1926.

THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA.

Brought up by Senator Barnes

Pursuant to Statute
By Command
In return to Order

Clerk of the Senate.
4th August, 1926.

# PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

# REPORT

TOGETHER WITH

# MINUTES OF EVIDENCE

RELATING TO THE PROPOSED

# CONSTRUCTION OF NEW WHARF

AT

# GARDEN ISLAND NAVAL ESTABLISHMENT, NEW SOUTH WALES.

*Presented pursuant to Statute; ordered to be printed,*

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MEMBERS OF THE PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

FIFTH COMMITTEE.

GEORGE HUGH MACKAY, Esq., M.P., Chairman.

| *Senate.* | *House of Representatives.* |
|---|---|
| Senator John Barnes. | Robert Cook, Esq., M.P. |
| Senator Patrick Joseph Lynch. | The Hon. Henry Gregory, M.P. |
| Senator Matthew Reid. | Andrew William Lacey, Esq., M.P. |
| | David Charles McGrath, Esq., M.P. |
| | Alfred Charles Seabrook, Esq., M.P. |

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EXTRACT FROM THE VOTES AND PROCEEDINGS OF THE HOUSE OF REPRESENTATIVES.

No. 30, dated 19th March, 1926.

4. PUBLIC WORKS COMMITTEE—REFERENCE OF WORK—GARDEN ISLAND NAVAL ESTABLISHMENT—NEW WHARF.—Mr. Hill (Minister for Works and Railways) moved, pursuant to notice, That, in accordance with the provisions of the *Commonwealth Public Works Committee Act* 1913-1921, the following proposed work be referred to the Parliamentary Standing Committee on Public Works for investigation and report, viz. :—Garden Island (New South Wales) Naval Establishment—Construction of a new wharf.

Mr. Hill having laid on the Table plans, &c., in connexion with the proposed work—

Question—put and passed.

LIST OF WITNESSES.





# NEW WHARF AT GARDEN ISLAND, N.S.W.

# REPORT.

The Parliamentary Standing Committee on Public Works, to which the House of Representatives referred, for investigation and report, the question of the proposed construction of a new wharf at Garden Island Naval Establishment, New South Wales, has the honour to report as follows :—

## INTRODUCTORY.

1. Garden Island, having an area of about 15½ acres, is situated in Sydney Harbour, and is the home base of H.M.A. Fleet. All repairs to Naval ships are carried out there ; and from this dépôt the Fleet is supplied with naval stores, torpedo and gun-mounting stores, and fuel oil. The longest wharf at the Island is 450 feet, which, it is represented, will be inadequate to accommodate the new cruisers now being built for Australia.

## PRESENT PROPOSAL.

2. The proposal submitted for the consideration of the Committee aims at the construction of a timber pile wharf 960 feet long. As the shore line is irregular, the wharf will vary in width from a few feet to a maximum of 133 feet. It is also suggested that there should be an extension on the southern side of the wharf of 52 feet to accommodate small craft. The proposed work will add an area of approximately 1½ acres to the Island.

3. The wharf is designed to carry a load of 500 lb. to the square foot, and is to be fitted with an electrically-driven travelling crane with a working load of 20 tons at a radius of 60 feet and capable of lifting 8 tons at a 90-ft. radius. On the wharf will be provided three electrically-driven capstans and the necessary bollards for mooring vessels.

4. Near the edge of the wharf, mains are to be carried and connexions provided in convenient positions for the following services :—

4-in. diameter fresh-water main.
5-in. diameter salt-water main.
3½-in. diameter compressed air main.
6-in. diameter oil fuel supply.
Cable to supply electric current to ships.
Cable to supply electric current to crane and capstans.

5. In constructing the wharf, it is suggested that the piles be of turpentine, the decking of brush box, and all the rest of the timber ironbark. To take the additional load imposed by the crane, it is intended to have the structure strengthened longitudinally by two steel girders.

## ESTIMATED COST.

6. The estimated cost of the proposal as submitted to the Committee was set down at—

| | |
|---|---|
| Piles in position | £24,560 |
| Caps and cross-walings | 8,058 |
| All other timber | 37,800 |
| Structural steel | 7,500 |
| Rails, bolts, spikes, fittings | 8,675 |
| Services (water, oil, air) | 5,000 |
| Services (electrical) | 4,000 |
| Additional small wharf | 1,000 |
| Removal of old work, &c. | 8,000 |
| Electric capstans, bollards | 1,000 |
| Sea-wall repairs | 2,000 |
| Crane and pontoon | 25,000 |
| General contingencies, &c. | 17,407 |
| | £150,000 |

and the time for completion about two years from date of commencement.

## COMMITTEE'S INVESTIGATIONS.

7. The Committee visited Garden Island, inspected the existing wharfage accommodation, and viewed the site of the proposed new wharf. A visit was also paid to various wharfs being erected in Sydney Harbour by the Sydney Harbour Trust, and an inspection made of the plant employed and the timber used in these structures. In addition, the plans of this proposed work were carefully examined, and evidence was taken from the First Naval Member, the Director of Naval Works, the Chief Engineer, Department of Works and Railways, the Captain-in-Charge of Garden Island, the Chief Engineer, Sydney Harbour Trust, the Director of Cockatoo Island Dockyard, the Director of Lighthouses, and others.

8. It was explained in evidence that the longest existing wharf at Garden Island is about 500 feet long, and, while capable of accommodating the present cruisers of the *Sydney* type, which are 457 feet long, it is represented to be totally inadequate to accommodate the new cruisers, which are to be 630 feet long. It is stated that a large proportion of the existing structures was erected 40 years ago, the decking in places has been attacked by white ant, the piles have suffered from the teredo, and it is claimed that the wharfs have outlived their useful life and are in urgent need of repair.

## SITE.

9. The position proposed for the new wharf is on the south-westerly side of Garden Island, with the front of the structure extending in a straight line almost north-east and south-west at a distance varying from about 40 feet to 60 feet seaward of the centre of the existing wharfs.

10. The average depth of water along the front of the old wharfs is about 20 feet, which is insufficient to accommodate vessels of a deeper draught than the *Sydney* type. The depth of water along the face of the proposed new wharf ranges from 24 to 34 feet, the average being about 27½ feet. The draught of the new cruisers is approximately 22 feet, and it is proposed to dredge to give a minimum depth at low water of 29 feet, the extra depth, it is represented, being required in case a vessel in a damaged condition is to be accommodated.

11. The harbour bottom is sandstone, covered with a few feet of clay, and is said to present suitable foundations for any wharf proposed to be erected.

12. In response to questions, it was learned that other sites were considered, but it was stated that no more suitable location than Garden Island could be provided excepting at very great cost.

13. In the course of the Committee's investigations, it was found that wharfage facilities sufficient to accommodate the new cruisers are in existence at Cockatoo Island, and, in view of the fact that that island is Commonwealth property, inquiries were made as to whether advantage could not be taken of that accommodation with a view to avoiding the proposed expenditure.

Cockatoo Island is a construction yard, and Garden Island a supply and repair dépôt, and it was represented on behalf of the Australian Navy that, excepting in war time, the Royal Navy practice separates repair work from construction work as much as possible, and it is considered bad policy to combine the two classes of work. Moreover, it was stated that Garden Island could not be replaced by Cockatoo Island. Even if repair work were undertaken at the latter place, the former would still have to remain a dépôt for the supply of oil, torpedoes, guns, gun-mountings, and many other supplies of a confidential nature which could not be stored in a place not under Naval control. Further, it was adduced in evidence that one of the conditions of the transfer of Garden Island to the Commonwealth was that it should be maintained as a repair station for the Imperial Navy.

14. Inquiries were made as to whether there was any likelihood of the accommodation now proposed to be provided proving inadequate in the course of a few years; but the Committee was informed that the 10,000-ton cruisers now on order are the largest vessels that can be built by Australia under the terms of the Washington Treaty, and that the length of wharf and depth of water to be provided will be sufficient to accommodate any Imperial ships likely to come to Australia.

15. Under these circumstances, the Committee agreed to recommend that the wharfage accommodation required be located in the position proposed.



## CLASS OF STRUCTURE.

16. The class of timber wharf recommended by the Department is of similar material and design to those usually erected for commercial purposes by the Sydney Harbour Trust. The Committee, however, instituted inquiries as to the advisability of providing a more substantial structure in concrete.

Evidence obtained indicated that the position chosen for the wharf lends itself admirably to the construction from point to point of the bay of a straight line of wall, which could be filled in at the back and covered with concrete, forming a solid and permanent work.

The advantages claimed for such a structure are that it would eliminate any annual cost for maintenance, would not be effected by white ant or teredo, would do away with the necessity of strengthening the wharf to take the travelling crane, could be loaded up to any weight, and be practically indestructible.

It was stated that the wall could be constructed of reinforced concrete trestles after the design of those used by the Sydney Harbour Trust, or could be formed of large massed concrete blocks or hollow blocks of reinforced concrete. Ample filling is available, as it was stated in evidence that the Sydney Harbour Trust has to dispose of 1,000,000 cubic yards of material taken from Sydney Harbour every year, and such material could be supplied at a cost of about 1s. a cubic yard.

17. The Chief Engineer, Department of Works and Railways, estimated that the cost of constructing a wharf of reinforced concrete cellular blocks would be about £247,570, or, with the trestle method of construction, £256,375, while the use of solid massed concrete blocks would be considerably more than either.

18. Although members generally were favorable to the use of concrete as providing a more substantial structure, they did not consider that the large extra expenditure involved in its use could be justified. It was accordingly agreed to recommend that the wharf be constructed of timber as proposed.

19. The decision arrived at by the Committee in connexion with this matter is shown by the following extract from its Minutes of Proceedings :—

Mr. Mackay moved—

That in order to provide accommodation for the new cruisers due in Australia in 1928, the construction of the timber wharf at Garden Island as submitted to the Committee be proceeded with as early as possible.

Seconded by Senator Reid.

The Committee divided on the motion—

| Ayes (6). | No (1). |
|---|---|
| Senator Lynch. | Mr. Gregory. |
| Senator Reid. | |
| Mr. Cook. | |
| Mr. Lacey. | |
| Mr. Mackay. | |
| Mr. Seabrook. | |

And so it was resolved in the affirmative.

## TIMBER TO BE USED.

20. In the proposal submitted to the Committee, it was suggested that the wharf be constructed with piles of turpentine, decking of brush box, and the remainder of ironbark. All the evidence indicated that turpentine piles are almost exclusively employed in Sydney Harbour, and most successfully resist the ravages of the teredo; but some witnesses were of opinion that the various States produced timbers which would be equally suitable for decking, walings, &c., as the New South Wales brush box or ironbark. As the Committee considers that the supply of this timber should not necessarily be restricted to New South Wales, if equally suitable timber at the same price can be obtained elsewhere, it recommends that turpentine piles be used in the wharf, but that tenders be invited in all States for the remainder of the timber required.

## SERVICES ON THE WHARF.

21. Evidence obtained indicated that the electric capstans, electric cables, and the fresh water, salt water, compressed air, and oil fuel services were in accordance with Naval requirements and are considered satisfactory; and the Committee is agreeable to their installation as proposed.

## TRAVELLING CRANE.

22. As the provision of a travelling crane of the size and capacity proposed involved the expenditure of the sum of £25,000, careful inquiries were made to ascertain whether some method could not be devised to eliminate or reduce this item. It was stated, however, that considerable weights have to be lifted during the overhaul or refitting of vessels, including guns of 20 tons in weight, torpedo tubes up to 16 tons, machinery up to 10 tons, &c., while plates, timber, and heavy engine parts requiring repairs are handled every day. It was represented that the sheer legs at present on the island are obsolete, as their use necessitates the moving of the vessel in every instance; and to bring over the 150-ton Titan floating crane from Cockatoo Island for heavy lifts would be inconvenient and uneconomical, and still necessitate the provision of a travelling crane for smaller lifts. It was further explained that the cost of this crane is due to a large extent to the fact that it is of great height and is required to be able to lift 20 tons at a 60-ft. radius and 8 tons at a radius of 90 feet.

23. As the Naval authorities contend that the provision of this crane is essential to the convenient working of the Island, and its use will save approximately £4,000 per annum in its lifting operations, the Committee agreed to recommend that it be installed as requested.

G. H. Mackay.

G. H. MACKAY,
Chairman.

Office of the Parliamentary Standing Committee on Public Works,
Federal Parliament House, Melbourne,
29th June, 1926.

# MINUTES OF EVIDENCE.

(*Taken at Sydney.*)

WEDNESDAY, 21ST APRIL, 1926.

*Present:*

Mr. MACKAY, Chairman;

| | |
|---|---|
| Senator Barnes | Mr. Lacey |
| Senator Reid | Mr. McGrath |
| Mr. Cook | Mr. Seabrook. |
| Mr. Gregory | |

George Francis O'Connor, Director of Naval Works, sworn and examined.

1. *To the Chairman.*—It is proposed to erect a new wharf at Garden Island. The existing accommodation is totally unsuitable for the new 10,000 ton cruisers, and if something is not done to overcome the difficulty these vessels will have to anchor in the stream. At present there is a series of short length wharfs alongside the island. It is proposed to embrace them in an extended wharf, which will be 960 feet long, running from about the extremity of the existing northern wharfs to the extremity of the existing southern wharf. The longest existing wharf is a little short of 500 feet long. It is at the north end. Portion of it—100 feet—was built 40 years ago. The other portion—400 feet in length—was built from 1914 to 1916. Of this wharf, 100 feet will be included in the new wharf construction. The portion which was built 40 years ago is pretty well gone by now, but it will do for the small craft for a number of years to come. Small repairs have taken place from time to time, and old piles which have gone have been replaced. The existing centre wharf will be removed altogether—that was part of the work carried out 40 years ago. It is in a bad state of repair. That section is 200 feet long and 32 feet wide. There is a third existing wharf at the south end—it is about 300 feet long, 100 feet of which is old work, the balance having been reconstructed about 1916. Between the existing centre wharf and the southern wharf is a portion of ground which has been reclaimed, and has always been occupied by the sheerlegs, an old-fashioned means of hoisting heavy machinery and guns out of vessels. The average depth of water along the old wharfs is about 20 feet, so that no vessels bigger than light cruisers of the *Sydney* type could come alongside it. The existing wharfs are not in a straight line, whereas the new wharf will connect the corners of the existing wharfs in a straight line. It will be a timber wharf of the ordinary harbour type. There will be 960 feet of main wharf and 52 feet of small wharf for small craft. Any portion of the old wharfs in good condition will be included in the new wharf, portion of the existing northern wharf will thus be included. It will be a pile-driven structure, with 15-feet spans on the longitudinal frontage and 10 feet spans across it. The estimated cost of the work is £150,000. The wharf itself will represent about £100,000. The sum of £20,000 is provided for a travelling electric-driven crane with a hoist of 20 tons at a radius of 60 feet and 8 tons at a radius of 90 feet. It will be one of the latest types of dockyard cranes. Its far reach will give it a great advantage. It will traverse the whole of the frontage of the wharf for a distance of 960 feet. It will take heavy lifts from the ships. It will remove guns for replacement or repairs. It will lift up to 20 tons, and I think 18 tons is the biggest weight of a gun on the new type of cruisers. At present there are sheerlegs on the island to take these lifts, but they do not reach out far enough to take a lift from the outside of a ship. Consequently, the vessel has to be taken out and turned the other way if the sheerlegs cannot reach the spot where the lift has to be taken. These sheerlegs will be dismantled and the new crane will take their place. They might be used for some other purpose, but they would be in the way if they remained where they are. The balance of the £150,000, namely, £30,000, will be spent in providing various services. There will be a 4-inch fresh water main, and a 5-inch salt water main running just inside the timbers on the front of the wharf. The former will be required to supply fresh water for ships, and the latter will be used for washing-down purposes and for a fire service. The fresh water is obtained from the Sydney water supply through a main which runs under the waters of the harbour to the island. Other services to be provided will be a compressed air main for various services to the ships, electric lighting mains of 240 and 110 volts, with a number of points at convenient spots on the wharf to light ships that are out of commission through their own wiring, a 6-inch oil main along the wharf for the bulk of its length, a crane power main—a high power installation of 240 volts intended for the use of the crane for the full length of the wharf, three electric capstans—one at each end of the wharf and one in the middle—and steel girders and double piling for the full length of the wharf to carry the heavy travelling crane. Ordinarily we depend on the Sydney Harbour Trust to carry out our naval work, not having the necessary plant ourselves. They generally submit an estimate, but it is subject to alteration. In case it is not enough, we have to pay more. That is not a satisfactory way of carrying on business. My Department has never asked for tenders from outside contractors for this class of work. We have hitherto been dependent upon the Sydney Harbour Trust to carry out any work for us, but I should say that this will be a big enough work to warrant the purchase of the necessary plant by the Works and Railways Department so that it may do the work itself. I do not know who is responsible for estimating that this work would cost no more than £60,000. A captain in charge of an establishment in submitting his year's programme may make up an estimate for himself or ask the Works Director for the State to give him an estimate for any proposal he may be submitting. When that £60,000 was mentioned as the probable cost of this work the full details of the scheme were not worked out. In any case, the cost was very much under-estimated. The work itself is very urgent. As a matter of fact, it will be difficult to build a wharf in time to receive the new 10,000 ton cruisers that are expected here in about two and a half years' time. I should say that it would take two years to complete this work if the equipment were available and the Works and Railways Department undertook the work themselves. I have not the faintest idea how long it would take the Sydney Harbour Trust if we had to depend on them. Without this new wharf the new cruisers would have to be moored in the stream, and all their stores and everything else taken out to them across the water. I do not see how they could be accommodated at the existing wharfs. I have had personal experience in wharf construction while working for the Fremantle Harbour Trust and the Bunbury Harbour Trust in Western

Australia. The teredo are supposed to be bad in certain timbers in Sydney Harbour, but it is said that they scarcely ever attack the turpentine piles which we shall be using. The old piles in the existing wharf were of ironbark, they were not sheathed. The mountain ash piles in use were sheathed. The longest pile on the new wharf will be 48 feet long. The bottom will be made even by sinking potholes in the rock to a certain depth. The rock is at a fairly even level. The concrete sleeves used on the piles on the naval wharf at Brisbane were put on before I saw the wharf. The scheme of sheathing with a concrete sleeve was tried on some piles at Fremantle. They were supposed to protect it against the teredo, but the reports are that this scheme has not proved a success. I cannot say what effect it has had at Brisbane. Small wharfs are constantly being constructed in Sydney Harbour. For short pile work I should say that reinforced concrete piles could be used, but for the work requiring long piles they are so heavy that it is difficult to handle them. For lengths up to 40 feet a concrete pile costs 14s. 3d., as against 8s. for a timber pile. You would require just as many concrete piles as timber piles. All the piles in the proposed wharf will bottom in the rock. This rock is generally known as Hawkesbury sandstone, which is easily drilled for piles. They can be driven for the last few feet into these potholes. That is the system generally adopted in Sydney Harbour. The piles do not go more than 5 feet into rock. The depth shown on the plan of this wharf is 4 feet. The piles will pass through silt first. At low water the depth in front of the new wharf will be 24 feet at the shallowest spot right at the end of the wharf, and 34 feet in the deepest, the average depth being 27½ feet. The draught of the new cruisers will be 23 ft. 6 in. The ordinary neap tides in Sydney Harbour have a range of 4 feet. At spring tides the range is 7 feet, but the average tide for Sydney Harbour, except under abnormal conditions, is 4 ft. 6 in. If the Australian fleet is multiplied by three under the new programme, I doubt whether the vessels could be handled at Garden Island without further expansion. However, there is room on the island for expansion; it is about 18 acres in extent. We have always understood that the island is the property of the Commonwealth. An arrangement was originally made by the State Government with the Royal Navy that it was to be the property of the Navy, and the Navy has continued to hold it. When the Royal Navy hauled down its flag at Garden Island we considered the island automatically passed over to the Commonwealth, and that the Commonwealth would possess all the properties of the Royal Navy. We have sufficient confidence in our ownership of the island to justify the Commonwealth in embarking on a further expenditure of £150,000 on it.

