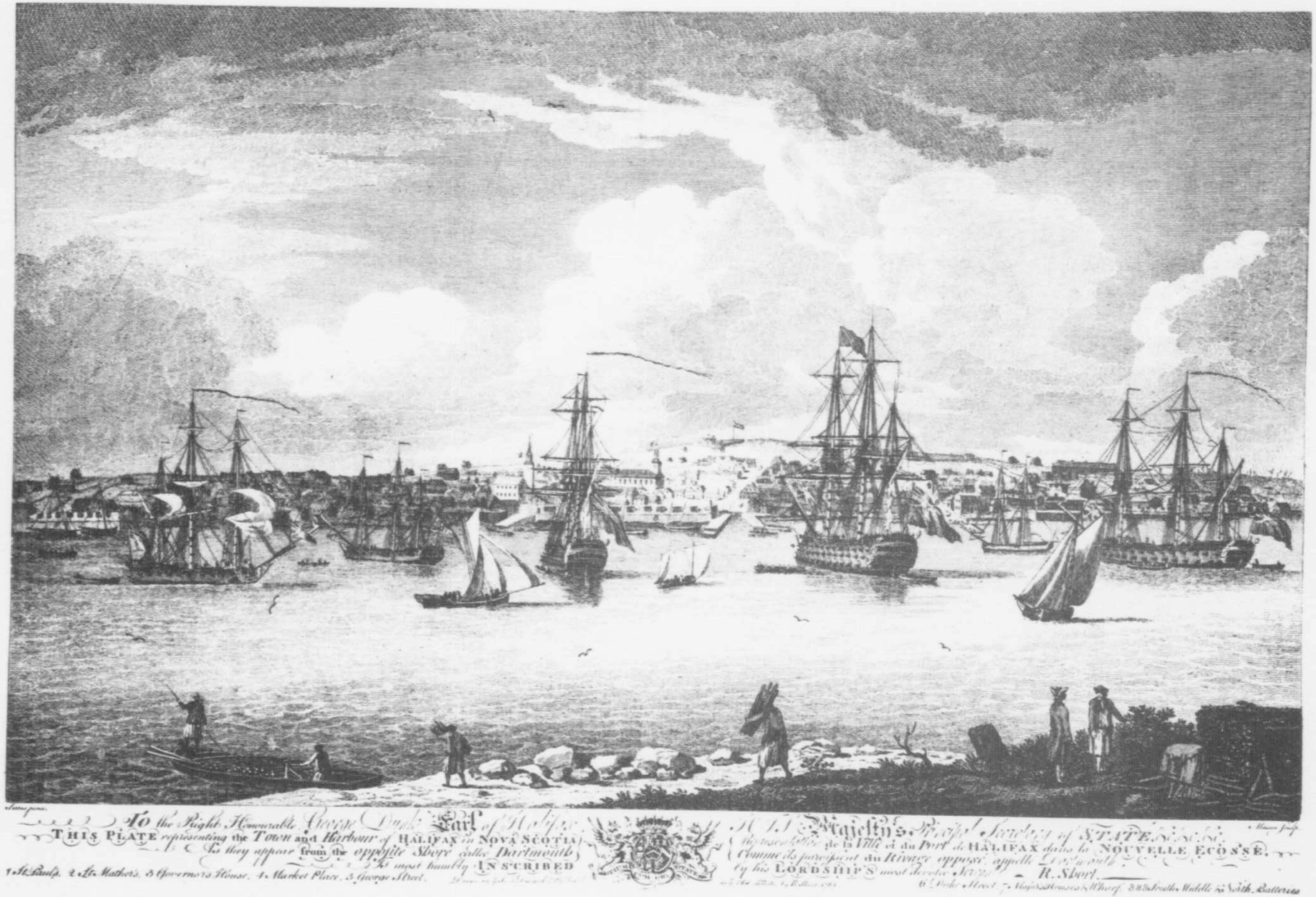
This Plan, showing the Halifax Peninsula unimproved, inspired the idea of the Georges Island modern Harbour site, with its easy and direct approach by Railway, and its facility of access for steamships.

The history of Nova Scotia, until the final peace of 1763, was marked by conflicts with the French. The population of the province, which then included New Brunswick, Cape Breton and Prince Edward Island, was in 1763, 13,000 souls; the value of its imports was £4,312-9-10 and of its exports £16,303-3-4.

This chart, a century-and-a-half old, gives sailing directions which could be used to-day.

> "You may enter with the largest ships into the Harbour of Halifax, either on the west side of Georges Island, where you will have twelve fathoms, or on the eastern side, where you will have fifteen fathoms."


DIRECTIONS for avoiding the LEDGES lying to the Eastward & Westward of SAMBRÓ ISLAND, whereon is now erected a LIGHT HOUSE, and for entering the HARBOUR of HALIFAX in NOVA SCOTIA.
Sambro Island is in 44°. 32' North Latitude, and 63°. 20' West Longitude from London.
Coming from the Westward.
As soon as you perceive the Light House, you are to observe that it ought to bear off you North East, if it bears more Easterly you must stretch off to the Southward, till you bring it in that Direction; and you will observe to keep the Light House open upon your Larbord Bow, and give Birth to the Island about one Mile and an half, and as much more as you think proper, there being no Danger to the Southward.
Note. The Western Ledges are two; one lies from the Island South West, distant about two Miles, the other West South West, distant about one League.
When you are abreast of the Light House, and it bears North of you, distant one Mile and an half, shape your Course North East, which will carry you to Jebucto Head at a proper Distance, clear of all Danger.
Note. Of the Eastern Ledges, some appear above Water, lying nearly in a Range, bearing from the Light House East North East, the outermost, one Mile and an half distant from the Light House.
Coming from the Eastward.
When you make the Light House coming from the Eastward, in sailing towards it you will open the Harbour, and cannot fail of seeing Jebucto Head; the Light House being four Miles distant from the Head to the South West.
Going into the Harbour of Halifax.
The deepest Water is upon the Western Shore, from Jebucto Head to Sandwich Point, you have from above Twenty, to not less than Twelve Fathom, except on a Shoal whereon are two Buoys lying South of Sandwich Point, distant a Mile, whose least Depth is three Fathom.
When you pass between Sandwich Point and Maugers Beach, borrow rather nearer to Sandwich Point, because of a Shoal running South West from Maugers Beach; then to keep the Mid Channel, steer your Course North, half a point Westerly for Georges Island; and when within half a Mile of the Island you may enter with the largest Ships into the Harbour of Halifax either on the West Side of the Isle, where you will have twelve Fathom, or on the Eastern Side, where you will have fifteen Fathom.
Note. The Courses here mentioned are according to the Mariners Compass, which varies Westerly from the true Meridian about Thirteen Degrees.
Scale of Miles
1
2
3
4
5
6
Western Ledges
The Bull
SAMBRO ISLAND
CAPE SAMBRO
Catch Harbour
High White Head
Jebucto Head
Dunk Cove
Sandwich Point
Sandwich River
Maugers Beach
Cornwallis Island
HALIFAX
HARBOUR
Dartmouth
Narrows
BEDFORD BASON
Fort Sackville
To the Right Honourable
George Dunk Earl of Halifax,
FIRST LORD COMMISSIONER,
and to the rest of the Right Honourable and Honourable
Commissioners for TRADE and PLANTATIONS
This Chart is most humbly Inscribed
By their most oblig'd & obedient humble Serv.t
Tho.s Jefferys.
A CHART of
the HARBOUR of
HALIFAX,
in
NOVA SCOTIA;
with
JEBUCTO BAY and CAPE SAMBRÓ
also the
Islands, Ledges of Rocks, Shoals & Soundings.
SURVEY'D by ORDER of
His Excellency Brigadier General Lawrence,
GOVERNOUR of the PROVINCE of NOVA SCOTIA,
By Charles Morris, Chief Surveyor, 1759.
Published by COMMAND of the
Right Honourable the LORDS of TRADE & PLANTATIONS,
For the Benefit of the Trade and Navigation of
Great Britain and its Colonies.
LONDON
Engraved by Thomas Jefferys, Geographer
to His Royal Highness the PRINCE of WALES,
near Charing Cross.


To the Right Honourable George Dunk Earl of Halifax, H. M. Majesty's Principal Secretary of STATE &c. &c. &c.
THIS PLATE representing the Town and Harbour of HALIFAX in NOVA SCOTIA, As they appear from the opposite Shore called Dartmouth, Is most humbly INSCRIBED by his LORDSHIP'S most devoted Servant R. Short.
Représentation de la Ville et du Port de HALIFAX dans la NOUVELLE ECOSSE, Comme ils paroissent du Rivage opposé, appellé Dartmouth.
1 St. Pauls. 2 St. Mather's. 3 Governor's House. 4 Market Place. 5 George Street. 6 Duke Street. 7 Major's Houses & Wharf. 8 & 9 South Middle & North Batteries

Immediately after the foundation of the town, Halifax became of great importance as a Naval Station. Nine years after the landing of Cornwallis, in May, 1758, Admiral Boscawen sailed out of Halifax with a fleet of 157 vessels for the siege of Louisbourg.

Again, during the American Revolution, troops and warships crowded the streets and Harbour.

Halifax was also a centre of naval activity during the war of 1812-15, and it was into the Harbour of Halifax that the British ship "Shannon" towed the American ship "Chesapeake" as a prize and broke the brief spell of success which had until then attended the United States Navy.

Fifteen years after the foundation of the Town and Harbour of Halifax, the above plate shows a wonderful picture of military and commercial progress and development. The navigation of that time required a Harbour to be a safe and convenient haven for ships. How suitable and convenient, for both safe anchorage and the lightering to shore and placing of freights in the water front warehouses, is clearly shown.

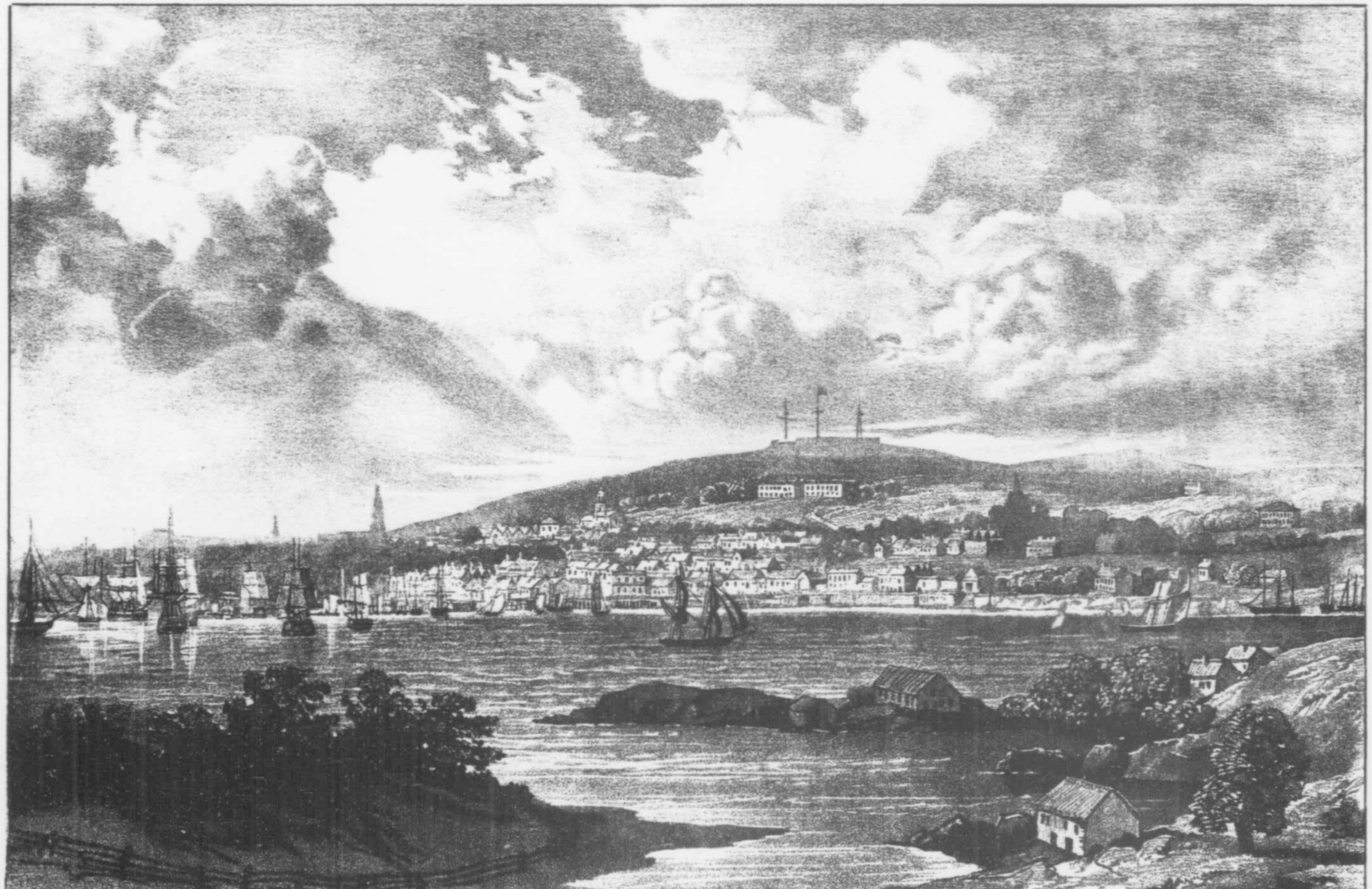
The South Battery, shown on this Plate, is the site now chosen for the 20th Century Ocean and Railway Terminals. This site gives primarily an easily accessible and safe port, and a convenient and economical location for the

junction between the Trans-oceanic ships and the Trans-continental railway trains.

A modern ship, carrying 10,000 tons of freight and 2,000 passengers in and out and making 16 round trips per annum, can theoretically carry 300,000 tons of cargo and 60,000 passengers per annum. This is not to be expected, but it would represent almost the equal tonnage and carrying capacity of the fleet of 1,800 vessels which was the pride of Canada in the year 1829.

The following is an account of vessels entered Inwards and cleared Outwards, with the estimated value of the Imports and Exports of the Port of Halifax in the year ended 5th January, 1829.

	Vessels Inwards				Vessels Outwards			
	No.	Tons	Men	Sterling value of cargoes	No.	Tons	Men	Sterling value of cargoes
United Kingdom.....	105	26,363	1,293	£311,100	86	22,390	1,033	£ 94,101
British West Indies..	299	27,724	1,655	163,548	332	31,803	1,896	224,221
British North America, viz,—Canada, New Brunswick and Newfoundland	1,140	59,913	3,545	129,544	1,250	70,744	4,093	179,010
Foreign Countries....	156	20,136	985	381,238	156	19,591	936	52,479
Total..........	1,700	135,126	7,483	£985,430	1,824	144,528	7,958	£549,811



On Stone by L.Haghe.

Day & Haghe Lith^rs to the King 17 Gate S^t Linc.Inn F^lds

VIEW OF HALIFAX FROM DARTMOUTH COVE.

BOUCHETTE 1832

Bouchette in 1832 describes Halifax as "one of the finest harbours in America. A thousand vessels may ride in it in safety. It is accessible at all seasons of the year, and easy of approach. It is the principal naval station of British North America.

"The Province building is the best built and handsomest edifice in North America.

"Dalhousie College, established in 1820, is a spacious and handsome structure situate at the end of the old military parade.

"Halifax contained, in 1790, 700 houses and 4,000 inhabitants; in 1828, 1,580 houses and 14,439 inhabitants. It is the seat of government, the principal emporium of the trade of the province, and returns two members to the House of Assembly. Besides Dalhousie College, there are a grammar school with an endowment of £1,200 from the province, three large schools on the national and Lancasterian plan, and several common schools. There are no fewer than six weekly newspapers published, and it has several charitable institutions. The manufactures carried on in Halifax are still in an imperfect state; they consist of a sugar refinery; distilleries of rum, gin and whiskey; breweries of porter and ale; and factories of soap, candles, leather, flour and cordage, and a few other minor articles. Halifax was declared a free warehousing-port in 1826, and its trade is very considerable. Nearly the whole of the import and better than one-half of the export trade of the province are carried on at Halifax. There were owned at Halifax in 1828, 73 square rigged vessels and 77 schooners; of which 70 were employed in the West India trade, four between Halifax and Great Britain, six in the trade with foreign Europe and Brazil, and the remainder in the fishery. There is a respectable private banking establishment at Halifax, and the Falmouth packet regularly arrives with mails once a month. The situation of Halifax is very beautiful. The noble harbour in front, Bedford Basin beyond, and the north-west arm in the rear, with the extensive forests in the background, unite in exciting the admiration of every beholder.

"It was not until 1817 or 1818 that the flood of emigration burst forth upon the British North American provinces with such force as to fix public attention and attract the attention of His Majesty's government; but since that period up to the present time, say thirteen years, no less than 200,000 persons from all parts of the United Kingdom, have been landed at the seaports."

In 1828 a line of Stage Coaches was established between Halifax and Annapolis, and a Steam Packet Line between Annapolis and St. John, N.B.

INTERCOLONIAL RAILWAY.

The first sod was turned at Richmond, near Halifax, on the Nova Scotia Railway, between Halifax and Truro in 1854, and the railway, sixty-one miles long, was opened for public traffic in 1858.

