Names and official ranks of the officers of the "Comissão Hidráulica", engaged in the studies of the proposed improvement of the Port of Santos.

1879.

H. M. Minho Ribeiro

Antônio P. Pires da Amarante

Rudolph Niesser

Domingos Sergio de Sávio e Silva

Alfredo Leitão

Miguel Antônio Lopes Resqueira

Theófilo Fernandes Sampaio

Nerón de Aquino Castro

Antônio P. Rocha Peix. Auxiliary

Engenheiro em Chefe.

Primeiro Engenheiro.

Chefe de Seção.

Engenheiro 1° Classe.

Engenheiro 1° Classe.

Engenheiro 2° Classe.

Engenheiro 2° Classe.

Engenheiro 2° Classe.

Auxiliar.
Reference to instructions from the government.

3. Situation of Santos.

4. Approach from the sea.


8. Examinations, etc.


10. Mud deposit in front of the port.

11. Recent improvements.


15. Trade of the Port of Santos.


17. Its effect upon the Community of Santos.

18. Transportation - its importance in connection with sea ports.

19. The Santos Harbor remains unimproved.

20. Consideration of different plans.

21. Earth filling - a part of any plan.

22. A solid stone arch quay - not advisable.

23. Drawbridges - to be avoided.

24. Wooden piers or Wooden Quays - not recommended.

25. The Controlling Circumstances of the harbor.

26. General plan of improvement.

T-Head Piers - and Inner Quay - Plan A.

27. Plan B.

28. Plan C.

29. General mode of doing the work.

30. General observation.

31. The plan of a Continuous arch Quay - not recommended.

32. The general plan of T-Head Piers A.

33. B

34. The present is a favorable time for doing the work.

35. A glance at the future.

36. The general plan marked B recommended.

37. Continuing remarks.
Alme Exmo
Senhor
O Exmo. Sr. o
João Luís Vieira
Governo Exmo. Sr. o
Presidente do Conselho de Ministros,
Ministro e Secretário de Estado, dos Negócios
da Agricultura, Comércio e Obras Públicas.

I have the honor to present
to your excellency the following report upon the
proposed improvement of the port of Santos:

In your excellency's Communication ("No
17, 3ª Secção Diretoria das Obras Públicas")
classed April 2.º 1879, my attention is particu-
larly directed to the following points:
1º Securing a sufficient depth of water to per-
rmit the foreign steamers visiting the port to Come
to the quay.
2º Filling the space between the land and the
projected quay in such a way as to satisfy the
Sanitary Conditions of the port.
3º Finally, in the arrangement of a general plan,
in order to facilitate the execution of the same
by private Contractors, to have in view the
erection of ware houses for the use of said
Contractors, together with other privileges to be
Conceded for a period to be determined, as re-
muneration upon the capital of the contractors
employed in constructing the quay.

In accordance with your excellency’s
instructions, the investigations of the Hydraulic Com-
mision have been directed toward ascertaining
the best mode of improving the sanitary and
commercial condition of this important port.

Our surveys, soundings, borings, and other ex-
aminations, combined with reliable data from
former surveys, especially from the able report of
Robert Pearson Pilkington Eng., Civil Engineer, made
in 1871, and the admirable harbor survey of
Captain E. Mancos, of the French Imperial
Navy, - 1867 - have enabled us to form a judg-
ment as to the most admirable method of perma-
nent improvement.

Situation of Santos.

The situation of this seaport is remarkably ad-
vantageous, on account of its safe yet close pro-
ximity to the ocean, being on the river Santos,
only ten kilometers (six miles) from the Cabocinos
bay of the same name. This bay has an area of
thirty-six square kilometers (about fourteen square
miles), opening directly to the Atlantic.

The city is in Latitude 23° 56’ 8” South, and
Longitude 46° 18' 55'' West, from Greenwich.
The Moella Light, on Moella Island, which lies outside on the eastern approach to the bay, is in
Latitude 24° 3' 6'' South, and Longitude 46° 15' 44.5'' West.

Approach from the Sea.
Approaching the river across the bay, there
is a depth of water of 10 metres (32.8 ft), or more,
to within two sea-miles of the fort. Warangana
at the mouth. The 9 metre Curva is within one
cone three-fourths sea-miles of the fort. The
depth then gradually decreases to 7.5 metres (24.6 ft)
as one mile from the fort, where the channel
that depth is 500 metres (1640 ft) wide.
Hence to the mouth, it increases in depth, but
diminishes in width; the river where it enters
the bay opposite the fort is 315 metres (1033 ft)
wide, but of great depth, and deepest sounding
measured 31 metres (101.68 ft), with sandy bottom
slightly mixed with muddy sediment.
All of the soundings refer to ordinary low tide;
and the usual tidal rise is 1.2 metres (4 ft). The
fort stands upon a projecting granite point on
the left bank, which is now the South side of the
river. Fort Trincomalee is immediately opposite,
on a low, sandy flat, the two forts being only
about four hundred metres apart.
Navigation of the River

The navigation for ocean vessels from the Bay to the City is excellent. At low tide, the least channel depth is 1/2 meter (24 feet) with a general depth of 10 to 15 meters (32.8 to 49.2 feet) along the lower half, and 8 to 10 meters (26.2 to 32.8 feet) along the upper half.

The narrowest place is at its mouth, where, as already stated, it is only 315 meters (1033 feet). Opposite the Río Viga, about two and a half kilometers above the fort, it is 440 meters (1443 feet).

At Otrantoillos, about three kilometers (nearly two miles) below the City, it is 440 meters, but the river between these two narrow places is eight tenths of a kilometer (nearly half an English mile) in width.

At Punta Napoema, where there is a battery, the river is 550 meters (1804 feet) wide, widening just above to one kilometer (just over half a mile).

The Río Arola river, a tidal stream with a separate ocean outlet, debouches onto the Santos river opposite the lower end of the City.