2 *To Senator Reid.*—Garden Island is a ship-repairing establishment. It is also the home for all the naval officers and ratings. The building of the new cruisers has made the building of a new wharf imperative. I would not say that it was not economical to carry on the work on the island with the present wharfage accommodation, but in order to carry on little bit by little bit has been added until things are in such a shape to-day that it is difficult to operate under existing conditions. The old wharfs are only holding together because they are bolted. They have really spent their life. Without a new wharf they would have to be renewed, and if we do not get a new wharf we shall have to tackle the job of renewing the old wharfs at once. A certain amount of expenditure is required to put the existing wharfs in a proper condition and to give the electric, water, and oil services proposed to be introduced. The estimated cost of that work would be £100,000, and would have to be carried out quite apart from the new construction proposed. The last report upon the timber in the existing wharfs is that the more recently constructed parts are in quite good order. Those piles are sheathed. It is not proposed to sheath the piles in the new wharf, because turpentine piles have been known to last up to 40 years or more in Sydney Harbour without sheathing so long as the bark is left on them when they are first driven. They say this is an advantage. I am not sure of it, because I have not had any experience of these piles. On Circular Quay goods sheds have been built on piles, and have been there for a great number of years. The new crane proposed to be installed will be a modern up-to-date dockyard crane that can be used for all heavy lifts. The sheerlegs on the island do their work in a very awkward fashion. They are a fixture. Whenever a heavy lift has to be made you must shift the ship to a point opposite them. The existing wharfs would not carry a crane unless a considerable amount of money was spent upon them. An improved crane is necessary to carry on the existing work economically. Therefore a portion of the proposed expenditure will not be solely due to meeting new conditions. The crane will serve all purposes, but as it must have a lifting capacity to handle the heavy lifts on the new cruisers it must be bigger than would have been otherwise necessary. The new wharf will increase the depth of water alongside except at the extreme ends. No dredging will be required for the new cruisers. A pile would not get any better hold by being sunk to a depth of 6 feet. The Sydney Harbour authorities are building on a pothole system, but we think they go down too far. The decking of the wharf will be 9 inch by 5 inch jarrah.

3 *To Mr. Lacey.*—The widest portion of the wharf will be 133 feet. Mr. Connell and I have come to the conclusion that jarrah decking will be better than ordinary Australian hardwood, which does not last too long. I think jarrah is the best timber for the purpose. All rail lines on the wharf will be sunk below the level of the decking. There will be no sheeting on the front of the wharf. The water will run back to the sea wall. We went into the matter of reclaiming the front, but found that it would cost three times as much to reclaim it as to have timber work all the way. We generally cut the piles straight off to make a flat bottom on them; they sit better in that way. If the hole is too big we put concrete in to stiffen the pile. The actual depth of the pile in the rock will be 4 feet. It is true that at low tide the depth of the water in front of the wharf at the end will be 24 feet, whereas the draught of the new cruisers will be 23 ft. 6 in., but no vessel would reach that depth at the point where the water is shallow. It would be in nothing less than 27 feet at low water. The draught at the stern end of the vessel is very much less than at the middle. A cruiser would be perfectly safe lying alongside that wharf. We went very carefully into the matter of the shallow depth at the end.

4 *To Mr. McGrath.*—During the war when three cruisers had to be overhauled at the one time the island was frightfully congested. They had to tie two vessels together and take everything to the outer vessel over the one lying alongside the wharf. The *Australia* could not berth at the wharf; she berthed around the corner on dolphins, which were specially driven for her. I do not see why the new crane should not be made in Australia. I do not think that patents would prevent it from being made here. It is a straight-out ordinary crane. It is its capacity to lift a big weight at a big radius which necessitates its special design. As a rule, the Sydney Harbour Trust has carried out all marine work in connexion with naval bases in Sydney. I think the biggest job was the last section of 120 feet of wharf at the southern end of the island. It is not satisfactory to us to have the work done by the Trust, for the reason that we have to depend on their convenience to make a start. They do not mind if they keep us waiting eighteen months before they commence a job. We have had to wait a year or two in order to get a start on a small job. The plant we would require to do this work ourselves would be ordinary pile-driving machines for heavy piles, some winches, barges, and various things for the transport of piles, and a pothole sinking plant. The Naval Department have none of this plant. It disposed of the whole of its plant when it sold the dredgers and barges some years ago. The expenditure on the purchase of the required plant would be comparatively small, except that the pothole-sinking plant is rather expensive. If we did the work ourselves it would be a day-labour job—if we could get the right man to run it. The Works and Railways Department does not do much work under the water, and it really has not the staff to undertake a job like this It would call in special people to do it, but they are not hard to get.



5. *To Mr. Seabrook.*—It is proposed to have 18-inch piles. From the high-water mark to the top of the jetty the depth is 12 feet. There will be no bottom walings and braces on the piles. They are not used on a nest of piles nowadays unless it goes to a greater depth than 48 feet over all. It spoils your work to introduce iron work into the piles below low-water if it is not necessary. There is a double waling running across the wharf on every tier connecting with the land. I think the wharf will be sufficiently tied to withstand any thrust that might be applied by a ship striking very hard. Fenders are not supposed to be there when a ship is tying up. During a gale of wind a fender would keep a ship off the wharf without any danger to it. I have not heard of any pile being broken on the island through the weight of a vessel coming alongside the wharf. In modern construction we avoid getting any bolting below water level such as would be necessary by having a bottom waling at the low-water line and bracing it by diagonal braces. In our design a pile has been inserted to take the thrust of any undue pressure. The crane will run along iron girders. I have been told that its weight will be about 100 tons distributed over the four corners; and as it will carry up to 20 tons the dead weight thus distributed will be 120 tons. I think it is necessary to have girders. I do not know that it would be better to have an extra pile and make the span between the piles under the travelling crane 7 ft. 6 in. instead of 15 feet, and do away with the girders. The usual type of construction is to have a steel girder under a heavy crane, but with the insertion of an extra pile you certainly could put in a timber beam to carry the weight. The top waling piece will be 14 inches by 14 inches; the decking timbers will be 9 inches by 5 inches. The mooring bollards will be cast iron, and they will be bolted through the curb, the decking, and the half caps. They will be better than having a pile running right up. Bolts and nuts are to be used. There will be no dummy bolts. It is only when a dishonest contractor under faulty supervision comes into the scene that dummy bolts are used. I think we should have girders where we have 15 feet spans. To put in another pile and beams suitable enough to carry a crane would cost more than a steel girder. I would not use a 14 inch x 14 inch beam with a central pile to carry the weight of the crane.

6. *To Mr. Cook.*—The piles will be obtained from Coff's Harbour or Myall River. The teredo is not supposed to be bad in Sydney Harbour where turpentine piles are used. It is not difficult to sink potholes in Hawkesbury sandstone. We might escape having to sink potholes at the southern end where there is from 15 to 20 feet of silt to go through. The proposed expenditure will provide accommodation for the four light cruisers and the two new cruisers in their turn. It will provide accommodation for all the fleet we have in view at the present time. I dare say it would provide for two additional cruisers of the type now under construction, but we could not have them all at the island at once. In peace time we could deal with them in turn so that there would be any amount of accommodation for them, but we could never deal with more than two at a time

7. *To Mr. Gregory.*—Without dredging we could not get battleships of the biggest type alongside the new wharf. In the event of such a vessel coming here for repair, the work could be done in the stream, but I doubt if a large ship of the *Hood* type 6 feet down by the stern could enter Sydney Harbour She would either have to sink or be repaired outside the harbour We have no docking or wharfage accommodation here to provide for a ship like that if she were lamed. The new seaplane carrier—a 6,000-ton ship of light draught—would be provided for at Garden Island. I went into the matter of what timber should be used on this wharf with the engineer of the Sydney Harbour Trust some years ago, and he said that jarrah piles seemed to be standing up to their work, but that no other piles except turpentine were doing so. The Harbour Trust has done some concrete work. I understand that the Fremantle Harbour Trust has abandoned the use of timber piles and adopted reinforced piles for long lengths, but the teredo is much worse at Fremantle than it is in Sydney. If we use turpentine piles without sheathing, we reckon that this wharf will last at least 40 years. Officers of the Works and Railways Department have studied the effect on wood in water in consultation with people who have been accustomed to this particular class of work. The Sydney Harbour Trust are not sheathing their piles; they have built very extensive goods sheds on the wharfs at Circular Quay, and they put heavy cargo in those sheds. If replacement is required they have a pile extracting machine, and they simply drive in a new pile in place of the old one. No expensive plant would be required to build this wharf except what would be necessary for making the potholes. That is done by a drill which is like a cylinder with teeth on it. It hits like a steam hammer and crumbles the rock inside. This rock is then washed out by the big force of a spray of water. I should use ironbark beams, which it is said can be obtained. The longitudinal beams are very close together. I would not use jarrah for waling pieces. The qualities of karri are not understood very well. Karri makes an excellent beam. However, so far, it has only been decided to use turpentine piles and jarrah decking. The electric crane will run along the outer rails close to the edge of the wharf It is designed to balance in such a way that the weight, wherever the job is, will be distributed over the four corners. It will have a fairly long wheel base We have made provision for the heavy weight of the crane by having double piles and steel girders beneath it. We shall be able to move our trucks from one line of rails to another without having crossings. We can do that with the crane: it will lift a load of 20 tons at a distance of 60 feet. The cross traverser used on the pier at Port Melbourne is an excellent idea. If we have the full width of accommodation for which we are asking, the whole rail system can be slightly modified to suit. I doubt if the sheerlegs will be put up anywhere else; they are practically obsolete. A 5-inch salt-water service on the wharf with the electrical booster pumps we propose under the scheme should be ample for fire protection purposes. I consider that this work should be done by the Works and Railways Department by day labour I do not know that there are contractors who would undertake to do it The first estimate of £60,000 was given on very little data, and it did not include all the necessary services It was just for a bare table fixed in the water, and I do not know who supplied it.

*(Taken at Sydney.)*

THURSDAY, 22ND APRIL, 1926.

*Present:*

Mr. MACKAY, Chairman;

| | |
|---|---|
| Senator Barnes | Mr. Lacey |
| Senator Reid | Mr. McGrath |
| Mr. Cook | Mr. Seabrook. |
| Mr. Gregory | |

John Francis Robins, Captain, Royal Australian Navy, Captain-in-Charge, of New South Wales, sworn and examined.

S. *To the Chairman.*—I submit to the Committee the following reasons why additional wharfage accommodation and lifting appliances are necessary at Garden Island:—Garden Island is the home Base of H.M.A. Fleet. All repairs to ships of the Fleet are carried out at Garden Island. The Fleet is also supplied with naval stores, torpedo and gunmounting stores, from the storehouses on the island, and an oil tank containing 5,840 tons of oil is provided for supply to H.M.A. ships. The island does not possess a wharf of sufficient length to accommodate one of the new cruisers, the longest wharf being 450 feet only. The present cruisers of the *Sydney* class are 457 feet long. The new cruisers will be 600 feet long. A new cruiser lying at the present wharf would overlap both factory steps and main steps. This would interfere considerably with the boats from the Fleet and the Establishments, which use these steps. The cruiser could also not be shifted either ahead or astern, which is frequently necessary for refitting or other purposes. The depth of wharf space between the factory and store buildings, and the existing water front, is very small. This leads to great congestion of material alongside the ships refitting, and is especially noticeable on the sheerlegs wharf, where all the main refitting work is carried out. Heavy lifts can only be made under the sheerlegs. These sheers are fixed, and it is consequently necessary to move ships backwards and forwards to plumb them, adding very largely to the expense of the work, and frequently involving considerable delay. The proposal is:—

(*a*) To construct a wharf approximately 960 feet long, carrying a 20-ton electrically-driven travelling crane, electrically-driven capstans for mooring, and the necessary bollards for securing ships, and provided conveniently near its edge with fire main, fresh water main, compressed-air service, and electrical connexions for supplying current to ships.

(*b*) To remove the obsolete and inadequate sheer legs, the floating crane *Titan* being requisitioned for the rare occasions on which lifts are necessary beyond the capacity of the new travelling crane.

(*c*) To renew the existing wharfs, where necessary. The main sheer and coal wharfs were constructed over 30 years ago, and are due for replacement.

The total estimated cost of proposals is £150,000, made up as follows:—

| | | |
|---|---|---|
| Rebuilding old wharf .. .. | | £24,000 |
| Travelling crane .. .. | | 20,000 |
| New wharf .. .. | £76,000 | |
| Stiffening for crane, and additional services—compressed air, electrical connexions, &c .. .. | 30,000 | |
| | | £106,000 |
| | | £150,000 |

A new 10,000-ton cruiser, and a cruiser of *Sydney* class, could be accommodated and refitted simultaneously at the main wharf. In time of war or emergency, when it might be necessary to store and oil both cruisers at the same time, two 10,000-ton cruisers could be accommodated alongside the island—one at the main wharf, and one at the oil wharf. The issue and return of naval stores and gear would be greatly facilitated. Much inconvenience and time are saved when dealing with storekeeping requirements of ships if the vessels are moored alongside the island, as lighterage, double handling, and a considerable amount of packing, are obviated. The extension of the oil fuel pipe line will also greatly facilitate the oiling of ships alongside Garden Island. Ships lying alongside will be provided with improved facilities, viz., electrical connexions, compressed air, and fresh water mains. The new electrical travelling crane will be able to deal with practically any weight likely to require removal from a modern light cruiser during a refit, including guns, torpedo tubes, boats, funnels, masts, and most items of machinery. It will plumb any point in the deck of the cruiser, thus obviating shifting ship for purpose of lifting heavy weights. The crane will be a valuable national defence asset, being of far greater utility for ship refitting than any existing crane in Australia. The following table gives a comparison of present light cruisers (5,400 tons) with the new cruisers (10,000 tons):—

| — | Present Light Cruisers. | New Cruisers. |
|---|---|---|
| Displacement—Tonnage | 5,400 tons | 10,000 tons approx. |
| Length .. .. | 457 feet | 600 feet approx. |
| Breadth .. .. | 49 feet 10 inches | 68 feet 4 inches |
| Draught (Maximum) .. | 18 feet 3 inches | 20 feet |
| Fuel Stowage .. | 1,210 tons coal<br>260 tons oil | 2,150 tons oil |
| Complement .. | 488 officers and men | 750 officers and men, approx. |

The following statement, showing the work carried out, stores supplied, and numbers of employees at Garden Island, will give the Committee an idea of the extent of the operations of the Establishment, and of its importance as the home Base of H.M.A. Fleet:—

Average number of hands employed in factory and storehouses for year ended 30th June, 1925. (*Note.*—These numbers include civilian staff only—officers and men of R.A.N. borne in H.M.A.S. *Penguin* are excluded, numbering, approximately, 350):—

830—No.

Total value of repair work carried out in factory at Garden Island during the year ended 30th June, 1925 (this includes repair work for H.M.A. Ships, H.M. Ships attached to and visiting the Station, Naval Establishments at Flinders and Jervis Bay, Naval Reserve Depôts in the various States, and the repair of naval stores):—

| | | |
|---|---|---|
| Labour .. .. .. | | £125,500 |
| Material .. .. .. | | 58,000 |
| Total .. .. | | £183,500 |

Total value of stores issued from storehouses at Garden Island to H.M.A. Ships and other Naval Services, during the year ended 30th June, 1925 (excluding stores for repair work, which are included above):—

| | | |
|---|---|---|
| Naval stores .. .. .. | | £136,000 |
| Torpedo .. .. .. | | 152,000 |
| Gunmounting .. .. .. | | 15,000 |
| Total .. .. | | £303,000 |

Total value of stores held at Garden Island:—

| | |
|---|---|
| Naval stores .. .. .. | £750,000 |
| Torpedo stores .. .. | £350,000 |
| Gunmounting stores .. .. | £120,000 |

The new cruisers now under construction in the United Kingdom are expected to arrive in Australia about the middle of June, 1928, and it is very desirable that the new wharf should be ready for use by this date, or at the earliest possible date after their arrival. The depth of water along the line of the new wharf will be 28 feet at low water, without dredging. The existing wharfs will require extensive repairs, at a cost of about £24,000. They are all constructed of timber. The new wharf is estimated to have a life of 40 years. Garden Island is the only repair yard we have in Australia. All the ships connected with the Navy go there for refitting. As the existing wharfs are set at an angle to one another, it is very difficult for ships to come alongside, especially during a southerly buster; but once they are alongside, they are quite safe, because the southerly buster is dead ahead. However, a ship would not come alongside if there was a heavy wind; she would wait until it lulled. I have been Captain-in-Charge for twelve months. I was also Captain-in-Charge for three months about five years ago. Since April, 1901, I have lived on Garden Island for three and a half years. I have never known a cruiser to strike the wharf heavily. I would prefer a concrete wharf, because it is more durable. It is absolutely necessary to have the expensive crane designed in the proposal before the Committee to deal with the heavy weights to be lifted from the ships. We have no appliance at present with the necessary height for any lift from 1 ton to 20 tons. There is a great deal of this lifting during refitting. Funnels may be lifted; part of a mast may be taken away. There are heavy hoists from the engine-room—cylinders or turbines may have to be hoisted out. There is always something to be lifted. The weight may be only 1 ton, but there is no method of handling it now along the whole length of the wharf. The present system is by means of the old fixed sheers, which are difficult to manage, the ship has to be moved to plumb the sheers, and then remoored to allow the sheers to lift the weight. It is then moved away again. These sheers will be of no use when the crane is provided, because the new front of the wharf will leave them inland. As a matter of fact, they are now obsolete. I think the new wharf will meet requirements for a long time ahead. It is not within the bounds of possibility that the department may transfer its activities to Jervis Bay. The weather would prevent that. I am certain that Garden Island will be continued. To repair the existing wharfs would not be sufficient to make provision for the new cruisers. The south wharf would accommodate one vessel; but she would prevent work from proceeding on the rest of the front, because her length would cover the whole wharf and the landing steps In other words, although the present accommodation may be sufficient for small ships, it will be totally inadequate for the new cruisers. The site of the new wharf has been very carefully considered. It will be on the lee side of the island. We do not do private work on the island, and we only accommodate ships belonging to the Navy. The island covers about 15 or 16 acres. It appears to be very congested, but it is not congested from the point of view of work. There is not much more space to build on; but, looking ahead, we cannot see that much more building will be required. Three new structures sanctioned this year will carry on our work for at least 20 or 30 years. Even with the arrival of the new cruisers, the improvements effected will be mostly to existing buildings, and no more ground space will be taken up. We have been awaiting the completion of the new wharf to provide new latrines for the workmen. Our fresh-water pressure has been reduced by the metropolitan water supply authorities; but we will restore the pressure by means of a booster pump in case of a fire. That will obviate having fire engines. There will be an ample depth of water at the wharf for the new cruisers. Whereas the draught of the *Australia* was 30 feet, the new cruisers have gone back to a draught of 20 feet. Therefore, the 28 feet of water at the wharf will be ample, and no dredging will be needed to accommodate the new cruisers.

9. *To Mr. Lacey.*—There will be 28 feet of water at the outer edge of the new wharf. It will be very easy to dredge out the spot at the southern end, where the depth is stated to be only 24 feet. If the new cruisers had not been ordered, and Garden Island had continued under normal conditions, it would still have been necessary to repair the existing wharfs. As a matter of fact, for many years past we have been trying to get them straightened out. The proposal was submitted to the Admiralty 25 years ago. The lay-out has never been regarded as good from a seamanship point of view No other point, coming up the Harbour, towards Garden Island, would need to be dredged to meet requirements. If the whole front of the new wharf were dredged to a depth of 32 feet, ships could come alongside at any part. The dredging could be undertaken at any time. The rails on the wharf will be sunk to the level of the decking. From the point of view of permanency, a concrete wharf would be infinitely preferable to a timber wharf. We must have a new wharf. It will improve everything on the island. The woodworking shops and the wood stores on the island are close to valuable buildings. There is a danger from fire. There is an idea to concentrate the wood-entering and wood-taking ships at the north end, and the enlargement of the wharf will give us room to place the wood stores there.

10. *To Mr. McGrath.*—At Garden Island, we repair submarines also. Aeroplanes are refitted at Randwick. We could repair two cruisers at the new wharf at the same time. That is the biggest margin for which we could make provision. If we had, in all, six 10,000-ton cruisers, we would thus be in a position to refit 33 per cent. at the one time, and it is a big limit. I do not think that we shall see bigger ships built than the *Australia*. The repairing facilities all over the world are so limited that, if bigger vessels were built, it would also be necessary to build bigger docks and so forth. That is our greatest safeguard in that respect. The *Titan* is a big floating crane belonging to the Navy Department. It is left at Cockatoo Island. It is a shipbuilding crane, capable of lifting a weight of 150 tons. It is an enormous affair, and is floated wherever it is required. It requires four men to handle it; and as steam has to be got up every time, it is an expensive affair, and unsuitable for our light repair work. When the new cruisers arrive, we shall have to increase our quantity of stores in proportion to their requirements. The cruisers will have a working life of ten years, and then a further fifteen. They are of a type which does not change very much. We shall not see any great changes in the construction of cruisers.

