Names and Official rank of the Officers of the "Commissão Hydraulica", engaged in the studies of the proposed improvement of the Port of Santos.

1879.

W. Milnor Roberts	Engenheiro em Chefe.
Antº P. Pinto de Amarante	Primeiro Engenheiro.
Rudolph Wieser	Chefe de Secção.
Domingos Sergio de Sabóia e Silva.	Engenº 1ª Classe.
Alfredo Lisboa.	Engnº 1ª Classe.
Miguel Antº Lopes Pecegueiro	Engenº 2ª Classe.
Theodoro Fernandes Sampaio.	Engenº 2ª Classe.
Thomaz de Aquino Castro	Engenº 2ª Classe.
João P. Rocha Pita.	Auxiliar

Headings of Pages to subjects in report. For English copy

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See Mr Lisbon 64	The general plan of T-Head Piers A.
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Commissão Hydraulica.

Illmo Exmo
Senhor
O Conselheiro
João Luis Vieira Cansansão de Sinimbu,
Digníssimo Presidente do Conselho de Ministros,
Ministro e Secretario de Estado, dos Negocios
da Agricultura, Commercio e Obras Publicas.

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 Directoria das Obras Publicas") dated April 2ª 1879, my attention is particularly directed to the following points.

1º Securing a sufficient depth of water to permit 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 warehouses for the use of said Contractors, together with other privileges to be

Conceded for a period to be determined, as remuneration upon the Capital of the Contractors employed in Constructing the Quay.

In accordance with your Excellency's instructions the investigations of the Hydraulic Commission have been directed towards ascertaining the best mode of improving the Sanitary and Commercial Condition of this important port.

Our surveys, soundings, borings, and other examinations, Combined with reliable data from former surveys, especially from the able report of Robert Pearson Brereton Esq., Civil Engineer, made in 1871, and the admirable harbor survey of Captain E. Mouchez, of the French Imperial Navy,- 1867- have enabled us to form a judgment as to the most advisable method of permanent improvement.

Situation of Santos.

The situation of this seaport is remarkably advantageous, on account of its safe yet close proximity to the ocean, being on the river Santos, only ten kilometers (six miles) from the Capacious 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' 43" West.

Approach from the Sea.

Approaching the river across the bay, there is a depth of water of 10 metres (32.8 feet), or more, to within two sea-miles of the fort Barra Grande at the mouth. The 9 metre Curve is within one and three fourths sea-miles of the fort. The depth then gradually lessens to 7½ metres (24 feet) at one mile from the fort, where the Channel of that depth is 500 metres (1640 feet) wide.
Thence 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 feet) wide, but of great depth, our deepest sounding there a 31 metres (101.68 feet), with Sandy bottom slightly mixed with muddy sediment.
All of the soundings refer to ordinary low tide; and the usual tidal rise is 1½ metres (5 feet).
The fort stands upon a projecting granite point on the left bank, which is here the South side of the river. Fort Tres Reis 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 7 1/3 metres (24 feet) with a general depth of 10 to 15 metres (32.8 to 49.2 feet) along the lower half, and 8 to 10 metres (26.24 to 32.8 feet) along the upper half.

The narrowest place is at its mouth, where, as already stated, it is only 315 metres (1033 feet).

Opposite the Rio Vigia, about two and a half Kilometers above the fort, it is 440 metres (1443 feet).

At Outreeintos, about three Kilometers (nearly two miles) below the City, it is 440 metres; but the river between these two narrow places is eight tenths of a Kilometer (nearly half an english mile) in width.

At Ponta Itapema, where there is a battery, the river is 550 metres (1804 feet) wide, widening just above to One Kilometer (five eighths of a mile).

The Bertioga river, a tidal stream with a separate ocean outlet, debouches into the Santos river opposite the lower end of the City.

The narrowest place in front of the City is 775 metres (2542 feet, or nearly half a mile) wide.