In 1867, the Minister of Public Works instructed Mr. (now Sir) Sandford Fleming, Engineer-in-Chief, to proceed at once with the surveys to connect the terminus of the Grand Trunk Railway at Riviere du Loup through to Truro in Nova Scotia.

In 1872 the railways in New Brunswick and Nova Scotia were called the Intercolonial Railway.

On July 1st, 1877, the whole line of the Intercolonial Railway was opened, and in 1879, by the purchase of the Riviere du Loup Line from the Grand Trunk Railway, the Government owned Intercolonial Railway was completed from Levis, opposite Quebec, to Halifax.

Sir Sandford Fleming, K.C.M.G., one of Canada's most eminent Civil Engineers, whose name will ever be connected with the Intercolonial Railway, wrote, in 1898, as follows:—

"The project of an Intercolonial Railway to connect the Maritime Provinces with what was then called Upper and Lower Canada early occupied public attention in British America.

"In the United Service Journal of 1832, Mr. Henry Fairbairn published the first suggestion, so far as known, of applying the railway system to Canada, as follows:—

"I propose, first, to form a railway for wagons from Quebec to the Harbour of St. Andrews upon the Bay of Fundy, a work which will convey the whole trade of the St. Lawrence in a single day to the Atlantic waters.

. . . .

"Another great line of railway may be formed from Halifax, through Nova Scotia to St. John, in the Province of New Brunswick, and thence into the United States, joining the railways which are fast spreading through that country, and which will soon reach from New York to Boston, and through the whole New England States. This railway will not only bring to the Atlantic the lumber, provisions, metal and other exports of the Provinces, but from the situation of the Harbour of Halifax it will doubtless command the whole stream of passengers, mails and light articles of commerce passing into the British possessions, and to the United States and every part of the continent of America.

"These words as penned so many years ago are worthy of preservation, not only for the correctness of view expressed and the enunciation of a policy which has been carried out. .

. . . .

CANADIAN TRANSPORTATION EAST AND WEST.

This Historical Sketch of the commercial progress of Halifax Harbour has an important bearing upon the trade vigilance required to solve and guard Canadian transportation problems. Regarding Halifax Harbour, it must be considered in its relation to the extent of any proposed scheme of port development as well as upon types and designs which should make it a success.

Halifax, with its unrivalled Harbour, has had, according to the records, almost every chance for great commercial development.

The excellence of the natural harbour has been so well known and unquestioned,

that it is now considered quite unnecessary to demonstrate its particular advantages.

From its foundation it took prominence as a Naval Station.

The settlement in Nova Scotia in 1788 of the United Empire Loyalists.

The flood of emigration to Nova Scotia from 1817 to 1830.

The wooden shipbuilding era and the great commercial advantages of trade by home built and owned sailing ships.

The remarkable and successful commencement of Steam Navigation between Great Britain and America, first started by Samuel Cunard of Halifax, in 1840, while the Americans tenaciously held on for several years to their sailing packets.

Halifax, therefore, held a leading position as an Atlantic commercial port at several periods during its first century from 1749 to 1849, but at each period, when success appeared to be permanent, Boston, New York or Philadelphia succeeded in capturing the shipping of the North Atlantic.

Many reasons have been assigned for this lack of continued success. Halifax had to depend upon the resources of the province of Nova Scotia alone, there being no suitable means of communication with the progressive and productive interior.

New York, by the construction of the Erie Canal, captured the trade at the expense of all her rival Atlantic ports, and Nova Scotia, with the rest of Canada, suffered from the lack of tolls on transportation.

The foundation of the Cunard Line of Ocean Steamships by Sir Samuel Cunard, the first line of steamships between Europe and America, and the use of Halifax as a Port-of-Call during the early years of the enterprise, gave a fresh impetus to the commerce of Halifax Harbour.

Appleton's Guide of 1850 gives the following notice of the sailing of steamships:—

> "The British and North American Royal Mail Steamships sailing between Boston and Liverpool and between New York and Liverpool, calling at Halifax to land and receive mails and passengers, are the "America," "Europa," "Niagara," "Canada," "Hibernia," "Britannia," "Caledonia," "Cambria," and "Acadia."
>
> "These vessels sail regularly every week.
>
> "Passage money from New York or Boston to Halifax $20.00."

In 1850, however, when the establishment of Atlantic steamships had reached a point of success, through the enterprise of her citizens, and Halifax had become a permanent Port-of-Call, success seemed assured. By building railroads to interior points, however, the United States ports again captured the trade, owing to lack of transportation facilities in Canada.

Finally, with the completion of the Intercolonial Railway from Halifax to Levis, in 1876, the commercial records indicated steady and important gains for several years but not sufficient to justify expectations. This time, although the railway may have been open to criticism, a more evident explanation of want of

success was the inadequate railway terminal and port facilities. The railway wharves and yards at Richmond, and later at the "Deep Water Terminals," were situated on a narrow and restricted shore having poor access to the city, with no connecting sites for warehouses and industries and with altogether inadequate accommodation for modern railway and ocean steamship traffic.

The successful competing ports in North America, New York, Philadelphia, Boston and Montreal have all been developed not only by being on lines of railway and steamship commerce, but by offering facilities to continental business and industrial activity.

An inspection of the present Ocean Terminals at Halifax is sufficient to prove that it is practically impossible to make it a successful port at the present site and on the present lines, so as to be suitable either for continental business, for industrial enterprise or for a modern railway terminal or ocean port.

Improved Harbour Facilities have been from time to time discussed. In 1904 and in 1906, the writer accompanied the Ministers of Marine and Fisheries, when careful inspections were made with a view to a proposition of Harbour improvements. The situation at Halifax and the magnificent natural Harbour gave every encouragement, but finding that almost all the Halifax water front then considered capable of successful improvement was locally owned, a location at

Dartmouth was carefully considered, but it did not offer sufficient encouragement for any project to be then undertaken.

At the present time, however, with the great improvement in railway travel, and with the construction of additional transcontinental railway lines converging towards Halifax, the question of improvements both for the railway terminals and for Harbour accommodation, has become a vital necessity, if the development of Canadian transportation lines is to be successful.

Visitors to Halifax who remain to learn of its wonderful attractions almost invariably adversely criticise the first views and impressions gained of it from the old wooden landing quays with their lack of facilities for steamships, the railway station and the thoroughfares leading to the city.

"The Times" special correspondent, narrating the progress of the Prince of Wales through Canada, records the impressions received in 1860:—

> "The town of Halifax by no means impresses the visitor on his first entrance. The road from the station passes through some of the poorest thoroughfares and meanest houses."

This will all be changed with the completion of the new Scheme of Ocean Terminals, as then the first view by passengers, either from Ocean Liners or Transcontinental coaches, will give an excellent first impression of the Gateway City of Canada.

It has been written (S. E. Dawson) that in the true fitness of things the proper place in the new world at which an Englishman should land is Halifax. "The transatlantic mind may there collect itself after the ocean voyage before encountering the oppressive superiority of Boston, the cosmopolitan indifference of New York, or the exuberant metaphors of the irrepressible West."

HALIFAX HARBOUR AND ITS RELATION TO THE CANADIAN TRANSPORTATION PROBLEM.

What does it mean to Canada to keep Transportation within her own territory? The practical miner is the author of the expression—"Foreign capital makes the Camp." Consideration will therefore be given only to Foreign Commerce.

Canada with a population of 8,000,000 has a foreign trade of $1,000,000,000 annually, or $125.00 per capita.

To quote from "Trade Strategy," by James Davenport Whelpley, New York, 1913,—

> "According to population England (The United Kingdom) has a foreign trade per capita of $125.00, Germany $67.00, and the United States $41.00.
>
> "In the case of England, a very large amount of her foreign trade is that of distributing agent for the producers of other countries."

It is said that Canadian producers receive only an average of 60 cents for products which cost the consumer $1.00.

Taking wheat, at a cost to the consumer of \$1.00 per bushel, the tolls on transportation, storage, handling, financing, insurance and selling, are therefore sometimes as much as 40 cents.

For every bushel of wheat exported, therefore, via Canadian transportation routes, the amount distributed before the wheat leaves Canada, along the line of route, practically according to population, is at least 25 cents.

With a foreign commerce of \$1,000,000,000 annually, the transportation tolls, whatever the exact amount, would appear to be imperatively worth collecting along Canadian routes and at Canadian ports.

The trade can only be guarded in Canada by making the home routes the cheapest and most attractive to the producer, and, granting this, even at some cost, there would be a large balance to the good.

> "The merchant whose desk overlooks the great harbour, and whose visitors smack of the sea, is no more concerned with international trade than the farmer a thousand miles from the seaboard."
>
> WHELPLEY.—"*The Trade of the World.*"

Halifax is situated geographically with three paramount advantages:—

1. As the best Terminal Port in North America for a fast transatlantic mail and passenger route, being the nearest port to Europe open all the year round and at all times.
2. As a safe and easily accessible winter port for Canada.

3. As an all year round Port-of-Call for shipping between Europe and North America.

SEE PLATE No. 1.—North America to Europe. Summer and winter routes via Halifax.

This half globe shows with geographical exactness Halifax with relation to the summer and winter routes to and from Atlantic Ports in North America.

For fully demonstrating the geographical suitability of Halifax as a Port-of-Call the following letter from a practical navigator, who has actually called at Halifax when in charge of passenger ships bound for New York, is given together with his Table of Distances:—

CANADIAN NORTHERN STEAMSHIPS LIMITED.

MARINE DEPARTMENT.

Capt. F. J. Thompson, Lieut. R.N.R., Halifax, N.S., March 13th, 1913.

Marine Superintendent.

F. W. Cowie, Esq.,

Montreal.

"Dear Mr. Cowie:—

"With reference to our conversation in regard to the difference in distance for a New York ship crossing the Atlantic to New York direct, and crossing to New York via Halifax, I have made out the attached table, and you will note for the twelve months, the average difference in distance is only 19½ miles.

"Should ships bound to New York direct be ordered to follow the extra southern track, this difference would be reduced.

"On the other hand, the track laid down for Canadian ships between February 15th and April 10th is not religiously followed, unless under exceptional ice conditions, the distance

made being usually 50 miles less, so that practically there is no loss of time going via Halifax except the time occupied going in and out of the Harbour and discharging passengers and baggage.

"This detention under ordinary conditions should not occupy more than four hours, i.e., allowing three quarters of an hour from Chebucto Head to the passenger landing (a distance of eight miles) and the same outwards, and allowing two hours and a half for disembarking passengers and landing mails and baggage, which with up-to-date facilities would be ample.

"There would therefore be a total loss in time of not more than five hours, which, in the event of the direct New York ship arriving there after sunset, would be entirely cancelled, as when a ship arrives at quarantine in New York Harbour after sunset she is not allowed to proceed to her berth till she has received pratique at daylight next morning.

"This condition and subsequent delay does not exist at the Port of Halifax in the case of mail steamers.

Yours very truly,

(Signed) Fred. J. Thompson.

TABLE OF DISTANCES.

Fastnet Rock (Ireland) to Ambrose Channel Light Vessel (New York).	Miles	Fastnet Rock (Ireland) to Chebucto Head (Halifax) and thence to Ambrose Channel Light Vessel (New York).	Miles	Miles
Jan. 15th to Aug. 14th......	2,833	*Feb. 15th to Apr. 10th...	2,356 plus 600:	2,956
		Apr. 11th to May 15th...	2,185 plus 600:	2,785
Aug. 15th to Jan. 14th......	2,724	May 16th to Nov. 14th...	2,162 plus 600:	2,762
		(Via Cape Race).		
		Nov. 15th to Feb. 14th...	2,185 plus 600:	2,785
Mean distance for year....	2,778.5			2,798

Difference in Distance via Halifax....... 19.5

Extra Southern track in ice season.................. 2,869 miles.

"* The long route to Halifax 2,356 miles is only taken for 54 days in the year, February 15th to April 10th.

"The above distances are taken from the Atlantic Steamship lines agreed to at a conference of representatives of all the large Atlantic Steamship Lines."

See Plate No. 2—Halifax as a Port-of-Call.

As a further illustration of the value of the route via Halifax to interior points in America, the following information is given with reference to passenger service from Europe to Chicago, via Halifax.

> "In the spring of 1913, the S.S. 'President Lincoln,' of the Hamburg-American Line, of 18,000 tons, arrived at Halifax at noon, and sailed at 3 P.M., arriving at New York at 10 A.M. on the second day.
>
> "The passengers landed at Halifax only left by train at 7 P.M., but they arrived in Chicago, after a very slow trip, at the same hour as those who continued on to New York were boarding the train at New York for Chicago.
>
> "The only complaint made by the Captain of the 'President Lincoln' was with reference to the Harbour facilities for the landing of passengers at Halifax."

It is therefore evident that with the best Landing Quay in North America, with the best terminal facilities for passengers, mails and express freight and for the despatching of transcontinental and other trains to all parts of North America, and with the extended and improved railway services, and finally with the tremendous development of Canada, there cannot fail to be a great increase in the adoption and use of Halifax both as a Terminal Port and as a Port-of-Call.

The unprecedented Railway development now in progress is a most significant feature which must not be overlooked in this connection namely:—

The Improvements on the Intercolonial Railway.

The Canadian Pacific Railway.

The National Transcontinental Railway.

The Canadian Northern Railway.

These railways are all stretching eastward and it is imperative that they shall meet at such an advantageous Ocean Terminal as Halifax a large share in the steamship trade of the North Atlantic.

The following interesting figures regarding the Trade and Commerce of Halifax were kindly furnished by the Secretary of the Board of Trade of Halifax, Mr. E. A. Saunders:—

Shipping Tonnage:	
1909-10	2,342,463
1910-11	2,479,029
1911-12	3,111,535
1912-13	3,182,923
Customs Receipts:	
1910	$1,691,145
1911	1,998,135
1912	2,117,619
1913	2,198,464
Number of Immigrants entered Canada through the Port of Halifax:	
1910	29,972
1911	55,712
1912	56,257
1913	79,195
Exports:	
1909-10	$11,595,755
1910-11	12,514,420
1911-12	15,467,270
1912-13	15,173,230

Imports:

1909-10	$ 9,356,322
1910-11	9,836,974
1911-12	11,512,546
1912-13	12,404,055

In 1913, one hundred and thirty seven Transatlantic steamships sailing between European and American Ports made Halifax a Port-of-Call. The total tonnage amounted to 1,200,000 tons, and the average tonnage of these steamships was over 8,000 tons.

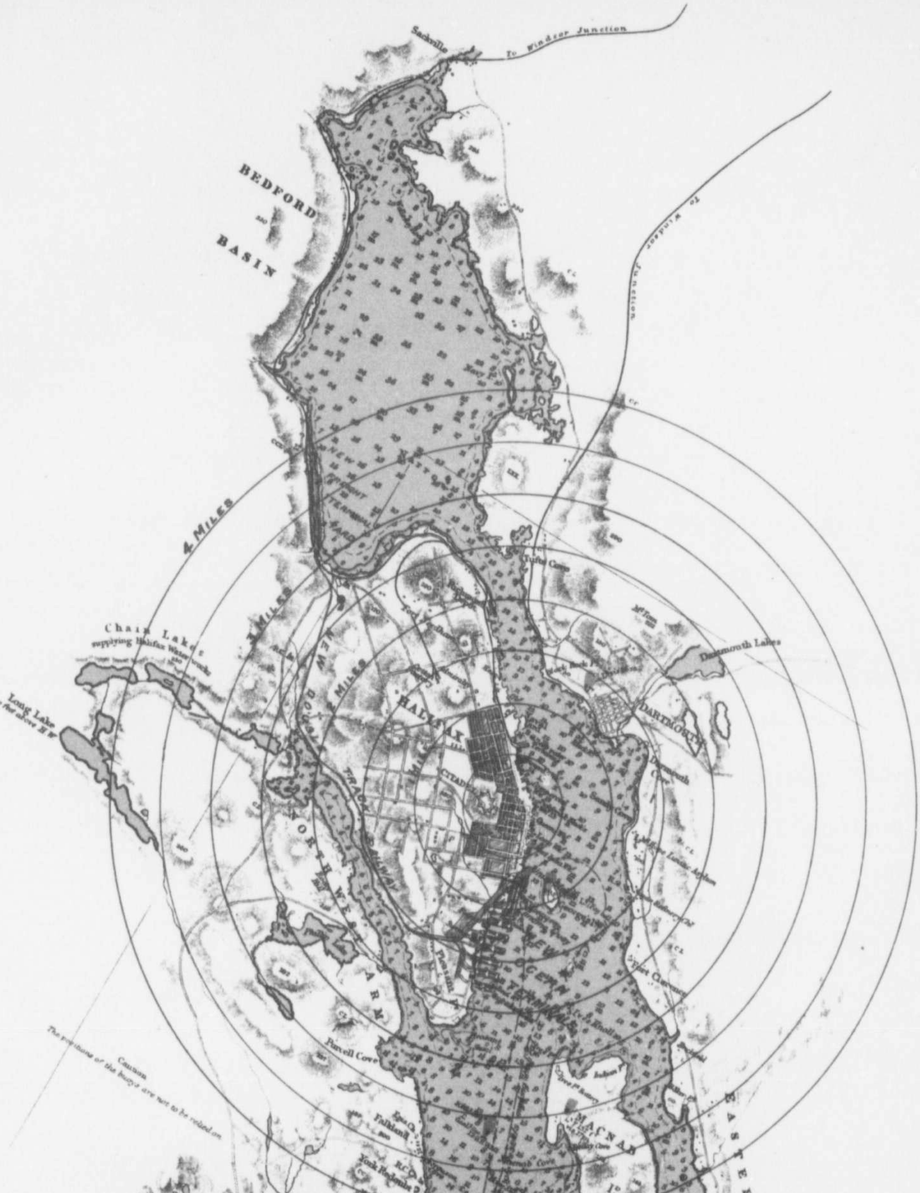
CONSIDERATIONS FOR HARBOUR TERMINALS FOR HALIFAX.