11. *To Mr. Seabrook.*—If the day comes when the repair work will become too big for Garden Island, and the main repair shop needs to be removed somewhere else, then the Fleet would have increased to such an extent that the stores would absorb the accommodation now taken up by the repair shop, and the island would become a big depôt. As each of the new ships carries 750 men, it would be necessary to have a big depôt on the island. The stores, torpedoes, and oil fuel, as well as the facilities for allowing a vessel to lay up when the men go on leave would be retained. In that connexion, we are providing electric light mains on the wharf, so that a ship can carry on the routine with power supplied from the island. Garden Island would thus become a big storehouse, and a new wharf would still be required to enable the new cruisers to take in stores, oil, &c. In 1902, the Admiralty took into consideration the question of razing down the hill at the north end to make more room for a victualling store; and I always understood that the New South Wales Government gave the Admiralty the victualling store at Darling Harbour in order to avoid cutting down the hill. The hill at the south end has been removed and used for reclamation purposes. However, we shall have plenty of room for further operations without th-

removal of the hill at the north end if the new wharf is completed. It has been reported to me by the engineers of the Department of Works and Railways, that the existing wharfs need extensive repairs. I know, of my own knowledge, that the existing wharfs need re-decking. I had one portion taken out, and the whole thing was affected by white ants, although the surface looked all right. The existing wharfs will not last for many years. We can get a direct lift from the sheerlegs. With them, you can just plumb the centre of a ship like the *Sydney*. With the travelling crane, we shall not only be in a position to lift a load of 20 tons from a cruiser alongside the wharf with the jib up to the working height, but we shall also be able to take a lift out of a destroyer on the far side of the cruiser. The crane is specially designed to deal with two boats lying alongside one another at the new wharf. The wharf will be capable of accommodating one of the new cruisers and one of the old cruisers; or one of the new cruisers could lie alongside the main wharf, and another similar cruiser alongside what is known as the oil wharf. In that way, we could have two of the new cruisers berthed simultaneously at the island.

12. *To Mr. Cook.*—The average number of persons engaged on the island is 800, excluding the personnel of the Fleet. When the new wharf is constructed, we can refit any modern cruiser with a draught of less than 28 feet. In regard to the space available on the island for repair work, there is accommodation for fifteen years ahead. Our Fleet is small now, but we do not know what its future expansion may be. I do not know of any other site in Australia more suitable for doing the work done at Garden Island. From a naval point of view, repair work should be kept separate from construction. It is better for the ships, and the Admiralty always keeps the two classes of work separate.

13. *To Mr. Gregory.*—The Admiralty has never considered the question of building vessels at Garden Island. It was never intended to be a shipbuilding yard. The proposed additional expenditure is to improve the island as a repair yard. It will improve the place tremendously, and greatly improve the facilities there. I am not a civil engineer, but, to my mind, an outer row of concrete piles would last for ever. If a ship came into contact with the wharf, it would be the ship itself that was damaged, and not the wharf. In any case, if a pile is broken, it can easily be replaced. Fender piles are not required if care is exercised in bringing vessels alongside. I have never seen a vessel damage the wharf at Garden Island. The sheerlegs on the island are obsolete. They were put up 30 years ago. They are of an out-of-date pattern, and their engine is obsolete. I do not think they could be used anywhere else; their life is finished for naval purposes. A 5-ft. sea water main on the wharf will be quite sufficient for fire protection purposes. It can always be supplemented by the fresh water main. The sea water main is provided so that fresh water need not be wasted on flushing the ships, or by being used in the lavatories. The booster pump on the island will enable us to get sufficient pressure in an emergency. There is no intention of increasing the activities on the island except for repairing purposes. There will be ample depth alongside the wharf for the seaplane-carrier, and for all requirements for a number of years ahead.

14. *To Senator Reid.*—Garden Island is used by the Australian Navy, but if any British naval vessel, such as a surveying ship, needs repairs, we do the work and charge it to the British Admiralty. We could repair any man-of-war, but any deep-draught vessel would have to go to Singapore for docking. We could effect repairs to any vessel up to 12,000 tons. We have a very good plant at the island for repair work. Any vessel up to a draft of 28 feet could come alongside the new wharf, and we could repair others in the stream. The biggest battleship—the *Hood*—is 860 feet long. Apart from the necessity for making provision for the new cruisers, the existing wharfs would have to be renewed to improve our facilities for effecting repairs. The new wharf will facilitate our work tremendously. It will give us more space. Vessels can come right alongside opposite the repair shops. Apart from the new cruisers, the outlay now proposed would be economical for the work we are now doing.

*The witness withdrew.*

Percival Edwin McNeil, Engineer Commander, Royal Australian Navy, and Engineer Manager, Garden Island, sworn and examined.

15. *To the Chairman.*—There are two main reasons why a new wharf is necessary. The first may be regarded as a strategical reason, which demands that ships of the Royal Australian Navy, particularly in war time, must have a main base equipped with a wharf to which they can secure on coming into harbour, to take in stores and fuel in the shortest possible time, exchange or replace any defective, worn, or lost armament, and generally get ready for sea again as quickly as possible. Garden Island, being the principal naval store and armament depôt in Australia, and possessing facilities for carrying out repairs, is obviously the site for this wharf. The existing wharfs have actually served this purpose in the past, but the advent of ships too great in length to be moored to these creates a necessity for a more suitable wharf to be built; and as the old wharfs have now reached the stage where their timbers require renewal, the opportunity to make the necessary alterations to meet future requirements at minimum cost is at hand. I refer to this briefly before passing on to the second reason, which is that which concerns me, as Engineer Manager of the island, particularly. The second main reason why the new wharf should be built is that it is necessary in order that our naval ships may be kept in a state of thorough efficiency in the most economical way. From this point of view, the crane included in the proposal is a requirement of immediate urgency, and the new wharf is essential to carry the crane, together with the pipe lines for various services. The principal weights to be handled on ships alongside Garden Island are:—

*Guns, up to 20 tons in Weight.*—All guns have to lifted periodically for examination and for overhaul of their mountings.

*Torpedo Tubes.*—These range up to about 16 tons in weight, are carried by all warships, and require to be lifted annually for overhaul.

*Torpedoes.*—Weight, approximately 1½ tons. The stock of spare torpedoes is kept on the island, and ships draw their supplies therefrom.

*Spare Machinery for Ships.*—Spare auxiliary engines, motors, and parts of main machinery, such as propellers, are stored on the island until required for fitting on ships. Weights range up to about 10 tons.

*Boats.*—Up to 5½ tons in weight. Boats are regarded as stores, and are drawn by ships from the island. When defective beyond the capacity of the ships' staffs to repair, they are returned to the island and repaired in the yard.

In addition to the foregoing, there is a great deal of crane work in connexion with general repairs to the ships. Boat davits must periodically be lifted from their sockets to be cleaned of rust and greased. Funnels, searchlights, auxiliary engines, and spars, have occasionally to be lifted; while plates, timber, and



heavy engine parts requiring repairs are handled every day. Naval stores, in cases up to 5 tons or so, have also to be handled frequently. The Naval Department owns a modern crane for heavy lifts in the *Titan*. This crane, however, which is designed to lift 150 tons, is entirely unsuitable for the every-day work of Garden Island. The only appliances on the island for lifting weights from ships are the sheerlegs, and small 3-ton and 5-ton travelling cranes. The latter are useful to a certain extent in removing weights from small craft like destroyers, but cannot reach positions on decks of cruisers in which they can be of any use. The sheerlegs are used, on an average, about one day per week. They require a working crew of five men, apart from those actually handling the weights on board. Owing to their fixed position, however, the ship has to be so placed that the weight lies under the sheerlegs, and this involves great labour in shifting ships. An incident illustrating the inconvenience and loss caused by the sheerlegs occurred two days ago. Two guns on H.M.A.S. *Adelaide* required lifting. Two tugs, and 28 dockyard men were employed on the job, and, in addition, much labour was expended by the naval ratings of the ship. Tugs were not available in the meal hour, so the ship was shifted during working hours. The wind was unfavorable, and things went rather badly. The two shifts required to place each of the guns in turn under the sheerlegs, and the securing of the ship occupied two and a quarter hours. The cost of the 28 men's labour was approximately £7. A wire rope was broken, which cost £10 15s. to replace; and the two tugs cost £5 each; making a total of £27 15s. The greatest loss, however, resulted from all electric current being shut off the ship for one and three-quarter hours. At least 150 men, belonging to the ship or the yard, employed in the depths of the ship, were unable to carry on their work for that period. The lifting of the guns would have been effected at a total cost of £1 or £2 had a crane of the type now asked for been available. The sheerlegs, besides being so inconvenient generally, are entirely unsuitable for the lifts of from ¼ ton to, say, 3 tons, which cover by far the great majority of weights to be lifted. As the result, these small weights must be manhandled, or improvised lifting arrangements used. It is estimated that the travelling crane would result in lifting operations being carried out at approximately £4,000 per annum less direct cost than at present. The indirect savings to be effected are difficult to calculate, but I believe they would be still greater. It is essential that the crane installed should be able to plumb any portion of the deck of vessels of the size of the cruisers now being built. This could be done, and the heaviest weights required to be lifted—the guns—could be handled by the crane now under consideration, which would be able to lift 20 tons at a radius of 60 feet, or 8 tons at a radius of 90 feet. Some slight modifications in these figures may be made when designs are finalized, but they represent approximately the requirements. The crane proposed is a far more useful one for ship repair work than any existent in Australia. In the event of any such unlikely contingency as the removal of the Naval Establishments from Garden Island, it could readily be transported to a new site. There is no doubt that war operations anywhere on this side of the world concerning this country would soon reveal a shortage of facilities for repairing ships, and particularly of cranes. This crane, therefore, should also be regarded as a national asset, a direct measure to meet the requirements of war time, but possessing the great merit of paying its way at all times. This crane could travel only along a straight wharf. As usually two ships, apart from the smaller craft, such as destroyers, will be alongside at one time, and it is essential that the crane have travel enough to serve the two ships, that the greatest service may be obtained from it, it is necessary that the wharf be long enough to accommodate a new cruiser and one of the existing cruisers at one time. The only practicable way to obtain a straight wharf of this length is that shown in the plans which have been prepared. The straightening out of the wharf as proposed would increase the area of the island by approximately 1¼ acres. The gain of space in front of the workshops, and the removal of the small boat traffic to the southern end of the wharf, would be very conducive to general efficiency in handling work on the island itself. The island is at present too congested on the western side. A crane of the dimensions proposed would be out of place without this increase of ground area. A considerable item of cost in the scheme is the provision of fresh and salt water, compressed air, electricity mains, and oil fuel mains along the wharf. Alongside a wharf equipped in this manner it will be unnecessary for a ship to maintain steam on her own boilers. This is a most important point, as under these conditions the ships' companies will be able to carry out more repair work themselves than at present, thus saving the cost of much dockyard labour. When the berths alongside are not occupied by ships undergoing refit, they will, undoubtedly, be eagerly sought by others anxious to get alongside so as to make the most effective use of the labour of the ships' companies in keeping the ships efficient. Such services can only be supplied by the island in a small way at present. I think the new crane will weigh more than 100 tons. As we originally intended, it was to run on a track 25 feet wide; but in preparing the plans of the wharf, the Works Department thought it advisable to gauge it at 30 feet. It would not be desirable to have this crane built in Australia. Crane building is a highly specialized industry. It is quite outside my sphere to say what strength will be required in the wharf to carry the crane. The crane itself will contain a motor, to enable it to traverse the wharf from one end to the other. In the plan, the main steps will not be eliminated; they are being developed to take the place of both the factory wharf and the main steps, that is to say, the existing steps are being altered and developed to provide better accommodation than the existing main steps and the factory steps together provide at present. Refitting of a cruiser lasts from three weeks to six weeks, according to the size of the vessel. The ships all take their turn. There is nearly always one vessel alongside for refitting. As a matter of fact, we sometimes have a little difficulty in that respect, because the Commodore of the Fleet is naturally anxious to take all his Fleet to sea at once; whereas at the island we always want one ship alongside to refit in order to keep the amount of work we have in hand at a steady level. There is, therefore, a good deal of compromise, and sometimes we have two or more ships alongside, and occasionally none at all. It is absolutely necessary that the crane should have the lifting power for which we are providing.

16. *To Mr. McGrath.*—The straightening out of the wharfs in the way proposed has been thought of for some years past. Five years ago, it was considered a most desirable alteration to make, but no actual request was put forward. The idea just simmered until the necessity for carrying out the work was forced on us by the ordering of the new cruisers. The old wharfs would have required the expenditure of a lot of money on them, even if this new work were not undertaken. The crane could be built in Australia if the designs were obtained elsewhere; but I take it that it could not be done locally for £20,000. There are no great engineering difficulties in the actual construction of it. Recently, the Sydney Harbour Trust have done some alterations and repairs for us. Their work has been satisfactory, and recently there has not been very much delay in carrying it out. We have no plant on the

island for building this wharf. We should require rock-borers and pile-drivers. We have no staff on the island with any knowledge of this class of work, and we should be obliged to rely on some one outside to do it for us.

17. *To Mr. Seabrook.*—This work is as necessary as is the Navy itself. It is absolutely essential for carrying on our work at the island. It is possible that the island may not prove large enough in 40 years; but I should say that for 20 years it will be quite large enough. At the end of that time, the repair work might have to leave, but the other activities would remain. The wharf will quite justify itself, even if the engineering work is taken away at the end of 20 years. The crane could be taken to the new refitting yard. I am inclined to estimate the weight of the crane at about 120 or 130 tons; but the actual strength of the wharf necessary to carry this weight seems to me to be determined by the weight on one bogie of the crane. Each leg has a small bogie. The Works Department decided that a spread of 30 feet would allow for a better pile arrangement underneath. The girder should stand a colossal weight. We understood that the complete load on each bogie would not exceed 80 tons, and I should say, offhand, that the girder would carry that weight easily. There are two girders, and the crane is carried at four points, approximately 30 feet apart, so that only one corner of the crane will be carried on a span. The actual weight will be divided by four. There will also be the load on the corner of the crane, due to the leverage of the jib, which would possibly bring it to 80 tons on one bogie. But that would be the greatest weight on one span.

18. *To Mr. Gregory.*—The Washington Treaty limited the armament of cruisers to guns of 8-inch bore, which weigh approximately 18 tons. There will be no creeping on to 9-in. and 10-in. guns. The matter has been fixed by the Washington Treaty for eight years. We may ask the builders of the crane to make provision for a 30-ton lift at a smaller radius. The present arrangement is for a 20-ton lift at a 60-ft. radius. There are two means of picking up the current for a travelling crane. One is from a contact wire taken in a conduit below the surface of the wharf; the other is by means of an electric cable, which automatically coils or uncoils from a drum on the crane. With the crane we could lift a weight of 8 tons from the inner side of a destroyer lying outside a cruiser at the wharf. It will do away with a tremendous lot of shifting of ships, and give increased rapidity in dealing with vessels requiring to get away quickly. We think we are justified in asking for this increased expenditure. The naval engineers accept responsibility that the crane asked for will meet their requirements, but not for the strength of the wharf. That is a matter for the engineers of the Works and Railways Department; and I think they would very much resent it if we even claimed any share of responsibility in that regard. At the same time, for our own personal interests, we would keep an eye on the thing, and point out anything we considered a weakness. Both water mains will be fitted with hose connexions, so that for fire purposes the one can supplement the other. I think the provision in that respect is quite ample.

19. *To Senator Reid.*—I have not seen a crane of this size at work, but I have seen others which approach it in size. There are probably patents attached to it. The various makers of cranes would most likely be called upon to submit designs, and a selection would be made. There would, no doubt, be patents involved which would hinder the work being done in Australia. It is, however, a practice for controllers of patents to license other firms to incorporate those patents in their work upon the payment of a royalty. I think it can be said that all modern cranes have patent devices on them. It would be better to have the work done by a firm with experience in the manufacture of this type of crane. Apart from the new cruisers, it would be an economical advantage to have a crane of this kind to carry on the work now done at the island. The present lay-out of the wharf is not adapted to accommodate a travelling crane; otherwise, no doubt, one would have been installed long ago.

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*(Taken at Melbourne.)*

WEDNESDAY, 28TH APRIL, 1926.

*Present:*

Mr. MACKAY, Chairman;

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| Senator Barnes | Mr. Lacey |
| Senator Reid | Mr. McGrath |
| Mr. Cook | Mr. Seabrook. |
| Mr. Gregory | |

Thomas Hill, Chief Engineer, Department of Works and Railways, sworn and examined.

20. *To the Chairman.*—I have prepared plans and descriptions of the proposed wharf at Garden Island. The proposal sets forward a wharf approximately 960 feet long with an extension of 52 feet on the southern end for the accommodation of small craft. The wharf is designed to carry a load of 500 lb. to the square foot, and is fitted with an electrically-driven travelling crane with a working load of 20 tons at 60-ft. radius, which is capable of lifting 8 tons on a 90-ft. radius. On the wharf there are provided three electrically-driven capstans for mooring, and the necessary bollards for securing vessels. Near the edge of the wharf mains have been carried and connexions provided in convenient positions for the following services:—

4-in. diameter fresh water main.
5-in. diameter salt water main.
3½-in. diameter compressed air main.
6-in. diameter oil fuel supply.
Cables to supply electric current to ships.
Cable to supply electric current to crane and capstans.

The design, as shown, is for a timber wharf, strengthened longitudinally with two steel girders to take the additional load imposed by the crane. The piles are of turpentine, the decking of brush box, and all the rest of the timber is ironbark. In working out the design, three methods were considered:—

(1) The construction of a wharf 960 feet long and 45 feet wide, and the reclaiming of the space between the wharf and the shore by means of a retaining wall and filling with spoil.
(2) Piling whole space and covering with timber decking—all timber.
(3) Whole space to be decked over, piles and headstocks of concrete, and superstructure of timber.

The comparative costs of these schemes are given below:—

| | |
|---|---|
| (1) 45 feet wide wharf and filling— | |
| Timber wharf ... ... ... | £75,000 |
| Filling—50,000 cubic yards, at 10s. | 25,000 |
| Surfacing—4,000 square yards ... | 4,000 |
| Retaining wall—900 feet long, 45 feet high ... ... ... ... | 90,000 |
| Crane and pontoon ... ... | 25,000 |
| | £219,000 |



| | |
|---|---|
| (2) All timber wharf, which we submit is the best proposal— | |
| Piles in position .. | £24,560 |
| Caps and cross walings .. .. | 8,058 |
| All other timber ... . | 37,80? |
| Structural steel ... ... | 7,500 |
| Rails, bolts, spikes, fittings ... | 8,675 |
| Services (water, oil, air) ... ... | 5,000 |
| Services (electrical) ... ... | 4,000 |
| Additional small wharf ... ... | 1,000 |
| Removal of old work, &c. ... | 8,000 |
| Electric capstans, bollards ... | 1,000 |
| Sea wall repairs ... ... ... | 2,000 |
| Crane and pontoon ... ... | 25,000 |
| General contingencies, &c. ... | 17,407 |
| | £150,000 |

| | | | |
|---|---|---|---|
| (3) Concrete piles and headstocks—timber superstructure— | | | |
| Work similar to (2) | ... | ... | £92,382 |
| Concrete piles ... | ... | £42,640 | |
| Headstocks ... | ... | 15,000 | |
| | | | 57,640 |
| | | | £150,022 |
| Crane and pontoon | ... | ... | 25,000 |
| | | | £175,022 |

With timber construction, 40 years is a fair estimate of the full life of the structure, and taking schemes (2) and (3) and capitalizing, the following result is obtained:—

Cost of timber structure—£125,000.

| | |
|---|---|
| Interest at 6 per cent. per annum ... | £7,500 |
| Maintenance—£2,000 every five years... | 400 |
| Sinking fund—Annual payment at 5 per cent. compound interest to amount to £125,000 in 40 years ... ... | 1,035 |
| Total annual expenditure ... ... | £8,935 |