The Channel width with a least depth of 7 1/3 metres (24 feet) at low tide, is from 350 to 400 metres

(1158 to 1312 feet). At the Outeiro inhos, about 3 kilometers below the City opposite the lower most of the two prominent hills, there is a rock in the river, 66 metres (216 feet) from the shore, over which at ordinary low tide, the depth of water is only 4.80 metres ($15\frac{3}{4}$ feet). Captain Mouchez's Chart of 1867 shows 4.10 metres over this rock. There is a wide, deep Channel outside of this rock, 250 metres (820 feet) with a depth of 8 to 16 metres ($26\frac{1}{4}$ to $52\frac{1}{2}$ feet), so that Vessels of the Largest Class keeping a hundred metres (328 feet) or more from the shore are perfectly safe. There is another rock shown on Captain Mouchez's Chart, about half way between the Outeiro inhos and the mouth of the river, marked 5 metres ($16\frac{1}{2}$ feet); but we have not found it with our Lanadings. It is marked on the chart opposite a house on the left bank, about 150 metres (492 feet) from the shore. Outside of it there is a wide Channel of good depth — 250 metres (820 feet) wide, 7.75 metres (25.4 feet) 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 six miles, it is a safe harbor. The usual tidal rise at Santos is from 1.50 to 1.90 metres; though our observations, made this season,

have shown an extreme fluctuation of 2.34 metres (7.67 feet) between the lowest and highest tide.

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.

Santos 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 962 / 112.5 metres, (369 / 3155,36 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 plane sloping very gently from the foot of the Monte serrat, or isolated hill, to the river; having an average width of 600 metres (1968 feet.)

The general river front is only from One metre to two metres above ordinary high tide, while the rear street near the hill is from five to six and a half metres above high tide, excepting toward the lower part of the City, where the cross street, the Praça da Cadeia, is nearly level from the

Alfandega back toward the hill.

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 site was probably selected because there is no other spot along the river possessing such favorable Conditions, the Country below the City is very flat, and generally only about one to one and a half metre above high tide; excepting the two rocky hills or knolls at the Outeiro-hos, about three kilometers below the port. Immediately behind the City stands Mont-Serrat, 165 metres (541 feet) 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 front of Brazil, rises with a steep slope to the height of over a thousand metres (3280 feet); through the depression through which the São Paulo Railway is built, is about 800 metres (2624 feet) above the sea, distant by the Circuitous line of the railway, 30 kilometers (18½ miles). Tide water, over the low flats, flows within ten kilometers (six to seven miles) of the summit of this serra.

The inclined planes of the railway rise at the rate of 1 in 9¾, overcoming an elevation of about 800 metres 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 overflown at high tide, though they 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 ages of the debris washed from the Serra; where the rainfall is very great, averaging about 4 metres 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 and Casqueira rivers meeting the waters of the river Santos; this is stating 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 ship Channel to this town has become too shallow for sea-going Vessels. The place is only a neat Village, handsomely situated, with one side looking out across Santos 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 Santos, were once part of the bay, which it has required many Centuries to fill; and, judging from the Comparatively small proportion of Sediment now transported by the rivers, it seems probable that forces once in active operation, under different Circumstances from those at present existing, were instrumental in distributing the debris from the surrounding Serras. Although the rainfall is there very great, the dense vegetation on the Serras prevents extensive washings of the slopes.
During the Construction of the São Paulo Railway, from 1862 to 1867, 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 lately, the quantity from this source has been small, and it does not

appear that there has been any material change in the position or depth of the Sediment, in the neighborhood of Santos, 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 will 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 Santos, is kept in a normal Condition by the large Volume of the tidal flow required to fill the "Largo da Cana", 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 passes, four times daily, 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 in these extensive tidal reservoirs above the City, is going on very slowly. During the subsidence of heavy rain freshets, 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 wet bottom.
It is the strong tidal flow that maintains the depth across the sands of the bay. It secures Santos, Commercially, as a seaport; 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 flat 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 sewerage, etc, is discharged upon this surface of 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 shore, 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 reach out to a sufficient depth for Vessels of moderate draught, they are not far enough out for the large Steamers and large Ships which now Come to this port.

A further temporary remedy would of Course 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, on the heads or Shoulders of men, 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 present inadequate method of handling Cargoes, as well as of the wretched sanitary Condition of the Harbor.

Examinations, etc.

In order to judge of the practicability 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 ~~the~~ 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 in 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 freshets is greatly ameliorated before they reach the City by spreading over the extensive

tidal lakes and bayous above Santos, 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 feet) at the City, is of rare occurrence. With a proper improvement, even a considerably greater rise 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 materials, and the sewerage, etc, discharged directly into deep, flowing water, they would be harmless. Instead of remaining as they do now, partly 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 sewerage, etc, would be insignificant, compared with the quantity of moving water in the river.