The narrowest place in front of the City is 715 meters (2342 feet, or nearly half a mile) wide. The channel width with a least depth of 7/3 meters (24 feet) at low tide is from 350 to 400 meters.
5.

(1158 to 1312 ft). At the Outerinhas, about 3 Kilometers below the city opposite the lowermost of the two prominent hills, there is a rock in the river, 60 meters (200 ft) from the shore, over which at ordinary low tide, the depth of water is only 4.30 meters (14.1 ft). Captain Mouchez's Chart of 1867 shows 4.10 meters over this rock. There is a wide, deep Channel outside of this rock, 250 meters (820 ft) wide with a depth of 8 to 16 meters (26 ft to 52 ft). So that vessels of the largest class keeping a hundred meters (328 ft) or more from the shore are perfectly safe. There is another rock shown on Captain Mouchez's Chart, about half way between the Outerinhas and the mouth of the river, marked 5 meters (16 ft); but we have not found it with our damanigo. It is marked opposite a house on the left bank, about 150 meters (492 ft) from the shore. Outside of there is a wide Channel of good depth - 250 meters wide (820 ft), 7.75 meters (25.4 ft) deep at low water. There is therefore a wide Channel of good depth, extending all the way from the bay to the upper end of the city.

No injurious swells from the bay can reach the port. In front of Santos, and all along the river, for ten miles, it is a safe harbor. The mean tidal rise at Santos is from 1.50 to 1.90 meters; though our observations made this season
have shown an extreme fluctuation of 2.34 meters (7.67 feet) between the lowest and highest tides. From the foregoing description it is obvious that the natural advantages of this port, from its proximity to the ocean, the width and depth of its Channel—approach, and its accessibility—especially for large steamers, are unusually great.

_Santo André and its Surroundings._

The length of the Commercial front, opposite which vessels lie, from the lower end of the Alfandega quay to the upper of the São Paulo Railway Company's new pier, is 1,125 meters, 3,697 feet. The City extends some distance above and below, but no Commerce is Carried on excepting between the points above designated. The City stands upon an inclined plan sloping very gently from the foot of the Merrimack, or inland hill, to the river; having an average width of 600 meters (1,968 feet).

The general river front is only from one meter to two meters above ordinary high tide, while the rear street near the hill is from five to six and a half meters above high tide, excepting toward the lower part of the City, where the town that, the Praia is nearly level from the
Alfândega back towards the town.

The first impression is that the city is quite flat; but our levelings show that most of it has a slope from the hill toward the river of about one foot in one hundred and fifty. The city was probably selected because there is no other spot along the river possessing such favorable conditions. The country below the city is very flat, to one and a half miles, generally only about one meter above high tide; excepting the two rocky knolls at the entrances, about three kilometers below the port.

Immediately behind the city stands Mount Serrat, 165 meters (541 ft) above the sea. The view from this elevation is very beautiful.

The main serra, "do Mar," which forms a striking feature of this portion of the Atlantic coast of Brazil, rises with a steep slope to the height of over a thousand meters (3280 ft), though the depression through which the São Paulo Railway is built, is about 800 meters (2624 ft) above the sea. The distance by the Circumferential line of the railway, 30 kilometers (18 3/4 miles). The water, and low flats, flow within ten kilometers (6.24 miles) of the summit of this serra.

The inclined planes of the railway rise at the rate of 1 in 9 3/4, overcoming an elevation of about 800 meters in the distance of eight kilometers.
(5 miles) divided among four planes. The natural face of the Serra is much steeper than these planes. The distance by this railway from Santos to São Paulo, the capital of the province, is 79 kilometers (49 miles).

Large areas above the City of Santos are covered with water, and other considerable areas are occasionally at high tide, though the are for the most part clothed with a growth of bushes and small trees.

The material of these tidal lands is alluvial deposit; the accumulated wages of the debris washed from the Serra, where the rainfall is very great, averaging about 4 meters in depth per annum.
In Santos it is about two-thirds of this depth.

The City is upon the island of Santos, which is formed by the tidal waters of the San Vicente river and Caqueira, meeting the waters of the river Santos; thus estuaries about 44.5 square kilometers, (17 square miles).

The ancient town of San Vicente is upon the same island, about eight kilometers (five miles) from Santos, with which it is now connected by a tramway. San Vicente is the oldest settlement.

* See appendix for tables of rainfall in Santos, and on the Serra.
on the Atlantic Coast of America. The former deep Channel to this town has become two Shallows for sea-going vessels. The place is only a neat Village, handsomely situated, with one side looking over across Santo Bay to the Ocean, the other side resting upon the San Vicente river. It is regarded as a very healthy town.

It is reasonable to conclude that all of the low, flat lands around Santo, were once part of this bay, which it has required many centuries to fill; and, judging from the comparatively small proportion of sediment now transported by the river, it seems probable that once an active operation, under different circumstances from those at present existing, were instrumental in distributing the debris from the surrounding Serras. Although the rainfall is very great, the dense vegetation on the Serras prevents extensive washing of the slopes.

During the Construction of the São Paulo Railway, from 1862 to 1887, and for some time after, large quantities of alluvial earth were washed from the excavations and fresh embankments into the streams, thus adding Considerably to the older accumulations of sediment; but luckily, the quantity from this source has been small, and it does not
10. appear that there has been any material change in the position or depth of the sediment, in the neighborhood of Santo, for some years. The practical bearing of this is, that, although in the course of many years there may be some accretion of sediment along the river, in places, it is not likely that there can be enough to seriously interfere with the normal channel of the river, which now maintains itself.

The broad, deep navigation in front of and below Santo, is kept in a normal condition by the large volume of the tidal flow required to fill the "Lagoa da Bandeira," and the other extensive basins above the city.