At 6 per cent., £8,935 will be received at interest annually on £148,916, so that the interest charges on scheme (3) cover the total annual charges on scheme (2). There is this added advantage that in 40 years time the payments to the sinking fund would, if necessary, provide an entirely new wharf, or allow of remodelling with the old timbers, whereas a concrete wharf after standing for 40 years could not readily be altered. I am not prepared to recommend the concrete wharf as being the better proposition. Although concrete has been used for this class of work, we have no evidence that it will last anything like the time that a timber wharf will. Cracks are likely to develop in concrete piling which may lead to the total collapse of the wharf. I am, therefore, not prepared to recommend the reinforced concrete proposition. Our experience in the Sydney Harbour is wide. We have for years maintained a number of Commonwealth wharfs and works there, and, in this case, we unhesitatingly favour a timber structure. It is not a matter of economy. I am not submitting the first proposition at all, because the cost of reclaiming the space between the wharf and the shore by means of a retaining wall, and filling in with spoil, is out of all reason. It is also a moot question whether it could be completed in two years time to be ready for the new cruisers. In any case it would be difficult to obtain 50,000 cubic yards of filling in the vicinity of Sydney Harbour. Number 1 proposition is, therefore, completely out of the question. We have given these proposals mature consideration, and have arrived at the conclusion that No. 2 proposition for an all-timber wharf is the one best adapted under the circumstances. It will save £69,000 on the first proposition and £25,000 on the third proposition, which is for concrete piles and head stocks. If possible the work will be done by contract. We have had experience of the Sydney Harbour Trust carrying out work for us. It is quite possible that, on some works in Sydney Harbour, delay has been caused because the Harbour Trust has not made its plant readily available to those carrying out the works. The Trust has carried out work for us. We have considered tenders too high, and the Trust has done the work at a considerable saving to us. The Trust does not tender against private contractors. It carries out the work at actual cost, plus 10 per cent. for supervision. There has been no difficulty in getting firms to contract for this class of work, but their prices have been high. In one case the lowest tender was £2,950, and the Sydney Harbour Trust carried out the work for £2,650. I believe that various haphazard figures have been put forward as the price for carrying out this work, but no estimate of £30,000 has been made by the Department of Works and Railways. No difficulty has been experienced in using turpentine piles in New South Wales. All the timbers used in the proposed work will come from the Northern Rivers district. These timbers last well. They are to some extent subject to the ravages of teredo, and that is why I have given the life of the structure as 40 years. The present wharf is of hardwood, and even that is 40 years old. Our experience in Sydney Harbour has been wide. The Harbour Trust uses turpentine piles. Usually, that class of timber is accepted as the best proposition. It is not necessary to sheath the piles. Such an expenditure would only be a waste of money. I have heard of the Hyde patent, which is in use in the Brisbane River, but the cost of sheathing in this case is not justified. At Garden Island the foundation has been thoroughly examined. It is composed of sandstone rock. The piles will be potted into the rock. There will be no difficulty in drilling. It is quite a common practice to pot-hole piles to a depth of 4 ft. 6 in. There will be no difficulty in drilling rock at a depth of 30 feet. The diver usually places the piles in position. I do not anticipate any difficulty in getting the plant for this work. We estimate a cost of about £7 10s. for drilling each hole. The cost would be practically the same whether for timber or concrete piles. We may be able to use in the new structure a portion of the decking and timbers of the old wharf, which are above water. We have allowed nothing in the estimate for that, in fact, we are providing a sum of money for removing the old wharf. It has reached the end of its life. It may last a few years yet, but once it is touched it will be of no use. The load of the crane over the 15-ft. bay between piles will equal 75 tons. The steel girdor is designed to take that load. It is really a built-up girder Any one versed in modern practice would not dream of using timber girders in such a proposition as this. To provide it the necessary strength, it would require a built-up timber beam, 36 inches by 14 inches, taking the sheer at 300 lb. to the square inch. The steel girder is undoubtedly the better proposition. It will also help to bind the whole structure together. The provision of a timber girder was considered, but we decided that it was out of the question, considering the amount of timber that would be required to carry the load. The estimate of a life of 40 years for the timber structure is based upon our considerable knowledge of Sydney Harbour conditions. We went so far as to prepare a design for a concrete wall, but, ultimately, decided against the proposition. A hair crack in reinforced concrete would permit of the penetration of salt water, and very likely lead to the ultimate collapse of the structure. We have not had sufficient experience of reinforced concrete piles to justify their extensive use in a structure like this. They could be used in small works where any loss through collapse would not be great, but it would not be advisable to use concrete piles in a huge undertaking such as this. Many engineers are not satisfied regarding the durability of reinforced concrete in salt water. There have been some

distressing failures in this connexion. The present concrete retaining wall has only been in existence for seven or ten years. There have been many failures in this class of work. An amount of £3,000 is provided for repair work on the existing wall, which is really not of concrete. Concrete is used in one or two places, but the wall is built mainly of sandstone and rubble. Then, again, the concrete is in mass form, and not reinforced. I am frightened, not of the concrete itself, but of the reinforcement, and the probability of salt water penetrating through it. We must be very careful as to the quality of the cement used, and to guard against injuries, because the slightest blow will cause cracks in the concrete At Rabaul we decided on a timber wharf in preference to one of reinforced concrete, although I should have liked to experiment with the use of reinforced concrete there. Both the salt water and fresh water mains will be sufficient for requirements.

21. *To Mr. Gregory.*—During the last fifteen years the Sydney Harbour Trust has carried out many of its own works. In designing this wharf there has been no collaboration with the Trust. It is our own design, and is based on our observation and experience of Sydney Harbour over a period of many years. Turpentine piles are not so subject to teredo ravages as are other woods. A life of 40 years is quite reasonable for turpentine piles. It is not proposed to sheath them, because the expense of so doing would not be justified. The saving on sheathing would about meet the cost of replacing the piles later. We have not used any concrete piles in Sydney Harbour. Some were used in Darling Harbour, but the general practice is to use turpentine piles. Even in Darling Harbour the use of concrete piles depends on the circumstances. In this case the turpentine piles would be much more satisfactory than concrete piles. We gave consideration to the question of building a concrete wall and filling up the space with dredge material. We took out the quantities for a depth of 45 feet, but the cost of such a scheme was found to be out of all proportion. The wall would need to be keyed into the rock. The width of 45 feet as shown under that proposition would be at the narrowest part. The average width of the wharf would be about 90 feet. I am aware that, near Onslow in Western Australia, there is a reinforced concrete jetty nearly 1 mile long, the total cost of the structure being £100,000. A great deal of that jetty was constructed at a shallow depth. It was necessary to go that distance out to get a sufficient depth of water. I have seen the ravages of teredo in Western Australia. At Rabaul we decided to use timber piles. In the case of the wharf at Darwin, I would suggest timber piles with sheathing, not of bronze metal, but of the Hyde patented process. The head stocks under the concrete proposition consist of that portion of the wharf between the top of the pile and the decking. I consider that the steel work for the carriage of the crane is absolutely necessary The weight of the crane would be 75 tons over 15 feet centres. That is the estimate, not for the whole load, but for the load on the front girder. Holes will be bored in the rock foundation to a depth of 4 ft. 6 in., and the piles will be potted into them. This will give a splendid foundation in the sandstone for the weight of the crane The Navy Department has asked for a 4-in. fresh water main and a 5-in salt water main. I intend to ask why that department considers a 5-in. main with a Booster pump necessary. For fire purposes I would sooner do without it, and rely on the ordinary fresh water main and Booster pump. I do not like two fire appliances in a dépôt We are increasing the mains by providing a 6-in. main right around the Island. Unless the salt water main is wanted for washing down, or other purposes, it will probably be cut out. I certainly think that tenders will be called for this work, and that they will be considered independent of the Harbour Trust altogether. We have no intention of approaching the Trust respecting this job. It has carried out other work for us at actual cost, with 10 per cent. for supervision, but it refuses to tender for work. This is a big job, which will give the contractor an opportunity to spend money on the plant. I certainly think that we shall receive a good tender for it. I have not seen the ravages of teredo pest on the Queensland wharfs. I am aware that, in Fremantle, the authorities are using reinforced concrete piles in place of wooden piles, but the wood used there is not so good as turpentine. Several factors have to be taken into consideration when building wharfs, and what I might advise in one place I might not advise in another. I think that the authorities at Fremantle are wise to experiment with reinforced concrete piles. I should not be at all surprised if their experiment turned out to be a failure, especially if the wharf receives severe blows from vessels. It is not intended to use fender piles on this wharf. Raking piles have been provided to take the thrust. The mass of the wharf will be so great that with the heavy girders and raking piles it will withstand a considerable impact without injury. There is no necessity to use sheathing in this case. If the structure were of reinforced concrete it would be necessary to have fender piles, and to take all precautions to prevent the wharf receiving the slightest blow. The estimated cost of £150,000 for a wharf 960 feet long is not a high price considering the size of the timbers to be used and the character of the structure. The timbers will comprise turpentine, ironbark, and brush box. The beams will be 40 feet long. The wharf will be of the same character inside as on the outside, because a weight of 500 lb. to the square foot will be distributed over the whole structure. Any attempt to reduce the weight and quality of the wharf would probably prove to be disastrous. The inner portion of the wharf will probably receive greater wear and bear greater weight than that part immediately adjacent to steamers. The additional space will be of great value to Garden Island, and facilitate the handling of material to and from ships. The electric power is obtained from Sydney, as is also the water supply.

22. *To Senator Reid.*—I know of instances of teredo attacking turpentine piles, but it takes a long time for the pest to have any effect. Before any damage is done the insect must penetrate the sap wood. The design of the wharf shows a complete absence of bolting or cutting below the water line. This is done designedly to prevent injury to the heart of the pile. When placing the pile in position every care will be taken to prevent injury to it. It would take a long time for teredo to affect the sap wood of turpentine. The piles will be lodged into position. In the event of the machine driller boring a hole slightly out of plumb, it will be necessary to force the pile by a tap or two. The machine can be adjusted. If the pile is not fitting tightly the diver puts concrete around it. Very little damage is done to the pile itself during this operation. For this wharf I prefer timber to reinforced concrete piles. They will last at least 40 years, and by that time it may be necessary to re-model the whole wharf. By providing a sinking fund in the same way as is done respecting the Government's main roads policy, the cost of this structure can be wiped out in 40 years. The beams and the superstructure generally will be of ironbark, the piles of turpentine, and the decking of brush box 5 inches thick. Ironbark is used for its strength and durability. I quite expect to receive tenders for this work from outside firms, apart altogether from the Sydney Harbour Trust or Sydney firms. In the case of the Rabaul wharf, we received five tenders from well-established firms The Sydney Harbour Trust does practically all its own work. There is no difficulty experienced in potting holes in rock foundation. A charge of 10 per cent. for supervision, although quite reasonable for a small job, would be high for the proposed work. There has been no collaboration with the Sydney Harbour Trust respecting this work, and I can assure the committee that tenders will be invited for it. The present wharf is in such a bad state that I would not spend one penny on it. It will not last more than four years, and would be absolutely useless for the load that will have to be carried when the new cruisers arrive. Leaving the cruisers out of the question altogether, it would be necessary to incur considerable expenditure very soon to improve the wharf facilities at Garden Island. It would be impossible for Garden Island to carry on any longer with the present wharf.



23. *To Mr. Seabrook.*—The length of the piles will be generally 40 feet, and they will be potted into a rock foundation to a distance of about 4 ft. 6 in. It is necessary to go to that depth to give sufficient security. A depth of 2 feet would not be sufficient, considering the length of pile and the load that it would have to carry. The diameter of the pile at the top will be about 12 inches, and at the bottom about 18 inches, averaging from 15 to 16 inches at low-water mark. The sea in the Sydney Harbour, especially at Garden Island, is not at all rough. I do not anticipate any trouble from the present design of the structure, even when the 10,000-ton cruisers are laying alongside. I have heard that some of the piles on the present jetty have been broken, but I do not wonder at that, because they are so rotten that the slightest blow would break them I am quite satisfied about the strength of the pile to be used on the proposed wharf. We gave consideration to the use of 18-in. x 10-in., instead of 14-in. x 14-in. girders, but the former are more difficult to obtain. In this case the ironbark girders will be hewn or axed in the bush. We have been using a lot of this class of timber on the river Murray works, up to the size of 18 inches x 18 inches. I consider that the 14-in. x 14-in. girders are suitable for this class of work. I do not think that it would be preferable to replace the steel girder with a timber one 36 inches x 14 inches, which size would be necessary taking the sheer at 300 lb. to the square inch. If, instead of using double piles with a 15-ft. span, single piles were used giving a bay of 7 ft. 6 in., it would not get rid of the sheer. That is why the steel girder is provided. I have seen drawings of this type of crane in use in the United States of America, and they show that it is being carried on a steel girder. I have not been able to locate a crane of such dimensions in Great Britain or Australia. It is news to me that a crane is in use on the King's Pier at Hobart, capable of lifting 25 tons, with a jib of at least 70 feet in length. I shall take the earliest opportunity to see it. The weight of a girder, I suppose, would run out at about 125 lb. to the foot run. The girders will be in 30-ft. lengths, each covering two spans. We may try to get 45-ft lengths. A steel girder is absolutely necessary We gave a great deal of consideration to this matter. The tendency of modern practice is to replace wood with steel wherever possible. I should like to use more steel than is proposed above high-water mark. When the structure is finished it will be continually tested, and the first sign of weakness will be immediately detected. In this respect there would be just as much difficulty with concrete as with wooden girders. Bottom walings will be put in above water level. They will be notched about 3 inches into the piles, independent of the bark. This will mean actually 8 inches to be taken out of each pile. We propose to fix the girder on top of the pile by a cast steel cap. I shall certainly give consideration to the suggestion that both the walings and the piles be notched, so as to give greater stability to the piles We intend to advertise for tenders for this work. Usually Commonwealth tenders are not advertised in all the States, but in this case advertisements will appear in all States. I have never known the Sydney Harbour Trust to tender for work. At times, if we have thought a tender high, we have asked the Trust to carry out the work at actual cost, with 10 per cent. added. In the main the work has been carried out at less than contract price. I can assure the committee that we have never had any suggestion of the Harbour Trust intending to tender for this work. Tenders will be called and advertised, certainly in four or five of the States. The old wharf will be demolished as the new wharf is being erected. I am very much afraid that the new cruisers will be here before the wharf is ready for them. We shall certainly find a use for any good material taken from the old wharf. The period of use of reinforced concrete piles has been so short that it cannot be taken as an index of what the ultimate life of the pile will be. Until this type of pile has been in use for a number of years it is not advisable to embark upon any large work as an experiment or test. At present, turpentine piles are preferable to reinforced concrete piles. It is not our function to give consideration to the question of whether this work will be sufficient for Commonwealth requirements in 40 years' time. That is really the function of the Navy Department. The crane will be imported under separate contract. I am satisfied that the timber wharf will give satisfaction, and will be quite capable of dealing with the load that will be placed upon it. Excavations in the rock for the present wharf were made 35 years ago. The character of the sandstone round Sydney Harbour is well known. Recently we put down piles at the back of the Island. The work was done for us by the Harbour Trust. There is a little sand above the rock. A long length of pile must have a secure grip in the rock.

24. *To Mr. Seabrook.*—I shall certainly consider the suggestion to have timber girders of 18 inches x 10 inches instead of 14 inches x 14 inches as proposed, and to notch the beam as well as the pile.

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*(Taken at Hobart.)*

WEDNESDAY, 5TH MAY, 1926.

*Present:*

Mr. MACKAY, Chairman;

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|---|---|
| Senator Barnes | Mr. Lacey |
| Senator Reid | Mr. McGrath |
| Mr. Cook | Mr. Seabrook. |
| Mr. Gregory | |

Herman Robert Hutchinson, Consulting Engineer to the Hobart Marine Board, sworn and examined.

25. *To the Chairman.*—For wharf construction in Hobart we have used timber on account of its cheapness, and it has proved fairly satisfactory. The teredo is not troublesome in these waters, but as a precaution against it we char the piles. The longest pile we use measures about 108 feet. The river bottom is mud and rock. The wharf at the Electrolytic Zinc works is built on sandstone, and I think we bored 8 feet into the rock and drove the pile into the hole. A hole having been prepared with an augur, the pile should be set at least 4 feet or 5 feet into the rock, and the foot of the pile concreted in. The concreting is done by a diver, and is necessarily slow work The large travelling crane on the Hobart wharf has a lifting capacity of 25 tons, and its total weight is 60 or 70 tons. In order to strengthen the wharf we piled it closer under the crane, the piles being 6 ft. 8 in. centres. I recommend the placing of steel girders under the crane to be installed on the Garden Island wharf. We use in Hobart a 6-inch waling, which is let into the pile about 3 inches. Timber facing of the piles is not necessary, but at one time chains were hung about the wharfs for the assistance of people who might fall into the water, and for the same reason the piles have been sheeted. This sheeting does not protect the piles to any great extent. The beams should

be of sawn timber if it can be obtained. Squared beams are out out of small trees and have the heart in them, sawn timber is much stronger. I do not think it is possible to satisfactorily drive iron-shod piles into sandstone. In constructing the Electrolytic Zinc Company's wharf we merely shot a hole into the sandstone and then drove the pile.

26. *To Senator Reid.*—At the ocean pier we put in about 400 piles, and in the Zinc Company's wharf 900 in rock. We bored the holes to a depth of about 8 feet, charged them heavily, and after firing stepped and drove the piles. We found that was sufficient without using concrete, but the practice to be adopted must be governed by the nature of the bottom. We prefer bluegum for piles, for we find that it will last from 30 to 60 years in water. All the damage to our wharfs is done by the limnoria, a crustaceaan not more than one-eighth of an inch long, which attacks the piles from the outside, and by boring millions of small holes gradually destroys it. The average length of the piles in the Hobart wharf is about 70 feet. The whole wharf is sheeted. The sheeting saves a certain amount of abrasion and reduces the light under the wharf. The limnoria is not so active in darkness.

27. *To Mr. Cook.*—We have not used concrete piles in Tasmania, but I have seen them in use in New Zealand harbours, where they appear to be very satisfactory. Some of the earlier concrete piles showed signs of rust on the outside, but that was due to the reinforcement not being sufficiently covered with concrete. I saw in New Zealand concrete piles up to 100 feet in length. I am not in a position to estimate the life of a pile in Sydney waters; even in different localities of Tasmania the life of piles varies. The object of using explosives in connexion with pile-driving is to shatter the sandstone and thus provide a foothold for the piles. In the Zinc Company's wharf the piles are 10 feet centres, and they load about 1 ton to the square foot. Steamers up to 7,000 tons displacement have berthed there. No trouble has been experienced with that wharf. We do not use bracing under the water, but we employ bracing piles extensively. If the bottoms of the piles are to be cemented into the sandstone, it would be advisable to bore a neat hole. Boring is more effective, but more costly than shooting the hole. The cost of concrete piles would be about two and a half times that of timber. In Hobart we pay only 2s. 6d. to 3s. 6d. per foot for timber.

28. *To Mr. Gregory.*—The quality of bluegum varies according to the nature of the country in which it is grown. Piles from open country where the timber is well grown and gets plenty of sun last much longer than others. There is a plentiful supply of 50 feet piles of good quality bluegum. I do not know how bluegum piles would stand in northern waters; they might be subject to the attacks of teredo. Some piles sent to Fiji some years ago did not last well, but I do not think they were of bluegum, which is a tough, interlocked timber, and does not split. Turpentine would probably last longer than bluegum The ordinary cost of bluegum piles is about 5s. 6d. per foot, including driving. Boring and shooting cost approximately £3 per hole. We bore the holes with a steam drill, and the cost of the explosive alone is about 30s. for each hole. To bore the hole entirely would have been more costly. For part of the work we were dealing with a diabase foundation, and we found that the pile which was set in and concreted was the best job. Whether the holes are bored or shot depends upon the nature of the bottom. In some circumstances the holes might be effectively bored with a calix drill.

29. *To Senator Barnes.*—When employing the shooting method, we first bore a hole of about 2½ or 3 inches diameter to a depth of about 8 feet. The explosive blows out a cone-shaped hole, shatters the surrounding material, and makes it possible for the pile to be driven through it. Our experience is that the piles fit very firmly in such a bed. Piles usually perish between wind and water. For 30 years we have charred all our piles, and then applied tar to fill in the crevices. This system, if carried out thoroughly, is effective, but it is almost impossible to close up a pile perfectly. Minute cracks open, and the limnoria finds its way in. We have tried Cunningham's process, but that has been no more effective.

30. *To Mr. Seabrook.*—Unless the holes in which the piles are to be stepped are bored to a depth of 4 ft. 6 in. the foot of the pile has very little hold. If the hole were only 2 feet deep and the pile had any movement, it would probably split the foundation material. A 2-foot hole is not enough to steady a 50-foot pile The deeper hole adds to the rigidity of the pile. I do not think there is any necessity to brace the piles. Walings are used only to tie the piles together. Our experience is that, instead of the piles smashing when the jetty is struck, the structure as a whole springs, and this checks any tendency to break individual piles. As a rule, 6-inch walings are thick enough, the piles being notched just sufficiently to step the waling against them. I think that 18 x 9 sawn timber would be better than 14 x 14 hewn beams. It is the beams that carry the weight; the decking merely distributes it. The strut pile proposed for the Garden Island wharf will help to strengthen the structure. The arrangement of steel girders and strut piles on the plan seems satisfactory. I do not think the cast-iron caps are likely to break away; the 9-inch piece of pile in the centre will carry the load. If one of the double piles perishes before its companion, it will have to be drawn and another put in its place. That, I admit, would be a difficult job. I know of no jetty in Australia in which steel beams are employed. At the ocean pier, Hobart, the piles are driven at 12-foot centres. The only bracing we employ is that which is necessary to hold the piles while they are being pulled into position. Bracing is too shallow to be effective against a blow; it does not materially strengthen the front of the pile. At the ocean pier there is over 50 feet of water. That means that the top of the wharf is 60 or 70 feet above the bottom of the pile; yet no under-water bracing is used in that structure; we depend on bracing piles.

