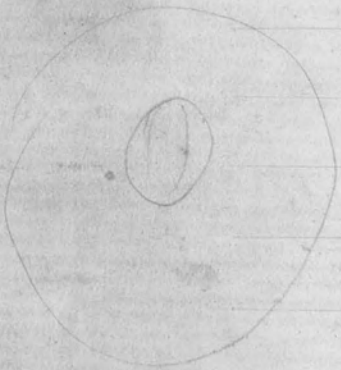


Pernambuco

7 Pages English.  
8 Page Portuguese translation.  
The translation must be revised.  
W.M.R.

Introductory

Discourse - Relating to Pernambuco.



The translation of the within  
pages of English to be revised.

## Introductory - Relating to Pernambuco

I have made myself somewhat familiar with the reports and plans proposed by the engineers who have hitherto examined the Port of Pernambuco, and I will have occasion to refer to some of their suggested improvements; but as these documents are all in the possession of the Government, I need not attempt to recapitulate their voluminous details. These numerous surveys extend from 1815 to 1875, a period of sixty years.

The latest elaborate report, that of Sir John Hawkshaw, the distinguished English engineer, dated in 1875, contains an admirable synopsis of the previous examinations and discussions of the various plans of other engineers, which, even in its condensed form occupies ten pages.

Without repeating all the details of this Synopsis, it may be well, for convenient reference, to mention them, briefly, <sup>for more particulars,</sup> referring, <sup>whenever</sup> to Sir John Hawkshaw's full report, <sup>in</sup> giving them, under the heading

### "Plans that have been suggested."

<u>Date</u>	<u>Remarks.</u>
1815	Commission. Repaired breaches in the wall, etc.
1819	The Barão Cacapava (General Andree) proposed to raise the reef and block up the southern end of the harbor. About this time the lighthouse was built. And General Juge de Brito proposed a scheme.
1838	M. Boyer, a French engineer proposed to dredge the shoals, canalize the river, and build quays.
1845	M. L. L. Vauthier, an eminent French engineer proposed two alternative projects - anchorage, and a floating <sup>basin</sup> .
1846	Brigadier Moraes Andree proposed to raise the reef, build a wall from the reef to the Ilha do Noqueira, and dredge the channels.

Date

- 1848 A Commission was appointed, consisting of  
Sr. Rodrigo J. de Freitas,  
Eliciano A. dos Santos,  
José Mamede A. Ferreira.  
Who made an elaborate survey and report.
- 1854 Mr. Charles Neate visited the harbor and reported  
plans, etc. to the government. Mr. Neate's report  
was submitted to Col. Oliveira who reported against it.
- 1856 Messrs. Law & Blount proposed a scheme for a dock,  
canalizing the river, and making a cut for both <sup>rivers.</sup>
- 1857 Mr. Peniston, engineer to the Recife and São Fran-  
cisco Railway proposed six improvements - inclu-  
ding dragging the Brequede Shoal, raising the  
leef, quays, and canalizing the Capiberibe river.  
This scheme was reported upon unfavorably by  
Mr. Neate.
- 1859 Mr. Henry Law reported twice to the President of the  
Municipality of Pernambuco.
- " Mr. Lowden proposed seven improvements, inclu-  
ding raising the reef to the South side of the Barra  
Grande, a cut through the isthmus of Olinda, <sup>etc.</sup>
- 1859-60 A Commission was appointed, consisting of  
Admiral Rodrigo de Freitas,  
Colonel Gomez Jardim,  
Lieut.-Colonel Raposo.  
This Commission made nine recommendations.
- 1860 Mr. W. Martineau <sup>wrote</sup> unto the Minister of Marine  
giving the results of a somewhat informal conver-  
sation with Mr. Bidder, an English engineer  
of eminence, who made four recommendations.
- 1861 N. E. Liais, an eminent French astronomer,  
published a plan and report. N. E. Liais pro-  
poses to let the rivers into the sea without letting  
them pass through the port, thus converting the  
present harbor into a tidal basin, etc.

- Date
- 1861 Mr. Law made two alternative proposals and <sup>tenders.</sup>
- 1862 Mr. Charles Neate, in conjunction with Mr. C. B. Lane proposed a plan and made an estimate. His estimate amounted to 11,600:000 \$000
- 1863 Sir John Hawkshaw reported on the preceding schemes, and showed on a plan, based on the statements, that had been made to him, the works he recommended.
- 1864 Dr. Gabaglia gave his opinion against Mr. Neate's <sup>scheme.</sup>
- 1865 Dr. Barros Barreto published a pamphlet discussing previous plans, and proposing a plan of his own. His plan agrees with Mr. Neate's in proposing a Cut at Fort Drum, but he places his dock in the Ribeira in front of the Caes do Appollo and Fort Drum. His estimate is 11,000:000 \$000 (£1,100,000) This included a new Custom house and Warehouses.
- " About this time Mr. de Mornay proposed a scheme, but afterwards agreed to support Messrs. Neate and Lane's.
- 1867 Councillor Manoel da Cunha Galvão published some remarks on the improvement of the harbor; and in conjunction with the Barão de Mauá, Dr. Muniz Barreto, and others, proposed carrying out Messrs. Neate and Lane's plan, which had already been approved by the Imperial Government.
- 1869 Mr. Mann, Superintendent of the Recife and São Francisco Railway, reported that he approved of the additional facilities given to the Recife and São Francisco Railway by Messrs. Neate and Lane.
- 1870 Ubu published the Carefully Compiled, but somewhat voluminous "Studies" of Dr. Raphael Archanjo Galvão. Dr. Galvão discussed previous projects; and presented twelve recommendations, with an estimated Cost of 14,200:000 \$000 (£1,420,000)

Date

1871

Dr. Pereira Passos, Councillor of the Ministry of Agriculture, advised the entire adoption of Dr. Galvão's project, as also did a Commission presided over by the Barão de Angra.

" About this time there was a controversy between Messrs. Neato and Dr. Galvão, the latter propounding certain questions which chiefly affected Mr. Neato's proposed cut at Fort Brum.

1873

Sir John Hawkshaw made another report as requested by the Government, in which he considered these questions of Dr. Galvão.

" In the same year "Cinzelho Nard" discussed and compared the schemes of Mr. Neato and Dr. Galvão, and finally reported in favor of the latter.

1874

Sir John Hawkshaw was requested to visit Brazil and to report on this and other harbors after personal inspection.

" During that year M. Victor Fournié, Director of Public Works in the Province of Pernambuco, published "an extremely clear and thoughtful study of "The Works" necessary for the development of the Port of Pernambuco."\*

Some of the suggestions of M. Fournié will be considered in the body of this report.

It is proper to mention that since the date of Sir John Hawkshaw's report (July 15, 1873) the government has done considerable work in repairing and building walls on the reef and a large amount of dredging in the harbor or Mosqueiro, ~~at~~ in the Beberibe river.

\* Étude sur les travaux nécessaires au développement du Port de Pernambuco - Par Victor Fournié; Paris 1874.

in a part of the Passarintos, which has deepened the water over a considerable area; so that <sup>many</sup> vessels can now load and unload more conveniently than formerly near the Custom House quays.

From the foregoing list it is evident that there has been no lack of investigations, or of propositions designed to improve this port; although the work <sup>actually</sup> accomplished, and undertaken, has been of comparatively small amount. It has been chiefly, raising and repairing walls on the reef, building quays, upon shallow foundations, and dredging.

The works recommended by Sir John Hawkshaw were as follows:

- I. "Quay 600 metres long, from the Custom House to the Marini Arsenal, including dredging Channel in front of this quay about 180 metres wide to a depth of 7 metres below low water spring tides, Estimated Cost £ 105,000
- II. "Quay at the "Caes do Collegio" with a causeway to the Recife and São Francisco Railway Station including dredging between this quay and the Custom <sup>House</sup>, £ 115,000
- III. Cleaning the Barra Grande, dredging where necessary in the Poco, dredging the Brequede Shoal and Channel up to the Southern end of the Arsenal to a depth of 6 metres below low water spring tides, £ 55,000

- IV. "Repairing and strengthening the wall on the reef and extending it to the point C. £40,000
- (Breakwater between the Barra do Picão and the Barra Grande, to be done if the breakwater AB is not done) £60,000
- V. Cut and wier South of Cinco Pontas £50,000
- " Culverts at Afogados £15,000
- VI. Breakwater AB £950,000

These recommendations will be considered in connection with the observations and calculations I have made, and according to the views formed after due consideration of the important questions involved.

Almost every point that can have a bearing upon the improvement of the Port of Pernambuco appears to have <sup>been</sup> studied by different engineers; although in regard to some of the suggestions, <sup>all of</sup> their consequences may not have <sup>been</sup> thoroughly developed.

Changing essentially the regimen of rivers, is one of the most delicate and difficult problems in hydraulics; so that ~~many of the suggestions~~ <sup>recommendations</sup> in that direction may <sup>properly</sup> call for a somewhat detailed investigation.

The position, and <sup>unusual</sup> the curvatures of the rivers discharging through the port, are quite peculiar. These rivers, or their lower basins, are beneficial, in connection with tidal movements; while their freshets are more or less injurious, in consequence of bringing

down and depositing large quantities of sediment. Whatever may be the quantity of sand brought into the port, <sup>through the entrances,</sup> by ocean tidal currents, by washing over the reef, or by the wind, it is almost certain that a larger amount comes down the rivers during their freshets; some of which is carried out through the port to sea, <sup>while</sup> some ~~is~~ is deposited in the rivers, and <sup>in</sup> the harbor, inside of the reef. On the river, above the tidal influence, <sup>which</sup> ~~the~~ extends to the distance of only a few kilometers, the movement of the sand is <sup>of course</sup> always down stream; and at every freshet it is picked up by the current and carried onward, partly in suspension, and partly along the bottom. ~~It~~ Mingling with the ocean water, which enters the harbor twice a day, the sand and muddy sediment partake of the gyrating movements naturally arising upon the meeting of opposing fresh and salt water currents. The results are traceable in the shoals that are formed and maintained in the lowermost parts of the rivers, in the harbor, and, on a large scale, in the Passar-intros. The removal or lessening of these shoals, where deep navigation is necessary, or very desirable, is not a simple problem. Merely "dredging", will in some cases answer for only a very brief period, unless it be done <sup>at places</sup> in view of the causes of the shoals; <sup>while</sup> ~~and~~ "cut-offs", may easily be productive of more harm than good; and <sup>therefore</sup> they should not be adopted without the most careful investigation of their probable effects, so far as experience and reason can discover them.

End of Introductory.

*There is no page 8 in this original text.*  
W. M. R.



To be translated

Report

Pernambuco

4 pages

General Description

J

# Pernambuco. Port

## General Description.

### Position.

The astronomical position of Pernambuco - or rather, of Olinda Point, the prominent land mark  $2\frac{1}{2}$  miles north of Pernambuco, is, Latitude  $8^{\circ} 0' 50''$  South, and Longitude  $34^{\circ} 50' 18''$  West from Greenwich.