First consideration must naturally be given to all phases of former want of success, and some of the leading features to be kept in view in the consideration of any proposed scheme of Terminals are the following:—

The safest and most easily accessible Landing Quay for vessels of the largest and most modern type is naturally the most essential feature.

The location of railway terminals for passengers and freight, in the most desirable possible situation, with regard to city population and industries, and on a site capable of the necessary expansion and directly connected with all street railway lines, is the next consideration.

The rush and emergency requirements of a modern Ocean Terminal must be provided for, and it is also necessary that the port and terminal facilities


Sackville
To Windsor Junction
BEDFORD BASIN
4 MILES
Chain Lakes
supplying Halifax Waterworks
Long Lake
HALIFAX
DARTMOUTH
Dartmouth Lakes
NORTH WEST ARM
Purcell Cove
EASTERN PASSAGE

and the Union Passenger Station with all accessories, be laid out with a view to concentration, convenience and economy of time.

The centralization of port facilities, giving convenient lines of communication in all the different directions required to advantageous industrial and commercial sites, is also most desirable.

Provision should be made for terminal facilities and warehouse accommodation, with special reference to the productions and natural resources of the province of Nova Scotia, so that a reliable and steady market may be assured for the products of the fisheries, the market gardens, the orchards and pastures of the district and the other natural resources and products of the province.

EXTENT OF HARBOUR ACCOMMODATION REQUIRED

The Halifax Board of Trade, in connection with proposed Terminal Piers at Halifax, in 1911, made recommendations as follows:—

> " Three large piers and one small pier and a flour pier would be totally inadequate for present requirements, without considering what future requirements will be."

That would mean that berths for 12 to 16 steamships were not considered adequate in 1911.

> " The purchase of more land to the south of the Terminals was considered absolutely necessary. The Harbour frontage there owned by the Railway being insufficient, it meant that terminal facilities would be cramped.

"The ends of piers should be at right angles."

These recommendations from a local point of view, and from a study of the requirements of Steamship Companies, and present and projected railway traffic led to the instructions that the proposed Scheme should provide accommodation as follows:—

1. As soon as possible accommodation for .... 9 steamships
2. In three or four years, with the advent of new railways, further accommodation for ....9 "
3. In three or four years more, after the opening of the Quebec Bridge, further accommodation for.................................9 "
4. Possible extensions on same lines.
5. All accommodation to be permanent, first class and to be suitable for modern steamships of the largest type.
6. All accommodation to be designed with due allowance made for probable increase in dimensions of vessels.
7. The Railway terminals to be improved and increased in the same proportion.

SURVEYS

For the purposes of obtaining information necessary for a comparative consideration of the various possible sites, all available maps and charts were secured.

The ordnance survey maps, the Admiralty charts and the Intercolonial Railway plans were carefully studied. After a very careful reconnaissance, with the aid of the plans and information available, including Bedford Basin, the Halifax Peninsula and the Dartmouth shore, it was found that sufficient information was not available.

TOPOGRAPHICAL SURVEYS

Arrangements were immediately made for three and later for four survey parties, and under the direction of the Superintending Engineer, very complete surveys were made of all the physical features of the shore, both natural and artificial, from the Intercolonial Railway Yards at Richmond, southward to Point Pleasant Battery; also westward across the peninsula north of Point Pleasant Park to the North West Arm, and northward for a width of about one-half mile along the North West Arm and through the valley to Fairview, and thence along the shore of Bedford Basin to a point north of Rockingham.

Careful and accurately closed traverses with accurate measurements were made and levels were taken, sufficient for all purposes of Harbour and Railway location, designs, estimates and contract plans.

The requirements called for a location for Ocean Terminals, convenient to city business points, with first class railway facilities, with safe and speedy access

for ocean vessels, and capable of providing in a concentrated district an ultimate length of quays of about 20,000 feet, all at reasonable cost.

As information was gained and one location set aside after another, the surveys where required were enlarged so as to determine the possibilities and advantages of the final Schemes.

After the George's Island site was approved by the Minister, and the character and location of the Railway approach determined, special attention was given to the particular districts affected. The land surveys were completed in December and the Superintending Engineer's office removed to Montreal. During the winter locations were made and test pits excavated and borings made at typical points for the purpose of obtaining further information as to the character of the soil and levels of the rock.

HYDROGRAPHICAL SURVEYS

In addition to these detailed land and topographical surveys, equally complete hydrographical surveys were made.

A comprehensive series of soundings was taken in the following manner: a system of parallel lines at right angles to the shore and not more than 100 feet apart was laid down, extending from Bedford Basin through the Narrows to Point Pleasant Battery. On these lines soundings were taken at regular intervals

of 25 feet and at intermediate points, where necessary, for a distance of 1800 feet out or until a depth of water was obtained beyond which economical pier construction would be out of the question.

On the site decided upon for the proposed Ocean Terminals soundings were taken out to a distance of from 1,700 to 1,800 feet from the shore.

In Bedford Basin, between Rockingham and Fairview, soundings were also taken in order to investigate the practicability and economy of making up sufficient land for a new railway freight Terminal Yard.

All the available records regarding climatic and tidal conditions were studied together with observations of winds and storms, and in addition an investigation of the currents was made. Surface floats and submerged floats at depths of 10, 20 and 30 feet were used, and the direction and velocity of the currents as indicated by them recorded. It was found that south of George's Island there was very little current, in fact the floats put in the water off the southern end of the proposed Ocean Terminals usually did not reach George's Island during a complete flow of the tide. On an ebb tide only a slight current was recorded in this portion of the Harbour. In the Narrows at Richmond and past the Naval Yard a marked current was recorded which during a slight wind blowing from the north was found to reach over two knots.

A curious fact was noted, namely that a little north of the Public Ferry route from Halifax to Dartmouth the current at ebb tide set towards the Dartmouth shore at a pronounced angle and diminished in strength. The 30 and 20 foot submerged floats crossed the Harbour and finally grounded. The surface and 10 foot submerged floats took a course directed towards the east of George's Island. This may explain to some extent the absence of currents at the George's Island Terminal Site.

From these investigations it was found that south of George's Island there were no currents which could appreciably affect the docking of vessels, but that north of the present Intercolonial Railway terminals, and especially in the Narrows, the currents were such as might present slight difficulties during the docking of large modern ships.

TEST BORINGS

Very careful attention was given to the question of test borings, and as soon as possible a steam drilling outfit was obtained and preliminary borings taken in various parts of the Harbour to determine the nature of the substrata.

On the site of the proposed Ocean piers and quays a very complete series of borings was taken. This work was done very carefully, as upon the results obtained the location and type of construction to be adopted very largely depended. Borings at intervals of about 150 feet were taken along the lines as finally laid out for the

quay walls and along the centre lines of the piers and basins. Further borings were then taken, where considered necessary, in the area to be occupied by the first unit, and especially where the depths and conditions had been found to be somewhat irregular.

From a study of the borings it was seen that there was comparatively little material overlying the rock, in most cases from 4 to 6 feet, of which 2 to 3 feet as a rule consisted of soft mud and the remainder of sand, clay, stones and gravel.

An exception to the fairly general rule was found along the line of the proposed bulkhead landing quay. For a distance of some 200 feet the depth to rock was found to be slightly over 70 feet below low water level, and in this location the rock was covered to a depth of about 20 feet with red sandy clay of variable hardness.

All the borings taken in Halifax Harbour at the Terminal Site were made by a portable steam "Cyclone" hollow rod drilling machine mounted on a wooden scow.

The drill worked inside a 2½ in. dia. wrought iron pipe and the material drilled through was pumped up inside the drill and discharged on the deck of the scow, where the wash borings could be examined in detail.

The scow was kept in position by means of four anchors, one at each corner,

and a crew of 5 men was employed. These men attended to the drill and the moving of the scow and its anchors, as required, from hole to hole.

It was found possible to easily move the scow distances of 200 feet without the aid of a tug, by lifting one of the anchors at a time and moving it forward, always keeping the three remaining mooring lines in place.

This drilling outfit worked continuously throughout the winter on the most exposed parts of the site for the Terminal Piers and without accident, thus showing conclusively that there was never a sufficiently rough sea to cause discomfort to a large ship.

SEA WATER IN HALIFAX HARBOUR

The water in Halifax Harbour is but little affected by any admixture of fresh water, as no river of any magnitude empties into the Harbour or Bedford Basin. It varies little, if any, in salinity, contains very little matter in suspension and may be said to be clear and uniform in quality all the year round. The main sewers of the City discharge into the Harbour, but the admixture of sewage, except at the outfalls, is hardly noticeable. Although there is a thin layer of fine mud extending over the bottom of almost the whole Harbour, the western shore of the Harbour is very free from sea-weeds and shell fish. The temperature of the sea water in the Harbour varies from a maximum of about 70° F. in summer down to

about freezing point in winter, but there is no record of the Harbour ever having been frozen over south of the north end of George's Island. The average temperature of the water in summer is about 60° F., and it is coldest during the months of January, February and March.

ALTERNATIVE PROPOSALS AS TO LOCATION

With full information available, four alternative proposals were carefully considered. Each of these proposals provided for a Scheme which would give accommodation for 20 to 30 full sized ocean steamships, as follows:

Scheme "A" Extension of Deep Water Terminals Northward to Graving Dock and Southward to H.M. Lumber Yard

The development of this area of the city water front would have to be carried out to suit the physical features of the shore, the depth of water, the position and nature of the rock and the approaches by railway and city streets, and to work in with the existing Graving Dock and Deep Water Terminals.

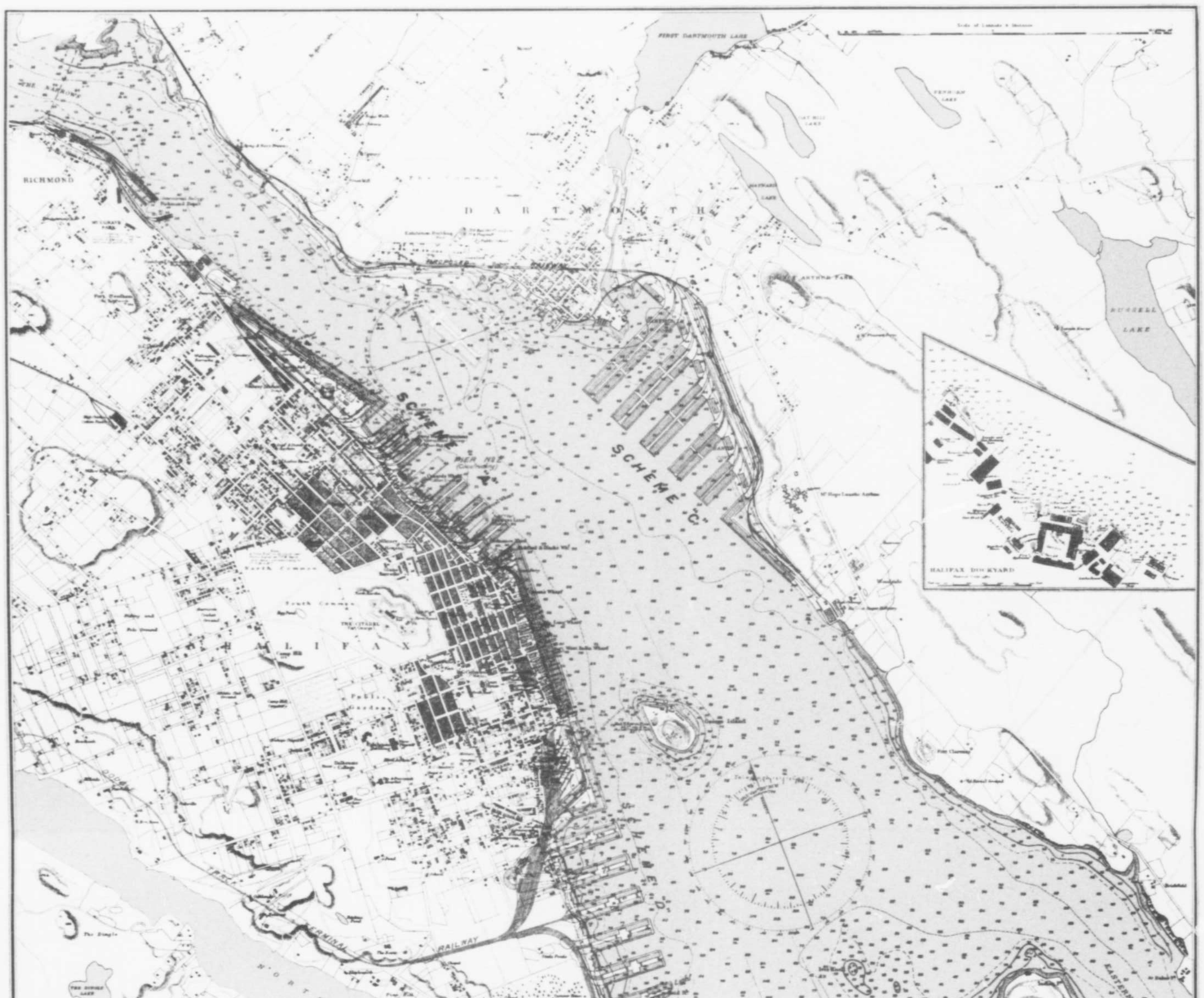
This Scheme would not be designed on quite symmetrical lines, but would include bulkhead wharves and piers of different dimensions.

The ultimate possible number of 600 ft. steamship berths would be *26*.

Advantages:

Central location.


HALIFAX HARBOUR
SURVEYED BY STAFF COMMANDER W.F. MAXWELL R.N.
1889
SOUNDINGS IN FEET
FIRST DARTMOUTH LAKE


NORTH AMERICA - EAST COAST
NOVA SCOTIA
HALIFAX HARBOUR
RICHMOND
DARTMOUTH
HALIFAX
SCHEME B
SCHEME A
SCHEME C
SCHEME D
NORTH WEST ARM
MACNAB ISLAND
EASTERN PASSAGE
FIRST DARTMOUTH LAKE
RUSSELL LAKE
HALIFAX DOCKYARD

Easy approach for ships.

Existing railway access.

Good bulkhead passenger Landing Quay at north end.

DISADVANTAGES:

The advantages due to central location would be largely neutralized by the compulsory removal of the principal businesses now in the centre of Halifax to a new location.

Present railway approach unsatisfactory.

Construction difficulties due to existing structures, old piles, etc., on lines of walls and works.

City approaches difficult on account of restricted width of land and steep slopes and narrow lines of communication.

Dislocation of established city business with no alternative suitable locations available on the peninsula for the class of business done.

Condemnation of all present coal building material, market produce, and fish berths which would immediately result in increased cost of living.

Disastrous effect on City Assessment Value and Taxation, at least temporarily.

Interference with present Railway and Ocean business during construction.

Removal from Halifax of H. M. Dockyard, which may become vitally necessary at any period in the history of the country

Removal of the Marine and Fisheries Department Depôt which requires a suitable location near the centre of business.

Unavoidable delay in moving present occupants and industries and consequent loss of time in completion of new works.

Present established businesses requiring to be removed:

Coal docks.

Commercial Cable Co's. wharf and depot.

Furness Line.

H.M. Ordnance Yard and Gun Wharf.

Pickford and Black's wharves and warehouses.

Halifax and Dartmouth Steam Ferry Dock.

Western Union Cable System Wharf and Depot.

King's Wharf.

Plant Line.

Red Cross Line.

Fish depots and establishments, including cold storage warehouses.

Halifax Electric Tramway Company's Light and Power station.

Practically the whole of the existing establishments between Upper and Lower Water Street and the Harbour front.

The cost of construction, including the disestablishment of businesses and land required, would be prohibitive.

Estimated Cost per Standard Steamship Berth, including land, quays, sheds and equipment $1,235,000.00

SCHEME "B"—TUFT'S COVE TO DARTMOUTH.

The development of Harbour Extensions in this locality is possible on fairly symmetrical and economical lines.

Along the east shore of the Narrows, south of Tuft's Cove, Bulkhead Quays would be constructed, and in the wider portion of the Harbour opposite the present Intercolonial Deep Water Terminals two long Piers would extend into the Harbour in a south easterly direction and be so located as not to interfere with the Dartmouth water front on the east or the access to the existing Intercolonial Railway Piers on the west.

The total accommodation would be.................. 24 Steamship Berths.

ADVANTAGES:

Easy approaches for ships.

Cheapness of construction.

Comparative cheapness of land to be acquired.

No extensive existing business to be dislocated, and only a small number of existing business and other buildings to be removed.

Existing Railway connection which could be made very good.

DISADVANTAGES:

It has been proven over and over again that a harbour located without convenient access from the city and remote from its business centre can never be made successful. Examples:

1. Levis.
2. Longueuil.
3. Brooklyn
4. Birkenhead, England.
5. The Tilbury Docks, London, England.
6. River front opposite Antwerp, Belgium.