31. *To Mr. Lacey.*—Bluegum is a stronger pile than turpentine. The latter is a small pile, but the bluegum is often 3 ft. 6 in. in the butt. On the other hand, turpentine is less subject to attack by the teredo. The large crane on the Hobart wharf lifts 25 tons at a distance of about 30 feet. The long out-lift does not affect the stability of the under-structure, because the crane itself is thoroughly balanced.

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*(Taken at Melbourne.)*

WEDNESDAY, 19TH MAY, 1926.

*Present:*

Mr. MACKAY, Chairman;

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|---|---|
| Senator Barnes | Mr. Lacey |
| Senator Reid | Mr. McGrath |
| Mr. Cook | Mr. Seabrook. |
| Mr. Gregory | |

Joshua Fielden Ramsbotham, M.Inst. C.E., M.Am. Soc. C.E., Director of Lighthouses, sworn and examined.

32. *To the Chairman.*—I have seen the plans and read the evidence relating to the proposal before the committee, and I have had experience of building a wharf of this nature. What strikes me at the outset is that the depth proposed is not uniform throughout the length of the wharf. At what is called the shallow end it is 24 feet; the greatest depth is 34 feet, and the average is 27 ft. 6 in. That was the evidence of Mr. O'Connor, Director of Naval Works. I certainly think that the first matter to be determined is the requisite depth. This is a most important point, and if necessary the Imperial naval authorities should be consulted if they have not already been. War is a most serious matter, and the building of this wharf is of serious concern. I am aware that it is intended to accommodate 10,000-ton cruisers, but we should look further than that. If a state of war exists it is not known what vessel may come here. Time is the essence of the whole contract, and there should be freedom to put whatever vessel you desire there, and deal quickly with shells or whatever has to be handled. I am satisfied that there is an ideal bottom for building a permanent wall, and I am entirely in accord with the proposal for a wall straight across. I do not think you could do better than adopt that method. There are two ways of doing it that strike me as economical and providing for permanent methods of construction. One way is to use concrete blocks. I suggest that they should be about 24 feet long by 10 feet deep by 8 feet wide These would weigh about 128 tons, and could be made cheaply on some site convenient for getting stone, sand, and cement. The crane at Cockatoo Island Dockyard is capable of lifting 150 tons. It could pick up the blocks, possibly place several of them on its own deck, and go to the site already prepared to receive the blocks, there placing them in position. A diver could supervise the work. All that would be necessary is care. The concrete should be eight of aggrégate to one of cement properly mixed, and you should see that the beds were properly prepared. The only thing that I can think of that might endanger the blocks is an earthquake. The alternative to the block method would be that proposed by me for the Darwin wharf, viz., the caisson system. If you could get the caissons constructed in one of the graving docks it would be the cheapest way. You would then float them out, sink them, and place them in position. I should have no hesitation in building a wall at Garden Island by either of the two methods I have described. The wall would be about 24 feet thick at the bottom, tapering upwards You would fill in behind the wall, and the ships would berth on the outside just as they do at a dock wall. That method would be more economical than the employment of a solid concrete wall, because if you built it in the dry, you would require steel or timber dams. With the caisson system there would be a solid wall when the caissons had been filled in. I saw the complete plans only last night, but I have looked up some figures relating to similar construction elsewhere. I could not find particulars relating to a 45 feet wall, but I noticed that the cost of a 49 feet wall built at Hull before the war was £19 6s. 8d. per foot run. A wall at Liverpool 55 feet high—10 feet in excess of what is required here—cost £28 6s. 8d. For the purpose of discussion we may accept the price of £20 a foot run before the war. Multiply that by four, and the approximate price you get is £80 per foot run. But go further still and multiply by five, and it brings the price to £100 per foot run. Taking that figure, it agrees with Mr. Hill's estimate, and the price of the retaining wall should be about £90,000. At the same time I cannot accept his cost for Scheme 1, since I say it is unnecessary to build the wharf 45 feet wide outside the retaining wall. Therefore his estimate of £219,000 should have £75,000 deducted from it, which brings the cost of Scheme 1 to £144,000. Accepting Mr. Hill's other figures, this proves to be the cheapest way of doing the job. Under my proposal for concrete blocks there would be more than 50,000 cubic yards of filling, as under Mr. Hill's scheme, because the wall would be only 24 feet wide as against 45 feet. There would be an extra strip of filling, and that would be the only difference, unless you moved your wall back 45 feet, in which case you would then have the same figure.



33. *To Senator Reid.*—I think that some dredging would be necessary in any case There should be a uniform depth right through

34. *To the Chairman.*—There are tremendous advantages in having a solid wall. If you are restricted to loads of 500 lb. to the square foot it is a source of very great weakness, especially in times of stress when you want to get a ship loaded or unloaded quickly Whether you are engaged in commercial or naval affairs, it is of enormous advantage to be able to handle any weights you like. I suggest that Mr Hill's estimate for Scheme 1 is £75,000 in excess of what it should be I prefer a concrete structure to a wooden one Commander Robins also favoured concrete You ask me whether the piles for a wooden structure should be placed in holes drilled into the rock to a depth of 4 ft 6 in. The first job I ever did in charge of work was to drive piles into rock My business on that occasion was to carry out orders and not to give advice There was a discussion between the engineer in chief and the chief assistant engineer as to the best method to adopt The rock was a good freestone, and the chief assistant engineer wanted to drill holes and blast it out The engineer in chief would not hear of this He said that the work must be done by divers Eventually he had a special cast-iron shoe made for square green-heart piles. The spike on the shoe was 2½ inches in diameter, and then the pile was driven. This answered well, and was fairly economical. I understand that a machine is employed in Sydney for taking holes out of rock and placing piles in. That would, no doubt, be a good method. After you have placed the piles in position, you have to stand them up, and I think that is the reason for sinking the holes to a depth of 4 ft. 6 in. I have had no experience of turpentine piles, but I have known the teredo to get into a new jarrah pile at Fremantle in eight weeks. I understand that the latest method adopted in Sydney Harbour is to drive three piles with a solid ring around them, and fill them in with concrete. I notice in the evidence on page 11 that Captain Robins referred to wharfs that required re-decking owing to the ravages of white ants. It seems to me that this is a very important aspect of the matter, and a timber structure would provide a glorious banquet for these insects. My experience at Liverpool was that light cranes were employed for quick work, and floating cranes for heavy work. I have seen 20, 30, 75, and 100 tons shore-cranes discarded, but, at the same time, there has been a very marked increase in the number of light cranes, which lift up to 3 or 5 tons. A 3-ton crane was the favourite. They are cheaper in first cost, quicker for the work, and I think more economical. The majority of the lifts that would be required at Garden Island would be light, and a 20-ton crane would be slow for that work. I should think that a couple of quick, light cranes should be installed, resort being had to the 150-ton crane for heavy lifts. I have not gone into the weights, but I should think that the heavy steel girders provided in the specifications to carry the proposed crane would be necessary. You ask me for any comments I may care to make in regard to timber construction. I do not think square joists are economical. You depend upon your depth for your strength, and not on your width. For the top of the wharf I suggest a temporary dressing of ashes, which should be watered and rolled until the whole formation had settled down; then the surface could be pitched with stone, after which ten inches of concrete might be laid. There could be a granolithic finish or a surface of wood-blocks.

35. *To Mr. Seabrook.*—I imagine that the drilling of the holes for the piles to a depth of 4 ft. 6 in. is to enable the piles to be stood up until they are permanently fastened in position. There should be no tendency for the piles to kick away unless it were the front piles, which might be bumped through a vessel

coming alongside. I can see no advantage in sinking the holes to a depth of 4 ft. 6 in., rather than say 2 feet, apart from the necessity to prevent wobble before the piles are fixed. This is really a question that I would prefer to leave to the Sydney Harbour Trust officials, who have had a good deal of experience in this work. I understand that a machine is available for taking out holes to enable the piles to be dropped into them, and I should say that that would be the cheapest way. The solid cast-iron shoe with steel nose which I have already described cost 50s. in England years ago, and it would cost more than double that figure in Australia to-day. Taking out holes would no doubt be cheaper than driving piles into rock. It seems to me that 14-in. x 14-in. beams are unnecessary. I would have expected them to be 14 inches x 9 inches. Beams measuring 18 inches x 9 inches would give a much stronger job, but you might have them too strong, and find it necessary to alter the spacing of the piles. I should say that even 16 inches x 9 inches would be too strong, but I have not seen the detail plans or the weights. It is merely a matter of calculation. The 14-in. x 9-in. waling to be notched into the pile about 4 inches will have no weight to carry. You ask me if waling of those dimensions is necessary. Possibly 14 inches x 7 inches would do. It is necessary to make a notch, but I do not quite know what the distance would be. I have generally seen it about 2 inches. I generally used 14-in. x 7-in. material in such cases. You ask me whether if, instead of using a double pile, an extra pile was placed between the piles, which have 15 feet centres, giving a space of 7 ft. 6 in between them, and 18-ft. 9-in. tie-beams, this would carry the crane. I very much doubt it. There is no bracing from deck level to rock level. If one pile gave way, the whole of the weight would then be on the other pile. It would not be an easy matter to renew a faulty pile. It would mean a certain amount of dismantling. I prefer concrete construction. When I spoke of a one-in-eight concrete, I meant five parts of stone, three of sand, and one of cement. All the dock walls at Liverpool were built of concrete mixed in those proportions. The sand is the controlling factor, and, of course, it must be of the proper quality. I am satisfied with Mr. Hill's estimate of £90,000 as the cost of the retaining wall. According to Mr. Hill's figures, and according to my own view, a concrete job would be the more satisfactory proposition.

36. *To Mr. Lacey.*—No wooden piles would be required with a concrete wharf, and the decking would be of cement. The blocks would have to be keyed or dovetailed to prevent them from slipping forward. It is also a good idea to put dowels in them and run neat cement between the blocks. The saving between wood and concrete construction would be the difference between £144,000 and £150,000, viz., £6,000, accepting Mr. Hill's estimate of £4,000 for surfacing. The radius of the floating crane is considerable.

37. *To Senator Barnes.*—I have had no opportunity of giving very close consideration to the matter of calculating the cost of the filling that would be necessary behind a concrete wall, but I am prepared to accept Mr. Hill's estimate of £90,000 for building the wall. That, I think is an outside figure. I do not agree that it will be impossible to get the filling done at the estimated price of 10s. a cubic yard. It struck me that portion of the island could be levelled and improved in the process of obtaining filling.

38 *To Mr. Cook.*—I have an idea that one witness gave evidence that it would cost £7 10s. to sink a hole for a pile. I suggest that evidence on this matter be obtained from the Sydney Harbour authorities. In regard to going down 4 ft. 6 in., I can only surmise that the engineers have in mind the placing of a pile in position until it was properly tied. Once fixed in its permanent position, there would be no occasion for it to be that distance in the ground. This remark certainly applies to the back piles. The front piles that are liable to be bumped by vessels might well be sunk to a depth of 4 ft. 6 in. I have had considerable experience of the effects of white ants, and I agree that it is very difficult to get rid of them. The best remedy I have found is arsenic. If the Committee favours timber construction, I should recommend the latest method adopted by the Sydney Harbour Trust, which places three piles together with circular bands around them, the centre being filled up with concrete. I do not advise concrete decking if timber piles are used, because of the danger of the piles being eaten away.

39. *To Mr. Gregory.*—As an engineer, I prefer the caisson system to concrete blocks, but caissons, which would give an everlasting job, would be more expensive. Using blocks, the joints would have to be broken as the wall went up. Filling could possibly be supplied by the Sydney Harbour Trust. It might be glad to get rid of some of the silt for dredging, but I do not think that much dredging will be required in connexion with the proposed wharf. It seems to me that 10s. a cubic yard is a good figure to allow for the filling, and if it could be obtained on the island, the cost would be considerably reduced. Assuming that the danger of the teredo can be overcome, I prefer the method adopted by the Sydney Harbour Trust of using three piles with concrete in the centre. Concrete piles surrounded by a ring are being employed in the Old Country. You can then increase your spans, because the piles take an increased load, and are better able to withstand the impact of steamers coming alongside. Although rough weather is sometimes experienced in Sydney Harbour, Garden Island is in the lee of the land. If the inside piles were sunk 2 ft. 6 in., that would be sufficient to secure them as soon as the weight came on them. Scouring is a danger to be considered. On that point also I would be guided by the advice of the Sydney Harbour Trust. I should advocate the use of a light crane with a big reach, using the Cockatoo Island crane for heavy work. It might be necessary to pile the back of the wharf to make certain that the crane would not sink.

40. *To Senator Reid.*—By the use of concrete blocks a satisfactory job could be done, but it would not be as good as if caissons were used. It occurs to me that the appearance of Garden Island might be improved by taking the filling from it. You inform me that the island is regarded as a beauty spot, and that there would be great objection to any interference with its surface. I cannot say what the people of Sydney would think of such a proposal. If the Sydney Harbour Trust could obtain sufficient material in its dredging operations, it would be a quick way of supplying the filling. There need be no delay with the work if concrete blocks were chosen, because the manufacture of these blocks could be commenced immediately, and the dredging of the site proceeded with. A decision should be arrived at as to what the future requirements will be. You should build the wall in accordance with those needs, and then dredge for present-day requirements. If you put the wall down to a depth of, say, 40 feet, you could at a future date dredge to that depth.

41. *To Mr. Seabrook.*—It seems to me that it would be inadvisable to dredge below the base of the wall.

42. *To Mr. Cook.*—If the work were done by day labour, adequate plant would have to be purchased.

43. *To Mr. Gregory.*—Whether tenders should be called for, or the work should be done by day labour, is a matter of policy.



*(Taken at Sydney).*

TUESDAY, 25TH MAY, 1920.

*Present:*

MR. MACKAY, Chairman;

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|---|---|
| Senator Reid | Mr. Lacey |
| Mr. Cook | Mr. McGrath |
| Mr. Gregory | Mr. Seabrook. |

Walter Edward Adams, Engineer-in-Chief, Sydney Harbour Trust, sworn and examined.

34. *To the Chairman.*—I am aware of the proposal to construct a timber wharf about 660 feet long, with a width of 45 feet, as well as a small extension of the existing wharf at Garden Island, and am acquainted with the site. I have not had an opportunity of examining the plans. For 25 years I have been with the Sydney Harbour Trust; prior to that I was for six years with the Department of Public Works. The average life of a timber wharf is reckoned as 30 years, excepting in the case of the exposed decking, the life of which is considered to be twelve years. We are not troubled greatly by white ants, but we experience some trouble in dealing with teredo, spheroma, and limnoria. Turpentine timber is not greatly affected by white ants. The bark of the turpentine is a great protection against destruction by borers. For 25 years turpentine timber only has been used for piles by the Sydney Harbour Trust. In some cases piles have retained their bark for 40 years, but that is not always the case. The difficulty is to get the piles to Sydney without the bark being damaged. Ring-barking the trees about three weeks before they are cut has the effect of attaching the bark to the tree. With a pile weighing 5 or 6 tons it is easy to damage the bark in handling. I submit a schedule showing the prices paid for turpentine piles of different length:—

AVERAGE PRICES PER FOOT OF PILES PURCHASED ON CONTRACT DURING PAST TWELVE MONTHS.

| | s. | d. |
|---|---|---|
| 35-ft. piles .. .. | 2 | 2½ |
| 37-ft. piles .. .. | 2 | 2½ |
| 40-ft. piles .. .. | 2 | 2½ |
| 42-ft. piles .. .. | 2 | 2½ |
| 43-ft. piles .. .. | 2 | 4 |
| 45-ft. piles .. .. | 2 | 5½ |
| 47-ft. piles .. .. | 2 | 3½ |
| 48-ft. piles .. .. | 2 | 5½ |
| 49-ft. piles .. .. | 2 | 5 |
| 50-ft. piles .. .. | 2 | 7½ |
| 51-ft. piles .. .. | 2 | 6 |
| 52-ft. piles .. .. | 2 | 7½ |
| 53-ft. piles .. .. | 2 | 8 |
| 55-ft. piles .. .. | 2 | 7½ |
| 57-ft. piles .. .. | 3 | 2½ |
| 60-ft. piles .. .. | 3 | 3½ |
| 65-ft. piles .. .. | 4 | 3 |
| 70-ft. piles .. .. | 5 | 3 |
| 75-ft. piles .. .. | 2 | 10½ |
| Average .. .. | | |

The prices given are for the piles delivered at Sydney. There is no difficulty in obtaining piles so long as sufficient notice is given. Although most of our contracts provide for a time limit, that limit is frequently exceeded. We call for tenders for the supply of the piles required, and in order to give the small man an opportunity to obtain contracts our officers inspect the piles in the country. For decking purposes we use brush-box exclusively. It comes from the Northern Rivers district of New South Wales; there is no difficulty in obtaining supplies. Many of our piles are sunk, or planted, in the rock bottom. All those near the shore are embedded in the rock. Holes have to be drilled to take them. The sandstone is too hard for piles with shoes to be driven into it. The machine for drilling these holes is a Rand drill, mounted on a pile-driving frame. It is worked by steam. The hole is jumped down to an average depth of 4 ft. 6 in. for the outer row, and to a depth of 3 ft. 6 in. or 4 feet for the back rows. A depth of 2 feet would not be sufficient to provide the proper stability. The surface of the rock is sometimes friable, and if the pile is not sunk well down into the solid rock it might easily be moved from the vertical. The value of the drilling plant is probably about £6,000; I shall supply the Committee with particulars of the cost. It is not difficult to obtain holes of uniform size. The services of a diver are necessary in places where the rock is covered with silt, or where the piles must be very accurately placed. In the work examined by the Committee yesterday very accurate drilling was necessary for caisson work. The diver, in such cases, has to steady the drill at the bottom. First, he centres the pilot drill, which acts as a guide to the larger drill. For 50 per cent. of the holes a diver is not required. Each hole drilled into the rock costs from £3 to £4. The piles are shaped at the end to fit the hole made by the drill. Before inserting the pile, the hole is cleaned of silt by the application of water at high pressure—up to 100 lb. per square inch. No concrete is placed around the pile in the hole. It is held sufficiently firm by the silt which gets in. Frequently we experience difficulty in withdrawing piles from the holes. I have had no experience personally with concrete piles, although the trust has made some for sheet-piling work. Our objection to them generally is that they will not stand a transverse strain. The trust has built no wharfs with concrete piles. I consider that at Garden Island a reinforced concrete wharf could be built, but, personally, I do not like that type of structure. It might be cheaper to build a retaining wall, and to fill in at the back. It would depend upon the area to be filled in. If only a narrow piece has to be reclaimed, the cost of a sea-wall would be heavy in comparison with the area reclaimed. A retaining wall built on the rocks might provide a cheaper job than if a wharf were built of timber or reinforced concrete. Especially would that be so in the case of a retaining wall built on the trestle system. I should not advise a trestle and plate wall. I suggest a wall built of trestles placed together, without plates. Such a wall would have to be carefully designed. For a wide wall of mass construction the foundations would be expensive. They would, of course, have to be built on the sandstone bottom. The foundations for a trestle wall would not need to be so wide. The advantage of a trestle wall is that all the work is done above the ground, the trestles then being lowered into place by a crane. For a wall of any kind the foundations would have to be kept clear of silt. If caissons were used, they would have to be floated into position. I think that they would be more expensive than trestles. They would require larger quantities of concrete. The cost of maintenance would be less in the case of a concrete wall than with one of timber construction. About 1,000,000 yards of material is removed from the harbour annually by dredging. The Trust could supply 50,000 yards of filling as quickly as required. We could supply pure sand, which is excellent filling, at about 1s. a yard. For material from the mainland about 10s. a yard is asked. In the interests of the Harbour Trust, I recently made a tour of the world. What I saw led me to the conclusion that the galvanizing of all steel used in harbour work is necessary. I think that the two heavy steel girders of 24 inches thickness and 12-in. flange, with two piles under each girder, as provided for in the plans, is necessary to carry the heavy movable crane asked for. The two piles together would take the weight of the girder better than if they were separated. The steel girders I consider to be necessary, as they would give an almost

inflexible track. They would be much better than wooden girders. Apart from maintenance costs, a timber wharf would be cheaper than one of concrete; but as it may be necessary to place ammunition dumps on the wharf at Garden Island, a timber wharf might not be strong enough to carry the unforeseen weights. Even with a difference of £10,000 in favour of a timber wharf, I should prefer a concrete wharf for the purpose for which the Garden Island wharf is required. In our work more girders are placed under the decking than in the plan now before me. With such large spans the decking is rather flexible. If the Trust were constructing this wharf, we would increase the number of girders, but some of them might be smaller. We also consider it necessary to have the wharf anchored by land ties. A large vessel sometimes places a tremendous strain on a wharf, and tends to pull it from the shore. We provide for land ties at every 30 feet. They are generally double-headed railway rails, which are anchored to a block of concrete inside the angle of repose. The strain on a wharf is so great that on occasions these land ties have been broken.