### Ocean Approach

The trade wind is <sup>sure</sup> to be from some point between North North East and South South East; so that however the wind may change on approaching the Coast, it is still fair if approached from the East.

Pernambuco light-house is an octagonal tower built near to the north end of the reef which forms the port; it exhibits a revolving light that shows twice bright and once red with an interval of one minute between each of the brightest periods.

The light is visible from the sea a distance of 15 miles.

"English Bank", is a detached shoal three fourths of a mile long North and South, by one fourth of a mile wide; the surface is very <sup>uneven</sup> uneven and rocky.

The centre of the bank bears East North East, distant 1 mile from the light-house.

During fresh South-East winds, the sea breaks on the

(2)

Centre of this bank. Half a mile north east of the north end of the English Bank there is a rock on which the depth at low water is 17 feet. The general depth between and surrounding these shoals is 24 to 30 feet.

A rocky bank begins <sup>eastward</sup> abreast of the Village of Afogados,  $1\frac{1}{4}$  miles southward of the light-house; from thence it trends southward at a distance of  $1\frac{1}{2}$  miles from the shore. The depths on this bank vary between 12 and 24 feet; but on the edges there are many rocky heads from 6 to 10 feet below the surface. According to the Brazilian Charts of 1859, the outer edge of this bank is marked by the Picão Light-house in range with Fort Penaco bearing North by West.

Vessels intending to go into port should approach it with the Light-house bearing about West. This will keep them clear of and south of the English Bank. The variation is about  $12^{\circ}$  West.

### Anchorage in Roadsteads.

The Customary <sup>outer</sup> anchorage called "Lameirão," for vessels of war and merchant ships unable to cross the bar, is in 5 fathoms (30 feet) of water 1 mile south east of the Light-house. The best holding ground is in 6 fathoms, Picão Light-house bearing North West  $\frac{3}{4}$  West, and the remarkable tree of Olinda North  $\frac{1}{4}$  East; southward of this anchorage the bottom is rocky; and it is well to examine the lead

before letting go the anchor any where.  
 Another good berth is about midway between  
 the South buoy on English Bank and Picão  
 Light-house, called "Laminhas" anchorage. The  
 depth here is 26 fms, the light-house bearing West,  
 the remarkable tree on Olinda North by East. The  
 disadvantage of this anchorage, for sailing vessels, is  
 in the difficulty of weighing with safety and  
 Casting so as to Clear English Bank; the  
 advantage is in the much shorter distance  
 boats have to go to Communicate with the shore.  
 For steamers not drawing more than seven metres  
 (23 fms) this is sometimes very convenient.

Pernambuco must always be important,  
 (independently of its great Commercial business,) as the  
 Port of Call for Merchant Ships before proceeding  
 to the port of discharge, or for loading, in other  
 parts of the Coast.

Pilots are necessary, not only for entering the  
 Port, but for anchoring properly in the roadsteads.

It is high water, full and Change, at Pernam-  
 buco at 4° 45'. Spring tides rise about 8 feet, neaps  
 about 5 feet.

Entrances.

The harbor is formed and maintained by the  
 rocky reef which lies parallel to the shore at the distance  
 of 200 to 300 metres out; the top of which is about  
 level with high water spring tides.

There are two entrances, one for light craft,  
 through the Barra Picão, just north of the Light-house,  
 the other about 600 metres north of the light-house,  
 through the Barra Grande, which is much wider and

deeper, and is marked by buoys.  
 Between the Barra Picão and the Barra Grande there is a submerged reef, which during low tide forms some protection to the Póço anchorage inside; but in high tide the sea rolls heavily over it, at times, and the Póço Anchorage then has little protection from the Ocean swell. The Course of vessels after entering through the Barra Grande is nearly parallel with the line of the submerged reef, which appears to be a continuation, in line, of the Port reef; though it has less height.

The depth of the entrance through the Barra Grande is from  $7\frac{1}{2}$  to 8 metres, at low tide, and inside between the submerged reef and the sandy shore the depths of  $7\frac{1}{2}$  metres, <sup>and over</sup> continues for some distance, and between the Barra Grande entrance and the Picão entrance, the least depth of the Channel at low tide, <sup>near to the latter,</sup> is 6 metres.

Immediately south of the Picão entrance the Channel shoals to  $4\frac{1}{2}$  metres, and so continues through what is known as "Brequede Shoal". Below this shoal, in the port, it gradually increases in depth, and near the Public landing it is again 6 metres, at low tide; and it becomes deeper farther south, to the main anchorage or mooring place, opposite the Custom House, where it is from  $7\frac{1}{2}$  to 10 metres deep.

The Brequede Shoal, and nothing else, prevents the use of the Port of Pernambuco, <sup>even at high tide,</sup> by vessels drawing more than 6 metres; whereas if this shoal had a Channel cut through it as deep as the Channel now is both north and south of this shoal, vessels of  $1\frac{1}{2}$  metres (4.92 feet) greater draught <sup>and depart</sup> could enter, at high tide.

English. To be translated.

Report - Pages 5 to 12 inclusive.

Pernambuco.

2

Report  
upon the Port of  
Pernambuco.

After a Careful personal examination of the port, and of its Natural and artificial Conditions and Surroundings, it has seemed to me proper to present ~~to your Excellency~~, in some detail, the reasons for the Conclusions arrived at.

Unquestionably, the position of the Port of Pernambuco, near the most easterly projection of the Continent, within eight degrees of the equator, is remarkably favorable for Convenient Commerce with Europe, Asia, Africa and North America, as well as with all ports in Brazil.

Its superior Commercial situation and advantages have been well described by many Competent writers, among whom are M. Ernest Mouchez, Captain in the French Navy, M. Victor Fournie, formerly Director of Public Works in the Province of Pernambuco, D.<sup>o</sup> de Barros Barreto, Civil Engineer, of Brazil, Sir John Hawkshaw, the distinguished English engineer, Commander Goringe of the United States Navy, and others.

Besides, the port of Pernambuco is probably as well known to Commercial Nations as almost any of the great shipping ports of the world.

Its rank, among ocean ports, as to harbor

facilities, was once relatively higher than it is now, simply because, while the general draught of ocean ships during the former Century has been greatly increased, the depths of this port, <sup>at least of</sup> ~~and~~ its entrance, remains about the same as before.

In former days nearly all of the vessels trading to Brazil could enter this port, without being compelled, on account of their draught, to anchor outside. Vessels drawing five and a half metres (18 feet) or over, were then as rare as vessels drawing seven and a half metres (24.6 feet) or over, are now.

Vessels drawing five and a half metres, and even six metres now enter the port; but heavy draught ships and many large steamers cannot enter.

Formerly, all the loading and unloading of vessels was done by lighters; now, a considerable portion is done at the Custom House and other quays; though, ~~considerable~~ <sup>the</sup> ~~valuable~~ <sup>the</sup> ~~products~~ <sup>the</sup> brought by water in the ~~Bay~~ <sup>Basacas</sup>, can be more conveniently transferred to vessels without using the quays.

The port, proper, ~~the Mosqueiro~~ has not deteriorated in any respect. On the contrary, it has been improved, by the government; having the same width and a greater depth. Vessels drawing six metres (19.68 feet) entering at high tide, can lie moored, or anchored in the Mosqueiro, safely; at low tide, in from seven to nine metres depth, in the Channel near the reef.

On the Pregueda Shoal, just inside, opposite the light-house and the old fort on the reef, the depth at low tide is only about four and a half



metres (about 15 feet) and at Spring tides, high water, six and eight tenths metres, (22.3 feet).

Unfortunately, the deep water in the port is of contracted width, preventing long ships of much draught from turning.

Of late years the dimensions of vessels, both in length and draught, have been greatly increased; though the number of long, deep vessels, compared with the entire number of Ocean vessels, is not yet very great; and this fact should not be overlooked.

It is therefore not the port of Pernambuco that has become less commodious than formerly, but that a demand has arisen for greater harbor depths, on account of the increased dimensions of modern ships.

The harbor, etc

The remarkable sandstone reef which forms and at the same time protects the port, stands, scarcely if at all seriously injured by the Ocean waves which ceaselessly beat against this grand natural breakwater.

More than two centuries ago the Hollandaise added some ~~works~~ <sup>wall</sup> upon a portion of this reef south of the ancient <sup>Dutch</sup> fort, and in recent years the Brazilian Government has raised and strengthened the top with brick-work, between the fort and the light house, and ~~also~~ north of the light house to the edge of the Picão Channel entrance; and also at points some distance south of the old fort.

This reef seems to require only a comparatively

small annual expenditure for repairs to maintain it intact in the future. There are, however, times at high spring tides, assisted by strong South East winds, when the sea breaks over the reef and causes considerable commotion in the harbor, but generally, it is a perfect protection against the swell from the ocean.

Upon most of its length the reef is very broad, from twenty to sixty or more metres, including the outside rocks upon which the sea first breaks.

Boring's made under the direction of Sir John Hautskaw, in 1874, show that the rock where it was examined, is from three to four metres in thickness, resting upon a bed of sand, shells, clay, etc, similar to the material found in other borings in the bed of the harbor.

The top is quite flat, and of regular height, not far <sup>above</sup> ~~from~~ the general level of ~~high~~ spring tides.

The raising of this reef, somewhat, is certainly a deniable thing; but this, <sup>is</sup> by no means a primary need of the port; because during a large portion of the time it is a sufficient protection.

The primary needs of the port are: greater depth over the Brequede Shoal, greater depth <sup>of the Shoal,</sup> inside ~~near~~ the quays, and a larger area of deep water for ships.

An outside, protected roadstead, or safe Outer harbor, <sup>regarded by some as</sup> is also a want; but this should be treated as a separate measure; especially as it obviously involves a very large expenditure to construct and maintain a Commodious outside harbor, <sup>by means of a breakwater built</sup> in from nine to <sup>ten</sup> ~~seven~~ metres depth, exposed to the unobstructed sweep of the <sup>Ocean.</sup> ~~off shore.~~

(though very rarely)

In heavy gales from the South East, at times, the Outer roadsteads of the Lameirão, and the nearer, Lamenhas, become unsafe; especially for sailing vessels; but as a rule, vessels remain safely at anchor; though the communication with the shore is exceedingly inconvenient, and loading and unloading with lighters cannot always take place, on account of the sea.\* [high waves.]

<sup>imposed so</sup> In case the inner harbor depth should be <sup>as to</sup> conveniently <sup>admit</sup> vessels <sup>at low tide</sup> ~~accommodate~~ <sup>draining</sup> ~~seem to seem~~ <sup>and a half</sup> metres, the necessity for a costly Outer harbor will thus be materially lessened.