The rise of the tide being from 1½ to 2 metres (5 to 6½ feet) a very large body of water, passing, for long a time, through the river, with considerable velocity, and being almost free from sediment in suspension, most of the time, there is no force or circumstance tending to materially alter the natural width or depth of the channel. The process of additional filling of these extensive tidal basins above the city, is going on very slowly. During the subidence of heavy rains from, there may be a slight increase of sedimentary deposit on the surface of the flats,
but the augmented fluvial current at such times tends to carry out to sea portions of sediment, both in suspension and from the mud bottom. It is the strong tidal flow that maintains the depth across the barans of the bay. It forces water, commercially, as a depot; and this large daily flow in front of the city, can, under proper arrangements, be made to contribute essentially to its sanitary improvement.

The drawbacks - Sanitary and Commercial.

The real drawback to the otherwise advantageous position of this port, is a deep deposit of muddy sediment all along the commercial front. This mud, having a very steep slope for some distance out, exposes a large area at low tide to the action of the sun, which, in a tropical climate, especially during the summer, must be prejudicial to health. The city has a population of about ten thousand, and nearly all the revenue, etc., is discharged upon this surface mud, so that at times the effluvia is almost intolerable. To the sense of smell, as well as disgusting to the sight. This is a serious sanitary drawback.

The same mud deposit occasions the commercial drawback, by creating shallow...
Water all along there, where deep water is needed to accommodate the Commerce. This has been partially remedied by light wooden piers on wooden piles extended out to deeper water, by private parties; but they are frail structures, of temporary Character, requiring renewal every few years; and although a few lead out to a sufficient depth for vessels of moderate draught, they are not far enough out for the large steamers and large vessels which now come to this port.

A further temporary remedy would be found by an extension of these frail piers into deeper water; but such a remedy would have no effect whatever toward curing the great sanitary evil; nor would it improve the present defective system of loading and unloading vessels. Coffee, etc., would still be carried, as it is now, in the heads or shadoks of mow, between the vessels and the shore.

It could not be expected that a system so inferior as this should be recommended as part of any permanent improvement to be sanctioned by the Government; for, even with piers thus extended, it would be but the perpetuation of the most inadequate method of handling Cargoes, as well as of the unsanitary Condition of the Harbor.
In order to judge of the practicality of plans of permanent improvement, on a scale commensurate with the present and prospective commerce of Santos, we made numerous soundings, in the harbor and along the river down to the bay, partly with the view of discovering what material changes, if any, had taken place since former soundings were taken. These soundings show that there have been no important changes in the middle depth of the channel, either in the harbor, or in the river; no changes that could have special influence in regard to any general plan of improvement of the port. The regimen of the stream appears to have become so well established that sedimentary deposits along the bottom remain comparatively unaffected by the ordinary ebb and flow of the tides. During heavy, long-continued rains, on the Serra, the fresh water flow is considerably augmented, but the proportion of sediment brought down is now not very great. The effect of these floods is greatly ameliorated before they reach the city by spreading over the extensive
tidal lakes and bayous above Santer, which absorb much of the flood for a time, allowing it to pass off gradually. It is said that an extra rise of 0.60 metre (2 ft) at the City, as was observed, would not do harm to the works.

At all times, excepting just at the turn of the tide, there is a good current in the river; so that with the mud-flats at the City covered with good material, and the sewage, etc., discharged directly into deep, flowing water, they would be harmless. Instead of remaining as they do now, badly stagnated, in eddies, along a flat, muddy shore, they would pass away along with the great river flow. Even with a much larger population, the amount of sewage, etc., would be insignificant, compared with the quantity of running water in the river.

Volume of flowing water in the river.

The cross-section of the river in front of the City shows an average width of 775.6 meters on an average depth of 7 meters at low tide, and an average depth of 18 meters at high tide. The average rate of flow of the flow tide is 0.267 metres per second, and of the
During the running out of the ebb tide the quantity of water flowing in front of the city in one hour averages 9,576,000 cubic metres, or 9,576,000,000 litres (English gallons 2,106,720,000 English gallons). Compared with this large volume the sewerage, etc., constitute an insignificant item.

The ebb tide outflow of course includes all the fresh water flow of the streams from the Serra, which in their way to the sea discharge into the San Pedro river. At present, owing to the shape of the city front, and its irregularities, the sewerage, etc., remain in eddies, only slowly mingling with the main body of the stream.

Mud deposit in front of the Port

The borings made through the muddy sediment along the city front, under the direction of the Hydraulic Commission, have revealed considerably greater depths of soft material than any mentioned in former reports. At one place toward the upper part of the harbor, this deposit is 20.97 metres (68.2 feet) deep to the sand. Other borings showed various depths, from 4 metres (13 feet) to 14.86 metres (48.5 feet). The average depth of sediment shown in nineteen borings along a length of about
light hundred feet (262 ft) or 10.88 metres, (35½ ft). These borings are near the range of the proposed cutler pier heads.

Below this superficial sedimentary deposit, there is a hard sandy bottom sufficient to support an iron quay or pier. There is no action now taking place, nor is there any action likely to occur at the bottom of this deposit that could be injurious to Columns properly sunk into the sand. The rein cement, have no effect upon the sediment a few metres beneath its surface. The lower portion of the deposit may therefore be regarded as permanent. Some portions of the sediment are much more solid than the mud near the surface, and at the lower end of the harbor near the Aafandega, there is a comparative little sediment above a natural rock bottom.

Recent Improvements.

Before proceeding to the study of the problem presented it may be proper to refer to the works completed within a few years by the government, and by the Sao Paulo Railway Company.

Since the opening of the Sao Paulo Railway, in 1867, some improvements have
been made at the lower end of the harbor and at the upper end. Intermediate there has been some improvement of the city front by stone paving, etc., but nothing of consequence in the river.

_Alfonaga Quay and New Alfonega._

The government built a wooden quay, 49 metres (160 feet) in length, near the lower part of the commercial front, and opposite to it a commodious Alfonega building has quite recently been opened to use.