45. *To Mr. Lacey.*—The wharf with concrete piles seen by the Committee yesterday was constructed by the Trust. In that case, the piles were placed with the big end downwards, which is contrary to the usual practice. We then dropped around each pile a concrete pipe. The bottom was sealed with cement, and the water between the wooden pile and the concrete shell pumped out, after which the space was filled with concrete. On the top we have steel girders cased in cement. We estimate the life of that wharf at 80 years, as against 30 years in the case of other wharfs. The cost is also about two and a half times that of other wharfs. The square timbers seen in our wharfs have the heart in the centre. In the case of ironbark, the quality is uniform throughout. Wood containing much sap should not be used. The holes for the inside piles need not be sunk to the same depth as those for the outer piles. In some instances, the holes for the outer piles have been sunk to a depth of 5 feet. Usually they are 4 feet, and 3 feet for inside holes. My objection to concrete wharfs is that concrete piles will not stand a transverse shock. They are not resilient like timber, and are likely to be disintegrated by deflection. We have not used them. I should not suggest a trestle and plate wall at Garden Island. For a wall of that height, trestles placed close together would be necessary to give the required strength. The trestles in this case would require to be about 30 feet high. Above low-water mark, I suggest mass work arranged so as to save the trestles. I have seen the crane at Cockatoo Island working. It has a long arm, possibly 60 feet in length. There is no difficulty in obtaining the use of that crane, as the authorities are only too glad to hire it out. It lifted a load of 60 tons for the electrical power-house. All our work is done by our own employees at day-labour rates. Their work compares very favorably with any I saw in other parts of the world.

46. *To Mr. Gregory.*—All our piles are of turpentine timber with the bark on. The bark is a great protector against limnoria. Toredo will destroy ironbark in three years, and Western Australian timbers—karri and jarrah—in about the same time. They do not like turpentine, which lasts for about 30 years. Reinforced concrete wharfs are suitable for comparatively small vessels and where suitable timber is scarce. Turpentine will not stand in the tropics. It is not so good at Brisbane as at Sydney. At on time we used metal sheathing, but we found that it did not last more than [illegible] years. As a precaution against white ants, we had been constantly inspecting the timber in the wharfs. They bore holes into the timbers most likely to be affected, and then fill them up with poison, finally sealing the holes. The ends of the girders are the most vulnerable places. Here holes are drilled to within half an inch of the other side of the girder. The holes are filled with a solution, and blocked up. They are inspected about once a month. In building a solid concrete wall, two methods are employed. One way is to have moulding boards on both sides and to pour concrete into the intervening space. The other way is to mould the blocks on the land. Difficulty is sometimes experienced in getting the concrete to set under water. That happened at Wellington, New Zealand, where the Harbour Trust spent £60,000, and the contractors a similar sum, without satisfactory results. A new cement, known as cement fondu, which sets quickly, is now obtainable. When the concrete blocks are made above ground, the quality of the work can always be determined. There is always a chance of the concrete not setting under water. If a concrete wall were to be constructed at Garden Island, I should recommend the block system in preference to mass construction. The trestle system would probably be the cheapest of all, and quite as satisfactory. Reinforced with steel, and filled in behind with sand, it would be sufficiently strong. Because of the greater depth of the water, the trestles would have to be bigger and heavier than those seen by the Committee yesterday. The wall would have to be about 50 feet high. With such a wall, I should suggest that above low-water line there should be a projection of about 1 foot. Fenders would also be necessary. All the steel which we use for reinforcing is galvanized. A piece of steel which has once been galvanized does not rust like other steel. A travelling crane would give the same results as the crane suggested. On our commercial wharfs we have cranes which will lift up to 3 tons. At one time it was proposed to build a floating crane, but, instead, we obtain the use of one from the Navy when required. We do not find it necessary to have an expensive crane for our work, as sheerlegs capable of lifting fairly heavy loads are obtainable from one or two private firms. In addition, the Naval crane is available. Holes for piles are always drilled. They are not blasted, because blasting would shatter the rock too much. The object of embedding the pile in the rock is to prevent it from getting out of plumb, and to resist side pressure. There are no heavy seas at Garden Island, and the piles would not require to be sunk in the rock to a great depth. We have never exceeded a depth of 5 feet, even when piles have been sunk nearer the heads than Garden Island.

47. *To Senator Reid.*—My experience of the sea bottom at Garden Island is based on some dredging which we carried out for the Navy there. The bottom was rock covered with clay. The rock shelves outward from the shore. We struck it at a depth of about 40 feet. We were asked to dredge only sufficiently deep to accommodate the *Australia*. So far as I can recollect, the *Australia*, when in full draught, was tied at the wharf. I should not anticipate any great difficulty in obtaining a good bottom for a solid wall. If a greater depth of water was required, no difficulty would be experienced in obtaining it. The Sydney Harbour Trust is now importing a machine to do that class of work without damaging the base of the wall. It could cut right up to the wall. For Garden Island, I should recommend a key wall of some kind. For the purpose required, I think that a concrete wall would be preferable to a timber wharf. The site is suitable for a concrete wall, because the bottom is good. We have built walls on the block system, using blocks up to 30 tons in weight. We have not used caissons, because there has been no suitable place. The big blocks proved suitable. At Garden Island, caissons could be used. With a timber wharf, the point of attack for white ants would be, first, the head-stocks, from which they would get into the girders. Even in front of a concrete wall a timber wharf would not be immune from attack, as white ants have a habit of overcoming difficulties. Our policy is to keep a careful watch for them. We do not dip the ends of the piles in a solution, because ironbark does not quickly absorb moisture. We find the best means of dealing with white ants is to bore holes in the timber and to fill them with a solution. We have now reached the position that we are not greatly concerned with white ants. The average weight of the loads lifted by the cranes in the harbour is probably not more than 1 ton; but some loads, for instance, a sentinel steam-wagon, would weigh 4 tons. The crane at Cockatoo Island is capable of doing all the work that is necessary at Garden Island, but in the case of an urgent job it might not be available when required.



48. *To Mr. Seabrook.*—I do not consider that waling is necessary. Its only purpose is to string the piles together and to stiffen the wharf. If walings are used, timber 12 inches by 9 inches is not too heavy. We do not use them in our wharfs. We allow for a weight of 600 lb. to the square foot. That weight is frequently exceeded. Instead of the strut shown in the plan, we use a land tie, which is anchored into a block of concrete. The effect of the strut pile in the design before us is rather to push the wharf out than otherwise. If it is required at all, I should prefer it to be placed the opposite way. Where there is a large amount of silt we drive the piles in, but not otherwise. If the bottom over the rock is clay, the drill leaves a hole almost like a hole in rock. Any silt is blown out under pressure, and the pile is inserted immediately. The silt holds it tight. A ship with a big list might break the pile below the water line. I do not think that the vertical fender is sufficiently strong. A ship coming to Garden Island might be one with a heavy list, in which case the bilge might cause trouble. Both vertical and horizontal fenders are, at times, unsatisfactory. It is usual in some cases to overcome the difficulty by hanging fenders over the side of the wharfs. The piles in the design before us are placed further apart than we place them in our work. In the front row we should place them about 8 feet apart. To fit in with the design, any alteration would require the piles in the front row to be 6 ft. 6 in. apart. That would not be too close to accommodate vessels of 10,000 tons. I should consider strutting the piles to the head stocks. The strutting pile shown would, in our wharfs, be displaced by land ties. In its present position the strut-pile is useless. It should be placed the other way, and not so nearly perpendicular. Its angle should be about from double pile to double pile. In my opinion, a solid wall, with filling behind, would be better than a wharf of timber construction. With a solid mass-work wall, sand filling would be sufficient; but with a wall of lighter construction some ballast in the front would be desirable. Sand is the best filling possible. For our crane, in similar positions, which lifts only about 3 tons, iron girders are not necessary. The weight of the crane is probably 60 tons; a timber wharf carries it. On none of our timber wharfs have we iron girders. I think it is desirable to have longitudinal girders. Personally, I should not construct a wharf with spans of 15 feet; I consider the distance is too great. If we used waling, we should have to notch it into the girder on each side, as shown in the design; but we do not use waling. Instead of the 12 in. by 9 in. timber on top of the double girder we should bore through the steel flange of the girder. If we were constructing the wharf, shorter spans would be used.

49. *To Mr. Cook.*—The Sydney Harbor Trust has constructed wharfs to the value of about £1,000,000. We have a very good plant and good workmen. Some of them have been with us continuously since the Trust commenced operations in 1902. The construction of the wharf at Garden Island by the Sydney Harbour Trust will be a matter of policy for the Trust to decide, if asked to do so. I think the Trust would do the work if asked. Any machinery belonging to the Trust could be hired, if not required by us; but we have not more machinery than is necessary. We are getting another drill. I think that the Trust could construct a wharf at Garden Island within two years if asked to do so. If tenders for the work were invited, I think that only one would be received. No contractor at Sydney has a plant equal to ours. One contractor could do the work, but he would probably want a good price. We could do the work as cheaply as a contractor, and do it better. For Garden Island a concrete sea wall would be the most suitable structure. There would be no filling available on Garden Island; but the Sydney Harbour Trust could supply sand for filling. Spoil would cost 9s. or 10s. a yard as against 1s. a yard for sand. I should suggest that the Committee give further consideration to the nature of the structure to be adopted.

50. *To the Chairman.*—Sand filling, where the sand is pumped in, settles almost immediately. On the road to Rose Bay the concrete surface was placed on the sand filling straight away, and no cracks are now visible. The concrete in that case was eight inches or nine inches in thickness. The thickness of the concrete depends on the purpose for which it is required. At Garden Island heavy wheel loads are likely. In that case bituminous concrete would probably be best, as it could be easily patched. Ordinary concrete does not patch easily. Sand-filling is pumped in wet. About fifteen per cent. of the material pumped is sand, the rest being water. The Sydney Harbour Trust does not compete with private industry, but would do work for contractors under certain conditions. We have drilled holes for private individuals where it has been shown that no one else could do the work. Our charges are based on the actual cost. We prefer to drill the holes ourselves to leasing the plant to others.

*The witness withdrew.*

John Francis Robins, *Captain Superintendent*, Royal Australian Navy, Sydney, recalled, and further examined.

51. *To the Chairman.*—The policy of the dockyard is to keep an average number of men constantly employed throughout the year. The fleet is asked to assist by detaching one ship at a time. For two or three years that policy has been carried out. The fleet of five or six vessels is under the Commodore, the other ships of the Navy being under the control of other officers. On an average, each vessel requires six weeks' refitting each year. In each case some lifts are necessary; but heavy lifts are not required on each occasion. Generally, we know beforehand when the services of a crane are necessary, but not always. The floating crane from Cockatoo Island has not been used at Garden Island (excepting to take the guns from the *Australia*). It is essentially a ship-building crane, and is different from a crane for repair work. It is entirely unsuitable for re-fitting work. The crane is the property of the Navy Department. It requires a crew of four, in addition to tugs to move it into position and to keep it in position. It is suitable for the calm water of Cockatoo Island, but not for Garden Island. If the crane were installed at Garden Island it would be used practically continuously. It is not so much a matter of the weight to be lifted as that we require a crane to work at a considerable height. We want a crane with a high arm. During my time at Garden Island no vessels have been sent to Cockatoo Island for re-fitting. During the war period, vessels were re-fitted at both places; but not in peace time. I consider the crane to be absolutely essential for the future of the repair yard. The present sheerlegs are obsolete. With a new moving crane there will be no need to shift the ship. At present that is necessary. A floating crane is unsuitable for our work, because there is always some movement on the water. The new crane

would also make it possible to lift lighters weighing 80 tons from the water to the wharf. A crane with a 95-ft. arm could lift 9 tons from a lighter alongside a vessel at the wharf. Such a crane would do all the work required at Garden Island. If Garden Island is to be kept up to date a crane of that capacity is necessary. There is no similar crane on land in any part of Australia.

52. *To Mr. Seabrook.*—There is no surge at Garden Island, but sometimes a strong wind.

53. *To Mr. Lacy.*—It would not be possible to work with the crane between the cruiser and the wharf. The crane would have to be on the outside. The floating crane is practically a small ship; it requires the service of a tug to move it. For some lifts the work must be perfectly plumb. A crane on the jetty can do such work, whereas a floating crane makes it very difficult because of the movement. A tug would have to be in attendance practically all the time the floating crane was in use. The floating crane would not only be uneconomical but unwieldy for our work. It is too big for our requirements. The new crane would do the work now performed by a small winch, which lifts up to three tons, and by the sheers which now lift all the heavier weights. The sheers now do all the work required; but the vessels have to be brought to them. That could not be done with the new cruisers. For our work the smoother and clearer the wharf the better.

54. *To Mr. Gregory.*—The floating crane at Cockatoo Island is the property of the Navy Department, but I do not know on whose recommendation it was bought. I am aware that the interest charges on the cost of the proposed crane would be considerable —probably £2,000 a year—but it would not be advisable to install a smaller crane for small jobs, and to hire the Cockatoo Island crane for heavy work, for the reason that a floating crane is not suitable for our work. With a floating crane the work cannot be kept plumb. In addition, we must have height. That really is more important than a crane to lift heavy weights. Our work requires a crane with a reach of 95 feet. The cost of working the crane would depend on the load to be lifted, and the electric power used. Less power would be required for a small load than for a heavy load. White ants are causing a good deal of destruction at Garden Island. They are to be found on the decking of the wharfs and in the trees on the land. As a protection against them all the planks are impregnated with a solution.

55. *To Senator Reid.*—No other crane with a sufficiently long reach and lifting power, and which could be placed on the island, is available. The cruisers will be equipped only with ordinary derricks which will be incapable of lifting out the guns, weighing about 20 tons. The position of the guns in the cruisers makes their removal an awkward job. I think that the crane asked for is the smallest that would be suitable. We have six lighters which are cleaned every three or four months. The crane asked for would lift the lighters bodily from the water. It would do all the work required at Garden Island.

56. *To Mr. Cook.*—I have had no experience of other naval works, and I know of no other repair establishment with a crane similar to that asked for. I consider that a land crane is essential.

57. *To Mr. McGrath.*—I know Cockatoo Island, but am unable to say whether the cruisers could be attended to there. Apart from political considerations, one is a shipbuilding yard, and the other a repair yard. The usual practice is to keep the two works separate. There is room at Cockatoo Island, and wharfs also. There is no filling at Garden Island, which could be used behind a concrete wall.

*The witness withdrew.*

Robert Farquhar, M.I.N.A., Director Australian Commonwealth Shipping Board, and Director of Cockatoo Island Dockyard, sworn and examined.

58. *To the Chairman.*—I am aware of the proposal to construct a wharf 900 feet long at Garden Island, and to install a travelling crane with a lifting capacity of 20 tons, capable of lifting from a lighter on the outside of a vessel moored at the wharf a load of 8 tons. The floating crane *Titan* is a floating crane mounted on a pontoon about 176 feet long, by a beam of 79 ft. 8 in. The crane is capable of lifting 150 tons at an outreach of 90 feet. With an outreach of 125 feet the crane is capable of lifting 100 tons. The crane is the property of the Navy Department. During the past twelve months the authorities at Garden Island have not requisitioned the floating crane, but in 1924 it was requisitioned for a short period for dismantling H.M.A.S. *Australia*. The crane is not self-propelled, and the cost of operating involves the hire of tugs. The operating charges for all services in connexion with the crane would probably be about £10 a day. To private concerns the cost would probably be greater. We do lifting for private people. Recently we lifted three locomotives from a steamer. The crane was situated outside the steamer. It picked up the locomotives, and landed them on the railway on the quay. The outreach of the crane is such that it enabled the locomotives to be lifted from the middle of the vessel and landed on the wharf. There are other floating cranes in Sydney capable of lifting heavy loads. One, an old hulk converted into a crane, is capable of lifting 30 tons. Another will lift 20 tons For all important lifts the Cockatoo Island crane is preferred, because it is safer. We should like to receive greater numbers of applications for the hire of the crane. To use this crane for lifting weights of, say, 10 tons, at Garden Island, would be uneconomical. We do not use the 150-ton floating crane for lifting light weights except when it is absolutely necessary. The provision of a wharf crane capable of lifting 20 tons seems a reasonable requirement of Garden Island. Excepting where the work is beyond the capacity of our wharf cranes, we prefer to use our travelling cranes on the jetty to using the floating crane. But for the floating crane, the machinery required for the *Fordsdale* and the *Ferndale* could not have been placed in position on those vessels. It is not likely that the authorities at Garden Island and at Cockatoo Island would require the use of the crane simultaneously. The Cruiser Wharf, 640 feet in length, at Cockatoo Island, would accommodate the new 10,000-ton cruisers. Lying outside the cruiser, the floating crane could lift a load from the wharf and place it on the vessel. The heaviest lift in connexion with the cruisers would be the boilers. In addition to the Cruiser Wharf we have also at Cockatoo Island the Destroyer Wharf, the Sutherland Wharf, and another small wharf. These wharfs have at times accommodated as many as sixteen vessels, in which case they were four abreast. I should welcome any suggestion to accommodate the 10,000-ton cruisers at Cockatoo Island, as, naturally, I wish to see all the work possible done there. If required, the vessels could be accommodated at Cockatoo Island. I prefer not to express an opinion regarding the necessity for the expenditure of £150,000 at Garden Island in view of the facilities existing at Cockatoo Island. I should like to see all the work possible done at Cockatoo Island. When I was appointed to my present position the Australian Commonwealth Line of Steamers possessed 52 vessels. Now there are only ten, and we have to cater for outside work. The question of having the cruisers repaired at Garden Island or at Cockatoo Island is a matter of government policy. Although I am not an authority on wharf construction, I think that a concrete wharf is better than one constructed of timber. The proposal to construct a sea-wall, to be filled in behind with sand from the Harbour, seems a good one, because it would



be there for all time. If required, caissons could be made at Cockatoo Island and floated to Garden Island.

59. *To Mr. Gregory.*—I have had experience in ten of the leading shipyards on the Clyde, six of which undertook repairs as well as building, the other four confining their operations exclusively to building. Cockatoo Island submits an estimate for all repair work; and we are thus tied down to the price of the job. For naval repairs we are tied down to the actual cost, plus a certain amount for overhead expenses which must not be exceeded. The cruisers will be without cranes, excepting the ordinary derricks and winches. They would not be able to do any heavy lifting work. If I were in control of Garden Island, I should certainly advocate the provision on the wharf of a crane capable of doing all ordinary lifting work; but for lifting heavy loads I should suggest that the floating crane now moored at Cockatoo Island should be used. The biggest lift in connexion with the cruisers will be the boilers, weighing about 47 tons. They would necessitate the use of the floating crane, but the necessity for lifting them would not arise often. One of the difficulties in using a floating crane is the effect of the wind. A travelling crane can be taken to the ship, whereas with a stationary crane the ship must be brought to the crane. With all cranes there is always a certain amount of swing on the lifting tackle, necessitating great care when the crane is in operation. Cockatoo Island submitted a tender for the construction of the 10,000-ton cruisers. It was our intention to use the floating crane for all heavy lifts. We should have used it to place the guns in position.

60. *To Senator Reid.*—My views on the ability of Cockatoo Island to carry out all work which might be required by the Navy Department in regard to repair work in the event of the Garden Island establishment being closed are contained in the report of the Royal Commission which some time ago inquired into that matter. I do not wish to be regarded as being antagonistic to Garden Island, but we could carry out at Cockatoo Island all the work required by the Navy Department, excepting that which the department reserves for the naval ratings. I refer to the attention necessary in regard to torpedoes, special equipment, and gun stores. Our crane could do all the lifting work necessary.

61. *To Mr. Lacey.*—Whenever the floating crane has to be moved from one wharf to another tugs are employed; but for moving it short distances along the wharf man power is sometimes employed. Generally, we prefer to have the services of a tug. The water at Cockatoo Island has less movement than at Garden Island.

62. *To Mr. McGrath.*—When Cockatoo Island was taken over by the Federal Government, I believe that it was recognized as Federal property; but I understand that the title has not been handed over. The area of the island is 25½ acres. When I gave evidence before the Royal Commission no announcement had been made of the intention to obtain two 10,000-ton cruisers. When I was appointed to my present position, I considered that Cockatoo Island would do all the work in connexion with the Commonwealth Line of Steamers, and all the repairs carried out at Garden Island for the Fleet, in addition to our being allowed to engage in private work. On that basis I considered that I could carry on successfully. The altered conditions caused me to inform the Royal Commission that I had been forced to take a different view of the position. Generally, the *Australia* was repaired at Garden Island, although she was always docked at Cockatoo Island. The dock there was the only one which would accommodate her.

63. *To Mr. Cook.*—If Garden Island is to carry on repairs to the Fleet, a crane of the capacity asked for is necessary. At Cockatoo Island we have a shore crane of 15 tons lifting capacity.

64. *To Mr. McGrath.*—If all the work of the Navy were done at Cockatoo Island, it would not be necessary to purchase a new crane. I submit a statement showing the conditions under which the crane was taken over from the Navy.