The outside breakwater projects have been particularly discussed and promoted by M. Tourne, Sir John <sup>Hawks</sup> ~~Hawthorn~~ and others; <sup>and will be again</sup> ~~subject will be considered.~~ <sup>referred to</sup>

### Some general Considerations.

There has been a large amount of surveying in connection with this port, and numerous projects have been promoted during the past fifty years, looking to ~~the~~ <sup>its</sup> improvement; yet comparatively little work <sup>has been</sup> ~~done~~ <sup>namely,</sup> some masonry for raising and forming the reef, and quay walls, founded only at very slight depths. Of late years, more particularly since 1874, a considerable amount of dredging has been done, with decidedly good effect; so that ~~now~~ <sup>dredging about</sup> vessels <sup>of considerable</sup> ~~draught~~ <sup>of</sup> five metres ~~or more~~ can now lie near the Custom House quays, both in the <sup>Port</sup> ~~Mosqueiro~~, and along the river frontage, where they would

\* I conclude that the roadsteads of Pernambuco, compared with ocean roadsteads generally, are remarkable safe; but it is unreasonable to compare these roadsteads with harbors.

and unload, without being obliged to use lighters; though ~~lighters~~ <sup>lighters</sup> are sometimes in part employed.

Lightering is still largely used in loading and unloading cargoes of vessels that are not moored near the quays.

Dredging of the harbor has been carried on under the direction of Dr. Feitosa, Director of the Port works, chiefly with two dragages, each <sup>said to</sup> have a capacity of 2400 tons per day; though they have not been worked beyond ~~more than~~ about 900 tons per day each.

Conducable areas in the Mosqueiro, as well as in the river, and in front of the Custom House point, <sup>thus</sup> have been deepened by dredging since 1874.

For some time past one of the dragages has been engaged dredging a channel of 4 metres depth below low water, in a direction towards the station of the Recife and São Francisco Railway, on the western side of the Passarinhos. ~~This will be more particularly referred to in another place.~~

Nothing has yet been done to deepen the water across the Breque de Shoal; so that it remains nearly the same as it was at the period of Sir John Hawkshaw's examination, in 1874.

Dr. Feitosa has kindly furnished me with a statement of the quantity dredged in the harbor each month since November, 1874; showing a total of 1,276,692 tons, dredged to the end of September, 1880, representing an average of 17,980 tons per month. A new drage, built under the direction of Dr. Feitosa, in Pernambuco, by the Government, has during my stay here, been tested, and found to work well. It

however  
is much smaller, having a capacity of one third of  
one of the others. It is now at work on the Peberle  
river, above the bridges.

The entrances at Barra Grande, and Barra  
Picão appear to remain without perceptible change,  
~~while~~ <sup>while</sup> the Pregueda Shoal seems to be normally  
maintained by the tides, the winds and the river  
freshets.

The six metre line, (below low tide,) inside of the  
submerged reef, north of the light house, between the  
Barra Grande and the Barra Picão, now ex-  
tends southward to opposite the Tartaruga rock, in  
the Barra Picão; the depths gradually increasing <sup>northward</sup> to  
4, 4½ and <sup>evenly</sup> 8 metres at the Barra Grande entrance.

In the port, beginning with 4.6 <sup>m</sup> on the Pregueda  
Shoal, the depth of the Channel gradually increases,  
till at the distance of eight hundred metres from the  
light house the six metre line again appears; thence  
it gradually increases to ten metres, not far out from  
the reef; the reef being nearly all the way steep on the  
harbor side, while it runs out with a flat slope on  
the Ocean side. This outside flat slope is a very valuable feature.

On the City side of the port, it is <sup>quite</sup> ~~comparatively~~  
shallow at low tide; excepting in front of the Arsenal,  
and where it has been recently dredged opposite the  
"Associação Commercial" building, and around the Custom-  
House quays.

The stone quays of the port, and in the river, having  
only a very shallow foundation, the dredging had to be  
stopped at some distance outside ~~of the~~ to prevent  
undermining and destroying them.

The booms, ~~already mentioned~~ made in  
different parts of the harbor in <sup>by Sir John Hawkshaw,</sup> 1874, show, throughout,

that the material to be excavated to obtain the additional depth consists of sand, shells, mud and clay of several colors, some mottled, and some yellow, etc.

These borings twenty seven in number, penetrated in one place 16 metres below low tide, in two other places 14 metres, and generally over 9 metres; so that it is proven that the material is not difficult to dredge. There is nothing to prevent nearly the entire port from having a depth of seven, or even of seven and a half metres below low tide (24.6 feet), and 9.7 metres (31.81 feet) at high water spring tides; it is merely a question of cost of dredging. At some future period this may be accomplished; but it is not proposed to undertake so much at present.

At the Brequede Shoal, where, on a width of 300 metres, the average depth is now less than 4 metres, the present cross section at low tide is nearly 1200 square metres; but if it were dredged to the depth of 7 metres, it would be 2100 square metres, or seventy five per cent. more.

When dredging for the improvement of this northerly part of the port, it will be advisable, at first, to dredge only a comparatively narrow channel - say 50 metres wide, <sup>6 metres depth,</sup> through the Brequede Shoal, continuing the same southward to the present 6 metre depth in the port.

With such a channel vessels drawing nearly 6 metres (19.66 feet) could enter and depart at low tide; and vessels of full draught <sup>7 metres,</sup> (22.96 feet) could <sup>easily</sup> enter and depart at high tide.

Pages 13 to 25 Inclusive

Draging - (13 pages) de Shoal.

English Copy - To be translated.

Draging - and Breque de Shoal

2  
Do.

## Concerning Dredging, etc.

After a careful examination of the present actual circumstances, and a study of the various plans of improvements proposed, one conclusion seems to be inevitable, namely, that dredging is the most important factor in the further amelioration and improvement of the port.

The principal need, <sup>as already mentioned,</sup> is greater depth, extended over a larger area; which can only be obtained by dredging.

With a general harbor depth at low tide of 7 metres (23 feet), at medium tide of 7.75 metres (25.4 ft), and at ordinary high tide of 8.5 metres (27.6 feet), the port of Pernambuco would take rank as one of the best among the good ocean harbors.

With this depth secured inside, the necessity for an additional harbor outside would scarcely exist; since only a few, of the hundreds of vessels yearly visiting Pernambuco, would then be obliged to remain outside. It is much cheaper to make additional harbor room inside of the submerged reef than it would be to make it outside by means of breakwaters.

Probably the most economical mode of dredging on a large scale would be to receive proposals from firms of experience, and contract to have it done by the cubic metre of space excavated. That is, paying for the deepening actually effected; and depositing the material so that it could not get back into the port.



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The manner of dredging will be more particularly referred to further on.

I endeavored to ascertain from Comparisons of numerous soundings which have been taken and recorded by the Director of the Port works at intervals since the date of those made under the direction of Sir John Hawkshaw, in 1874, and from new soundings made under my direction, in 1880, what changes have taken place in the depths of different parts of the harbor.

From these soundings it appears that the approximate average depth of the port is greater now than it was in 1874, as follows:

Beginning opposite the present northern end of the Quay, about 325 metres below the Light-house, and thence southward to the Public Landing, a distance of about 700 metres, the average width is 248 metres. Over this area of 173,600 square metres, the depth appears to have been increased  $0^m.93$ . Thence to Custom House Point, a distance of 525 metres, having an average width of <sup>and an area of 105,000 square metres,</sup> 200 metres, the depth appears to have been increased  $1^m.01$ . On the circular area fronting the Custom House, covering about  $\frac{1}{3}$ , 500 square metres, the average depth appears to have been increased  $1\frac{1}{3}$  metre. Between this part of the port and the Reef Bridge, a distance of 290 metres, with an average width of 200 metres and an area of 58,000 square metres, the average depth appears to have <sup>been</sup> increased  $1^m.20$ .

What proportion of the increased average depth is due to dredging, and what to the natural scour

15.

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of the tidal and river currents there are no means of knowing; for there has been an increase of depth in places where no dredging was done.

Around the Curving part of the Custom House frontage the depth not far out from the wharf has been considerably increased, so that vessels drawing five metres (16 1/2 feet) can now approach near enough to load and unload by the use of long, movable platforms.

While dredging was going on in the port in front of the Quay, it became necessary to stop it some distance outside of the walls and buildings to avoid undermining them, as they all have very shallow foundations - <sup>being</sup> about the level of low tide. If it were designed to dredge to the depth of six metres at the Quay, these walls would have to be entirely rebuilt after being founded six to seven metres lower; or, new walls of similar <sup>extra</sup> depth would have to be built in front of the present Quay; or, the present Quay would have to be rendered secure by an extensive system of deep piling in front of them. The most economical plan would be to stop the deep dredging a certain distance outside of the Quay and extend short piers <sup>from the Quay,</sup> at intervals, at the ends of which vessels drawing six metres could lie safely at low tide. This last suggestion will be referred to more particularly in its proper place.

The Director of the works of the Port, Dr. Feitza, furnished me with a statement of the amount of material dredged monthly, from November, 1874, to September, 1880, inclusive. The quantities yearly, are stated as follows:

Year	Period	Tons
1874	Two months, Nov. + Dec.	49,920
1875		248,092
1876		148,815
1877		269,650
1878		200,111
1879		221,370
1880	First nine months.	138,434
Total		1,276,692 Tons.

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The material dredged is chiefly sand mixed some-  
times with mud, and a little clay. The bulk  
of the material is discharged directly into the hoppers  
of the steamers which convey it through the port,  
and outside of the reef to a place nearly op-  
posite the obstructed entrance "Barra da  
Antigua" or "das Jangadas", where, at the distance  
of about four hundred metres from the reef, it is  
dumped into the sea.

There are <sup>dredgers and two</sup> two steamers, so that when both dredges  
are working at the same time, which however seems to  
have been a rare occurrence, and each steamer ma-  
king three trips daily, carrying three hundred tons per  
trip, there would <sup>be</sup> nine hundred tons to each, or  
eighteen hundred tons in all. During my examinations  
at this port there was only one steamer running, and some-  
times both dredges were disabled and no dredging  
going on. The dredges have required a large amount  
of repairing, occasioning great loss of time, and of  
course additional expense.

It takes  $1\frac{1}{2}$  hours to load one steamer, and  $1\frac{1}{4}$   
hours for the trip outward and back, or, including small  
delays, about 3 hours to load, discharge and  
return ready for another load. As there is only  
one steamer to each dredge, the dredges must  
necessarily be idle nearly half the time, excepting  
when, in the interim, they may sometimes be  
loading scows or lighters for ballasting vessels,  
or furnishing small quantities of sand for City uses.

The daily capacity of the dredges, when in  
good working order, is said to be 2400 tons each,  
though their ordinary <sup>work,</sup> is, as already mentioned, 900  
tons per day for each dredge; and usually only one  
dredge is at work. The quantity <sup>of sand</sup> sold for ballast and  
other uses I did not ascertain.