The quay is connected with the shore by a locomotive iron bridge of 22 metres (72 feet) span. This quay has been in use four or five years for discharging steamers and other vessels bringing foreign duties (merchandise).

It already exhibits evidences of decay, and it has settled irregularly. Consisting of tanbark material, it must soon be extensively repaired, or be replaced by another structure.

This quay can be arranged in harmony with a general plan of improvement of the port.

There is now a depth of water on the new side of the quay, of 11.60 metres (38 feet) at low tide, and on the stone side, above the bridge, 3.60 metres (12 feet).
By arrangement two steamers or sailing vessels can unload in front at the same time, and one smaller vessel at the rear of the wharf.

Sailing vessels are required to give place to the large steamers, even though they may at the time be partly discharged, and wait till the steamer has finished discharging. This is of course vexatious to the sailing vessels, and occasions loss of time and additional cost and naturally induces unfavorable comments upon the port facilities.

Sao Paulo Railway Pier.

The Railway Company, about the time their road was opened, in 1867, built an iron pier, connected with timber and plank, at the upper part of the harbor, and extended their track (1.60 metre (5.25 feet) gauge) from their main line to the outer end of the pier, thus connecting directly the railway transportation with the ocean water carriage—a very wise measure.

This “old pier,” as it is now called, stands about on a line with the range of the proposed pier heads. It is still used for loading and unloading vessels of moderate tonnage.

The second, or “New Pier,” was finished and
opened to use, during the present season.

It is a substantial structure, supported upon caisson hollow screw-columns sunk through the mud deposit to a good foundation in the sand. The depth through which the columns were sunk in the sediment varied from 8 to 16 metres (26 to 52 ft). The end columns, which are the longest, are about 1 1/2 metres (4 1/2 ft) in length.

This pier has a straight-arm quiver support structure, enclosed with concrete plant.

It is 112.50 metres (369 ft) long, and 13 metres (42 ft) wide. There are four rows of columns, at intervals of 9 metres (29 ft). It has three railway tracks connecting with the main line.

The depth of water on the outside of the pier, at low tide is 4.8 metres at the outer end (15 ft); and 0.8 metre (2.6 ft) at the land end. On the inside of the pier, the depth at low tide is from 4 metres (13 ft) to 3 metres (about 10 ft).

Both of these piers are almost constantly in use; Chieftly for unloading Coal, Oil andinelarid, locomotives, engines, Caro, heavy machinery, general railway plant, and various vehicles not required to pass through the Custom House, destined for the interior by rail, as well as for loading vehicles from the interior, almost the entire Custom House being on the Coronelio the Sao Paulo Railway.
These piers would materially aid to
harbor Conveniences of Santos.
The new piers projects obliquely down,
making an angle of 32 degrees with the line
of the old pier, and nearly the same angle
with the proposed line of improvement.
Its course is convenient for its railway connection,
and for the approach of vessels; but it cannot
be made a part of the proposed permanent
improvement of the Harbor. It is an independent
structure, devoted to the special uses above mentioned.
Being an open pier, with its line of Columns 9
meters (29.5 feet) apart, it offers, of itself, but little
obstruction to the tidal currents; but when vessels
drawing nearly or quite the full depth of water
are lying at the pier, the flow is of course shut
off; and the effect in these practical cases is
practically the
same as if the pier were dotted.

In view, therefore, of a Complete, harmonious plan
of permanent improvement of the entire harbor,
if this pier were yet to be located, it would be
advisable to change its direction; making it
more nearly parallel with the Natural Currents.
As it stands, while it Cannot be a part of the
general improvement, it is not certain that it will
be conducive of serious injury after the proposed
improvement shall be completed.
If, however, hereafter, this pier should be found to seriously injure the navigation interests of the port, it may become the subject of a special arrangement to meet the case. It is proposed to bear in mind that the São Paulo Railway traffic, means, the Common of Santos, of both imports and exports. This is the only railway from the port to the interior and the old system of horse transportation of coffee, etc., ceased soon after its opening. The old road, once the highway to the city of São Paulo, and the interior, is now almost entirely deserted, and there is scarcely any use for such a road now.

It is stated that the new railway pier above described, Cost nearly Rs. 100,000.

**Transport.**

There are two tramroads in Santos. The Company, "Melhoramento da Cidade da Santos," laid a line 0.80 meter (2.62 feet) gauge from the Railway Station, above the upper end of the harbor, partly along the mile front, and partly through streets. It connects with several private warehouses, on different streets, and with the Alfandega, at the lower end of the harbor. It also extends across the low flat land to the "Parada," a distance of about 5½ kilometers—about 3½ miles. This tramroad is
useful in transferring to some extent the Carriage of Coffee and other articles from Calcutta on the 25th of each month. 

Neither the Carts or the Carts are allowed on the street or on the wharves, whence the Coffee, etc., are carried to the Vendors on the Heads or Shadown nine working. These men labor hard, and do their work with energy; but the system involves a tax upon the Producer, and upon the Vends, which a more modern arrangement would avoid.

(The Shipment of Coffee from Santos in 1878, was, in round numbers, 68,000 tons; and allowing 17 sacks to the ton, there were 1,176,000 sacks. If by a better system a saving of only 100 Reis (5 cents) per sack could be secured, it would, upon this quantity, amount to Rs. 117,600 (58,800). This saving, in a single item of export, in a single year (1878), is about 6 per cent. in the estimated Cost of the permanent improvement of the Harbor. Which railway connection between the railway station and the Ports of loading and unloading, are effectual saving more than equivalent to the interest upon the Cost of the improved improvements.)
A second tramroad was laid by Messrs. Emrich & Abreu, having a gauge of 1.35 meter (4 ft. 5 inches) from a more central part of Santos, extending across the island to the ancient town of São Vicente. It passes through a district not very far from the São Paulo Railway Station, but without connecting with it. It is used chiefly for passengers. The railway, and the two tramroads, having different gauges, there can be no interchange of cars between any two of them.

