REPORT

OF

THE COMMITTEE

APPOINTED TO ENQUIRE INTO

THE CONSTRUCTION, CONDITION, AND COST

OF THE

FORTIFICATIONS,

ERECTED, OR IN COURSE OF ERECTION, UNDER 30TH & 31ST VICT., AND PREVIOUS STATUTES.

TOGETHER WITH THE

MINUTES OF EVIDENCE

AND

APPENDIX.

Presented to both Houses of Parliament by Command of Her Majesty.

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1869.

REPORT.

TO HER MAJESTY'S PRINCIPAL SECRETARY OF STATE FOR WAR.

We, the undersigned, Members of a Committee appointed to enquire into the Construction, Condition, and Cost of the Fortifications and Works erected, or in the course of erection, under the 30th and 31st Vic., c. 145, and previous statutes, have the honour to make the following Report:—

PRELIMINARY STATEMENT.

1. The points to which our attention was directed by our letter of instructions, dated April 16th, 1868, were: Instructions.

1st. Whether these forts and works have been well and skilfully constructed with reference—

a. To their stability and permanency.

b. To the arrangements made, or proposed to be made, in them for the service of the guns and otherwise to meet the requirements of a modern armament.

c. To the power of resistance (offensive and defensive) that they offer to any attack to which they may be exposed.

d. To the cost incurred, and to the future expenditure that may be needed for their completion (if this enquiry can be readily accomplished by the Committee, and without involving them in a considerable sacrifice of time).

2nd. Whether any, and which of the works, so far as the same have yet proceeded, are, with reference to their foundations or otherwise, in an insecure condition, and need any and what support or reparation; and what would be the probable cost of such support or reparation.

3rd. Whether the Estimates in the Schedule of the Fortification Act of 1867, before referred to, will suffice for the completion of the works as contemplated, and if not, what additional sums will probably be required.

These instructions were somewhat modified (see letters in Appendix No. I.) as regards the iron forts and shields, and we are not now called upon with reference to them, to give an opinion as to the amount of resistance which iron structures may be expected to offer.

2. In order to give a clear view of the present state of the works, and of the expenditure that has been incurred upon them, we propose first shortly to revert to the circumstances under which they were begun, and to give some account of the changes that have been since made in the original plans.

It will be remembered that in 1859 public attention was strongly drawn to the unprotected state of our Naval Arsenals, and the dangers to which the United Kingdom might be exposed by a foreign invasion. A Royal Commission was in consequence issued on the 20th August, 1859, appointing six officers of the Army and Navy, and one Civilian, Commissioners to enquire into the state and sufficiency of the Fortifications then existing or in progress for the defence of the United Kingdom, and to "offer such "suggestions as might seem to them meet, as (regard being had to the works completed "and in progress, and to the ordinary number of our Royal Artillery, voted by "Parliament) will render our United Kingdom in a complete state of defence." Defence Commission, 1859.

The instructions of the Secretary of State for War accompanying this Commission, and bearing the same date, directed the Commissioners to examine the plans of the works then in progress at—

Portsmouth (including the Isle of Wight and Spithead),
Plymouth,
Portland,
Pembroke,
Dover,
Chatham, and
The Medway,

and having inspected the ground, to consider what would be the best means of rendering those places defensible within as short a time as possible, and how they could be put in the most complete state of defence by permanent fortifications. They were also to consider what steps should be taken for defending the approaches to Woolwich.

3. On the 7th February, 1860, the Commissioners made their report.

They began by stating their reasons for believing that neither our fleet, our standing army, nor our volunteer forces, nor even the three combined could be relied on as sufficient in themselves for the security of the kingdom against foreign invasion.

They next considered the question of fortifications, and they pointed out that the objects proposed to be attained by fortifying any place, are to enable a small body of troops to resist a superior force, or to enable partially trained bodies of men to contend successfully with those more perfectly disciplined than themselves, and they stated that they were led to the conclusion that by a judicious application of fortifications, the means would be afforded of utilizing in the highest degree both the fleet and the regular army and the forces which would be brought in aid of it, and further, that without fortifications there is no mode of defence that would give the same amount of security to the country, and at the same time be so economical both in money and in troops.

They recommended that the fortifications should be restricted to vital points, and those they considered to be the Royal Dockyards, and Woolwich, with the harbours of Portland, Dover, and Cork.

They next refer to the defence of London, and the importance of shielding the heart of the empire from attack, but as that question had not been brought under their consideration, they content themselves with pointing out the bearing which the fortification of the Dockyards and Arsenals would have upon it.

They then describe the general measures they would recommend, and conclude with a detailed report of the works they would propose for the defence of the places named in their instructions, in each case giving an approximate estimate of the cost of the works, and of the number of men required to garrison them; that number they estimated at 69,000; the amount of money required for the whole, including the purchase of land and barrack accommodation for 30,850 men, they estimated at 10,350,000*l.* In this amount was included the sum of 1,610,000*l.** for works already authorized, but for which the money had not been voted, and 1,885,000*l.* for the purchase of land.

The armament for the works, they estimated, would cost 500,000*l.*, and they further recommended that 1,000,000*l.* should be applied to providing floating defences.

The total amount required they thus estimated at 11,850,000*l.*

With reference to that portion of their instructions, directing them to consider what would be the best means of rendering the Dockyards and other places defensible within as short a time as possible, they recommended that the designs should be so contrived that the main ramparts and ditches should be formed without being delayed by the building of revetments, or the construction of bombproof barracks and permanent magazines, so that a certain degree of protection might be obtained in three or four months, and the amount of defence subsequently increased as the works progressed.

For the execution of the works, they recommended that contracts for the excavations should be made and put into operation immediately after the general designs had been decided upon, and the land obtained. The building of escarp and counterscarp walls might be proceeded with as soon as the excavations were sufficiently far advanced for that purpose; in the meanwhile the detailed drawings and specifications for all the building portions of the work might be prepared, and in three or four months from the time of commencement, the whole might be in full operation.

4. The Government, after considering the Report, determined, with the sanction of Parliament, to raise by loan the money required for the purchase of land and the construction of the works, leaving the armament and floating defences to be provided for in the Annual Estimates. Steps taken by the Government.

Before applying to Parliament, they made important reductions in the estimates by omitting the following works that had formed part of the plan of the Royal Commissioners:—

At Portsmouth.—Two Spithead works, the three minor works on Portsdown Hill, and part of the advanced Gosport defences. Omissions at Portsmouth.

At Plymouth.—The Inner Line and part of the Outer Line of the North-East Defences, the whole of the Saltash position, and the connecting lines of the Western position. Plymouth.

Pembroke.—All the works on the north side of the haven except Fort Scoveston, and on the south side the line of works to protect the Dockyard. Pembroke.

Portland.—The purchase of land for the position of Wyke Regis. Portland.

Chatham and the Medway.—The Western Defences and the Grain Spit Fort. Chatham and the Medway.

Woolwich.—The whole. Woolwich.

The reduction in the estimates of the Commissioners consequent on these omissions, exclusive of several minor works not separately estimated, amounted to— Further reductions.

	£
At Portsmouth	480,000
„ Plymouth	1,470,000
„ Pembroke	380,000
„ Portland	100,000
„ Medway and Sheerness	100,000
„ Chatham	700,000
„ Woolwich	700,000
	£3,930,000

At the same time they added 150,000*l.* for the site for a Central Arsenal, making the net reduction 3,780,000*l.*

This amount, deducted from the total estimate of 10,350,000*l.*, leaves 6,570,000*l.* as the portion of the Commissioners' estimate (including land) due to the works sanctioned in 1860. Of this sum 390,000*l.* were voted in the Annual Estimates of 1860-1, leaving, according to the estimate of the Commissioners, 6,180,000*l.* as the amount required for these works. Reduced Estimate.

The estimate of the Commissioners was stated by them to be only approximate, as no detailed plan had been made, but they had every reason to believe that it would be found sufficient, and it was adopted in the return to Parliament in 1860 of the estimated cost of the new works. Parly. Paper, No. 448.

This expectation has not been realized, and the cost of the works has very greatly exceeded their estimate, and this may be attributed to the fact that in the interval between the date of the Report and the present time, many circumstances have combined greatly to enhance the cost of the works. Insufficiency of Estimates.

5. Among these causes may be mentioned:—1st. The construction of several of the works on a much larger scale and adapted for a greater number of guns than those recommended by the Commissioners. 2nd. The necessity of having recourse, in the Sea Defences, to iron structures of a most costly nature, and of adding largely to the thickness and strength of the masonry in all the works, to enable them to resist the heavy projectiles from rifled guns that have since been introduced into all services. 3rd. A considerable increase in the price both of labour and materials. 4th. Unforeseen difficulties in some places in obtaining secure foundations; and lastly, a larger demand for the land purchased than had been anticipated at the time of their Report. Causes which tended to increase the cost of the works.

It is not possible to institute any close comparison between the estimates as framed by the Commissioners and those now found to be required, since, in many instances, the positions selected by them have not been adopted, and different ground has been taken up, while the works designed and constructed differ widely from those originally contemplated.

6. From a Memorandum of the Secretary of State for War, of the 12th May, 1862, it appears that already at that time it was calculated there would be an excess upon the estimate of 1860 of about 300,000*l.* on the cost of land, and of about 380,000*l.* on that of works, making a total probable excess of 680,000*l.* Modification of Original Estimate.

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This excess was provided for in the Schedule of the Act of 1862 (25 & 26 Vic. cap. 78), which was the first of the statutes referred to in our instructions, which contains an estimate of the total cost of each work or group of works.

In this schedule the cost of the works was separated from that of the land, for which a special item was introduced, combining in one sum the cost of the land for all the works. As money was required, the new Acts of Parliament enumerated in the margin were passed, to which similar schedules were attached, containing the total estimated cost at the time of the passing of the Act of each work or group of works.

26 and 27 Vic., cap. 30.
27 and 28 Vic., cap. 109.
28 and 29 Vic., cap. 61.
30 and 31 Vic., cap. 145.

In these schedules variations have been made occasionally to considerable amounts, to suit the changes in the works, and in some cases several have been grouped together, so that the amounts appropriated to each group have become available for any of the works in the group. In our detailed Report upon each work or group of works, we have noted all these changes, the aggregate result of which is shown in the following Table, which is a summary of the schedules. In the amount shown for works in each year, up to 1865 inclusive, deductions have been made for the Central Arsenal, the East Defences of Chatham, and the Maker Barracks, which were estimated separately in those years, but have been omitted altogether in the Schedule of 1867; but no account is taken of the omission of some smaller works, and reductions in others, which have been made with a view to a reduction of the estimates, but all of which are noticed in our detailed Report.

The last column contains a summary of the estimated cost of the various works when completed, exclusive of all sums defrayed, or proposed to be defrayed, from other sources than the Loan for Defences.

SUMMARY of Estimates in the various Schedules of the Acts of Parliament, and of the Estimated Cost of the Works in 1869.

	1862.	1863.	1864.	1865.	1867.	1869.
	£	£	£	£	£	£
Works	5,630,000	5,620,000	5,620,000	5,625,000	5,715,000	6,084,069
Incidental expenses ..	50,000	120,000	120,000	140,000	165,000	194,835
Site for Central Arsenal	150,000	150,000	150,000	150,000	..	..
Land	1,030,000	1,030,000	1,030,000	1,080,000	1,115,000	1,102,033
Total	6,860,000	6,920,000	6,920,000	6,995,000	6,995,000	7,380,937
Providing and fixing iron shields	..	..	..	..	475,000	570,500
Deduct for works omitted,—viz., Chatham E. Defences, Maker, and Central Arsenal	670,000	670,000	670,000	670,000	..	..
Total cost of works now sanctioned.	6,190,000	6,250,000	6,250,000	6,325,000	7,470,000	7,951,437

7. It is no part of our duty to express any opinion on the original plans, or on the changes that have been made in them, except so far as the cost incurred has been affected by them; but in estimating the resisting powers of the various works, the absence of collateral support and the facilities for attack afforded to an enemy by the omission to occupy some important position, become of paramount importance, and we shall have occasion, in the subsequent part of our Report, to call attention to some instances in which the defence might thus be seriously compromised.

rtance of of the s omitted.

Of the great value of the works that have been constructed, and the formidable obstacle they would oppose to an enemy, there can be no doubt; but to give to those vital points that complete protection contemplated in the Royal Commission, it would be necessary, whenever the danger of attack might arise, to take immediate measures for securing the weak points left in the lines by the omissions alluded to.

s which d to pro- the dura- f the en-

8. The length of time occupied by our inquiry demands some explanation from us. Having first, by examining General Lefroy, Colonel Jervois, Admiral Key, and other competent witnesses, informed ourselves of the general arrangements proposed, and of the nature and power of the artillery likely to be employed both in the attack and defence of the various works, we entered upon a personal investigation of the state of each work, and of the plans upon which their construction ... carried on. In

adapted they might have been to their object at the time the plans were made, would require additional strength and considerable modifications to enable them to resist the more powerful artillery since introduced, and to meet the requirements of the new armament proposed for them. In others, the plans had been left incomplete, pending the experiments in progress for ascertaining the relative powers of iron structures and rifled projectiles.

Before, therefore, we could satisfactorily fulfil our instructions, it became necessary to refer back the plans and estimates to the War Department for careful revision, and it was not till the close of the last, and the beginning of the present year, that the finally approved plans were laid before us; and even now, at the date of our Report, the plans, in some cases, in consequence of the progress of invention, and more especially looking to the probable adoption of the Moncrieff gun carriage, have only been provisionally approved, pending the result of further experiments.

From that time, we have been constantly and assiduously employed in the examination of the plans and estimates, and we trust that the time so occupied will prove to have been not ill-spent, since it has enabled us now to lay before the Secretary of State a full and accurate account of the various works, of their cost, and of the amount required to complete them.

In the prosecution of this arduous duty, we have received the most cordial assistance from the Officers of the Fortification Department, and we cannot speak too highly of the able and skilful manner in which the designs have been prepared by them.

With these preliminary remarks, we now proceed to the more immediate subject of our inquiry.

Committee visited each work.

9. We have personally examined the whole of the works we are directed to report upon, and except in one or two cases where individual members were unavoidably prevented from accompanying their colleagues, we have together visited each work in succession.

Witnesses examined.

We have also called before us and examined such of the Commanding Officers of the Royal Engineers, and of the officers in charge of the works in each district, as we thought necessary.

Position and General Design of works accepted as approved.

In accordance with our instructions, we have in all cases accepted as approved the position and general design of the works, and strictly limiting our inquiry to the matters specially pointed out to us, we have not thought it our duty to offer any remarks upon the general plans, except in those cases where, as we have already stated, we think the power of a work to resist an attack might be seriously impaired by the absence of some collateral support, or by some faulty construction.

General observations applicable to all the works.

Before entering upon the consideration of each separate work, we propose first to offer some general observations applicable to the whole, and to deal with some points common to them all, connected with the service of the guns, the magazine arrangements, and the protection of the magazines and gun detachments from an enemy's fire, not, however, including in the latter, for the reasons already stated, the various modes of applying iron to defensive purposes.

And first as regards stability and permanency.

Stability and permanency of works. Clause *a*.

10. We have satisfied ourselves that the works throughout have been well and solidly constructed, and with a due regard to permanency and stability. We have carefully examined into the truth of the allegations that many of the works are in an insecure condition, and we find that, although accidents have occurred during their construction, those accidents have by no means exceeded what might have been reasonably expected in works of such magnitude, and we believe that the statements made with respect to their want of stability are greatly exaggerated. It is to be remembered that the sites for these works have been selected solely for the advantages they offered for purposes of defence, and that many of those sites presented great difficulties, some being in the sea, on shoals or in deep water, exposed to the action of violent storms and heavy seas; others on very treacherous soil, ill-suited for the foundations of heavy works, and others again where heavy slips were fully to be expected. The measures adopted to meet the difficulties as they arose appear to us to have been generally judicious, and though further difficulties may still be met with, it may be expected that the designs now adopted may be so carried out as to secure the necessary stability and permanency.

Arrangements for the service of the guns, &c. Clause *b*.

11. Following the order of our instructions, we next advert to the arrangements for the service of the guns.

The introduction of heavy rifled artillery has inevitably led to great changes in

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those arrangements; and, as the same cause has also led to many changes in the construction of the works, to avoid repetition, we shall, at the same time, advert to some points connected with their resisting power.

See Appendix No. III.

In the Appendix will be found extracts from the Instructions for Coast Batteries, drawn up in 1853, and revised in 1861. At that time, the 68-pounder gun was the heaviest gun contemplated, and the Committee of 1861 did not anticipate the introduction of rifled artillery of more than one nature (probably the 110-pounder breech-loading Armstrong).

All the arrangements therefore, the space between the guns, and the thickness of the parapets, were fixed with reference to those guns; and it was by the rules laid down in those instructions that the designers of the new works under the Loan were guided. Fortunately, before the works were generally too far advanced, the success of the heavier rifled guns had been established, and the necessity of making provision for them was recognized. The space between the guns was increased; the disposition of the magazines and shell stores was altered; for the sea defences iron was gradually substituted more and more for stone, until in some of the works for the outer walls of the superstructure iron alone will be used.

To give greater security to the magazines and to facilitate the supply of powder to the guns, the basements under the gun casemates have been appropriated generally to the storage of ammunition, and direct communication has been established between the magazine passages and the gun casemates above, by means of lifts. To guard against danger, separate passages are provided for the powder, the shells, and for lighting the magazines.

12. The new arrangements had been submitted to the Artillery Authorities on the 4th September, 1865, and again on the 30th July and 7th February, 1867, and approved by them; they are fully described in the paper referred to, and we need not here enter into any details respecting them. We have ourselves carefully considered those arrangements, and, with reference to them, we have examined General Lefroy, Rear-Admiral Cooper Key, General Taylor, Colonel Jervois, and Colonel Wilmot. We have also witnessed at Gilkicker, practice with two 12-ton guns in casemates, fitted at our request with the appliances proposed for working them. Although from the arrangements being incomplete, and the men not sufficiently accustomed to them, the supply of ammunition was less rapid than with more experience and more complete fittings it would probably have been, yet the result of that trial led to the conclusion that it would be difficult, in a hot action, to keep up a sufficiently rapid supply of shells by means of the lift alone, and it became a question of importance whether shells of large size, with heavy bursting charges, could be safely placed in any convenient place near the guns.

Experiment in service of guns, and magazines. See Appendix No. V.

To ascertain this, a pile of shells was fired at at Shoeburyness, and, although many of them exploded with destructive effect, the result appeared to be that there would be little risk in placing them in any position where they would not be exposed to direct fire, or to the impact of heavy fragments of shells bursting near them.

Experiment on shells. See Appendix No. V.

Upon the whole, we think that the arrangements are good, and we have little doubt that, with the improvements in details, which further experience will probably suggest, they will be found well adapted for the service of the guns.

13. In some of the works, the shell passages are too narrow to admit of men passing each other freely, and we recommend that, where the guns are to be served directly through them from the stores, they should be made in future not less than 5 feet wide.

The use of the shell passages as the means of access to the light boxes is not in our opinion objectionable, and in those batteries where the space available for the storage of ammunition is limited, that plan might in future be safely adopted.

Dampness in magazines.

In many of the works our attention was called to dampness in the magazines, and in several the floors have already decayed to an extent to make it necessary to renew them. In some few instances this dampness may have been caused by imperfect drainage, but in the great majority of them it has undoubtedly been caused by the admission of the external air at times favourable to the deposit of moisture on the walls.

See Appendix No. IV.

A paper, drawn up by our Secretary, Lieutenant Ardagh, will be found in the Appendix, in which the question of the ventilation of magazines is ably discussed, and the principles on which it should be based clearly enunciated. We believe that the treatment recommended by him would, to a great extent, remedy the evil. As, however, in many cases the magazines are deeply buried in the earth, and the conditions, even with the greatest attention, unfavourable to the preservation of perishable material, it is worth consideration whether asphalte might not safely be substituted for wood

14. Another change, most valuable in itself, has also exercised a material influence on the designs for the various works.

Improvements in Barracks.

By a reference to the Report of the Defence Commissioners, it will be seen that they recommended that barrack accommodation should be provided for a much larger number of men than the works will now afford. In some instances where it was thought unnecessary to incur the expense, the cost of the work has been reduced by diminishing or omitting the barrack accommodation, while in all the amount of accommodation in the buildings themselves has been largely reduced, from the following cause :—

In 1861, the Commissioners for improving the sanitary condition of Barracks and Hospitals found that these buildings generally were deficient in ventilation, drainage, water supply, and in the provisions for warmth, cooking, washing, recreation, &c., to such a degree as to be detrimental to the comfort, and injurious to the health of the soldiers.

They recommended that instead of 400 cubic feet per man, not less than 600 cubic feet should in future be allowed, and in hospitals 1,200 cubic feet per bed.

The number of men that could be accommodated in barrack-rooms was thus reduced one-third, and in hospital wards nearly one-half below that formerly allotted. Extensive recommendations were also made by them for the improvement of barracks in other particulars ; and general rules for the construction of barracks and hospitals, with their appliances, were laid down.

15. These recommendations were made after the Defence Commissioners had reported, and while the designs for the various works recommended by them were in preparation. In the Appendix will be found an extract from the Report on casemated-barrack-rooms, and it will be seen that the Sanitary Commissioners expressly called attention to the necessity of adopting in the works about to be constructed the improvements suggested by them. In accordance with their recommendation these improvements have as far as possible been adopted, the increased space has been allotted to men and patients; and libraries, canteens, recreation rooms, and schools, have been added where practicable.

See Appendix No. VI.

The result has been a large reduction not only in the number of rooms appropriated as barrack-rooms, but also in the number of men allotted to each room, and a consequent large increase in the cost of housing the soldiers.

This increased cost is no doubt in a great measure repaid by the improvement in the general condition and comfort of the men, and by a diminution of disease. At the same time one effect has been that as the size of the works could not be increased without adding largely to their cost, and developing them to an extent unnecessary for the defence of the position they occupy, the number of men they can accommodate in time of peace is reduced much below that necessary for a state of war, although the amount of bombproof cover remaining the same, would, when required, be made available to the same extent as before.

16. The next clause, *c* of the 1st Articles of our Instructions, relates to the powers of resistance of the various works.

Power of resistance. Clause *c*.

At a very early period of our enquiry our attention was directed to the important question—what amount of resistance might granite walls and earthen parapets be expected to oppose to the powerful rifled shot and shell of the present day? On this point we examined Brigadier-General Lefroy, Rear-Admiral Cooper Key, General Taylor, Colonel Wilmot, and Colonel Jervois. From their evidence it appeared that the data necessary for determining this question were scarcely sufficient to enable us to arrive at any very accurate conclusion. The opinion of these witnesses appeared to be that granite walls and piers 14 feet 6 inches thick might be breached by a continued fire from heavy rifled guns, but that they would probably be found sufficient to resist the attack of ships which when engaging forts would have great difficulty in maintaining a fire of sufficient accuracy to attain that result.

The amount of penetration into earth appeared to be equally uncertain, but Colonel Jervois thought it not improbable that it might be necessary to give additional strength to parapets by substituting concrete for a portion of the earth. Thinking it most desirable that this question should be set at rest, we suggested to the War Department, in a letter of the 18th May, 1868, that experiments should be made to test the resisting powers of masonry and earthwork.

Appendix No. I.

This suggestion was approved by the Secretary of State, and directions were given that the necessary preparations for carrying out such experiments should be made. Some progress had been made in these preparations, when at a later period we were informed that any further proceedings in the matter were for the present postponed. In the

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interval a Minute of the Ordnance Select Committee which had accidentally been omitted from their records was laid before us. It recorded the amount of penetration of heavy projectiles into earth, as ascertained in May 1866, on the demolition of a butt at Shoeburyness into which heavy shot had been fired from a casemate in the month of March. From that minute, and from other data, a table has been compiled by our Secretary, which may be looked upon as giving the approximate amount of maximum penetration which heavy rifled guns of different calibres may be expected to attain.

Appendix No. III.

17. Should these calculations be borne out by future experience, it may be concluded that walls of granite and masonry, 14 feet 6 inches thick, will be found sufficient to meet such an attack from ships as they are likely to be subjected to, but that it will be necessary to substitute concrete or some other hard material for earth to a certain extent in the parapets, both of the Sea and Land Defences, wherever it may not be practicable to increase the thickness up to the limits given in the table.

This course has already been adopted in many cases, and especially would it be followed in those works in which it is proposed to apply the Moncrieff system. In the works for land defence the parapets only are formed, and it is not intended to cut the embrasures or lay the racers for the guns, until a necessity arises for mantling the works and placing them in a state of defence; thus the measures necessary to adapt them to the Moncrieff system, and the strengthening of the parapets, may safely be deferred till the details of that system are more fully worked out, and we strongly recommend that in the interval the proposed experiments for testing the resisting power of various materials should be carried out.

Moncrieff Gun Carriages.

18. The introduction of the Moncrieff gun carriage will also have an important bearing on the resisting power of some of the works in which it is proposed to adopt it.

Designs for the adaptation of these works to this system have lately been laid before us, in some cases as approved plans, subject only to the condition that the gun carriage should prove as suitable for heavier guns as for the seven-ton gun; in others as alternative plans subject to further consideration. In the Appendix will be found a tabular statement of the works to which it is proposed to apply the system, showing the change in the armament and the financial effects that would result from the alteration.

Appendix No. VIII.

19. There are four classes of batteries, as now designed, to which it is proposed to apply it:—

1st. Batteries *en barbette*.
2nd. Batteries with open embrasures.
3rd. Batteries with embrasures to be protected by iron shields.
4th. Casemated batteries.

In addition to these it is also proposed, in some cases, to substitute Moncrieff gun pits for revolving turrets.

In the first case the Moncrieff system will give increased protection to the guns and gun detachments. The minimum height at which barbette batteries may safely be adopted, and below which it would be desirable to substitute for them batteries for guns on Moncrieff carriages, must be determined by the peculiar conditions of each case, depending on the distance and width of the channel to be protected, and the position which ships can take up for attack.

In the second case, the Moncrieff system appears to offer still greater advantages in the increased strength that may be given to the parapets, in addition to the greater protection to the guns and men.

In both these cases the conversion will be attended with some increased cost.

In the third case the parapets will also be strengthened, and a great saving effected by dispensing with costly iron shields, and the power of each separate gun will be extended over a much larger area, by the greater lateral range allowed by the Moncrieff system.

The amount of protection must depend, in either system, on the character of the position, and the measures adopted to protect the guns and gun detachments from enfilade fire.

In the fourth case, that of casemated batteries, the comparative advantages and disadvantages of each system will probably be the subject of very different opinions.

Having previously called the attention of Captain Moncrieff to the plans of the Thames Forts, as an example of the mode in which such works might be adapted to his

those advantages which his system carried out in its integrity is

inferior degree, those advantages which his system, carried out in its integrity, is calculated to afford. He pointed out some objections deserving of attentive consideration, though, if the work already done is to be made use of, some of them could not probably be removed. We did not think it necessary to enter into any lengthened discussion of the plans with him, since we are not called on to decide upon them, nor could we have done so without materially delaying our Report. We have, therefore, only to observe that the propriety of adopting his system must, in each case, be considered with reference to the position and circumstances of the work; and after a careful examination of the relative advantages and disadvantages offered by it, as compared with the system for which it is proposed to substitute it.

In the last case, where it is proposed to substitute Moncrieff gun-pits for turrets, both systems are yet so untried that we can give no decided opinion on them. Should the 25-ton guns be successfully worked on a Moncrieff carriage, and with sufficient rapidity, the saving of expense would offer a powerful inducement for preferring that system to the costly turrets.

20. The last clause of the 1st Article of our Instructions, relating to the cost incurred and the future expenditure required, as it has occupied a large portion of our time, demands more notice. Expendit

We have already stated the circumstances under which the works were begun, and the recommendations of the Defence Commissioners that, as soon as the general designs had been decided upon, and the land purchased, the excavations should at once be commenced, and the ramparts proceeded with; and while they were in progress the detailed drawings and specifications for the completion of the works should be prepared. Immediat commenc ment of recomme by Defen Commiss

This course was followed, and contracts were entered into for the first portions of the works, and followed by fresh contracts for the remaining portions. We have enquired into the manner in which the detailed estimates on which the contracts were based were made out, and we are satisfied that much care was bestowed upon them, and that they were framed with a due regard to economy. Mode in works we carried o

21. At the same time, it followed from this course of proceeding that the total estimate, as first submitted to Parliament, could only be an approximate one, until the details for the completion of the whole could be got out.

In the execution of the works, different courses have been followed, as the circumstances of time and place made advisable. The usual course was, in the first instance, to make contracts for the earlier portions of the works for a lump sum, based on bills of quantities agreed upon between the Contractors and the Officers of the War Department. The subsequent contracts were generally on a schedule of prices, subject to a percentage of increase or diminution, according to the terms agreed upon. In some cases, after the completion of the first contracts, or on the failure of the contractors, the works were continued under the immediate direction of the Engineer Department, the labour being either hired, or military, or the two combined.

At Portland, the works at the Verne and Breakwater have been chiefly performed by convicts, and at Cork, the works at Fort Carlisle (after the excavation of the ditches and formation of the ramparts), and Fort Westmoreland, Spike Island, were first carried on by convict labour, and are now continued by military labour.

From the evidence of the officers superintending the works, we find that the employment of military labour has led to a considerable diminution of expenditure, and that the work so performed is in every way satisfactory, and that the transfer of the execution of the work from the Contractors to the Engineer Department, has not been disadvantageous to the public.

22. Various changes were from year to year made in the Estimates laid before Parliament. In the earlier schedules no separate provision was made for iron shields. It will be seen from the evidence of Colonel Jervois that the iron protection to embrasures, contemplated in 1860 and 1862, was not of an expensive nature, and it was considered that the cost of it would be covered by the original estimate. When the Schedules of 1864 and 1865 were framed the use of more expensive shields was contemplated, but as no estimate of their cost had been prepared no special provision was made for them; we think, however, that it is to be regretted that no intimation was then given that an addition to the estimates would at a future time be required to defray their cost, and that the omission of any such notice was likely to create the erroneous impression that the works could be completed for a smaller sum than that which would undoubtedly be required to put them in a proper state of defence. 2513, *et s*

GENERAL REPORT.

Col. Jervois' Report in 1867.

Increased protection necessary against Heavy Guns.

Inadequacy of Estimates.

23. In 1867 a Report was made by Colonel Jervois, and laid before Parliament, of the state of the works, the cost incurred, and the future expenditure required; and in this Report, for the first time, the estimated cost of iron shields and iron superstructure was separately introduced. The estimate in the Schedule of the Act of that year was revised to meet the altered circumstances, but subsequent experiments have shown that, even then, the power of rifled guns was not sufficiently appreciated, and a great increase in the amount of protection has been found necessary, involving a corresponding increase of expenditure.

In some instances the estimate of 1867 was undoubtedly inadequate to complete the works upon the plans then approved. In the works on Portsdown Hill this deficiency in the estimate was the most marked; in the report on those works an explanation of the mode in which the estimate was framed, and our opinion on the course adopted will be found.

From these general remarks we now proceed to report upon each work in detail.

PORTSMOUTH.

GENERAL REPORT.

Recommendations of the Defence Commission.

24. In their Report the Royal Commissioners divided the Sea Defences of Portsmouth under five heads :—

1. The entrance to the harbour.
2. The prevention of a landing within the fortified position to landward.
3. The protection of the anchorage at Spithead, and of the dockyard from bombardment.
4. The defences of the Needles Passage.
5. The measures necessary to prevent an enemy obtaining a footing in the Isle of Wight.

The Land Defences they classed as the Portsdown Hill and Gosport Positions.

Sea Defences.

Spithead Defences.

25.—1. For the first object, the defence of the channel leading into the harbour, they considered that the existing works strengthened by additional batteries at Southsea would be sufficient.

2. To oppose a landing to the eastward of the harbour, Southsea Castle, and Fort Cumberland, with the two intervening forts about to be constructed at Lumps and Eastney, would suffice; and to the westward, the lines in progress at Stokes Bay with their batteries, and an extension of the battery at Gilkicker, would be also sufficient.

3. The defence of Spithead and of the dockyard from bombardment was the next and most important point of their enquiry.

After describing some of various schemes that had been suggested, they recommended that the casemated forts, which it had already been proposed to construct on the Horse Sand and No Man's Land Shoals, should be proceeded with, that a work should be constructed between that on the Horse Sand and Portsea Island, another on the Spit Sand, and a fifth on the Sturbridge Shoal, with batteries at Appley House and Nettlestone Point in the Isle of Wight. The most important of these works they recommended to be built of masonry faced with hard granite, with three tiers of guns in casemates and embrasures in wrought-iron, and with guns and mortars on the roof.

They go on to state that, after having given the most thorough consideration to this question, they were of opinion that nothing short of the project proposed would meet the necessities of the case.

Defence of Needles

4. For the defence of the Needles they did not consider the existing works at Hurst Castle, Sconce Point, and Cliff End would suffice, and they recommended that batteries should be constructed on the heights above Cliff End,—at the point between Totland and Coldwell Bays, at Hatherwood Point, and near the Needles Point, and that casemated batteries should be substituted for the batteries at Hurst Castle. For the protection of the batteries on the southern side of the channel, and to prevent their being taken in reverse, they recommended a work between Cliff End and Freshwater, with barrack accommodation for the men to work the additional guns recommended by them.

Defence of Isle of Wight

5. Under the last head, the defence of the Isle of Wight, they considered that the northern shore would be sufficiently protected by the works already recommended.

For the defence of the south-west coast they recommended a military road between Chale and Compton Grange, with two towers, one near Brook, and one near Brixton, and a battery with a keep in its rear on Atherfield Point. For the defence of Sandown Bay, affording "the best and, indeed, the only good landing place" on the south side of the island between the Needles and Spithead, they recommended that a new permanent work should be substituted for the old bastioned fort then existing, and that batteries with keeps in their rear should be constructed on the rising ground near Yaverland, at Lanonard (to the westward of Sandown), and at a point below Sandown

PORTSMOUTH.

Barracks; that, to protect the rear of the batteries on the eastern side of the bay, a tower should be placed on the summit of Bembridge Down; and lastly, a battery with a keep in its rear on St. Helen's Point, to oppose a landing between Bembridge and Nettlestone Point.

26. The measures recommended by them for the Land Defences were as follows:—

Land Defences.

1. The occupation of the position on Portsdown Hill by four principal works, at Crookhorn, at the Windmill, the Fir Clumps, and Nelson's Column; three minor works at intervening points; and a line of ditch and rampart connecting the flanks of the position with Langston Harbour and Portsmouth Harbour, and with two detached works in advance of the flanks.
2. The construction of three works in advance of the line between Forts Gomer and Elson; one on the right near Newgate, one in the centre near Roome, and the third in advance of Browndown near the shore.
3. The completion of the three works then in progress between Forts Gomer and Elson.
4. And the completion of the strong lines already designed behind the Hilsea Channel to take the place of the insignificant field works there existing.

Reduction of Estimates.

27. We have already given a summary of the changes made in this scheme for the Sea Defences; we now proceed to show more in detail what those changes were, and their effect on the financial part of the plan.

The works struck out at Portsmouth by the Government, before going to Parliament, would have cost, according to the estimate of the Commissioners, 460,000*l.*

These works were:—

1. The intermediate work between the Horse Sand and Portsea Island.
2. The work on the Spit Bank.
3. The two works, one near Roome and the other at Lee Farm in advance of Brown down, forming part of the Gosport Advanced Position.

Before the first grant was voted, a further reduction of 20,000*l.* was made by omitting the connecting lines between Forts Gomer and Elson. Subsequently the difficulty of obtaining a foundation on the Sturbridge Shoal made it necessary to abandon that position, and it was proposed to substitute two smaller works on the Spit Bank and Ryde Sand. The latter it has also been found necessary to give up from the same difficulty of obtaining a foundation.

Changes in Sea Defences.

28. In the works themselves great changes have been made to meet the advance in the power of artillery.

In the two large forts on the Horse Sand and No Man's Land Shoal an iron superstructure to mount 49 guns in two tiers has been substituted for the granite fort of three tiers with iron embrasures mounting 120 guns. In the new design preparation is also made for five turrets to carry ten of the heaviest guns that may be adopted into the service; with this addition, the power of the forts against ships will far exceed that of the original works with their more numerous but lighter guns; these turrets have not yet been sanctioned, and no provision is made for them in the Estimates. Arrangements are also proposed for introducing into the forts the electric wires required for submarine defence.

A reduction has also been made in the Spit Bank work, now designed to mount 15 guns in one tier, with preparation for two turrets. In this case the sea face alone is to be of iron, the granite walls being retained on the land side. Another fort of similar construction has been placed near the edge of the shoals in front of St. Helen's Point, instead of the work contemplated on that Point, and a heavy mortar battery with five rifled guns at Puckpool has been substituted for the two works at Appley House and Nettlestone Point.