If the new Ocean Terminals are to be located away from Halifax there are other and perhaps better locations which should be considered, for example:

Country Harbour.

High elevations, steep slopes and rocky nature of adjacent land.

Improvement of Railway required from Windsor Junction to Dartmouth or a New Bridge over the Narrows and Railway from Richmond.

Duplicate train service would be required to the ocean terminals and to Halifax.

Difficulty of manoeuvring and turning steamships in the Narrows.

Estimated Cost per Standard Steamship Berth, including Land, Quays, Sheds and Equipment.. $800,000.00

SCHEME "C"—DARTMOUTH COVE.

A Harbour development at Dartmouth Cove is quite possible on the several different lines of successful harbour types of construction.

The proposed type would be long piers and a bulkhead landing quay at the southern end.

Total accommodation..... .... 28 Steamship Berths.

ADVANTAGES:

Steamship berths to the required extent could be provided.

Easy approaches for ships.

Land, including shore rights, comparatively cheap.

Existing Railway connection.

Bulkhead passenger landing quay.

Disadvantages:

A new and improved railway approach through Dartmouth would be required and improvement of the Railway from Windsor Junction as in Scheme "B."

Location has the same disadvantages as Scheme "B" relative to centre of business.

Height and steep slopes of adjacent land.

Great average depth of water and to rock might make construction on the whole slow and expensive.

Exposure of landing quay to south, southeast and northwest winds.

Interference with the Roadstead or Anchorage northeast of George's Island.

If this bay was located on the Halifax shore it would have some advantages.

Estimated Cost per Standard Steamship Berth, including Land, Quays, Sheds and Equipment $880,000.00

Scheme "D"—George's Island Extension, as Adopted.

From the date of the foundation of Halifax it would appear that Harbour development should have extended southward as the size of ships increased and protection required lessened. It now appears strange that when the railway was projected to Halifax it was not located to the westward, around the city, to a terminal conveniently situated relative to the centre of the city.

The physical features of the shore and the depth of water are the best in the whole Harbour and are well suited for harbour development. The approaches from the city are very much superior to any possible approaches from any other location on the Peninsula.

Total accommodation.............................27 Steamship Berths.

ADVANTAGES:

The Union Passenger Station and Ocean Steamship Terminals are located very close and convenient to the centre of the city.

The Passenger Landing Quay is of the Bulkhead type to facilitate the docking and departure of ships and is located on a part of the water front where Pier construction would not be permissible on account of George's Island, which, however, protects the site from north and northeast winds, and leaves a deep water channel of at least 800 feet in width.

The Landing Quay which is the special advantageous feature of the Scheme will provide the safest and most rapid exchange between the Steamship and the Railway of any harbour in the world.

The whole development from the Landing Quay to the final Pier will be laid out on orthogonal lines and may be described as first class throughout with every berth satisfactory for steamship accommodation.

The utilization of a part of the city water front, hitherto but little developed and largely unoccupied.

Comparatively small effect on assessment value and taxation of city.

For shipping, a ship making Halifax a Port-of-Call may take aboard the Quarantine officials and their examination may be completed by the time the steamship is turned and ready to dock.

At the Landing Quay the docking of steamships and their departure will be easy and expeditious.

Owing to the great width and depth of the Harbour opposite the Piers the manœuvering of the largest ships and their access to the Pier berths will be attended with unusual facility.

For railway terminals, the location, the contour of the site and the access to the steamship terminals are excellent.

Any size of steamship now plying the Atlantic, or that seems likely to be projected for many years to come can be adequately accommodated.

Ample accommodation will be provided for vessels making Halifax a Port-of-Call, for vessels making it their Home Port and for any proposed Fast Line Services.

Local freight yards are provided which will give excellent accommodation for

the local city freight and teaming traffic, situated close to the centre of the city and with easy access to all parts of the Halifax Peninsula.

If at any future time it is required further extensions may be made southward or northward on symmetrical lines.

As designed for strictly first class accommodation or what may be classed the best Ocean and Railway Terminals on the Atlantic coast, the proposed George's Island Extensions, when fully understood, require no further argument.

The cost per ocean steamship berth available, including everything required for Harbour facilities, will be comparatively low.

Estimated Cost per Standard Steamship Berth, including Land, Quays, Sheds and Equipment $860,000.00

DISADVANTAGES.

The only disadvantages which have up to the present time been established are the following:—

The new railway access will pass through a residential district of which the Halifax citizens are very proud, and its cost will be high, due to the preservation of the city's amenities.

Point Pleasant Park will be, to a certain extent, encroached upon.

The location of the Harbour accommodation has been regarded as being more exposed than the present Deep Water Terminals.

The present value of the site as compared with Schemes "B" and "C" is greater.

In explanation of these features it may be stated that instructions have been issued that every care is to be taken to design the railway access to preserve as much as possible the natural beauties of the surroundings. Point Pleasant Park will be encroached upon, but in lieu thereof a promenade is suggested extending the whole length of the bulkhead quay on top of the steamship terminal buildings, nearly 2,000 feet long and 40 feet wide. The breakwater will also compensate for the elimination of a portion of the water front of the park. As regards the question of exposure, ocean and local navigators of high repute state that in their opinion, modern vessels will not be incommoded and that the breakwater and the arrangement of the piers will prevent any serious surging of the vessels.

As a whole the Scheme will not interfere with any future Harbour or industrial development of Halifax. It is designed on broad lines in the interest of not only the city but for the improvement of the trade and commerce of the whole Dominion. It may also be stated that at no Port in the world is there a record of any equal development at anything like an equal expenditure, the natural advantages of the Harbour, the tidal range, the absence of currents or any tendency to silt, and the physical features of the site being unusually favourable both as regards first cost and future maintenance.

NEW RAILWAY APPROACH TO TERMINALS

The new railway approach to the proposed Ocean Terminals will commence on the Intercolonial Railway near Rockingham at a distance of about five miles from the existing Deep Water Terminals, and about six miles from the proposed New Ocean Terminals.

Between Rockingham and Fairview there is to be constructed a new Freight Terminal Yard, by reclaiming a large and comparatively shallow area from Bedford Basin.

A suitable site for this Yard would otherwise be difficult to provide on account of the very hilly and rocky nature of the Peninsula and surrounding country.

The material required to form the new Freight Terminal Yard is to be obtained from the surplus of excavated materials from the railway. The new Yard will be open ended and will have ample standing room for cars on body tracks, about 4,000 feet long, and the whole will be readily capable of extension. This Yard will take care of all freight to and from the old and new terminals. Transfer or switching engines will be used between the new Freight Yard at Rockingham, and the Ocean Terminals.

There will be no grade crossings, the railway being carried under the Halifax and South Western Railway, and in all cases either under or over roads and

streets by means of bridges. These bridges will be designed to harmonize as far as possible with their surroundings. In order to preserve the natural beauties of the North West Arm and so as not to detract from the value of the south and west ends of the city as residential districts, the railway, from Quinpool Road to Young Avenue, that is in the sections of the city along the North West Arm and in the vicinity of Point Pleasant Park, will be in a cutting carefully constructed and sufficiently deep to give the necessary clearance to carry the railway under the bridges carrying the roads and streets.

The railway has been designed for heavy freight as well as fast passenger trains. The maximum curvature is four degrees and all curves will be laid out with suitable easement curves. The maximum grade is to be 0.60 per cent compensated 0.04 per cent per degree of curvature. The railway will be double tracked throughout with additional lead tracks at the yards and terminals. The bridges, culverts, and all structures will be of a permanent character.

From Young Ave. the passenger trains are to be carried on high level tracks to the new city station and from thence by a double track to the back of the first floor of the large freight and passenger shed on the Bulkhead Passenger Landing Quay.

The new Union Station is proposed to be situated near the corner of Pleasant and South Streets. It will be a large handsome and substantial structure provi-

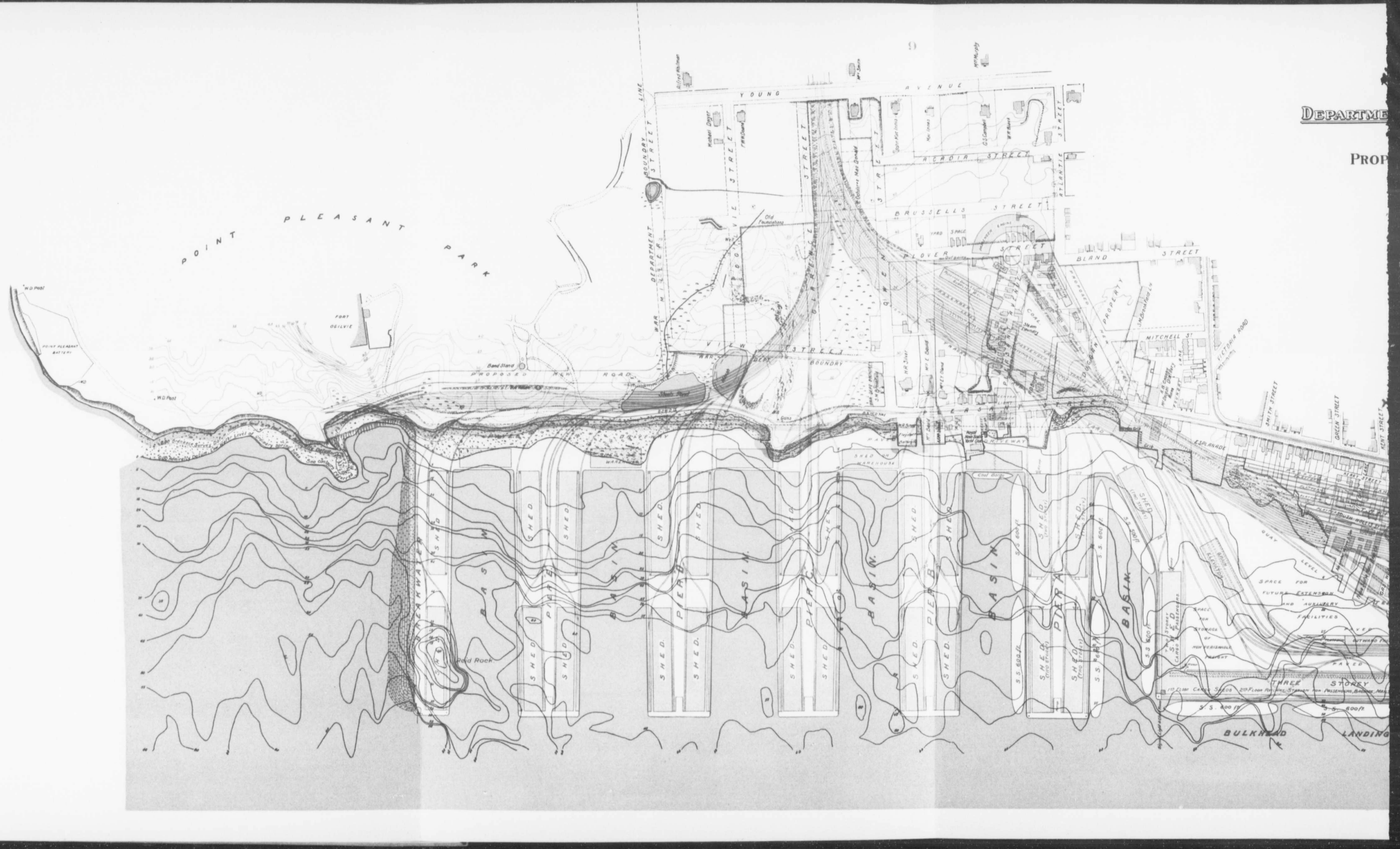
ded with all modern conveniences and facilities for passengers and for the handling of baggage, mails, express, etc.

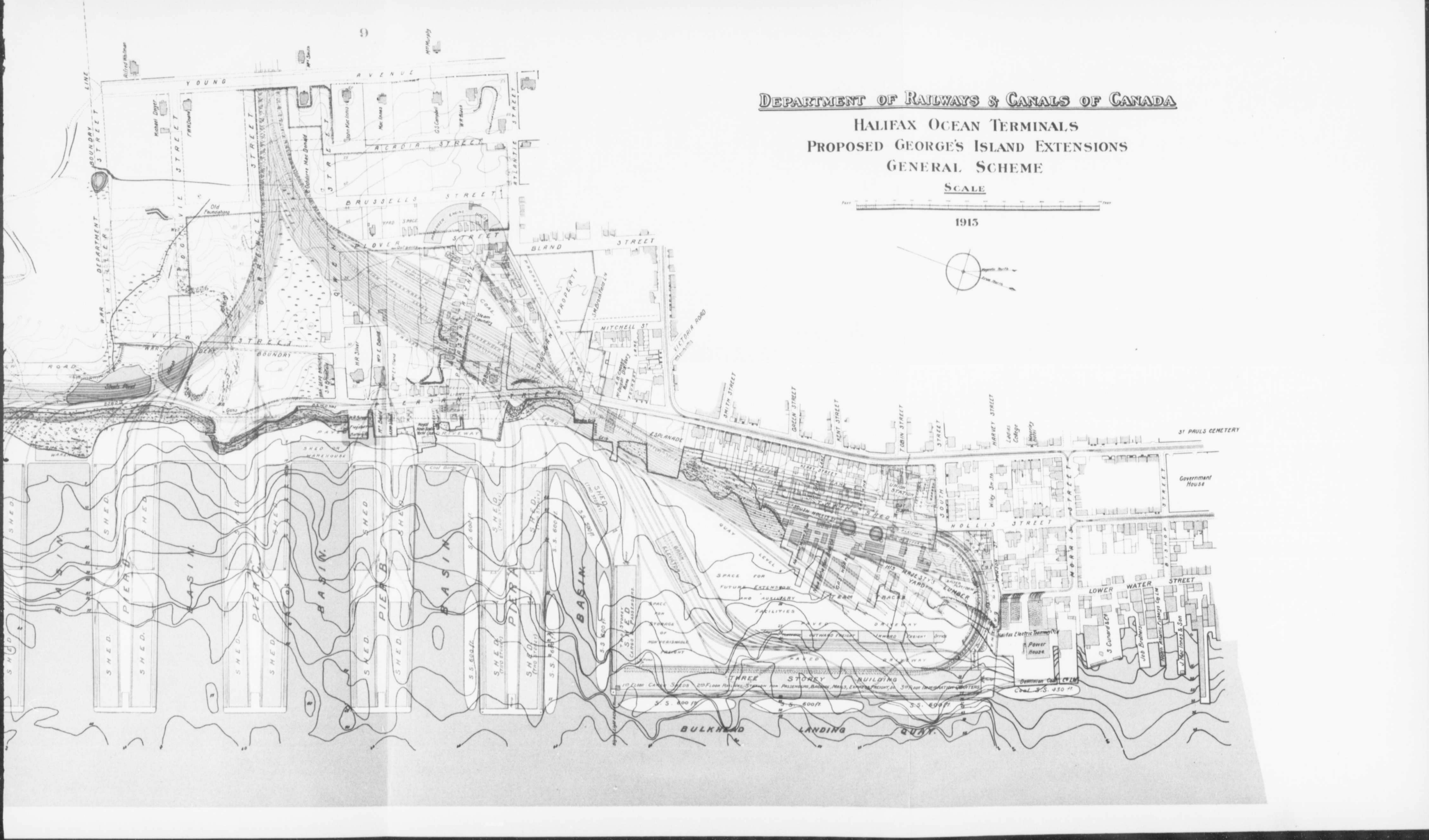
The Coach Yard for storing, cleaning, outfitting and repairing passenger cars, etc., is proposed to be situated immediately south west of and adjoining the Union Station, and will be of ample capacity and equipped with steam heating and all necessary supply buildings and other facilities.

AREA AND GENERAL ARRANGEMENT OF SCHEME OF DOCKS

The area of land expropriated for Terminal purposes east of Young Avenue is 70½ acres and of this total 22 acres lie east of Pleasant Street and above high water mark. In addition to these areas there is an area above high water mark of about 14 acres to be taken from the lands of Point Pleasant Park owned by the Imperial Government and leased to the Park Commissioners. The area of land to be reclaimed from the Harbour beyond high water mark and made up into Yards, Quays, and Piers for the First Unit, i. e. north of the North line of Pier "B", is 53½ acres and for the whole scheme is 114 acres.

The area of water to be occupied by shipping, i. e. the water area west of the Pier Head Line, is for the First Unit 18 acres and for the whole scheme 62 acres.


POINT PLEASANT PARK
YOUNG AVENUE
BRUSSELS STREET
BASIN
PIER
BULKHEAD LANDING QUAY


DEPARTMENT OF RAILWAYS & CANALS OF CANADA
HALIFAX OCEAN TERMINALS
PROPOSED GEORGE'S ISLAND EXTENSIONS
GENERAL SCHEME
SCALE
1913
YOUNG AVENUE
BRUSSELS STREET
BLAND STREET
LOWER WATER STREET
ST PAUL'S CEMETERY
Government House
THREE STOREY BUILDING
BULKHEAD LANDING QUAY

The total area to be used for Terminals will therefore be 260½ acres of which 198½ acres will be land and 62 acres water.

The materials for filling the reclaimed areas behind the Quay Walls will be obtained from the excavations for the New Approach Railway and Yards, dredgings from the Basins and by dredgings from the South Eastern side of the Harbour.