Volume of flowing water in the river.

The cross-sections of the river in front of the City show an average width of 775.6 metres an average depth of 7 metres ~~at low tide, and an average depth of metres at high tide~~. The average rate of flow of the flood tide is 0.267 metres per second, and of the

ebb tide 0.490 metres per second.

During the running out of the ebb tide the quantity of water flowing in front of the city in one hour averages 9.576.000.000 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 on their way to the sea discharge into the Santos 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 loose material than any mentioned in former reports. At one place, toward the upper part of the harbor, this deposit is 20.97 metres (68 3/4 feet) deep to the sand. Other borings showed various depths, from 4 metres (13 feet) to 14.86 metres (48 3/4 feet). The average depth of sediment shown in nineteen borings along a length of about

eight hundred metres (2624 feet) is 10.88 metres, (35½ feet). These borings are near the range of the proposed outer pier-heads.

Below this extensive 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 river Currents 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 Alfandega, there is Comparatively 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 São Paulo Railway Company.

Since the Opening of the São 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.

Alfandega Quay - and New Alfandega.

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 Alfandega building has quite recently been opened to use.

The quay is Connected with the shore by a wrought-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 dutiable Merchandize.

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

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

There is now a depth of water on the west side of the quay, of 4.60 metres (15 feet) at low tide, and on the other side, above the bridge, 3 metres (nearly 10 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 quay.
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, as it occasions loss of time and additional Cost, and naturally induces unfavorable Comments upon the port facilities.

São Paulo Railway Pier.

The Railway Company, about the time their road was opened, in 1867, built an iron pier, decked with timber and plank, at the upper part of the harbor, and extended their track (1.60 metre (5 feet 3 inches) 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 draught.

The second, or "new pier," was finished and

opened to use, during the present season.
It is a substantial structure, supported upon Cast-iron hollow screw-columns sunk through the mud deposit to a good foundation in the sand. The depths through which the columns were sunk in the sediment varied from 8 to 16 metres (26 to 52 feet). The end columns, which are the longest, are about 17½ metres (57 feet) in length.
This pier has a wrought-iron girder superstructure, decked with Creosoted plank.
It is 112.50 metres (369 feet) long, and 13 metres (42½ feet) wide. There are four rows of Columns, at intervals of 9 metres (29½ feet). 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, (15¾ feet); and 0.8 metre (2.60 feet) at the land end. On the inside of the pier, the depth at low tide is from 4 metres (13 feet) to 3 metres (about 10 feet).

Both of these piers are almost Constantly in use; Chiefly for unloading Coal, iron and steel rails, locomotives, engines, Cars, heavy machinery, general railway plant, and various articles not required to pass through the Custom House, destined for the interior by rail; as well as for loading articles from the interior; almost the entire business being in Connection the São Paulo Railway.

These piers therefore add materially to the harbor Conveniences of Santos.

The new pier 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 lines of Columns 9 metres (29½ 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 is then practically the same as if the pier were solid.

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 productive 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 proper to bear in mind that the São Paulo Railway traffic, means, the Commerce of Santos, of both imports and exports. This is the only railway from this port to the interior; and the old system of mule 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$000.

Tramroads.

There are two tramroads in Santos. The Company, "Melhoramento da Cidade de Santos", laid a line 0.80 metre (2.62 feet) gauge from the Railway Station, above the upper end of the harbor, partly along the river 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 "Barra", a distance of about 5½ kilometers — about 3½ miles. This tramroad is

will useful in transfering to some extent the Carriage of Coffee and other articles from Carts to the over high paving to the tramway Cars.

Neither the carts or the Cars are allowed on the Jetties, already mentioned; they are obliged to stop, on the wharves, whence the Coffee, etc, are carried to the vessels on the heads or shoulders of men. These men labor hard, and do their work with energy; but the system involves a tax upon the producer, and upon the vessel, 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$000 ($58.800). This saving, on a single item of export, in a single year, (1878), is about 6 per cent on the estimated Cost of the permanent improvement of the harbor. Direct railway Connection between the railway station and the points of loading and unloading, will effect a saving more than equivalent to the interest upon the Cost of the proposed improvement.)

A second tramroad was laid by Messrs "Emerich & Abeas", having a gauge of 1.35 metre (4 feet 5 inches) from a more central part of Santos, extending across the island to the ancient town of San Vicente. It passes through a street 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 metre (5 feet 3 inches) should extend along the City front to the Alfandega, and also out upon the piers.