To establish a perfect system of transfer between the São Paulo Railway and the shipping of the Port of Santos, a track of the same gauge, 1.60 meter (5 ft. 3 inches) should extend along the City front to the Alfandega, and also out upon the pier.

F acade of the Port of Santos.

Since the opening of the São Paulo railway, in 1867, larger, deeper-draught steamers and sailing vessels have been patronizing this port; mainly on account of the annually increasing quantity and superior quality of Coffee brought in by railway from the interior of the rich Province of São Paulo.

In 1868, the Coffee Shipment was only 21,000 tons, while in 1878 it was over 68,000 tons; or an
increase of 41,000 tons, equal to 150 per cent.

According to the published reports of the São Paulo Railway Company, the quantity of coffee carried on the road in 1867-68 was 30,193 tons; and in 1877-78, 68,462 tons, showing an increase of 129 per cent.

The total tonnage, including coffee, cotton, salt, sugar, and locomotives, was, in 1867-68, 58,245 tons; and in 1877-78, 125,850 tons; or a general increase of 133 per cent. One item, cotton, decreased, from 6,824 tons in 1867-68 to 5,885 tons in 1877-78; yet notwithstanding this decrease of one article, the aggregate increase was as above given.

The particulars, during each of the 10 years, will be found in Table I in the Appendix.

The number of vessels which entered the port of Santos, during the year from January 1st to January 1st of the next year, was 461, of which 125 were foreign steamers, and 129 steamers of the Country. The particulars of all the vessels were kindly furnished by Mr. Senhor Manuel Antunes de Lima Vieira, Major Commandante of the Barra Grande, and are given in Table II in the Appendix. During the 5 months, from January to May,
both inclusive, there arrived at their port 200 vessels, of which 61 were foreign steamers and 52 were steamers of the Country. The particulars relating to these 200 vessels are given in Table (in the Appendix).

The Commission is indebted to Sr. Sec. J. Martins dos Santos for tabular statements, showing the exports of the Province of São Paulo from the port of Santos, from 1868 to 1878 both inclusive, and for a table during the same period of the number of vessels and number of kilogrammes of foreign articles imported that passed duty to the Province. These will be found in the Appendix.

From these tables it appears that while the total value of articles exported from the Province in 1868-69 amounted to £5,20,800; 308,460 in 1877-78 they amounted to £24,887,257 or 305. The number of vessels received in 1868-69 was 3,389, and in 1877-78, 3,916. The number of kilogrammes received in 1868-69 was 153,540, and in 1877-78, 364,475.

There seems to be no reason to assume that the Commerce of Santos will not continue to steadily increase, even without any improvement of the port; much more if it be made attractive by adequate accommodations.
26.

The Railway System of the Province of São Paulo—The effect upon the Commerce of Santos.

The São Paulo Railway, which is the main trunk line of the railway system of the Province, was opened to public use in 1867, and accepted by the government August 1, 1868. It is 139.2 kilometers (86 miles) long, and cost £23,535,000 (US$11,777,500) being at the rate of £169,216,000 per kilometer (£136,200 per mile).

The City of São Paulo is 79 kilometers (49 miles) from Santos. It has become the centre for a growing and already extensive railway system, which accommodates a Considerable portion of the Province.

This system must continue to advance, and spread its branches farther into the interior, with the augmenting population. There are now in operation in this Province 1080 kilometers (669 miles) of finished lines, with others in progress and projected.

Most of these lines have been extended into Coffee-growing regions, which, in Consequence of the copious facilities of transportation thus afforded, have been Cultivated to a much greater extent than they Centred have been within the railways.
It is almost certain that but for the extension of these modern means of transporting bulky agricultural products, the culture of coffee, etc., in the province of Sao Paulo, for ocean shipment, must have been circumscribed within narrow limits, and the further settlement of the back country greatly retarded, if not entirely checked.

**Transportation**

Its importance in connection with Seaports.

Transportation, from time immemorial, has been as controlling a factor in the business of the world, and since the interchange of productions between different countries has become universal, the cost of transportation is daily becoming more important. It is in fact a principal element in Commerce, so that railways, which in the beginning were only Conveniences, are now an absolute necessity, and the trade of every great Country must be mainly dependent on these economical aids.

In Brazil, her production of coffee, sugar, cotton, etc., would be restricted to a comparatively narrow margin along the sea-coast, but for her interior railways and water
Communications. With railways and improved water courses, no country is so extensive but that every portion yet may be settled and cultivated, wherever the soil admits of cultivation. Important, however, as railways are, they should not be regarded as dispensing navigable water channels. When judiciously arranged, these become mutual adjuncts. When all the main trunk lines of a country have been constructed, there will still be numerous minor railways needed to connect them with the rest of the empire; is meanwhile, these great water-courses that have been properly improved.

In the United States, where the railway system has been so extensively introduced, the people are already turning their attention to the improvement of the great rivers, as necessary for the development and economical accommodation of the vast interior plate and territories.

The seaports of the world are the points between which most of the international exchange are made; therefore every facility added, every obstruction removed, of whatever nature it may be, between the interior producing regions and the ports of shipment is a direct saving to the country, and therefore a national benefit. Whether this saving be effected in the interior, or the
route, or at the place of shipment, it is, according to its extent, a public advantage. Hence, while extending railways and other improvements into the interior in order to remove obstructions and add to the facilities of intercommunication throughout the producing territory, it is sound national policy at the same time to encourage improvements at the Ocean ports, where the home products are delivered for shipment, and foreign productions are received destined for the interior.