The Breakwater and Piers are laid out at right angles to the Bulkhead and Pierhead Quays and also to the direction of greatest exposure so that first the Breakwater which is southmost and then each Pier after the other protects and shelters the next Pier to the Northward.

The Breakwater itself will be largely protected by Point Pleasant Shoal to the South of it.

In front of the Piers and Basins is an area of about 1 mile square with a depth of at least 70 ft. at L.W.O.S.T. forming an ideal natural turning, manoeuvring and anchorage basin free from currents and perfectly landlocked and protected except for a slight exposure to the south from which direction winds are very infrequent and never intense.

Basin No. 1 is located far enough south to allow vessels to enter and leave it without any danger of touching on the south end of George's Island.

The Ocean Terminals will include a Bulkhead Passenger Landing Quay 2,006

feet long with a depth of 45 feet of water at Low Water of Ordinary Spring Tides. Extending for the full length of the quay a large two-and-a-half storey passenger and freight building, 116 feet wide, is proposed. The ground floor will be used exclusively for freight. The second floor will be used for passengers, baggage, mails and express freight, and will be fitted to meet all the requirements of such traffic. On this floor also ticket offices, waiting rooms, customs offices and examination rooms, etc., are proposed to be located. The Immigration Quarters for both Canadian and United States immigrants will be located on a mezzanine floor above the upper floor and will be reached by broad stairways and corridors.

A double track railway with suitable platforms extends the full length of the shed on the second floor, thus enabling the passenger and mail trains to be sent away or to come alongside the ships with the greatest despatch, it only being necessary for the passengers to cross the floor and take their places in the waiting trains or ships.

On the roof of the second floor may be constructed a public promenade which it is anticipated would be very popular both with tourists and residents, as it would command an unobstructed view of the Harbour and Shipping.

There will be freight tracks at quay level both at the front and back of this building, and a freight landing and trucking platform 11 feet wide, and tracks for

semi-portal electric travelling cranes for baggage and freight handling will extend along the front of the building.

The bottom floor of the shed and the freight handling and trucking platform are at car floor level or four feet above quay level. This will facilitate to a great extent the unloading and loading of railway freight cars.

In addition, on this quay behind the large passenger and freight shed, there will be inward and outward local freight sheds, offices, team tracks, switching and standing tracks, loading platforms, etc., and space for future extensions.

A large grain elevator of the most modern type designed to take grain from Railway Cars and to store it or convey it to any berth in the First Unit is also proposed to be constructed on this space and provided with adequate Railway trackage.

On the north wall of Basin No. 1 are berths for two ships, one 700 feet long with a depth of water of 35 feet below low water level of ordinary spring tides and the other 500 feet long with a depth of water of 30 feet at low tide. On these berths will be provided spacious double storey freight sheds, 100 feet wide, with two tracks at the back and one along the front of the quay.

The five piers and six basins will each be 1,250 feet long and each from 320 to 360 feet wide. The basins will be dredged at their inner ends and where

required to give a depth of 45 feet below low water of ordinary spring tides, and will therefore be deep enough to accommodate the very largest prospective class of transatlantic or other steamers.

A study of the plans will show that the piers are tapered towards their outer ends. The reason for this is to reduce the amount of dredging and walls at the heads of the basins, the amount of walls and filling at the pierheads, and to give the greatest widths of approach from both sea and land, where most required, namely, at the outer ends of the basins and inner ends of the piers respectively.

There will be four berths to each Pier and each berth will be provided with its own large double storey steel and concrete transit shed and facilities, railway tracks and platforms and independent railway connections for switching cars, team entrances and ramps, etc., so that the operations at any berth will not be interfered with by those at any other berth adjoining or opposite. The lower floors of the sheds will be at car floor level and will be used for outbound or ocean going freight and the upper floors will be used for inbound freight and outbound passengers, etc.

At the extreme southern or seaward side of the piers a rubble mound Breakwater to be built along with the First Unit of the Docks is to be constructed

with selected rock obtained from the cuttings for the new approach railway.

The Breakwater will extend eastward from the shore at Fort Ogilvie into the Harbour for a distance of about 1,500 feet and will be built out to and upon a ledge of rock known as "Reid Rock," which is at present in places very close to the surface at low water.

The outer or seaward slope will be $1\frac{1}{2}$ to 1, inner slope $1\frac{1}{4}$ to 1 and top width 30 feet at 8 feet above H.W.L.O.S.T. The slopes will be protected below low water level with rough blocks or rock "Pierre Perdu" weighing 5 to 8 tons each and the top and slopes above L. W. L. will be roughly paved with similar blocks.

Later when required, a double berth Quay wall 1,250 ft. long will be constructed along the north or inner side of the breakwater and the intervening space between the rubble slope and the quay wall filled in for the quays and sheds.

In the event of an extension southward should any further piers be required in the future, the breakwater as now proposed will simply form part of the hearting for a complete pier.

The Quays and Piers, teamways, roads, etc., will be paved throughout and complete systems for fresh water supply and fire protection, heating, etc., will be installed.

The existing city sewers discharging at the Esplanade and near Steel's Ponds will be intercepted and diverted into a new main outfall sewer carried along the north Quay Wall and discharging under water into the Harbour at the outer end of Pier "A." A storm water flow from this sewer will be provided at the head of Basin No. 1.

Electric light and power will be supplied from a proposed central light, heat and power plant and the Quays and Sheds will be equipped with the best Mechanical freight handling appliances.

Coaling of ships can be done expeditiously at any of the berths from elevator barges on each side of the ship or from Railway cars on the Quay face tracks on one side of the ship and barges on the other.

MATERIALS AND TYPES OF CONSTRUCTION

Second to the decision as to location, the most careful consideration was given to material and types of construction.

The instructions as to requirements, having called for a Scheme which would provide Ocean Terminals at least equal to the best—not the largest—on the Atlantic coast of America the essential characteristic of design was necessarily permanence.

In the consideration of designs, the material of construction was the first factor.

TIMBER

Timber, a natural product of Canada, makes a good and comparatively cheap material for the substructure of wharves or quay walls. Totally submerged in water it is practically permanent if not subjected to the attacks of sea worms.

Two inveterate enemies of marine timber structures are active in the coast waters of the Maritime Provinces, viz:— the Gribble or Nipper (Limnoria Lignorum) and the Ship-worm (Teredo Navalis).

These marine borers confine their active operations in Nova Scotia to two distinct zones. The Limnoria is active along the Atlantic coast from the Strait of Canso to and including the Bay of Fundy. The Teredo thrives around the coast of the Island of Cape Breton and along the shore of Northumberland Strait. Their common meeting ground extends from the Strait of Canso to Halifax Harbour, with the Limnoria at the latter very much in the ascendancy.

The life of the best untreated native timber in marine works in Halifax Habour, under ordinary conditions, does not exceed 15 years, and in most cases not more than 6 or 8 years. If treated with creosoting oils, experience has shown that its life is considerably longer, and creosoted timber in actual construction in Halifax Harbour for a period of 10 years is still in good condition.

For permanent work, however, upon which permanent sheds and other expensive

structures are to be built, and where constant examination and easy repairs are not possible, the use of timber even when creosoted would be very questionable.

As timber construction in quay walls would result in a considerable saving in initial cost, its use was most carefully considered and a report was obtained from Mr. C. E. W. Dodwell, B.A., M.I.C E., M. Can. Soc. C. E., who has had special experience in connection with marine structures in this locality and who has found creosoted timber very satisfactory. It was, however, decided that the use of timber was not permissible in view of the uncertainty as to the quality of creosotes and their permeation of the timbers available; their power to resist indefinitely decay and attack from sea-worms and insects; danger from fire; liability to damage and high cost of maintenance; as well as having regard to the best modern practice of European and American Engineers in first class marine works where timber, even including green-heart, is now but sparingly used.

CONCRETE

Concrete in its various applications was next studied. Unlike timber, concrete is not subjected to the attacks of the Teredo, and Limnoria and their allies. There are no instances on record of damage done to concrete structures by sea-worms although it is known that the Pholas dactylus and the Saxicava will attack limestone.

The advantages of using a material for sea water construction which absolutely resists the attacks of all kinds of sea worms can hardly be overrated.

The chemical action of sea water upon concrete was also studied. All the available data published upon the subject, together with the actual results of experiments personally made on similar works by members of the staff, were carefully looked into, and it was considered that any deterioration which has been recorded was due to construction methods or inferior quality of the materials, or to imperfect mixtures. It was therefore concluded that concrete might be used with safety in the sea water and in the climatic conditions in Halifax Harbour, under certain conditions of construction and according to limitations laid down as to materials and proportions.

REINFORCED CONCRETE IN MARINE WORKS

In the Minutes of Proceedings of the Institution of Civil Engineers, the following is recorded as the opinion of Mr. Wentworth-Shields, Docks Engineer for the London and Southwestern Railway Co., under whose supervision the new works at Southampton Docks have been and are being constructed.

He agreed "That there was nothing specially to be feared about the life of reinforced concrete in marine works. His own experience showed that there were circumstances in which it was liable to deterioration on account of being used in the sea or in salt water. About ten years ago, when the use of reinforced concrete was begun at Southampton, a good deal

of misgiving was felt as to the fate of those portions of the structure—reinforced concrete jetties—which were built under water; but it had been found that, although in some structures deterioration had set in, no deterioration was taking place below the water level. The oldest of the structures built at Southampton under or close to the water was a jetty which was in perfect condition. In some of the other structures deterioration had taken place to a certain extent which was undoubtedly due to electrolysis. In one jetty in particular, in which an electric wire was earthed to the jetty and a distinct amount of current had passed constantly through the structure to the sea at a pressure of about 7 volts—although it was supposed to be a neutral wire—there had been distinct deterioration above the water level during the past ten years. But the parts below water were as good as at first, as far as any action of sea water was concerned; that was to say, sea water did not seem to have produced any chemical or other deteriorative action. On the other hand, reinforced concrete would not bear being knocked about by heavy ships."

Portland Cement concrete is invariably brittle, and unless it is perfectly protected where it has to resist shocks or heavy pressures there is a tendency for pieces of it to be chipped away. This in the case of reinforced concrete used in sea water construction is a very serious matter as the steel is liable to be exposed to powerful corrosive influences. Even if chipping or fracture does not occur the application of high stresses must produce cracks which may not be noticeable but which may ultimately allow the sea water to attack the steel reinforcement. Thus, to avoid these sources of danger it is necessary in reinforced concrete for marine work to amply cover the steel with concrete and also to protect the concrete from abrasion, shocks and high stresses. Another grave source of danger in Nova Scotia is the action of frost upon it, between high and low water in which

case, if the concrete is not perfectly constructed and of an impervious nature, it will in a very short time be subject to disintegration.

The Second Report of the Committee of the Institution of Civil Engineers on Reinforced Concrete, just published, gives the conclusions drawn from the observations of the eminent men composing that Committee, and these conclusions have an important bearing upon the use of reinforced concrete in marine works, as applied in the designs adopted for Halifax Harbour.

On various reports and observations the following instances from this report are cited:—

DECK OF CATTLE WHARF, LIVERPOOL DOCKS.

Construction of reinforced concrete, main beams, cross beams and floor, supported on green-heart piles.

Length of experience fourteen years

Failure or deterioration. The steel rusted to 3-16 inch at worst places, apparently due to unconsolidated concrete at the crossing of the metal bars, and to stress cracks.

DECK SUPPORTED BY PILES, FORMING QUAY ALONGSIDE WHICH VESSELS DISCHARGE AND LOAD

Length of Experience, eight years

Failure or deterioration. Chief defects at junctions caused by voids left, owing to difficulty in consolidating the concrete and reinforcement bars interlaced.

COALING JETTY, SOUTHAMPTON DOCKS.

Equipped with six large electric cranes.

Length of experience, twelve years.

The structure exposed to effects of moist air, possible electric currents, stresses due to working of cranes as well as the blows from vessels.

Failure or deterioration. The work suffered severely from rusting of the reinforcement above water level and damage by vessels. The cracking of the concrete, owing to the rusting of the reinforcement above water level, was very extensive, there being corrosion increased by electrolytic action. No deterioration noticeable below water.

In the designs hereinafter described for the Halifax Harbour quay walls there is no reinforced concrete exposed above low water level. The reinforced concrete below low water level is all designed to be moulded and matured in air under perfect construction conditions. The reinforcement is designed to be protected by at least two inches of concrete and the danger of cracks, due to erection or other stresses or shocks from vessels, is reduced to a minimum.

The conclusions to be drawn from this valuable report are therefore very favourable to the designs adopted for the quay walls at Halifax Harbour

LOCAL EXPERIENCE IN USE OF CONCRETE

The use of Portland cement concrete in Halifax Harbour has not, until very recently, been extensive. In general dry stone masonry and timber or other structures of a temporary nature have been used.

The largest and most important work that has yet been carried out in concrete, moulded in place, is the Halifax Graving Dock. Other examples along the western shore of the Harbour are to be found in small works, such as retaining walls and other structures in H. M. Naval Yard; a retaining wall on the Harbour front at Mr. Michael Carney's property, 147 Pleasant Street; a main outfall sewer near Steel's Pond; and a retaining wall at Point Pleasant Battery.

Considerable disintegration or decay of the concrete work has taken place in the walls of the Graving dock and a large amount of repair work has had to be done. The original concrete in some extensive parts of the walls has been replaced with varying success, in some places with brick work laid in cement mortar, and in other places with a rich concrete. It is believed that original concrete used in the walls was of good quality.

Practically all the examples of Portland cement concrete work in the Harbour

show signs of disintegration from about low water level upward, and especially within the range of the tides. This disintegration appears to be due to the effects of frost, and is particularly noticeable where the concrete is alternately wetted in sea-water and then exposed to the air by the rise and fall of the tides. It is how-ever noticeable that granite exposed to the same effects of frost and sea water in the Graving Dock and at other points in the Harbour does not show similar marked signs of disintegration.

Concrete works on shore and not exposed to contact with sea-water, as in retaining walls, buildings, and other structures in the City of Halifax, in several instances also show signs of weakness and disintegration.

The inference therefore to be drawn from existing examples of concrete work at Halifax, and assuming that the ingredients and workmanship were of average quality, is that owing to climatic or other conditions prevailing at Halifax, concrete, as a construction material, when exposed to the air and water is open to some doubt as to its durability, and that wherever concrete is so used it should only be of the very best quality.

CONCRETE CONSTRUCTION MATERIALS AVAILABLE

Good hard trap and other suitable kinds of rock can be obtained in abundance along the shores of Bedford Basin, and ironstone and granite from the North West

Arm. Granite can also be obtained in unlimited quantities from the precipitous western shore of the entrance to the harbour from Purcell's Cove westward and along the coast of Nova Scotia.

At Purcell's Cove, which is the nearest deposit of granite with water carriage to Halifax (2 miles in sheltered waters), a sufficient area of land has been specially acquired by the Government for a granite quarry to supply the whole of the proposed works.

Shingle, gravel and sand can be obtained from the eastern passage, leading into the harbour, between McNab and Lawler Islands and the mainland. Sand of very good quality and gravel of almost any desired size can also be obtained in large quantities from Mahone Bay and its numerous islands between Chester and Lunenburg, and in smaller quantities between Halifax, and Chester. There are also deposits of sand and gravel along the eastern shore of Nova Scotia in the vicinity of the Chezzetcooks and at other points.

CONSTRUCTION PROBLEMS

The more serious problems involved in the design and construction of the quay walls or wharves for Halifax arise from:—

The great depth of water (45 ft.) to be provided at low water of ordinary spring tides.

The varying levels of the present bottom of the harbour and particularly of the rock surface above and below the proposed dock bottoms.

The dip of the strata and the irregular nature of the rock and its broken and laminated character.

The impracticability of cofferdamming parts of the works and the difficulties and dangers of cofferdams where such may be practicable on account of the exposure, great depth of water and the danger of heavy leakage through the underlying rock, as well as through the dam itself.

The effect of the frequent "ground swell," and of wind and waves on staging and floating plant, and the difficulty in securing good holding bottom for piles, or anchors, also the great length of "spuds" required for dredges and scows, and the regulation of the plant to suit the rise and fall of the tide.

The low range of tide and consequent difficulty in securing bracing for either temporary or permanent works.

Necessity for practically a vertical faced wall or wharf with only a small batter or toe projection, so as to suit the modern midship section of large ships and prevent the sides and bilge keels of ships from striking against the wall or wharf under water where damage to the ship or wharf structure would not be readily noticed and would be expensive or difficult to repair.

The necessity for protecting the face and coping of the quay walls or wharves above low water from disintegration from the effects of frost and sea water and from the action of the ships, and ships' moorings rubbing against the same.

Protection of the tops of walls, etc., for a depth of four or five feet from the quay level, against displacement by the action of frost on the filling behind the walls.

The provision of a solid and reliable foundation for the quay walls or wharves resting upon the solid rock or rubble filling and fitting into the irregularities of the rock and rubble in such a way as to give a full bearing and to prevent sliding of the wall or wharf structure.

The avoidance of taking out any more of the rock under water than is absolutely necessary and having to replace it with concrete.

The reduction of slow and expensive diver or subaqueous work to a minimum.

The necessity for rapid construction of a permanent and reliable character, and adapted to the local and climatic conditions.

The provision of large transit sheds and buildings along the quays and consequent heavy surcharges on the walls or wharves.