Trade 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 quantities 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 27,000 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 127 per cent.

The total tonnage, including Coffee, Cotton, Salt, Sugar and Sundries, was, in 1867-68, 58.245 tons; and in 1877-78, 135,850 tons; or a general increase of 133 per cent.

One item, Cotton, decreased, from 6,824 tons in 1867-68, to 585 tons in 1877-78; yet notwithstanding this decrease of this one article, the aggregate increase was as above given.

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

The number of Vessels which entered the port of Santos, during the year from January 1st 1878 to January 1st 1879, was 461, of which 125 were foreign steamers, and 129 steamers of the Country. The particulars of all the Vessels were kindly furnished by Ill.mo Snr. Manoel Antonio de Lima Vieira, Major Commandante at Fort Barra Grande, and are given in Table ( ) in the Appendix.

During the 5 months, from January to May,

both inclusive, there arrived at this 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 Illmo Senr. F. 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 Volumes and number of Kilogrammes of foreign articles imported that paid 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 ~~Rs~~ 20,800:303$460 in 1877-78 they amounted to Rs 29,887:257$305. The number of Volumes received in 1868-69 was 3,589, and in 1877-78, 6,916.

The number of Kilogrammes received in 1868-69 was 153.540, and 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 improvements of the port; much more if it be made attractive by adequate Conveniences.

The Railway System of the Province of São Paulo – Its 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 Jundiahy in 1867, and accepted by the government August 1st, 1868. It is 139.2 Kilometers (86 miles) long, and cost ~~Rs~~ 23,555:000$000 ($11,777.500) being at the rate of Rs 169:216$000 pr 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, ~~pari passu~~ along 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 improved facilities of transportation thus afforded, have been cultivated to a much greater extent than they could have been without the railways.

It is almost certain that but for the extension of this modern means of transporting bulky agricultural products, the culture of coffee, etc, in the province of São Paulo, for ocean shipment, must have been circumscribed within narrow limits, and the proper settlement of its back country greatly retarded, if not entirely checked.

Transportation—
Its importance in Connection with Seaports.

Transportation, from time immemorial, has been a Controlling 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 upon 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 of it may be settled and cultivated, wherever the soil admits of Cultivation. Important, however, as railways are, they should not be regarded as superseding navigable water Channels. When judiciously arranged these become mutual adjuncts.

When are the main trunk lines of Brazil shall have been Constructed, there will still be numerous minor railways needed to connect them with the rivers of the empire, if, meanwhile, these great water-courses shall 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 States and territories.

The seaports of the world are the points between which most of the international exchanges are made; therefore every facility added, every obstruction removed, of whatever nature it may be, between the interior producing region and the port of shipment is a direct saving to the Country, and therefore a national benefit. Whether this saving be effected in the interior, on the

mete, 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 exorbitant Charges on railways for the Carriage of freight and passengers, Constitute an artificial Obstruction, as real and a important as any other; and while, if carried to excess, may be even more potent than any physical obstruction now existing. In the United States, Competition has remedied this difficulty. This point will doubtless 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 surveys, etc, with the view to its improvement, thus determine 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 Continue; 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 undertakeing their Construction, without a guarantee of interest by the government.

Consideration of different Plans

Earth Filling - a part of any plan.

Any plan that omits a radical remedy for the mud-flats nuisance, would be imperfect. Fortunately, the remedy is simple; namely, filling on the flats with good material out to or beyond low-water mark, carrying the sewerage, etc, by pipes or Culverts through the embankments thus made, and delivering the same below high-tide.

Upon the completion of proper works the sewers will discharge into a strong river current, instead of trickling out upon the mud and eddies along shore, as they do at present, and the offensive matter will be at once lost in the large volume of morning waters.

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

A solid Stone outer Quay — Not advisable.

Such a work has heretofore 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 inner 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. We therefore not recommended.

Drawbridges — to be avoided.

Plans have heretofore 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, could scarcely 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 to be improved is of limited extent; though, with proper arrangements, it will 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 785 metres (2574ft), about half a mile. In front of this, and for some distance above the railway piers, there is a good depth in the Channel of the river.

Between the shore 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 Alfandega quay, gradually widening toward the upper part of the harbor in the neighborhood of the railway piers.