Isle of Wight.

29. In the Isle of Wight, for the defence of Sandown Bay, the work at Languard has been given up, and another work at Redcliffe, to the eastward, added. The three works at Brixton, Brook, and Atherfield have been given up, and a military road alone made from Freshwater to Chale.

The new casemated batteries at Hurst Castle and the auxiliary batteries at Southsea, are much more powerful than those contemplated by the Commissioners; and lastly, at Gilkicker instead of only [illegible] to give

over.

and lastly at Gibraltar instead of only strengthening and extending the batteries to give an addition of nine guns a new and powerful casemated work has been constructed and a mortar battery for 16 mortars is to be added between Gibraltar and Europt Monckton.

30. The financial effect of these changes will be stated at the end of the report on each group of works; and it is only necessary here to observe that the increase in the expenditure has not arisen from any want of care or of a due regard to economy in their construction, and that the manner in which the works have been constructed reflects great credit on the officers to whose supervision they have been committed, and is well calculated to ensure their stability and permanency. Financial effect.

SEA DEFENCES - OUTER LINE

SPITEHAD WORKS.

HORSE SAND FORT.

31. This is a circular work, situated on the Horse Shoal, upon which, at a depth of 11 feet below water spring tides, a level space having first been prepared, the foundations were laid in the form of a ring 231 feet in external diameter, and 53 feet 6 inches in thickness at the base, with granite facing on the outside, and Bramley Fall or Portland stone on the inside, the intervening space being filled with massive concrete blocks. Design

Foundations

The space thus formed inside the ring was filled with clay and shingle, and a thick bed of concrete laid thereon, to afford foundations for the inner portion of the superstructure. On this broad and solid base, which at a height of 1½ foot above high water of ordinary spring tides is 210 feet in diameter, an outer wall, 16 feet high and 14½ feetthick, of granite and roach Portland stone has been built, and provision is made for protecting it with iron plates, should this hereafter be found necessary.

The foundations and the outer wall in this and the other Spithead works were constructed under the direction of Mr. Hawkshaw, C.E.

We have already stated that we have no sufficient data to enable us to form any confident opinion as to the power of 14 feet 6 inches of granite and stone to resist the navy projectiles of the present day, but we think it probable that ships would not be able to bring a fire upon this work capable of inflicting serious damage without being themselves disabled by the heavy fire of its powerful artillery, and that it will not, therefore, be necessary to incur the great additional expense which plating it with iron would involve; especially as, even if this outer wall should be penetrated, there would still be another wall to be overcome before the interior of the work could be reached.

Upon the basement it is proposed to place an iron superstructure for 49 guns in two tiers, and preparations will also be made for five turrets to be added hereafter, if sanctioned. The estimate for this iron superstructure is based upon accurate calculations of the quantities of iron of various kinds that will be required for its construction, in order to enable it to offer an adequate resistance to any attack to which it may be exposed; but as the precise arrangement of these materials is not decided on, and as we are not required to give any opinion on that point, we have only to state that the amount estimated would appear to be a sufficient provision for the completion of the work in a satisfactory manner. Superstructure

The arrangements for the service of the guns and for the supply of ammunition are satisfactory. The work, as far as it has gone, is well and skilfully constructed, as regards permanency and stability, and there have been no failures. Report

The estimate for this work in the Schedule for 1862 was 260,000l., and in subsequent Schedules it remained at the same amount till 1867, when it was increased to 365,000l. The sum expended to the 30th June, 1868, amounted to 115,834l., and a farther sum of 308,860l. will be required to complete it, thus made up :- Estimate

	£	£
Expenditure to 30th June, 1868		115,834
Estimated cost of masonry	68,238	
Ironwork for 40 casemates, with intervals of 24 feet 2 inches, at 4,488l. each; and 10 casemates with intervals of 26 feet, at 4,860l. each	228,120	
Additional work, not included above	6,967	
Arrangement for torpedo wires	2,700	
Proportion of expenses of experiments at Shoeburyness	2,835	
		308,860

£424,694

2

No Man's Land Fort.

Portsmouth.

Design.

32. This work is of a similar construction to that on the Horse Sand, but to obtain a solid foundation, it was necessary to go 20 feet below low water ordinary spring tides, and the cost was thus largely increased.

Estimate.

The estimate for this work in the Schedule for 1862 was 290,000*l.*, and, as in the preceding case, no change was made in the amount till 1867, when it was increased to 406,000*l.*

The amount expended to June 30th, 1868, was 152,937*l.*

The amount required for completion, varying only in some small details from that of the Horse Sand, is 309,563*l.*, and the total cost will thus amount to 462,500*l.*

Spit Bank Fort.

Design.

33. The foundations for this work are similar to those for the Horse Sand Fort. The external diameter of the masonry base at high water level is 151 feet.

It is designed for 15 guns in one tier, nine in an iron superstructure occupying rather more than half the circumference looking seaward, and six in granite casemates towards the land and Portsmouth Harbour. Preparations are also made for two turrets.

Report.

The work is well and solidly built, and there have been no failures; the arrangements for the service of the guns and for the supply of ammunition are good and satisfactory.

It has already been stated that the Defence Commissioners recommended a work on the Sturbridge Shoal, that provision was made for it in the Schedule of 1862, and that the work on the Spit Bank, recommended by them, was given up. All attempts to obtain a secure foundation on the Sturbridge having failed, it was decided to substitute two smaller works on the Spit and Ryde Sands. The same difficulty in obtaining a secure foundation led to the abandonment of the position on the Ryde Sand, and the work on the Spit Bank is alone in course of construction. The attempts alluded to involved an expenditure of 10,074*l.* under the Loan, and 2,310*l.* out of annual votes, and this amount has been added to the expenditure on this item of the Schedule, though it cannot be considered as any part of the cost of the work on the Spit Bank.

Estimate.

The amount inserted in the Schedule of 1862 for the Sturbridge work was 306,000*l.* This sum was increased in 1863 to 310,000*l.*; the Sturbridge work was omitted from the Schedule of the Act of 1864, but the same amount was retained for "other Spithead works" till 1867, when it was reduced to 293,000*l.* at the same time that the amount for St. Helen's and Puckpool was increased; this estimate was intended to provide for two works on the Spit Bank and Ryde Sand; the latter, for the reasons given above, was afterwards abandoned.

The account will then stand thus:—

	£	£
Expenditure on Spit Bank to June 30th, 1868		45,101
Further sum for foundations	23,249	
To complete masonry	47,365	
To complete iron:—		
Seven casemates of 25 feet intervals, at 4,643*l.*; two ditto of 29 feet, at 5,387*l.*	43,275	
Proportion of Shoebury experiments	510	
		114,399
		159,500
Estimated cost of shields		7,800
Estimated total cost of work		167,300
Expenditure at Sturbridge, &c.		12,384
		£179,684

St. Helen's Fort.

Design.

34. This fort is placed on the outer edge of the shoal, where the sand is nearly uncovered at low water spring tides. The foundations for the work are formed by a ring of iron caissons sunk to an average depth of 25 feet 6 inches below the surface of the shoal, passing through sand and shingle, and 5 feet into the clay. Within this ring the sand has been dredged out, and the space thus excavated filled with concrete; this bed of concrete is 10 feet thick, and its surface is 2 feet above low water of ordinary spring tides.

The outer wall of the basement is completed. The superstructure will be of iron on the outer half of the fort where exposed to fire from ships, and of granite towards the land; it will be armed with six heavy guns to seaward, and four lighter guns behind shields on the land face. PORTSMOUTH.

It is well-designed as to permanency and stability, and the arrangements for the service of the guns are satisfactory. The calculations of the probable cost of the iron walls are based on the same data as those for the other Spithead forts, and the remarks on the Horse Sand Fort apply equally to this work. Report.

This work was not contemplated in 1862, but in the Schedule for that year the sum of 87,000*l.* was inserted for batteries at Puckpool and St. Helen's Point. In 1863 it was decided to substitute a work on the shoal for that on shore, and the same amount was retained in subsequent Schedules, till 1867, when it was increased to 145,000*l.* The sum expended to the 30th June, 1868, amounted to 47,779*l.* The further sum required amounts to 70,332*l.*, that is, for the masonry 41,358*l.*, and for the iron 28,974*l.*, making the estimateof the total cost of the work, when completed, without shields, 118,111*l.*; and including four shields, estimated at 5,200*l.*, 123,311*l.* Estimate.

PUCKPOOL BATTERY.

35. This is a powerful mortar battery on the north-eastern shore of the Isle of Wight bearing, though at long range, on the approach to Spithead and the southern part of that anchorage. Design.

It was commenced in 1863, and completed in March 1865 for an armament of 21 mortars, with space on the ramparts for 11 light guns. In 1867 it was modified and altered for an armament of 38 mortars in a double line, and five guns. In 1868, when the failure to obtain a foundation either on the Sturbridge or Ryde Sand made it necessary to abandon the attempt to construct a work in either of those positions, it was decided to increase the power of the guns in this work, and again to modify it by reducing the number of mortars from 38 to 30, and to substitute 25-ton guns for four of the lighter guns formerly proposed; the fifth gun for flank defence will be a 7-inch breech-loading gun. The merlons have also been strengthened by the introduction of concrete, and two additional expense magazines provided. On the right flank there is a small barrack containing accommodation for four officers and 67 men. It is well supplied with water. Armament. Modification.

The work has been skilfully constructed. The arrangements for the service of the guns, and for the storing and supply of ammunition, are good. Report.

The sum expended to the 30th June, 1868, amounted to 16,840*l.*, and the further sum required to complete is estimated at 4,024*l.*, making a total of 20,864*l.* To this must be added, before the battery would be ready for occupation, a further estimated expenditure of 8,100*l.* for shields, making a total of 28,964*l.* Estimate.

In 1867, the total cost of the two works at St. Helen's and Puckpool, when no shields were proposed for Puckpool, was estimated at 145,000*l.*, the cost, including shields, is now estimated at 152,275*l.*

An alternative plan has been laid before us for dispensing with the iron shields at Puckpool and substituting guns mounted on Moncrieff carriages. The cost of the alteration would be 2,824*l.*; the whole cost of this work would be reduced from 28,964*l.* to 11,988*l.*; and of the two together to 146,999*l.* Alternative plan.

We will not here further allude to the financial effects of the adoption of the Moncrieff system, since in the Appendix will be found a tabular statement, giving in each case a full account of what the effect of the change will be.

SEA DEFENCES.—INNER LINE.

and is now approaching completion

GILKICKER BATTERY.

36. This work was begun in June 1863, under a contract for the basement. In November of the same year, the contractor failed, and the work was stopped. In June 1864 it was re-commenced under a fresh contract has been carried on steadily since,

PORTSMOUTH.

Design.

It is designed as a casemated granite work, mounting 22 guns behind iron shields, with 5 guns also protected by shields on the roof, and will contain barrack accommodation for five officers, four serjeants, and 98 men on a peace establishment.

Report.

There have been no failures of any sort, and the work is skilfully built, both for permanency and for resisting power.

Magazine accommodation.

The disposition of the shell stores and magazines in the basement is good, but the passages by which the shells are conveyed from the stores to the lifts are only 4 feet, and in some places 3 feet 6 inches wide, scarcely allowing two men to pass each other with trucks, and making it difficult, if not impossible, to supply the shells with sufficient rapidity from the basement alone.

A record of a trial of two guns in this battery will be found in the Appendix, No. V., and in another part of this Report we have pointed out the measures which we think necessary to give full efficiency to the heavy guns in casemated batteries.

In the design laid before us it is proposed to cut through the rear wall of the casemates, for the purpose of passing the lamps for lighting the magazines and shell stores from the outside into the light boxes, without carrying them through the shell passages. The considerable expense of this alteration might, in our opinion, be saved, by allowing the light boxes to open directly into the shell passage, as we see no objection to the lights being inserted in their places from that passage.

Mortar Battery.

A design has also been laid before us for an auxiliary mortar battery, on the left flank of the fort, to be prepared for 16 mortars. This design has not been finally approved. It appears to be well calculated for its object, and is estimated to cost 8,800*l.*

Estimate.

The original estimate for Gilkicker Fort, in 1862, was 50,000*l.*, and this in 1863 was increased to 58,000*l.* The additional cost of the shields was then estimated at 30,000*l.*, but no provision was made for a mortar battery. The amount expended to the 30th June was 45,984*l.*, the further sum required is 15,411*l.*, making a total of 61,395*l.* To this must be added 38,725*l.*, for providing iron shields, bringing up the total cost to 100,120*l.*, and with the mortar battery to 108,920*l.*

SOUTHSEA CASTLE.

Design.

37. The works undertaken here under the Defence Loan consisted of auxiliary batteries connected with the Old Castle, the whole closed by a gorge wall, loopholed for flanking fire.

Armament.

The batteries are constructed for 32 guns—one rifled 13·3-inch gun on the left flank of the West Battery; 22 rifled guns, of 9 or 10-inch; nine 7-inch guns for flank defence; and four mortars. The battery is partially armed. The position selected for the mortars behind the Castle appears to us to be objectionable, and we recommend a revision of this part of the plan. This will involve no additional expense, as the work has not been commenced.

Mortar Battery.

Modifications.

At the time of our visit, the protection to the guns and magazines appeared to be insufficient to withstand the heavy projectiles of the present day, and a plan has since been sanctioned for giving increased strength to the parapets. A plan has also been laid before us, in which it is proposed to dispense with the iron shields, to substitute the Moncrieff system in that portion of the battery intended for heavy guns, and to increase still further the strength of the parapet.

Report.

The magazines for the 7-inch guns might be exposed to a dropping shot from an enfilade fire, making a different arrangement and additional protection necessary. The design has been amended in this respect, and the cost of the alteration included in the estimate. The magazine accommodation will then be good and well-arranged. The arrangements for the supply of ammunition to the guns are not yet finally settled, awaiting the result of further experience with heavy guns. For the 23-ton gun some special provision will be necessary for the conveyance of its heavy shells from the magazine below.

The auxiliary batteries were begun in March 1863, and are complete, with the exception of the shields for embrasures. They have been well constructed.

Castle.

In the Castle there is accommodation for three officers and 63 men. The old magazine in its basement is ill-lighted and ill-ventilated, and the want of ventilation is the more felt from the latrines being in its immediate neighbourhood. There is a project for mounting three of the heaviest guns and four mortars on the top of the Castle, but this has not yet been sanctioned. Should it be adopted, the opportunity should be taken to revise the magazine arrangements.

The amount expended to the 30th June was 29,394*l.* The further sum required to carry out the improvements mentioned above is 11,460*l.*, making a total of 40,854*l.* To this must be added the sum of 35,025*l.* for shields, making a total of 75,879*l.* PORTSMOUTH. Estimate.

Should the Moncrieff system be adopted, there would be an additional cost in preparing for it of 6,862*l.*, but the total cost of the battery on that system would be reduced to 47,716*l.* Alternative.

EASTNEY BATTERIES.

38. The Eastney Work consists of two batteries, connected by a parapet, in front of the barracks of the Royal Marine Artillery. They are intended to command the approach to Langston Harbour and the water to the eastward of the Horse Fort. Design.

The face of each battery, and of the connecting parapet, is covered by a dry ditch, and the gorge is closed by a loopholed wall 3 feet thick. Each battery has 10 embrasures, and two guns *en barbette*, and is now armed with five 7-inch breech-loading guns, and seven 8-inch smooth-bore guns. The magazine accommodation is sufficient, but the provision for artillery stores is scarcely adequate. Armament.

As these batteries are at a great distance from the channel leading into Spithead, and have a large extent of shoal water in front of them, they could take but little part in an engagement with large ships, and their present armament seems to be sufficient to keep small vessels or boats at a distance. For this purpose they have been skilfully constructed. They were commenced in June 1861, and completed in March 1863, for the sum of 17,435*l.*, and no further expenditure is required upon them. Estimate.

LUMPS BATTERY.

39. This work has 14 guns in embrasures, and three *en barbette*. It is armed with 68-pounders, 8-inch guns, and breech-loading 7-inch rifled guns. It is surrounded by a ditch, into which the water can be admitted, but as the ditch will not retain the water, it is at present an imperfect obstacle to an assaulting party, and although protected by the flanking fire of three caponnières, some measure seems to be necessary to improve it, which might however be deferred till a time of expected attack. Design. Armament.

The work was begun in November 1859, and completed in October 1861. It is well constructed, and except the defect mentioned above, well adapted to its object—that of preventing a landing between Eastney and Southsea Castle. The magazine accommodation is ample, and well protected. The work is supplied with water by the Southsea Water Company. Report.

The cost of this work was 18,945*l.*; of that sum 14,726*l.* were charged to the Annual Estimates; and the expenditure, under the Loan, amounted only to 4,219*l.* No further expenditure is required. Estimate.

In the Schedule of 1862 provision was made, exclusive of land, of a sum for Southsea Castle of 35,000*l.*; for Eastney, 15,000*l.*; and for Lumps, 5,000*l.*: in all, 55,000*l.* This, in 1867, was increased to 60,000*l.* for the works, and 30,000*l.* for the shields, making the total estimate 90,000*l.*

The estimated expenditure under the Loan on the three works, exclusive of shields, amounts to 60,998*l.*, and with the shields, to 96,023*l.*

SUMMARY.

40. The total amount estimated by the Defence Commissioners to be required for the defence of Spithead, including the purchase of land, was 1,100,000*l.* The amount expended out of the Annual Votes was 17,036*l.* The estimate for the works contemplated in 1862 was, exclusive of land, 1,048,000*l.*; in 1867, the great power developed in rifled guns having made a large increase of resisting power necessary in these forts, the estimate was increased to 1,327,000*l.*, exclusive of the iron shields for Southsea and Gilkicker, and with those shields to 1,387,000*l.* The cost of completing the works without shields is now estimated at 1,328,446*l.*, and the cost of the shields at 94,850*l.*, making with the previous expenditure a total of 1,440,332*l.*, of which 1,421,786*l.* will be charged against the Loan.

The abandonment of the work on the Ryde Sand has led to a saving of 115,626*l.* on the item of 293,000*l.* in the estimate of 1867 for the Spit Bank Fort and other works; by this saving the great increase since 1862 in the estimated cost of the other Spithead works has been partly met, yet it will be seen that the increased estimate of 1867 still falls short of their present estimated cost by 34,786*l.*

Portsmouth.

Of this excess 6,200*l.* has been caused by the provision of means for combining submarine defences with the forts; 13,500*l.* has been caused by the necessity of adding to the thickness of the shields, and a sum of 82,273*l.*, being 22 per cent. on the iron superstructure of the two forts at Horse Sand and No Man's Land, is to be attributed to the strengthening of the iron work consequent on the experiments made at Shoeburyness in 1868.

If the Moncrieff system be adopted, there will be an excess on the total estimate of 1867 of 1,347*l.* The works in our opinion have been constructed with great skill, and with due regard to economy; and their increased cost is to be attributed to the causes we have mentioned above.

NEEDLES PASSAGE DEFENCES.

Hurst Castle.

Design.

41. This powerful work, embracing the old Castle, and extending on each side of it, consists of 61 casemates in which the guns are to be protected by iron shields, 37 to the westward of the Castle, and 24 to the eastward. The original design also provided a barbette battery on the roof. This part of the design has been given up, and it is now proposed to place on the roof three turrets for six guns, or four guns on the Moncrieff system.

Magazines.

There is no basement accommodation except in the Old Castle, which contains a large magazine. The plans for the magazines have undergone considerable alteration and improvement. The present arrangement provides four new main magazines and shell stores, two in each battery, in addition to the large reserve magazines in the Keep. There are also seven expense magazines and seven shell stores in rear of the casemates, to be supplied from the main magazines by a verandah passage. These seven magazines will have to supply the 61 heavy guns in the casemates, or from eight to nine guns each; and considering that, except a few guns on the flanks, the guns will be 10-inch rifled guns, it would seem too much to expect that a sufficient supply of ammunition could be kept up from them during a hot action with ships. We therefore recommend that the whole of the space now divided between powder and shells should be appropriated to powder alone, and that some simple arrangement should be made for a deposit of shells, for immediate use, in rear of each casemate, where they would not be exposed to direct fire, or to the impact of heavy fragments of shells bursting near them, to be supplied as required from the main shell stores. We also recommended that the floor of the verandah, which is now on a somewhat lower level than the floor of the casemates, should be raised to the same height, so as to facilitate the passage into the casemates of trucks with heavy cartridges or shells; this modification has now been introduced in the approved plan. Separate magazines and shell stores will be provided for the turrets, or Moncrieff guns, on the roof. The old magazines in the Keep are spacious. At the time of our visit we observed that they were ill-ventilated, and that the floors were so much affected by dry-rot that it was necessary to take them up. Plans have now been laid before us for improving the ventilation, and the cost of doing so is included in the estimate for completion.

Recommendations.

The rear of the work is closed by a massive wall, to which additional strength has been given, where it is exposed to fire from either flank.

Report.

The new batteries are well and solidly built. The foundations are protected in front by a large bed of shingle, varying much in quantity, as it is thrown up or washed away by the sea. The tendency, for the last three or four years, has been towards an increase, and there seems no reason to fear that the stability of the foundations will ever be affected by the action of the waves.

The first contract was in February 1861, for the foundations, which were satisfactorily completed in March 1862. The next contract was for the battery, some rear buildings, rear wall, and bridges, with some alterations in the Castle, and a new lighthouse and light-keeper's dwelling, for a sum of 68,875*l.* When this sum had been expended, a further contract, under which the work is now approaching completion, was made with the same contractor at an advance of 15 per cent. on the schedule of prices in his former contract.

The estimate in the Schedule of 1862 was 108,000*l.*; in 1867 it was increased to 110,000*l.*, and 61,000*l.* was added for shields, making a total estimate of 171,000*l.* PORTSMOUTH. Estimate.

The total amount expended to the 30th June, 1868, was 97,832*l.*, and a further sum of 22,989*l.* will be required to complete the work, exclusive of turrets and iron shields, making a total of 120,821*l.* The cost of shields to be added is estimated at 88,450*l.*, making the total cost 209,271*l.*, and with turrets 269,271*l.*

Should the four Moncrieff guns be sanctioned instead of the turrets, the additional cost of the work would be 8,302*l.* and the total cost of the work, with this addition, would be 217,573*l.*, instead of 269,271*l.* In the Appendix will be found a comparative statement of the cost of the two plans.

ISLE OF WIGHT DEFENCES.

Needles Battery.

42. This is a barbette battery built on the projecting point of the chalk ridge above the Needles Rocks, at an elevation of 254 feet above the sea.* It commands the narrow channel between the Needles Rocks and the Shingles, the edge of that shoal being distant a little more than 2,000 yards, so that ships passing would be exposed to a plunging fire upon their decks, while the height of the battery above the sea protects it from any serious attack from shipping. Design.

It is designed for 6 guns, and is at present armed with 7-inch breech-loading guns, which it is proposed to replace at a future time with heavier guns. The gorge is closed and protected by a ditch, cut in the chalk, across the narrow ridge on which the work stands. It contains barracks for one officer, two non-commissioned officers, and 21 men. Armament.

The battery was commenced in September 1861, and completed in June 1863. In 1865, the facing of the escarp bulged slightly, but so little as to need no repair, and there has been no further movement. Water is supplied from rain-water tanks, having a capacity of 10,400 gallons. There is sufficient magazine and store accommodation, and the work has been well and skilfully constructed. Report.

The estimate in the Schedule of 1862 was 7,000*l.*, exclusive of land. The expenditure to the 30th June, 1868, amounted to 6,958*l.*, and a further sum of 698*l.* will be required to adapt it for a heavier armament, making the total cost 7,656*l.* This additional sum will be charged to the Annual Estimates. Estimate.

Hatherwood Battery.

43. This is also a barbette battery placed on a point on the north-east side of Alum Bay, at the same height above the sea as the Needles Battery, with which it crosses its fire on the Needles Passage. Design.

It was commenced in 1865, and is finished, with the exception of some small details and the modifications required to adapt it for guns heavier than those originally contemplated. It is now intended for an armament of four 9-inch guns and three 7-inch. It is sufficiently supplied with water from a well. Barrack accommodation for two officers and 50 men was provided in the original design, but this has been omitted, and the only provision is now a small building in the rear, adapted for two married soldiers. It has been well and skilfully constructed, and there have been no failures. The store and magazine arrangements are good. Armament. Report.

The estimated cost in the original Schedule amounted to 4,000*l.* The expenditure to the 30th June, 1868, amounted to 4,581*l.*, and a further sum of 1,244*l.* is required to complete it, making the total estimated cost 5,825*l.* Estimate.

Warden Point Battery.

44. This work was commenced in 1862, and finished in June 1863.

To secure the cliff, and to prevent the bank from slipping, the slope and back of the hill were drained, under the direction of Mr. Parkes, C.E., and a sea wall was built along the shore to resist the action of the sea. On the representation of the Commanding Royal Engineer, the foundations of this wall were carried deeper than originally designed; the total height was increased from 9½ to 12½ feet, and the length from 900 Sea Wall and Drainage.

* Unless otherwise specially stated, all the heights of works as given in this Report, refer to the highest point of the crest of their parapets, the altitude of which is given above mean tide level.

PORTSMOUTH.

to 1,100 feet; the toe was in part further protected by an apron of Purbeck pitching, with sheet piles in front. The drainage extended over the whole site, comprising an area of 23 acres.

It is scarcely to be expected that the action of the sea and of the rain will be entirely arrested by these precautionary measures, and it is probable that some expenditure will be necessary from time to time to prevent injury to the work, but we have not thought it necessary to include any additional sum for this purpose, since any measures that may be required hereafter would be more properly charged to the maintenance than to the completion of the work.

Design. Armament. The work is enclosed, and will mount eight 12-ton 9-inch guns *en barbette*, 105 feet above the sea. It is about 2,500 yards to the eastward of Hatherwood, and about the same distance from Hurst Castle on the opposite side of the channel.

Report. The work has been well and skilfully constructed. The magazine accommodation is sufficient, and it is well-protected. There have been some complaints of dampness; this does not appear to have been caused by defective drainage, but rather by the admission of the damp external air to the cold internal walls. The arrangements for the artillery stores are not altogether satisfactory, but a different disposition of the available spaces would remedy the inconvenience without the necessity of incurring any additional expense.

The original design provided the same barrack accommodation as at Hatherwood, and this, with the exception of a small guard-room, has also been omitted here.

Estimate. The estimated cost of this work in the Schedule of 1862 amounted to 9,000*l.*, exclusive of land, but in the Schedule of 1867 10,000*l.* was added to the total for this group of works, to meet part of the largely increased expenditure found to be necessary here and at Cliff End. The payments to the 30th June, 1868, amounted to 11,746*l.*, the further sum required to complete is 1,153*l.*, making the total estimated cost 12,899*l.*

CLIFF END.

45. The site selected for the Cliff End Battery extends along the brow of the hill above the old Cliff End Fort and Fort Victoria; the battery will be about 1,800 yards from Warden Point, and nearly the same distance from Hurst Castle, opposite to it, and will co-operate with these various works in the defence of the channel at its narrowest point.

rainage of ite. To prepare the site, the whole ridge, with the slopes on each side, chiefly composed of a slippery clay, have been drained under the superintendence of Mr. Parkes, C.E.

The object of the drainage has been to carry off all the water that can fall upon the surface or find its way into the hill beneath the site of the fort, and thus give stability to the soil; as far as it has gone the operation we are told has been successful, but till the result of that drainage has been more fully ascertained, we consider that the construction of the fort had better be postponed. To protect the toe of the cliff, a sea wall has been built, which seems likely to accomplish its object, though it is possible that some further protection to it from the scouring power of the sea may be necessary. Under any circumstances, it is probable that some expenditure will be required here as at Warden Point, from time to time, to maintain the slope in a secure condition.

a Wall.

ign. nament. Plans have been laid before the Committee for the construction of a work to comprise two batteries—one on the right for eight guns, *en barbette*, 129 feet above the sea; the other on the left for 12 guns, at heights varying from 90 to 115 feet. The proposed arrangements for the service of the guns, the supply of ammunition, and for artillery stores, are good and satisfactory. The project appears to be well devised to meet the requirements of this important position.

ort.

mate. The amount estimated in 1862 for this work, exclusive of land, was 30,000*l.*

The sum expended to 30th June, 1868, on the sea wall and drainage, to prepare the site, amounts to 18,129*l.* The estimated sum required to complete the proposed work as a barbette battery is 14,585*l.*, making a total sum of 32,714*l.*

An alternative plan for adapting the left battery to the Moncrieff system has been prepared, and the additional sum required for it is 2,700*l.*, making a total of 35,414*l.*

GOLDEN HILL BARRACK.

and it. **46.** This work is placed on an eminence to the west of the valley of the Yare, about midway between Yarmouth and Freshwater. It is intended to be a defensible barrack and keep to the batteries for the defence of the Needles Passage. It was originally designed as a much larger work with the same barrack accommodation as that with which it has now been constructed intended for 250 officers.

and men, but reduced by modern requirements to that for eight officers, 128 men, a hospital staff, and 14 patients. The excavations for the work were commenced in 1863. PORTSMOUTH.

The work is hexagonal with a ditch, and scarps 31 feet high, covered by a raised glacis, and designed for 18 light guns. The ditch is flanked by musketry caponnières at the alternate angles. The entrance to the work is through a tunnel in the glacis and over a drawbridge. The parapets, 9 feet thick, were originally constructed with an exterior slope of one to one, without berms, of blue slipper clay, imperfectly drained, resting on a bed of concrete and asphalte, covering the arches, and sloping outwards 1 inch in 4 feet. After heavy rains in January 1868, the clay, becoming saturated with water, slipped into the ditch on four sides of the work. These slopes were repaired by inserting a toe of concrete in Medina cement at the foot of the exterior slope, and 2-inch agricultural pipes to carry off the water, and putting in layers of clay and burnt ballast, revetting the whole with sods. The cost of this repair was 177*l.* Armament. Failures.

The counterscarp, at a slope of 1½ to 1, formed also chiefly of the same blue clay, slipped in November 1864, and by the summer of 1866 the slip had extended to nearly three-fourths of the whole length. The remedies adopted were thorough drainage, driving in fir poles, interweaving them with brushwood, and filling up with alternate layers of blue and burnt clay. These repairs were finished in August 1867. The cost of the repair was 1,751*l.* There has been lately some further slight subsidence in the counterscarp, and it is probable that to maintain the work some small expenditure may be necessary from time to time. Repairs.

This work, though not calculated to resist the attack of a strong force with artillery, provides a defensible barrack for partly manning the Needles Batteries, and a central point of support to troops opposing an enemy who may have landed.

With the exception of the slight failures pointed out, it has been well constructed as regards permanency and stability, and the arrangements for the service of the guns are satisfactory. Report.

The estimate for this work in the Schedule of 1862 was 30,000*l.* Estimate.

The sum expended to the 30th June, 1868, amounted to 32,476*l.*; the sum required for completion is 5,546*l.*; making the total 38,022*l.*

Summary.

47. In the Schedule of 1862 the amount estimated for the works on the Isle of Wight for the defence of the Needles amounted to 80,000*l.*, exclusive of land; and this in 1867 was increased to 90,000*l.* Summary. Needles.

The estimated cost is now 97,116*l.*; of this sum 698*l.* will be charged to the Annual Estimates, leaving 96,418*l.* chargeable to the Loan.

48. The total sum required for the defences of the Needles, including Hurst Castle, was estimated by the Commissioners at 150,000*l.*, including the purchase of land. Needles and Hurst Castle.

The amount paid for land has been 22,757*l.* The estimated cost of the works in 1862 was 188,000*l.* exclusive of land. This in 1867 was increased to 200,000*l.*, and 61,000*l.* were added for shields. The cost is now estimated at 217,937*l.* for the works, and 88,450*l.* for shields, making a total of 306,387*l.*, of which 305,689*l.* will be charged to the Loan.

The increase on the estimate of the Commissioners, in the first Schedule of 1862, is chiefly to be attributed to the much greater development of the Hurst Castle Batteries beyond that contemplated by them. The subsequent increase is chiefly due to the increased cost of labour and materials, to the drainage at Cliff End and Warden Point, and to the necessity of adding strength to the iron shields.

ISLE OF WIGHT COAST DEFENCES.

Bembridge Fort.

49. This work, built on Bembridge Down, forms a keep to the coast batteries in Sandown Bay, and occupies the heights commanding the space between Brading Haven and the sea. It is to be armed with six 7-inch breech-loading guns, and there is space on the ramparts for four more. It is well supplied with water. Design. Armament.

PORTSMOUTH.

Alteration. The work was commenced in May 1862, and completed in July 1867. There have been no failures, but there have been some alterations from the original design in the substitution of single for double caponnières, and in the more complete revetment of the escarp and counterscarp. There is barrack accommodation for 4 officers and 106 men.

On our visit there appeared to be a want of sufficient protection to the expense magazines and to the inner wall of the main magazine. In the plan now laid before us this defect has been remedied, and some minor details altered, and the cost of the alterations is included in the estimate.

Report. The work is well and skilfully built, as to permanency and stability, and is well adapted to the position it occupies. The magazine arrangements will be satisfactory, as well as the provision for the service of the guns.

Estimate. The sum expended to the 30th June amounted to 44,362*l.*, and the further sum required to carry out the proposed improvements, and to complete the fort, is 2,423*l.*, making a total of 46,785*l.*, of which it is proposed to charge 2,207*l.* to the Annual Estimates, leaving the charge against the Loan 44,578*l.*

REDCLIFF BATTERY.

Design. **50.** This work is built close to the edge of the cliff, a little to the west of Culver Cliff, about 1,000 yards to the east of Yaverland Battery, and 150 feet above the sea. Like the other works in the neighbourhood, it was begun in April 1861, and completed in September 1863. It is armed with four 7-inch breech-loading guns, and has ample

Armament. magazine accommodation; the gorge is closed by a loopholed wall and a shallow ditch, flanked by caponnières. There is no barrack accommodation, except a small

Report. guard-room. The battery is well devised for its object,—that of assisting Yaverland and Sandown Fort in preventing a landing in the bay. On the left flank of the work part of the cliff began to give way in 1867, and in August 1868 fell into the sea.

Land slip. This slip appears rather to be owing to the action of the land springs than to that of the sea, and though the Commanding Royal Engineer has expressed an opinion that no further slip may be expected for a considerable time, it is probable that the stability of a portion of the parapet is likely to be affected at no very distant period.

Remarks. The formation of the ground, near the position selected, would not have admitted of its being placed further from the edge of the cliff without largely increasing the cost. The measures required to secure it would be difficult and very expensive, and we do not recommend that they should be undertaken, but that any failure should be dealt with when it occurs, by moving the parapet back as much as the confined space in the work will allow.

Cost. The sum expended to June 30th, 1868, was 4,776*l.*, and no further sum is required to complete it.

YAVERLAND BATTERY.

Design. **51.** This work is built on a knoll or spur from the Downs, about 1,800 yards to the east of Sandown Battery, at an elevation of 108 feet above the sea. It is armed with eight

Armament. 7-inch breech-loading guns, is well provided with magazine accommodation, and is enclosed by a ditch and loop-holed wall flanked by musketry.

Report. It was commenced in April 1861, and completed in September 1863. In the winter of 1863 the counterscarp, although the slope originally designed at 1 to 1 had been increased to 1½ to 1, gave way on the sea face. The face of the cliff, and this part of the counterscarp, were in consequence drained, and a sea-wall was built. These measures were completed in 1864, and there have been no failures since. The formation of the ground in this case admitted of the work being thrown back, so as to give room for a ditch and glacis between it and the sea. The gorge is closed by a wall and barrack, and the ditch is protected by a Carnot wall, and flanked by caponnières.

The barrack contains accommodation for 2 officers and 57 men, and is supplied with water from the Water Company, and has a rain-water tank having a capacity for 4,000 gallons.

Cost. It is well and skilfully constructed, both as regards stability and its powers of resistance. It has cost 20,500*l.*, and no further expenditure is required.

SANDOWN FORT.

Design. **52.** This is a granite fort for 18 guns in casemates behind iron shields, and 10 guns

Armament. on the terreplein above; it stands close to the beach near the centre of the bay. It was begun in April 1861, and brought to its present state of forwardness in September 1864.

The Main Magazine has proved to be extremely damp: the arrangements designed

originally for a lighter armament, were unsuited to the heavier guns of the present day, and modified plans, with improved drainage and ventilation, have been prepared; additional drainage for the ditch has been recommended on sanitary grounds, and is provided for in the estimates. PORTSMOUTH.

The gorge of this work is enclosed by a wall, and the whole enceinte is surrounded by a ditch, flanked by musketry caponnières.