65. *To the Chairman.* At certain sides it would be just possible to accommodate one of the 10,000-ton cruisers in the dock at Cockatoo Island, but as it would leave only 2 feet clear in length, the docking of the vessel would be rather a difficult operation. I suggest that the dock at Cockatoo Island be lengthened by 60 feet to accommodate the cruisers. They could be accommodated at Mort's dock, but that is a private dock, and it is not advisable to have all the vessels docked in private docks.

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*(Taken at Melbourne.)*

MONDAY, 31ST MAY, 1926.

*Present:*

Mr. MACKAY, Chairman;

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| Senator Lynch | Mr. Gregory |
| Senator Reid | Mr. McGrath. |

Percival Henry Hall-Thompson, Rear Admiral, First Naval Member of the Naval Board; sworn and examined:

66. *To the Chairman.*—I regard the provision of the proposed wharf at Garden Island as a matter of urgency. It has become urgent on account of the building by Australia of the new 10,000-ton cruisers. There is no wharf at Garden Island to take those cruisers with safety. The length of the ships will be 630 feet. The *Australia* was 590 feet long, and it was always with the greatest misgiving that we placed her alongside the wharf. Incidentally, the present wharf has wood piling, and is about 40 years old. It is in urgent need of repair; and it seems an economic proposition to execute the repairs at the same time as we build the new wharf. The draught of the new cruisers is not definitely settled. Calculated on the tons displacement, they should draw about 19 feet, but allowance should be made for 22 feet. Fully loaded and stored, they will probably draw 19 ft. 9 in. When we were considering building the cruisers in Australia, their fully loaded draught was given as 22 feet. The depth required alongside the wharf is from 28 to 29 feet at low water. That will give a 6-feet clearance, which is necessary if the cruisers should come in damaged. I do not think it will be necessary, during the next ten or twenty years, to provide accommodation for larger cruisers than those now being built. The question of the future possession of Garden Island is not, from my point of view, entirely a Commonwealth matter. When the Admiralty turned Garden Island over to the Commonwealth Government it was a *sine qua non* of the agreement that it should be maintained as a repair base in its then existing state. Its retention is very important to the Admiralty, and in the arrangements for Imperial defence it is one of the repair stations upon which the Admiralty counts in time of war. It is as necessary to the Imperial Government as it is to the Commonwealth Government. The question of space for extension at Garden Island depends upon the policy of the Government as regards the future of the Navy Present indications are that Garden Island will be able to deal with the situation for as long as one can see ahead. We have now practically all the equipment we want, and no extension in buildings or machinery shops will be required if the number of

cruisers is double, or even treble. I have not had experience of concrete pile wharfs. From an engineering point of view, I cannot express an opinion on the *merits of a concrete as against a wooden wharf.* All the wharfs at Portsmouth are of wood piles; at Gibraltar and Malta they are of solid concrete. It would be extremely bad policy to combine the work done at Cockatoo Island with the navy work at Garden Island. The Royal Navy separates as much as possible repair from construction work. The only place I know of where both repairs and construction work are done is the Royal Dockyards, but even there the two branches are kept distinctly separate. As far as I know the large ship-building yards in England do not undertake repairs except under exceptional circumstances, as during a great war. The Admiralty sends nothing to the Clyde for repairs in peace time. The proposed 20-ton crane will be continually required to lift heavy weights, such as guns and turbines. Many heavy weights have to be lifted in connexion with the annual refitting and the triennial surveys of ships. The crane will be sufficient to lift any ordinary weight required without moving the ship. We now depend on fixed sheer-legs, and the ship has to be moved about until the weight to be lifted is directly under them. It would be possible to use the floating crane from Cockatoo Island, but it would involve extra expense in the long run. That crane is an expensive one to operate. The proposed *crane will be used sufficiently often to make its* installation an economically sound proposition, but a wharf without the crane would be better than no wharf at all. I am satisfied with the provisions proposed for oil fuel and water mains.

67. *To Senator Reid.*—Admiralty repair work is in a class by itself, and the Admiralty, to a certain *extent, breeds separate specialists for construction and* repair work. If a ship that has to be repaired is sent to a big construction department, there is a tendency to rebuild it rather than repair it. I am not *an engineer, but I think those are the main reasons* why the Admiralty separates repair from construction work. A constructional department tends to overestimate for repairs. The Admiralty almost always does its own repairs. The exception would be if a ship, for example, ran ashore and was broken in half and salvaged. She might then be sent to a private yard to be rebuilt. All running repairs are done at the Royal yards. Apart from other considerations, navy repair work can be done more economically at Garden Island than at Cockatoo. We need to be ready to accommodate the cruisers as soon as they arrive. They will be new ships, and will be more or less in the experimental stage. The Admiralty certainly will have had some experience with similar ships, but there will be a lot of quite new gear in them, and it is possible that some failure will develop in the auxiliary machinery or the gun machinery. We certainly ought to be ready to repair them on *arrival. I think that 28 feet of water* will be sufficient to accommodate any Imperial ships that will be likely to come out here, or any ships of our own navy, until the next naval war has been decided. The *10,000-ton cruisers are the biggest ships that can be* built by Australia under the Washington Treaty. The added risk to a ship in berthing at a concrete wharf would be very small, and I would not ask the committee to consider that aspect of the question. I would not say that the proposed crane is absolutely essential, but it is a good economical proposition, and will save money in the long run.

68. *To Mr. McGrath.*—I have been with the Australian Navy for two and a half years. I know the facts regarding the ownership of Garden Island. I do not understand that the question under consideration is as to who owns the island, but as to who shall pay for the improvements made about 40 years ago. My humble opinion is that it is essential that *the navy retain Garden Island.* The new cruisers could be berthed at Cockatoo. I expect there are facilities there to repair them, but I do not know whether the facilities are as good as those at Garden Island. H.M.A.S. *Australia* went to Cockatoo, but I do not know whether she was repaired there. In the Royal Dockyards there is a large staff of workmen continuously employed, and there are no overhead charges as such. The carrying out of navy repairs at the Royal Dockyards avoids the re-engagement and discharge of men. One reason why the Admiralty finds it more economical to do its own repairs is that it is able to keep its dockyard fully employed. I understand that the Commonwealth Shipping Board, which controls Cockatoo, was supposed to pay its way, pay interest on capital invested, and be subject to no political control. Although Cockatoo Island is owned by the Federal Government, I would still recommend the proposed expenditure at Garden Island. Garden Island cannot be replaced by Cockatoo. Even if repair work were taken to Cockatoo, Garden Island would have to remain a dépôt for the supply of *oil, torpedoes, guns, gun-mountings, and many other* things of a confidential character required by the navy. There is no room to store such things as torpedoes at Cockatoo. Spare guns must always be kept at Garden Island. A ship at Cockatoo is out of sight and out of mind from where the rest of the fleet can anchor, and is not under the control of the officer commanding. The men are not under the same naval control and discipline when working at Cockatoo as when working at Garden Island. When ships come alongside at Garden Island the artificers of the ship's company do a large amount of the repair work, and they make use of the machines on the island. If that were done at Cockatoo there would possibly be trade union trouble. If we still have to retain Garden Island as a naval dépôt, we may as well retain the repairing facilities which are now there. In the event of its being decided that Garden Island is the property of the New South Wales Government, I can*not say whether it would then be uneconomical for the* Commonwealth Government to retain it. The area of the island is about 16 acres. I do not know the area of Cockatoo Island, but it is larger than that of Garden Island. Torpedoes and guns could not be stored in a place that is not under naval control. The navy would not supply guns to be stored in a place not under navy control. Many of the stores are essentially of a confidential nature. There is sufficient depth of water at Cockatoo for the 10,000-ton cruisers. I do not know much about the accommodation at Cockatoo, but I know that the wharf is there. The men at Garden Island belong to trade unions just as do the men at Cockatoo, but for some reason they do not object to navy men doing repair work. Some of the men at Garden Island have been employed at the same work for many years. I agree that a crane of 3 tons capacity would do a large part of the weight-lifting required when a ship comes alongside; but *there would be many lifts of over 3 tons.* To bring from Cockatoo the 150-ton floating crane to lift weights of 25 tons would be uneconomical.

69. *To Senator Lynch.*—One of the conditions of the transfer of Garden Island to the Commonwealth Government was that it should be maintained as a repair station for the Imperial Navy. That was an expressed condition. *It would be a fair thing to con*sult the Admiralty about the proposed wharf; but I am practically certain that in any case the expenditure will not be wasted because of developments in *the Royal Navy. I should* have no hesitation in consulting the Admiralty, but I should like to see the wharf proceeded with immediately. The new cruisers will arrive probably in the middle of 1928. I can say for certain that the Admiralty will agree to the building of the new wharf; but whether they would ask for anything more, I do not know. I can guarantee that the wharf if built will not be a failure *or a waste of money from the Imperial point of view.* The draught of H.M.S. *Hood* was 34 feet. There is no accommodation for a ship of that size south of the equator. To provide such accommodation would entail enormous expenditure. No more *Hoods* can be built under the Washington Treaty. We can build ships with the same calibre guns, but not ships of the same tonnage. I cannot conceive that capital ships of the size of the *Hood* will ever be on this coast until the British Fleet has been beaten at sea. In war time the capital ships of the British Navy would be engaged in waters far distant from Australia, being based as near as possible to the enemy's coast. I do not think it is necessary to consult the Admiralty about the wharf. The proposal is adequate. I understand that money is tight, and we have done the best we can with the money available. The 10,000-ton cruisers will be light-draught ships, because they must have speed. The Washington Treaty does not impose a limit on wharf and dock accommodation in home territory, but such limitations are imposed in the case of Hong Kong and other places. I am not aware that any of the signatory powers to the Washington Treaty have made additions that they are not entitled to make to their shore equipment. I do not say that it is impossible, but it would be very unwise to combine navy and mercantile work in the same shipyard. *Many alternative sites to Garden Island have been* considered. Sydney is not an ideal place, and there are many better places. Money, however, is short, and for the present the scheme for a large navy has been abandoned. The development of Darwin is strategically of extreme importance, but that has no bearing on the provision of the proposed wharf.

70. *To Mr. Gregory.*—To make provision for the repair of capital ships would mean the construction of a full-powered naval base. Negotiations are now proceeding with the New South Wales Government for the construction of a floating dock, which, however, would not take a capital ship, although it would be large *enough to take the 10,000-ton cruisers in a damaged* condition. It is advisable to have a specialized staff for carrying out navy repairs. That is particularly essential in war time. The navy is not much concerned whether the wharf is built of wood or concrete.

71. *To the Chairman.*—The weight on the wharf would *not be likely to exceed 500* lb. to the square foot. In any case, I imagine that whatever wharf is built the engineers will make it strong enough. During the taking of evidence at Garden Island Mr. O'Connor made some remark about the work of the Sydney Harbour Trust. As reported in the press, his remarks appeared to be a reflection on the Trust. He did *not make the insinuation attributed to him.* The relations between the Sydney Harbour Trust and the Navy have been of the very best, and any work done for us by the Trust has been well done. Mr. O'Connor was trying to make the point that the Harbour Trust had work of its own to do, and that sometimes navy work had to wait.



*(Taken at Melbourne.)*

WEDNESDAY, 23RD JUNE, 1926.

*Present:*

Mr. MACKAY, Chairman;

| | |
|---|---|
| Senator Barnes | Mr. Lacey |
| Senator Lynch | Mr. McGrath |
| Senator Reid | Mr. Seabrook |
| Mr. Gregory | |

Thomas Hill, Chief Engineer, Department of Works and Railways, recalled and further examined

72. *To the Chairman.*—I have calculated that the proposed timber wharf would require 820 piles of an average length of 44 feet. The maximum length would be *55 feet, and about 40 per cent. of the piles* would be over 50 feet in length. The price has been taken at 10s. per foot in place. That would give a wharf, as outlined in the drawing, covering not only *the 45 feet of wharf, but the filling in between it and* the existing wharf. If the retaining wall 900 feet long and 45 feet high mentioned in my estimate for No. 1 scheme, were constructed and filled in at the back, it would still be necessary to expend £75,000 in constructing a timber wharf in front of it. I have prepared a further plan showing what the effect would be if the 45-feet wharf were not constructed. The additional area given to Garden Island would be practically negligible. It would leave only a space at the widest part of about 80 feet, narrowing out to nothing at other points. It would cause crowding, and the expenditure would probably not be justified. There would be no room to swing the material from the cranes. Nos. 1, 2, and 3 schemes are all based on the *same width of wharf. The first design that I intend* to submit to the Committee to-day is not purely a concrete proposition, but provides for a concrete wall with a 45 feet timber projection. You ask me whether *by eliminating the timber wharf, it would be possible to* give a concrete wharf, filled in solid at the back, for £219,000, less £75,000. My answer is in the negative. In preparing estimates like these one takes certain leading items, which cover sufficient to enable one to arrive at an estimate in the absence of definite quantities. I think that Mr. Ramsbotham suggested that the 45-ft. timber wharf could be eliminated, and the concrete wall moved 45 feet further out to sea. I would point out, however, that a concrete wall, filled in solid at the back, would probably cost from £160,000 to £170,000, not £144,000. In the £150,000 proposal the actual timber construction covered by the 45 feet is only estimated to cost £58,000. Under my proposal for a concrete wall there would be a 45-ft. timber wharf *in front of it. That would immediately enable us to* do away with a great deal of false work and timber work that would be necessary if there were no 45-ft. timber wharf. Having that timber wharf, the con*struction of the concrete wall on the landward side* of it would be a simple matter. Again, the water would be about 10 feet shallower. To move the concrete wall 45 feet further out, as shown by the blue line on the plan, we should have no assistance from any timber work. We should have to provide our own means of putting the casing for the concrete into position, and removing it afterwards, and we should be working in deeper water. If we had a concrete wall on the outside of the wharf, we should not require any concrete wall at the back, but I would not suggest a solid wall. If it is decided to adopt concrete and cut out the 45-ft. timber wharf, I shall give estimates of what the work should cost, and state how it could be done; but I do not agree with Mr. Ramsbotham that *you should take the cost of the suggested concrete wall* in conjunction with the 45-ft. timber construction, and set off that figure against the cost of construction of a concrete wall, because the timber wharf would

be of great help in the construction of the concrete wall under my first proposal. I have not changed my opinion in regard to the proposal for a timber wharf. If the concrete wall were moved further out, it would be more costly to build. I have prepared estimates of the cost of doing the work in concrete according to Mr. Adam's suggestion—trestles close together without panels between them—and, according to another scheme, adopting what I call cellular or hollow concrete blocks which I think would be better. The trestle is of reinforced concrete, and is 37 feet in height, extending from the bottom to low water mark. Above that, it carries a massed concrete retaining wall. The idea is to have the trestles as small as possible. Each trestle would be approximately 30 feet long and 5 feet wide at the base, and 37 feet high, and the weight would be from 48 to 50 tons. It would be cast solid on the ground. There would be no room at Garden Island to do this work, and the best plan I can think of would be to cast the trestles on the Commonwealth property at Newington, tow them down in barges, and place them in position by means of cranes carried on the barges. The bedding of these trestles would present difficulties. All the mud would have to be cleared off the rock, which would have to be levelled up and prepared with bag concrete to provide a perfectly level bed to enable the trestles to be placed in position, and set true. If I had a choice between a solid wall at the front, with cheap filling from the Sydney Harbour, and the proposal I have just outlined, I would prefer the latter. There would be no panelling. Each trestle would fit against the other. They could be made wider, but I think 5 feet is a reasonable width having regard to the weight to be handled. The trestles would be keyed, and, perhaps, a little grout would be run between them; but if they were well cast and bedded, they would jam together satisfactorily. My estimate of the cost of a trestle construction, with a concrete wall and filling, is as follows:—

| | £ |
|---|---|
| Foundations (bag concrete), 3,690 cubic yards at £10 .. .. .. .. .. | 36,900 |
| Reinforced concrete trestles in position, 5,190 cubic yards at £20 .. .. .. | 103,800 |
| Mass concrete above low water level, 1,760 cubic yards at £5 .. .. .. .. | 8,800 |
| Riprap, 28,700 cubic yards at 10s. .. .. | 14,350 |
| Filling, dumped, 39,000 cubic yards at 1s. .. | 1,950 |
| Filling, handled, 67,100 cubic yards at 5s. .. | 16,775 |
| Surfacing, 8,800 square yards at £1 .. .. | 8,800 |
| Services and contingencies .. .. .. | 40,000 |
| Crane and pontoon .. .. .. .. | 25,000 |
| Total .. .. .. .. | 256,375 |

You ask me whether I am strongly in favour of recommending a timber wharf. To me the matter appears to be one of engineering expenditure Garden Island is very small. In the first place, I am faced with the question of whether a good deal of the services required could be provided at Cockatoo Island, Garden Island being used as a store. If the work is to be done at Garden Island, I do not think the workshop there, and the area of the land, are big enough. By building a concrete wharf instead of a timber wharf, you would be prevented, practically for all time, from extending the island. By constructing a timber wharf, the saving would be sufficient to wipe off the cost in 30 years, after which there would be much more room for extension at no extra cost. It seems to me to be a sound financial proposition to spend £150,000 on a timber wharf, or, at a slightly heavier cost, to adopt another scheme I have in mind, rather than go to the cost of building a concrete wharf. Personally, I like concrete for stability, but you can pay too big a price for it. That is the reason why I submit that the timber proposal is the one that should be adopted. It leaves you after 30 years with a free hand, and with your expenditure wiped off. My alternative scheme provides for the use of hollow concrete blocks. The weight of each would be 18 tons. The bed would need to be prepared, but not so well prepared as for trestles, because the blocks would have a greater bearing surface. The idea would be to make them with keys. Reinforced or steel columns would rise from the base, and would act as guides when the blocks were being lowered into position. They would fit one above the other like a series of boxes. The first blocks would be filled in with concrete, so that they would exclude sand and water, and the rest of the structure would be filled in with sand by pumps from barges. This would be a simple block to handle, and it would give absolute uniformity of line in construction. The filling could be sand or any similar material. The dimensions of each block would be 15 feet by 16 feet by 8 feet. This proposal appeals to me in every way. There would be no land work. Divers would be employed, and the bed would be prepared by means of a riprap bank or bag cement. The guides having been erected, the blocks would be simply lowered into position. This method has been successfully adopted elsewhere, and is preferable to a solid concrete, or any other class of wall. You suggest that the possibility of obtaining a large quantity of silt from the Sydney Harbour makes the concrete wall proposition attractive, but I point out that silt does not cost much. I prefer the hollow block method of construction in every way. Such a wall is more satisfactory to construct, and it gives a better job. The cost works out at about £9,000 less than the trestle proposal. I would prefer the hollow block proposal at £247,570 to the trestle proposal at £256,375. I could save £20,000 with the hollow blocks for the concrete alone, and obtain a better class of construction. The blocks would be of reinforced concrete. I mentioned that I did not like reinforced concrete piles because they might become cracked, and the sea water destroys the reinforcement. Experience shows that the weak point in these piles is not in the portion that is totally submerged, but the portion between wind and water. The rise and fall of the tide admits sufficient oxygen to cause corrosion at that point, but below low water mark the pile remains unaffected. If it is decided to adopt concrete, I favour the use of hollow or cellular blocks constructed of reinforced concrete. My scheme is estimated to cost £247,570. The details are as follow:—

| | £ |
|---|---|
| Foundation (bag concrete), 3,600 cubic yards at £10 .. .. .. .. .. | 36,000 |
| Reinforced concrete blocks in position, 8,250 cubic yards at £10 .. .. .. | 82,500 |
| Concrete in bottom layer of blocks, 4,450 cubic yards at £5 .. .. .. .. | 22,250 |
| Mass concrete wall above low water level, 1,760 cubic yards at £5 .. .. .. .. | 8,800 |
| Ballast, 7,040 cubic yards, at 10s. .. .. | 3,520 |
| Filling, dumped, 39,000 cubic yards at 1s. .. | 1,950 |
| Filling, handled, 71,400 cubic yards at 5s. .. | 17,850 |
| Surfacing, 8,800 square yards at £1 .. .. | 8,800 |
| Services and contingencies .. .. .. | 40,000 |
| Crane and pontoon .. .. .. .. | 25,000 |
| Total .. .. .. .. | 247,570 |

I have still a further suggestion. I have estimated that for £194,700 a 45-ft. timber wharf and riprap bank with concrete wall could be provided. This would permit of no large sum being sunk in concrete, and there would not be a rigid line of demarcation beyond which it would be impossible to go, should extension be required in the future. When the timber wharf decays, you could carry on with more riprap, or replace the timber. This would reduce the cost of the work. I suggest that the riprap bank should be made of very good material. The advantage of this scheme is that it permits of extension, and further holds the wharf in its place. It not only gives extra rigidity, but reduces the quantity of material that would be subject to attack by white ant or borer. I have shown the cost of the timber wharf at £85,000, but the actual timber construction represents only £53,000, which is the value of the material that would be subject to decay. My estimate of the cost of the scheme is as follows:—

| | £ |
|---|---|
| 45-ft. timber wharf, riprap bank, with concrete wall raised low water, and filling— | |
| Timber wharf .. .. .. .. | 85,000 |
| Riprap, 13,100 cubic yards at £2 .. .. | 66,200 |
| Mass wall, 1,760 cubic yards at £5 .. .. | 8,800 |
| Filling, dumped, 4,000 cubic yards at 1s. .. | 200 |
| Filling, handled, 22,000 cubic yards at 5s. .. | 5,500 |
| Surfacing .. .. .. .. .. | 4,000 |
| Crane and pontoon .. .. .. .. | 25,000 |
| Total .. .. .. .. | 194,700 |

The riprap would need to be of a more costly nature than ordinary Sydney sandstone. It would have to come from Bowral, or from the nearest quarries to Sydney. It should be in the nature of derrick stone. If the riprap could be placed in position at less than £2 per cubic yard, there would be a possibility of considerable saving. Taking all the circumstances into consideration, however, I still think that an all timber wharf is the best proposition for Garden Island. The scheme for a concrete wall and filling at a total cost of £196,582 could not be carried out for the sum mentioned. It would cost considerably more, and would not be as efficient as the alternative scheme that I have suggested. There is a very great difference between sea wall construction and building a wall 45 feet further back with a timber jetty to work from. The solid wall would be more expensive than either the trestle scheme or the hollow block scheme. It is necessary to provide for accommodation for vessels during construction, and this would hamper work undertaken by ordinary methods of construction. Either of the concrete proposals could be adopted at Garden Island.