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 river shore and wharves are but little above the level of high tide; generally about One metre, or less than two metres; and irregular.

The tidal rise is Commonly 1.60 metres (5¼ ft.) though sometimes it is 2 metres (6½ feet). The range between extreme low tide and extreme high tide, during our tidal observations this season, was 2,34 metres, (7.70 feet).

The ~~ordinary~~ stronger currents in the river surface, when free from fluvial freshets are 0.33 metre (1.08 ft.) per second on the flood tide, and 0.61 metre (2. ft.) per second on the ebb tide. The average, as already stated, being 0.26 metre on the flood, and 0.49 metre on the ebb.

When there is a freshet in the stream, caused by heavy rains on the Serra, the ebb current

is considerably stronger, while the rate of the flood current is reduced. The winds also affect the currents considerably at times. The current is never strong enough to occasion serious trouble to the shipping; so that vessels can be comfortably at anchor in the Channel, or lie quietly when secured to the quay or the piers.

Owing to the insufficient depth at the ends of the present temporary piers, it is a common thing for vessels to be partly imbedded 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 outer vessel. Such vessels are not however always in port to be hired; and there is no regular lighterage system.

From the foregoing statement of the circumstances, it will be seen that the predominating cause of the inconvenient harbor arrangements is the extensive, deep mass of sediment lying between the City front and the river Channel.

The Channel of 7½ metres (24 ft) depth at

low tide, is of limited width, so that long piers, extending out from the shore, arranged for vessels to lie alongside, 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.

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General Plan of Improvement.

The circumstances indicate a general plan of open quays or piers resting upon iron 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 mound 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 metres (16.4 feet) 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 iron pier heads are to be built, in deeper water; so that with a moderate amount of dredging a depth of

6¾ metres (22 feet) at low tide, can be had.

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

Each pier head to be 25 metres (82 feet) long, and 12½ Metres (41 feet) wide, Connected with the inner quay by an iron bridge about 9 metres span.

These pier-heads will Consist of wrought-iron superstructures supported upon hollow, Cylendrical Cast-iron screw 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 metres (246 feet), and between the bridges, wide, 87½ Metres (287 feet).

In view of the number of long vessels now visiting this port, and of the general increase in the length of steamers, the number of pier-heads (7) is deemed to be ample. It might be considered advisable, if any Change in the number be made, to reduce it to six, thus 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 of course much smaller than the largest Class of Steamers.

Plan B.

A modification of plan A is to leave out the lower T-Head pier, and increase the length of the Alfandega quay, adding 64 metres (210 feet) and 75 metres (246 feet), 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 near the Alfandega will be curved, as shown in the drawing marked B, and the space between the Alfandega quay, as enlarged, and the proposed inner quay is to be dredged, so that vessels can lie in both sides of the Alfandega quay, and also at the inner quay.

The open water space between the upper end of the New Alfandega quay when extended, and the nearest pier-head, will be 100 metres (328 feet). It may be found unnecessary to extend the Alfandega quay at once to the full length indicated, thus leaving the water space still longer. *

Plan C

A substitute for the T-Head Piers is represented on the plan marked C,

This plan would shut out nearly all vessels from the indicated inner quay. In fact, an inner quay would be almost useless; for, even small

* On account of the additional shipping room to be created in the immediate vicinity of the New Alfandega, the modification as presented in the drawing marked B, is desirable.

boats could not approach the inner quay at high tide, expecting at the open space near the Alexandra quay. At low tide they might pass under the iron superstructure of the quay. The arrangement would be inconvenient.

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

Estimated Cost of Plan A. Rs 1,658:4724575

" " " " B. Rs 1,741:3764580

" " " " C. Rs 2.128:0914700

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.

Under satisfactory 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, it is believed, may Constitute a Considerable per Centage of the total Cost. Its value will depend largely upon the manner in which it may be improved, and ~~used~~ utilized

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 to each end of the Commercial front, 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 close together 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 in order to cover the mud-flat as soon as possible. Some of this filling may be done with carts.

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

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

* Foot Note.
As a saving in time and cost, it may be found advantageous to sink Masonry Wells, or Cones as a foundation for the nip-rap and to ensure mud-square settlement.

rip-rap mound, though allowing a portion of the earth filling to be carried in along with the inside of the rip-rap.

The outer 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 wall may be laid.

When the slope wall is finished, the vertical wall can be built, and coped with stone, forming the top angle of the inner quay.