And since commercial impediments refer chiefly to cost of transportation, it is plain that constant charges on railways for the carriage of freight and passengers, constitute an artificial obstruction as real and as important as any other, and which if carried to excess may be equal in effect to physical obstruction than any new existing. In the United States competition has remedied this difficulty. This present will occasion a future Command special attention in Brazil.

Why Santos Harbor remains unimproved.

One of the reasons assigned for the absence of a permanent improvement of this harbor, is, that the Imperial Government having some years ago undertaken canals, etc., with the view to its improvement, thus deterred the City of Santos and Province of São Paulo from
entering upon the construction of any work of importance, and private parties were not inclined to expend much, even upon their own water fronts, not knowing how they might be afterward affected by the government works.

Meanwhile, the ancient mud-flats, and the primitive methods of loading and discharging vessels continued; and so do the inconveniences giving occasion for complaints from owners and masters of vessels visiting the port.

Another reason for the delay is said to be, because the sums estimated as necessary to complete permanent improvements have been so large as to discourage capitalists from lending money for their construction, without a guarantee of interest by the government.

Continuation of different Plans

Earth Filling- a part of any plan.

Any plan that omits a radical remedy for the mud-flat nuisance, could be imperfect. Fortunately, the remedy is simple; namely, filling one the flats with good material cut to or beyond low-water mark, carrying the sewerage, etc., by pipes or culverts, through the embankments then made, and delivering it below high-tide.
Upon the completion of proper works the waters will drift away into a strong river current, instead of trickling out upon the mead and eddies along those as they do at present, and the offensive matter will be at once lost in the large volume of moving water.

A similar suggestion was included in the scheme proposed by Mr. Browne, in 1871, and it has probably found a part of other indicated projects.

Such a work has hitherto been proposed.

In an engineering point of view, alone, it may be practicable to build a solid stone outer quay founded below the bottom of the sedimentary material, with an immense earth embankment behind it; but the cost would be very great, and, under the unfavorable conditions presented, many years would be required for its construction; and when completed it would not be the most advantageous arrangement for the commerce. It is therefore not recommended.

Drawbridges to be avoided.

Plains have hitherto been suggested which included drawbridges.

Any plan involving the construction and use
of drawbridges is undesirable. Drawbridges are applicable only where other less objectionable appliances cannot be employed. Under circumstances where railway and navigation interests cross each other, they are sometimes a necessity; but in this harbor the two interests are perfectly harmonious, and drawbridges are unnecessary.

Wooden piers or wooden quays.
Not recommended.

Wooden quays, or wooden piers, resting upon wooden piles, even if the piles were creosoted, or coppered, were scarcely to be regarded as a permanent improvement; although in some situations they may be advisable, they are not recommended in connection with the port of Santos.

The Controlling Circumstances of this Harbor.

The commercial front of the city is limited in extent; though, with proper arrangements, it can be ample for many years. Its length from the lower end of the Alfandega quay to the lower end of the old railway pier is 285 meters (935 ft), about half a mile. In front of this, and for some distance above the railway pier, there is a good depth in the Channel of the River.
Between the stone and the Channel there is an extensive, gently-sloping shallow mud-flat, much of which is bare at low tide. It is quite narrow at the Alfonsega quay, gradually widening towards the upper part of the harbor in the neighborhood of the Railway wharf.

Along this frontage there are, in all, fourteen temporary wooden piers, belonging to individuals. Some of them are quite insignificant, and are not approached by vessels. They project at irregular distances, and with irregular lengths; and none of them reach to a sufficient depth of water for vessels of deep draught.

The streets and wharves are but little above the level of high tide; generally about 0.6 meter, or less than two meters; and irregular.

The tides rise to a Commencement 1.60 meters (5' 2") above, sometimes it is 2 meters (6' 5" ft). The range between extreme low tide and extreme high tide, during our tide observations, this spring was 2.24 meters (7' 8")

The stronger Currents in the river surface, when free from fluvial frets are 0.33 meter (1' 1") per second on the flood, and 0.61 meter (2' 0") per second on the ebb. The average, as already stated, being 0.26 meter on the flood, and 0.45 meter on the ebb.

When there is a fretter in the stream, caused by heavy rains on the Sierra, the ebb current...
considerably stronger, while the rate of the flood current is reduced. The tides also affect the constant change of tone. The current is never strong enough to occasion serious trouble to the shipping, so that vessels can be Confederately or quietly another in the Channel, or taken secured to the quay or the pier.

Being to the insufficient depth of the end of the present temporary pier, it is a common thing for vessels to be partly embedded in the mud at low tide, from which they are lifted by the next rise of tide. Many Captains and owners of vessels are naturally averse to grounding their vessels in this way, and they therefore moor out to deeper water.

An ordinary expedient, especially in the case of the large steamers, is to hire a smaller vessel to lie inside, at or near the end of pier, and load or unload across the river vessel. Such vessels are not however always in port to be hired; and there is no regular lightering system.

From the foregoing statement of the circumstances, it will be seen that the predominating causes of the inconvenient harbor arrangements is the extensive deep mass of sediment lying between the Ctown and the new Channel.

The Channel of 11/2 miles (24 ft) depth at
low tide, is of limited width, so that long piers, extending out from the shore, arranged for vessels to lie along side, would be highly objectionable, on account of contracting the Channel space for turning vessels, and because vessels lying thus, at right angles to the stream, would seriously obstruct the tidal flow, and create injurious eddies just where they should be avoided.

General Plan of Improvement.

The circumstances indicate a general plan of open quays or piers resting upon tim supports.

The Plan of T-Head piers and Inner Quay.

An embankment, already mentioned, is to be made over the shallow, muddy front, the outer portion being composed of rip-rap, or a mixture of rough stone filled up to low water mark. Above this level there will be ordinary embankment, faced with a light slope-wall between low and high water marks, and finished at the top with a light vertical wall.