The fort contains barrack accommodation for 4 officers and 67 non-commissioned officers and men. It has been well and skilfully built as regards permanency and stability, and its power of resistance is well adapted to the position it occupies. It is proposed to adapt the upper battery for the reception of guns on Moncrieff carriages at a cost of 3,090*l*. When the intended improvements are carried out, the arrangements for the service of the guns will be satisfactory.

The sum expended to the 30th June amounted to 41,983*l*., and the further sum required is 8,493*l*., making a total of 50,476*l*. The cost of the shields for the 18 guns in casemates is estimated at 23,400*l*., making the total cost 73,876*l*. Of the additional sum required, 4,945*l*. will be charged to the Annual Estimates, leaving the charge against the Loan, 68,931*l*. Estimate.

Sandown Barrack Battery.

53. This battery stands on the edge of the cliff, 140 feet above the sea, and about 1,500 yards to the west of Sandown Fort. It was begun in April 1861, and completed in September 1863. It is armed with five 7-inch breech-loading guns. The arrangements for the service of the guns are sufficient. Design. Armament.

The work is well-built, but the parapet is very close to the edge of the cliff, which is here nearly perpendicular, the foot of it being washed by the sea at high tides, and although the cliff is formed of sounder material than that at Redcliffe, it does not seem improbable that the action of water may in time endanger the stability of the parapet; we do not recommend that any measures should be adopted with a view of averting this danger, as it could only be done at a cost far exceeding its value, and we think it would be better to meet it when necessary, by moving the parapet back as far as the work will admit. Report.

The cost of this work has been 6,233*l*., and no further expenditure is required. Cost.

Military Road.

54. The Defence Commissioners, in their Report, recommend that two towers should be constructed—one near Brook and one at Brixton, with a battery and keep on Atherfield Point, and that a permanent road should be made along the top of the cliffs, between Chale and Compton Grange, a farm between two and three miles east of Freshwater Bay. Design.

The works recommended have been omitted, and a military road alone has been formed between Chale and Freshwater. At the latter place it joined the public road which crosses Freshwater Bay, but the sea having washed away the road, the communication with Freshwater is cut off. As the maintenance of this road devolves on the people of the neighbourhood, and as in case of emergency a temporary communication between Freshwater and the military road might be easily made, we do not recommend that any expenditure should be incurred by the Government in restoring the communication. The estimate for the military road and posts for defence of the sea coast, in the Schedule of 1862, was 35,000*l*., at which amount it remained until grouped, in 1865, with the other works for the defence of the South Coast of the Isle of Wight. The sum expended on the road amounts to 16,728*l*., and no further expenditure is required, showing a saving of 18,272*l*. consequent on the omission of the works above referred to. Report. Estimate.

Summary.

55. The cost of the Isle of Wight coast defences, including the purchase of land, was estimated by the Defence Commissioners at 130,000*l*. Isle of Wight Coast Defences.

The same amount of 130,000*l*. was inserted in the Schedule of 1862, exclusive of land. In 1864 the estimate was increased to 140,000*l*., and in 1867 to 145,000*l*., and 18,000*l*. for shields; making the total estimate under the Loan, 163,000*l*. Estimate.

The cost of this group, as now estimated, exclusive of land, for which 34,745*l*. have been paid, will amount to 145,498*l*., and 23,400*l*. for shields, making a total of 168,898; of this sum 7,152*l*. will be charged to the Annual Estimates, and 161,746*l*. to the Loan.

Occupation of Site

56. The Portsdown Hill position, six miles in extent, is occupied by five works, viz: Fort Purbrook with its two outworks on the east, Fort Widley, Fort Southwick, Fort Nelson and Fort Wallington on the west.

In addition to these works the Defence Commissioners recommended the construction of three intermediate works, considering the distance between the forts as now constructed, and the nature of the ground between them, it would undoubtedly be necessary for the defence of the line that those intermediate points should be occupied whenever it may be necessary to place it in a state of defence.

Centre Position

The two central works, Forts Southwick and Widley, as nearly as possible identical in design, are respectively 400 and 325 feet above the sea, and are distant from each other 3,100 yards. The ground in the immediate front of Fort Southwick slopes at an inclination of 1 in 8 for a distance of 400 yards, and from thence more and more gradually to the bottom of the valley, part of which is occupied by the fish pond of Southwick Park, an artificial piece of water about half a mile in length, formed by damming the stream which drains the valley. The front of Widley, and the northern slope of the hill between these works, is of the same character as that just described, and presents no remarkable features, there being very few spots on the belt, a mile in width, in front of the works, which are not seen by one or both of them.

The right of the position is occupied by Fort Purbrook, at a distance of 2,200 yards from Fort Widley. Beyond Fort Purbrook, Portsdown Hill falls towards the village of Bedhampton, and on the termination of the ridge, 800 yards to the east of Fort Purbrook, is an outwork called Farlington Redoubt, open in the gorge to the fort and commanding some slopes unseen by it. The Defence Commissioners also recommended that from this point to Langstone Harbour Lines should be formed to protect the flank of the position from anenemy advancing from the eastward.

The southern extremity of this line was to have been occupied by a strong work on a site which has been acquired by the War Department for that object, in front of the east reservoir of the Farlington Waterworks. It is not at present contemplated to construct this work, or the connecting line, but it would undoubtedly be advisable to occupy the ground, whenever it becomes necessary to place Portsmouth in a state of defence.

Fort Purbrook has another outwork on the northern slope of the hill at Crookhorn, designed with a view of commanding ground which is unseen from the main work. It is situated 300 yards in front of the work, and 75 feet below it.

[illegible] of Position

2,200 yards to the left of Fort Southwick, on the termination of the main ridge of the hill, at an elevation of 275 feet (125 feet below Southwick) is placed Fort Nelson.

The Commissioners also recommended that lines should be made to connect Fort Nelso with the head of Fareham Lake, but this part of the scheme has been abandoned.

Fort Wallington, the work on the extreme left of the line, is 1,800 yards distant from Fort Nelson, and is placed on a spur 100 feet above the sea, overlooking the valley of the Wallington River, which here forms a semicircular bend to the westward. The importance of this position has been much enhanced by the abandonment of the lines between Fareham Lake and Fort Nelson; while the proximity of the villages of Fareham and Wallington, the irregular features in the neighbourhood, and the existence of a hill to the north-west favourable to the attack, render the detached position of this work difficult to secure. However, the obstacles to a regular attack on its north and west fronts should be very serious.

General design of works

57. The four works on the right and centre of thd Portsdown Hill, - Forts Pubrock, Widley, Southwick, and Nelson, - are very similar in design, and may thus be generally described:-

Each fort is surrounded by a ditch 50 feet wide at bottom, cut in chalk. The counterscarp, 32 feet in height, is vertical and unrevetted; the escarp is strengthened by brick piers at inte vals, with arches, thrown across supporting the wll of the chemin des rondes, which raises the escarp to a total height of 34 to 37 feet. The ditch is flanked by one double and two single caponnieres, except at Fort Purbrook which has only one double and one single caponniere. Each caponniere has two tiers of guns, and the

minor branches of the ditch are flanked by musketry galleries. The chemin des Portsmouth rondes is traversed by loopholed buildings which flank it. The counterslope of the glacis falls without interruption to the top of the counterscarp; the width of the ditch at the top, including this slope, exceeds 60 feet. The main magazine is sunk under the middle of the parade, and is perfectly protected from fire; it is connected with the keep and caponnieres by underground galleries. Expense magazines and shell stores are provided in the traverses on the ramparts. There is ample space for the storage of powder and shells, and for the arrangements necessary for the service of the guns. The expense magazines are well protected against vertical fire, but the protection against horizontal fire, in some cases does not exceed 2 feet 3 inches of brickwork, 1 foot of concrete, and 4 feet of earth and might prove insufficient. It would therefore be necessary to consider the measures that should be taken to place them in a state of security at a time of expected attack.

Barrack accommodation is provided in each work for about 200 officers and men, and 14 patients; the distribution varies slightly in the different works. Barrack accommodation

The armament of each work consists of from 29 to 31 guns on the ramparts, and 5 to 10 mortars. The number of lighter guns for the defence of the flanks and gorge varies from 41 to 62. Armament

The forts, except Wallington, are all supplied with water from the Farlington Water Works, pumped into reservoirs each capable of holding 84,000 gallons, and laid on to the buildings. Water

FORT PURBROOK AND OUTWORKS

58. This fort is intended for an armament of 29 guns on the ramparts, and 5 mortars, with 62 smaller guns for the defence of the flanks and gorge. Armament

The gorge wall, which is about 35 feet in height, is flanked by the keep, which projects in the form of a redan.

The outworks at Crookhorn and Farlington were originally designed as enclosed works with masonry scarps and counterscarps, and flanking galleries with bombproof magazines, and with a barrack in the former. The ditches have been already excavated, and it is now proposed to complete these works within them, as positions for 9 and 13 guns respectively, but without flanking galleries, bombproof cover, or magazines. Outworks

The first contract was commenced in June 1861, and completed in September 1862, at a cost of 31,576l. A second contract was begun in March 1865, and under it the fort, not including the outworks or barrack fittings, is now nearly finished. The work still remaining to be done here includes the construction of the two outworks of which the ditches only have been excavated, and the formation of the slopes in the neighbourhood of the three works. Report

No failures occurred during the progress of the work, which is well and skilfully constructed as regards permanence, and stability, and its power of resistance both offensive and defensive.

With respect to the outworks, we are of opinion, considering the very advanced position of the work at Farlington, that the total absence of all flanking defence for its ditches, and of bombproof magazines, or shelter of any description, is a very serious diminution in the defensive powers of the east flank of the position, which will be the more felt in consequence of the omission of the lines originally recommended by the Defence Commission, to close the interval between Fort Purbrook and Langston Harbour, and of the detached work afterwards proposed in substitution for those lines.

In 1862, the estimate for these works was 135,000l. In 1865, that estimate was merged in the general estimate of 535,000l. for the Portsdown Hill Works. Estimate

The sum expended to the 30th June, 1868, amounted to 85,053l. and the further sum required is 49,339l. making the total estimated cost 134,392l.

FORT WIDLEY.

59. Fort Widley is intended for an armament of 29 guns on the ramparts, 10 mortars in casemates, and 41 lighter guns for the defence of the flanks and gorge. The trace of the gorge differs from that of Purbrook. Armament

This work has been constructed under two contracts: the first for a lump sum of 59,432l., the second on a schedule of prices. It was commenced in October 1861, and is nearly completed. Some slips occurred in front of the east and west demi-caponnieres; they were caused by heavy rains falling on the flint masonry before the mortar had set, and were repaired at a cost of 248l.

Portsmouth — There have been no other failures, and the work is well and skilfully constructed.

Estimate — In 1862, the estimate for this work was 75,000l., and it was also in 1865 included in the general estimate of 535,000l.

The sum expended to the 30th June, 1868, amounted to 89,178l., the further sum required to complete is 4,802l., and the total estimated cost is 93,980l.

FORT SOUTHWICK.

Armament. — 60. This fort is almost identical with the last, except that it mounts 31 guns instead of 29 on the ramparts.

Report — It has also been constructed under two similar contracts, and was begun at the same time. An accident occurred to the main magazine, owing to the centres of the arches having been removed too soon, causing an expenditure of 613l. for its repair. An attempt was made to obtain water by sinking a well which was carried down to a depth of 275 feet without obtaining an adequate supply of water, and it is like the other forts now supplied from the Farlington Water Works.

The fort is well and silfully constructed and there have been no failures.

Estimate — In 1862, the estimate of this work was 85,000l., and like the others it was merged in the general estimate of 1865.

The sum expended to June 30th, 1868, amounted to 90,940l., the further sum required is 3,322l., making a total estimated cost of 94,262l.

FORT NELSON.

Armament. — 61. Fort Nelson, in the trace of its gorge, and other features, resembles Fort Purbrook. It is intended for an armament of 30 guns on the rampars, and 9 mortars in casemates, with 48 lighter guns for the defence of the flanks and gorge.

Report — This fort has also been constructed under two contracts, the first for a lump sum of 54,236l., the second on a schedule of prices. It was begun in February 1862, and is nearly completed. A slight failure occurred in the retaining wall of the earthwork over the barrack, and was made good at a cost of 539l. The work has been skilfully constructed.

Estimate — In the Schedule of 1862, the cost of this work was estimated at 75,000l., and it was also included in the general estimate for 1865.

The sum expended to the 30th June, 1868, amounted to 78,649l; the further sum required is 3,477l., making a total estimated cost of 82,126l.

FORT WALLINGTON.

Difficulties of Site — 62. Between Fort Nelson and Fort Wallington the ground falls rapidly, and at the point selected for the latter the chalk crops out, and is replaced by a loose clay or marl known locally as "blue slipper", which, when saturated with water, becomes semi-liquid, and is a source of serious difficulties to engineers and builders.

Armament — It is designed for an armament of 17 guns on the rampars, 6 mortars in casemates, with 28 lighter guns for the defence of the gorge and flanks.

Ditches — The ditch is 33 feet wide at bottom. cut partly in chalk, and partly in loam and "blue slipper".

The counterscarp on the west face is 14 feet high, and the counterslope of the glacis rises 21 feet more at a slope of $1\frac{1}{2}$ to 1; on the other faces it is unrevetted, and will be formed at a slope of 1 to 1. The escarp is 29 feet high, and on the north and east faces is built with two tiers of relieving arches faced by a brick wall 2 feet 3 inches thick. The west escarp was designed as a solid wall of brickwork, averaging 7 feet in thickness. The ditch is flanked by two demi-caponnieres, and a double range of counterscarp gun casemates, all of two stories. The gorge wall is 31 feet high, and is flanked by the redan which projects in its centre. The chemin des rondes is flanked by loopholed traverses.

Magazines — There is ample magazine accommodation. The main magazine is under the rampart at the south-east flank, and is well protected atainst vertical fire. Against horizontal fire it is covered by 17 feet of earth, 1 foot of concrete, and 3 feet of brickwork. The expense magazines in the traverses are similar to those in the other forts, and the same alteration to secure them from horizontal fire is desirable.

Barrack Accommodation — The barrack accommodation is designed for 8 officdrs, 172 men, 16 hospital patients, and 2 horses. There

Portsmouth report

the fort from the reservoir at the Fareham Water Works, which is close to the glacis.

In July 1861, a contract was entered into for the first part of the work, for a sum of 26,000l., and the work was commenced in September 1861;. some unimportant deviations from the original design were authorised in the course of execution; and it was completed in March 1865.

The second portion of the work, executed under a schedule of prices, consisted of the barracks and redan, guard-room and cells, main magazine, gorge ditch, and walls, completion of drainage &c., except barrack fitments. The water supply was provided under a separate schedule. This portion was completed in September 1867.

The third portion, also executed under a schedule of prices, comprised the completion of the ramparts, parades, and terreplein, building expense magazines, and forming traverses in ramparts.

Failure

In June 1867, when the ramparts were nearly finished, the work was interrupted by the symptoms of weakness in the escarp wall on the left face and flank, and the flanking chambers at the north and west caponnieres. The wall had begun to bulge forward at the top from the weight of the rampart acting on the blue slipper underneath. The clay at the back of

Repairs

the wall was taken out and the spaces between the counterforts filled in with concrete. The face of the escarp was rebuilt for about 7 feet from the top for a length of 33 feet. Several minor revetment walls showed signs of weakness, and were strengthened in a similar manner. The fourth portion of the work consisted of the making good of the escarp just mentioned, and was finished in March 1868.

With the exception of the failures in revetment walls which we have described, this work has been well and skilfully constructed, with reference to cost permanence, and stability, and powers of resistance offensive and defensive. The cause of the excess of cost of this work over the others on the Portsdown Line is at once to be found in the nature of the soil, which involved the construction of expensive revetments, and these revetments although greatly strengthened, proved insufficient to give stability to the masonry in the worst portions of the soil.

Damp in Magazines

In a former part of our Report we have noticed the numerous cases in which the floors of the magazines have become defective, and have stated the measures which we think might be adopted to remedy this defect. Those remarks apply with much force to the main magazines of these works, which, sunk to a great depth in the chalk, offer conditions favourable to the decay of all perishable material.

Estimate

In the Schedule of 1862, the cost of this work was estimated at 75,000l., and no increase had been made in this estimate before it was merged in the general estimate of 535,000l. for the Portsdown Hill Works.

The sum expended to the 30th June, 1868, amounted to 91,408l., the further sum is 11,787l., making a total estimated cost of 103,195l.

FORT FAREHAM.

Position and design

63. The Royal Commission recommended an outer line of three forts between Fareham and Lee Farm, on the Solent. Of this line Fort Fareham alone has been constructed, near the town of that name, and 3,500 yards in advance of Fort Elson, which forms the right of the Gosport line of works. It is visible from fort Wallington, from which it can be seen at a distance of 2,500 yards, but the interposition of the town of Fareham and the river make it practically an isolated work.

Besides forming the right of the proposed advanced line, Fort Fareham protects the roads and railways which connect the Gosport and Portsdown positions; it secures ground from which the works on the left of that position might be subjected to a reverse fire, and, unless it were captured, disabled, or very effectually masked, the attack of the Gosport Forts would be extremely hazardous.

Contracts.

The first contract was to sink five wells to a depth of 135 feet. This was completed in July 1861, and no water having been found, a fresh contract for sinking them to 200 feet was made, and completed in September of that year. Their total cost was 2,384. The next contract, for the construction of the fort, was commenced in October 1861, and completed in December 1864. Some slight failures took place and were made good at a small cost , and the same contractors made some additions to the work, on a schedule of prices contract. A further contract for fitting up

tide level, or 9 feet above the bottom of the existing ditch) will render unnecessary the provision of an artificial supply which has therefore not been provided for in the estimates.

The work is constructed for an armament of 41 guns on its ramparts, of which 19 are in haxo casemates. There will be seven in the redan which flanks the gorge, and 15 in the caponnières which flank the ditches, besides three mortars. The ditches are flanked by one full, and three demi-caponnières, each having one tier of three guns with musketry. The parapets and glacis having subsided considerably during the consolidation of the earthwork, since their formation, a considerable quantity of material is still required to bring them up to the finished levels. This is to be obtained partly from the deepening of the ditch, and partly from the foot of the glacis.

The main magazine, as well as all the expense magazines are under the rampart, there being in the approved plans lifts from the latter to bomb-proof buildings on the terreplein and to the haxo casemates. The storage and supply of ammunition will be safe, commodious, and convenient.

The northern terreplein, and the casemates underneath it, are to be defiladed by a traverse, which will cross the parade, joining the existing parados which covers the gorge wall and the redan thrown forward from its centre.

There is barrack accommodation for eight officers, 210 non-commissioned officers and men, five staff serjeants, and eight hospital patients.

The work, as far as it has gone, is well and skilfully constructed as regards stability and permanency, and when completed according to the approved plans will be suited to the requirements of modern armaments, and when its ditch was filled with water would afford a fair amount of resistance to any attack to which it may be exposed.

The estimate for this work in the Schedule of 1862, was 113,000*l*. In 1863, it was reduced to 80,000*l*., and in 1865, it was merged in the general estimate of 535,000*l*.

The payments on the work, up to the 30th June, 1868, amounted to 87,224*l*.: the further amount required to complete is 17,276*l*., and the total estimated cost will be 104,500*l*.

Summary.

64. In their Report the Commissioners estimated the cost of three works for the Gosport advance at 350,000*l*. One of these works only, that at Newgate, now called Fort Fareham, has been constructed, and as the three works were of nearly equal size it may be assumed that Fort Fareham would, in their estimation, have cost 120,000*l*. Their estimate for the works on Portsdown Hill was 650,000*l*., making the total, including land and Fort Fareham, 770,000*l*. The amount paid for land and clearance rights is 308,700*l*.

In the Schedule of 1862, the cost of these works sanctioned and since constructed or in progress was estimated at 558,000*l*., exclusive of land. This sum was in 1863 reduced to 535,000*l*., and it remained at this amount till 1867, when it was increased to 550,000*l*.

The cost as now estimated will amount to 612,522*l*., or 62,522*l*. in excess of the Estimate of 1867. This excess is thus accounted for by Colonel Jervois: When the Schedule for 1867 was framed, it was considered advisable to limit the estimate for the Outer Line, which includes the Portsdown Position and Fort Fareham, to what would be absolutely necessary to render the works substantially complete, leaving for future consideration the preparation of the buildings for the reception of troops, and the construction of the Outworks to Fort Purbrook. The estimate for these items now amounts to 42,852*l*. The additions proposed at Fort Fareham and Fort Wallington since 1867 are estimated to cost 13,709*l*. None of these items were included in the estimate of 1867, but are all provided for in the present estimates, and thus an excess of 56,560*l*. is accounted for. The remainder of the excess, about 6,000*l*., is due to increased expenditure on Forts Wallington and Fareham, not then anticipated.

The deficiency in the Estimate of 1867 is thus explained; but we think it is to be regretted that a fuller explanation of the course decided upon was not made at the time. The Schedules of the various Acts give in the first column the estimated cost of the works under the Loan; that estimated cost would be understood to mean the cost of completing the works up to the point considered necessary in a time of peace, and this in other cases has included the preparation of buildings for the reception of troops. When, therefore, the Government in this instance decided to postpone that preparation and the construction of the Outworks at Purbrook, some notice of that decision would appear to have been required to prevent the erroneous impression that would otherwise be created as to the final cost of the works, and this the more, since the expenditure already incurred on the Outworks made it necessary still to include them with Fort Purbrook in the Schedule.

The estimates now given include the completion of the Outworks on a much reduced scale from that originally contemplated; in other respects they only provide what is necessary to place the works in a substantial condition for defence and occupation, leaving their complete mantling to be provided for when necessary. We conceive, therefore, that no smaller sum could now properly be inserted in the estimates, though it rests with the Government and Parliament to decide whether the works shall be so completed, or whether any portion of them should be postponed or abandoned.

LAND DEFENCES.--INNER LINE.

HILSEA LINES.

Position.

65. Portsea Island is separated from the main-land by a natural canal, almost dry at low water, joining the Portsmouth and Langston Harbours, and called Hilsea Channel.

Works proposed in 1857.

A line of earthworks of small command and weak profile, constructed during the French Revolutionary War, formed the only defence when, in 1857, Field-Marshal Sir J. F. Burgoyne, Inspector-General of Fortifications, submitted a Report from Colonel Jervois, C.B. (then Assistant Inspector-General of Fortifications), in which the lines nearly as they now exist were proposed. The plans were approved by the Government, and at the date of the Report of the Defence Commission, were in progress, and received their approval. It is not, however, intended to construct the outworks which formed part of the original project.

Description.

The line lies on an arc whose chord is 2,700 yards, and versed sine 450 yards. It consists of four bastioned fronts, comprising three whole and two demi-bastions, with exterior sides of 770 yards, and lines of defence of 500 yards. There is space on the ramparts for an armament of 168 guns. The flanks were designed before the introduction of rifled artillery, with casemates for 50 guns, and were then considered to be out of the range of fire from Portsdown Hill. The merlons of earth were originally placed between each embrasure to cover the masonry, but they were hardly thick enough, and every alternate embrasure has been blocked, and a solid merlon placed between the alternate guns, a plan which is often adopted on the Continent. These casemates also afford a large amount of bombproof cover; the accommodation, which does not comprise that part of the casemates occupied by the guns, is for 408 men.

The terreplein is well provided with traverses, each containing a bombproof chamber. The protection of these buildings against horizontal fire is insufficient, being 3 feet of brickwork and 4 feet 6 inches to 5 feet 6 inches of earth. The traverses are raised 2 feet above the crest of the parapet. Immediately in front of the rampart is a wet ditch, 130 feet wide at top, 90 feet wide at bottom, and containing 8 feet of water.

Ditch.

Beyond this ditch is the tidal channel, which has been excavated to a width of 105 feet at bottom, and to a depth of 13 feet below high water mark of spring tides. Each end is now closed by a dam, for the purpose of keeping out the water during the progress of the works. It has been designed with the intention that the dams should ultimately be cut away, and the channels prolonged by dredging, to communicate with the navigable creeks of Portsmouth and Langston Harbours. Gunboats would then be able to pass from one to the other, and co-operate in the defence. As the formation of this channel beyond the extent of the lines forms no part of the work devolving on the Fortification Department, it is uncertain when it may be made, and in the meantime it will be necessary to retain the dams, to prevent the cutting in front of the lines from being silted up by the mud which would in all probability be deposited, should it be opened to the two harbours before the necessary measures had been taken for forming the channels into them.

Navigable Channel.

Communications.

Communications across the ditch and channel are provided as follows. The London Road has been diverted, will cross the channel by a rolling bridge 60 feet in span, be carried over the ditch by a standing bridge, and pass under the rampart at the left curtain. The railway at present runs over a pile bridge, and under the rampart at the right-centre curtain. It will be necessary to provide an opening in this bridge for gunboats to pass, similar to that described for the road, but no measures have yet been decided upon with reference to it.

...ccra. The general command of the parapets over the country in front is 30 feet, and the ground behind them is well traversed, and would afford a secure camping ground for a large body of troops.

...ntracts. **66**. The Hilsea Lines were commenced in August 1858, under a contract for levelling the old earthworks, and building the casemates in the flanks. A second contract, for constructing coffer-dams, excavating the channel and the ditch, and forming the ramparts, was commenced in December 1860, and suspended in December 1861, in consequence of the failure of the contractor. A third contract, for forming earthworks and constructing expense magazines, was commenced in June 1863, and completed in July 1864. A fourth contract, for the completion of the works, was commenced in March 1865, and was closed in November 1866, in consequence of the failure of the Contractors. The work was then transferred to their agent. Under this contract the works are to be completed before the 31st December, 1868, and there is every reason to believe that such will be the case.

...port. A few unimportant slips of earthwork have occurred in the progress of the works, not more, however, than were to be expected in the formation of such a long line of rampart. They were anticipated and provided for in the contracts, and they will cause no additional expenditure. The Lines are in a secure and stable condition, and have been well and skilfully constructed. They are adapted to the requirements of a modern armament; and the enomous obstacles presented by two wet ditches, combined with the powerful flanking fire from guns both in casemates and on the ramparts, render their defensive power unusually great.

In the Schedule of 1862 the estimate for these Lines was 120,000*l*., at which amount it remained till merged in 1865 in the General Estimate for the Inner Line of Land Defences.

Estimate. The payments made up to the 30th June, 1868, amount to 97,895*l*., chargeable to the Loan, and exclusive of 69,685*l*. previously provided in the Annual Estimates; the further amount required to complete is 41,674*l*. and the total estimated cost 209,254*l*., of which 139,569*l*. will be charged to the Loan.

GOSPORT FORTS.

Works proposed in 1857. **67**. The works recommended by the Defence Commission between Fort Elson and Fort Gomer were those which had been proposed by the Inspector-General of Fortifications in 1857, and sanctioned, in conjunction with the Hilsea Lines, by the Government, as a scheme for improving the land defences of Portsmouth. The Commissioners approved of these works, and further recommended that they should be connected by permanent lines, and that the flank defence of the ditches of Fort Elson should be improved.

The completion of the Lines and the improvement of Fort Elson have not been included among the works under the Loan.

The three works which have been constructed—Forts Grange, Rowner, and Brockhurst, divide the interval between the previously existing works, Forts Gomer and Elson, into four equal parts. The distance from centre to centre of each pair of the five works is 1,000 yards, and the intervals between them about 700 yards.

General Description of Works. The plans of the three new works are almost identical, and a description of one will serve for all.

The trace of the rampart of each of the works is that of a bastion with a very obtuse salient, so that the faces are not exposed to enfilade. The flanks are long, and their fire is directed on the fronts of the collateral works, to which they afford support. The defensive enceinte consists of a wet ditch, 112 feet in width, with an intended depth of 8 feet of water, flanked by a double caponnière at the salient, by two single caponnières at the shoulders, and by the keep in the centre of the gorge.

A glacis and covered way extends in front of the faces, and will communicate with the work by means of foot bridges, which will be thrown across when required. The double caponnière is screened from fire by a large mound, forming an advanced covered way in front of the salient. The parapets have a command of 30 feet over the surface of the country, which is almost level. The ramparts of the work are intended for an armament

Armament. of 19 guns on the faces and 16 on the flanks, of which four are in haxo casemates. A lower tier of 9 guns on each flank in casemates, protected by earth merlons, will give

powerful fire over the intervals, and on the front of the adjoining works. The keep will be armed with 10 guns on its terreplein, one of which will be in a haxo casemate, and with Powerful fire.
in casemates, including those flanking the gorge ditch. The full siege armament will therefore consist of 53 heavy guns on the ramparts and in casemates, and 30 lighter guns in the keep and the caponnières, besides four 13-inch mortars.

There are two main magazines under the ramparts, besides one in the keep, all Magazines.
sufficiently well protected against fire. The 19 expense magazines are all bomb-proof, at excepting those in the single caponnières, are inadequately protected against the horizontal fire of the artillery of the present day. As the expense magazines on the Rampart stand in all instances over the barrack casemates, there will be no difficulty when the work is to be put in a state of defence, in making lifts to communicate between them, and in converting one or more of the barrack rooms into expense magazines as may be required.

The keep or interior redoubt is circular. The front portion of its parapet has a com- Keep.
mand of 7 feet over the main work, the rear portion is on a level with it. The cordon of its exterior wall, as well as the coping of the wall which connects it with the flanks, is 12 feet above the plane of site, and 18 feet below the crest of the main parapet. The Keep is surrounded by a wet ditch, and is flanked by small musketry caponnières, which project from its circumference.

Each fort contains casemated barrack accommodation for 2 field officers, 14 officers, Barrack Accommodation.
800 non-commissioned officers and men, 8 hospital patients; and 4 horses.

The amount expended on the three works prior to the Loan, was 169,228*l.*, which, divided among them, will give a sum of 59,469*l.* per each work.

In 1862, the estimated cost of each of these three works, in addition to the amount Estimate.
expended prior to the Loan, was 30,000*l.*

Fort Grange.

68. A contract for the construction of Fort Grange was entered into on the 31st August, 1858, and the fort was finished on the 20th January, 1863, in accordance with the original design, and without any failures of importance.

The ditch of this work is intended to be wet, but as no adequate provision has as yet been made for filling it with water, and the ditch without it does not afford a sufficient obstacle, it will be necessary before a time of expected attack to provide means for filling it.

The cost of this work under the Loan has been 46,635*l.*, and the total cost 163,045*l.* Cost.

Fort Rowner.

69. Fort Rowner was commenced, under contract, in the summer of 1858. The work Failures.
proceeded until September 1861, when fractures were discovered in some of the arches on the left flank and in the interior redoubt. The former were easily repaired, and tie rods were introduced to remedy the latter.

In September 1862, and again in September 1863, a portion of the escarp was pressed forward into the ditch, broken into several portions, and more or less upheaved.

The first failure was made good by the contractors, and the work was taken over Repairs.
from them on the 20th December, 1862, with the exception of some pieces of imperfect work, which were subsequently made good. The failure of September 1863 was made good by military labour, at a cost of 1,561*l.* The nature of the soil on which this work stands appears to have presented considerable difficulties in the course of its execution, all of which have, however, been completely remedied or obviated.

The cost of the work under the Loan has been 53,979*l.*, and the total cost 110,388*l.* Cost.

Fort Brockhurst.

70. Fort Brockhurst was commenced under a contract on the 31st March, 1858, and completed on the 20th December, 1862, according to the original design, without failure, at a cost under the Loan of 52,500*l.*, and a total cost of 108,909*l.* Cost.

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71. Notwithstanding the failures at Fort Rowner, we consider that all three works Report.
taken together have been well and skilfully constructed with reference to their structural stability and their powers of offence and defence, (subject however to the remark that the masonry of the keeps and the haxo casemates upon them might be exposed to serious injury by the fire of guns placed in battery against them), and that no further expenditure is required upon them.

STOKES BAY LINES.

osition.

72. The Stokes Bay Lines extend from the glacis of Fort Monckton to the rear of Browndown Batteries, in front of Fort Gomer, a distance of 2,700 yards. They are intended to secure the Gosport position against the possibility of being turned by an enemy landing on the beach, which is practicable and convenient for such an operation throughout the whole extent of the bay.

Design.

The line consists of a rampart, covering a road which runs along its rear, with a wet ditch in front, 60 feet in width, and containing water 9 feet in depth, at high water of spring tides.

The lines are flanked by five batteries, containing 40 guns, besides the pieces on the old Browndown Batteries, and those in the new and powerful work at Gilkicker, which co-operate with the lines in the defence of the bay.

On the extreme right, the covered way, rampart, and ditch are continued across the valley of the Alver Stream (which is uniformly 1 foot below high water mark of ordinary spring tides), in the rear of the old Browndown Batteries, forming a dam, by closing the ends of which, the marsh extending in front of Forts Gomer and Grange, as far as Chark Common, may be inundated. This dam, which also serves as an advanced covered way, protecting the Browndown Batteries, is flanked in front by No. 2 Battery, and has at the salient a short return directed on Fort Gomer, which commands its terreplein. The communication with the front is provided for by a bridge across the ditch, and a cut in the parapet of the return. The open nature of the shingle makes it almost impossible to retain water at a high level in the ditch at this point.

The Stokes Bay Lines formed a part of the scheme of defence proposed in 1857. They were in progress when the Defence Commission was appointed, and were approved of by them.

Estimate.

In 1862 the estimate for these lines was 40,000*l.*, and this amount was reduced in 1863 to 28,000*l.*, and in 1865 it was merged in the General Estimate for the Inner Line of Land Defences.

The expenditure on the works, previous to the Loan, was 48,672*l.*, which was defrayed out of the annual estimates. A farther sum of 26,448*l.* has been expended on them out of the Loan, making their total cost 75,120*l.*

Summary.

Inner Line of Defence and Gosport Position Estimate.

The estimate in the Schedule of 1862, for the works forming the Inner Line of Defence and Gosport Position, amounted in the aggregate to 340,000*l.* This estimate was successively reduced in 1863 and 1864 to 328,000*l.* and 308,000*l.*, and again increased in 1867 to 318,000*l.* The expenditure under the Loan will, it is now estimated, amount to 319,131*l.*, and the total cost of the works, including previous expenditure, will be 606,716*l.*

General Remarks on Land Defences.

Report.

We have now completed the description of the works occupying the Portsdown Hill and Gosport positions, and the Lines at Hilsea and Stokes Bay, and we have entered minutely into all the particulars regarding them, and recorded all the failures, however slight, that have occurred during the progress of the works; from this record it is evident that the works have been constructed with great care, and that the accidents which have occurred in their construction have by no means exceeded what might reasonably have been anticipated in works of such extent, occupying sites pointed out and fixed by the necessities of defence, but presenting great variety in their nature, making their foundations in some cases very difficult, and in other cases the works themselves liable to slips or such accidents as may be expected in treacherous soils.

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y 1861, a contract was entered into for the first part of the work, for a ,6,000*l.*, and the work was commenced in September 1861; some unimportant os from the original design were authorised in the course of execution; and it mpleted in March 1865. Portsmouth. Report.

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The third portion, also executed under a schedule of prices, comprised the letion of the ramparts, parades, and terreplein, building expense magazines, and ng traverses in ramparts.

In June 1867, when the ramparts were nearly finished, the work was interrupted by Failure. ymptoms of weakness in the escarp wall on the left face and flank, and the flanking ters at the north and west caponnières. The wall had begun to bulge forward at r from the weight of the rampart acting on the blue slipper beneath. The clay at ck of the wall was taken out and the spaces between the counterforts filled in with e. The face of the escarp was rebuilt for about 7 feet from the top for a length Repairs. h feet. Several minor revetment walls showed signs of weakness, and were thened in a similar manner. The fourth portion of the work consisted of the good of the escarp just mentioned, and was finished in March 1868.

With the exception of the failures in revetment walls which we have described, ork has been well and skilfully constructed, with reference to cost, permanence, and ity, and powers of resistance offensive and defensive. The cause of the excess of cost work over the others on the Portsdown Line is at once to be found in the nature of il, which involved the construction of expensive revetments, and these revetments, gh greatly strengthened, proved insufficient to give stability to the masonry in the portions of the soil.

In a former part of our Report we have noticed the numerous cases in which the Damp in Magazines. of the magazines have become defective, and have stated the measures which we might be adopted to remedy this defect. Those remarks apply with much force to ain magazines of these works, which, sunk to a great depth in the chalk, offer ions favourable to the decay of all perishable material.

In the Schedule of 1862, the cost of this work was estimated at 75,000*l.*, and no Estimate. se had been made in this estimate before it was merged in the general estimate 5,000*l.* for the Portsdown Hill Works.