The supporting upon the quay walls or wharves of the front columns of the transit sheds, and the railway and crane tracks, etc.

QUAY WALLS AND WHARVES

The whole question of the Design of quay walls and wharf structures was carefully investigated. Data published by the best authorities on the subject were obtained and recent examples of the best types of quay walls and wharves constructed by European and American engineers were studied and compared.

All the usual permanent types of wharf construction and of gravity quay walls were considered with special reference to economic construction conditions in Halifax Harbour, and various types requiring the use of temporary staging and forms under water, floating appliances, cofferdams, pneumatic chambers, etc., were investigated.

In order to meet the programme of rapid construction required by Mr. Gutelius, General Manager, Canadian Government Railways, and from the point of view of economy the usual sections of blockwork or masswork gravity quay walls were not considered advisable.

It was decided that timber had to be eliminated except for fendering or where not exposed to seawater.

Solid blocks of either stone or concrete it was found could not compete in rapidity of construction with hollow blocks or shells of reinforced concrete.

Piling was not found suitable for the site.

Cylinders of various materials and types, sunk either by the open or pneumatic processes, were carefully considered but rejected.

Mass work deposited under water in large bags or between forms or lines of blocks was not considered satisfactory and was not approved

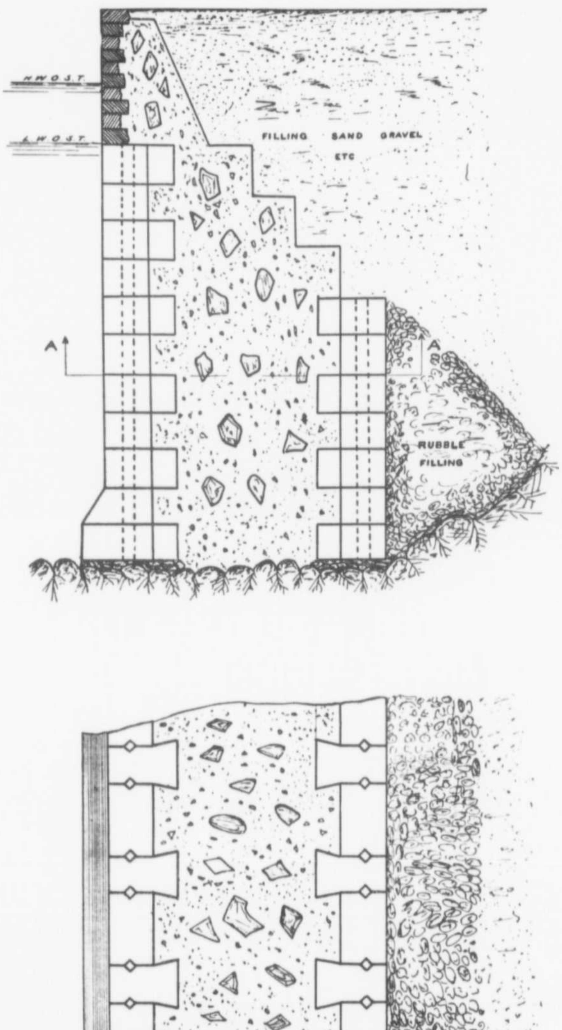
Floating caissons to be sunk and filled with mass concrete or other filling and constructed of timber, steel or reinforced concrete did not show any real saving or advantage and would, in the case of the last mentioned material, be difficult and slow of construction under the circumstances encountered at Halifax.

The various proposals as to type and design of quay walls and wharves were all finally eliminated except five, as follows:---

Design A.

This design represents a typical blockwork wall with a mass concrete hearting.

The bottom of the harbour would be dredged to the required depth. The bed for the bottom courses of blocks at the back and front of the wall would be prepared by bell or helmet divers, either with concrete bagwork or mass concrete. The bed would require to be very carefully levelled, as any difference or irregularity would be increased about eight times at the top course of blocks. After the back and front blocks in each course are placed mass concrete is deposited between them to form the hearting of the wall. The blocks are then effectually keyed together as shown.



SECTION A-A

DESIGN 'A'

A wall of this type, to ensure rapidity of construction, would probably require elaborate temporary staging, in order to set the blocks and properly deposit the concrete in reasonable time.

A temporary staging on the site of the proposed Ocean Terminals would be expensive, not only in its initial cost but in the cost of maintenance, on account of its somewhat exposed position. In many places a pile staging could not be conveniently used, as there is very little, if any, soft material overlying the rock.

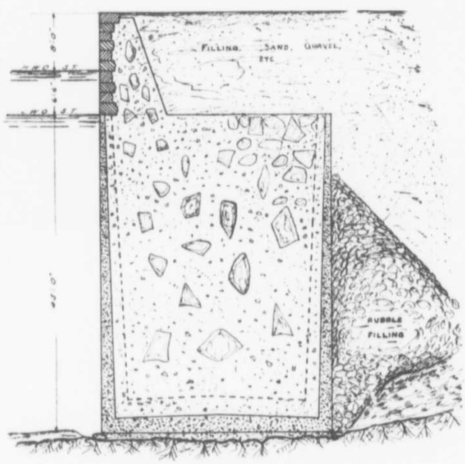
Estimate of Cost, Design A, including mooring hooks, ladders, stairs, fenders, etc., and excluding only dredging and filling, say $550.00 per lineal foot.

Design B.

The wall, as proposed in Design B, consists of a series of reinforced concrete caissons, 110 feet long, filled with concrete. These caissons would be built in a graving or floating dock or between or upon scows or partly built on launching ways and then launched and completed in the water. On completion they would be towed to the required positions, sunk and filled so as to form the quay walls.

This scheme presents many difficulties. Owing to the great weight and draft of the caissons and the graving dock not being available heavy floating plant or long and expensive launching ways would have to be provided. It would be necessary to use tugs to assist with the launching and also to tow and set the

caissons into position. During the winter time it would not be possible to build the caissons on account of the frost, and except in calm weather and a smooth sea it would be impracticable to proceed with the work of sinking them in position. The caissons until ready for placing in position would have to be moored out in deep water



REINFORCED CONCRETE CAISSON

DESIGN "B"

well off shore, and there would be considerable risk from leakage and sinking. The preparation of the bottom to receive the caissons would entail serious expense. In many places it would be necessary to dredge solid rock to depths ranging up to 20 feet and a full width of say 35 feet, in order to prepare a bed for the caissons.

This bed would be levelled up by means of mass concrete or concrete in bags deposited by divers and would be a horizontal plane of weakness on which sliding would be liable to take place. The levelling of the bed after the dredging was completed would entail a great deal of very careful diver work, as any irregularity would probably warp and damage the caissons to a serious extent.

The rate of progress in constructing this type of wall would be slow as it would be dependent largely on the weather and the rate at which the caissons could be economically constructed and seasoned.

Estimate of cost, Design B, including mooring hooks, ladders, stairs, fenders, etc., and excluding only dredging and filling, say $540.00 per lineal foot.

Design C.

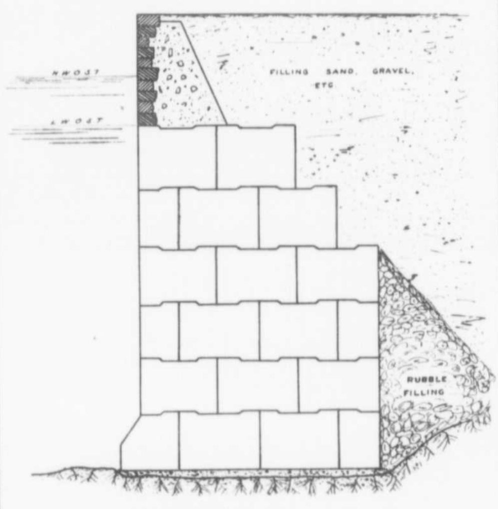
This design shows a typical section of a wall of the solid blockwork type. These blocks weigh from 30 to 50 tons, thus necessitating the use of heavy floating cranes or cranes on temporary staging.

As in Designs "A" and "B" the preparation of the bottom to receive the first row of blocks would be very expensive, as the utmost care would be necessary. Here again the rate of progress in construction would, unless substantial temporary staging was used, depend upon the weather conditions, and possibly during winter the plant would be idle a large part of the time.

The blocks would be so moulded as to prevent one course sliding upon another.

The main advantage of a wall of this type is that none of the concrete is deposited under water before it is thoroughly matured.

Estimate of cost, Design C, including mooring hooks, ladders, stairs, fenders,



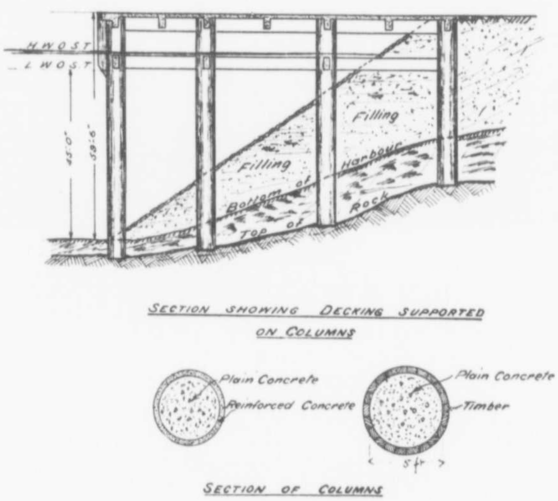
DESIGN C

etc., and excluding only dredging and filling, say $550.00 per lineal foot.

Design D.

This design shows wharves and piers in which the reinforced concrete decking would be supported on concrete cylinders or pillars. The outer covering of the

cylinders could be of reinforced concrete, in which case it would be permanent, or it could be of timber or steel. In either case the interior would be filled with a good quality of mass concrete, say 1 - 2 ½ - 5. The cylinders would be spaced longitudinally at about 22 feet centres along the line of the quay or pier and trans-



SECTION SHOWING DECKING SUPPORTED ON COLUMNS

SECTION OF COLUMNS

DESIGN "D"

versely at about 30 feet centres, or so as to suit the spacing to be adopted for the transit shed columns.

A reinforced concrete pile structure, if practicable, might be cheaper, but in many places on the site of the Ocean Terminals holding bottom for piles could not

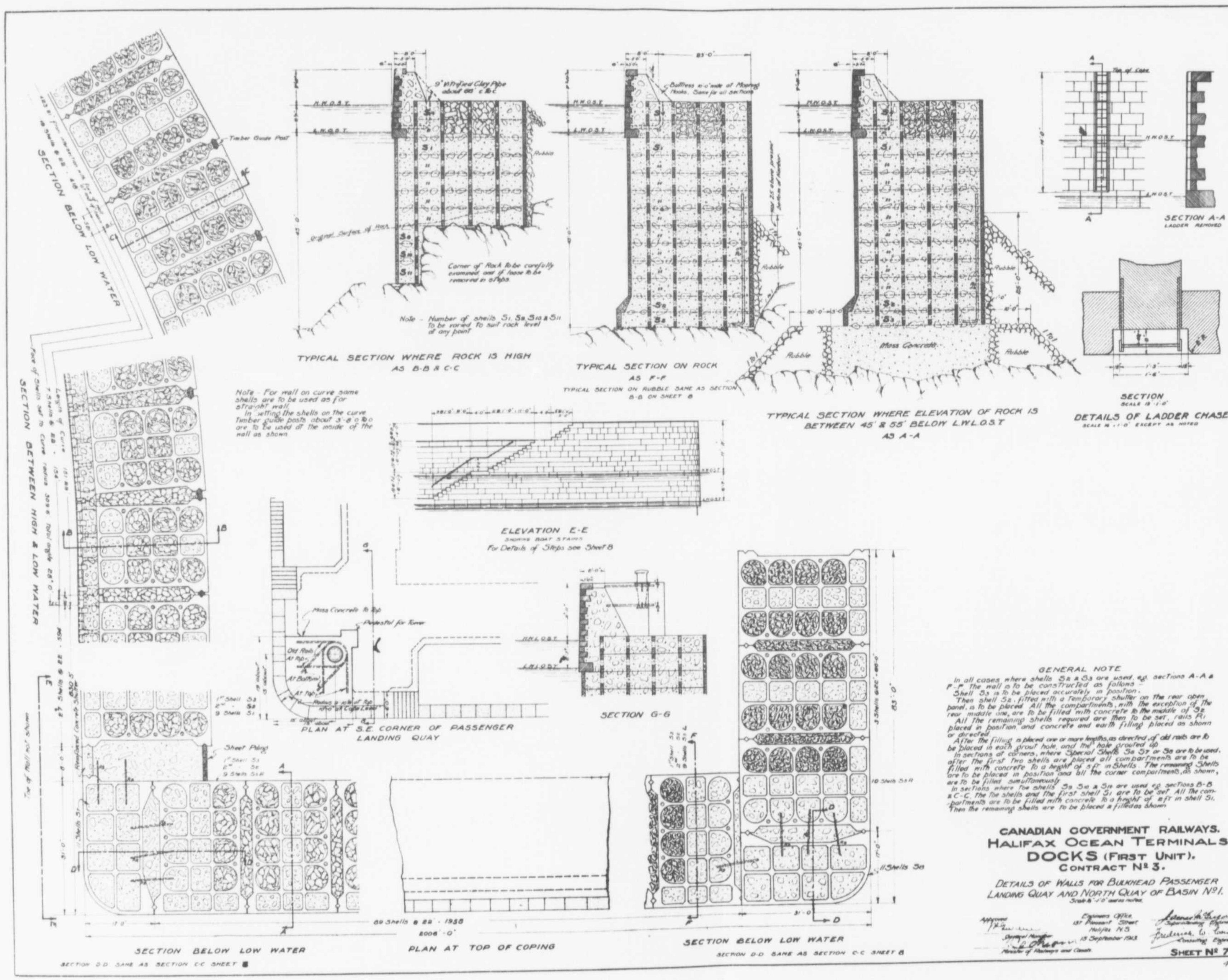
be obtained on account of the rock being near to the bottom of the harbour and in many places reaching considerably above the dredged depth required.

A great objection to any open work reinforced concrete pier is its susceptibility to damage from ships, the action of the frost on the concrete between high and low water, and the consequent necessity of adequately protecting it. The low range of tide at Halifax also renders difficult the effective and necessary bracing of this type of structure.

In the design as shown the reinforced concrete work between high and low water would be protected by surrounding it with creosoted timber or otherwise.

Considerable difficulty would in places be experienced in preparing the bottom and setting the cylinders in a vertical position. Until the decking and bracing was completed the cylinders would be rather unstable, and with ships and floating plant moving near them, the risk of accident would be great. The rate of construction would be slow.

The initial cost does not show a sufficient saving to justify the adoption of these open types of construction in preference to quays of a more solid type. In the case of accident, the results might be very serious and considerable difficulty might be experienced in carrying out efficient repairs.


SECTION BELOW LOW WATER
Timber Guide Post
SECTION BETWEEN HIGH & LOW WATER
9" Vitrified Clay Pipe about 60' c.to c.
H.W.O.S.T.
L.W.O.S.T.
Original Surface of Rock
Rubble
Corner of Rock to be carefully examined and if loose to be removed in steps.
Note - Number of shells S1, S9, S10 & S11 to be varied to suit rock level at any point
TYPICAL SECTION WHERE ROCK IS HIGH
AS B-B & C-C
Buttress in c'ntre of Mooring Hooks. Same for all sections
TYPICAL SECTION ON ROCK
AS F-F
TYPICAL SECTION ON RUBBLE SAME AS SECTION B-B ON SHEET 8
Rubble
Mass Concrete
TYPICAL SECTION WHERE ELEVATION OF ROCK IS
BETWEEN 45' & 55' BELOW L.W.O.S.T
AS A-A
SECTION A-A
LADDER REMOVED
SECTION
DETAILS OF LADDER CHASE
Note: For wall on curve same shells are to be used as for straight wall.
In setting the shells on the curve Timber guide posts about 3'-6" c.to c. are to be used at the inside of the wall as shown.
ELEVATION E-E
SHOWING BOAT STAIRS
For Details of Steps see Sheet 8
Mass Concrete to Top
Pedestal for Tower
PLAN AT S.E. CORNER OF PASSENGER
LANDING QUAY
SECTION G-G
Sheet Piling
SECTION BELOW LOW WATER
SECTION D-D SAME AS SECTION C-C SHEET 8
PLAN AT TOP OF COPING
SECTION BELOW LOW WATER
SECTION D-D SAME AS SECTION C-C SHEET 8
GENERAL NOTE
In all cases where shells S2 & S3 are used, e.g. sections A-A & F-F the wall is to be constructed as follows -
Shell S3 is to be placed accurately in position.
Then shell S2, fitted with a temporary shutter on the rear open panel, is to be placed. All the compartments, with the exception of the rear middle one, are to be filled with concrete to the middle of S2.
All the remaining shells required are then to be set, rails R1 placed in position, and concrete and earth filling placed as shown or directed.
After the filling is placed one or more lengths, as directed, of old rails are to be placed in each grout hole, and the hole grouted up.
In sections at corners, where Special Shells S6 S7 or S8 are to be used, after the first two shells are placed all compartments are to be filled with concrete to a height of 5 ft. in Shells. The remaining Shells are to be placed in position and all the corner compartments, as shown, are to be filled simultaneously.
In sections where toe shells S9 S10 & S11 are used e.g. sections B-B & C-C, the toe shells and the first shell S1 are to be set. All the compartments are to be filled with concrete to a height of 8 ft in shell S1. Then the remaining shells are to be placed & filled as shown.
CANADIAN GOVERNMENT RAILWAYS.
HALIFAX OCEAN TERMINALS.
DOCKS (FIRST UNIT).
CONTRACT Nº 3.
DETAILS OF WALLS FOR BULKHEAD PASSENGER
LANDING QUAY AND NORTH QUAY OF BASIN Nº 1.
Approved
General Manager
Minister of Railways and Canals
Engineers Office
137 Pleasant Street
Halifax N.S.
15 September 1913
Superintending Engineer
Frederick W. Cowie
Consulting Engineer
SHEET Nº 7