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Looking at the place outside of the reef where the loose, sandy dredge material has heretofore been, and where it is now daily deposited, (when a dredge is working, and the steamer is running,) I think that it cannot possibly remain there long. The littoral currents, and the wave action from easterly, and more especially from south easterly winds must easily move it. Precisely what becomes of this sand does not seem to be known, but probably a portion is ultimately washed back over the reef, or carried in through the entrances and thus back into some part of the harbor.

It would be more useful, and in the end more economical, to dispose of this dredged material so as to form land. This point will be referred to again.

According to the Monthly Statement of the Dredging, the greatest quantity taken out in any month was 36,500 tons - in January, 1879, and the least 8178 tons, in April, 1880.

Taking the whole period, from November, 1874, to September, 1880, - 71 months, the average per month, as stated, was 17,981 tons.

Assuming that 1.63 tons of wet sand equal 1 cubic meter, it makes 783,246 Cubic Meters as the total quantity dredged during 71 months.

This would fill an area 2000 meters long 196 meters wide 2 meters deep - a very large area - nearly equal to the mangrove portion of the entire port.

Comparisons of the soundings, although they show a considerable increase of depths since 1874, do not exhibit so great an addition to the depths.

As there have been no observations showing the

Quantity of sediment brought down by the river floods, or of the quantity of sand that is brought in from the sea, it is not possible to make a reliable Comparison between the number of tons dredged and the actual quantity of effective dredging. There is no doubt that a portion of water goes to make up the 300 tons per trip of the Screw Steamers.

One of the dredges has been for some time engaged in the special duty of dredging a Canal from a point opposite the Custom House, through the Passarinhos Sand bar, toward the present terminal station of the "Recife and São Francisco Railway". This will be more particularly referred to in another place. It looks like useless labor.

It is certain that the port has been decidedly improved, in several places, by means of dredging; although the "Baque de Shoal", at the very entrance, has not been dredged, and remains nearly as it was in 1874; though there is a little better depth of the main Channel, not far out from the reef, south of the Light House.

Every considerable river freshet naturally brings down quantities of up Country detritus, either in suspension or carried along the bottom, and this must be either taken out to sea with the current of the river and the ebb tidal flow, or else it must be dropped somewhere in the harbor; and since it is clear that the river and harbor below the Recife Bridge have deepened during the last six years, it is obvious that the two factors, namely, the out going currents, and dredging, have served, not only to sustain the former depths, but to augment it; but the proportions appertaining to these factors, respectively, are unknown.

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At high tide there appears a large expanse of water South of the Custom House which presents quite an imposing appearance; but at low tide it becomes little more than an immense sand bar. The name, "Corvoas dos Passarinhos" bespeaks its character. In the direction in which the above mentioned special dredging has been slowly advancing, the average depth is less than one metre.

The distance from where the dredge is now working to opposite the Railway Station is about one thousand metres. Supposing the Canal was to be cut only 50 metres wide, with three metres depth of dredging, and that it did not <sup>partially</sup> fill up by the currents, eddies and river floods, during the process, the quantity of material to be excavated would be 150,000 Cubic metres, or about 244,500 tons. At the average rate of working during the past six years of one dredge - about 9000 tons per month, it would occupy 27 months; during which period at least two river floods must occur. The excavation which has been going on is much wider than 50 metres; that, <sup>width is there</sup> ~~is~~ <sup>has</sup> merely been assumed, as a minimum.

These river floods, and the tidal currents have a tendency to create eddies in the Passarinhos; in fact they have formed and maintain this great sand bar. A study of the shape of the river, of the horse-shoe curve around Custom House Point, of the position of the outer reef, and of the counter freshet currents of the river here meeting each other - one from the Afogados Bridge, the other from the Recife Bridge, combined with the curious courses of the tidal currents through this part of the harbor, <sup>shows</sup> causes

permanently acting to maintain not only the ~~the~~ great sand-bar already mentioned, but likewise the shallows in front of the "Baia de São Antonio". While the Causes remain, the tendency will be to reform <sup>the bar</sup> after it has been excavated. So that it is in the highest degree probable that if a Canal were dredged through the bar up to the Railway Station - unless some other works were added in the river, it would require considerable re-dredging here after to maintain the depth.

It is quite different in the main harbor, where the tidal currents scour the Channel; and this is especially the case where most of the vessels lie, where it has been scoured to the depth of 8, 9, and even 10 meters below low water level.

It would seem to be less costly and more likely to be successful, to carry the railway to deep water than to carry the deep water to the Railway, and maintain the artificial depth.

Sir John Hawkshaw advised the construction of a Causeway from the "Caes do Collegio" to the Recife and São Francisco Railway Station, and "dredging between this quay and the Custom House, but he did not suggest dredging a Canal through the great sand bar to the Railway Station. On the contrary, he recommended a "Causeway" upon which the railway could be extended to deep water; which is quite another thing.

### What may be effected by Dredging.

From mid-channel opposite the Light House, to mid-channel opposite the Custom House, it is

1550 metres; thence <sup>(21)</sup> around to the Recife Bridge ~~to~~  
(which stops navigation of Ocean vessels) it is 650  
metres; in all 2200 metres - or nearly 1½ miles.  
The width of the port opposite the Light House,  
if the line of the present quay were extended north-  
ward that far, would be 300 metres. It is 250  
metres wide at the Marine Arsenal; but at the  
"Associação Commercial Building" it is contracted  
to 180 metres; and this building is flush with  
the line of the quay, there being not even a  
foot-passage in front. The port then widens  
out to 200 metres toward the Custom House.

X  
Opposite the Circular front of the Custom House  
is a wide river, spreading into the broad ex-  
panse of the shallow Passarinhos. The naviga-  
ble portion of this part of the river has already  
been dredged to a depth of 4 to 5 metres upon  
a considerable width, and <sup>it easily admits of</sup> ~~this part can~~ being  
made much wider, and also deeper, by dredging.  
From the curved portion of the river opposite the  
Custom House up <sup>to</sup> the Recife Bridge, the width is from  
200 metres to 180 metres; averaging about 190 metres  
between the Custom House wharf and the "Caes do Collegio".

The total area of the water surface described  
is about 125 acres, english - in round numbers 50 hectares,  
though considerable portions are not at present available  
for ships for want of depth, as the soundings show.  
By judicious dredging nearly the entire area can be  
made available.

For vessels of 4½ metres (14.76 feet) draught there are



(22)

now nearly 100 acres available. For vessels of  $5\frac{1}{2}$  metres (18 feet) draught there are about 70 acres; but for vessels of 6 metres (19.68 feet) there are at present only about 30 acres available; chiefly between the arsenal and the Custom House, over toward the reef, where, upon a length of 500 metres, there is now a depth of 7 to 9 metres, at low tide.

By securing the quay wall foundations, or by the construction of <sup>short</sup> piers, nearly the whole area will admit of being dredged to a depth of 7 metres. Two turning places for long vessels can be made; one just southward of the Custom House, the other above the light-house - in case the Poco Harbor shall be protected. And when the whole width between the quay and the reef shall be deepened, most vessels can be turned at any place north of the Marine Arsenal, where it will be from 250 metres (820 feet) to 300 metres (984 feet) wide.

It is not to be expected that this important improvement is to be secured at once; but if systematically entered upon, it can be effected in a few years; as will be more particularly shown in another part of this report.

It will of course be necessary to dredge the "Bregueda Shoal", which stands in the harbor just south of the light-house, and <sup>south</sup> of the Picão entrance. This shoal is of a peculiar character, and demands particular notice.

The Breque de Shoal, etc.

As the material in this shoal is not rock, or hard clay, but consists of sand, mud, peat, and some clay, deposited by conflicting currents of the tides, the winds, and the river freshets, it may be well to note the causes of its formation, and of its comparatively permanent character.

The primary cause is the opening through the submerged reef, north of the light house, known as the "Barra Picão"; the tidal current, as well as the wind current through which crosses, (nearly at right angles,) the main <sup>flood</sup> tidal current into the harbor entering from the wide expanse of the Barra Grande, mingled with that which comes in over the submerged reef. These meet and counteract each other so as to form eddies, the natural result of which is a sand bar. The action is very much the same as in the case of a strong tributary stream entering a river, at right angles; which always creates a bar, at or near the junction.

In the case of this sand bar, it is aggravated by the concave shape of the opposite sandy shore, which curves around to the end of the present quay wall, where the curve abruptly terminates. The flood-tide current sweeping round this concave shore, is suddenly deflected at the end of the quay wall obliquely across the <sup>more direct</sup> current from the Barra Grande running nearly parallel with the reef, and the ebb current from the Barra Picão. The ebb tide has not power to scour it away, because the channel widens immediately north of the quay wall, and part of the out-going water is diverted through the Barra Picão, while the main flow passes out over the submerged reef, and through the wide Barra Grande; the harbor opposite this reef widening greatly owing to the concavity of the shore.

So long as these Causes Continue, the Shoal will remain; though it may be temporarily somewhat modified during heavy river freshets, when the tidal Current may be for the time being overpowered.

If this Shoal should be dredged, without modifying the Causes mentioned, it would be only a question of time, and probably <sup>for</sup> a very short time, when it would form again; so that only repeated dredging could maintain the proper depth. But unless something be done to check the ocean swell rushing through the Barra Picão, it will be difficult to dredge this Shoal.

The natural remedy is <sup>undoubtedly</sup> the closing of the Barra Picão, and raising the submerged reef, making it a breakwater, and extending the quay wall northward to <sup>some distance above</sup> ~~opposite~~ the light house, ~~with a return wall running to the head.~~ <sup>of main</sup> The tidal Current would then have <sup>only</sup> one general direction, and there would no longer exist a reason for the formation of Continences of a bar at that place; so that when one dredged it could be easily kept clear <sup>and</sup> of full depth.

Some engineers have advised the closing of the Barra <sup>Picão</sup> ~~Picão~~; but the majority have recommended leaving it open, on account of its Convenience for the passage of boats and vessels of moderate draught. If it ~~was~~ be decided to raise the submerged reef, there might be left <sup>open</sup> a comparatively small, oblique opening through, at the Barra Picão, which from its shape would be less likely to create a shoal in the inside. If the shoal were the only consideration, and if the submerged reef were raised, the Barra Picão should be closed; but as an opening there is deemed <sup>useful and</sup> ~~important~~, a compromise,

# leaving an opening of diminished width, <sup>and changed shape</sup> may be admitted.

It is to be considered that the addition of this indicated new, safe harbor, in the Poco, between the Barra Grande and the lighthouse, creating eight hundred metres in length of protected port room, with a Channel <sup>of 15</sup>  $7\frac{1}{2}$  metres deep at low tide, would afford anchorage at all stages of the tide for the largest vessels that call at Pernambuco, excepting only the very few of the largest, and <sup>even</sup> they could <sup>then</sup> enter <sup>the Poco</sup> at high tide.