The sum expended to the 30th June, 1868, amounted to 91,408*l.*; the further sum 787*l.*, making a total estimated cost of 103,195*l.*

Fort Fareham.

83. The Royal Commission recommended an outer line of three forts between Fare- Position and Design. ad Lee Farm, on the Solent. Of this line Fort Fareham alone has been constructed, he town of that name, and 3,500 yards in advance of Fort Elson, which forms the f the Gosport line of works. It is visible from Fort Wallington, from which it can n at a distance of 2,500 yards, but the interposition of the town of Fareham and er, make it practically an isolated work.

Besides forming the right of the proposed advanced line, Fort Fareham protects the nd railways which connect the Gosport and Portsdown positions; it secures ground hich the works on the left of that position might be subjected to a reverse fire, nless it were captured, disabled, or very effectually masked, the attack of the rt Forts would be extremely hazardous.

The first contract was to sink five wells to a depth of 135 feet. This was completed Contracts. y 1861, and no water having been found, a fresh contract for sinking them to et was made, and completed in September of that year. Their total cost was

The next contract, for the construction of the fort, was commenced in October nd completed in December 1864. Some slight failures took place and were made t a small cost, and the same contractors made some additions to the work, on a le of prices contract. A further contract for fitting up casemates, laying on water, as made in February 1867, and completed in April 1868.

The work is situated on a flat site, on a clay soil, 40 feet above mean tide level. Site. tch, which is at present 60 feet broad at bottom, is intended to be wet. In order ide the earth necessary for the completion of the work it will be deepened to such ent by the formation of a cunette that it is expected that the natural drainage, and pply from the wells (in which the water now rises to a level of 33 feet above mean

GENERAL SUMMARY.

73. We have shown the various changes that have been made from time to time in the estimates, and we have now only to sum up the results.

The Defence Commissioners estimated that the complete protection of Portsmouth would require a sum of 2,400,000*l.*, in addition to 400,000*l.* for works then in progress In this sum the purchase of land was included. Estimate.

This estimate, as before stated, was reduced by the Government in 1860 (*see* Parly. Paper, No. 448, Session 1860), by the omission of two of the Spithead Forts, of the three minor works on Portsdown Hill, and of two of the works and the connecting lines of the Gosport Position, to 1,920,000*l.*, in addition to 400,000*l.* for works already sanctioned—making a total estimate (including the purchase of land) of 2,320,000*l.* for the approved project for the defence of Portsmouth.

In 1860-1, the amount voted in the Annual Estimates was 127,000*l.*; the total expenditure on land amounted to 437,005*l.*

In framing the Estimates for 1862, further changes were made, and the modified scheme of the Government, while it omitted the important works noticed above, provided also for the alteration of some and the enlargement and strengthening of others; the expenditure on land was separated from that on works, and provided for in one general item at the end of the Schedule. The result of these changes was to increase the estimate; including the 127,000*l.* paid out of the Annual Votes, it now amounted to 2,391,000*l.* for works alone; adding to that amount the sum of 437,005*l.* paid for land, the total cost of the works in the modified scheme of the Government, if completed according to the estimate of that year, would have been 2,828,005*l.*, or slightly in excess of the sum estimated by the Commissioners as the cost of the works recommended by them. Alteration.

At that time, although the probability of the introduction of iron into the construction of the works was foreseen, it was not anticipated that their cost would be seriously increased by it. In succeeding years the fallacy of this opinion became apparent, and in 1867 Colonel Jervois reported that, to meet the rapid advance in rifled artillery, it would be necessary to add 139,000*l.* to the estimate for iron shields, and 254,000*l.* to that for iron superstructures at Portsmouth.

The estimate for that year, exclusive of land, was in consequence increased to 2,540,000*l.*, with 139,000*l.* for shields, making a total estimated charge against the Loan of 2,679,000*l.*

The amount of expenditure under the Loan for the works when completed is now estimated at 2,614,174*l.*, and for shields 206,700*l.*, making a total estimate of 2,820,874*l.*

The expenditure previous to the Loan, with that to be charged against the Annual Estimates, amounts to 313,981*l.*

The account will then stand thus—

	£
Expenditure on Land	437,005
„ under the Loan	2,820,874
„ „ Annual Votes	313,981
Total	3,571,860
Estimate of Defence Commissioners	2,800,000
Excess	£771,860

74. It thus appears that the cost of giving the desired protection to Portsmouth, has exceeded the Estimate of the Defence Commissioners by 771,860*l.* This increase must in our opinion be attributed to the increased cost of the land, the greatly improved character of the works, and the much more costly nature of the construction adopted in the Sea Defences, and not to any want of economy in the execution of the works.

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GENERAL REPORT.

Recommendations of Royal Commissioners.

75. In a preceding part of our Report we described in general terms the plan proposed by the Royal Commissioners for the defence of the United Kingdom, and the alterations made in that plan before it was submitted for the sanction of Parliament.

As the reductions made at Plymouth were very large, and have materially affected the defensive strength of that important position, and the resisting power of its various works, we propose, before entering upon the description of those works, to state somewhat more in detail what were the original recommendations, and what the plans adopted.

The Commissioners, in their Report, after pointing out that, in addition to protecting our ships and Government establishments, a strongly fortified position in this part of the United Kingdom would be of great importance with reference to the west of England generally, stated that their recommendations were for the most part in accordance with a Memorandum, drawn up in February 1858, and already partly adopted by the Government.

Sea Defences.

76. They then deal first with the Sea Defences. They point out the objects to which they should be directed, and they recommend that for the defence of the Hamoaze, the batteries on Drake's Island, Eastern King, and Western King should be strengthened, and a battery constructed near the site of the saluting battery at Mount Edgcumbe. For the other two objects which might be considered as one, the security of the Sound and the protection of the Dockyard from bombardment, they recommended that more powerful batteries should be constructed at Staddon Point (now generally called Bovisand), and at Picklecombe, in lieu of the imperfect works then existing at those places; that the battery at Cawsand, already commenced, should be completed, and a new open battery with a defensible guard-house in its rear should be made at Hooe Lake Point; and lastly that behind the centre of the breakwater a powerful casemated fort of such a form as to bring fire to bear in every direction, more especially to seaward, should be constructed. In the Schedule attached to their Report it is stated that this work should be armed with 100 guns.

All these positions recommended by them have been occupied, except that at Hooe Lake Point, for which no provision has been made; but the character of the works has been materially altered, and a much smaller number of heavy rifled guns substituted for the numerous 68-pounders and 8-inch guns then contemplated.

Land Defences.

77. The Land Defences they divided under four heads:—

1st. The fortification of the peninsula between the St. Germains River and the sea, to be called the "Western Defences."

2nd. The country between the St. Germains River and the Tamar, to be called the "Saltash Defences."

3rd. The country between the Tamar and the Catwater, to be called the "North-Eastern Defences."

4th. Between the Catwater and the Sound, to be called the "Staddon Heights Defences."

Western Defences.

1st. For the "Western Defences" Parliament had already sanctioned a line of works in front of the village of Antony, to consist of two powerful forts at Tregantle and Screasdon, with a minor intermediate work between them. This line they considered to be judiciously chosen, and they only recommended in addition the construction of a permanent ditch and rampart between them.

In these defences they also included the shore of Whitesand Bay, and for its defence they recommended a work on Knatterbury Hill, and a battery near the village of Rame, flanking the beach at the east end of the bay; the re-modelling of the old redoubts on the Maker Heights, and the construction of a defensible barrack in their rear. The changes made in this group of works are the omission of the intermediate work, and the

lines between Tregantle and Screasdon, of the works on the Maker Heights, and of the work on Knatterbury Hill, for which, though still included in the Schedule, no provision has been made. The battery near Rame, now called Polhawn, has been constructed, and connected with Tregantle by a military road, which has been substituted for the work on Knatterbury Hill recommended by the Commissioners. PLYMOUTH.

2nd. For the Saltash Defences they proposed six works, but these were altogether omitted from the Schedule submitted to Parliament, and have never been sanctioned. Saltash Defences.

3rd. In the North-Eastern Defences they recommended an Outer Line between St. Boreaux and Catdown, with an Inner Line. North-Eastern Defences.

The Inner Line has been abandoned, and the Outer Line thrown forward, so that its right rests on the upper part of the Laira Estuary instead of on Catdown.

4th. For the Staddon Heights Defences they recommended two works connected with each other and with Hooe Lake by lines of ditch and rampart. Two works with auxiliary batteries have been constructed and connected with each other and with Bovisand by a ditch and rampart, but the line connecting them with Hooe Lake has been given up, and an enclosed work, called Fort Stamford, on the high ground in rear, substituted for it. Staddon Defences.

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78. We now proceed to relate the result of our enquiry. SEA DEFENCES.

The works undertaken for the defence of the Naval Arsenal and Port of Plymouth are in a very advanced state; the sea defences, with the exception of the Breakwater and the iron protection for the guns, are nearly complete. Several of the principal batteries and forts are completed, and the others are approaching completion. We have examined these works in detail, and have found them to be well and skilfully constructed so far as regards permanency and stability, and we are of opinion that when their nature and extent are considered their almost total freedom from accident or failure reflects great credit on those who have been employed in their construction.

The arrangements made or proposed for the service of the guns, and otherwise, to meet the requirements of a modern armament, are, with the slight exceptions noticed in the detailed Reports of the various works, well adapted for their purpose.

Cawsand Battery, and the batteries at Eastern and Western Kings, have been constructed for lighter guns than those now alone considered fit to oppose ships of war, and will require to be re-modelled if such guns are to be mounted in them.

With reference to the powers of resistance, we are of opinion that when the works in course of construction shall have been finished, and adequately armed and manned, an attempt to enter the sound and harbour by a hostile naval force would be an operation of extreme difficulty and danger; observing, however, that the existing power of the works on the western side of the sound would be much increased by re-modelling Cawsand Battery for a heavier armament, and by the addition of submarine defences, for which the necessary preparations should be made. With these additions we believe that no hostile force would be able to gain an entrance, by naval means alone, into the sound.

With regard to the works designed and constructed to prevent a landing in White-sand Bay, we are of opinion that Polhawn Battery, unsupported as it now exists, is insufficient.

The military road which connects it with Tregantle, and which we are informed has been substituted for the work at Knatterbury recommended by the Commissioners, affords the means of moving guns of position to any threatened point, and with a small additional battery of heavy guns to support Polhawn, that protection against a landing which in our opinion does not at present exist might be obtained.

An additional precaution might be adopted by making some preparation for mounting heavy guns in or near Fort Tregantle, to fire to seaward and to keep ships at a distance from that part of the coast.

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79. The natural division of the Land Defences into four groups has already been described in the extract from the Report of the Commissioners already quoted. LAND DEFENCES.

The object for which the fortification of these positions is intended is to prevent an enemy who might have effected a landing on any point of the coast beyond the immediate reach of the sea defences from capturing the Dockyard, or taking up any position from which it could be bombarded or destroyed by fire; but as no long line of defence, such as these works constitute, embracing a circuit of 15 statute miles, is stronger than its weakest point, the entire omission of the Saltash Defences causes a serious breach in the line, and materially lessens the powers of resistance of the other works. This omission was made upon economical grounds, having been decided upon by the Government before Object.

Omission of Saltash Defences.

PLYMOUTH.

Plans to be prepared for Saltash Defences.

any of the works recommended by the Commissioners were submitted to Parliament, concur in thinking that there was no pressing necessity for incurring the heavy which the permanent fortification of this position would have called for, and, its inland situation and the extensive works with which it is connected, we are of that its defence will be sufficiently provided for by making a careful study of the and by the preparation in detail of well matured plans of such works as may be these should be of a solid and substantial character, and such as being short notice might speedily be made defensible, and eventually by further become really formidable defences requiring very powerful means for their reduction.

and for ground between Tregantle and Screasdon.

A similar course should be adopted with reference to the difficult ground Tregantle and Screasdon, which the omission of the intermediate work originally plated has left more open than is desirable in case of a threatened attack.

North-Eastern Defences from Tamar to Crownhill.

80. Of the works which form the North-East Defences Crownhill Fort, which centre, in advance of the whole of the rest of the line, is the most important, and key of the position; much care and skill have been bestowed upon its construction, a formidable work to attack, and, if properly defended, would require the development very powerful means for its reduction.

Should such an attack be made, it would, from its advanced position and the of the ground in front of the line, receive but little support from the adjoining works; the fire of which is limited by high ground in their immediate front. is especially the case to the left, and it would, therefore, appear desirable that careful study should be made of the ground on its immediate flanks, and designs with a view to its occupation by strong field works at a time of expected attack, without increasing the extent of the position for defence, would add most materially powers of resistance; the line of works, as now constructed, will afford powerful to these field works.

The omission of Fort Widey and of the keeps at St. Budeaux and Ernesettle, formed part of the original design for the occupation of this ground, would cause siderable diminution in its defensive power.

From Crownhill to the Plym.

The position from Crownhill to the Plym is one of great natural strength, has been well and skilfully adapted for defence. With the ordinary work generally to place a fortress in a state of defence at a time of expected attack, it would, adequate force, afford a very protracted and powerful resistance.

Between Fort Laira and Staddon.

81. Between Fort Laira on the right flank of the North-Eastern Defences and Staddon Position a break in the line has been caused by a departure from the original of the Defence Commissioners, by which the North-Eastern Defences have been advanced to the front, their right flank nearly two miles, while the left flank of the Staddon Defences has been thrown back, thus leaving a gap of about two miles in extent fended, except by the difficulties of the passage of the River Plym.

Staddon Defences.

The position between the Plym and the sea as now occupied is one of great strength completely protecting the batteries at Staddon Point from a land attack, and covering high ground commanding the eastern side of the sound; but, from the cause just the works do not now provide for the entire defence of the position; and we recommend that the same course should be followed here as at Saltash,—viz., that well-matured should be prepared by which the unoccupied ground might be quickly made defensible by such works as might afterwards be extended to provide for the complete defence of position.

DETAILED REPORT.

SEA DEFENCES.—OUTER LINE.

BOVISAND BATTERY.

BOVISAND OR STADDON POINT BATTERY.

Original Design and Armament.

82. This work was originally designed in November 1860 as a granite casemated battery of two tiers, to mount 50 68-pr. and 110-pr. guns, protected by iron shields, with a large detached magazine in the rear.

Contracts were made for the foundations and basement, and the work was begun in 1861.

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In 1864 the plans were revised, to adapt the work to the heavier artillery of the present day, and it is now proposed to mount 23 guns of 12 and 18 tons in a single tier of casemates protected by iron shields, with magazines and stores in the basement underneath the gun casemates, instead of the detached magazine referred to above. Revised Design and Armament.

In September 1864 a contract was made for the completion of the work on this revised plan.

The foundations are on rock, it is well and solidly built, and there is no reason to doubt its stability and permanency, or its capability of resisting any attack to which it may be exposed. Report.

The arrangements for the service of the guns are generally satisfactory; but to meet all the requirements of the present day, some slight modifications may be necessary.

In this work the powder passes from the magazines into side passages, and provision should be made for lighting them. The disposition of the bays should be so arranged as to interfere as little as possible with the lighting. In some instances the lifts are in the immediate neighbourhood of the hatches, and the allotment of the openings prepared for the lifts and lights should be re-arranged, or the position of the hatches altered, to remove any risk that might arise from this cause.

The estimated cost of this work in the Schedule of 1862 was 80,000*l.*, which was reduced in 1863, on the revision of the plans, to 60,000*l.* and has been subsequently continued at that sum. The estimated cost of the shields in 1867 was 22,000*l.*, making the total cost of the work as then estimated 82,000*l.* The sum expended to June 30th, 1868, was 43,429*l.*, the further sum required is 14,835*l.*, making a total of 58,264*l.* The estimate for iron shields is 29,900*l.*, and the whole cost of the work, when completed, is estimated at 88,164*l.* Estimate.

BREAKWATER FORT.

BREAKWATER FORT.

83. This fort is placed immediately behind the centre of the Breakwater, in six fathoms water. Original Design.

The original design, approved in November 1860, was for a work constructed in masonry faced with granite, with four floors protected by bombproof arches; the two lower floors for stores and barracks, and the two upper floors for 33 guns, with a battery of seven guns on the top above the casemates, to fire through embrasures in a masonry parapet. The whole of the 40 guns were to be protected by iron shields. Armament.

The foundations were commenced in 1861, and have been carried up solid over the whole area of the fort, according to the original design, to a level of 2 feet above low water mark; above this level the work has been subject to several modifications consequent in great measure on the development given to the power of artillery. Foundations.

The fort, as now designed, will consist of only two floors, the lower for magazines and stores, and the upper for 18 heavy rifled guns in casemates, entirely protected from direct fire by iron, and preparation has been made for adding on the top two turrets for two guns each. Revised Design. Armament.

The work is ready to receive the iron superstructure, having been brought up to a level of 16 feet 6 inches above high water of spring tides, or 12 feet 6 inches above the level of the Breakwater; it appears so far to have been well and skilfully constructed as regards permanency and stability, and to be fully equal to the support of the structure which is to come upon it, but some of the arrangements above this level do not appear altogether satisfactory; the arched domes, as designed for the support of the turrets, are not strong enough, and the proposed manner of securing the pivots to those domes is not well adapted to sustain the shocks to which the work may be subjected in war. These arrangements, however, are merely to provide for the addition of turrets in case their construction should hereafter be approved; we are informed that it is not intended at present to erect them, and their cost is not included in the estimates which have been submitted to us, nor has the design for them yet been finally decided upon; it will, therefore, only be necessary that these points should be carefully considered before their erection is proceeded with. Superstructure. Preparation for Turrets.

The passage by which the cartridges will be conveyed to the lifts is only 3 feet wide, special arrangements for the supply of powder will therefore be necessary, to prevent confusion and delay. The recesses for the lifts are too contracted, and should be widened sufficiently to allow two men to work together in placing the cartridges in the lift. In one of the magazines the hatch is directly opposite to the lift recess, an arrangement undoubtedly objectionable, and which should be altered. Arrangements for supply of ammunition.

This fort, as far as it has gone, is well and skilfully constructed; the arrangements for the service of the guns are satisfactory; the masonry work appears to us Report.

PLYMOUTH.

to be of adequate strength to resist the attack of ships armed with the most powerful artillery of the present day, and to protect the magazines from danger; but in accordance with our instructions we have not enquired into the resisting power of the iron superstructure.

Estimate. The estimated cost of this work in the Schedule of the Act of 1862 was 145,000*l.*, and this sum was in 1867 increased to 155,000*l.* The amount expended to the 30th June was 100,142*l.*, and the further sum of 66,920*l.* will be required to complete it, making a total of 167,062*l.*

Remarks. With reference to this increased cost as compared with the estimate of 1867, it would appear that if the fort had been completed according to the designs which had then been approved, there would have been a small saving upon that estimate. The excess therefore is to be attributed to the additional precautions which have been considered necessary as a result of the last year's experiments at Shoeburyness, and we fully concur in the necessity of their adoption.

PICKLECOMBE BATTERY.

Original Design. Armament. Revised Design. Armament. **84.** This work was designed in November 1860 as a casemated granite battery for 42 68- and 110-prs. in two tiers, and 16 guns on the platform, all protected by iron shields, with a large detached magazine in the rear. It was re-modelled in 1864: the magazines were removed to the basement under the gun casemates, the two tiers of guns were retained, but the guns on the platform were given up. It is now intended to mount 42 12 and 18-ton guns, protected by iron shields, which also cover the vertical space between each casemate.

Report. The foundations of the work are on rock, and there have been no failures. It is well and skilfully constructed, both as regards permanency and stability and its power of resisting any attack that might be made upon it. The magazine arrangements are similar to those at Bovisand, and the observations there made will apply equally to this work.

Here, where the shields protecting the two tiers of gun casemates are continuous vertically, we recommend that provision should be made to prevent the men, when loading, suffering from the concussion from the guns fired above or below them.

Estimate. The estimated cost of this work in the Schedule of 1862 was 85,000*l.*; it was reduced in 1864 to 80,000*l.*, and again increased in 1867 to 87,000*l.* The cost of the shields was then estimated at 42,000*l.*, making a total of 129,000*l.* The sum expended to the 30th June, 1868, was 66,525*l.*, and a further sum of 14,351*l.* is required to complete it, making a total of 80,876*l.* The estimate for iron shields is 68,250*l.*, making the whole cost of the work, when completed, 149,126*l.*

CAWSAND BATTERY.

Design Armament. **85.** This is an enclosed work mounting 9 guns behind earthen parapets on the sea faces, and 14 guns on the land side; it is armed with 68-pounders, 8-inch guns, and 7-inch breech-loading rifled guns: it was commenced in 1861, and completed in 1863, and is well constructed so far as permanency and stability are concerned. The arrangements for the service of the guns are adequate to the existing armament.

Position. It is commanded by the high ground immediately in its rear, and is chiefly intended to oppose any attempt to land in the bay. If re-armed with heavy rifled guns it might assist in opposing the entrance of a hostile fleet into the sound, and afford support to Picklecombe against an attack from the southward. This support would be the more necessary should the construction of the work on Hooe Lake Point, recommended by the Defence Commission, not be proceeded with; no provision has been made for this work in the Schedule of 1867.

To obstruct a force landed near the village of Rame, the Royal Commissioners recommended, in addition to the battery at Polhawn, the construction of a small work on Knatterbury Hill, and the land required for it has been purchased. They further recommended that the existing works on Maker Heights should be repaired and strengthened. No provision is now made to carry out these recommendations. The absence of any works on these points might expose Cawsand Battery to an attack from the rear that might render it untenable, and thus prevent it from fulfilling the object for which it is chiefly intended.

Exposure to attack from the rear.

Report. There have been no failures of any importance, and the work is well-constructed.

Estimate. The estimate for this work in the Schedule of 1862 amounted to 10,000*l.* in addition

3,257*l.*, previously charged against the Annual Estimates. In 1863 it was increased to 13,000*l.*, and the expenditure upon it, under the Loan, amounted to 12,914*l.* The total cost of the work has been 16,171*l.* PLYMOUTH.

SUMMARY.—OUTER SEA DEFENCES.

86. In 1862, the estimate for the works forming the Outer Line of the Sea Defences amounted in the aggregate to 320,000*l.* This estimate was reduced in 1863 to 283,000*l.*, and in 1864 to 298,000*l.* In 1867 it was again increased to 315,000*l.*, with 64,000*l.* for shields, making the total estimated cost 379,000*l.* Estimate.

The total cost of the works is now estimated at 322,373*l.*, including 3,257*l.*, paid out of the Annual Votes, and the cost of the shields at 98,150*l.*, making a total of 420,523*l.*, of which 417,266*l.* will be charged against the Loan.

SEA DEFENCES.—INNER LINE.

DRAKE'S ISLAND.

87. The lower battery on Drake's Island is a granite casemated battery for 21 12-ton guns, protected by iron shields. Design Armament.

There is a large magazine in the rear entirely protected from fire, communicating by subterranean galleries with the expense magazines immediately in rear of the passage behind the casemates. At the time of our visit there were only three of these expense magazines; a fourth has now been planned, but the original design having been modified in order to give more protection to these magazines from direct fire, the approaches to them and to the shell stores are so contracted and inconvenient, that we doubt whether the supply of ammunition to the guns could be maintained with the rapidity required in this important position. Magazine Accommodation.

The upper battery was designed for a barbette battery to mount five of the heaviest rifled guns. The design has now been modified, and so altered as to admit of its adaptation to the Moncrieff system, should that system be adopted. The alterations necessary to effect that object are also shown on the approved plans. According to this design it is intended, in constructing the barbette battery, to carry up the retaining walls of the traverses to the full height required for the Moncrieff carriages. The upper part of these walls will thus be exposed to fire from ships in the offing; we think this objectionable, and we recommend that the walls should not be raised in the neighbourhood of the guns until the Moncrieff carriage is adopted. Design of Upper Battery.

The foundations are on rock, and the work is well and skilfully designed with reference to its stability and permanency, and also to its power of resisting any attack that may be made upon it. The arrangements for the service of the guns are good, subject to the foregoing remarks on the magazine passages. Report.

In 1862, the estimate for this work was 35,000*l.*; in 1863, it was reduced to 32,000*l.*; and in 1865, it was merged in the Estimate for the Inner Line of Defence. The estimated cost of the shields in 1867, was 22,000*l.* The amount expended to June 30th, 1868, is 26,586*l.*, and a further sum of 8,222*l.* will be required to complete it, making a total of 34,808*l.* It is proposed to charge 566*l.* of this amount to the Annual Estimates; the estimate for iron shields is 27,300*l.*, making the total cost of the work when completed 62,108*l.*, and the charge against the Loan 61,542*l.* Should the Moncrieff system be adopted for the upper battery the additional cost would be 1,416*l.*, making the total 63,524*l.* Estimate.

GARDEN BATTERY, MOUNT EDGCUMBE.

88. The Garden Battery is a casemated granite battery for 7 guns, to be protected by iron shields. It was begun in 1862, and completed, exclusive of shields, in 1863, in conformity with the original design, for the sum of 7,804*l.* Design and Armament.

The magazines as constructed are not secure against a front fire. The attention of the officers of the War Department was called to this defect, and a plan has been laid before us for remedying it which, if carried out, will afford the desired security. There Revision of Magazines.

Plymouth. were also some complaints of dampness in the magazine, caused by defects in the asphalte that have now been remedied.

Report. The work has been well and skilfully constructed with reference to its stability and permanency, and also to its power of resistance, with the exception above pointed out.

In 1862, the estimate for this work was 8,000*l.*, and it was increased to 10,000*l.* in 1863; it remained at that amount till merged in the Estimate for the Inner Line. The estimated cost of the shields in 1867 was 7,000*l.*

Estimate. The amount expended is 7,804*l.* The estimate for the protection of the magazines is 1,898*l.*, making a total of 9,702*l.*; this additional expenditure will not be charged against the Loan, but will be provided in the Annual Fortification Votes.

The estimate for iron shields is 9,100*l.*, making the total cost of the work, when completed, 18,802*l.*, of which 16,904*l.* will be charged against the Loan.

Eastern and Western Kings.

Armament. **89.** New earthwork open batteries for 7 and 9 guns respectively, firing through embrazures, have been added here to previously existing works; they were constructed in 1861–2, and there have been no failures in their construction.

Report. The supply of powder to Eastern Kings would be maintained with difficulty under existing arrangements. The parapet and traverses, and the protection of the magazines in these batteries, are not calculated to resist the fire of the heavy artillery of the present day, and in these respects therefore, if considered of importance, they should be re-modelled to meet the requirements, both offensive and defensive, of any attack to which they may be exposed.

Estimate. The amount for these batteries included in the estimate of 47,000*l.* for the inner line, is stated to be,—for Western Kings, 2,900*l.*, in addition to 289*l.*, previously expended under the Annual Estimates; for Eastern Kings, 2,100*l.* The amount expended under the Loan has been,—for Western Kings, 2,887*l.*, making a total of 3,176*l.*; and for Eastern Kings, 2,019*l.*

Summary.—Inner Sea Defences.

Estimate. **90.** In 1862, the estimate for the works forming the Inner Line of Defence to Hamoaze amounted in the aggregate to 48,000*l.* In 1863 and subsequent years it was 47,000*l.* In 1867, the cost of the shields for these works was estimated at 29,000*l.*, making the total estimate under the Loan 76,000*l.*

The cost of the works when completed is now estimated, exclusive of shields, at 49,416*l.*, of which 46,952*l.* will be charged to the Loan; the cost of the shields is estimated at 36,400*l.*, and the total cost of the works 86,105*l.*, of which 83,352*l.* will be a charge against the Loan. The excess on the estimate of 1867 is wholly due to the increased cost of the shields.

WESTERN DEFENCES.

Object of Works. **91.** These defences occupy a position, known as the Antony Position, one mile and a quarter in length, extending in front of the village of Antony from the St. Germain's River to the sea, and are designed to shut an enemy out from access by land to the peninsula within them, from which he might bombard the dockyard and arsenal.

General Design. According to the design upon which these works were commenced in 1858, it was intended to occupy this position by Fort Tregantle on the left, and Fort Scraesdon on the right, with a minor intervening work about midway between them; this plan also provided for the construction of permanent lines to secure the left flank between Tregantle Fort and the sea, and the right flank between Scraesdon Fort and the St. Germain's River. The Royal Commission adopted this design, but attached so much importance to the position that they recommended the addition of a permanent ditch and rampart between the various forts, instead of connecting them by lines to be thrown up at the time of expected attack.

Purchase of Land. The land had been purchased for the whole of the above works previous to 1858; but the two principal forts only, Tregantle and Scraesdon, with the line between Tregantle and the sea, have been constructed.

FORT TREGANTLE.

92. Fort Tregantle, on the left flank, designed for 35 guns, exclusive of the lighter guns for the defence of the ditch, is an enclosed work, about 360 feet above the sea, having ditches on the east, the north, and west sides, with revetted scarps and counterscarps flanked by caponnières. The southern side facing the sea is enclosed by lofty casemates fitted up as barracks, so arranged as to permit of a complete flanking defence, both by artillery and musketry. Within the work at its gorge is a masonry keep with guns in casemates looking into its interior, and with an earthen parapet on top; this keep contains the main magazine, and is surrounded by a ditch with revetted sides flanked from galleries. Design and Armament.

The whole of this fort appears to have been solidly and carefully constructed, and no flaws or failures have occurred during its construction. Report.

The original design has been substantially followed in execution, with the exception of the omission of a small advanced work in front of the salient. There have also been some variations in the ditch and rampart on the north front, combining improvements in defence with economy in construction. The keep has also been altered by advancing it more into the body of the work, thus simplifying and improving the trace of its gorge; and additional galleries have been constructed in the ditch of the keep.

With reference to the actual construction of the work we found that the main magazine had proved damp from the infiltration of water through the rock in which it has been constructed; measures are in course of execution to remedy this evil which promise a satisfactory result. Improvement of Magazine.

A revetment wall supporting the extreme left gun of the work has been carried up so high that the upper portion is exposed to fire from the front which would endanger that gun. Some alteration appears desirable at this point, which can be done at slight expense, but with the loss of a position for one gun. Alterations recommended.

The embrasures are, in several instances, formed with heavy blocks of granite at their inner angles, which are objectionable as likely to cause much loss to the gun attachments; the Committee recommend that they be removed, as also the interior revetments of the parapets adjoining the embrasures where they can be struck by shot.

The arrangements for the service of the guns are adapted to meet the requirements of a modern armament.

As regards the powers of resistance of this work we consider that, subject to the foregoing remarks as to one gun on the left and the granite blocks in the embrasures, this fort is well adapted for the purpose for which it has been designed; but we are of opinion that the masonry of the keep, with its gun casemates, would be exposed to serious injury by the fire from guns placed in battery against the work. The exterior of the casemated barrack, 45 feet in height, on the sea side, is entirely open to view from its very base, at ranges of 1,200 yards, with elevations that are not difficult of attainment, and therefore it is advisable that arrangements be made by which ships in the offing might be subjected to the fire of a small number of heavy guns, to prevent them from taking up a position which might be seriously detrimental to the defence of the fort and adjoining defences. According to present arrangements no heavy gun can be brought to bear from the sea front on ships in the offing. Powers of resistance.

The estimated cost of this work in the Schedule of 1862 and subsequent schedules was 130,000*l.* in addition to 53,494*l.*, the amount previously expended under the Annual Votes. The expenditure under the Loan to the 30th June amounted to 135,425*l.* The further sum required for the revision of the magazines, and the alterations suggested, is 1,080*l.*, making a total of 136,505*l.*, of which 880*l.* will be provided out of the Annual Votes, and 135,625*l.* will be charged against the Loan. The whole cost of the work will be 189,999*l.* Estimate.

FORT SCRAESDON.

93. Fort Scraesdon, on the right of the Antony Position, was designed in 1859 as a detached work upon two levels, completely enclosed in a ditch with revetted scarps 30 feet in height, flanked from caponnières and galleries within it. That part of this fort which is on the upper level, 254 feet above the sea, has two faces, the west and south-west, looking over the country in front of the Antony Position; and a third, the south, sweeping the ground immediately in rear of Fort Tregantle. 27 guns will be mounted on the ramparts. Original Design.

The portion on the lower level, 173 feet above the sea, has its principal face towards the north looking across the St. Germain's River, and a short face on the north-west looking up that river.

PLYMOUTH.

According to the original design it was intended to construct an interior enclosed work within the work on the upper level, to be formed by a range of casemated buildings with parapet on top running completely around and parallel to the exterior sides, with a line of casemates across the work from east to west separating the part of the fort on the upper level from that on the lower.

This latter line of casemates being covered with earth towards the north, and having a parapet on it, was designed to serve as a screen to prevent the interior of the work from being seen from the high ground on the opposite side of the St. Germain's River, about 2,000 yards distant.

Revised Design.

94. This design, but omitting the keep, has been followed in execution with some deviations in the flanking galleries of the ditch, and the whole appears to have been constructed in a manner to ensure permanence and stability. The escarp revetments of the lower work are all arched, communications having been made through the piers of the arches and loop-holes in the chambers, thus constituting a complete escarp gallery for defence around the lower work. During the progress of construction it became evident by the development of cracks over some of the openings between the chambers that the thrust against them was too great at that particular spot; the openings in the walls were therefore at once reduced at an expense of 1,800*l.*, since which time there has been no further movement, and the work appears perfectly stable.

The interior casemates round the exterior sides of the upper work have not been constructed, and as a consequence the barrack accommodation has been most materially reduced. It is intended, however, and in fact it is absolutely necessary, in order to make this fort defensible, that a massive traverse should be constructed across its terreplein to protect the existing casemates and especially the entrance to the grand magazine, which is to be re-modelled, from the effect of shot and shells coming over the front face of the fort, to which they would otherwise be exposed. This traverse, as designed, is to be supported by relieving arches, which will be fitted up for the accommodation of about 80 men.

Three haxo casemates which were not in the original design have been added on the lower level, the guns from which are intended to sweep the St. Germain's River towards the east. As these guns are not of any great importance in the defence, and unless the Saltash Position is occupied may be exposed to direct fire of artillery, it would appear doubtful whether much advantage has been gained by their addition.

Service of Guns.

The arrangements for the service of the guns on the ramparts have not been completed, and the embrasures have not been cut. We have, however, to remark that the magazine accommodation is ample, and we are of opinion that it will neither be necessary nor advisable to complete the arrangements for placing guns on the ramparts until a necessity arises for the fort to be mantled for defence.

Powers of Resistance.

In reporting on the powers of resistance of the Forts Tregantle and Scraesdon it is necessary that they should be considered together as forming, in conjunction with each other, the permanent defences of the Antony Position.

95. Although these forts in themselves are very powerful, the ground in their immediate front is so undulating that an intermediate work as contemplated in the original design and approved by the Defence Commissioners would be necessary to supplement them in case of attack, for the purpose of sweeping ground which affords extensive cover and favourable positions for the attack inconveniently near to them. The position would also be much strengthened by the construction at a time of expected attack of a rampart and ditch between Fort Screasdon and the St. Germains River as originally intended, now protected only by a slight earthen breastwork.

The permanent line recommended by the Defence Commissioners to connect these forts has never been included in any schedule of works approved by Parliament, but the estimates include a military road covered by an earthen breastwork for communicating along the whole length of the position, which is to be made at a cost of 3,767*l.*, and will add much to its strength.

We are not prepared to recommend that the intermediate work should be undertaken at once, but it is so essential for the defence, that it is desirable that careful studies should be made and a well-devised project prepared, the execution of which could be undertaken at any required moment with a view to the full occupation of the position by strong works in a manner which would permit of a solid defence.

Estimate.

The estimated cost of Scraesdon, in the Schedule of 1862 and subsequent schedules, was 130,000*l.*, in addition to 16,803*l.* expended out of Annual Votes prior to the Loan. The expenditure to June 30th, 1868, amounted [illegible] required to

complete is 10,781*l.*, making a total of 120,608*l.*, chargeable to the Loan, and the whole cost of the work when completed will be 137,411*l.*

The cost of the military road connecting the two works amounting, as stated, to 3,767*l.*, is also charged against the 260,000*l.*, taken as the cost of the Antony Position under the Loan.

The total cost of the two works, including the military road, is estimated at 331,177*l.*, of which 260,000*l.* are to be charged against the Loan, being the exact amount of the estimate.

POLHAWN BATTERY, KNATTERBURY HILL AND WHITESAND BAY.

96. The only other work strictly belonging to the sea defences is Polhawn Battery. This is a casemated work mounting seven 68-pounders, firing through embrazures pierced in granite walls, and having a loop-holed gorge for its protection on the land side: It is intended to command the approach to the eastern side of Whitesand Bay, and is unsupported by any other work or battery, but is connected with Tregantle by a military road, which has been constructed along the top of the ridge overlooking Whitesand Bay, to afford an easy communication for guns and troops from the Antony Position to Cawsand Bay and the Maker Heights. The disembarkation of a force in Whitesand Bay, in rear of the Antony Position, must at all times be a most difficult operation, which would seem to have been sufficiently guarded against by the facility thus afforded for moving a few guns of position along this road, and by the construction of the Polhawn Battery, if that battery were so supported as not to be readily silenced from the sea.