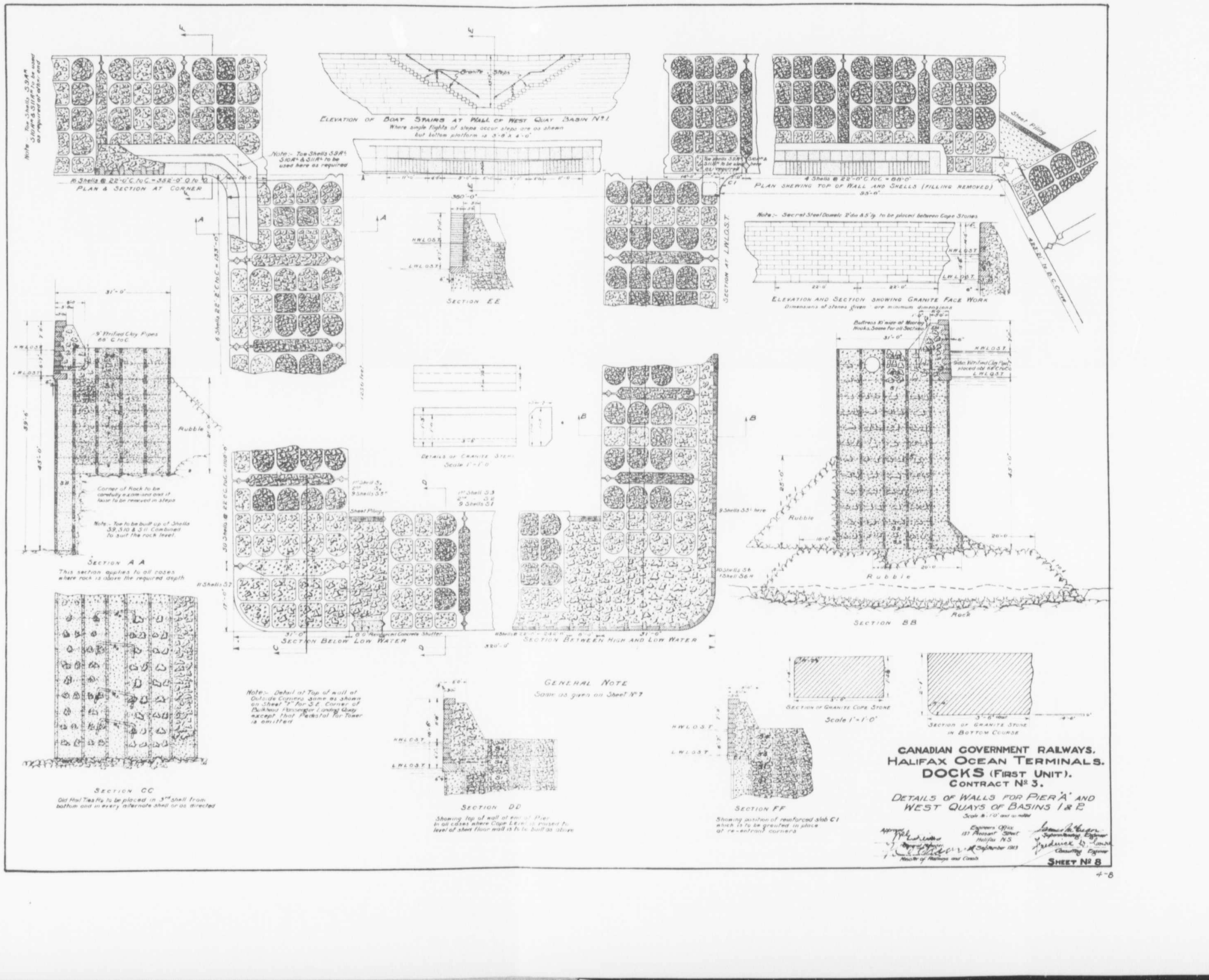
4-7

Estimate of cost, Design D, including mooring hooks, ladders, stairs, fenders, etc., and excluding only dredging and filling, say $490.00 per lineal foot.

Design "E" (Adopted).

A design was finally evolved and adopted by which it is hoped to combine the undoubted advantages of reinforced concrete with those of cheaper mass work and eliminate to a great extent the objectionable features of each, and at the same time produce a wall of the gravity type which will be economical and easy to construct, as it will require little temporary work, and the use of a large floating crane will not be necessary. The wall is designed to be sufficiently wide at H. W. L. to carry the tracks for the block setting "Titan" or travelling crane and later to support the front rows of the transit shed pedestals and columns.

In this design of wall it is proposed to construct stacks of cellular reinforced concrete shells or hollow blocks, one directly above the other, and securely bonded and bedded by means of mass concrete and grout deposited in the front and middle compartments and in the grout holes. The other compartments are to be filled with rock or other approved filling, in order to give the wall sufficient weight. All the bottom shells and half of the height of the next shells above are to be completely filled with concrete to form a solid full width foundation and ballast floor. Each stack of shells section of the wall is to be 22 feet long, is


ELEVATION OF BOAT STAIRS AT WALL OF WEST QUAY BASIN No. 1
PLAN & SECTION AT CORNER
PLAN SHEWING TOP OF WALL AND SHELLS (FILLING REMOVED)
ELEVATION AND SECTION SHOWING GRANITE FACE WORK
SECTION EE
SECTION AT L.W.O.S.T.
SECTION AA
SECTION BB
SECTION CC
SECTION DD
SECTION FF
SECTION BELOW LOW WATER
SECTION BETWEEN HIGH AND LOW WATER
DETAILS OF GRANITE STEPS
SECTION OF GRANITE COPE STONE
SECTION OF GRANITE STONE IN BOTTOM COURSE
GENERAL NOTE
Same as given on Sheet No. 7
Rubble
Rock
CANADIAN GOVERNMENT RAILWAYS.
HALIFAX OCEAN TERMINALS.
DOCKS (FIRST UNIT).
CONTRACT No. 3.
DETAILS OF WALLS FOR PIER "A" AND
WEST QUAYS OF BASINS 1 & 2
Engineers Office
137 Pleasant Street
Halifax N.S.
September 1913
Superintending Engineer
Consulting Engineer
Minister of Railways and Canals
SHEET No. 8
4-8

to be keyed to the adjoining sections by means of vertical guide posts. The object of these posts, which are to be constructed of reinforced concrete and of varying sizes so as to maintain true distances to centres of stacks, is to prevent all lateral movement in the event of settlement taking place, to facilitate the setting of the shells under water and to prevent the escape of the filling in and behind the wall.

The spaces between the stacks of shells are to be filled with rubble or other filling, thus forming an expansion joint, and a means whereby each stack of shells can settle independently without affecting the adjoining portions of the wall.

This type of wall will lend itself to speedy and comparatively economical construction, and is well adapted to the three principal features of the bed of the harbour:

1. Where the rock is at the required depth.

2. Where it is below the required depth.

3. Where it is above the required depth.

In cases (1) and (2) the sections of the wall are the same, one being founded upon the rock and the other upon a mound or mattress of rubble or upon a bed of mass concrete, as shown. In these two cases, after the necessary excavation or dredging has been made, it is proposed, by means of a large diving bell working

in advance of the wall, to clean the bottom and set small pillows or stools of concrete for each of the four corners of the bottom shell. The pillows or stools are to be placed to the exact levels required. The bottom shell is then to be set by means of a block setting "Titan" or special travelling crane working from and reaching over the end of the portion of the wall already constructed. It will be seen that this method of setting the bottom shell reduces the amount of exact diver work to a minimum as the rock between the stools has only to be cleaned and left rough to receive the mass concrete to be deposited through the cells of the bottom blocks.

After the first shell is set and carefully levelled, the second will be put in place, and after closing up any openings between the rough bottom and the concrete shells all the compartments, with the exception of the rear middle one, are to be filled with good mass concrete deposited under water to a height of five feet above the bottom of the shells. This will form a good solid and permanent foundation for the wall, and the roughness of the rock or rubble will tend to prevent the wall from sliding on its foundations.

The remaining shells are then to be placed in position, using the key posts as guides in setting them and finishing above H. W. L.

Two old railway rails for reinforcing are then to be placed vertically in the

back middle compartment or cell, and this compartment and also all the front and centre compartments of all the shells are to be filled to the top with concrete. The depth of concrete permitted to be placed per day is to be restricted to a safe limit. The remaining compartments and the spaces between the stacks of shells to be filled with rubble or approved filling. Old railway rails are to be put in the vertical grout holes and grouted up.

After this stack has been completed the key posts for the next stack are to be placed in position and accurately plumbed and adjusted with their lower ends secured by the steel straps moulded into the bottom shell.

While concreting and filling are going on in one stack of shells the two bottom shells for the next stack or section of the wall are to be placed and followed by the remainder of the stack of shells in the same manner as before.

According to this proposed method of construction, two sections of the wall are to be built at the same time, the two bottom shells of the first section are to be set and concreted and the remainder of the stack of shells is then to be set to the top. Concreting and filling in this stack will be proceeded with while the two bottom shells of the next section are being set and concreted. This, it is anticipated, will be favourable to rapid progress in construction.

The reinforced concrete shells whose outer faces come into contact with the

sea water are to be built only up to one foot below extreme low water level, and the portion of the quay wall above this level is to be constructed with smaller blocks up to H.W.L., and with rubble concrete faced with cut granite masonry and finished with a cut granite coping, three feet wide.

The reinforced and mass concrete therefore will not be exposed to the action of frosts between high and low water.

Mooring hooks, or bollards, each designed to fit into and correspond with the granite coping and to safely withstand a pull of 75 tons, are to be placed along the face of the quays at intervals of 88 feet, and in places where it is thought necessary this spacing is to be reduced to 66 feet.

In order to balance the pull on the mooring hooks, or bollards, the walls at these points are to be anchored back to concrete blocks by means of 2¾ in. dia. steel anchor ties.

Granite boat stairs and landings are provided at the pier heads, the heads of basins, and at the ends of the Passenger Landing Quay. Iron ladders are also to be placed in suitable recesses at frequent intervals along the faces of the walls.

Estimated cost of adopted design, including mooring hooks, ladders, stairs, fenders, etc., and excluding only dredging and filling, say $490.00 per lineal foot.

SPECIAL FEATURES OF DESIGN

The type of wall adopted appeared to be, everything considered, most applicable to the conditions and requirements of the Halifax Ocean Terminals.

The reinforced concrete is used under the most favourable conditions, not being subjected to shocks and being entirely submerged. All the reinforced concrete is to be mixed with fresh water moulded in air and allowed to thoroughly mature before coming into contact with sea water. When placed it will not be subject to frost action.

The mass concrete deposited under water is used under conditions which for this class of work are almost ideal.

In under water work, and especially when working in sea water, it is important that the forms be left on as long as possible. In the design adopted the forms, which consist of the reinforced concrete shells, are permanent. The "green" mass concrete will be placed in very clean water and cannot be washed away as the current is very slight and the mass concrete is protected by the shells.

The design of the wall obviates the necessity of using expensive temporary staging or a floating crane. This latter is important, as block-setting by means of a floating crane is, under the most favourable conditions, both tedious and laborious.

Expensive foundations for the front row of shed columns are rendered unnecessary, as these columns are to be set on pedestals built directly on the wall.

Settlement and expansion and contraction are provided for by means of the short sections, the reinforced concrete guide and key posts, and the ordinary filling between the stacks of shells.

Where the wall is founded upon rubble slight settlement is sure to occur, in which case the vertical joints between the stacks of shells will allow each stack to settle independently and be kept vertical by means of the key posts.

As has been stated, the design suits the conditions which are known to exist. Nevertheless unforeseen difficulties have been provided for. The arrangement of the filling in the shells can be altered, concrete substituted for rubble where thought necessary, and in extreme cases all the compartments may be filled with concrete, thus forming a solid monolithic wall.

A study of the design will indicate the fact that it is a combination of several types of wall, the whole section taken by itself being a true gravity wall. The mass concrete which fills the front and centre cells of the shells forms with them a counterforted wall; the vertical old rail reinforcement, protected as it is with grout and concrete from the action of the sea water, together with the reinforcement in the shells, acts as a heavily braced piled structure; the whole stack

closely resembles the rock filled timber crib construction so frequently and successfully adopted in Canadian inland waters.

The question of stability has been thoroughly investigated, and the design carefully compared with the best practice in existing and proposed quay walls.

The cellular blocks can be made under ideal manufacturing conditions in a suitably arranged compact and well organised block moulding yard, easily accessible by land and water, convenient to the site, and laid out and equipped at a comparatively small cost.

The principle of the hollow reinforced concrete shell for forms under water was first adopted in Montreal Harbour in 1910. It has proved to be extremely satisfactory and to lend itself to facility of construction.

Reinforced hollow concrete blocks or shells 20 feet 1 inch by 27 feet by 8 feet and weighing over 100 tons have also been successfully used in the construction of a leading jetty at the entrance to the Irlam Lock on the Manchester Ship Canal.

THEORETICAL ANALYSIS OF DESIGN OF QUAY WALL ADOPTED

Stability of a Quay Wall Unit:

A complete section of the wall, as proposed, consisting of one stack of shells, *i.e.*, a 22 foot length of wall, with the compartments filled as in the completed

structure, was considered as a unit, and the theoretical toe pressure and horizontal thrust, due to the weight of the section, the superimposed loads and the earth pressure, were computed as follows.:—

Assumptions:

The wall built up of horizontal sections and filled for the most part with permeable material, may be subjected to buoyancy. In the case when the wall is built on a rubble foundation, which is the governing one with reference to the allowable toe pressure and horizontal thrust, the whole submerged section will be subjected to the full effect of buoyancy.

If the material backing the wall be porous, its weight per unit of volume below water level will be diminished by buoyancy and, consequently, its pressure upon the wall, which is a function of the weight per unit of volume, will also be diminished. The effect of this condition upon the angle of repose of the material must also be considered.

If the backing material is or at any time becomes consolidated, so that its weight per unit of volume is not affected by buoyancy, its face will be subjected to hydrostatic pressure, and this will more than counteract any possible increase of the earth pressure.

The filling was assumed to be materials, such as sand or gravel, weighing, when

not submerged, 115 pounds per cubic foot. The angle of repose was taken as 32° for the submerged backing, and 38° for the material above water level.

EARTH PRESSURE.

(a) The earth pressure upon the wall and its overturning moment were computed according to the Rankine hypothesis of reciprocal pressures.

(b) The computations were repeated, employing the "sliding wedge" hypothesis, and taking account of the frictional forces exerted by the materials upon the back of the wall, as in the formulæ deduced by Poncelet.

Thus it was considered that the maximum and minimum theoretical estimates were obtained and that somewhere between these two the true condition would lie.

In applying both of these methods a surcharge consisting of the height of the backing above the cope level, plus the superimposed load, was considered, and the material behind the wall was assumed to be divided into two strata of different densities corresponding to the conditions above and below water level.

In applying method (b) it was assumed that the angle of friction (*i.e.* the angle whose tangent-coeff. of friction) between the material and the back of the wall was 38° above water level and 16° below water level.

TOE PRESSURE AND HORIZONTAL THRUST.

The following results were obtained:—

Method (a) max. toe pressure = 5.7 tons (2,000 lbs.) per sq. foot.

Horizontal thrust = 64,000 lbs. per lineal foot of wall.

Method (b) Max. toe pressure = 4.8 tons (2,000 lbs.) per sq. foot.

Horizontal thrust = 54,000 lbs. per lineal foot of wall.

COMPARISON WITH SOUTHAMPTON DOCK WALLS.

In the worst possible case of the quay wall at Halifax, namely, where it will be built on a carefully prepared rubble mound overlying solid rock, assuming the full effect of buoyancy, we have, as stated above, a toe pressure, according to the Rankine formula now generally admitted to give excessive results, of 5.7 tons per sq. foot.

This does not appear excessive when compared with dock walls at Southampton Harbour, where experience has shown that the safe pressure on the quay wall foundations may be taken as 5.4 tons (2,000 lbs.) per sq. foot according to an advance proof of a paper recently presented to the Institution of Civil Engineers by Mr. F. E. Wentworth-Sheilds, M. Inst. C.E.

In this paper it is also stated that:—

"the formation of the estuary at Southampton consists for the most part of soft mud and peat, overlying a thin bed of gravel, under which again occurs beds of more or less sandy clay, on which most of the quay walls are built."

RESISTANCE TO SLIDING.

The other principal condition of stability is that the outward horizontal forces

shall be equalled by the inward horizontal forces, so that there will be no liability to sliding.