7. Provision 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 required for their framing and erection.

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

9. One dredging machine at least should be provided. One should be in hand in an early stage of the operations. Experience will determine this.

10. 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 shown a priori.

~~10~~. Nun of the foregoing is applicable to each of the three plans presented.

10 After the embankments shall have sufficiently settled, the sewers, from Certain streets of the City, are to be laid across under them in ditches to be excavated for that purpose, and arranged with outlets passing 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 pier railways, are 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 the low grounds opposite their Station, upon some plan approved by the government, so that the whole, when finished, shall present a handsome and Commodious ~~Park~~ front.

~~General Observations.~~

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 interested, to have an understanding that the Concessionaires should have the privilege of suggesting modifications respecting plans and detail methods of doing the work, which, after approval by the government, might be adopted.

At the office of the "Commission", in Santos, every facility was 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, who kindly offered their rooms for that purpose, and members of the Camara, and other Citizens were invited to examine and express their views. The general opinion seemed to favor the T. Head Pier plans.

The people of Santos being specially and deeply interested in the Sanitary and Commercial improvement of their Port and City, their opinions and advice were regarded by the Commission as

entitled to the fullest consideration.

The plan of a Continuous outer iron quay.

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 very much less shipping room; and, on account of the much greater area of perishable surface, of decking, and of iron 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 combine least cost with the greatest amount of commercial accommodation, ~~This general plan is considered best~~ and it is well adapted to ~~xxxx~~ the circumstances of the port. *

The plan, marked B, is ~~thus~~ a modification of the proposed general plan, in order to make the most advantageous use of the present arrangements of the Alfandega quay, bridges, and buildings. ~~While it adds~~ If the Alfandega quay be extended to the full length shown in the drawing it will add about 83:000$000 to the cost, it will materially increase the commercial facilities in the immediate neighborhood of the Alfandega.

In case the plan of extending the

* The long, deep-draught steamers and heavy ships can load and unload at the outer pier-heads, while vessels of more moderate draught can at the same time load and unload at the inner quay.

Alfandega quay and leaving out one T-Head
as shown on the drawing marked B
Pier, should be approved, it might not be necess-
ary, ~~xxxxxxx~~, to extend it to the full length shown
It can be arranged so as to cost somewhat less than the amount
in the drawing. The question of the extent
In case the general plan marked B, and in detail, referred
and particular method, of remodelling the
present Alfandega wooden quay ~~xxxxxxxxxxxxxx~~ might
be left to be arranged when the mode of ~~xxxx~~ securing
~~certain for some time in abeyance.~~
the Construction of the improvement should be fixed.
~~xxxxxx xxxxx~~ The residue of the works, including
the inner quay and
the Six piers, could be put under ~~xxx xxxxxxx~~ of Construction.

~~with~~ the inner quay completed, the erection of
if it should be advisable
some of the T-Head piers could be deferred, with-
out serious detriment, for a time. It is not in-
tended by these statements to advise delay, in any
portion of the proposed improvement, but merely to
show what can be done, if needful.

The present is a favorable time to do the work.

Intelligent gentlemen who are familiar
with the Port of Santos and the Province of São
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 Con-
cessionaires to collect a ~~xxxxxxx~~ annual income
to be derived from port Charges, and from the Control
of the new ground to be created by the works, and the
right to erect buildings thereon.

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already instilled life and animation, creating active and improved industries in the interior where before there was Comparative stagnation.
Undoubtedly, it is to the vigorous prosecution of this railway system that the large and rapid increase of the Commerce of Santos is due; and, in the future, if this system should be wisely Conducted 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 hoped that the railway Systems of Brazil having their termini at Sea-Coast Cities, will not be brought to a Stand-still by high rates for transportation. With moderate Charges, these lines may be gradually extended farther 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.

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The annual receipts at this port, from Customs, are now Considerably more than the entire Cost of the proposed improvement; 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 Conspired 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 alone should equal the Cost of the improvement. With a Convenient, safe and healthy 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.

A glance at the future.

The province of São 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 Commerce 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, thermometrical and barometrical observations, Commerce of the port, etc, which could not conveniently be embodied in the text.

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

The Commission is under many obligations to a number 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. Laurindo Abelardo de Brito, M.D. President of the Province of São Paulo.

José Coelho Netto Capitão de fragata
Secretario da Camara Joaquim Pereira Moraes