Design and Armament.

Position.

Military Road

The left flank of Polhawn Battery is exposed to the attack at short ranges of ships anchored out of line of fire from its guns, and it could not in our opinion offer a long resistance to an attack from that quarter, against which it would be perfectly powerless. This work was constructed in 1861-3, and appears to have been well executed so far as materials and workmanship are concerned, and the arrangements are adequate for the service of the guns with which it is now armed.

Report.

A site has been purchased at Knatterbury Hill, a short distance to the northward of Polhawn, the occupation of which was recommended by the Royal Commission, for the protection of this work from assault, and also to support the battery at Cawsand; but no work has been ordered on this site, and instead of it the military road alluded to has been made. The amounts estimated for Whitesand Bay and Knatterbury in the Schedule of 1862, were respectively 10,000*l.* and 5,000*l.* The expenditure has been,—on Polhawn Battery, 8,850*l.* and on the military road, 5,776*l.*, together making 14,626*l.* The position of Knatterbury is one of great importance to the protection both of Polhawn and Cawsand.

Omission of work on Knatterbury Hill.

Estimate.

NORTH-EASTERN DEFENCES.

97. The Defence Commissioners recommended an Outer Line to be taken up for the defence of Plymouth, on the north-east, its left on the Tamar, slightly in advance of Saltash Bridge, and its right on Cat Down, supported by an Inner Line. The estimated cost of the works forming the two lines, including the purchase of the land, amounted to 1,550,000*l.* The Government did not think it necessary to incur this heavy expense, and they decided that only such works as could be executed for the sum of 350,000*l.* exclusive of land, or 600,000*l.* with land, should be undertaken, thus reducing the cost on this front alone by the sum of 950,000*l.* To carry out this decision of the Government several schemes were considered, and it was finally determined to abandon the inner line, to advance the right of the outer line to Efford, near the head of the Laira Basin, and to occupy the ridge which connects the villages of Egg Buckland and St. Budeaux.

Recommendations of Defence Commission.

Design adopted.

In this design the batteries at Ernesettle and St. Budeaux were supported by keeps on the high ground immediately in their rear, and a work called Fort Widey was designed to occupy a position near Knacker's Knoll flanking the ground in front, right and left of Crownhill; no provision has been made for these works.

Immediately in rear of the works from Ernesettle to Laira inclusive, a military road covered by a parapet, extends along the whole of the North-East Defences, affording a convenient communication between the works, and adding materially to the strength of the position.

The works on the line, excepting Efford and Laira, were commenced by contract in 1863. In 1866, the contractor failed, and from that time the works have been carried on

by Officers of Engineers without the intervention of a contractor; the result, we are informed, has been satisfactory, both as to execution and to economy.

ERNESETTLE FORT.

Position and Design.

98. Ernesettle Fort, forming the left of the position, is 210 feet above the sea, and situated on a spur extending from the village of St. Budeaux towards the Tamar. It

Armament.

contains a casemated barrack for 60 men. It is intended for an armament of 15 guns and 6 mortars; the guns in an open battery, with three large traverses, covering expense magazines, the mortars under bombproof arches on the west flank.

The ditch in front is cut in the solid rock, and is 25 feet wide at bottom, with sides sloping at one-half to one, the base of the slope being equal to half the height. The escarps are over 30 feet in height, and the counterscarps vary from 15 to 30 feet. In rear is a gorge wall, 30 feet high, and the whole enceinte is flanked by musketry galleries.

Report.

There is ample magazine accommodation, but the protection to the main magazine, as shown in the plan, was scarcely sufficient. The plan for remedying this defect has been prepared, and the cost of the alteration is included in the estimate.

No special accommodation appears to have been provided for artillery stores, but there would be no difficulty in appropriating suitable places for them when required. This remark will apply equally to all the works to the left of Crown Hill.

In the mortar battery the opening between the casemate and the earthen parapet in front appears to be rather narrow for the proper service of the mortars. It also seems desirable that the passage giving access from the interior of the work to the mortar battery and to the casemates should be covered by a traverse in front.

Estimate.

The amount expended to 30th June, 1868, was 15,000*l.*, and the further sum required is 2,630*l.*, making the total cost 17,630*l.*

AGATON FORT.

Position and Design.

99. Agaton Fort stands on a hill, 280 feet above the sea, 480 yards in advance of the village of St. Budeaux, and 800 yards from Ernesettle. It is surrounded by a ditch and a

Armament.

gorge wall of the same character as at Ernesettle, and is flanked by guns and musketry. It is constructed for 20 guns, all in open battery, excepting one in a haxo casemate on the left flank, and 6 mortars in 2 nests at the foot of the exterior slope.

Estimate.

The amount expended to the 30th June, 1868, was 35,000*l.*, and a further sum of 6,133*l.* is required to complete it, making a total of 41,133*l.*

KNOWLES BATTERY.

Position and Design.

100. Knowles Battery is on a spur 190 feet high, slightly in advance of the general line, and 800 yards from Agaton on the left, and Woodlands on the right. It is con-

Armament.

structed for an armament of 13 guns in open battery, except one in a haxo casemate on the right flank. There are three expense magazines in traverses, and a reserve magazine in the guard-house, affording sufficient accommodation for powder and shells.

The ground in front of this work is swept by the fire of Agaton and Woodlands, but the ditch itself is devoid of flank defence. The scarps are cut in the rock at a slope of one-half to one, and are a little over 20 feet high. The gorge wall is 30 feet high, and is flanked by a gun and five loopholes on each side of a two-storied guard-house, which, towards the battery, is covered by an earthen parapet, which will be protected by a stockade at its foot.

About 1,000 yards in advance of the line joining Knowles and Woodlands, the ridge of which Crown Hill is the highest point terminates in an eminence called Whitleigh Hill, 325 feet above the sea, or 135 feet above Knowles, and 95 feet above Woodlands; this hill limits the fire of these batteries, and offers a strong aggressive position, from which the works to the left of Crown Hill might be attacked.

Estimate.

The expenditure to June 30th, 1868, amounted to 18,000*l.*, and a further sum of 1,562*l.* will be required to complete it, making a total of 19,562*l.*

WOODLANDS FORT.

Position.

101. Woodlands Fort occupies a site on the ridge, half-way between the villages of St. Budeaux and Knacker's Knowl, at an elevation of 230 feet above the sea, and is

Armament.

constructed for an armament of 18 guns, of which two are in haxo casemates on the

flanks. The ditch is on the same scale as at Agaton, and is flanked by guns and musketry. PLYMOUTH.

It has a defensible guard-room and casemated barrack accommodation for 100 men in addition to that afforded by the caponnières and flanking galleries, and has ample accommodation for powder and shells in three expense magazines in the traverses, and a main magazine.

The expenditure to the 30th June, 1868, was 20,000*l.*, and 7,973*l.* will be required to complete it, making a total of 27,973*l.* Estimate.

CROWN HILL.

102. Crown Hill, the key of the North-Eastern Defences, stands unsupported upon the hill from which it takes its name, about 500 yards in advance of the Knacker's Knowl cross roads, and of a line drawn from Woodlands to Bowden. It is distant 1,800 yards from Woodlands on the left, and 1,300 yards from Bowden on the right, and is constructed for an armament of 32 guns, of which four are in haxo casemates, and 6 mortars. The highest point of its parapet is 450 feet above the sea. Position. Armament.

The ditch is 30 feet broad at bottom, excavated in the solid rock: the escarp is revetted with masonry, and the counterscarp formed as in the other works, at a slope of one-half to one;—one double and five single caponnières for guns and musketry flank the branches of the ditch; in front there is a covered way, and the Leats which convey the principal part of the water supply of Plymouth and Devonport pass under the northern glacis in tunnels having communications so constructed as to be available as counter mines if required. Design.

There are casemated barracks for 300 men, and provision is made in well protected magazines for an ample supply of powder and shells. Suitable provision is also made for artillery stores, side-arms, &c.

The expenditure to the 30th June, 1868, was 57,000*l.*, and a further sum of 19,409*l.* is required to complete it, making a total of 76,409*l.* Estimate.

POSITION IN FRONT OF EGG BUCKLAND.

103. This position is occupied by—

Bowden Fort;
Egg Buckland Keep;
Forder Battery;
Austin Fort.

BOWDEN FORT.

104. The western face of Bowden flanks the valley towards the rear of Crown Hill. The eastern face commands the front of Forder Battery. It is constructed as a work for 12 guns in open battery, and 3 mortars, standing 345 feet above the sea. The ditch is excavated in rock, and is flanked at its salient points by musketry galleries; the escarps and counterscarps are formed at a slope of one-half to one. The gorge is closed by a wall 22 feet high, flanked by a defensible guard-room, containing bombproof barrack-rooms for 16 men, and there is ample magazine accommodation. Position. Armament. Design.

At the time of our visit little had been done to this work since the failure of the contractor.

The expenditure to the 30th June, 1868, was 11,000*l.*, and a further sum of 4,891*l.* will be required to complete it, making a total of 15,891*l.* Estimate.

EGG BUCKLAND KEEP.

105. This work stands 357 feet above the sea, 400 yards to the east of Bowden, and 800 yards from Austin on the right, and occupies the most commanding point of the position; it is designed as a barrack keep to afford accommodation for the garrisons of the adjoining works, as well as to increase their defensive power. It has revetments 30 feet high flanked by musketry, and completely protected by a glacis. The two-storied casemated barrack contains accommodation for 230 men, and ample stores for powder and shells. Position. Design.

The expenditure to the 30th June, 1868, was 10,000*l.* A further sum of 4,642*l.* will be required to complete it, making a total of 14,642*l.* Estimate.

FORDER BATTERY.

Position. Armament. Design.

106. Forder Battery stands on a spur below Egg Buckland Keep, at a height of 344 feet above the sea, and is constructed for an armament of 16 guns, with five traverses containing expense magazines. The terreplein is entirely open to the Egg Buckland Keep.

The front, from Bowden to Austin, is covered by a ditch, flanked at its salient in front of Forder by a double caponnière, communicating with Forder Battery and Egg Buckland Keep by an underground gallery. The other portions of this ditch, near the collateral works, are flanked from them.

This work is less advanced than some of the others.

Estimate.

The expenditure to the 30th June, 1868, was 9,991*l.*, and the further sum required to complete is 6,452*l.*, making a total of 16,443*l.*

AUSTIN FORT.

Position. Armament. Design.

107. Austin Fort, on the right of the Egg Buckland Position, and 800 yards from the keep, stands on the last spur of the range, and is 312 feet above the sea. It is constructed for an armament of 15 guns and 5 mortars, with five traverses containing expense magazines. The ditch is cut in rock, at a slope of one-half to one, except the north counterscarp, which has an arched revetment in masonry, with a loopholed gallery communicating at each end with the gun casemates and musketry galleries which flank the ditch. The gorge wall, 30 feet high, is flanked by a central guard-house having two tiers of guns and musketry, and containing barrack accommodation for about 60 men, and a reserve magazine.

Estimate.

The expenditure to the 30th June, 1868, was 12,000*l.*, and the further sum required 8,607*l.*, making a total of 20,607*l.*

SUMMARY.—ERNESETTLE TO AUSTIN.

108. The cost of completing the military road from Ernesettle to Austin is estimated at 2, 665*l.*; with this addition, the cost of the works of this division when completed is now estimated at 252,955*l.* As this sum includes the purchase of plant and general charges not yet exactly apportioned to each separate work, the expenditure incurred to the 30th June, 1868, on each, must be looked upon as approximate, but is sufficiently near for all practical purposes, the total sum being accurately stated. The estimate for the completion of each work has been separately made, and we believe it to be accurate and sufficient.

EFFORD AND LAIRA POSITION.

Description of position.

109. The right flank of the North-East Defences is occupied by two works, Fort Efford and Laira Battery, separated only by a distance of 300 yards from centre to centre.

Fort Efford stands on the last knoll of a ridge extending from Compton, at a height of 246 feet above the sea, and 1,300 yards from Austin.

Laira Battery is placed on a lower spur, overlooking the Laira, at an elevation of 123 feet.

The ground in front of both works is steep, in many places inaccessible, or requiring but little labour in scarping to make it so; ditches, or counterscarps, have therefore been found unnecessary. For flank defence each work depends upon the fire of collateral batteries.

A curtain, with an emplacement for four guns, has been thrown across the valley between Efford and Laira, and its ditch is flanked by two casemates for guns at Efford.

An emplacement for five guns has been prepared on the military road connecting Efford and Egg Buckland, and another for six guns has been designed 300 yards in rear of Laira Battery; two of the guns to bear on the right of Laira Battery, and four on the Laira River and ground opposite.

FORT EFFORD.

rmament.

110. This work is being built by contract on a schedule of prices, and is designed to mount 21 guns on its terreplein, of which three are in haxo casemates, with lifts in connection with magazines in the basement. There are also two magazines in traverses, one communicating with a magazine below by a lift.

On the right flank casemates for five guns, flank the front of Laira Battery, and on a still lower level are the two casemates before mentioned, flanking the ditch which connects Efford with Laira. PLYMOUTH Design.

The front of this work is protected by scarps at slopes not less steep than one-half to one, and from 27 to 33 feet high. The gorge is closed by a wall upwards of 20 feet in height, flanked by a defensible guard-room in its centre. At its northern extremity the gorge wall joins the escarp, but at the southern end it terminates in the parapet, and thus access is now afforded to the interior of the work; a design for completing the gorge defences and removing this defect has been prepared, and the sum required for it is included in the estimate.

The casemated barracks contain accommodation for 5 officers and 108 men.

The ventilation of the five-gun battery on the right flank is very defective, and should be improved. Report.

The work is not completely defiladed from high ground in its vicinity, from which an enemy might bring a reverse fire on the battery in its left flank, and make the casemates under it inconvenient for occupation. A traverse might be constructed to remedy this defect. The casemates under the right flank, and the haxo casemates, are also exposed to direct fire from the same high ground.

The expenditure to June 30th, 1868, has been 32,721*l.*, and a further sum of 17,682*l.* will be required, making a total of 50,403*l.* Estimate.

Laira Battery.

111. Laira Battery is designed for 10 guns in embrasures and 3 in haxo casemates. It has ample magazine room, and barrack accommodation for 2 officers and 30 men, with the requisite conveniences. Armament. Design.

The gorge is exposed to Efford, and is closed by a simple enclosure wall. The military road connecting the Efford Position with Egg Buckland joins the Plymouth and Exeter Road below the battery. Like Efford this work would be exposed to fire from batteries placed on commanding ground in the vicinity; from which however it is defiladed. Report.

The expenditure to June 30th, 1868, has been 10,877*l.*, and the further sum required is 5,928*l.*, making a total of 16,805*l.* Estimate.

Summary.—North-Eastern Defences.

112. The estimate for the North-Eastern Defences in 1862 and subsequent years, was 350,000*l.* To the expenditure on the works, which has hitherto included that on the military road, the future expenditure under that head estimated at 2,418*l.* must be added, making the total estimated expenditure, when completed, to amount to— Estimate.

	£
Ernesettle to Austin	252,955
Laira Division..	69,626
Total	£322,581

The several works thus described, and forming the North-Eastern Defences of Plymouth, have all been well and skilfully constructed so as to give them the necessary stability and permanency. In some of them we have pointed out some slight defects that might in our opinion somewhat weaken their defensive powers; with those slight exceptions we consider them to possess adequate powers of resistance; the arrangements for the service of the guns are good. Report.

STADDON POSITION.

113. This position extends from the Catwater to Bovisand, and covers the high ground from which the harbour and naval establishments are visible. Recommendations of Defence Commission.

The Defence Commissioners recommended the occupation of these heights by two works, connected by lines of ditch and rampart with the flanks, also closed by lines connecting them with the sea on one side and with Hooe Lake on the other.

This scheme has been modified.

Fort Staddon and Brownhill Battery occupy the positions selected by the Commission, and the lines connecting these two batteries with each

Bovisand have been formed, but in lieu of the line on the left flank connecting Fort Staddon with Hooe Lake, another work, called Fort Stamford, has been constructed further to the rear, on the heights above the village of Turnchapel.

FORT STADDON.

Armament. Design.

114. This, the principal work, stands 406 feet above the sea, and is intended for an armament of 16 guns on the terreplein, 12 on the keep, 6 in haxo casemates, and 6 mortars in covered casemates. It has ample magazine accommodation, and barracks for about 200 men. There is an excellent well, with an ample supply of water. Tanks are also provided.

The defensive portions of this work consist of a ditch 50 feet wide round the front and 40 feet at the gorge, and 30 feet deep, having masonry escarps and counterscarps, and flanked by two tiers of guns and musketry in caponnières and galleries.

From the inner end of the right flank of Fort Staddon a scarp 20 feet high has been cut in the rocky slope, extending to a point 800 yards from the Fort, between Brownhill and the King's Reservoir; at that point it turns towards Watch-house Brake, being broken to meet the irregularities of the ground; from Watch-house Brake a ditch completes the defensive connection with Bovisand Battery. These scarps are revetted artificially only where necessary; they are flanked on the east by Fort Staddon, and on the south by a small redoubt on the hill over Bovisand, called Watch-house Brake Battery, containing an expense magazine, and prepared for five guns.

Watch-house Brake Battery.

Brownhill Battery.

The high ground in rear of the salient of the scarp is occupied by Brownhill Battery, a work of five faces, with an open gorge. An armament of 14 guns can be placed in this work, and four traverses, with bomb-proof chambers in them, will supply them with ammunition.

Twelve-acre Brake Battery.

At a point intermediate between Brownhill and Watch-house Brake, an emplacement for three guns, and a bomb-proof expense magazine have been provided: this is called the 12-acre Brake Battery.

Road.

A road covered by a parapet connects Fort Staddon with these three works, and with Bovisand Battery.

Estimate.

The estimate for Fort Staddon in the Schedule of 1862 was 93,000*l.*, and in that year the estimates for the whole of the works for the North-Eastern Defences and the Staddon Position amounted in the aggregate to 518,000*l.* In the Schedule of 1867 Forts Staddon and Stamford were classed with the North-Eastern Defences, and the whole cost of the works for the whole was estimated at the same sum of 518,000*l.* The expenditure on this work, to the 30th June, 1868, amounted to 111,562*l.*, and the sum required to complete is 1,282*l.*, making a total cost of 112,844*l.*, of which 112,120*l.* will be charged to the Loan.

FORT STAMFORD.

Position.

115. Fort Stamford, on a hill 165 feet high, between Jennycliffe Bay and Hooe Lake, forms the left of this position.

Its southern faces command the merchant ship anchorage in Jennycliffe Bay, and at long range will co-operate with the sea batteries in the defence of the sound. That part of the work is intended to receive an armament of 7 12-ton guns; 13 guns will be mounted on the land front; and positions have been prepared for 6 mortars at the salients.

Armament.

Design.

The front ditch is 50 feet wide and 30 feet deep, as at Staddon, and is flanked by one double and two single caponnières with two tiers of guns and musketry. The gorge wall is 45 feet high, and is flanked by casemates under the counterscarp at the north end. The magazine arrangements are good and sufficient. The casemated barracks in the gorge of the work contain quarters for 200 men besides officers, non-commissioned officers, and married soldiers, and the requisite offices; it is well supplied with water.

A central traverse crosses the work for the purpose of defilading the communications, but from the higher ground which is seen to the east some small portions of the escarps are not entirely concealed.

Estimate.

The amount estimated for Fort Stamford in the Schedule of 1862 was 75,000*l.*, the expenditure to June 30th amounted to 59,123*l.*, the sum required to complete is 11,236*l.*, making a total of 70,359*l.*

The expenditure on Brownhill and Watchhouse Brake Batteries, and the connecting Lines, amounted on June 30th to 24,533*l.*; a further sum of 1,235*l.* is required to complete, making a total of 25,768*l.*

The total cost of the works on the Staddon Position is, therefore, 208,971*l.*

Report.

All the works in the Staddon Position are well and skilfully constructed with reference to stability and permanency, and possess great powers of resistance.

116. The cost of the works forming the North-Eastern Defences and the Staddon Position was estimated in 1862 and in subsequent years at 518,000*l.* Their total cost when completed is now estimated at 531,552*l.*, of which 530,828*l.* will be charged against the Loan. The excess on the Staddon Position amounts to 40,247*l.*; this has been partly met by a saving of 27,419*l.* on the North-Eastern Defences, making the net excess on the whole group 12,828*l.* Estimate.

DEVONPORT LINES.

117. For re-modelling the Mount Wise Batteries and Devonport Lines, 10,000*l.* were included in the Schedule of 1862. The expenditure upon them amounts to 12,724*l.*, of which 2,905*l.* were charged to Annual Estimate, and 9,819*l.* to the Loan. Estimate.

These works call for no remark.

GENERAL SUMMARY.

118. The cost of the works recommended by the Defence Commissioners for the protection of Plymouth, including the purchase of land, was estimated by them at 2,670,000*l.*, in addition to 350,000*l.* required for works then in progress, making a total cost of 3,020,000*l.* The cost of the land was estimated by them at 755,000*l.* The Government did not adopt the whole of their scheme, but in 1860, by the omission of the connecting lines of the Western Defences, and of the whole of the works for the defence of the Saltash Position, and by limiting those for the North-Eastern Defences to four, they reduced the estimate, including the purchase of land, to 1,200,000*l.*, in addition to 350,000*l.* for works already sanctioned—making the total estimate for the works they proposed for the defence of Plymouth 1,550,000*l.*

The amount voted in 1860-1 for works already sanctioned was 85,000*l.*; the amount paid for land has been 282,840*l.*

In 1862, when the land was separately estimated for, the estimate for the works was 1,191,000*l.*, and including the 85,000*l.* voted in 1860-1, 1,276,000*l.*; adding to this amount the 282,840*l.* paid for land, the total cost of the works in the modified scheme of the Government, as then estimated, would have amounted to 1,558,840*l.*

119. The estimates for the various works fluctuated in subsequent years, but the total amount was somewhat reduced. In 1867, when the cost of iron shields and iron superstructures had so much increased, and when the Maker Barracks, estimated to cost 20,000*l.*, were omitted, the estimates for the works themselves were somewhat lower than in 1862, and amounted to 1,165,000*l.*, but 93,000*l.* were added for shields, and 20,000*l.* for the increased cost of the iron-work on the Breakwater Fort, making the total estimated cost of the works when completed 1,258,000*l.*, to be provided for out of the Loan, in addition to 85,000*l.* paid out of Annual Votes.

The cost of the works under the Loan is now estimated at 1,181,341*l.*, and of the shields at 134,550*l.*, amounting together to 1,315,891*l.* The excess on the estimate of 1867 is chiefly due to the great increase on the iron shields.

The account will then stand thus:—

	£
Expenditure on land	282,840
„ under the Loan	1,315,891
„ „ Annual Votes ..	80,816
Total	£1,679,547
Estimate of Defence Commissioners ..	2,670,000
Saving	£990,453

PLYMOUTH.

Remarks.

120. The present scheme undoubtedly does not provide that complete protec[tion] which the Defence Commissioners proposed. The defence of the country between [the] St. Germains River and the Tamar, and of the interval between the head of [the] Estuary and Staddon Position is unprovided for, and in other places some of the [de]porting works have been omitted; the works thus omitted, which formed part of [the] scheme of the Royal Commission, would be an important feature in the defence [of] Plymouth against an enemy who had gained such a footing in the country as [to] enable him to attack it upon either of the points thus left open. In compar[ing] therefore the expenditure incurred and required for the completion of the works [in] progress with their estimate, this important difference must not be lost sight [of]; as, this however is a question of general policy, and not one bearing on the detail construction of the various works, it requires no comment from us, and we need [only] remark that, with all the most vulnerable points protected by powerful works, the [dan]ger of the gaps in the line would be comparatively easy, and as we have pointed out, should be carefully provided for before a time of expected attack.

PEMBROKE.

Committee of 1858.

121. In December 1858, a Report on the Sea Defences of Milford Haven was made by a Committee appointed by the Secretary of State for War.

Old Works.

The works which then existed, consisted of batteries at the entrance of the haven, on West Blockhouse Point, Dale Point, and Thorn Island, a tower for three guns on the Stack Rock; and at the dockyard the Pater Battery mounting 23 guns, with two towers for one and three guns respectively.

New Works recommended.

The Committee recommended in addition the construction of a casemated circular battery for about 45 guns on the Stack Rock; the establishment of batteries for 20 and 10 guns respectively at South Hook Point and Chapel Bay; the establishment of batteries for 45 guns at Popton and Hubberstone Points; and lastly, the improvement of the existing works at the entrance of the haven, and the establishment of a floating barrier between Popton and Hubberstone. They also recommended defensible barracks in the rear of South Hook, Popton, and Hubberstone Batteries. This project, of which the estimated cost was 190,000*l.*, had been approved by the Government, money had been voted by Parliament, and several of the works were partially contracted for and commenced.

Recommendation of Defence Commission.

With this scheme the Defence Commissioners entirely concurred, recommending the active prosecution of the works.

For the defence of the dockyard by land they recommended on the south side, self-defensible batteries at four points—Tenby, Lydstep, Freshwater East, and Freshwater West, to prevent a landing in the bays to the southward; and four works between Pennaar Pill and East Llanion Pill, on sites already purchased by the Government; these works to be connected by lines, for which it would be necessary to purchase the intervening land.

For the defence of the approach from the northward they recommended the construction of six small works at intervals of 1,400 yards resting on the haven, the left near Newton, the right at Burton.

Modifications.

Of these various works, the sea batteries for the defence of the haven, with the exception of the battery at Chapel Bay, have been or are in course of construction, as well as one at Tenby. For the battery at Chapel Bay a plan has been laid before us, but has not yet been finally decided on. Four other small works are to be constructed on the south coast,—at Proud Giltar, Eastmoor, Trewent Point, and Freshwater West, commanding the landing places pointed out by the Defence Commission.

The plans for Proud Giltar and Trewent have been sanctioned, and it is intended to construct works of a similar character on the other two points.

The line between Pennaar Pill and Llanion Pill has not been sanctioned.

On the north side one fort alone, Fort Scoveston, has been constructed in the position selected by the Defence Commissioners for the centre of the line.

In the event of an enemy advancing in force from St. Bride's or Fishguard Bay, this work would afford a valuable support to the defenders; but unless the ground on both sides of the work between it and the haven were occupied, it would not prevent him from attaining a position from which the dockyard might be bombarded.

SEA DEFENCES.

Stack Rock.

Position.

122. This fort stands on a rocky islet nearly covered at high water, 800 yards from South Hook Battery, and 1,500 yards from Chapel Bay. The main channel, 900 yards wide, lies between it and the latter work.

Original Design.

The original design was a tower, containing two tiers of 19 gun casemates each, and 16 guns on the terreplein, making 54 in all, firing through masonry embrasures.

On this plan, the foundations were commenced in 1859, under a contract, and completed in July 1861. The designs were then modified by the substitution of massive granite piers with iron shields in lieu of the masonry embrasures, and by otherwise

Modifications.

PLYMOUTH

Remarks.

ing the work. In December 1860, another contract was made for the casemates of the basement, and completed in February 1863; finally, in June 1864, a further contract on a schedule of prices was entered into for the completion of the work on a revised plan, and under that contract the building is now proceeding.

Further modifications, rendered necessary by the increasing power of artillery, were subsequently introduced. The greater part of the casemates in the basement were appropriated for magazines, and the gun casemates of the upper tier were converted into soldiers' rooms and hospital. In the basement, the outer walls protecting the magazines were increased in thickness from 9 to 12 feet, and ultimately to 14 feet, with a 3 foot passage intervening between them and the outer walls of the magazines. The improved plans for the supply of powder and shells by lifts to the casemates were adopted as far as the confined space would allow.

Armament.

The work, as now designed, is constructed for sixteen 18-ton guns on one floor in the front casemates, and seven 7-inch guns on two floors in the gorge. Preparations are also to be made for three turrets to mount two 25-ton guns each.

There is barrack accommodation for four officers and 152 men, and 12 hospital patients.

Report.

The work has been well and skilfully constructed, with reference to permanency and stability, and there have been no failures. The foundations for the turrets are so arranged that, with due precautions and a proper distribution of the weights, they may be made amply sufficient for their purpose. The plans for the turrets do not come before us; should any alterations be required in the masonry for their reception, the cost of those alterations would be included in the cost of the turrets, for which no provision has been made.

The magazine accommodation and arrangements for the service of the guns are ample and good.

The amount of accommodation given up to the hospital materially limits that for the garrison, and it might probably be found expedient to make arrangements for landing the sick when necessary, and to increase the amount of accommodation for the garrison.

Estimate.

This work, as well as the other batteries for the defence of Milford Haven, was commenced under a Vote of the Annual Estimates prior to the Loan, and the amount expended under that Vote was 7,611*l.* In the Schedule of the Act of 1862, the estimate for its completion was 60,000*l.*, and it remained at this amount till 1865, when it was included in the General Estimate for the Sea Defences. The expenditure under the Loan to the 30th June was 48,445*l.*, and the further sum required to complete it is estimated at 19,984*l.* (exclusive of shields and turrets), together amounting to 68,429*l.* The estimated cost of the shields is 20,800*l.*, making the total cost of the work when completed 96,840*l.*, of which 89,229*l.* will be charged against the Loan.

South Hook.

Design of Battery and Barrack.

123. This work consists of two open earthen batteries with embrasures, connected by a covered way, and from 90 to 100 feet above high water mark, and secured in the rear by a defensible barrack, capable of mounting guns on the roof, and connected with the battery by a parapet and ditch on each side. The western battery will mount fifteen, and the eastern five guns.

Armament.

The cliff in front, though at present accessible at many points, may be effectually scarped when necessary. The approach to it, as well as the cliff itself, is well seen from the Stack Rock.

The original design has been followed with slight alterations in the batteries, but the barracks have been constructed on an entirely different plan. The work was commenced in December 1859; the battery was completed in April 1861, and the barracks in March 1865. Some modifications have been made in the batteries. Improvements have been designed in the main magazine, and additional artillery stores provided. The barrack now consists of a two-storied building with a bomb-proof roof on which guns can be mounted. The outer wall, 4 feet thick, forms a scarp 35 feet in height. Its outline is an arc with the chord broken into a bastioned shape. A double counterscarp gallery in front flanks the east and west branches of the ditch. There is accommodation for a garrison of 180 officers and men, with an adequate supply of water.

Report.

The arrangements for the service of the guns are satisfactory. The work has been well and skilfully constructed, and is secure against a coup de main.

Estimate.

In 1862, the estimate for this work was 30,000*l.* This estimate was increased in 1863 to 35,000*l.*, and in 1865 was merged in the General Estimate for the Sea Defences.

Defences. The expenditure under the Loan to the 30th June, 1868, amounted to 53,443*l.* The further sum required is 5,872*l.*, and as this sum will be provided out of the Annual Votes, the charge against the Loan, exclusive of shields, will still be 53,443*l.* the estimated cost of the shields is 14,300*l.* The total cost of the work when completed will be 81,826*l.*, of which 67,743*l.* will be charged against the Loan.

Cost of Moncrieff System.

The additional cost of adapting the work to the Moncrieff system, should it be adopted, will be 6,068*l.*, and with this addition the total cost of the work would amount to 87,894*l.*

POPTON POINT BATTERY.

Design of Battery.

126. The original design for this work was similar to that at Hubberstone. During its construction, the casemates were modified for the introduction of iron shields, and the open batteries were somewhat altered in design. It now consists of a casemated battery for 11 guns, protected by iron shields, and 20 in open battery on a higher level partly over the casemates. The casemate guns are 45 feet, and the parapet of the upper battery 77 feet above high water mark. The rear is secured by a defensible barrack, connected with the battery by a wall and ditch.

Armament.

Progress.

The battery was commenced in 1859, under a contract. Between 1859 and 1864, when the battery was completed (exclusive of shields), modifications were made, as in other works, to meet the requirements of an improved system of construction. Some increased expenditure was required to meet some difficulties in obtaining a secure foundation; those difficulties were successfully overcome, and there have been no failures.

Proposed Modifications.

Since our visit in August 1868, improvements of the same character as those at Hubberstone have been designed, to adapt the work for a heavier armament, to substitute six guns on Moncrieff carriages for the seven now forming the open battery over the casemates, and to improve the magazine accommodation. Here also the value of the battery would be much increased by the adoption of the Moncrieff system.

Design of Barrack.

The barrack keep at Popton is of a different design to those at Hubberstone and at South Hook; it is in the form of an irregular hexagon, with scarps 22 feet in height, flanked by musketry from six bastionettes, the lower portion protected by a glacis. It contains accommodation for 10 officers, 260 men, and four patients, in buildings roofed with concrete supported on iron joists, not, however, capable of resisting heavy shells. Light guns may be mounted on the roof.

Report.

The barrack was begun in 1861, under a contract, and has been completed. It is well supplied with water.

The whole work has been skilfully constructed both as to permanency and stability, and, subject to the same remarks as those made with respect to the parapet at Hubberstone, possesses fair resisting power. The arrangements for the service of the guns, when the modifications proposed shall have been completed, will be satisfactory.

Estimate.

The amount expended at Popton, prior to the Loan, was 9,623*l.* In 1862, the estimate for completing it, exclusive of land, was 45,000*l.* In 1863, this estimate was increased to 56,000*l.*, and in 1865 was merged in the general estimate for the Sea Defences. The expenditure under the Loan to the 30th June, 1868, amounted to 57,937*l.*; the further sum required to complete it, exclusive of shields, is 3,399*l.*, and as this sum will be provided out of the Annual Votes, the charge against the Loan will still be 57,937*l.* The estimated cost of the shields is 14,300*l.*, and the total cost of the work when completed will be 85,259*l.*, of which 72,237*l.* will be charged against the Loan.

Cost of Moncrieff System.

The cost of adapting the battery to the Moncrieff system is estimated at 4,968*l.*, and with this addition the total cost of the work would amount to 90,227*l.*

CHAPEL BAY BATTERY.

Position.

127. Chapel Bay lies on the south side of Milford Haven, opposite to the Stack Rock, the deep water channel being between them.

The battery is designed to co-operate with the Stack Rock Fort and the South-Hook Batteries, in the defence of the lower portion of the Haven. A site has been acquired, and plans for its construction (not however finally approved), have been laid before us.

Design.

The proposed work is of a rectangular shape, enclosed on the front and flanks by a parapet, with a ditch containing a detached wall 16 feet high, and on the gorge by a wall of the same height and a ditch; in the centre of the gorge is a defensible barrack,

The amount expended prior to the Loan, out of the Annual Estimates, was 4,088*l*. The whole sum expended to the 30th June, 1868, under the Loan, was 38,851*l*. The improvements in the magazines and artillery stores will require 5,215*l*., which it is proposed to charge to the Annual Votes. The total estimated cost will then be 48,154*l*., of which 38,851*l*. will be charged to the Loan.

HUBBERSTONE AND POPTON POINT BATTERIES.

124. Hubberstone and Popton Points are opposite to each other at a distance of 1,700 yards. They are about two miles inside the Stack Rock, and about four miles from the dockyard. The edges of the deep-water channel are 400 yards from Popton and 700 from Hubberstone.

HUBBERSTONE BATTERY.

Original Design of Battery.

125. The original design for this work consisted of a casemated battery for 12 guns, firing through masonry embrasures, with 10 guns on the terreplein above, and 10 guns in an open earthen battery, secured in the rear by a defensible barrack.

The open battery for 10 guns was commenced in 1860, under a contract, and was completed and ready for armament in November 1860. Under this contract also the foundations of the casemates were commenced in accordance with the original design, but before much had been done it was decided to adopt the granite pier and iron shield construction. In October 1861, a further contract was made for the completion of the casemated battery, exclusive of shields, for the sum of 18,967*l*.

During the progress of the work some modifications were introduced into the design, the principal being the substitution, already alluded to, of iron shields for stone embrasures, the widening of the terreplein, and increasing the strength of the embrasures and traverses. In October 1863, the work was completed by the contractor, and handed over to the War Department.

Present Design and Armament.

The work now comprises a casemated battery for 11 guns, with eight guns in open battery over them, and nine guns in open battery on the left flank. The platform in the casemates is 41 feet above the sea, and the crest of the parapet in the batteries from 73 to 79 feet. The parapet of the battery over the casemates is thin, and consists of rubble masonry, affording a very inadequate protection for the guns. The expense magazines also in this battery were insufficiently protected; this defect has been to a certain extent remedied by increasing the protection by 2½ feet additional of brickwork.