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*(Taken at Melbourne.)*

THURSDAY, 24TH JUNE, 1926.

*Present:*

Mr. MACKAY, Chairman;

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|---|---|
| Senator Barnes | Mr. Lacey |
| Senator Lynch | Mr. McGrath |
| Senator Reid | Mr. Seabrook. |
| Mr. Gregory | |

Thomas Hill, Chief Engineer, Department of Works and Railways, recalled and further examined.

73. *To the Chairman:*—If a concrete wall was placed on the line of the face of the timber structure, about 70,000 more cubic yards of material would be required. I do not agree that filling can be placed in position at a cost of 1s. a cubic yard. Some of it could be brought by barge behind the wall and dumped by opening the bottom of the barge. That could be placed at 1s. a yard, but not much could be dealt with in that way. This retaining wall cannot be built as a single wall; a portion of the wharf must be built and handed over to the Navy before the other portion can be proceeded with. The loading and unloading of ships and the carrying out of repairs will continue in the meantime. Only a small proportion of the stuff could be dumped, because the sand or silt would flood over the foundations of the portion to be built on in the future. I do not see any possibility of placing all the filling in position for 1s. a cubic yard. Including the towage of barges and the delays that inevitably will occur, I assess the cost at an average of 5s. a cubic yard. I do not think that the scheme could be carried out for £200,000; the cost would be more like £247,000. The wharf as designed is calculated to carry a load of 500 lb to the square foot, with a safety factor of five. In times of stress it could be safely loaded to 1,500 lb to the square foot. It is really designed to carry 2,500 lb. to the square foot. Special provision would have to be made for the crane. The sandstone bottom is suitable for concrete construction. It will be necessary to dredge off the covering of 2 or 3 feet of mud. I have not discussed the relative merits of timber and concrete construction with the engineers of the Sydney Harbour Trust. Until the character of a structure is determined we usually do not approach such authorities. The Sydney Harbour Trust may be asked to undertake the work after tenders have been invited, and for that reason I should be chary of approaching them at present. We have a thorough knowledge of the conditions in Sydney Harbour. I have seen drawings of the electric capstans at Darwin wharf. They were designed for handling trucks on the wharf, but they are not now used. The ships at Garden Island will not have steam up when they are being overhauled or dismantled, and it may be necessary to move them. The electric capstans are a naval suggestion Such matters are not discussed in great detail in the initial stages of a proposal, they will be a subject for further discussion later. An amount of £1,200 has been included for them. The first question to be decided is, is there going to be a wharf? It is perhaps open to question whether electric capstans are necessary. I have had some further discussions with the Naval Board about the salt water main I do not propose tying the timber wharf to the shore We are relying on the 820 piles, sunk 4 ft 6 in. in the rock and braced together with walings and decking, making a rigid structure, so that there will be no necessary for tying to the shore. I am aware that the Sydney Harbour Trust ties its wharfs, but some of them have broken away. The Harbour Trust wharfs are shallow by comparison with this proposal, and they have consequently less grip of the rock. At one part this wharf is 133 feet in width, and it can never move. I do not think that the proposed crane could be built in Australia. The Department is keen on having everything possible done in this country, but, except at very high cost, the crane is one of those things that would be better imported. I can locate only two cranes of such a size and range in the world; they are in the United States naval yard. If we find that the crane can reasonably be made in Australia, we shall have it made here, but I cannot hold out much hope of that. The area that would be added to the island by the complete scheme is 1.63 acres. If the wharf were reduced by a width of 45 feet the area would be reduced to .65 acres. We do not consider that it is necessary to approach the Sydney Harbour Trust for permission to carry out this work, but even if we have to approach them we do not anticipate that there will be any difficulty. The question of whether warships should be repaired at Cockatoo Island of Garden Island is worthy of consideration. I have submitted a proposition and two alternatives. Proposition No. 1, which I still adhere to, as costing the largest amount of money that I would spend on the work, provides for a timber wharf at a cost of £150,000. The first alternative wharf at a cost of £150,000. The first alternative wharf at a cost of £150,000. The first alternative consists of three-quarters permanent materials and the remainder, £58,000 worth of perishable materials. The cost of that structure is £194,700. If an all-concrete structure is decided upon, I suggest block construction with practically all sand filling at a cost of £247,570. I have given the matter very close consideration, and think that my estimates are close to the mark I speak with a knowledge of what work is costing in Sydney Harbour. I have stated 2s. 6d per foot as the first cost of piles. That price is the price delivered in trucks at Sydney. Mr. Adams's estimate did not take into account the cost of transporting the piles to Garden Island and placing them in position. The other 7s. 6d. included in my figure is for transport and placing the

piles in position. The item of £17,407 for general contingencies is for supervision, planning, and other small matters that are bound to arise The amount represents about 8 per cent If the work was done by contract or by the Sydney Harbour Trust it would still be necessary to employ a clerk of works and inspectors I should not assume that the Sydney Harbour Trust would charge 10 per cent on the actual cost of the work. I should think that a charge of 5 per cent. or 6 per cent. for supervision would be ample. In big undertakings like this, we generally pay the salary of the clerk of works and inspectors, and allow an amount for office expenses or draughtsmen. The works on which the Harbour Trust is paid 10 per cent. are small jobs; and for these, 10 per cent. is not too high. On a job like this wharf, a special rate would be made. I do not wish the Committee to consider that the Harbour Trust will carry out this work. Good firms are now taking up this and similar classes of engineering work, and I expect to receive two or three good tenders Unless we think the work can be done cheaper by the Harbour Trust, tenders will be accepted

74. *To Mr. Gregory.*—The concrete retaining wall at the back of the timber wharf in the original proposition was proposed as a solid wall. It is the ordinary retaining wall type of sufficient thickness to hold up weight. It is an easy problem, and we were thinking of pouring the concrete, having the benefit of the timber wharf to help us. The retaining wall would be concrete, but not large concrete blocks. Having the assistance of the timber wharf right along, we had the idea of placing blocks on the outside and pouring or packing material in between. We can get still water there, and in those circumstances I do not mind putting concrete down a funnel. There would be no fear of the cement washing away. Therefore, I would pour it in. The naval authorities require the extra 45 feet of width on the wharf. Without it I do not think they could handle the work they have to undertake. If that extra 45 feet were cut out, the crane could not be used, big weights could not be handled out of the cruisers, and the vessels would lie too close to the workshops and factories. Mr. Ramsbotham, in giving evidence, said that the cost of a 40-ft. wall, built at Hull before the war, was £19 6s. 8d. per foot run, and that a wall at Liverpool 55 feet high cost £28 6s. 8d. He said that, for the purpose of discussion, we could accept a price of £2d a foot before the war, and that, multiplying this price by five, you would get an approximate of £100 per foot run. On that basis he agreed with my estimate that the price of the retaining wall at Garden Island would be about £90,000. I have examined Mr Ramsbotham's figures. He suggests the use of concrete blocks weighing about 128 tons each. The mass concrete alone required to run this wall across would mean about 30,000 yards. The blocks, if made at Cockatoo Island, would cost about £3 or £3 10s. a yard *in situ*, after which they would have to be placed in position. Thus there would be easily £100,000 in the concrete alone. To make the blocks at Cockatoo Island would mean the employment for a couple of years of the steam barge with a crane on it. The barge would be needed to lift the blocks, and Cockatoo Island would not have the use of it for that period. Even on Mr. Ramsbotham's moderate estimate I do not think his scheme of solid concrete blocks could be carried out for less than £250,000. The bottom would have to be prepared by divers; and a good deal of excavation work would be required to place blocks of that size in position to prevent the base from sliding. Altogether, I do not see how the work could be done at anything like the cost he has suggested. It is true that the bottom would have to be prepared even for hollow block or trestle work, but more excavation would be required for the solid concrete blocks to prevent any sliding on the base. I would get a better class of construction with hollow blocks. I would have a bigger base, and I would have no fear of sliding. I would have a better distribution of the load, and, instead of using concrete, I would use sand for the weight to hold the mass in position. I cannot agree with Mr. Ramsbotham's figures. The high cost of concrete work is due to the cost of sand and other material, as well as wages. Cement has not come down in price in recent years. It is quoted at 18s. a barrel on the Sydney wharf. It must be remembered that all the material has to be conveyed from the Sydney wharf to the island. The cellular blocks that I recommend would be made of reinforced concrete. I have no fear of any future damage to reinforced concrete below water. There is certainly always danger of vibration and cracking, but I would not fear that if it occurred below the point where the work is subject to the influence of air and salt water alternately. There is no danger of salt water setting up electrolysis. It has been proved by a series of experiments that damage occurs only between wind and water. Even with cracks there is no difficulty with a reinforced pile where there can be no aeration and wave action. And even the effect between wind and water can be overcome by coppering. Experiments have shown that, by galvanizing or coppering that portion of the reinforced concrete structure between wind and water, this danger can be overcome; but the experiments have not been carried far enough to show that this method, although it promises well, is absolutely effective. I do not strongly recommend a trestle wall. I do not like the weight of the trestles. They do not give as good a base as would be obtained by the tubular system I recommend. Neither would they prove as good a type of construction. There would be weights of 103 tons to handle as against 18. There would be difficulty in getting them to fit below the water. It would be necessary to exercise more care in preparing the base to get the trestles, with their big height of 37 feet and width of 27 ft. 6 in., to fit against one another. The hollow concrete blocks would simply be slid down the guides already erected, and there would be no question of not getting a good alignment in front. The trestles would fit one against the other, and there would be no panelling in between. It would be quite safe to build a wall on top of the trestle construction, and the weight could be kept down with a stone packing. The trestles delivered and placed in position would cost £103,000. With a wall such as Mr. Ramsbotham suggests, you must cut into the rock to prevent it from sliding on its base. I estimate that the cost of the foundations for either type of wall would be £37,000. I would not require to put down a floor for the class of construction I propose, but for a solid block wall I would excavate the rock, so as to key the wall into it and prevent it from sliding on its base. I do not think that the use of a dredge would reduce the estimated cost of £37,000 for making a foundation for concrete blocks. There is a fair amount of material to be removed at the site of the wharf. With the solid block system you require more concrete than you need in the hollow block construction. With the hollow block system I recommend, you also save the amount of excavation into the rock required under the solid block system, because you simply clean the rock off and bring it to a level surface with bag concrete. In the other type of construction the sand stone would need to be excavated to a sufficient depth to receive the base of the wall, and more concrete would be needed. You have to set off the bag concrete as against the concrete used in the wall. I think the figures are in favour of the hollow block construction for the same height of base. We have put bores down at different intervals. and found that the rock is not level. As a matter of fact, it seems to be fairly rough and decomposed on the surface. Some of the soft stone will need



to be removed. The whole of it will have to be examined and hammered. From what we can ascertain, the rock is not scoured hard and clean, and some of the soft stuff will have to be removed. The holes into which the timber piles will be driven will be 4 ft. 6 in. deep. It is quite true that the Sydney Harbour Trust bores to a depth of 3 ft. 6 in. only for internal piles, but we need the extra depth for the strength of the timber structure. We think it desirable to get the whole of the 820 piles well fixed into the rock in order to prevent any possible movement of the structure. When it is a matter of simply bearing weight, a 3 ft. 6 in. excavation is sufficient, but we want more than that. With the stress there will be on this wharf, we require a maximum grip of the rock for the piles. In our estimate we have allowed a sum of £2,000 for five years to cover the maintenance cost. We anticipate a certain amount of destruction of decking timbers by white ants. But we are not so much in fear of the white ants as we formerly were, because treatment with arsenic and other preparations has proved quite satisfactory. There is bound to be some damage by white ant, but the problem has been tackled very successfully in Sydney Harbour.

75. *To Senator Reid.*—In order to get a good shoulder to prevent a concrete wall from sliding on its base, we would require to sink into the rock for about 3 feet or 4 feet. We need for a shoulder at least 2 feet of sound rock The surface of rock would not need to be sloping away too quickly. If we found that it did so, we should go deeper. The angle of repose against it would be, in this case, 3 to 1. In reservoirs we reckon on an angle of 3 to 1 on the up-stream side where the wall is submerged. The whole of the material content of the solid wall rests on that base. For a solid wall at Garden Island, with a loading of 500 lb. or more to the square foot, I think you would require a base of from 35 feet to 40 feet. To clear off the rock for the form of blocks I recommend, I have estimated a cost of £5,000 or £6,000 for the whole length of 900 feet It is included in the contingency item of £22,000. It would be necessary to keep a dredge there clearing off the silt, and to have divers examining the bottom until we got a decent bottom on which to place the bag concrete. But we would not take as much care with that class of construction as we would with a solid wall, because we would have a width of base that would enable us to distribute the load. Even if the rock is decomposed, it is a very good weight carrier for our purpose. The hollow blocks would not have to resist the actual shearing or cutting as would the solid walls. At the site of this wall the rock slopes rapidly away from the shore, so that to get a satisfactory shoulder for a solid wall we would need to cut into it for some distance. I do not think anything would be gained by making a concrete base with a shoulder on it instead of cutting into the solid rock for the shoulder. When you have your excavating plant there it is better to finish the job with the one set rather than bring in another. Our cement supplies are always obtained from firms who tender for them. There is very little variation in price. I recommend carrying up the hollow concrete blocks in a rectangular base to low-water mark, after which it would be tapered off with a massed concrete wall or wharf on top. It would be a solid wall for the 10 feet above low-water. On the back of the blocks would be a stone packing of a triangular form. That will lead to economy. It would not be necessary to take the blocks out very far at the base and up to half way if we put the filling on the base, but it would not be an economy to alter the shape and form of the blocks for the remainder of the height. It is better to carry the same form right up, getting the advantage of the hollows loaded with sand, giving us a downward pressure to the base and preventing that sliding that I fear with a solid wall, which would be tapering and reducing its weight as it got down. The backing would be ordinary stuff costing about 10s a yard It might be sandstone excavated in the harbour. I would not go beyond a timber wharf, which I estimate to cost £150,000 I am looking at it from the point of view of present and possible future naval requirements. I am taking into account, particularly, the size of the island. If the Navy Department vacated the island, I cannot imagine any commercial use to which it could be put. I am regarding the matter from a financial point of view. For commercial purposes the same objection would be raised to it as is raised to Cockatoo—it is not attached to the mainland. All goods have to be transported by water to and from the island, and the cost of water transport in Sydney Harbour is steadily increasing, and communication is liable to interruption. The area of the island is very limited, and there is an eminence in the middle of it which cannot be removed. I do not fear the effect of white ants in a timber structure. We may lose a few pieces of decking, but not many. I doubt whether a concrete wall between the wharf and the earth would keep ants out. I prefer to rely upon protecting the timber itself.

76. *To Mr. Lacey.*—I have considered the proposal to have piles with a cement covering. That would involve encasing 41,000 feet of piling at prices varying from 3s. 6d. to 6s. per foot. Assuming 5s. a foot in that deep water, about £10,000 would be added to the cost. Including that as another alternative, I would still advocate the timber wharf. The extra cost of encasing the piles only would not be justified That scheme would necessitate the use of fender piles, so that £10,000 would not be the only extra cost. The total extra cost would be from £20,000 to £30,000 I cannot estimate the life of the wharf to within five years, and I am not at present in a position to say that the extra cost of encasing the piles would be compensated for in the increased life of the wharf. If the piles were encased, it would pay to put more money into the superstructure. I estimate the life of this wharf at between 30 and 40 years. The Sydney Harbour Trust, when they construct with piles encased in concrete, estimate the life of wharfs at 80 years. If the piles were encased I should want to revise the whole design, as the expenditure would not be justified for the piles alone. There will probably be a necessity, before the lapse of 30 years, to extend the wharf or to do something else with it. Such piles could not be re-drawn or re-spaced as readily as timber piles, nor could they be so readily repaired. Boring holes to a depth of 4 ft. 6 in. for the piles is necessary, because the vessels will be tied to the wharf and will bump it. I have considered the question of having shallower holes and tying the wharf back to the shore, but I prefer to put the money into the deeper boring. It should not be assumed that it costs twice as much to bore a 5-feet hole as to bore a 2-ft. 6-in hole. The extra cost of going 2 feet deeper will not be much, and will ensure a rigid super-structure.

77. *To Mr. Seabrook.*—In the concrete structure, the concrete blocks are 30 feet long, in order to resist the pressure of the super imposed material and the loads that will be placed on the wharf There must be a certain mass of concrete that will not move on its base In designing, a certain base is taken: the load on the base is compared with the pressures, and from that is calculated the mass, which gives the height The height divided into the mass gives the length of base There will be pressure in the filling. The water pressure on the other side cannot be considered. It is not like a retaining wall which is dry on one side and wet on the other. It is intended to fill the spaces in the blocks. I maintain that it is not only necessary to have the blocks 30 feet long, but also to have stone packing. In the design of the timber wharf, while I insist that the 14-inch by 14-inch girders and the walings are necessary, I agree that the raking pile could be removed and placed in the centre at the front. The raking pile is

good, but its rake is too light. I do not agree that the rake should be reversed. It was placed there with the object of taking the heavy overhang of the crane and resisting the bump of a ship. It was not intended to prevent the wharf from coming away from the land. I think that the wharf would be rigid enough without the pile. If the struts were placed the other way I would welcome the idea of laid ties. The material to fasten the ties to is not good. Mr. Adams did not realize the purpose of the raking piles. The outside piles are strong enough, but we had the idea of attaching fenders if necessary. I wish to avoid cutting the piles below the water line, and, that is why I endeavoured to obtain rigidity in another way. If a concentrated load is placed on the wharf, spreaders should be used. The floor of an ordinary building is designed to carry a weight of 80 lb. to the square foot, but no one would place a heavy steel safe on one part of it without providing for distributing the load over a considerable area. Certain points on the decking might not carry the loads I have mentioned, but they would do so safely with the use of spreaders. I have tried to think of materials that could equal the load the wharf is designed to carry, and, except for coal, I can think of nothing. Boilers and big guns would not give a concentrated load anything like that allowed for. The strength of the wharf will be ample. The cases of wharf damage mentioned by Mr. Adams were probably caused in the hurry of getting ships off to time. A wharf at Garden Island will be used under better conditions. Any damage to the wharf would be only local damage. If the concrete wall is built, tying would be necessary; but I have not shown that in the drawings. That is a different thing altogether. With a narrow strip right along, the best thing would be to anchor it to the wall.

78. *To the Chairman.*—If this was an ordinary commercial wharf its cost would be £106,000. The extra cost is for services required on a naval wharf. The rail anchors or ties suggested by Mr. Adams would not be sufficient. With big cruisers lying alongside that wharf I would not rely on ties. I hope to cut the holes in the rock so clean that the piles can be driven into them without its being necessary to use concrete to pack them in.

79. *To Mr. Seabrook.*—The 12-inch by 6-inch timber on top of the steel girders is really an intermediary to which the rail on which the crane runs may be spiked. It is, so to speak, a trimming or evening-up piece. A built-up girder is awkward to true up with a steel rail. If it had been a rolled joist without riveting or plates off we might have got it true enough to carry a steel rail on it. But there are little difficulties in doing that. It is not much to have an intermediate longitudinal sleeper between the girder and the rail.

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