The foot of the rip-rap filling is to be far enough out to secure, with the aid of a little dredging, 5 meters (16.4 ft) depth of water at low tide. The rip-rap is to be prevented from slipping outward by a close row of timber piling.

Outside of this inner quay, the outer piers have to be built, in deeper water, so that with a moderate amount of dredging a depth of
6.4 meters (22 feet) at low tide, can be had.

The front line of the pier heads will be 21.35 meters (70 feet) out from the top angle of the lower quay described. Seven pier heads will accommodate conveniently the space along the City front to be improved.

Each pier head to be 25.0 meters (82 feet) long, and 12.5 meters (41 feet) wide, connected with the inner quay by an iron bridge of 74.9 meters span.

These pier heads will consist of wrought-iron superstructure supported upon hollow, cylindrical Cast-iron bored Columns, sunk through the sediment to a secure foundation.

The open water space between two adjacent pier heads, for the passage of vessels to the inner quay, will be 75 meters (246 feet), and between the bridges, midway, 87.4 meters (287 feet).

In view of the number of long vessels now visiting this port, and of the general opinion in the length of these vessels, the number of pier heads (1) is deemed to be ample. It might be considered advisable, if any change in the number be made, to reduce or to stop, the inner waters lengthening the space between them, and making the access to the inner quay more convenient. The inner quay will be quite advantageous for a large majority of the vessels, which are at present so much smaller than the largest class of steamers.
Plan B.

A modification of plan A is to leave out the lower T-Head pair, and increase the length of the Alfonseca quay, adding 64 metres (210 ft) and 75 metres (246 ft) at the upper and lower ends of the present quay, respectively; making a total length of quay of 188 metres (616.6 ft).

The inner line of quay would be corrected, as shown in the drawing marked B, and the space between the Alfonseca quay as enlarged, and the proposed inner quay to beched, so that vessels can lie in both lines of the Alfonseca quay, and also at the inner quay.

The open water space from the upper end of the New Alfonseca when extended, and the nearest pier-head, will be 100 metres (328 ft). It may be found unnecessary to extend the Alfonseca quay at once to the full length indicated, leaving the water space still larger.

Plan C

A substitute for the T-Head Pier is represented on the plan marked C.

This plan would thus afford vessels from the indicated inner quay. In fact, an inner quay would be almost useless; for, even small
Costs could not approach the inner groy of high tide
expecting at the open space near the Alfreda groy.
At low tide they might uncover the iron framework
of the groy. The arrangement would be inconvenient.

The estimated cost of these plans, A, B, and C,
is as follows:

Estimated Cost of Plan A. £ 1,653; 472/; 575
                   "       " B. £ 1,741; 378/; 850
                   "       " C. £ 2,128; 091/; 700

These estimates do not include any sum
that may be required for expropriation of lands,
buildings, or temporary piers; or the cost of warehouses.

Nor has any estimate been made of the
value of new land to be created by the embankment.

Unsatisfactory arrangements between
the government, the owners of property, and the
parties who may undertake the Construction of
the works, the Value of the new land may be
considerable per centage of the total
Cost. Its value will depend largely upon
the manner in which it may be improved,
and Scott Whiting.
General Mode of Doing the Work.

1. Two lines of temporary tramways are to be laid from convenient places at the base of the hill back of the City, one at each end of the Commercial Point, for the conveyance of earth and stone for the embankments, nip-rap mound, slope-wall, and vertical wall, for which appropriate plant should be provided.

2. Arrangements should be made for an early delivery of the timber piles; and two pile machines, with the requisite appliances should be prepared, so that the piles can be driven in advance of the nip-rap filling. These piles are to be driven with a "follower," so that their heads will be as low as the surface of the mud.

3. The filling from the shore out to low water mark, can be commenced at once. To cover the mud-flat as soon as possible, is done with care.

4. As soon as the timber piling is a little advanced, the nip-rap and outer portion of the embankment can be carried on a temporary tramway at each end of the harbor, and dropped into position outside of the piling.

5. After the nip-rap mound shall have advanced fifteen or twenty meters, the earth filling of the main embankment can follow, keeping it always somewhat behind the
40.

rip-rap mound, through allowing a portion of the earth filling to be carried along with them of the rip-rap.

The entire embankment should be allowed to settle for some time, according to circumstances, before laying the slope wall upon its outer face, to guard against irregular settling of the slope wall.

6. After the embankment, in its outer part, has sufficiently settled, the slope may be laid. When the slope wall is finished, the vertical wall can be built, and capped with stone, forming the top angle of the inner quay.

7. Premises should be made in the beginning for the manufacture and delivery of the cast iron and wrought iron work of the pier-heads and bridges, and for the plant requisite for their framing and erection.

8. The erection of the pier heads need not wait for, or be dependent upon the completion of the inner quay. The building of the Columns, and the framing and setting up of the Superstructure, may proceed at the same time, or in advance. If regarded, the pier heads could be temporarily connected with the shore, even before the inner quay opposite to them should be entirely completed.

9. In the management of works of this character, very much must necessarily be left to the judgment
and direction of the Engineer in Charge.

Some inconveniences must naturally arise to various parties in conducting such works, and a Spirit of Mutual Accommodation seems to prevail.

40. Most of the foregoing is applicable to each of the three plans presented.

10. After the embankments shall have sufficiently settled, the responsive from certain levels of the river to be laid across them in ditches to be excavated for that purpose, and arranged with cutover paling through the slope wall to the river.

11. The entire area of the newly made ground is to be laid out in streets, and blocks, as shown in the plans; and the streets are to be paved with stone blocks. The details of the street and joint railway, to be arranged hereafter.

12. It is understood that the São Paulo Railway Company will probably enter into a special agreement with the government to fill up and improve that portion of Cutia Station, as some plan approved by the government or that the whole, when finished, shall present a handsome and commodious front.