# <sup>of 15</sup>  $7\frac{1}{2}$  metres, and oceanward it directly increases to <sup>eight, and</sup> nine, and out in the roadstead to ten, and eleven metres; excepting on the "English Bank", which is one thousand metres (about five eighths of a mile) out, nearly eastward, and has only  $3\frac{1}{2}$  to  $4\frac{1}{2}$  metres ( $11\frac{1}{2}$  to  $14\frac{3}{4}$  feet) upon it at low tide.

This bank lies in nearly a north and south direction, and the distance between the bays at its two ends is 1300 metres (a little more than three fourths of a mile). Vessels can pass either north or south of this bank.

There is another bank (only dangerous to <sup>draught</sup> deep vessels) five hundred metres to the east of north of the English bank, having 7 metres depth ( $23\frac{1}{2}$  feet) at low tide.

With these two exceptions, there is a depth of <sup>of 15</sup>  $7\frac{1}{2}$  metres, at low tide, for vessels entering at Barra Grande, and  $7\frac{1}{2}$  metres inside, in the Poco.

With the submerged reef raised sufficiently high to protect the Poco from the ocean swell there would be at once presented, without any dredging an elegant harbor of refuge and most valuable anchorage, which could afterward be improved by a moderate amount of dredging.

(English Copy) To be translated

Report

Pernambuco

River sediment, deposits of sand  
Currents, Reservoirs, etc.

(4 pages) 26 to 29 hrs

River sediment - deposits of sand - Currents -  
Reservoirs, etc

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Reservoirs

River Sediment - Deposits of Sand, Currents, etc

From observations of the rivers discharging their water through the port of Pernambuco, from the position of the reef, and the entrances through it, and from the situation, extent and Character of the Shoals in the river and harbor, I am convinced that a very large proportion of these sandy deposits has been brought down by the rivers during freshets, the time <sup>when</sup> most of this material is carried in suspension, or by the current along the bottom.

During most of the year, when the natural volume of the rivers is quite small, and the quantity of sediment thus moved <sup>by the rivers</sup> is insignificant, the port, ~~and~~ the lower ends of the rivers, and the large area of the Passarinhas, constitute <sup>only</sup> a considerable tidal basin, very little affected by the trifling amount of the fluvial waters of the rivers.

At such periods sea-coast lands, to some extent, may be carried into this tidal basin by the flood tide, in two ways; through the entrances, moved along the bottom by the current, and by being washed over the reef - especially during the prevalence of strong winds at high tide.

The quantity of sand thus carried or thrown into the harbor cannot be satisfactorily ascertained. With strong winds from the north east, and on the flood tide, the coast-land must move southward along the shore of the Poco, directly into the port, portions of which <sup>may be</sup> ~~are~~ carried out again by the ebb current. When the <sup>and south</sup> south east winds blow, and this is the prevailing <sup>direction of the</sup> winds at this port, the tendency is to drive the coast-lands northward.

Hence, with changes of prevailing winds, fluctuations take place in the position of the Coast-lands and the Shoals in front, between the Poco and Olinda?

With strong southerly winds not only much of the Coast-sand may pass out <sup>of</sup> the North end of the harbor, but also portions of the ~~sediment~~ sediment previously brought down by the rivers; especially in freshets, when a considerable proportion may be discharged with the ebb tide. During the flood tide, the general tendency is to carry the sand inward, and, also, by opening the river <sup>in intermediate stages</sup> currents, to cause the sediment to be deposited.

Whilst the freshet continues, although this retarding operation takes place twice a day with the flood tide, the prevailing movement of the river sediment is <sup>there</sup> outward; but as the ~~freshet~~ <sup>freshet</sup> subsides, the tidal currents resume their predominance, and much of the river sediment may be dropped in the eddies of the <sup>Crooked</sup> streams, and upon the shoals in the harbor, to be shifted about with the shifting currents.

Only a careful series of observations, continued through several years, on the entire tidal basin, could exhibit the periodical fluctuations in these sedimentary deposits; but as the movement of the sand and mud of these rivers, above the reach of the tides, is always downward, toward the Ocean, there can be no doubt that considerable quantities are swept through the port, and out to sea every year.

For several kilometers square, back of the reef, including all of the City, it has the appearance of being a delta formation, only slightly elevated above the level of the sea; and but for

the Conglomerate sandstone and shell reef, in front, which has here formed a navigable Canal or natural harbor parallel with the Coast. These rivers, <sup>might</sup> ~~would~~ present only shallow Channels at their mouths, which, during the dry season <sup>might</sup> ~~would~~ be nearly closed by the action of the Coast sands. The reef is the breakwater established by nature, which creates and maintains the harbor.

For several hundred years these general features have continued substantially the same, notwithstanding the annual discharge of large quantities of sediment from the rivers. The soundings shown on the Charts of the wasteads in front of the City of Pernambuco present no material fluctuations at different periods. The action of the winds and tides through a long series of years appear to have resulted in a normal condition which does not perceptibly change from year to year. Still, it must be the case, that <sup>the</sup> Coast sands are mixed with the prevailing littoral currents, sometimes in one direction and sometimes in an opposite direction, according to the prevailing wind.

#### Plans for reducing the River Floods.

Several plans <sup>have</sup> at different times ~~been~~ been proposed for relieving <sup>the</sup> low grounds of the City and suburbs, as well as the cultivated lands along the rivers, from the injurious effects of freshets. An elaborate discussion and a number of suggestions in this connection appear in the report of N. Raphael <sup>Archanjo</sup> Galvão, ~~1814~~, who made a very intelligent preliminary study of the subject. It can only be regarded as preliminary; because it would require extensive <sup>and</sup> minute surveys and many



Careful observations, having special reference to the project, before plans of the nature indicated <sup>could</sup> be intelligently designed, and a reliable estimate of the probable cost given.

#### Reservoirs.

Without doubt reservoirs can be built that would assist in restraining the natural, sudden discharge of river freshets, to a certain extent; and by such means the height of the freshets in the lower parts of the Casibaribe could be somewhat reduced; but only proportionally to the quantity <sup>of water</sup> that could be <sup>trapped</sup> caught and stored in the reservoirs. In the case of this river, which, measured along its windings, has a length of more than two hundred and fifty kilometers, and a drainage area exceeding four thousand square kilometers, there would have to be numerous large reservoirs to catch and hold back enough freshet water to materially reduce <sup>or to reduce it even perceptibly,</sup> the height, at the lower end of the valley. And such reservoirs would have to be in charge of intelligent, responsible men, and managed with great care.

The cost of the original construction, <sup>annual</sup> repairs, and management of such structures, remote from the city, might easily prove to be altogether out of proportion to the assumed benefits. My impression is that upon a thorough investigation this would prove to be <sup>the</sup> case in this instance; but such a question can only be finally settled after elaborate survey, and <sup>very</sup> careful consideration of the whole subject.

I do not hesitate to declare the opinion, <sup>however,</sup> that the other improvements which have been proposed at the port, promise very much more important practical results than can be hoped for from artificial reservoirs <sup>built</sup> far up the river. Reservoirs will not constitute a part of the recommendations now to be made.

(English) Joh translation

(9 pages.)

30 to 38 me.

Pernambuco

Concerning proposed River Cut-offs



Concerning Proposed River "Cut-offs".

Several plans have been presented for "Cut-offs", in the Capibaribe and Beberibe rivers, within the limits of the City, designed to ameliorate the damages from river freshets upon the low lands, and as a supposed partial relief from injurious accumulations of river sediment.

The two rivers above named are quite unlike. The Capibaribe is a comparatively large stream, over two hundred <sup>and fifty</sup> kilometers long, draining more than ~~four hundred~~ <sup>four thousand</sup> square kilometers, having its source in the mountains.

The Beberibe is an insignificant stream, <sup>quite</sup> ~~only~~ <sup>and only about</sup> ~~thirty~~ <sup>thirty</sup> kilometers long, near to the City, with a very limited drainage, perhaps not more than <sup>fifty or</sup> sixty square kilometers.

But the lower portions of these rivers have some importance on account of the considerable tidal basin they create, and which gathers a large volume of sea water, <sup>all of</sup> which passes through the port with the flood and ebb tides, greatly assisting the scour, and maintaining the depths of the port.

Just above the Palau point these two rivers, <sup>then</sup> ~~running~~ <sup>running</sup> in opposite directions, <sup>counter</sup> ~~to~~ <sup>to</sup> each other, meet, thus forming a large sand-bar. While their tidal basins are not very dissimilar, the fluvial discharge of the Capibaribe, especially in freshets, is vastly more than that of the Beberibe.

In ordinary low water stages of these streams, the currents from their fluvial discharge are insignificant, and the movements in their basins are governed <sup>substantially</sup> by the tides; they thus have <sup>along their channels</sup> currents in opposite directions twice each day.

The currents, confined within curved shores, are forced to make nearly right angle <sup>turns</sup> at the Custom house, at the Palace point, and near the Dom Pedro Hospital; having Countercurrents, and eddies, which result in the formation and maintenance of large sand bars; particularly in the wide, open water above the Palace point, where the <sup>two</sup> out going or ebb-tide currents from the two rivers run directly against each other, ~~and~~ then turn and together flow <sup>through</sup> the Recife Bridge, and <sup>thence again curve</sup> around into the Commercial harbor, and so out <sup>to the</sup> sea. In front of the Custom house, the outflow from the two rivers meets <sup>important tidal</sup> another current from the right branch <sup>of the Capibaribe, flowing through</sup> the Afogados bridge and <sup>through</sup> the wide basin of the Panarintos, which also brings the water from the <sup>tidal basin of</sup> Giquia, the Tigipio, and the Jordão rivers.

When freshets occur in these rivers the fluvial discharge from the Capibaribe being <sup>very much</sup> greater than that from the <sup>and all others combined</sup> Tebrito, the current from the Capibaribe <sup>completely</sup> overpowers the other, and changes the currents of the flow at their conjunction, altering the shapes of the sand bars, while the tidal rise, twice a day, though it may not be strong enough to reverse the river current, <sup>recently</sup> adds to the height of the freshet, especially during the changes of the moon, at spring tides.

While these river freshets, carrying large quantities of sediment, sometimes create injurious sand bars, they also help to sweep out to sea portions of previously formed sand bars; the quantity of sedimentary material thus swept off, at each freshet, depending upon the

Pomona River Cut-off

magnitude of the <sup>fresh</sup> ~~flood~~ and the length of time it may continue.

Independently of fresh action, the varying tidal currents, naturally creating eddies, in different places, are also carrying out on the ebb tide more or less of the deposits; so that the tidal action is essential to the existence of the navigable harbor.

When, therefore, it is proposed to make a radical change in the regimen of any of these rivers, which, with the tides maintain the natural, <sup>normal</sup> condition of the navigation, it becomes necessary to study <sup>critically</sup> ~~carefully~~ the probable effects, before undertaking <sup>any</sup> such change.