Proposed Modifications.

Since our visit in August, designs have been approved for alterations for the magazines, and plans have been laid before us for the substitution of eight guns mounted on Moncrieff carriages, for the eight guns now on the terreplein over the casemates. Arrangements have also been made for providing additional artillery stores and side-arm accommodation. The adoption of the Moncrieff system will give some additional strength to the weak part of the parapet, noticed above, and will add greatly to the value of the battery.

Design of Barrack.

The barrack, which is of similar construction to that at South Hook, was commenced in November 1861, under a contract. Several alterations were made during the progress of the work; and it was completed in March 1865. The principal alterations were the substitution of bomb-proof for splinter-proof buildings in the Keep, and the addition of a story in the gorge buildings.

Improvement recommended.

The work is well and skilfully constructed, except that the protection given by the west ditch, and wall connecting the battery and barrack, appears at one point to be disproportioned to the strength of the rest of the work, as the ditch is there but 4 feet below the level of the ground outside, and the escarp wall is only 10 feet in height. There is also a point on the east ditch to which the same remark applies, and we recommend that a cut should be made in both ditches in such a manner as to make a 25 feet ladder necessary to reach the top of the escarp. The cost of this alteration would be defrayed out of the Annual Estimates, and the amount is included in the estimate of the total cost of the work when completed.

The arrangements for the supply of ammunition and for the service of the guns are good.

Estimate.

The amount expended on this work prior to the Loan was 8,211*l*. In 1862, the estimate for completing it, exclusive of shields, was 35,000*l*. In 1863, this estimate was increased to 55,000*l*., and in 1865, it was merged in the General Estimate for the Sea

containing accommodation for 3 officers, 2 non-commissioned officers, and 60 men, besides the necessary offices, and the main magazine. The whole enceinte is flanked by musketry caponnières, and the barrack has independent flank defence of the same nature. The front parapet will contain emplacements for six 9-inch guns, mounted *en barbette*, at a height of 122 feet above the sea, with suitable expense magazines for shell and cartridge. Armament.

The design is well calculated to meet the requirements of the position; the arrangements for the guns are good; and there is a sufficient provision of magazine and artillery store accommodation. The defensive power of the work is sufficient to enable it to afford an adequate resistance to such attacks as it is likely to be subject to. Report.

The estimate for the battery at Chapel Bay in 1862, was 10,000*l.*, and it remained at this amount till it was merged in the general estimate for the Sea Defences in 1865. The estimated cost of the work submitted to us is 13,754*l.* Estimate.

Summary.—Sea Defences.

128. In 1862, the total estimate for the Sea Defences, in addition to the amount already expended out of the Annual Votes, was 180,000*l.* exclusive of land. In 1863, this estimate was increased to 216,000*l.*, and in 1867 to 225,000*l.*, with 40,000*l.* additional for the cost of the iron shields for the Stack Rock, Hubberstone, and Popton Point. The total cost of these works, exclusive of shields, is now estimated at 276,433*l.*, including 29,533*l.* expended prior to the Loan. The cost of the iron shields is estimated at 49,400*l.*, and the total cost of the works, complete, at 325,833*l.*; the charge against the Loan will be 232,414*l.* for works, and 49,400*l.* for shields, or 281,814*l.* against the 265,000*l.* estimated in 1867.

The cost would be increased by 11,036*l.* should the Moncrieff system be adopted.

LAND DEFENCES.

Fort Scoveston.

129. Of the six small works recommended by the Defence Commission for the protection of the Dockyard and Haven against an enemy approaching from the northward, Scoveston Fort, occupying an advanced position in the centre of the line, has alone been constructed. Design.

It is a hexagonal work, with sides of about 130 yards. The ditch is 36 feet 6 inches wide at bottom, the escarp, which is 22 feet high, being faced with masonry, and the counterscarp cut in the natural rock; it is flanked by one double and four single caponnières, each having four embrasures and eight loopholes. The work is enclosed by a rampart with chemin des rondes, covered way, and glacis. The ramparts, which are well traversed, afford space for mounting 32 guns. The rear faces are protected by a parados from reverse fire, and a traverse is thrown across the interior parade for the same purpose. There is a sufficient provision of magazine and store accommodation, and bombproof casemates for 128 men. Armament.

The work is well and skilfully constructed, and though isolated is capable of offering considerable resistance to any attack to which it may be subjected. There have been no failures, and it is in a secure and stable condition. Report.

It was commenced on the 20th August, 1861, and continued under two successive contracts, in November 1862 and April 1864. Progress.

In 1862, the estimate for Fort Scoveston was 76,000*l.* In 1863, a reduction was made in the work, by omitting part of the barracks and the revetment walls, where they could safely be dispensed with. The estimate was thus reduced to 50,000*l.*, and it has remained at that amount in subsequent schedules. The expenditure to the 30th June, 1868, amounted to 40,610*l.*; the further sum required is estimated at 4,852*l.*, and the total cost of the work, when completed, at 45,462*l.* Estimate.

Positions recommended by Defence Commission.

130. The points recommended by the Defence Commission to be occupied by works to oppose the landing of a hostile force were Tenby, Caldy Island, Lydstep, Freshwater East and Freshwater West, and the cost of the works was estimated at 100,000*l.*

Positions finally taken up.

The points finally selected are somewhat different from those recommended by the Commissioners. St. Catherine's Island for Tenby; Proud Giltar for Lydstep Haven and Caldy Sound; East Moor to command the Manorbeer and Swanslake Bays; a work on Trewent Point on the southern side of Freshwater East to guard that landing place; and a work near the centre of Freshwater West Bay.

St. Catherine's Island.

Armament.

Report.

Of this group the only work yet commenced is that on St. Catherine's Island, Tenby; it was begun in January 1868, under a contract, and is designed for six guns in casemates, with small iron shields, and five *en barbette* above them.

The work is well and skilfully designed both for ensuring stability and permanency, and for defending the approaches to Tenby. There have been no failures, and the work, as far as it has gone, is well built. The arrangements for the service of the guns are good and the supply of ammunition well provided for.

Upon the approved plan it is noted that it is under consideration whether the Moncrieff system should be substituted for the guns *en barbette*.

Proud Giltar and Trewent.

Plans for the works at Proud Giltar for six guns, and at Trewent Point for seven guns, have also been laid before us, but nothing has yet been done beyond purchasing the sites; the designs appear to be well suited to their object and to be economically framed.

Eastmoor and Freshwater.

No plans have yet been prepared for Eastmoor or Freshwater West; but we are informed that it is intended to construct works at these places which shall not exceed 8,000*l.* each in cost.

Estimate.

In 1862, the cost of this group of works was estimated at 80,000*l.* In 1867, this estimate was reduced to 50,000*l.* The only expenditure incurred has been at St. Catherine's, amounting, on June 30th, 1868, to 1,926*l.*; the estimated cost of the work when completed is 12,660*l.*, and 3,600*l.* will be required for shields. The estimate for Proud Giltar is 6,668*l.*, and 1,200*l.* for shields; and for Trewent Point, 8,718*l.*, with also 1,200*l.* for shields. For each of the works at Eastmoor and Freshwater West, 8,000*l.* have been taken. The total cost of the works would then be 44,046*l.*, and, completed with shields, 50,046*l.* We see no reason to doubt that for this sum the contemplated works may be constructed.

GENERAL SUMMARY.

131. The cost of the works recommended by the Defence Commissioners for the protection of Pembroke was estimated by them at 600,000*l.*, including the purchase of land, estimated at 150,000*l.*, and in addition to 165,000*l.* for works then sanctioned for the Sea Defences.

In 1860, the Government, by omitting the enceinte on the south side of the haven, and all the works on the north side except Fort Scoveston, reduced this estimate to 220,000*l.*, in addition to the 165,000*l.* for works already sanctioned—making a total of 385,000*l.* for the defence of Pembroke, including the purchase of land.

The amount expended out of the Annual Votes prior to the Loan was 29,533*l.*; the cost of land purchased amounted to 21,365*l.*

In 1862, when the cost of the land and of the works was separated, the estimates for the works under the Loan amounted in the aggregate to 336,000*l.*, and with the cost of the land to 355,735*l.*

In 1867 the estimate for the works themselves was reduced to 325,000*l.*, but 40,000*l.* was added for iron shields, making together 365,000*l.*, and with the land 386,365*l.*

The amount required from the Loan for the whole of these works when completed, is now estimated at 321,922*l.*, with 55,400*l.* for shields, making together 377,322*l.*, and with the land and previous expenditure on the annual votes 442,706*l.* The excess on

the Estimate of 1867 of 12,332*l.* is due to the increased cost of the iron shields. The necessity for that increase we have already alluded to.

The total cost of the works, including the previous and proposed future expenditure out of the Annual Votes, will amount to 421,341*l.*, or if the Moncrieff system should be adopted, to 432,377*l.*

The account will then stand thus :—

	£
Expenditure on land	21,365
„ under the Loan	377,322
„ „ Annual Votes	44,019
Total	£442,706
Estimate of Defence Commissioners ..	765,000
Saving	£322,294

Remarks.

132. The diminution of expenditure for the protection of Pembroke, as at Plymouth, is due to the omission of a large portion of the scheme recommended by the Commissioners for the Land Defences. Fort Scoveston alone, occupying the salient point on the north side of the haven having, as we have said, been sanctioned by the Government, who, having carefully provided for the Sea Defences, considered the completion of the Land Defences of less importance, and deferred it.

Fort Scoveston possesses considerable powers of resistance, and would afford a very powerful support to a body of troops acting on the defensive against a force attempting to advance from the northward to gain possession of the dockyard; but as previously observed, being alone it does not afford that complete defence which the Commissioners contemplated by the construction of a chain of works enclosing the dockyard on both sides of the haven.

Whether the remote contingency of such an attack should be provided against is a question of general policy, and we only allude to it as incidentally bearing on the resisting power of the works on which we are called to report. As regards the Sea Defences constructed under the Loan, we are of opinion that, combined with floating barriers, as recommended by the Defence Commission, and with submarine defences, they will afford a very perfect protection to the dockyards against an attack by purely naval means.

PORTLAND.

GENERAL REPORT.

Works designed in 1857.

133. The works at Portland were designed in 1857, and approved by Her Majesty in November of that year.

In the beginning of 1860 the Royal Commission reported that those works, when completed, would be very powerful, and that they would suffice to render the harbour quite secure against attack.

Recommendations of Royal Commission.

The works enumerated by them were: the Verne Citadel, supporting earthen batteries on its eastern, western, and northern sides; a small battery on the inner pier-head of the southern entrance of the harbour; a large casemated work on the extremity of the breakwater; two open batteries on Dirdale Point and Blacknor Point respectively, about 2,000 yards to the southward of the Verne; and lastly, heavy batteries, chiefly earthen, on the Nothe at the entrance of Weymouth Harbour. They also recommended the purchase of a belt of land, estimated to cost 100,000*l.*, as a measure of precaution to secure possession of the high ground from the Nothe Point, by Wyke Regis, to the East Fleet, which they considered an admirable position for the defence of the harbour against bombardment by an enemy landed in the country. The purchase of this land has not, however, been sanctioned; with the exception of the batteries to the north and west of the citadel, and the two small batteries to the southward, works are in course of construction on the sites selected.

Works now in progress.

Should the batteries to the north and west of the Verne Citadel be permanently given up, the protection of the roadstead from the fire of ships in West Bay would not be provided for.

We now proceed to describe the various works.

The Verne Citadel and the East Weir Batteries are grouped together in the schedule, and may be considered as forming one position.

VERNE CITADEL.

General Description.

134. The extensive works of the citadel have been constructed partly by contract, partly by free labour, under the superintendence of the Royal Engineer Department, and partly by convict labour; they are now carried on exclusively by convict labour.

The ditches, which are of great width and depth, were formed by excavating the stone required for the formation of the breakwater under an agreement with the Admiralty.

Report.

The work is of great strength, and well and skilfully constructed, and with the natural advantages of its position would undoubtedly resist any attack that could be made upon it. The barracks are most commodious, and afford, on a peace establishment, accommodation for 18 officers, 484 men, and 30 hospital patients.

It is not necessary to notice the various alterations that have been made during the progress of the work. The outlay has been large, and considering the natural strength of the position, and the depth and width of the ditches, perhaps a greater expense than necessary has been incurred in the flank defences. Some heavy work remains to be done in the formation of the glacis on the south-east and south-west fronts, and it is worth considering whether the amount of it may not be diminished without affecting the strength of the fortress.

The Citadel provides accommodation for the gun detachments required to man the East Weir Batteries, and access to those batteries will be given by a tunnel from the south-east angle of the work opening on the heads of the roads leading to them. Looking at their distance from the barracks, and the number of men required to man the batteries, it may be doubted whether on an emergency a single communication at this one point would admit of their being manned with sufficient quickness, and it would seem desirable to arrange for another communication from the main entrance which, we are informed, may easily be made, and at slight expense.

mmunications with tteries.

THE EAST WEIR BATTERIES.

Position. 135. At the time of the Report of the Defence Commission some batteries had already been constructed on the eastern side of the Verne Hill, but these were of little value, and are being replaced by more powerful works.

Armament. The position is now occupied by six batteries, which will mount in all 27 guns at heights varying from 150 to 234 feet above the sea; they are open earthen batteries with embrasures, and it is intended to apply Captain Moncrieff's system to the flank guns of each battery.

Drainage. Some trouble was experienced in obtaining secure foundations, and it was found necessary to drain considerable portions of the slope of the hill. This drainage has been effectual as far as it has gone, and even the extraordinary amount of rain which fell in December 1868 produced no bad effect. A portion of the slope on which No. 1 Battery will be placed, which has not been drained, has shown signs of movement, and will require drainage; if done by convict labour the cost will add but little to the estimated amount required for the battery.

Progress. The four batteries on the right are most advanced towards completion. No. 1 and No. 6 on the left were not begun at the time of our visit.

Report. The batteries are well designed and, as far as they have gone, well executed both as regards permanency and stability, and their power offensive and defensive against an enemy. They contain no barrack accommodation except what in time of war might be derived from the occupation of the Provost Establishment in their rear.

The arrangements for the service of the guns are good.

Estimate. 136. In 1862 the cost of the completion of the Verne Citadel and the batteries connected with it was estimated at 127,000*l.* In 1864 this estimate was reduced to 120,000*l.*, and again increased in 1867 to 125,000*l.*

The expenditure to the 30th June, 1868, amounted to 121,515*l.*; and the sums required to complete them amounted to 13,721*l.* for the citadel, and 4,138*l.* for the batteries; of the sum required for the citadel, 3,248*l.* is to be charged to the Annual Estimates, leaving the total cost under the Loan 136,126*l.*

In addition to the charge against the Loan, 76,293*l.* had been expended on these works at Portland out of the Annual Votes prior to the Grant, making the total cost of the Verne Fortress 215,667*l.*

PORTLAND BREAKWATER.

INNER PIER-HEAD FORT.

Present Armament. 137. This work, for four 68-pr. and four 8-inch guns, was designed in 1859, constructed under the Admiralty superintendence, and handed over to the War Department about 1862. There were some slight settlements, but no failure of importance.

Revision Needed. The fort is armed, but, from its construction being entirely in masonry with the guns pointing through embrasures, it is not calculated to be of much use against iron-clad ships, and the magazine arrangements are defective. A re-arrangement and improvement of the whole work would be necessary to fit it to receive the heavier armament required to give that valuable support to the defence which its position is well calculated to afford.

No plans or estimates for re-modelling it have been prepared, and should it hereafter be done the cost would probably be defrayed out of the Annual Votes, and no additional charge would be thrown upon the Loan.

Cost. The sum expended out of the Loan amounts to 2,280*l.* There had been expended out of Annual Votes 8,395*l.*, making the total cost of the work 10,675*l.*

PORTLAND BREAKWATER FORT.

Foundations. 138. The foundations for this work have been laid by Mr. Coode, C.E., for the Admiralty, upon a mass of *pierre perdue*, carefully brought up in layers from the clay bottom, which is about 58 feet below low water mark, to within 20 feet of that level. A ring of masonry, 200 feet in external diameter, and averaging 11 feet in thickness, with radial piers 27 feet in length, is built from 27 feet below to 12 feet above high water mark.

PORTLAND.

Transfer to War Department.

Description in Mr. Coode's Evidence.

Settlements.

In May last, the work having been brought up to this height, was transferred to the War Department. A description of the mode in which the foundations were laid, will be found in Mr. Coode's Evidence (No. 2,377 *et seq.*). It is sufficient here to say that great care was taken to distribute the material equally with a suitable mixture of large and small stones and refuse from the quarries.

The general settlement but little exceeded that expected by Mr. Coode, whose calculations were based on his experience in constructing the inner heads of the Breakwater. This settlement appears to be still going on, though to a much less degree than formerly.

There has been some doubt as to the accuracy of the bench marks, by which the amount of subsidence has been ascertained, but there seems reason to believe that the amount stated is, for all practical purposes, sufficiently correct.

In October 1864 a more serious settlement, because an unequal one, occurred, during and after a heavy gale. It extended for nearly half the circumference of the circle on the northern and inner side, and at the lowest point, amounted to about 2 feet 3 inches.

Borings.

Before commencing the foundations, borings had been made on each quarter, and though attended with great trouble, from the depth of the water (58 feet at low water) and the exposed situation, they were carried from 8 to 12 feet into the ground. The upper part bored through was the dark blue Kimmeridge clay of the locality, becoming tougher as it went down; underneath this was marl, through which no progress could be made.

When this settlement took place it was attributed to the yielding of the clay or the strata below, since the piles carrying the staging, driven 7 or 8 feet into the ground, went down with the masonry.

Measures adopted.

To meet this settlement, and to guard against a recurrence of it, materials to the amount of near 15,000 tons were added all round the foundations, but chiefly opposite where the settlement had taken place. The upper courses of masonry were taken down, a compensation course added, the levels adjusted, and the cracks that had opened in the masonry in various places filled up. Since these measures were adopted the settlement has been nearly uniform; the depression in 1868, between May and November, varying only from $\frac{6}{10}$ths of an inch to little more than an inch.

After the transfer to the War Department it was resolved to prepare for the reception of the superstructure, by taking out the hearting of loose material and substituting a bed of concrete 10 feet thick, filling up the whole centre of the circle.

Designs for Completion.

Alternative designs have been placed before us—one for an iron fort, with two tiers of casemates, to mount 14 guns in the lower tier and 15 in the upper, or 29 in all.

The second project is for a single tier iron fort, mounting 14 guns.

The third project is for a work comprising four turrets, each for two guns of the heaviest calibre.

Estimate.

The expenditure to the 30th June, 1868, when the masonry ring had been brought up to 12 feet above high water mark amounted to 75,968*l.*; the cost of completing the work on each of the three plans, and the pressure on the foundations are thus estimated.

	Total Cost, including Foundations.	Average Pressure per superficial foot on upper surface of *pierre perdue* foundation.
	£	Tons.
Two-tiered Fort, 29 Guns	273,658	1·84
One-tiered Fort, 14 Guns	199,213	1·59
4 Turrets, 8 Guns	229,846	1·96

It appears that the consolidation of the *pierre perdue* is now nearly come to an end, and that such further subsidence as may occur will be chiefly due to the compression of the underlying strata.

Report.

It is possible that a further subsidence may take place, but as the weight to be added according to either of the improved plans will fall well within the base, we are of opinion that, if care be taken in construction to carry the work up so that it shall produce no unequal pressure on its circumference, there is every prospect that the fort may be completed with safety on either plan. As the proper action of the turrets, however, depends upon machinery, which may be expected to be easily impeded by an alteration in levels,

It would appear that apart from other considerations, the turret plan, from its liability to get out of working order, is the least eligible of the three.

Postponement of Work.

We think it, however, judicious to postpone the decision as to the precise nature of the superstructure, until the completion of the concrete bed, and the experience which the period of its construction will afford, have thrown additional light on the subject.

Estimate.

In the Schedule of 1862 the cost of the completion of the Breakwater Batteries was estimated at 145,000*l.*, at which amount they remained in all subsequent schedules, until grouped in 1867 with the Nothe Fort. The expenditure to the 30th June, 1868, amounted to 75,968*l.*, the amount required to complete the work on the most expensive plan (a two-tiered iron fort) would be 197,690*l.*, and the total cost under the Loan 273,658*l.*; to this must be added 3,445*l.* expended out of Annual Votes—making the whole cost 277,103*l.* If the cheaper plan of the one-tiered fort were adopted, this amount would be reduced to 202,658*l.*, of which 199,213*l.* would be charged to the Loan.

The Nothe Fort.

Original Design.

139. This work was originally intended to comprise a casemated battery and open earthen batteries. The earthen batteries have been given up, and it is now a casemated granite fort, designed for 10 heavy guns, protected by iron shields, and two light guns looking into Weymouth Harbour.

Armament.

Progress.

The foundations were begun about the end of 1860; the land was drained and a sea wall built. These works were executed on a contract which, after some discussion, was closed at the desire of the contractors in 1862; much of their plant and materials were taken by the War Office, and the erection of the fort has since been continued by military labour; this arrangement has been attended with a considerable saving, and the result has been satisfactory.

Report.

The only failure that has occurred was in the sea wall built by contract in 1860-1, which in 1867, after heavy rains, showed signs of weakness; this weakness was traced to defective work and the use of improper material by the contractor; it was remedied at the cost of 110*l.*

The upper part of the fort is now completed with an earthen parapet, but the terre-plein is unfitted to carry an armament of heavy guns. We are informed that there is at present no intention of adapting it for such an armament, and no money for such a purpose is included in the estimate for completion.

The protection afforded for the powder and shell recesses in this fort, as at present constructed, is inadequate; a design has been prepared for increasing it to the necessary extent, and the cost is included in the Estimates.

The work is well and skilfully constructed as regards permanency and stability, and, when completed as recommended, will possess considerable powers of resistance.

Modifications.

Since our visit modifications have been proposed to remedy the defects of the magazine accommodation, and as now designed the service of the guns will be well provided for. The cost of these alterations is estimated at 2,142*l.*

Estimate.

The expenditure on this work, to the 30th June, was 86,872*l.* The amount required to complete is 6,408*l.*, making a total of 93,280*l.*, of which 89,504*l.* will be charged to the Loan, and 3,776*l.* provided out of the Annual Estimates. The estimated cost of the shields is 13,000*l.*, bringing up the whole cost of the work, when completed, to 106,280*l.* In addition to this, there had been expended out of the Annual Estimates 10,769*l.* prior to the grant of the Loan, making a total cost of 117,049*l.*, of which 102,504*l.* will be charged to the Loan.

Summary.

140. In 1862, the cost of the Nothe Fort was estimated at 80,000*l.* In 1864 this estimate was increased to 87,000*l.*; at the same time the cost of the Breakwater Fort was estimated at 145,000*l.*; amounting together to 235,000*l.* In 1867 this estimate was increased to 295,000*l.*, with 21,000*l.* for shields. The cost of the works under the Loan, when completed, is now estimated at 365,442*l.*, and of the shields 13,000*l.*, making a total charge of 378,442*l.*, and the whole cost of the works, including previous expenditure, 404,827*l.*

141. The Defence Commissioners estimated that 630,000*l.* would be required to complete the protection of the anchorage at Portland,—viz., 380,000*l.* for the works in progress; 150,000*l.* for the works at Dirdale Point and Blacknor, including their sites, and for the batteries outside the Verne; and 100,000*l.* for the purchase of a belt of land at Wyke Regis. Neither the purchase of the land nor the works at Dirdale Point and Blacknor were sanctioned by the Government, and in 1860 (Parly. Paper No. 449) no addition was made to the works already sanctioned.

The amount paid for land was 39,332*l.*

In the Schedule of 1862 the amount required from the Loan to complete the works sanctioned, exclusive of land, was estimated in the aggregate at 352,000*l.* In 1865, this estimate was increased to 420,000*l.*, with 21,000*l.* for iron shields, making together 441,000*l.* The cost to the Loan of the works when completed is now estimated at 501,568*l.*, with 13,000*l.* for shields, or together 514,568*l.*

This estimate is founded on the supposition that the most expensive plan for the Breakwater work would be adopted. This sum would be reduced, if the turret plan were adopted, to 470,756*l.*, and if the one-tiered iron fort were adopted to 440,123*l.*

The expenditure prior to the Loan has amounted to 98,902*l.*, and it is proposed to charge 7,024*l.* of the future expenditure to the Annual Votes. With these additions the total cost of the works will amount to 620,494*l.*, and with the land to 659,826*l.*

THAMES.

Important interests at stake.

142. THE Defence Commissioners considered the efficient defence of the Thames an object of the most vital importance, as involving "interests of vast magnitude; including "the security of the great powder magazine establishment at Purfleet, the important "Arsenal, at Woolwich; the large amount of valuable property extending for many "miles on either bank of the river; the fleet of merchant shipping moored in the port "of London; and lastly, the Metropolis itself."

Recommendations of Defence Commissioners.

They recommended—1st. That the entrance of the river should be guarded by moveable floating batteries stationed at Sheerness. 2nd. That the batteries which then existed at Coalhouse Point and at Shornmead, for 17 and 13 guns respectively,—being at that part of the river which is best adapted for preventing, by means of permanent works, the advance of a hostile fleet,—should be enlarged; that a new work should be constructed at the southern point of the entrance to Cliffe Creek; and that a floating barrier should be moored across the river in time of war, under the protection of these batteries. 3rd. That the works at Tilbury and Gravesend should be placed in a thoroughly efficient state in every respect as a second line; and that a second floating barrier should be prepared to be moored between them. 4th. They further recommended, in reference to the defence of Chatham, the construction of a self-defensible work on the rising ground near the village of Slough, considering that in the event of attack this work and the inundation of the marshes between it and Cliffe Creek would prevent the possibility of a landing, and thus the Dockyard would be protected from attack from the north.

New Works proposed.

As this latter work would also co-operate in the defence of the Thames, it was included in their Schedule with the other new works already alluded to, as follows:—

Coalhouse Point..	30 guns;	barrack accommodation,	300 men.
Cliffe Creek ..	30 „	„	„	300 „
Shornmead ..	30 „	„	„	300 „
Slough	20 „	„	„	200 „

Estimated expense, 180,000*l.*

Recommendations adopted.

These recommendations were adopted by the Government; and works were designed to occupy the positions indicated, and the works at Tilbury and Gravesend are now being re-modelled and adapted for a modern armament, the cost of the alterations being defrayed entirely from Annual Votes.

Position.

Coalhouse, Cliffe, and Shornmead form a triangle, whose sides are respectively 1,500, 2,500, and 2,000 yards. Coalhouse is 4,500 yards from Tilbury Fort, and Shornmead 4,250 from New Tavern Fort, Gravesend.

COALHOUSE FORT.

Old works.

143. The site of this fort was occupied by a work built in 1795, and demolished in 1854-5, when an earthen battery for 17 guns, with barracks, &c., was constructed in its place.

Site.

The subsoil consists of clay, peat, and silt, forming a very unstable foundation, which appears to have been a constant source of difficulty.

Original design of new work.

The original plan for the new work, dated 23rd November, 1860, comprised 28 guns in casemates, to fire through iron shields, and 28 guns *en barbette* on the roof, with a main magazine in rear, four expense magazines, and four shell-filling rooms detached in rear of the casemates. The embrasures were to have been protected with iron shields 1 foot thick, but no details had been decided upon. The whole enceinte was to be flanked with musketry caponnières. Foundations of concrete, 6 feet in depth, extended under all the buildings.

Construction of foundations.

In 1861, the old fort was demolished, with the exception of some of the interior buildings, and a contract was entered into for laying the foundations for the battery, magazine, and gorge buildings. The foundations for the battery were to have been 52 feet in width, and 8 feet in depth, of concrete encased in piles 30 feet long; but before the excavation was completed, it was decided to carry the concrete down to the level of mean low water of spring tides, making it 15 feet in thickness. These foundations were commenced in July 1861, and finished in August 1862, at a cost of 29,000*l.*, the extra cost of the additional concrete being 8,250*l.*

Basement.

A contract was then entered into for the construction of the basement which was commenced in July 1863, and completed in November 1865, some delay having ensued from the failure of the contractor, and the transfer of the contract to other parties.

Crack and settlement.

In that month a crack appeared in casemate No. 19, extending through the whole of the front wall, and partially through the rear wall; this crack is near to, and in the same direction as a crack which appeared in 1857, in the officers' quarters of the old work. Since then the crack has not materially increased, and no further settlement has taken place elsewhere. The unequal settlement to which this crack is due may, we think, in great measure be attributed to the varying nature of the ground upon which the work is placed, caused by the construction of the forts which formerly existed at this place, and by the greater portion of the weight being massed towards the outer edge of the concrete.

Design in 1867.

144. In 1867 the design was changed, and it was decided to complete the battery for 28 guns, to be mounted in an iron casemated superstructure semi-elliptical in section, strongly plated in front, and covered with concrete resting on buckled iron plates, and a contract was entered into in November of that year for altering the basement to adapt it for magazines according to the latest improvements; for completing the casemates, excepting iron; and for the construction of the gorge buildings. This work was commenced in January 1868, and is in progress at the present time.

Alternative plans now proposed.

This semi-elliptical superstructure has since been abandoned, and a design has been prepared for the construction of casemates of a form somewhat similar to that adopted for the Plymouth Breakwater Fort. According to this design, which is called A

Plan A.

to distinguish it from two alternative designs B and C, which have likewise been laid before us, the fort will still mount 28 guns; the gorge buildings are being proceeded with, but no steps have yet been taken with reference to the iron work.

The alternative Plans B and C have been designed with a view to a partial adaptation of the work to Captain Moncrieff's system.

Plan B.

According to Plan B, 12 guns will be mounted at one end of the battery looking down the river, in casemates precisely of the same construction as those in Plan A, above referred to, and 8 guns at the other end of the battery in gun-pits, firing over a parapet of concrete, faced with massive granite; the gun casemates at the one end and the crest of the parapet of the gun-pits at the other, will have the same relief, but between each gun-pit a traverse will be raised 5 feet above the general level, to protect the guns from flank fire, to which they would otherwise be exposed.

Plan C.

According to Plan C, the battery will consist of only 14 guns, mounted alternately in casemates and on Moncrieff carriages, the casemates forming, as it were, a traverse between each gun-pit; these casemates will be faced with granite, and the guns in them protected by iron shields.

Flanks.

The front of the battery in each case will be flanked by musketry caponnières covered by the glacis, which also protects the basement of the battery. The gorge buildings which complete the enceinte mutually flank each other.

Report.

As regards stability and permanence we are of opinion that if the precautions hereafter referred to in the report on Shornmead are carefully attended to, although some further subsidence may be expected before the completion of the work, it is probable that it will not be of such a nature as to cause any apprehension for the safety of the structure if completed according to either of the plans which have been laid before us, but that Plan C is the least advantageous of the three. The arrangements for the service of the guns are in each case satisfactory. To make the original foundations available for the gorge buildings a trace has been adopted, which although capable of offering a solid resistance against a *coup de main* is not such as would otherwise have been desirable.

Estimates.

In the Schedule of 1862 the cost of this fort was estimated at 90,000*l.*, at which it remained in each successive schedule until 1867, when it was increased to 164,000*l.*, including 54,000*l.* for the iron superstructure. The amount expended to the 30th June, 1868, was 52,512*l.*, and the further amount required to complete on Design A is 158,551*l.*, making the total estimated cost 211,063*l.* If Moncrieff's system be partially adopted according to Plan B, the estimated cost will be reduced to 163,179*l.*, and if Plan C be adopted it will be still further reduced to 142,197*l.*

CLIFFE FORT.

Site.

145. This is an entirely new work. Borings were made on the site in August 1860, to a depth of 43 feet from the surface of the marsh, showing that the substrata consisted

of sand, clay, and peat. Plans were completed in November 1860 for a battery, comprising 20 guns, in granite casemates, with iron shields; 13 guns on the terreplein above, also protected by iron shields; 3 guns *en barbette*; and 2 for land defence, firing through masonry embrasures. The front, which forms a quadrant, was to have been flanked by two musketry caponnières, and the gorge buildings formed two bastioned fronts. A main magazine, four shell-filling rooms, and four expense magazines were provided within the work. All these buildings were to rest on a cake of concrete, 7 feet in thickness. Original design.

In May 1861, a further examination of the soil was made, when at a depth of 35 feet, an iron bar was thrust down a further distance of 17 feet in 15 minutes, without meeting any solid resistance, thus confirming the result of the borings of 1860. In 1863, a well was sunk to a depth of 340 feet, the water being good and abundant; gravel was found at a depth of 60 feet, and the chalk was entered at a depth of 79 feet.

In July 1861, a contract was made for laying in the concrete foundation, designed with reference to the projected work described above; it was to have been 35 feet in width, and 8 feet in depth, encased with piles 30 feet long; but while the excavation was going on, it was determined to increase the thickness of this bed of concrete, as at Coalhouse, to 14 feet. These foundations were completed in November 1862. Foundation.

The contract for the basement of the battery of this fort was carried out in a similar way to that at Coalhouse, and was completed in November 1865. Basement.

146. The first report of any settlement in this work was in August 1865, when the Commanding Royal Engineer stated that the front of the basement had sunk 3 inches more than the rear face, but without any crack or fissure showing itself. In October 1865, after some heavy rains, cracks were observed in the middle of the basement, extending through the front and rear walls, and in the concrete foundations of the gorge. These cracks increased in size until November 1865, but no additional cracks have since appeared, and the existing cracks have only increased very slightly. The concrete bed on which the basement of the battery rests has subsided unequally, and at the date of our visit the levels, referred to a datum point at the right rear angle showed the following depressions:—On the right, at the front angle, 5½ inches; at the centre, in rear, 7½ inches; in front, 13 inches; on the left, in rear, 6½ inches; in front, 8 inches. That portion of the foundation which is to support the battery is separated by several large cracks from that intended to support the gorge buildings. Subsidence and cracks. Present condition.

It appears probable that these cracks have been caused by unequal subsidence, arising from the building being placed too near the outer margin of the concrete foundation. Cause of crack

There are 31,400 cubic yards of concrete in the foundations, weighing 45,500 tons, and covering an area of 60,000 square feet, thus producing a pressure of ·75 tons per square foot on the soil, at a depth of 15 feet 8 inches below the natural surface. The pressure of the earth which has been removed would have amounted to ·69 tons at this depth, so that the excess of pressure caused by the cake of concrete alone is trifling, being but ·06 tons per square foot. The basement weighs 12,200 tons, and the area of the concrete which supports it is 28,560 square feet. An additional weight of ·42 tons per square foot is therefore sustained by this portion, and it is to the unequal distribution of this weight, producing an unequal compression on the peat, or some other yielding stratum below, that the inequality in the subsidence must be attributed. Pressure on foundation.

147. As at Coalhouse, the battery for this work was intended to have been casemated with a semi-elliptical iron superstructure, but this has been abandoned, and three designs, A, B, C, for completing the work, analogous to those designed for Coalhouse, have been laid before us. The first, A, is for 20 guns in iron casemates; the second, B, for 7 guns in iron casemates, and 6 guns on Moncrieff carriages; and the third, C, for 10 guns alternately in granite casemates, with iron shields, and on Moncrieff carriages. Alternative plans now proposed.

The weights of the proposed superstructures, and the total pressure per foot superficial which they will bring upon the stratum, upon which the concrete foundations rest, are as follows:— Pressure on foundations.

		Tons.	Tons.
A plan	20 casemates	12,756	1·59
B plan	7 „	5,644	1·59
	6 Moncrieff gun-pits	10,677	1·80
C plan	5 casemates	23,197	1·93
	5 Moncrieff gun-pits		

THAMES.

Report.

As regards permanence and stability, we are of the same opinion as expressed with regard to Coalhouse, and that either mode of construction may be adopted, subject to precautions hereafter to be referred to, and we would recommend that the centres of the arch of No. 12 casemate should not be removed until the whole structure is completed. Plan C in this case also is the least advantageous structure of the three designs. The arrangements for the service of the guns are satisfactory.

Estimate.

In the Schedule of 1862, the total cost of this fort was estimated at 80,000*l.*, to which amount it remained in all successive Acts till 1867, when it was increased to 121,000*l.* The expenditure to the 30th June, 1868, was 39,440*l.*; a further sum of 123,497*l.* is required to complete it, making the total estimated cost of the work, completed entirely with casemates according to Design A, 162,937*l.* If Design B be adopted, the cost will be 124,815*l.*; and if Design C be adopted, it will be still further reduced to 114,191*l.*

SHORNMEAD.

Old works.

148. In 1795 a 4-gun battery was constructed at Shornmead, which was demolished in 1847 and replaced by a 13-gun battery with a defensible gorge; but in 1848, before this latter work was completed, extensive subsidences, cracks, and slips took place, to repair which various fruitless efforts were made, and continued at intervals until 1861, when it was demolished, and the excavations for the present work were commenced.