Consider again the worst case of the wall to be built, namely, that on a carefully placed rubble mound overlying a rough solid rock bottom. The computed average weight of the wall per lineal foot, without the superimposed load upon the foundations, is 179,000 lbs. Assuming a coeff. of friction of 1 at the base of the wall in the rubble foundation, *i.e.*, an angle of repose for the rubble of 45°, the factor of safety against sliding is 2.8 according to method (a) and 3.3 according to method (b). Since the bottom shell is to be filled with concrete deposited upon and penetrating into the rubble bed the above assumption is a very safe one.

In all the other cases where the wall is founded directly upon the prepared rock bottom the conditions will be even more favourable.

INTERNAL STABILITY.

The conditions of stability and stress within the wall unit were also investigated. The horizontal section immediately above the cantilever toe at the top of the second shell was considered.

The forces and moments acting upon this section were computed and from the conditions of equilibrium equations were formulated by which the position of the neutral axis and the stress intensities at the front and back of the section were calculated.

It was found that the maximum pressure on the concrete at the front could not exceed 120 pounds per square inch, and that the tension in the old railway tie rails at the back would not exceed 115 pounds per square inch.

DESIGN AND STABILITY OF REINFORCED CONCRETE SHELLS.

The general dimensions of the wall and concrete shells were fixed by the position and design of the proposed transit sheds. These sheds were designed with special reference to the trade of the Port and to have room in front for a railway track, a crane track and a loading and trucking platform. As it would result in economy and give additional stability, the foundations for the front row of shed columns were designed to rest on the rear of the quay wall. This fixed the length of the shells, *i.e.*, the breadth of the wall at 31 feet. The result of experience fixed the spacing of the shed columns at 22 feet, and this decided the width of the shells so as to place a column on the centre of each stack.

The spacing of the diaphragms within the shells and the outlines and various dimensions were chosen to give the maximum practicable economy of concrete, both for reinforced and mass work, consistent with the required strength and stability, and finally the height of the shells was fixed by the limit of lifting power determined upon for the construction plant.

The walls and diaphragms of the shells were designed to withstand the burst-

ing pressures due to the rubble or gravel filling in the compartments. For stresses due to these loads and all other loads, which might act upon the completed structure, the following working intensities were used:—

Compressive stress in concrete = 500 lbs. per square inch.

Tensile stress in steel = 16,000 lbs. per square inch.

The shells were also analyzed for possible stresses due to a head of unset concrete in the front and middle compartments; for stresses due to dead load when the shells are stacked in the moulding yard, and for erection stresses due to the weight of the erection crane, to lifting, setting and all other causes.

For these cases higher working intensities were allowed, as follows:—

Compressive stress in concrete 600 to 700 lbs. per square inch.

Tensile stress in steel = up to 20,000 lbs. per square inch, when there was no danger of producing injurious cracks in the concrete.

For erection stresses an impact allowance of 25% was made.

The cantilever toe extensions of the two base shells were amply reinforced to provide a high factor of safety on account of the important effect of the toe upon the stability of the wall. The maximum theoretical toe pressure was used as the working load, and the unit stress on the steel was kept down to 10,000 lbs.

per square inch, so that there might be no danger of corrosion of the reinforcement due to the salt water entering any tension hair cracks in the concrete.

The bottom shell was also analyzed for the stresses due to its own weight when supported at the corners only upon the prepared concrete foundation seats set by the diving bell in the wall foundations.

In designing the reinforcement for the various sections all the stresses were computed as exactly as the nature of the problem permitted, so that the minimum amount of reinforcement would be used for stresses which would not occur after the wall was completed.

Protection of Steel.

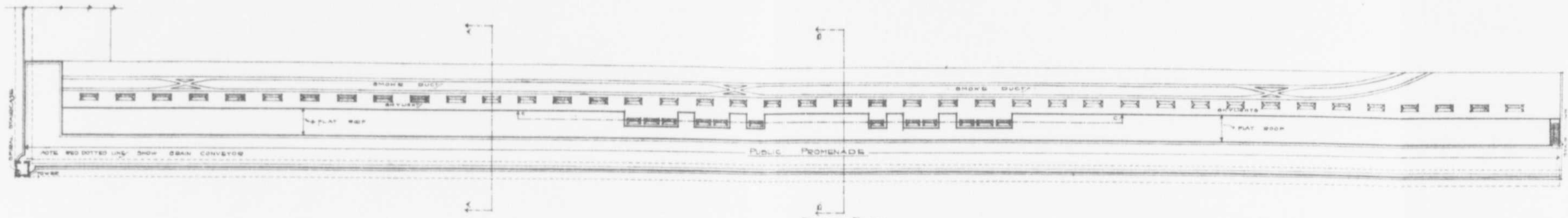
Whenever possible at least two inches of protecting concrete is provided for the reinforcing steel.

CONCLUSIONS

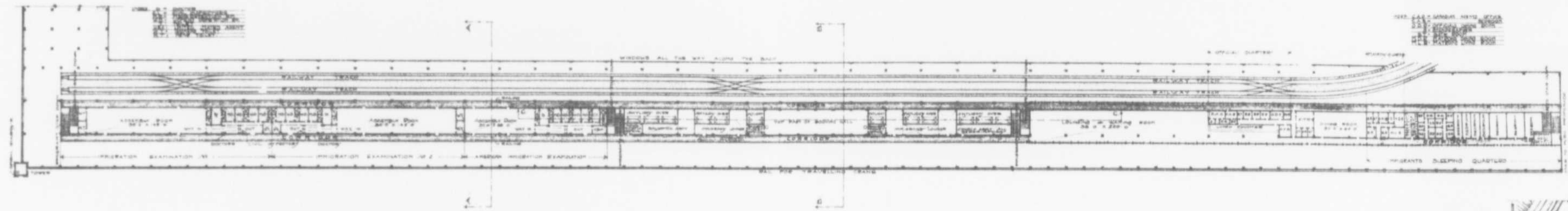
In this report careful consideration has been given to the utilization of the magnificent natural Port of Halifax in connection with certain phases of the Canadian Transportation problem.

The Scheme proposed is bold both in extent and design, but is not extravagant.

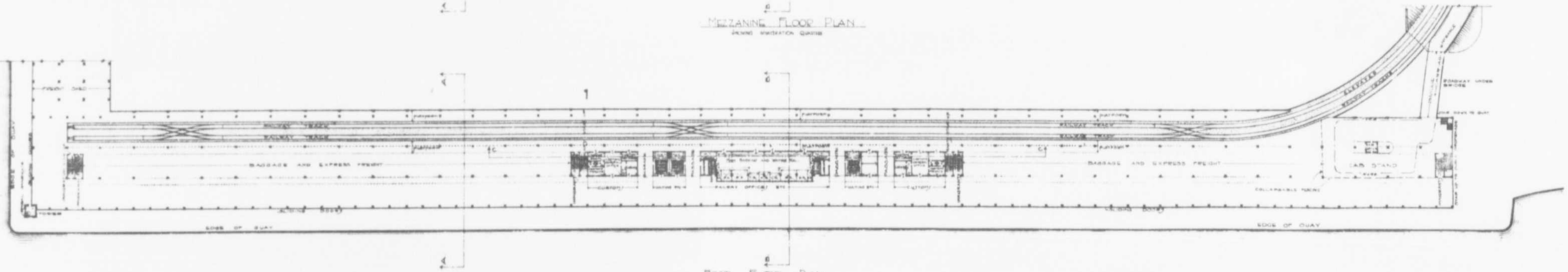
Its main feature is a bid for new business. It is not designed with a view



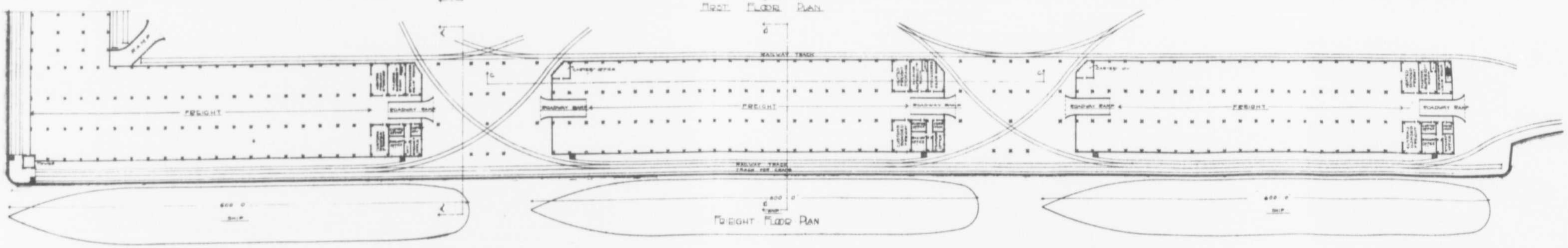
Roof Plan



Mezzanine Floor Plan



First Floor Plan



Freight Floor Plan

to cutting into the business of other Canadian Ports. The scheme has in view the capturing to Canadian ports and to Canadian routes as much as possible of the new business which is resulting from the development of Canada and the Great West.

The design calls for Ocean Terminals combining the best and most successful features of modern harbour design, in connection with the most up-to-date Railway Terminals.

It was recognized that the very best in design and workmanship and facilities was required in order to attract the new business.

For the complete success of these Ocean Terminals it will be necessary to adopt every known means of making the magnificent entrance to Halifax Harbour for ocean steamships perfectly safe and easy of access under all conditions of weather.

It will also be necessary to provide such facilities and equipment as will enable the rush and exigency work incidental to the arrival and departure of ocean steamships to be carried out without confusion or delays.

The scheme has in view such accommodation as will take care of the through business, the local business in Nova Scotia and also business which will result from the establishment of industries for which the situation of Halifax will offer an excellent field when the transportation facilities are given which will place Halifax on the

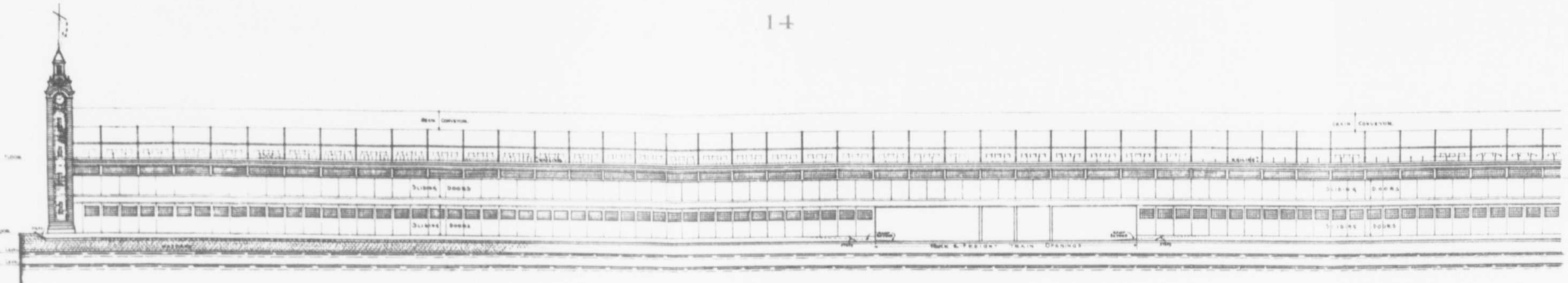
most important Canadian trade route open all the year round to Europe and the Panama Canal.

It has already been announced that the Intercolonial Railway from Halifax to connecting points will be very greatly improved.

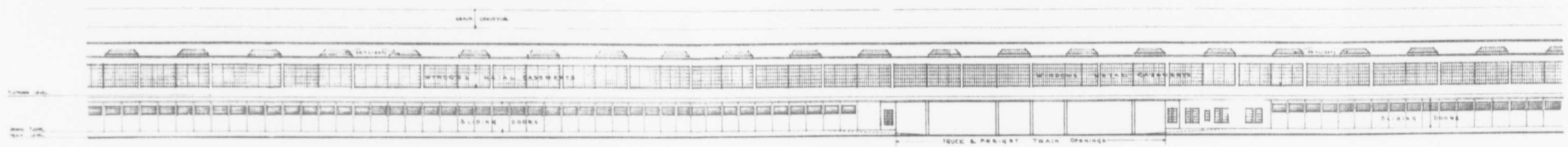
In view of the fact that the scheme is designed very largely for the highest class of ocean steamship business, for fast service, for the attraction of passenger travel, and for the carrying of mails and fast freight, it will be necessary, in order to give a full measure of success, to design the terminals so that passengers coming up the harbour may have an impressive first view of the "Gateway of Canada." The steamship landing accommodation for all classes of passengers must necessarily be perfect and be constructed with due regard to elegance and comfort, as well as economy. The New Union Passenger Station for the City should be so connected to the Steamship terminals that passengers, whether hurriedly arriving or departing by regular or special trains, or coming and going at leisure, should have equally good accommodation.

It follows that for the Transatlantic trade, as well as for the local and tourist trades, hotel accommodation of the highest class adjoining the terminals will be a necessity.

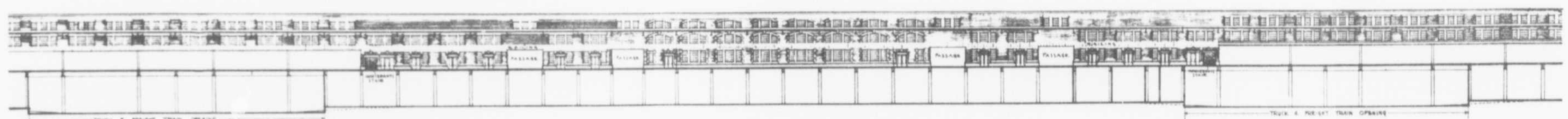
Finally, it may be stated that the most urgent requirement of harbour and



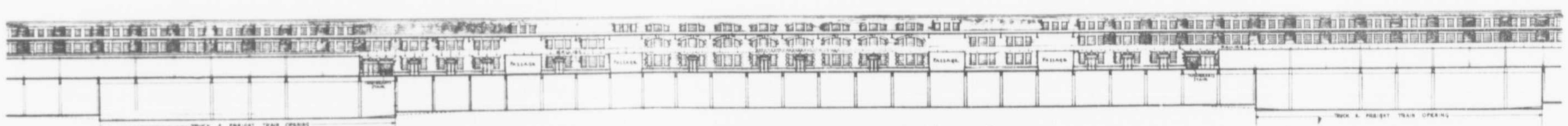
ELEVATION OF SHED TOWARDS WATER FRONT (FACING EAST)



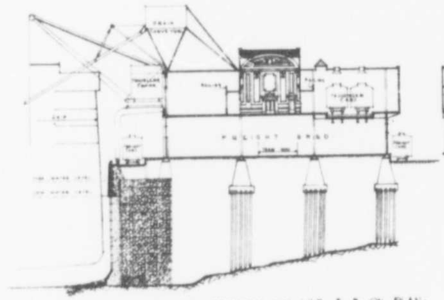
ELEVATION OF SHED TOWARDS RAILWAY (FACING WEST)



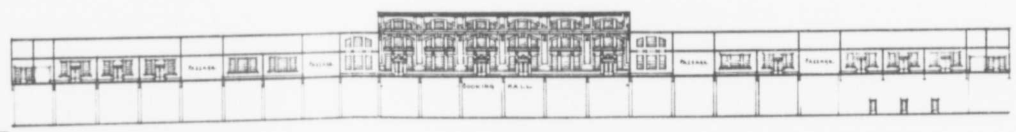
ELEVATION OF STATION BUILDINGS TOWARDS SHIP SIDE (FACING EAST)



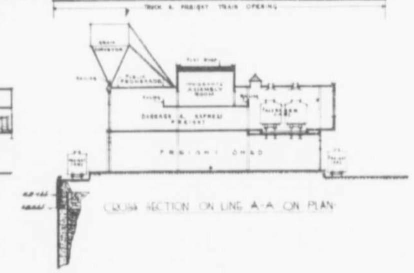
ELEVATION OF STATION BUILDINGS TOWARDS RAILWAY (FACING WEST)



CROSS SECTION ON LINE B-B ON PLAN



LONGITUDINAL SECTION ON LINE C-C ON PLAN



CROSS SECTION ON LINE A-A ON PLAN

ELEVATIONS & SECTIONS OF LANDING QUAY · SHEDS · & STATION ·

docks systems throughout the world at the present time is increase in the depth and dimensions of docks and piers. The large ship has been found more economical than the smaller one, and the only limits now imposed upon the ever increasing size of vessels are those due to restricted harbour depths and accommodation. The economic limit of speed for vessels rises with the increase in draft and size, and the long deep ship is always better than the short shallow ship carrying the same total deadweight. This has a most important bearing on the economics of fast mail, passenger and freight steamship services, and naval architects reckon that the value of a harbour increases, at least, in proportion to the cube of its depth. They also predict that in the next twenty or thirty years depths may be required up to 60 feet, and eminent authorities agree that no first class harbour intended for the larger class of ships should now be constructed with a depth of less than 45 feet, that is, the depth at low water of ordinary spring tides provided under this scheme.

In the matters of depth and dimensions of quays and piers, width of waterway and facility for manœuvring large ships, Halifax harbour will, on the completion of this scheme, be unexcelled in America and probably in the whole world. The entrance channel is straight and easy to navigate, and both it and the harbour are wide and remarkably free from currents and high winds, and they now have

a natural depth of 60 feet at low water of ordinary spring tides. Should it ever become necessary this enormous depth can also be obtained at the Proposed Landing Quay at a comparatively low cost by a simple extension outward of about forty or fifty feet in width.