As mentioned in Sir John Hawkshaw's report, the natural discharging capacity of these rivers has been somewhat obstructed by the piers of the bridges, and by the closed embankments over the low ground just north of the two bridges over the right branch of the Capitanite.

Prior to the building of these embankments, the low ground offered a considerable area over which the freshets freely passed. Now the water way is confined within the abutments of the bridges, reducing the natural freshet water-way about forty per cent.

Although the reduction of the freshet water way at this point may not have caused any perceptible change, <sup>in any respect,</sup> in the port, it of course adds somewhat to the freshet height above the bridges. Hence, the recommendation of Sir John Hawkshaw to restore, to some extent, the area of the former freshet water-way, by constructing cut-offs,

## Cut offs

or making openings in the embankments, or by lengthening the bridges.

Some reduction of the freshet height would be caused by the additional water-way; but it might not be very great, owing to the tortuous Character of the river above, and the Counter action of the flood tide <sup>a day.</sup> twice.

One advantage of the proposed additional water way near the Afogados bridges, and of the proposed cut from the left bank of the Capibaribe into the Passarelinhos, is, that the <sup>freshet</sup> water would have a shorter and more direct route through the harbor to the sea; but this is not the only Circumstance to be considered. The increase of the freshet discharge through these places involves <sup>also</sup> a corresponding decrease <sup>of the discharge</sup> <sup>at</sup> the palace point, and of the outward current in part of the "Baixo da Boa Vista". The increased <sup>more rapid</sup> discharge into the Passarelinhos, would raise the level of that basin; and this would tend to retard the discharge through the Recife bridges. To what extent these proposed outlets and the proposed cut would affect the outgoing currents, is by no means easy to determine, in advance; because they are complicated by tidal currents; particularly in the absence of complete records of the heights of freshets and <sup>of the</sup> rates of the <sup>river</sup> current at different points.

To the extent that the quantity of freshet water passing around the palace point might be reduced, there would be a reduction in the quantity of sediment carried that way; though the same sediment would <sup>then</sup> pass into the Passarelinhos, and thence through the harbor, <sup>it might be</sup> very nearly the same as it does now.

A slight reduction in the height of the fresh level <sup>some distance</sup> above the proposed cut might be effected; but the height in the river at the Custom House, for instance, would be rather increased. Whether, on the whole, it would prove to be an advantage or a disadvantage is <sup>quite</sup> uncertain. It must be kept in mind that the entire outflow of all of the five rivers mentioned, must pass the narrowest part of the port, at the "Associação Commercial" building, where it has a width of only 180 metres.

Only by careful levels, at different points, taken during freshets, for the special purpose of a study of the probable effect of Cut-offs could any satisfactory calculations be made.

Sir John A. Leveson had some approximate levels taken of the freshet heights, as shown to him by the inhabitants of the neighborhoods.

In metres above high-water spring tides:

		1854.	1869
		m.	m.
At Caxanga, about 17 Kil. above Recife Bridge,		7.2	7.
" Monteiro " 11 " " "		6.2	5.9
" Torre " 7 " " "		3.6	2.7
" Magdalena Bridge " 5 " " "		2.2	2.1
" Gasworks. " 2 " " "		0.7	0.6

There were unusually great freshets; yet it will be observed that notwithstanding the very great rise at Caxanga, and at Monteiro, (7, and 6 metres,) the rise was only 0.7 (or 2 1/4 feet) at the Gas works, above the level of <sup>m</sup> high-water spring tides. I visited all of these places.

At Caxanga, there is a bridge over the stream about eight metres above the surface of low water, where the water way is confined between the

abutments to a width of about 55 metres, so that during high floods the entire flat valley is covered with water. Of course this contraction of the further water way causes the flood line higher than it otherwise would be above the bridge. On the other hand, by <sup>checking and</sup> ~~thus~~ holding back the flood, it lessens the height of the fresh, somewhat, below the bridge.

Various schemes have been suggested for regulating the floods of the Capibaribe; but it is doubtful whether any will ever be executed that would make any essential difference in the port; though they might subserve other purposes.

The proposed cut between the Rebouças river and the Poço, recommended by some of the engineers, is radically different from that proposed by <sup>Mr. Fournier and</sup> ~~Mr.~~ John Hawkshaw at the Capibaribe river. Its effect would be to turn, directly into the sea, a certain quantity <sup>of river</sup> flood water, and sediment, and prevent that quantity <sup>of water and of sediment,</sup> whatever it might be, from passing under the Recife Bridge, and <sup>so</sup> around through the port. The quantity would depend upon the width and depth of the cut; and, if it were <sup>movable</sup> a weir, upon its management. If it were made an open cut, it would manage itself; and it might produce results <sup>reliably</sup> ~~reliably~~ calculated in advance; some of which might <sup>possibly</sup> ~~possibly~~ prove to be very disadvantageous.

If the cut were intended mainly to lessen the flooding of the low grounds about the city, along the river, it would have to <sup>be</sup> quite wide, and deep, to materially reduce the height of these streams;



and even then, it becomes obvious from a study of the circumstances, that the effect <sup>above</sup> could not be very great; since it appears that the <sup>high</sup> ~~water~~ ~~level~~ ~~of~~ ~~the~~ ~~year~~ ~~1854~~ ~~only~~ raised the water at the Gasworks 0.<sup>m</sup>7 (2 1/4 fms.) above the level of high-water spring tides, and only a portion of that difference of 0.<sup>m</sup>7 metres could, by any possibility, be reduced, by any number, or any dimensions of <sup>such</sup> Cuts. Such a Cut would deepen <sup>by occurring</sup> that particular part of the Beberik river; but it would <sup>also</sup> reduce the depth, and increase the shoals below the Recife Bridge, and in the port, by lessening the natural volume <sup>of water</sup> which now passes <sup>through</sup> from these tidal basins, and which is essential to scour out the Channel and maintain its depth.

Therefore, if a Cut were made at that place, it should have <sup>an</sup> <sup>movable</sup> <sup>bar</sup>; to be opened only during freshets. Even this is not a simple proposition; because its probable effect upon the Channel <sup>and the bars</sup> depths in the Poco has to be considered. A large volume of water, carrying with it sand and mud, thus discharged, at right angles to the <sup>general</sup> direction of the Poco navigation, and the face of the <sup>tidal</sup> <sup>inflow</sup> at the Barra Grande, would create a <sup>powerful</sup> conflict between the action of the sea and the <sup>opposing</sup> flood water from the river, which would certainly form a sand bar; and when once formed, it would be exceedingly difficult to remove, on account of the roughness of the water, which would seriously interfere with the working of Arrages, if it did not prevent it.

If the submerged reef should be raised, as recommended, so as to afford protection, and produce

Comparatively still water, in the Poco, the discharge of river freshets and sediment <sup>into it</sup>, in the manner indicated, would <sup>be</sup> even more objectionable; in fact, it would be entirely inadmissible.

Another proposition was to dam the river, ~~down~~ and force them to discharge through a Cut in the isthmus, <sup>farther north</sup> between Recife and Olinda, into the sea, preventing the river water from entering the harbor by means of a guiding dyke, and leaving the port, and the river below the dams, <sup>to be</sup> a separate tidal basin, free from the encroachments of the river freshets or river sediment. This is also a complicated question.

At the first view this appears very plausible, and as if it were a simple problem, merely relieving the port from the ill effects of freshets and river sediment; but when <sup>more</sup> carefully considered it is found to be something radically different. It would <sup>at once</sup> deprive the harbor of a very large portion of the tidal basins, the volumes from which are now essential to maintain the navigable depths; and the port would be liable to fill up with sea-sand washed in; and furthermore, by preventing any of the freshet water from spreading, as it now does, over the extensive area of the Passarinho, the inundations in the back part of the City, all over the low grounds, would be increased instead of being diminished. So that, for the slight advantage of discharging the river sediments north of the harbor, <sup>much</sup> greater evils would have to be encountered.

Although I have not had the opportunity of witnessing a freshet in the Capibaribe, I have examined <sup>this stream</sup> it as far up as Casangaé - about 17 Kilometers, in its low stage, and noted the marks of the high freshets. During the dry

season the fresh water flow is quite trifling; but when, as in 1854, it rises to the height of seven metres (23 feet) at Caponga, in a width of 55 metres (180 feet) <sup>with</sup> ~~and~~ a very rapid current, between abutments confining it, it becomes torrential; discharging not less than 20,000 cubic metres per second, or about one third as <sup>much</sup> ~~fast~~ <sup>water</sup> as the whole tidal flow through the harbor at high spring tide.

The recommendation of Sir John Hawkshaw to restore natural water-way which had been cut off by the embankments and bridge of the railway Company, has a basis of sound hydraulic principles. Nature, for an unknown period, but certainly for several centuries, contrived and sustained a good navigable harbor at the Recife by means of the present tidal basins. As yet, these have been little changed by art; and, according to the best judgment I have been able to form, I should hesitate long before advising a cut-off to be made, any where, which might seriously affect the present regimen of this port and its <sup>very peculiar</sup> tidal basin.

(English.) To be translated =

Boyle from the Island of Pernambuco

(2 pages)

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Pernambuco

Boyle from the Ilha de Noqueira.

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Dyke from the island of Nogueira.

The partially completed dyke, extending from the "Ilha do Nogueira" toward the reef, near the Antigua Barreta, originally designed to close the natural basin between the reef and the island, was intended to catch and stop the blown sand, and <sup>thus</sup> prevent its entrance into the harbor. To a <sup>considerable</sup> extent it has answered this purpose.

This dyke has a completed length of 1200 metres. Between its present end and the reef, where a rough foundation of stone has been dropped in-<sup>open space</sup> and which becomes bare at low tide, the <sup>distance</sup> is 150 metres; and through this opening a considerable body of <sup>tidal</sup> water flows ~~into~~ into the natural basin south of the dyke with the flood tide, and passes out again with the ebb tide, running through the port, and thus assisting the <sup>in the channels</sup> scour. Much water also flows over the reef south of the dyke whilst the tide is up, which does not return <sup>to the sea</sup> over the reef, but passes out with the ebb tide through the port, thus augmenting the <sup>of the ebb flow</sup> quantity <sup>and to that extent</sup> ~~and~~ assisting the scour. Considerable water also runs through the irregular, partly closed old entrance at the "Antigua Barreta" when the tide is up, and <sup>much of</sup> this also flows out through the port. By closing the dyke, these sources which <sup>now</sup> furnish <sup>an</sup> additional scouring power, would be cut off, and the scouring inside along the reef, <sup>as well as</sup> ~~and~~ between the reef and the city, would be correspondingly lessened. On these accounts, I regard the recommendation of Sir John A. Anterkhaw, to leave

Dyke from the island of Nogueira.

the space open, as proper.