Original design.

The original design for the new work, dated 23rd November, 1860, comprised a range of 20 gun casemates with iron shields, 14 guns on the roof, behind a masonry parapet, also with iron shields, and 2 pivot guns, making 36 guns in all. A main magazine, four expense powder magazines, and four shell-filling rooms were provided in rear, besides additional barrack accommodation beyond that already in existence in the gorge building. The enceinte was to be flanked by musketry.

Borings.

Preliminary borings were made in May 1861, indicating strata of soft clay and peat to a depth of 25 feet. An iron rod was put down to a further depth of 15 feet without reaching any solid ground. Records of subsequent borings show that beyond this there are about 40 feet of sand and gravel, and chalk was found at a depth of 76 feet from the surface.

Foundations.

In 1861 a contract was entered into for laying in concrete foundations under the proposed buildings, 8 feet in depth, encased in piles 30 feet long. During the excavations the earth in the bottom of the trench showed a tendency to rise in the middle, and a considerable upheaval was caused by the proximity of a heap of ballast pressing on the natural surface with a weight of ·35 tons per foot superficial; the trench at this time was 7 feet in depth, and was encased on each side with 30-foot piles; the nearest edge of the ballast heap was 19 feet from the side of the trench. It was then decided to increase the depth to the level of mean low water of spring tides, making the thickness of the concrete foundation 14 feet 6 inches. These foundations were completed in November 1862. The bed of concrete thus laid in measured 20,800 cubic yards, and weighed 30,000 tons, pressing on each square foot of the bottom of the trench with a weight of ·75 of a ton, or ·06 of a ton more than before the excavations were made.

Subsidence.

Eight months afterwards, in April 1863, before the basement was commenced, a subsidence of 3 inches was observed in the upper surface of the concrete, and was attributed to shrinkage in the concrete, which, in consequence of the difficulty experienced in keeping the trench open, had been thrown in as fast as possible.

Basement.

149. The Commanding Royal Engineer recommended that the construction of this fort should be delayed to the last of the Thames forts on account of its foundation not being so good as that of the others. A contract was, however, entered into in May 1863, for the construction of the basement at this as well as the other forts. The first contractor having failed to carry out the work, it was transferred to another, and completed in May 1865.

Pressure on Foundation.

The weight of the basement is 9,200 tons, and the area of the concrete foundation which supports it is 24,000 square feet; it therefore adds a pressure of ·37 tons per superficial foot to that produced by the concrete alone, making a total pressure of 1·12 tons per square foot. This is in a measure balanced by the pressure of the surrounding earth, which amounts to about ·70 tons per square foot at that depth, thus leaving an unbalanced excess of ·42 tons per square foot on the underlying strata.

Settlement and cracks.

In November 1864, previous to the completion of the basement, settlement was again noticed in the work, the depression having taken place very regularly in a slope downwards from the right to the centre, rising again very slightly towards the extreme left, a slight crack in No. 12 casemate appearing about the same time. In March 1865 this crack

increased, and another appeared in No. 4 casemate, the latter being near where the new work crosses the ditch of the old work of 1847. The unequal compression of the underlying strata by the previously existing works appears to have determined the position of the fractures. The cracks increased so very slowly that in March 1866 it was considered that the settlement had reached its maximum, and accordingly the arch of No. 12 casemate was made good, but it again opened at the end of 1867, and has not since been touched.

Present condition.

The present state of the levels referred to a datum point at the right rear angle of the casemates, shows the following depressions:—At the right front angle $6\frac{1}{2}$ inches; at the centre,—in rear $6\frac{1}{2}$ inches, in front $11\frac{1}{2}$ inches; near the old ditch,—in rear $14\frac{1}{2}$ inches, in front 17 inches; on the left,—in rear $5\frac{1}{2}$ inches, in front 10 inches.

Alternative Plans.

150. The designs for this work have gone through the same series of changes as those for Coalhouse and Cliffe, and three alternative plans for its completion, A, B, and C, have been laid before us. The first, A, for 20 iron casemates; the second, B, for nine iron casemates, and five guns on Moncrieff carriages; and the third, C, for 10 guns alternately in granite casemates, with iron shields, and on Moncrieff carriages.

Weights of work when finished.

The weights of these superstructures, and the total pressure per superficial foot which would in each case be brought to bear on the underlying strata, are shown below:—

		Tons.	Tons.
A plan	.. 20 iron casemates ..	9,322	1·54
B plan	.. 9 " ..	4,476	1·54
	.. 5 Moncrieff gun-pits ..	7,275	1·75
C plan	.. 5 casemates	16,952	1·88
	.. 5 Moncrieff gun-pits ..		

Difficulties of site.

151. From the description which has been given of these three forts at Coalhouse, Cliffe, and Shornmead it will be evident that the sites on which the necessities of defence have required them to be placed are of a very treacherous nature, having soft compressible strata underlying them to a very considerable depth, and imposing great difficulties in the way of the construction of works, which to accomplish their object, must be of a very weighty character. When to these difficulties are added others arising from the disturbance of the ground by the construction of former works at Coalhouse and Shornmead it may be easily understood that the task imposed, of placing forts on these sites, involved, as regards foundations, a problem of no very easy solution.

Subsidence at Shornmead.

At Shornmead, where the settlement has been greatest, an average weight of ·42 tons on the square foot in excess of the weight of the ground in its natural condition has produced a subsidence of the centre line of the casemates varying from $2\frac{1}{2}$ to 15 inches at the worst point. This subsidence being invariably more to the front than at the back of the line of casemates, in consequence of the centre of gravity of the mass being about 3 feet in front of the centre of the base supporting it.

At Cliffe.

At Cliffe the subsidence has been less, varying from $2\frac{1}{4}$ to 10 inches, but following the same law, the front having sunk more than the rear; and at Coalhouse similar effects have been produced, but in a much less degree.

These facts all point to the necessity of using very great care in loading the foundations equally, so that the centre of pressure shall be maintained as nearly as possible in the the centre of gravity of the base. The question still remains whether it is to be expected that the foundations as laid will be capable of supporting the buildings that are to be placed upon them. These buildings will increase the weight in addition to that which the ground in its natural state carried from ·42 of a ton now on it to ·84, 1·05, and 1·18 tons respectively per square foot, according as A, B, or C plan is adopted.

Further subsidence to be anticipated.

It is very evident from the mere statement of these weights that a very considerable amount of subsidence must take place in either case, and therefore it is desirable as much as possible to avoid any construction which might be endangered by unequal settlement. For this reason, and because it is the heaviest of the three plans and also mounts the fewest guns, we are of opinion that Plan C for mounting guns alternately in casemates and gun-pits is the least advantageous, although the less costly. In the other two structures the roof is supported on iron beams which are less likely to be disturbed by settlements.

Special precautions.

The bed of concrete in the foundations having been broken through in several places, we recommend that in the construction of the work the continuity of the superstructures be interrupted at those points where cracks have occurred and their completion deferred until the subsidence has reached its limits, also that the centres should be retained under the arches in which any movement has occurred, until the whole work has taken its final

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bearing. Any new buildings which it may be necessary to construct in connection with those now erected, should be kept separate from them until they, as well as the buildings with which they are to be connected, have also taken their final bearing.

timate.

In the Schedule of 1862 the total cost of this fort was estimated at 80,000*l.*, at which it remained in all subsequent schedules until 1867, when it was increased to 118,000*l.*

The expenditure to the 30th June, 1868, was 32,600*l.*, the further sum required to complete it is 115,105*l.*; making the total estimate of its cost, if constructed entirely with iron casemates according to Plan A, 147,705*l.*

If Plan B be adopted, the cost will be reduced to 115,753*l.*, and if Plan C, it will be still further reduced to 99,088*l.*

SLOUGH FORT.

Position.

152. Slough Fort is situated on the point of that name on the right bank of the Thames, about ten miles below Cliffe Fort, and four miles to the west of the works on the Isle of Grain at the entrance of the Medway. Except at this point, all access to the mainland on the southern shore of the Thames can be effectually cut off by inundating the marshes which intervene between the river and the high ground; and this fort has been constructed to prevent an enemy landing at the only accessible point for the purpose of attacking Chatham Dockyard from the north. The work is semicircular in form, and is constructed principally of granite and Kentish rag-stone. The magazines are in the basement; the gun-floor consists of seven casemates for 7-inch 7-ton guns, protected by the smaller class of iron shields, 7 feet square; the terreplein above is prepared for three guns, with two expense magazines having lifts communicating with the lower floors. There is accommodation for three officers, one non-commissioned officer, and 70 men; with offices, and an adequate water supply. The escarp is 38 feet high, and the gorge is flanked by musketry. The entrance is at present closed by a gate, which we consider an insufficient protection; a ditch and drawbridge has therefore been introduced at our recommendation into the approved plans, the cost of which is included in the estimate, and will, we are informed, be defrayed out of the Annual Votes.

Design.

Report.

The work has been well and skilfully constructed, and is well calculated for the object for which it was designed; the arrangements for serving the guns and for storing ammunition are good, and there have been no failures. The work is complete, with the exception of some trifling fittings, and the drawbridge.

Estimate.

The estimate for this work in the Schedule of 1862 was 15,000*l.* This estimate was increased in 1865 to 20,000*l.* In 1867, an addition of 4,000*l.* was made for shields, making the total estimate for the work, 24,000*l.*

The expenditure up to the 30th June, 1868, was 22,343*l.* A further sum of 800*l.* is required to complete it, of which it is proposed to charge 160*l.* to the Annual Estimates. The cost under the Loan, exclusive of shields, will be 22,983*l.* The shields will cost 4,200*l.*, and the total cost of the work, including shields, will be 27,343*l.*

GENERAL REPORT.

Permanency and stability.

153. We have already treated of the permanency and stability of the works for the defence of the Thames in reporting on Shornmead, which presents the greatest difficulties in construction.

Power of resistance.

Plan A.

Plan B.

As regards their powers of resistance, we have to report that the alternative designs A and B will give the same number of guns under precisely similar conditions in the most important portion of each battery looking down the river. By the substitution of Moncrieff gun-pits, as proposed in plan B, for casemates on the other portions of the batteries which look across and up the river, the guns on those portions will be reduced one half, at Coalhouse there will be 8 instead of 16; at Cliffe, 6 instead of 13; at Shornmead, 5 instead of 11. If several ships could engage this portion of each battery simultaneously, this reduction in the number of guns might be detrimental; but here, where the river is of no great breadth, and the channel close to the battery, this objection has not the same force.

Each battery would engage single ships in succession, and thus, by the greater power of concentration afforded by the Moncrieff carriage, a heavier fire would be brought against each ship than could be obtained by the guns in casemates firing through embrasures. We think, therefore, that with the protection against a flanking fire afforded by the raised traverses, the Moncrieff gun-pits might, if approved, be substituted for the casemated batteries as proposed in Plan B, and the batteries so constructed, notwithstanding the reduction in the number of the guns might, with the assistance of submarine defences, and a good substantial floating barrier, supported by the Inner Line at Gravesend, afford a substantial defence to the Thames against attack by naval means.

Plan C.

According to Plan C, the reduction in the number of guns will be made in those faces which look down the river, as well as on those which look across and up it; this will cause a very great diminution in the power of the most important parts of the batteries, and diminish their efficiency most seriously. The powers of concentration also on the other portions of the batteries are not so great as on Plan B. These considerations coupled with the reasons before referred to, relating to their structure, lead to the conclusion that Plan C is the least advantageous of the three which have been brought before us.

The whole of the forts are so designed as to be capable, if properly manned, of affording adequate resistance to a *coup-de-main*. It is, however, most desirable, considering the vast amount of property to be protected and the importance of the security of the Thames, that the Inner Line at Tilbury and Gravesend should, as recommended by the Commissioners, be placed in a thoroughly efficient state in all respects; and in the event of war that it also should be provided with a floating barrier or submarine defences.

154. In making the above observations as to the sufficiency of these batteries for the purpose for which they are intended, we think it right to observe that, by our instructions, it is no part of our duty to determine what is the best plan for adapting these works for Captain Moncrieff's system, but only to report our opinions on the powers of resistance of the various works, if constructed on the designs laid before us: but as Captain Moncrieff, in the evidence he has given to us, has made some objections to the proposed adaptation of the existing works at Coalhouse, Cliffe, and Shornmead, to his system, according to either of the plans proposed, we assume that they have yet to receive much further consideration before the designs are finally approved.

In the Report of the Defence Commissioners, the total cost of these works, including land, was estimated at 180,000*l*. The land has cost 7,877*l*.

Estimate.

In the Schedule of 1862, their total cost, exclusive of land, was estimated at 365,000*l*., which was increased in that of 1865 to 270,000*l*., and again in 1867 to 426,000*l*. and 4,000*l*. additional for shields, making their total estimated cost 430,000*l*.

The estimated cost to complete them according to Plan A, with iron casemates throughout, will be 544,848*l*., with 4,200*l*. additional for shields at Slough, making a total of 549,048*l*., or 119,048*l*. in excess of the estimate of 1867.

If Plan B be adopted throughout, the estimated cost to complete these works, including 4,200*l*. for shields, will be 431,090*l*., or 1,090*l*. more than the estimate of 1867.

If Plan C be adopted throughout, their estimated cost, including 4,200*l*. as before for shields, will be 382,819*l*., or 47,181*l*. less than the estimate of 1867.

MEDWAY AND SHEERNESS.

GENERAL REPORT.

Recommendations of Defence Commissioners.

155. In considering the defences of the Medway, the three objects to which the Commissioners turned their attention were :—

1. The security of Sheerness Dockyard against bombardment.

2. To guard against the occupation, by an enemy, of the anchorage in the entrance of the Medway.

3. To deny the navigation of the river to an enemy, thus securing Chatham Dockyard against a naval attack.

Under the first head they stated that the works necessary to protect Sheerness against bombardment would be of so extensive and costly a nature that they would not recommend any permanent defensive measures for that purpose. They considered, however, that moveable floating batteries should be stationed at Sheerness for the purpose of aiding in the defence of the Thames and Medway.

For the second object, the protection of the anchorage, they recommended that in addition to the batteries on the north front of the Sheerness lines, which were well armed and covered the channel of approach, a powerful casemated work should be constructed on Garrison Point, in lieu of the existing battery, and a second on the Grain Spit, enclosing the existing tower, supported by an open battery on the Isle of Grain. This battery to be secured against assault by a work on the rising ground at its rear.

For the third object, the closing of the river to an enemy, they recommended that works should be constructed about four miles below St. Mary's Island, at Okeham-ness, and the small island to the eastward of it on the opposite shore, and that at a time of expected attack a boom should be placed between them to close the navigation of the river.

For the defence of Sheerness against an attack by land they considered the existing old fortifications inadequate, and they recommended that a position about 3,500 yards in advance of them should be occupied by three works; the main one on Furze Hill with an advanced work on each side of it. The ground between this advanced position and the existing works might in great part be inundated to the depth of 2 feet, by cutting through the sea wall.

Estimate.

The cost of these works, including land, they estimated at 300,000*l.* for the sea defences, and 150,000*l.* for the land.

Alterations.

The alterations made in this scheme were—1. The omission of the work on the Grain Spit, estimated at 100,000*l.* 2. The substitution of the position of Hoo and Darnet, higher up the river, for Okeham-ness and the island opposite to it. 3. The substitution of a line of ditch and parapet between Cheney Rock and the Medway, near Queenborough, for the advanced position in front of Sheerness. This line to be secured at each end by a tower.

SEA DEFENCES.

156. The works on the Isle of Grain consist of a fort and open battery.

GRAIN FORT.

Description and Armament.

The Isle of Grain Fort occupies the highest point of the Island. It has earthen ramparts and an unrevetted ditch flanked by musketry caponnières, in which a palisade is intended to be placed, with a casemated keep at the gorge containing barrack accommodation for 250 men. It was originally designed, and has been constructed, for 16 heavy guns bearing on the entrance of the Medway, at a range of 1,500 yards to the nearest point of the channel, with 12 lighter guns on the land faces. A design has been laid before us for adapting the battery to the Moncrieff system if thought desirable, involving the reduction of one gun.

In the construction of the work no difficulty was experienced in obtaining a secure foundation. The earthen ramparts were at first made with a slope of one to one; this slope, from the nature of the material used, proved insufficient to give them stability; an attempt was made to remedy the evil by re-building them with the same material at a slope of one and a-half to one, with layers of brushwood, but this also failed in part, and they have now, where necessary, been re-modelled with a slope of one and three-quarters to one, by removing the clay and replacing it by gravel and sand from the glacis. The new work as far as it has gone stands well. With this exception the work has been well and skilfully constructed, and we see no reason to doubt its permanency; though should any further failure of the slopes take place in those parts not re-modelled, some outlay might be required to put them in a proper state. Report.

Since our visit to the fort in May, several necessary improvements have been proposed in the arrangements for the supply of ammunition, and when carried out the service of the guns will be well provided for. Modifications.

A magazine was also proposed in the upper part of the centre of the keep, for the supply of the seven guns to be mounted on the roof, but as the position selected would be exposed to shots passing over the rampart, we recommended that it should be placed in the basement, with a lift to the roof, so as to be quite secure from all fire; this alteration has now been made in the plan, and provided for in the Estimates.

The embrasures, as originally designed, had the weakness inherent in that form of battery when exposed to heavy projectiles, and it is now proposed to adopt the Moncrieff system, should it be found applicable to guns of 12 or 18 tons. It may be doubted whether at this distance from the deep-water channel an ordinary barbette battery might not answer the purpose as well as the more expensive plan for the Moncrieff system. It would then be equal in power of resistance to any attack that might be made upon it, and the fire of its heavy guns would materially assist in the defence of the passage against ships attempting to force it.

The amount expended to the 30th June, 1868, was 99,845*l.*; and the further sum required for its completion with embrasures is 14,869*l.*, making a total of 114,714*l.* Should it be determined to adopt the Moncrieff system, the cost of the alteration is estimated at 5,886*l.* in addition, and the total cost of the work so completed will be 120,600*l.* There are also outstanding claims from the contractor for this work and the battery, on which we are unable to give any opinion. Estimate.

Isle of Grain Battery

157. This work stands on the shore about 1,000 yards to the southward of the fort which sees into it, and with which it communicates by a covered road. It was designed as an open earthen battery for 14 guns bearing on the entrance of the Medway, and is 900 yards from the nearest point of the deep water channel. Description and Armament.

The difficulties met with in other places on the banks of the Thames and Medway were experienced here to the fullest extent. The subsidence of the rampart, with the bed of concrete forming its heart, has been on an average 5 feet, and in some places as much as 7 feet 9 inches, nor have we any reason to suppose that it has reached its limit. Although the settlement of a bank of earth is of little importance as compared with that of an expensive work of masonry, we are still of opinion that it would not be advisable to add more weight than is absolutely necessary, or to incur much expense upon this work. Difficulties of Site.

A plan has been laid before us for completing it as a barbette battery on a temporary arrangement that might afterwards be converted into a permanent one for 10 Moncrieff guns. If any temporary arrangement should be adopted it should, in our opinion, be of such a nature as not to involve the necessity of any extensive removal of the material used in the foundations for the platforms and parapet; but we would rather recommend that the material required should alone be added at present, and that the final formation of the terreplein and parapets should be left until the mode of arming the battery is decided upon, and the effect of the additional weight and its altered distribution has been ascertained. Under any circumstances, it would seem desirable that the plan suggested by Colonel Jervois should be adopted, of making each gun platform independent, and so constructing it as to admit of the adjustment of its level when required, without interfering with the adjacent guns. The subsidence which affected the rampart extended also to the main magazine in a less degree; some serious cracks occurred in the brickwork, and part of the earth above it was removed to reduce the pressure upon it. It is now proposed to make good the defects in the brickwork of the magazine, and to place above it the amount of earth required for its Plan for completion. Recommendations.

Sheerness.

subsiding to a degree to endanger the safety of the building may be doubted, and we recommend that as little money as possible should be expended upon the building until this has been ascertained. As regards the powers of resistance, we have to observe that its position within 900 yards of the deep-water channel, and at a height of 25 feet above high-water mark is not favourable for a barbette battery. In the estimates for 1867 provision was made for 14 shields which it is not now intended to supply.

Estimate.

The sum expended on the battery to the 30th June, 1868, amounted to 27,453*l.* The amount estimated as necessary to complete it as a barbette battery is 4,278*l.*, making a total of 31,734*l.* The additional cost of adapting it for the Moncrieff system is 3,400*l.*, and the cost of the work so completed would be 35,134*l.*

Garrison Point Fort.

Object of Work.

158. This work is designed for the protection of the narrow entrance of the Medway between the point on which it stands and the Isle of Grain, and brings only a few guns to bear on the approach to the entrance from the Nore. The defence of this approach and of the gorge of the fort against ships attempting to take up a position to the eastward of it will be, as before, chiefly entrusted to the old North-Eastern Sheerness Lines, which, we are informed, are to be re-modelled and armed with heavy rifled guns: as these Lines are not included in the Schedules of the Acts for the Loan for Defences they do not come within the scope of our enquiry, we have only, therefore, to remark that the re-modelling of these Lines is essential to the support of the fort against an attack from seaward. Additional support would be given to it were the work proposed by the Royal Commissioners on the Grain Spit, and recommended by Colonel Jervois, constructed, or the Martello Tower now existing adapted for the reception of one or two heavy guns, to bring a cross-fire on ships approaching the entrance.

Sheerness Lines.

Grain Spit.

Armament.

Garrison Point Fort is a casemated fort for 36 heavy guns in two tiers, protected by iron shields, and preparations are made for two turrets, each to carry two 25-ton guns. No plan has yet been prepared for these turrets, and we cannot therefore say how far the preparations made may be sufficient to bear their weight. Any expenditure that may be necessary to adapt the work for their reception is not provided for in the estimate for completion now given, and it would therefore form part of the additional estimate for providing the turrets.

Report.

The fort is well and solidly built. It is yet to be ascertained what amount of resistance the granite wall and piers, 14′ 6″ thick, would offer to concentrated broadsides of heavy rifled guns; but looking to the amount of fire to which ships attempting to approach the fort would be subjected, and the facilities for applying submarine defences, it is probable that the protection they would afford would be found sufficient.

Modifications.

Since our visit in May, modifications have been made in the designs to bring them into conformity with the most approved plans for the supply of ammunition, and the arrangements, when carried out, will be well adapted for the service of the guns. Here, as at Picklecombe, some provision should be made for screening the men while loading from the effect of the explosion of the heavy charges from the guns immediately above or below them.

Estimate.

In the Schedule of 1862 the estimated cost of this work was 80,000*l.*, at which it remained till 1865 when it was grouped with the other works.

The sum expended on this work to the 30th June, 1868, amounted to 81,067*l.* The sum estimated for completion amounts to 8,162*l.*, making a total of 89,229*l.*

The estimate for iron shields is 61,750*l.*, making the whole cost of the work, when completed, 150,979*l.*

Summary.

Estimate.

159. In the Schedule of the Act of 1862 the estimate for these three works amounted in the aggregate to 165,000*l.* This was raised in 1864 to 180,000*l.*, and in 1867 to 227,000*l.*, exclusive of land and of shields. The cost of the shields was estimated at 58,000*l.*, and the whole cost at 285,000*l.*

The amount is now estimated at 235,677*l.* for the works, and 61,750*l.* for shields, making a total of 297,427*l.*

Hoo and Darnet Forts.

Hoo and Darnet Forts.

Recommendation of Royal Commission.

160. The Defence Commissioners recommended the construction of two works capable of mounting 25 guns each, one on Okeham Ness, and the other on the small island to the eastward of it, and that a boom should be placed, at a time of expected attack, between them. It was subsequently determined to construct these works at Hoo and Darnet, two projecting points below Gillingham Reach, commanding the winding channel at that part of the river.

Original Design.

The original design provided two circular forts exactly similar to each other, with basement floor for stores, two tiers of gun casemates, nine on the lower and 16 on the upper floor, all protected by iron shields, with a magazine in each across the centre. This was the approved plan in June 1861, when the first contract was let for excavating to a depth of 10 feet, and laying in a bed of concrete over the whole surface of the forts 8 feet in thickness, enclosed all round by close piling 28 feet in depth.

Preliminary examination of site by boring.

Previously to the work being commenced, borings had been taken to a depth of 18 feet at Hoo, and 28 feet at Darnet. The borings at Hoo showed clay and sand, and those at Darnet the same, but having thin layers of peat intervening between the different strata of clay. In driving the piles previous to commencing the excavations, a difference was found in the subsoil; the piles at Darnet drove too easily, the last blow of the monkey (17 cwt.) driving them 4 or 5 inches; the ground at Hoo was harder, although more variable, some of the piles requiring several blows to drive them 1 inch. On the excavation being made, the soft and yielding nature of the ground at Darnet became further manifest by the piles giving way inwards, and much difficulty was experienced in keeping them perpendicular until the concrete was put in. About this time, 1st October, 1861, an experimental pile was driven in the excavation at Darnet to a depth of 50 feet from the surface of the ground. This pile was driven by a monkey weighing 17 cwt., at an average of nearly 7 inches to each blow, the last blow driving it $5\frac{1}{2}$ inches, and showing that no very material resistance was met with at that depth. In consequence of the difficulties encountered in the excavations, and the knowledge obtained by the pile-driving, it was decided to increase the thickness of the bed of concrete at Hoo from 8 to 10 feet, and at Darnet from 8 to 15 feet.

Difficulties encountered.

Depth of the Foundation increased.

In October 1862, a south-west gale prevailing, the dam surrounding the work at Darnet gave way, and the foundations were filled by a spring tide to a depth of $2\frac{1}{2}$ feet. In November 1862, the contract for the concrete foundations in both forts was completed, and the bed of concrete in each case covered with 12 inches of mud to preserve it from injury, after which the foundations were allowed to rest until the following summer, when preparations were made for the erection of the basement stories of both forts. No sinking was observed during this intervening period. The extra cost of construction entailed by these additional precautions in the foundations, was for Hoo 3,999*l.*, and for Darnet 12,302*l.*

Modification.

161. Previous to the commencement of the basement story, the original design, as approved by the Defence Committee, was departed from by abandoning the central magazines, and making provision for the ammunition in the basement, underneath the guns; this alteration entailed an increased thickness in the outer walls of the forts on the more exposed sides, thus producing an unequal distribution of the weight of the buildings upon the concrete foundations, and also removing weight from the centre of the concreted area, thereby occasioning a tendency in the work to settle outwardly.

Wells.

In May 1863, a well was commenced in Hoo Fort, and in sinking it the concrete was found to be so saturated and porous that the water was just kept under by pumping 4,500 gallons per hour, and in the following October the same thing happened at Darnet.

Basement.

A contract was entered into in May 1863, for the construction of the basement stories of both forts, which were commenced soon after. At this time, no settlement of the concrete had been observed; the Commanding Royal Engineer reported in July 1863, that the upper layers of the concrete were not in good condition, but the lower layers in Portland cement were quite hard. To give additional strength to the work in the basement stories, the footings were built in Portland cement, and hoop-iron bond was inserted throughout the work. The value of these precautions has been illustrated in recent alterations at Fort Hoo, where it has been only possible to cut away any portion of the brickwork at immense labour and cost. The basement stories thus commenced in June 1863, were continued through the winter, though occasionally stopped by frosts. In December, two succeeding spring tides inundated the works at Darnet to a depth of 3 feet 10 inches.

First appearance of Cracks.

On the 16th April, 1864, the work being at a height of about 11 feet above the concrete, cracks were reported in the masonry at Hoo, but none in the concrete. On the 21st April, 1864, when the height of the work at Darnet averaged between 8 and 9 feet, a crack was discovered in the masonry and concrete; water flowed up through the latter to such an extent that an attempt to stop it by cement failed; before the 30th April, two other cracks had appeared, and the three were reported to have united on the surface of the concrete towards the centre of the fort. These cracks at Darnet continued to extend

MEDWAY AND SHEERNESS.

The cracks in both forts occurred at nearly the same three points, and were no doubt caused by the unequal pressure on the concrete, which had in consequence subsided unequally.

Precautions.

162. Strong bonds, of 1½ inch × 1½ inch iron, were inserted in the granite coping at Darnet, to hold the work together, but as it was found that the movement still went on, it was decided in August to place a belt of iron (8 inches by 1 inch) round the lower course of stone footing. This belt was completed in November 1864, and subsequently, in January, seven tie rods, of 2½-inch round iron, were fixed, radiating from the centre, and secured by clips to this iron belt. At the beginning of September, the work under the contracts for the basement stories of both forts had been nearly completed. From the nature and position of the cracks, it became evident that they were caused by the principal weight of the building being placed too near the outer edge of the concrete, and by inequality in its distribution over the concrete foundation. It was, therefore, determined to equalise the pressure over the whole surface of the concrete of both forts, by weighting their interiors with 3,500 tons of ballast each, and to finish the sea wall and glacis around them, which would serve in some measure as a counterpoise to prevent the mud under the forts from being forced outwards. The ballasting was commenced at the end of October 1864, and the glacis in March 1865. By these means the cracks were prevented from getting worse. The extent to which they had gone had caused the arched entrance gateway at Darnet to open out about 2 inches; another casemate, about the same; and a third about 1 inch, these being the three casemates through which the cracks passed.

Mode of Draining the Concrete.

In March 1866, a syphon arrangement of pipes was introduced at both Hoo and Darnet, with a view to draining the water with which the upper half of the concrete in each fort was saturated. By these means the concrete has been drained, and since kept dry. The water from it was highly charged with lime, and it would appear that the weight of water thus removed from the foundations amounted to from 1,500 to 2,000 tons. These syphons are still in operation, and it is of great importance that they should be carefully maintained, at any rate for some time.

Description of work as it is now in process of completion.

163. In 1867, a modified plan was submitted to, and approved by the Defence Committee, by which a single tier of 11 casemated guns was to be placed on the basement stories, erected at each fort in substitution for the two tiers for 25 guns. In this design the magazine arrangements in the basement have been re-modelled, with the double object of making a more equal distribution of the weight on the foundations, and of adapting them to the latest improvements which have been suggested and approved up to the present time. The superstructure is to consist of one tier of 11 casemated guns of 12 or 18 tons. The diameter of the superstructure is reduced from 186 to 138 feet, thus relieving the outer ring from pressure, and distributing the weight more equally over the whole surface of the concrete. In the course of the summer, under the new contract, above 8,000 tons weight of materials have been added at Hoo in the completion of the basement and the commencement of the gun floor, and no subsidence whatever has taken place. There seems therefore to be no reasonable doubt that the measures now adopted will prove successful, and it is proposed to complete Darnet on the same plan.

Progress of Hoo in the summer of 1868.

Success of measures adopted.

Report.

164. A careful consideration of the circumstances stated above, and a close examination of the works, have led us to the following conclusions:—

Unforeseen difficulties in site.

First. That the difficulties occasioned by the loose and yielding nature of the subsoil were greater than the designers of the works had anticipated. At a very early stage of the work the insufficiency of the concrete bed was discovered, and additional thickness and strength were given to it.

Failure of the Foundations.

Second. The subsequent failure of the foundations may be attributed to the weight of the building being placed too near the outer edge of the concrete and to the alteration in the disposition of the magazines, by which the pressure on a portion of the outer ring was increased at the same time that the weight on the centre was removed; thus the equilibrium was destroyed and an unequal settlement took place, causing the cracks in the masonry which have been noticed.

Remedies applied have been judicious.

Third. The measures adopted on the discovery of the cracks appear to us to have arrested the tendency to unequal settlement that had caused those cracks.

Fourth. The death or absence of many of the officers charged with the superintendence of the works in their earlier stages has made it difficult to ascertain the exact amount of subsidence that has taken place since the works were begun, but there is reason to believe that since the remedial measures were completed the settlement has not been great.

We are therefore of opinion that if great care be taken in executing the works and in maintaining during their progress, as far as practicable, an equal pressure on all parts of the foundation, there is little reason to apprehend any further failure of such a nature as to interfere with the practical utility of the work, and the completion of the forts on the proposed plan may therefore be proceeded with. Little probability of further failure.

165. We have also had under our consideration the probable power of resistance that these forts would oppose to an attack by heavily armed iron-clad ships, as well as their powers of offence. Although it may be doubted whether granite piers would afford the same protection as iron walls, such as those now under consideration for other sea forts, we are of opinion that in the position occupied by these forts, forming an inner line of defence to the Medway, commanding a narrow winding channel easily protected by torpedoes, they would in all probability be found sufficient to resist any attack that might be made upon them, and that it is not necessary to incur the heavy additional expense which the substitution of iron for granite would involve. Offensive and defensive capabilities.

The number of guns to be mounted in each fort has been reduced from 25 to 11, but their offensive power and the weight of metal thrown by them has been much increased by the substitution of heavy rifled guns for the 68 and 110-pounders originally contemplated, and if 18-ton 10-inch guns are mounted in the embrasures bearing on the channel, it would be difficult for any ship to approach the forts without suffering such damage as would probably compel her to retire. Armament.

166. We are therefore of opinion that the fort should be completed as proposed, with such slight modifications as may be necessary to adapt the internal arrangements for the supply of ammunition and the service of the guns to the latest and most approved system. Recommend the Forts to be completed.

The estimate for the completion of the Hoo Fort laid before us amounted to 26,388*l.* In this estimate we found that no margin was left for contingencies beyond two sums of 250*l.* for probable amount of extra work, and 436*l.*, being 10 per cent. on the amount estimated for work not included in the contract. We think it would be imprudent to calculate on the contingencies not exceeding these two sums; at the same time, looking at the amount of work already done, we consider that it will not be necessary to add the full amount for unforeseen contingencies of 10 per cent. (usually charged) on the whole contract, and that an addition of 5 per cent. will be sufficient to meet any extra demands that may arise. Estimate. Fort Hoo.

In the case of Darnet, where the failures have been more serious, and less work ha been done, we think that the full amount of 10 per cent. should be added.

In 1862 the estimate for the Hoo Fort was 50,000*l.*, and for Darnet 59,000*l.*; they both remained at the same amount till 1867, when the combined estimate for the two forts was increased from 109,000*l.* to 128,000*l.* The estimated cost of the shields in 1867 was 22,000*l.*, making the total estimated cost of the works when completed 150,000*l.*

The expenditure to the 30th June, 1868, at Hoo, was 36,807*l.*; the further sum required 27,540*l.*; together amounting to 64,347*l.* The estimated cost of the shields is 15,950*l.*, and the total cost of the work when completed 80,297*l.*

The expenditure on Darnet to the 30th June, 1868, amounted to 43,485*l.*; the further sum required to complete is 32,204*l.*; together amounting to 75,689*l.* The estimated cost of the shields is 15,950*l.*, making the total cost of the work when completed 91,639*l.* The total estimate for these works without shields will be 140,036*l.*, with shields 171,936*l.*, showing an excess on the estimate of 1867 for the works of 12,036*l.*, and for shields of 9,900*l.* Fort Darnet.

SUMMARY.—SEA DEFENCES.

167. The total cost of the Sea Defences of the Medway and Sheerness was estimated in 1867 at 355,000*l.*, and 60,000*l.* for shields, or 415,000*l.* in all. The cost of the works when completed, it is now estimated, would amount to 375,713*l.*, and 93,650*l.* for shields, making the total cost 469,363*l.*, or 54,363*l.* in excess; of this amount 33,650*l.*, it will be seen, is due to the increased cost of the shields. Estimate.

LAND FRONT OF SHEERNESS.

QUEENBOROUGH LINES.

QUEENBOROUGH AND CHENEY BATTERIES.

Description of Lines.

168. The Queenborough Lines consist of a rampart having a command of 10 feet over the country in front, with a wet ditch 75 feet wide at top, and 6 feet below the ground level. The lines run across the Minster Marshes, which intervene between the town of Sheerness and the high ground between the towns of Queenborough and Minster. The ditch forms a straight line, and the rampart towards the centre is broken into two flanks for three guns each.

Inundation.

The marshes are about 2 feet below high water mark, and are intersected by a network of ditches and drains which would render it quite impassable if covered with even a few inches of water, which might be done by cutting through the sea or river embankments, while the line of rampart will act as a dam to prevent the extension of the inundation to Mile Town and Sheerness.

Subsidence.

During and subsequent to the construction of the lines, a subsidence of the strata on which the rampart rested, appears to have gone on, being apparent in the unequal settlement of two expense magazines, not, however, to an important degree.

Towers.

At each extremity of the line it was intended to construct a tower for the reception of a two-gun turret. These towers would strengthen the weak points of the line, viz., their flanks, and will co-operate with the works already described, in the defence of the Medway.

Alternative Plan.

169. An alternative plan for the substitution of three guns mounted on Captain Moncrieff's system, for each two-gun turret, has been laid before us.