13. Upon either of the three plans, the precise shape of the detail specifications will depend in part...
upon the particular system under which the improvement is to be carried out: whether by government work; or under a Contract, at stipulated prices; or under a Concession, based on privileges conceded by the government to parties who will raise the funds and perform the work, under the supervision of the government engineers.

In the latter case, it might be advantageous to the parties to have an understanding that the concessionaires should have the privilege of suggesting modifications respecting plans and details of methods of work, which, after approval by the government, might be adopted.

At the office of the "Commission, in Santos, every facility had been afforded to all who were disposed to take an interest in the proposed improvement, to examine the plans, and to offer any suggestions that might occur to them. The plans were also exhibited and explained before the "Associação Commercio" of Santos, and members of the Câmara, and other citizens were invited to examine and inform. The general opinion seemed to favor the General Plan, and after

The people of Santos, being specially interested in the Sanitary and Commercial Improvement of their City, their opinions and advice were regarded by the Commission as
entitled to the fullest Consideration.

The plan marked C, of a Continuous quay,
excepting one open space 100 meters long, as
shown in the drawing, is more expensive
than either of the others; but although it
is considerably more costly in first Construction,
it would afford much less shipping-room;
and, on account of the much greater area
of tolerable surface, of docking, and gain
superstructure, it would cost considerably more
for its (yearly Maintenance. For these reasons
it is not recommended.

The general plan, marked A, Consisting of an inner quay, and outer T-Head
Piers, appears to Combination least Cost with
the greatest amount of Commercial accommodation,
and it is with
this general plan we are entirely adapted
to these Circumstances of the Port.

The plan marked B, is least a modification
of the proposed general plan, in order
to make the most advantageous use of the
present arrangements of the Alfandega
Buildings. A slight alteration
of the length shown in the drawing, of unit and
about 83,000$000 to the Cost, materially
increasing the Commercial facilities in the
immediate neighborhood of the Alfandega.

In case the plan of extending the
Alfandega guany and leaving out one T-Head as shown in the drawing on B.

It might not be necessary, to extend it to the full length shown in the drawing.

The question of the extent of the modelling of the wooden present Alfandega guany might be left to be arranged when the inquiry is deep enough to answer for some time in advance.

The construction of the improvement should be fixed.

The reserve of the works, including the inner guay and the deck, would be executed by the contractors of Construction.

The present is a favorable time to do the work.

Intelligent gentlemen who are familiar with the Port of Santos and the Province of Sao Paulo, have intimated that the requisite capital can now be raised for this improvement upon a reasonable concession of privileges to be granted by the Government entitling the Concessioneiros to collect a moderate annual income by derive from Port Charges, and the control of the new quay to be created by the works, and the right to erect buildings thereon.
already entitled life andanimation, creating active
and improved industries in the interior where be-
fore there was Comparative Astatician.
Undoubtedly, it is to the vigorous prosecution of this
railway system that the large and rapid in-
crease of the Commerce of Santos is due; and,
in the future, if this system should be wisely con-
ducted in regard to freight charges so as to
produce the greatest good to the greatest number,
thus encouraging the people, the business on the
railways and the exports and imports at
Santos will probably be doubled long before
the expiration of another decade. During the
last fiscal year it increased 20 per cent.
over 1877-78.

It is to be feared that the railway systems
of Brazil, having their termini at Sea-Coast Cities,
can not be brought to a Stand-still by high
rates for transportation. With moderate charge,
these lines may be gradually extended further
and farther into the Heart of the Country; thus
giving encouragement not only to the present
settlers, but to others who can then venture to
Cultivate lands far from the Coast. Under
a well managed network of railway facilities,
no limit can be assigned to the Commerce
of the Country.
625
328
3440
130
2025
2214

800
30
50

44000

20 \times 3 = 60

2000
78000
3000
300

150600

2400
36
200

120000

1000000

100,000 \times 100 Rs
10,000,000

50,000

17/850/50 Rs

17/500/30

30

72 \times 300
21600

506

10,000,000 Sacks

10,000,000

10,000,000

10,000,000
The annual receipts at this port, from Customs, are now considerably more than the entire cost of the proposed improvements; and the statistics show that the receipts are yearly augmenting. With a material increase of shipping facilities, and a decisive and most beneficial change in the sanitary condition of the Harbor, as well as of the City, Commerce at this point would naturally be further stimulated.

It is said that for some years property in Santos has been depreciating in value; although the Commerce has been constantly increasing. Several causes may have combined to produce this; but, if now, all property values should, in consequence of the completion of the proposed works, be enhanced, it might easily be that this enhancement in the City should nearly equal the cost of the improvement.

With a convenient, safe, shipping port, freed entirely from its present drawbacks, ten per cent interest per annum upon the cost of the works, would be an insignificant item. The result, instead of being a tax, would be a positive gain to the community.

The province of Sao Paulo, although it can boast of settlements more than three hundred years old, is yet, in all the essential elements of modern commerce in its infancy. That is, in its commercial, agricultural, and manufacturing industries. The railway system of this province has
At Santos, the Commune is now quite sufficient to fully warrant the expenditure required for its adequate accommodation. Its continuous increase, or the amount of its annual augmentation, will depend very much upon the exercise of judgment and energy of the people of the interior; without which the greatest natural advantages of soil and climate avail little.

In the appendix will be found some interesting information relating to tides, flow of the river, rainfall, meteorological and barometrical observations, commerce of the port, etc., which could not conveniently be embodied in the text.

Accompanying the report are maps, charts, and drawings, and an index to facilitate the study of the different items referred to.

The Commune is under obligations to many members of the officers of the government, and of the Province of São Paulo, as well as of the City of Santos, and of the São Paulo Railway Company and others, for much valuable information and many courtesies; especially to the following:

His Excellency Dr. Caetano Melo de Pinto, M.D.,
President of the Province of São Paulo.

José Coelho Neto, capitão de fragata
Secretario da Camara Joaquim Pereira Marques