The dyke, as it stands, has another effect, which may be regarded as beneficial; by Concentrating to some extent the flow through the "Passareiros" in front of the "Daires de S. Jose", guiding the discharge from the river Capibaribe (right branch) and the Tigipio, <sup>etc,</sup> along the dyke, and turning the ebb current over toward the reef, and thence directly through the port instead of being scattered over the wide area between the Ilha do Nogueira and the reef.

This basin is however, <sup>still</sup> very wide, being over 900 meters in width between the "Recife and São Francisco Railway Station", and the dyke; and most of it <sup>is</sup> exceedingly shallow that the effect just mentioned is much less than it would be if it <sup>had only</sup> ~~of~~ one third the present width. Still, it contains at high tide a large volume of water, which with the ebb, all runs out through the port.

This basin has obviously fulfilled another function, by stopping an immense mass of sand which otherwise must have been discharged through the harbor, or settled <sup>somewhere in it</sup> ~~elsewhere~~ in the form of sand bars.

Plans for the utilization of a considerable portion of the "Covao dos Passareiros", by means of docks, Canals, and warehouses, were proposed by Richard Jose Tiburcio Pereira de Magalhães, Capitão do Corpo de Engenheiros, some years ago.

At some future period, when the business of this port shall be largely increased, it may be found advantageous to utilize some of this shallow basin, by dragging <sup>out</sup> docks, and building warehouses; but other works of more pressing necessity should be previously completed. Those which appertain mainly to an anticipated <sup>large</sup> future increase of Commerce may safely be deferred.

To be translated

9 pages 41 to 49 inc

Pernambuco.

Conclusão.

The city of Pernambuco already possesses an excellent harbor, and good waasteads; the latter being unusually free from dangerous gales, with safe anchorages in nine and ten metres, or more depth, situated from three <sup>of a mile</sup> fourths to one and one fourth miles out from the port. These anchorages are not subject to material changes, and vessels rarely encounter serious trouble when at anchor.

The port, admirable as it is for a certain class of vessels of moderate draught, admits of essential improvement. It can be made much deeper, more convenient, and more capacious, by the expenditure of a sum, which, compared with the resulting benefits cannot be regarded as unreasonable.

The works that appear most desirable and necessary may be referred to in the following order; and to ensure a clear understanding of the good to be accomplished by the proposed improvements it may be proper to present them somewhat in detail, as follows:

I. Systematic Dredging - and works Connected.

Supposing a contract to be made with experienced, competent parties to perform the required dredging,



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it could be advantageously carried on in the following manner:

First, establishing 6 metres below low water spring tides, as the depth to be dredged.

Second, cutting a channel 50 metres wide from the light-house southward, through the Preguede Shoal and down to a point opposite the Public Landing, just below the Marini Arsenal, (about 900 metres) below which there is already a channel 6 metres or more in depth.

The soundings of 1880 show that the greatest depth of the material to be removed through this part of the Preguede Shoal, will be only 1.50 metres. In round numbers, there will be 300 metres in length of 1.50 metre depth, 300 metres of 1.00 metre, and 300 metres of 0.50 metre depth of excavation; in all 45,000 cubic metres.

Half of this will be difficult, on account of the roughness of the water in the shoal; the residue will be easy.

Allowing that it might cost 2,000 per cubic metre, it would amount to only 90,000,000.

What will have been thereby secured? A clear channel, having a least depth of 6 metres at low-water spring tide, and of 8 metres at high tide, from the ocean to the extreme southerly extremity of the port in front of the Custom House!

For this comparatively small sum, the Commercial Capacity of the port of Pernambuco would be at once increased one and a half metres in depth for entering and departing vessels!

At present, vessels drawing over  $4\frac{1}{2}$  metres (14.76 feet) cannot enter at low tide, and 6 metres (19.68 feet) draught is considered the maximum admissible at high tide.

With an increase of  $1\frac{1}{2}$  metres, vessels drawing 6 metres could enter and depart at ordinary low tide, and vessels drawing  $7\frac{1}{2}$  metres (24.60 feet) could enter and depart at high tide.

With a first Claw Drage, and the requisite accompaniments, in the hands of experienced men, this could be effected in three or four months.

As before explained, there is no difficulty in berthing vessels - after they are inside of the Pregueda Shoal, in a depth of 7 to 10 metres, in the Mosqueiro, opposite the Custom House.

If nothing else were to be done than the making of this cut, and thus increasing the entrance depth of the port one and a half metres, it would be worth ten times the estimated cost of obtaining it.

Third. The next process would be to double the width of this excavated Channel, making it 100 metres wide; at least on all south of the Pregueda Shoal. The widening of the Channel through the Shoal could be deferred till the works at the Picão Entrance should reduce the roughness of the water on the Shoal.

Fourth. Draging, could then go on over all parts of the port south of the Pregueda Shoal,

4  
Wherever it is now less than 6 metres deep at low tide, but leaving a margin in front of the quay walls without dredging

To obtain 150 metres wide, 6 metres depth, along the entire length from the Light House around to the Recife Bridge, it would require the dredging of about 400,000 Cubic metres, in addition to the about 45,000 Cubic metres. An extra excavation of 90,000 cubic metres would make a wide turning place, or "Gare", in front of the Custom House at the N. end of the Passarinhos.

The dredged material from the Southern portion of the port and from the indicated Gare, or turning place, should be deposited from scows so as to form land; or it could be placed at some convenient point in the Passarinhos, and kept from being washed away by piles and planking; so that none need be sent outside of the reef.

The total quantity of dredging advised is 535,000 Cubic metres. If desired, this could be executed in two years.

II Raising the Submerged Reef between the Barra Picão and the Barra Grande - etc.

It is proposed to raise this reef with stone, to be brought down the "Limonio Railway." In company with Chief Engineer Elliott, I examined this railway and the country through which it runs, as far as San Lorenzo Station, 26 Kilometres from the City, making particular observations for stone. There is

an abundance of excellent granite, well adapted to breakwater purposes, between 15 and 25 kilometers from Recife. The stones can be conveniently quarried, loaded on cars, transported by locomotive to a temporary wharf to be prepared near the Company's terminal station, and thence easily transferred to scows, which can be taken by a tug to the submerged reef, and dropped in place, beginning on the seaward side, and working inward.

It is not intended to make it into a quay; but only to raise it with rough, large stones, to such height as will cause it to break the swell of the sea, and render the Poco anchorage comparatively calm, and safe at all times.

I calculate that it may require 30,000 cubic meters of rough stone. Divided into two years it would be 15,000 cubic meters per year; and allowing 300 working days, it would be 50 cubic meters per day, and at  $2\frac{1}{2}$  cubic meters per car, it would require 20 car loads per day. As the railway distance need not exceed 25 kilometers ( $15\frac{1}{2}$  miles), this quantity would be easily manageable, while the distance the scows would have to go would only average about half a mile.

The beneficial effect of this breakwater would be very great. It would at once transform the present unsatisfactory, and often rough Poco anchorage,

The breakwater should be made of rough large stones with the top wall of large hammer-dressed stones bonded in fragments concrete with cement at the top and front.

into a most desirable harbor, affording at low tide anchorage for vessels of 6 and 7 metres draught, and rendering the passage at all times smooth from the Barra Grande entrance to the port.

Next to cutting a channel through the Brequeira shoal, the construction of this breakwater is the most important of the improvements now proposed.

III. Extending the unfinished quay northward on piles.

The present quay, continued nearly in the same line, should be extended about 500 metres northward to a point opposite the Picão entrance. This wall should run so as to be parallel with the direction of the submerged reef, at the distance of about 300 metres from it, admitting of future extension in the same line. This wall is intended to serve several purposes: one, to limit and regulate the width of that part of the new port; another, to make a convenient place behind for the deposit of the material to be dredged from the northern part of the port. With this handy place of deposit, where most or all of the dredged material, as above, can be either dumped or shovelled from the scows, it should help to reduce the cost of dragging and chipping of the sand. At the same time, it will assist in forming valuable land, available for commercial purposes. Another effect of the wall will be to direct

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the tidal currents through the southerly part of the Poco on a line parallel with the reef; rendering it less liable to create a bar.

IV. Protecting and regulating the Picão entrance, -  
and raising the reef, thence to the light-house.

This entrance should either be entirely closed, or it should be arranged so that the swell from the ocean through it will be partially subdued; and so that it may act less injuriously in creating and maintaining a bar inside. With the submerged reef raised so as to become a breakwater, and with the reef raised southward from the Tarrago rocks, and with a spur protection of stone running seaward obliquely from the south side of the entrance, the Barra Picão may be rendered safer and more convenient.

It is however to be considered, that when the Port of Pernambuco shall have been deepened so as to admit nearly all vessels that may desire to enter, there will be much less use for this minor entrance than there is at present, as few boats will <sup>then</sup> be called upon to go outside to vessels. It will be chiefly convenient for light craft coming from, or going to, places south of Pernambuco. For all places north of this city, the Barra Grande entrance is all sufficient.

## V. Building short, open iron quay-piers.

It has heretofore been proposed to build a new wall, in front of the present quay, to be founded not less than seven metres below the level of low tide. This would of course prove to be a very costly structure, on account of so large a portion being under water. The object of this new wall being to enable the dredging to be carried to the full depth close to the wall, (against which vessels could lie,) and to obtain the full depth of dredging on the entire width of the port.

Instead, it is recommended that the limits of depth of dredging be stopped about fifteen metres out from the present quay, and that at convenient points along the quay and Custom House, open, iron piers, not over 15 metres long be extended out from the quay to the limits of depth, so that vessels can at all times load and unload at the ends of the piers. The spaces along the quay between the piers can still be used, precisely as they are now used, by light-draught vessels, when the tide is up. This arrangement of piers will be especially advantageous in front of the Custom House.

If, at a future time it should be deemed worth the cost to found a new quay, to the full depth of the port, the piers could not interfere with it. Even after the completion of such a quay, the piers will be found advantageous.

It is not probable that, even then, lightening would be entirely dispensed with.

VI. Repairing walls and building new wall on the reef opposite the Commercial Part of the City.

When this work is less pressing than the others indicated, it is desirable that there should be a substantial wall along the reef, sufficient to prevent heavy seas from breaking over and disturbing the shipping moored near the reef. A plain, stone or brick wall, about two metres thick and one and a half metres high, will answer the purpose.

Based upon the views expressed in this report, are the following recommendations, with an approximate estimate of the Cost.

Recommendations.