Remarks.

In the case of these batteries, at either flank of the Queenborough Lines, it is so essential that the guns should be capable of traversing, in order that they may be used as occasion may require either to flank the lines on the land side, or the beach, or to fire to seaward, that the necessity of a turret has always been recognised, and the designs provide for mounting no other guns than those in turrets. The turrets, therefore, form an integral part of the defence, and are not mere additions, as at Garrison Point, the Breakwater Fort, and elsewhere, which may be added or not, as thought desirable to existing batteries. Their approximate cost has, therefore, been included in the estimates, although no design has yet been decided upon for their construction.

The greater simplicity of construction, and economy, point to this as an advantageous position for the application of the Moncrieff system.

Estimate.

There has been expended at the Queenborough Lines, up to the 30th June, 1868, 18,586*l.*, and a further sum of 320*l.* is required to complete, making a total estimated cost of 18,906*l.*

The batteries at Cheney and Queenborough have not yet been commenced.

Queenborough Battery, if constructed for the reception of a two-gun turret, will cost 10,853*l.*, exclusive of a probable further amount of 20,000*l.* for the iron turret, raising the total, when complete, to 30,853*l.* If the adoption of Captain Moncrieff's carriage is decided upon, the cost of completing the three-gun battery will be 14,877*l.*

For Cheney Rock Battery the estimates will stand as follows:—

	£
Estimate for completion, excepting turret	10,528
Add probable cost of turret	20,000
Total estimated cost, with two-gun turret.. ..	30,528
Estimated cost of work completed for three guns on Moncrieff carriages	13,826
The estimated cost of this group of works in the Schedule of 1867	40,000

The present estimates, if the batteries are prepared for turrets, but exclusive of the cost of the turrets, is 40,287*l.*; with turrets the amount will be 80,287*l.*

If completed for Moncrieff gun carriages, the total cost will be 47,609*l.*

170. The estimate of the Defence Commissioners for the works recommended by them for the protection of Sheerness and the Medway amounted to 450,000*l.*, including 50,000*l.* for the purchase of land.

In 1860 the Government, by omitting the Grain Spit Fort, reduced this estimate to 350,000*l.*

The expenditure on land has amounted to 62,714*l.* In 1862, after separating the cost of the works from that of the land, the estimates for the works amounted in the aggregate to 314,000*l.*, and, adding the cost of the land, to 375,726*l.* In 1864, the estimate for the works was increased to 329,000*l.*, and in 1867 again increased to 395,000*l.*, with 80,000*l.* added for shields—making a total estimate of 475,000*l.*

The estimate now amounts to 416,000*l.* for the works, 40,000*l.* for the turrets for Queenborough and Cheney Batteries, and 93,650*l.* for shields—making a total of 549,650*l.* Should the Moncrieff gun-pits be adopted for the batteries named, the cost of the works will amount to 432,608*l.* and with shields to 526,258*l.*

The defence of the Medway and Sheerness, including the cost of the land, will amount to 612,364*l.*, or above 150,000*l.* beyond the estimate of the Commissioners. This increase appears to be due to the great cost of the foundations, a larger amount paid for land, the rise in the price of labour and materials, and the adoption of costly iron shields.

DOVER.

Recommendations of Royal Commission.

171. When the Royal Commission was appointed in 1859, certain improvements in the very imperfect fortifications at Dover had already been sanctioned by Parliament and commenced.

The Commissioners in their Report stated that the questions that arise at Dover were in some respects dissimilar from those that had been discussed in treating of other places. They considered that "it is in fact the only place in England which partakes of the nature of a strategical fortress or intrenched camp in its primary object."

"The objection" (referred to in the opening part of their Report) "to the construction of fortifications purely for strategical purposes applies, therefore, in some respects to Dover; and if there were no works of defence or military establishments there already," it appeared to the Commissioners "that it would become a question whether that place should or should not be fortified." Weighing the reasons for fortifying it, and bearing in mind the extensive, though imperfect works of fortification already existing at Dover, and the improvements already sanctioned by Parliament, they were of opinion "that no other course was open but to complete the works in progress, and give them such additional strength as may be considered necessary to render them secure."

They therefore recommended that the plans authorized, which appeared to be well-devised, should be carried out, and that in addition a new work should be constructed on the hill overlooking the Castle.

The works in existence consisted of—

Works existing in 1859.

1. A citadel and a small fort called the Drop Redoubt, on the Western Heights above the town, partly connected by lines left unfinished; and an old fort called Archcliffe Fort, close to the shore below the Citadel, and also connected with it by a line.

2. The Castle, on the Eastern Heights, with a small battery at the foot of the cliff below it, called Guildford Battery.

Works carried out or in progress under Loan for Defences.

The additions and alterations authorized and approved by the Commission, and since carried out or in progress, are—

1. The addition of an outwork to the West of the Citadel.

2. The completion of the casemated officers' quarters, and sundry smaller works in the Citadel.

3. The completion, in an approved form, of the lines between the Citadel and Drop Redoubt, and the addition of a bastion in the centre, called the North Centre Bastion.

4. Re-modelling the Drop Redoubt, and constructing lines to the eastward of it.

5. Constructing the South Lines and South Entrance, with barracks on the South Front.

6. Re-modelling the East Front of the Castle Heights, and constructing casemates for 72 men.

7. A new work on the hill overlooking the Castle.

GENERAL REPORT.

172. We are of opinion that the works generally have been well constructed as regards permanency and stability, that the slight failures which have occurred are not more in number, or greater in extent than might have been reasonably anticipated, and that these failures have been satisfactorily remedied.

That they have been well and skilfully constructed with reference to arrangements for the service of the guns for which they were designed, but that for the requirements of a modern armament the re-modelled works generally, though containing sufficient storage for powder are insufficiently provided with expense magazines and artillery store accommodation. In accordance with the system adopted generally for the land defences, it is not intended to provide racers for the guns, or cut the embrasures until the necessity for them arises. The works have been sufficiently advanced for a peace establishment, and any further expenditure required to complete them or to supply the deficiencies would not form part of the charge against the Loan, and may be left to be provided out of the Annual Estimates, or till the fortress has to be mantled at a time of expected attack.

The batteries on the sea front have been constructed for guns of less power than those which at the present time are alone considered adequate to contend with shipping, and if they are to be re-armed will require to be re-modelled. DOVER.

173. The resisting power of these works must be considered with reference rather to any attempt that might be made by an enemy to obtain possession of the strong ground commanding the harbour and roadstead than to an attack from the sea, from which indeed in most of them their height above the water affords sufficient protection, and with reference to the resistance which they would be capable of offering to such an attempt, we are of opinion that when the works have been completed and mantled, the defences newly-constructed as additions to those previously existing will have rendered Dover so strong that, if properly armed and adequately garrisoned, it ought to be capable of sustaining a lengthened siege requiring the development of very powerful means of attack, and that until taken it would effectually deny the use of the harbour and roadstead to an enemy, though it could not prevent injury to the town and shipping by a bombardment from the sea. Powers of Resistance.

Some protection against such a bombardment would have been afforded by the 16 heavy guns intended to be mounted in Archcliffe Fort and Guildford Battery behind iron shields, for which provision was made in the Estimates and Schedule of 1867. These shields are omitted from the estimates now submitted to us, and we are informed that guns mounted on the Moncrieff principle will be substituted for them, and the cost of adapting the batteries to them will be provided for in future Annual Estimates. We have only to observe that we consider it essential that some heavy guns should be mounted on the sea front, as without them the fortress will be unable to afford any protection to the town or harbour from bombardment or insult, even by a single armour-clad ship.

In case of attack by land, the fortress would be much strengthened by the addition of a continuous line connecting the Eastern and Western Heights; but as the formation of such a line would cause the destruction of much valuable property, and be attended with a very heavy expense, we are of opinion that no step should be taken beyond the preparation of a well matured plan, to be carried into execution without delay when the emergency arose.

WESTERN OUTWORK.

174. This work is for land defence; it has casemated accommodation for three officers and 181 men, and is intended for an armament of 27 guns on the terreplein, and 14 in its caponnières and casemates. WESTERN OUTWORK. Design.

During some severe weather in 1866, the counterscarp wall of the South Cut gave way; it had been constructed in rubble chalk, with brick and flint facing, built in stone lime mortar; it was replaced by a Portland cement concrete wall, at a cost of 622*l*. In other respects the work appears to have been well and skilfully constructed with reference to its stability and permanency. Report.

The expense magazine and artillery store accommodation is scarcely sufficient for the number of guns it is intended to mount. In other respects the construction is adapted to meet the requirements of a modern armament.

The total cost of this work was 86,143*l*., of which 62,419*l*. was paid out of the Loan for Defences. Cost.

THE CITADEL.

175. The works performed in the Citadel were limited to the completion of the officers' casemated barrack, deepening ditches, heightening escarps, forming a glacis, constructing galleries and bridges of communication, &c. CITADEL.

There was a slight failure in an escarp wall after the severe weather of 1866, which was remedied; the work appears to have been well and skilfully constructed with reference to permanency and stability. Report.

There is a deficiency of expense magazine and store accommodation; in other respects the construction is adapted to meet the requirements of a modern armament for land defence.

The total cost of the new works in the Citadel has been 61,486*l*., of which 34,560*l*. has been charged to the Loan for Defences. Cost.

North Centre Bastion and North Entrance.

North Centre Bastion and North Entrance.

176. The North Centre Bastion was designed as a flanking work to the long line between the Drop Redoubt and the Citadel. It is intended to mount 15 guns on terreplein, and six guns in flanking casemates.

The works at the north entrance consist of an advanced ditch and glacis, with flanking casemates. They were commenced in March 1860, and completed in February 1864.

Report. In 1866 it was found that the escarp wall of the North-East Bastion was being thrust forward. Remedial measures were at once taken which, at a cost of 1,366*l.*, saved the fall, rendering it unnecessary to take it down. The work has since been completed; no further movement of the wall has taken place, and it now appears to be perfectly secure.

The works are well and skilfully constructed with reference to permanency and stability.

Cost. Their total cost amounted to 52,251*l.*, of which 38,017*l.* were charged to the Loan for Defences.

Drop Redoubt and East Lines.

Drop Redoubt and East Lines.

177. The new works here consist of four caponnières at the angles, bombproof quarters for the officers, a ditch and lines connecting the Redoubt with the Drop Battery, and a magazine for the latter. They were commenced in October 1859, and completed in February 1862.

Report. The works have been well and skilfully constructed, with reference to permanency and stability. They are constructed for 17 guns on terreplein, and 15 in caponnières.

The magazine is not sufficiently protected from direct fire.

One face of the battery bears on the sea, and might take part in the defence of the place against ships. To enable it to do so with effect, heavier guns than those for which it was designed would be necessary; and should it be determined to re-arm it, considerable alterations would be required in the battery, as well as additional magazine accommodation. The new work is otherwise well adapted to its object.

Cost. The total expenditure on alterations and additions amounted to 37,577*l.*, of which 13,276*l.* were charged to the Loan for Defences.

South Front Barrack, South Entrance, and Lines.

South Front Barrack, South Entrance, and Lines.

178. These works comprise a casemated barrack for the wing of a regiment; scarps and ditches to the South and South-West Lines, with gun casemate and guard-rooms at the entrance.

They were commenced in October 1861, and completed in June 1863.

Report. These lines have been designed chiefly for land defence, and for that purpose the works as now constructed are, with the exception of insufficient expense magazine and store accommodation, suited to the requirements of a modern armament.

They are intended to mount 18 guns on terreplein, and 12 in casemates, with barrack accommodation for 14 officers and 436 men. In some of the positions the guns would bear on ships approaching the harbour, and heavier guns than those now provided would be required to act with effect against them; and a revision of the armament would make considerable alterations necessary, both in the works and in the magazine accommodation.

Cost. The total cost of the alterations and additions amounted to 54,520*l.*, of which 48,425*l.* were paid out of the Loan for Defences.

Summary.

179. The estimate in the Schedule of 1862 for the works on the Western Heights amounted to 149,000*l.*, which was increased to 191,000*l.*

The total expenditure on the Western Heights has been:—

	Annual Estimates.	Loan.	Total.
	£	£	£
Drop Redoubt	24,301	13,276	37,577
North Centre Bastion ..	14,234	38,017	52,251
Western Outwork	23,724	62,419	86,143
South Front and Entrance .	6,095	48,425	54,520
Citadel	26,926	34,560	61,486
Total	95,280	196,697	291,977

CASTLE HEIGHTS.

180. The only sum expended out of the Loan on the Castle Heights amounted to 6,583*l.*, for providing casemated barracks for 72 men under the East Front Ramparts. The work has been well done, and calls for no remark.

CASTLE HILL FORT.

181. This is the only new work at Dover, and wholly charged to the Loan for Defences.

Design.

It occupies a site about 400 feet above mean tide level, on the same ridge as the Castle, and 700 yards distant from it. The ditches are 35 feet in width at bottom, flanked by one double and three single caponnières, all of two tiers. The gorge ditch forms a re-entering angle with casemated flanks for guns and musketry. The scarps and counterscarps are in chalk, protected by a facing of concrete and flint work, and well defiladed. There is a chemin des rondes, as well as a covered way. The average height of the crest of the parapet is 434 feet. 29 guns can be mounted on the ramparts, of which six will be in haxo casemates; at the right of the gorge, two guns on the parade level will flank the ditch, connecting the East Wing Battery with the main work; 26 smaller pieces will be placed in the caponnières and flanking batteries.

In rear of the flanks of the work, and about 300 yards distant from it, are the East and West Wing Batteries, for five and four guns respectively, with the requisite magazine accommodation. These batteries are secured independently by ditches, and are connected by lines with the main work.

There are bombproof casemates under the main ramparts of the fort for seven officers and 270 men, and the aggregate capacity of the magazines is for 3,672 barrels of powder.

Report.

This work was commenced in June 1861, under a contract for the erection of the casemated barracks; it is now being completed by military labour, and is well and skilfully constructed, with reference to permanency and stability.

There have been some slight failures, requiring an outlay of 770*l.* in repairs; a more serious outlay was caused by the occurrence of large clay "potholes," and of a want of compactness in the chalk, making it necessary, in places, to revet both scarps and counterscarps with concrete, at an additional cost of 11,807*l.*

All the arrangements for the service of the guns, for the supply of ammunition, and for stores, are good.

Estimate.

The estimate for this work in the Schedule of 1862 was 90,000*l.* In 1863 it was reduced to 80,000*l.*, and subsequently merged in the general estimate for Dover.

The expenditure on the work, to the 30th June, amounted to 77,716*l.*; and a further sum of 10,337*l.* will be required to complete it, making the total cost of the work 88,053*l.*

GENERAL SUMMARY.

182. The cost of the works at Dover was estimated by the Commissioners at 165,000*l.* for works in progress, and 170,000*l.* for the new works recommended by them. Of this total of 335,000*l.*, 80,000*l.* were voted in the Annual Estimates for 1860-1, leaving 255,000*l.* to be provided out of the Loan. The expenditure on the Annual Votes prior to the Loan amounted to 95,280*l.*

The expenditure on the land has amounted to 1,141*l.*

The estimate for the various works under the Loan in the Schedule of 1862 amounted to 249,000*l.*; in 1863 this amount was increased to 278,000*l.*, and in 1867 to 285,000*l.* It was also at that time, as we have stated, proposed to provide shields for Archcliffe and Guildford Batteries, estimated to cost 16,000*l.*—making a total estimate of 301,000*l.*

It is now intended that any expenditure on the re-modelling of these batteries should be defrayed from the Annual Votes, and no provision for them is included in the Estimates. The expenditure under the Loan is now estimated at 291,333*l.*, and the total cost of the re-modelled and new works, including the purchase of land, will amount to 387,754*l.*

CORK.

CORK.

Recommendations of Defence Commission.

183. In the Report of the Royal Commission it was recommended that the land defences of Forts Carlisle and Camden should be re-modelled, and a sufficient space enclosed to admit of an extension of the sea batteries on the harbour face so as to afford a reverse fire on ships passing up the channel, and that more guns should be brought to bear on the approach to the harbour; and that the existing works on Spike Island should be completed, and additional guns mounted on the southern face bearing on the harbour and entrance.

They further recommmended the occupation of Cork Beg by a small work; the re-modelling of an old battery under the hospital at Queenstown, and the construction of a small open battery on White Point.

These last three works have not been included in the Schedules of the Acts for the Loan Defences.

The forts at Spike Island, Carlisle, and Camden, when completed, armed, and adequately manned, will, if combined with submarine defences, fully provide for the security of Cork Harbour against an attack by naval means alone.

SPIKE ISLAND.

SPIKE ISLAND.

Completion of Fort Westmoreland.

184. Fort Westmoreland, a work already existing on Spike Island, was adopted by the Defence Commissioners, who recommended that it should be completed and prepared for an increased armament. The amount estimated as necessary for this purpose, based on the work being entirely done by convict labour, was 10,000*l.*, and the expenditure up to 1864 amounted to 2,000*l.*

Batteries.

Present Design.

In June 1864, a plan was approved for preparing the work for an armament of 30 guns, 18 bearing on the entrance, and 12 on the harbour. That plan has now been revised, to adapt it for a heavier armament, and 16 guns behind shields or on Moncrieff carriages are to take the place of the 30 originally intended. The traverses and magazines occupy the places originally designed for them.

Up to 1867, the work was carried on by convict labour, but in the course of that year the whole of the convicts were transferred to the Admiralty, and the work was practically suspended till February 1868, when the revised plans were taken in hand by military labour, the number of men employed being very small.

Report.

Character of Work.

No failures have occurred, the work already done is good, and the design seems to be well adapted to secure permanency and stability, as well as to offer resistance to any attack that may be made upon it. No provision is made for arming the curtain between Nos. 2 and 3 Bastions, bearing directly on the entrance of the harbour. Four additional heavy guns in that position would materially increase the offensive power of the fort against ships attempting to force an entrance, and in our opinion the work should be so completed as to admit of this curtain being armed.

Service of Guns.

The arrangements for the service of the guns are satisfactory.

Estimate.

The estimate for the work was, as we have said, based on the employment of convict labour, and will be quite inadequate to meet the expense of completing it by military or civil labour. The amount already expended is 4,618*l.*, and the further sum required to complete it amounts to 12,695*l.*, making a total of 17,313*l.*

The cost of the shields is estimated at 24,000*l.*, making the total cost of the work 41,313*l.* The cost of adapting the alternative plan for mounting the guns on Moncrieff carriages is estimated at 5,764*l.*, and the total cost of the work so completed would amount to 23,077*l.*

CARLISLE FORT.

CARLISLE FORT.

Land Defences.

185. The first work begun under the Loan was Carlisle Fort.

The land defences consist of a line of rampart enclosing the sites of the various batteries with a ditch 40 feet wide and 30 feet deep, cut in the natural rock, and flanked by caponnières, and casemates in the escarp; there is also a covered way. The highest point of the rampart is 264 feet above the sea. The designs were made in 1860, and

contract was entered into for the excavation of the main ditch, and formation of the parapet. The works were begun in August 1861. In February 1863 the contractors became bankrupt, and the work was carried on by persons employed by the trustees of the bankrupts, and in September of that year they were relieved from the task by the War Department.

The further works which have been proposed to carry out the recommendations of the Commissioners may be thus described:—The original fort, with slight modifications, will form the Keep; and Rupert's Tower, reduced in height, will be utilized to cover the ground on the flank and rear of the Southern Battery, which cannot be seen from the Keep. The Centre and Southern Lower Batteries will be completed for the reception of 16 guns behind shields, or on Moncrieff's carriages, disposed in groups varying from 60 to 190 feet above mean tide level. No plan has been proposed for re-modelling the two Northern Lower Batteries, constructed previous to the Loan for 11 guns, and no sum for such re-modelling has been included in the estimates before us.

Keeps.

Sea Batteries.

From 1864 to 1867 the works were carried on slowly by convict labour, 180 men being the largest number employed. In October 1867, a party of soldiers of the Line commenced work, and in December the whole of the convicts were transferred to the Admiralty works at Spike Island; from that time military and civil labour alone have been employed. Up to the present time nothing has been done beyond excavating the sites of the batteries and communications and building the magazines.

Progress.

The work, as far as it has gone, has been well and solidly constructed. The design laid before us appears well adapted to secure permanency and solidity, and to give to the work the power of resistance required in this important position. In the design it is proposed to close each extremity of the main ditch by a wall; this wall would cost 1,300*l.*, and this expenditure appears to us to be unnecessary, except so far as it may be required to provide against the encroachment of the sea, and we recommend that it should be confined to that object. The entrance to the fort on the land side is carried in nearly a straight line through the defences, and requires some modification or protection.

Report.

Character of Work.

The arrangements for the magazines and for the service of the guns are good.

Service of the Guns.

In the various schedules, the estimated cost of this work, based on the employment of a considerable amount of convict labour, was 79,000*l.*; convict labour cannot now be obtained, and although in the modification of the plans considerable reductions have been made, that sum will be quite inadequate to its completion. The expenditure incurred to 30th June, 1868, amounted to 27,627*l.*, and the further sum required to complete, including liabilities, amounts to 59,872*l.*, making a total of 87,499*l.* The cost of the shields is estimated at 24,000*l.*, making a total cost of 111,499*l.* The alternative plan for substituting the Moncrieff system for the 16 guns protected by shields has been laid before us. The cost of adapting the work for this alteration would be 6,556*l.*, and the total cost of the work so completed would be 94,055*l.*

Estimate.

FORT CAMDEN.

FORT CAMDEN.

Land Defences.

186. The new land front, consisting of a ditch and rampart similar to those at Carlisle, was begun in February 1862, under a contract for building casemated barracks on the north flank and making a road to Crosshaven; after much delay this contract was completed in September 1864. In February 1865 a second contract, on a schedule of prices, was entered into for the completion of the land front, and whatever other work might be ordered. The work under this contract was not satisfactorily done, and in February 1867 the contract was wound up, and the work has since been carried on by military labour.

Present Design. Land Defences. Sea Batteries.

The project for completion has now been considerably modified. The land front is unaltered, except in very slight details. The lower battery, adapted for 10 guns behind shields, or eight Moncrieff guns, will extend along the sea front, and include the site now occupied by the old battery; above it two batteries *en barbette* for three guns each are designed on each side of the existing officers' quarters, at a height of 170 feet above the sea. To secure the position against an enemy who might have made good a landing below, a scarp with a slight ditch will be cut in the rocky slope between the Upper and Lower Batteries; this obstacle, which we consider will afford sufficient protection, has been substituted at our suggestion for the more expensive proposal of a ditch 20 feet deep, shown on the original plan. It has also been proposed to remove the present officers' quarters to another position, and to add another three-gun battery on their site. The cost of this would amount to 8,700*l.*, but it is not now intended to propose this additional expenditure.

Defensive enclosure on sea side.

Report.

Character of Work.

The work already done is solid, and no failures have occurred; and the design laid before us seems well adapted to secure permanency and stability, and to give the necessary power of resistance. It will be necessary to make provision for raising water from the spring at the lower battery to the level of the upper parade, or for otherwise obtaining a supply. The amount estimated for this purpose will probably be found sufficient. The arrangements for the magazines, and for the service of the guns, are satisfactory.

Service of Guns. Estimate.

The estimated cost of this work in all the schedules is 70,000*l.* The expenditure up to the 30th June amounted to 32,334*l.*, and the further sum required to complete, is estimated at 35,897*l.*, making a total of 68,231*l.*

The cost of the shields is now estimated at 15,000*l.*, and the total cost of the work at 83,231*l.* The alternative plan for substituting eight guns on Moncrieff carriages for 10 guns behind shields has been laid before us; the cost of adapting the work to this system would be 2,696*l.*, and the total cost of the work so completed would amount to 70,927*l.*

GENERAL SUMMARY.

Estimate.

187. The cost of the works for the defence of Cork Harbour, recommended by the Defence Commissioners, was estimated by them at 120,000*l.*, including the purchase of land, and this amount was adopted by the Government in the Parliamentary Paper of 1860, No. 448. The estimate in the Schedule of 1862 amounted in the aggregate to 159,000*l.*, exclusive of land. The cost of the land amounted to 3,160*l.* In 1867 30,000*l.* was added to this sum as the estimated cost of the shields required, making a total cost of 189,000*l.* The estimated cost of the works, when completed, is now 173,043*l.*, with 63,000*l.* for shields, making a total of 236,043*l.* If completed for the Moncrieff system, the total cost will amount to 188,059*l.* The increased cost of the works beyond the original estimate is to be attributed to the withdrawal of convict labour from Spike Island and Fort Carlisle. The excess which would thus be caused on the forts, if completed for shields, will be more than covered if the Moncrieff system be adopted.

LANDS AND INCIDENTAL EXPENSES.

LANDS.

188. The estimate in the Schedule of 1862 for the purchase of land was 1,030,000*l.*, at which amount it remained until 1865, when it was increased to 1,080,000*l.* It was further increased in 1867 to 1,115,000*l.*, but according to the estimates now before us will be reduced to 1,102,033*l.* This reduction is stated to be due to the outstanding claims in 1867, having been settled for a less sum than then expected. It is to be observed that this large expenditure is not unproductive, but has been stated as yielding a very considerable revenue.

INCIDENTAL EXPENSES.

189. In the Schedule of 1862 the item for Incidental Expenses was estimated at 50,000; this was increased in 1863 to 120,000*l.*, in 1865 to 140,000*l.*, and again in 1867 to 165,000*l.* According to the estimates now before us this estimate has been increased to 194,835*l.*, showing an increase of 29,835*l.* This estimate, however, does not show the total expenditure on this item, which is mainly for the payment of the staff and other incidental expenses of a like nature connected with the works under the Loan, as under the authority of the Treasury, this expenditure, as well as that on lands, is subject to reduction by the amount received from the sale of timber, rents, and certain other credits.

SUMMARY.

SUMMARY.

Conclusion.

190. We have now gone in detail through the whole of the works on which we are directed to report, and we have in each case stated our opinion of their construction and power, and it now only remains for us shortly to sum up the results of our enquiry.

Circumstances under which the works were commenced.

We have stated the circumstances under which the works were commenced, and the measures that were taken for carrying into effect the recommendations of the Defence Commissioners, so far as they were adopted by the Government, and as they were embodied for the first time in a detailed estimate in the Schedule of the Act of 1862.

Stability and Permanency.

191. Bearing those circumstances in mind we are of opinion—

1st. That the works have been constructed with a due regard to the conditions necessary to secure their stability and permanency; and although it could not be expected that works of such magnitude could be carried on without occasional failures and mistakes, those failures and mistakes have been much fewer and of less importance than might have been anticipated.

Costly changes in designs.

192.—2nd. That many costly changes from the original designs were rendered absolutely necessary by the great advance in the power of rifled artillery; that great skill has been shown in adapting the original designs of the works to the altered circumstances of the times; that the arrangements for the service of the guns are good; and that the increase of resisting power in the works has kept pace with the increase of the power of the guns.

Resisting Power.

Increased cost.

193.—3rd. The increase of cost has been very great; by the Table at page x. it will be seen that the estimate of 1862 amounted to 6,860,000*l.*, from which must be deducted the sum of 670,000*l.* for works since omitted, leaving 6,190,000*l.* The expenditure as now estimated will be 7,951,437*l.*, showing an excess of 1,761,437*l.* on the works now in progress. The amount under the Loan sanctioned by Parliament in 1862 having been 6,860,000*l.*, the increased demand will now be 1,091,437*l.*; part of this increase is due to the additional strength proposed to be given to iron structures since 1867.

Comparison of Estimate of 1862 and 1869.

Increase since 1867.

Rise in wages and cost of materials.

The increase since 1862 is not wholly due to the changes in the works alluded to, a portion of it is to be attributed to a considerable rise in wages and in the cost of materials that took place in the earlier part of the interval.

Alternative plans.

194.—4th. It is to be observed that in the Schedule attached to our Report the estimates we have adopted are for the plans for the expensive iron structures and not for the alternative plans that have been laid before us. We have thought it right to follow this course since in most cases the adoption of the alternative plans is dependent upon the success of the application of the Moncrieff system to the heavier guns. Without casting any doubt on that ultimate success we felt that it would not be right to assume it as certain, and to adopt estimates which, in the event of its failure, would be found inadequate to complete the works.

Saving by adoption of Moncrieff system.

By a reference to Table viii. in the Appendix it will be seen that the saving consequent on its adoption is estimated at 194,159*l.*, and thus the amount required from the Loan would be reduced to 7,757,278*l.*; against this saving must be put some increase of the cost of the armament arising from the increased cost of the carriages. No reliable data can yet be given for comparing the cost of these carriages with others that may be adopted; we do not therefore attempt to fix any sum as the amount of increased cost under this head.

Amount expended under the Loan.

195.—5th. The sum expended under the Loan to the 30th June last amounted to 3,878,970*l.* for works, and 1,239,868*l.* for land and incidental expenses, making a total of 5,118,838*l.* The total amount required to complete the works, is now estimated at 2,832,599*l.* The excess on the estimate of the Act of 1867 will be 481,437*l.*

Further sum required.

Adequacy of Estimates.

196.—6th. Lastly we believe that the estimates laid before us have been most carefully prepared, and that they will be found adequate to complete the works in accordance with the designs on which they are formed.

FRED. WM. GREY, *Admiral*,
Président.

C. DICKSON,
Major-General.

J. L. A. SIMMONS,
Major-General.

H. D. HARNESS,
Colonel, R.E.

T. ELWYN,
Colonel, R.A.

JOHN HAWKSHAW,
C.E., F.R.S.

J. C. ARDAGH, *Lieut. R.E.*
Secretary.

109, VICTORIA STREET,
28th April, 1869.

APPENDIX No. VIII.

LOAN FOR DEFENCES.

RETURN showing the Works in which it is proposed to adopt the Moncrieff Gun Carriage system; the Armament, nature of Defence for the Guns, and Cost of the Designs as previously approved, and as proposed to be modified according to Moncrieff's System.

Name of Work.	Work as Proposed to be Executed previous to Captain Moncrieff's Invention.					Design, as modified, for the introduction of Captain Moncrieff's Gun Carriages.						Saving.	Excess.	Remarks.
	Armament.				Estimated Cost including Turrets and Shields.	Armament.				Cost of adapting Work.	Total Cost.			
	Iron Casemates.	Granite Casemates with Shields.	Open Batteries with Shields.	Open Batteries without Shields.		Moncrieff's Gun Pits.	Iron Casemates.	Granite Casemates with Shields.	Open Batteries without Shields.					
					£					£	£	£	£	
Puckpool (30 Mortars)	..	..	4	1	28,964	4	..	..	1	2,824	23,688	5,276	..	
Southsea	..	..	23	9	75,879	23	..	..	9	6,862	47,716	28,163	..	
Hurst (3 Turrets) ..	..	61	(6 in turrets)		269,271	4	..	61	..	8,302	217,573	51,698	..	The estimated cost includes for Turrets.
Cliffe End	..	..	..	20	32,714	12	..	..	8	2,700	35,414	..	2,700	
Sandown Fort ..	..	18	..	10	73,876	10	..	18	..	3,090	76,966	..	3,090	
Drake's Island ..	..	21	..	5	62,108	5	..	21	..	1,416	63,524	..	1,416	
Hubberstone ..	..	11	..	16	73,615	8	..	11	8	6,068	79,683	..	6,068	
Popton	..	11	..	17	75,636	6	..	11	11	4,968	80,604	..	4,968	
East Weir	..	..	..	27	..	10	..	..	17	2,070	..	..	2,070	
Coal-House Fort ..	..	28	..	..	A. 211,063	8	12	..	..	B. ..	163,179	47,884	..	Should the Thames Forts be constructed according to design, a further saving of 48,271*l.* will be effected.
Cliffe	..	20	..	..	A. 162,937	6	7	..	..	B. ..	124,815	38,122	..	
Shornmead	..	20	..	..	A. 147,705	5	9	..	..	B. ..	115,753	31,952	..	
Grain Fort	..	..	..	..	114,714	15	..	..	..	5,886	120,600	..	5,886	
Grain Battery ..	..	..	..	15	31,734	10	..	..	..	3,400	35,134	..	3,400	
Queenborough ..	..	..	..	14	30,853	3	..	..	..	4,024	14,877	16,976	..	
Cheney	..	2 Guns in a Turret.			30,528	3	..	..	..	3,298	13,826	16,702	..	The estimated cost includes for Turrets.
Spike Island ..	..	2 Guns in a Turret.			41,313	16	..	..	..	5,764	23,077	18,236	..	
Carlisle	..	..	16	..	111,499	16	..	..	..	6,556	94,055	17,444	..	
Camden	..	..	16	..	83,231	8	..	..	6	2,696	70,927	12,304	..	
	..	..	10	4										
	68	122	69	138	1,657,640*	172	28	122	60	69,924	1,401,411	283,757	29,598	
			10 in turrets.									29,598		
	Total, 407.					Total, 382.								
Saving by Moncrieff's System												254,159†		
For comparison with the Schedule of the Report, deduct for turrets at Hurst Castle, not included therein ..												60,000		
Saving on Works enumerated in the Schedule of the Report												194,159		

* This sum includes 100,000*l.* for turrets at Hurst Castle, Queenborough, and Cheney, which have not yet been sanctioned.—W. F. D. J.

† From this saving must be deducted the extra cost of the Moncrieff carriages.

WM. F. DRUMMOND JERVOIS.

15th March, 1869.

APPENDIX No. VII.

ARMAMENT RETURN.

[illegible] the number of Heavy Rifled Guns required for the Armament of Sea Batteries, erected, or in course of erection, under the "Loan for Defences."

NOTE.—A portion has already been supplied and mounted.

	Name of Work.	Description of Gun. 12" of 25 tons.	10" of 18 tons.	9" of 12 tons.	7" of 6½ tons.
	1. Horse Sand Fort	10	24	25	..
	2. No Man's Land Fort	10	24	25	..
	3. Spit Bank Fort	4	9	..	6
	4. St. Helen's Fort	4	6	..	4
[illegible]	5. Puckpool Battery	4	..	..	..
	7. Gilkicker Battery	5	17	5	..
[illegible]	8. Southsea Batteries	1	..	22	9
	9. Hurst Castle (Plan A)	6	..	61	..
	12. Needles Battery	..	..	2	4
	13. Hatherwood Battery	..	..	4	3
	14. Warden Point Battery	..	..	4	4
	15. Cliff End Batteries	..	..	20	..
	20. Sandown Fort	..	..	18	10
Plymouth	34. Bovisand Battery	..	14	9	..
	35. Plymouth Breakwater Fort	4	18	..	..
	36. Picklecombe Battery	..	19	19	4
[illegible]	38. Mount Edgecumbe Battery	..	..	7	..
	39. Drake's Island Batteries	5	..	21	..
	61. Fort Stamford	..	..	7	..
	65. Stack Rock Fort	6	16	..	7
	66. South Hook Battery	..	..	5	15
Pembroke	67. Hubberstone Battery	..	1	11	15
	68. Popton Battery	..	1	13	14
	69. Chapel Bay Battery	..	..	6	..
[illegible]	71. St. Catherine's Fort	..	..	3	8
	72. Proud Giltar Battery	..	..	..	2
	73. East Moor Battery	..	..	..	4
	74. Trewent Battery	..	..	..	5
Portland	75. Freshwater West Battery	..	..	..	4
	77. East Weir Batteries	..	..	27	..
[illegible]	79. Portland Breakwater Fort (Plan A)	..	* 14	15	..
	80. Nothe Fort	..	6	4	..
Thames	81. Coal House Fort (Plan A)	..	* 28	..	..
	82. Cliffe Fort (Plan A)	..	* 20	..	..
[illegible]	83. Shornmead Fort (Plan A)	..	* 20	..	..
	84. Slough Fort	..	..	..	7
	85. Grain Fort	..	11	4	..
Medway	86. Grain Battery	..	..	10	..
	87. Garrison Point Battery	4	..	36	..
[illegible]	88. Hoo Fort	..	..	11	..
	89. Darnet Fort	..	..	11	..
	91. Queenborough Battery (Plan A)	..	..	* 2	..
	92. Cheney Battery (Plan A)	..	..	* 2	..
Cork	100. Spike Island	..	4	12	..
[illegible]	101. Carlisle Fort	..	4	3	12
	102. Camden Fort	..	..	8	6
		63	256	432	143
	General Total	..	..	..	894

* ALTERNATIVE PLANS:—

	B.	C.
Portland	14, 10-inch	8, 12-inch.
Coalhouse	20, 10-inch	14, 10-inch.
Cliffe	13, 10-inch	10, 10-inch.
Shornmead	14, 10-inch	10, 10-inch.
Queenborough	2, 9-inch.	
Cheney	2, 9-inch.	

WM. F. DRUMMOND JERVOIS.