	<u>Estimated Cost.</u>
I. Systematic dredging - and work connected.	420:000 000
II. Raising the submerged reef between the Barra Picão and the Barra Grande - establishing beacon lights, etc.	550:000 000
III. Extending the unfinished quay wall northward.	95:000 000
IV. Protecting and regulating the Picão entrance, and raising the reef thence toward the lighthouse	230:000 000
V. Building short, open iron quay-piers.	120:000 000
VI. Repairing walls, and building new wall on the Reef opposite the Commercial Part of the City.	60:000 000
	1,475:000 000
Add 20 per cent. for superintendence, engineering & contingencies.	295:000 000
Total	1,770:000 000



In regard to the estimates of cost of the several works recommended by Sir John Hawkshaw, at the port of Pernambuco, as no plans or sections are given in the report, there are no means of determining their sufficiency. By far the larger work recommended in his report is the breakwater outside of the reef, designed to create an outside harbor; the cost of which is estimated at £900,000, which at the present rate of exchange would be about 10,000,000 \$000 (ten millions of dollars.) This amount seems ample for the breakwater; but if, as suggested, it is also to be a Commercial quay at which vessels may discharge and take in cargo, the actual cost would depend very much upon the particular mode of construction. In order to be available as a Commercial Quay, it would involve the building of a railway bridge somewhere across the southern portion of the port, connecting the breakwater with the Custom-house and with the Commercial front of the City.

Whatever were the particular plans proposed, there appears no reason to doubt that the estimates made at the time were sufficient for the completion of the works indicated.

There is nothing original with myself in the works now recommended to the Consideration of the Government, in Connection with Pernambuco; in some form or other they have been before suggested by other engineers - excepting, perhaps, the short iron piers at the quays.

It will be observed that I lay great stress upon the Necessity of dredging, and upon the very valuable results to be realized therefrom. During the past thirty years this branch of engineering has been very materially improved, and the cost of dredging has been greatly reduced; so that there is no longer among engineers the same apprehension as formerly of the silting up of harbors, the remedy being at hand at moderate cost.

Dredging is also a leading item among the recommendations of Sir John Hawkshaw, and of other engineers who preceded him in examinations of this Port. Sir John Hawkshaw likewise particularly mentions in his report that in case the Government should deem the outside breakwaters too costly, that the submerged reef should be raised so as to form a protection for the Poco anchorage.

In my judgment, dredging, and the raising of the submerged reef are the primary factors in the improvement of this important Port.

Ilmo Exmo Sr

I have the honor to acknowledge the receipt of your Ex.º Officio dated 25 de Fevereiro 1881, transmitting the Officio da Associação Commercial Beneficente de Pernambuco, <sup>instructing</sup> ~~requering~~ me to examine it and give my opinion upon the subject in my report to be presented to His Ex.º Conselho M. Buarque de Macedo, Ministro da Agricultura, etc, etc.

I have the honor to inform your Ex.º that I have examined the same, and that my views will appear in that part of my forthcoming report relating to the port of Pernambuco. Your Ex.º will please find endorsed the Officio da "Associação Commercial Beneficente de Pernambuco."

I have the honor to remain, etc.

Ilmo Exmo Sr

Antonio Alvaro do Santos Souza  
Chefe Interim  
Directoria das Obras Publicas

Rio de Janeiro

28 de Março, 1881.

M. Meira Roberts  
Engenheiro Civil.

Agreeably to the Instructions of His Excellency *Cornelheiro* M. Buarque de Macedo, *Ministro da Agricultura, etc, etc*, conveyed in the Office of His Excellency, Chief of the *Directoria das Obras Publicas*, dated 25<sup>th</sup> of February, 1881, I have examined the views presented in the Office of the *Associação Commercial Beneficente de Pernambuco*, dated 31. of May 1880, relating to the mode of providing for the payment for proposed improvements of the port.

These views, emanating from a body of intelligent gentlemen who are perfectly familiar with the needs of the port and with all the circumstances bearing upon the subject, are entitled to great weight, and, so far as I am able to judge, from my personal examinations and a careful study of the premises, they appear, in the main, reasonable and proper.

If individuals or a Company are to raise the requisite funds to construct the works I have recommended, there would seem to be required, at least for most of them, a guarantee of some sort from the general or provincial government or from both; or a grant authorizing the raising of funds from charges to be made upon the shipping, or from a percentage of the receipts of the government from Customs.

I have not recommended the construction of docks by the government. Individuals, or a Company might be authorized to establish docks, at their own cost, and be allowed to charge for their use, without however making their use compulsory. In the *Passerinhos*, such docks could be constructed, at comparatively moderate cost, and, in connection with bonded warehouses, they might perhaps be made profitable; but most of the works estimated in my report are not of a nature to afford much remuneration to parties constructing them.

The primary need of the port is systematic dredging, so as to secure a depth of 6 metres at low tide, and  $7\frac{1}{2}$  metres at ordinary high tide; depths that will enable nearly every vessel that is now compelled to anchor outside to enter the port. Practically, to open the inner harbor to the Merchant Marine of the world. Calling the sum required to complete this item, ~~the~~ dredging, in round numbers, 500:000,000, the yearly interest at 6 per cent is 30:000,000.

The yearly Customs receipts of the port may be called about 8,000:000,000 of the general government, and 2,000:000,000 of the provincial government. Three per cent of which would meet the interest of the Cost of dredging. This would not be a large sum to be provided by the governments.

If the improvement of the port that would result from its increased depth and capacity is not worth the expenditure needed for its accomplishment, then would seem to be no very powerful reason for undertaking it; and this remark is applicable in the case of the other works proposed. The total estimated cost of all of the improvements indicated is 1,770:000,000, the interest of which at 6 per cent per annum, ~~the~~ would be about 9 per cent of the assumed annual receipts from Customs.

In my report is an estimate of the cost of eight iron piers at 15:000,000 each. Four of these are designed to be arranged in connection with the Alfandega, while the others may be arranged between the government and individual owners of the quays, by making their ~~various~~ bonded or by any other means which would give rise. The proposed quay-wall extension, is the only item of work recommended that would seem to offer any prospect of direct return; which may arise from the <sup>filling in</sup> creation of land behind, from the dredging,

from  
 and the quay frontage it would make in the port.  
 It is true that the construction of the breakwater on  
 the submerged reef, will create a safe, deep harbor  
 inside, in which vessels <sup>can</sup> anchor; but revenue  
 from <sup>special</sup> anchorage charges in that connection, could <sup>hardly</sup> ~~be~~ be  
 large enough to pay the interest upon the cost of the work.

In general, it may be considered that the works  
 recommended are not of a nature to yield direct  
 revenue. Meanwhile, under guarantees of the  
 Government, two important railways are being ex-  
 tended into the interior, the completion of which  
 is certainly destined to materially augment the  
 general commerce, trade and population, and thus to  
 warrant the outlay required to improve and enlarge  
 the commercial facilities of the port.

The Office of the Associação Commercial of Pernam-  
 buco <sup>refers to,</sup> very properly lays great stress upon the importance  
 of railway extensions to the interior as a means of  
 developing and bringing to market the products  
 of the Country, as the principal source of the future  
 increased business; though it is not necessarily the sole  
 means, since Pernambuco is advantageously situated,  
 and highly favored by nature as a desirable man-  
 ufacturing City.

The merchants of the City are by no means the  
 only parties interested in the future growth of the Trade  
 and Commerce of Pernambuco; the Citizens generally of  
 the City, of the Province, and of the whole Country have  
 an interest in it, since it leads to an increase of  
 revenue to the general and Provincial Governments; Con-  
 stituting a pecuniary return upon the cost of the improve-  
 ments, for the benefit of all.

Should the Government approve of the recommendations  
 of this report, and decide to receive proposals from  
 individuals or Companies for the construction of the

works, it will be necessary to give assurance of an adequate profit upon the capital required.

A sinking fund of 40:000 \$ 000 per annum, at 6 percent per annum would in 25 years amount to a sum equal to the total estimated cost of the works, namely, 1.770:000 \$ 000. Besides this there would be the yearly sum, <sup>during the same period,</sup> to meet the interest, <sup>or profit</sup> on the Capital invested.

In view of the financial situation, <sup>referred to,</sup> ~~as mentioned,~~ and of the restrictions indicated in the Office of the Associação Commercial of Pernambuco, in regard to any increase of port charges, it is not easy to arrive at a satisfactory solution of the problem respecting the most advisable method of securing the Capital for carrying out the proposed improvements.

I desire to return my thanks for many kind  
Comments and valuable information received from  
Officers of the government, and other gentlemen; and  
it is proper that I should mention the following:

In Pernambuco.— His Excellency Conde de Albuquerque  
President of the province; Dr  
Antonio Vicente do Nascimento Feitosa, do engenheiro  
Chefe interno da repartição das obras publicas provinciales;  
J. Hermann Augusto Erhardt, Engineer Civil; Thomas  
Swift Esq., acting Consul of the U. States; Mr. Henry Foster;  
E. W. Bonham Esq., British Consul General; Mr. Elliott, and  
Mr. Jansen, engineers, in charge of the Limoeiro Railway;  
Wells Hood Esq., Superintendent of the Recife and São Fran-  
cisco Railway; and Mr. Craven, Manager of the Per-  
nambuco Gas Works, ~~de Alcaçova~~.

In Ceará.— His Excellency Conde de Albuquerque  
de Padua Fleury, President of the province; M.<sup>mo</sup> Sr. Capitão  
Tenente Antonio Severiano Nunes, Capitão do porto; M.<sup>mo</sup>  
Sr. de Amaral Olinda de Vasconcelos, Director, M.<sup>mo</sup> Sr.  
engenheiro Chefe, and M.<sup>mo</sup> Sr.  
# Dr. Julius Penhas.  
Dr. H. Foglar Superintendent of Machinery, all of the Patente  
Railway; M.<sup>mo</sup> Sr. Dr. Alfredo Borges, engenheiro Civil,  
and John Mackay Esq., merchant, of Ceará.

In Maranhão.— His Excellency, Conde de Albuquerque  
Cinnato Pinto da Silva, President of the province;  
M.<sup>mo</sup> Ex.<sup>mo</sup> Sr. Barão de São Marcos, ad interno Capitão do porto;  
M.<sup>mo</sup> Sr. O Major João Manoel da Cunha; M.<sup>mo</sup> Sr. Praga  
Inspector of the Treasury; M.<sup>mo</sup> Ex.<sup>mo</sup> Sr. de Parão de Iba  
J. J. Tavares, Esq., Consular agent of the U. States; J. Wilson  
Esq., British Consul General; Mr. Airlie, agent of the  
English Steamers; and M.<sup>mo</sup> Sr. F. de Paula Silva Penir

In Aracaju, Province of Sergipe.—  
Excellency, <sup>Conde de</sup> D. Luis Alves Leite de Oliveira, <sup>Recebe</sup>



of the province; M<sup>rs</sup> Sr. José Avelino Silva Jacques,  
Capitão de Mare Guerra, Capitão do Porto; and  
M. Schramm, Merchant, in Maroni, I am specially  
indebted to M<sup>r</sup> H. F. Lebonof, of Aracajá, for material  
assistance during my examinations, founding, etc.

I am also under special obligations to Sr.  
Alcides de Pernambuco and his son the  
engineer Alfredo Carlos Alcides the latter  
of whom rendered me valuable assistance  
not only in my examination of the port of  
Pernambuco but also in that of Ceará &  
Mirambau.