

MADRAS RECORD OFFICE.

Government of Madras.

Revenue DEPARTMENT.

G.O. No.	389	Press ~~Mis.~~
221-222. Dated	12-2-	1868.

Not to be folded or roughly handled

*Proceedings of the Madras Government, Revenue Department,
12th February 1868.*

No. 221. Read the following Proceedings of the Madras Government in the
Public Works Department :—

Ordering that the report on the proposed high
level fresh water canal to connect the Kuam
and Adyar rivers, lie over, until receipt of
the plans and estimates for the low level salt
water canal. (Here enter 21st January 1868, No. 215.)

No. 222. ORDER THEREON, 12th February 1868, No. 389.

Miscellaneous.

Communicated to the Revenue
Board.

(True Extract.)

(Signed) F. BRANDT,
Under Secretary to Government.

To the Board of Revenue, with Proceedings Public Works Department, No. 215.

Exd. F. R. Bantleman.

Proceedings of the Madras Government, Public Works Department
21st January 1863.

No. 418. Read the following letter from W. FRASER, Esq., C. E., Executive Engineer, to the Secretary to Government, Public Works Department, dated Madras, 17th December 1867, No. 210:—

1. I have the honor to submit plans, estimates, and report on the proposed high level fresh water Junction Canal. I have kept these plans back for some time, with the intention of submitting those for the sea level canal at the same time; but as the preparation of the latter will occupy me for some days yet, I deem it better to send up the plans of the high level scheme without further delay, that it may be understood when the Government come to consider the rival projects.

2. The detailed estimates and specification will be sent up in a short time.

MADRAS JUNCTION CANAL.

REPORT ON A PROPOSED HIGH LEVEL FRESH WATER CANAL TO CONNECT
THE KUAM AND ADIYAR RIVERS, AND THUS TO UNITE THE
EAST COAST CANAL ON THE NORTH
AND SOUTH OF MADRAS.

1. The formation of a canal between the Kuam and the Adiyar rivers for the purpose of connecting the northern and southern portions of the East Coast Canal is not a new idea. It was under discussion in March 1855, when I came to India; and, at various periods between that date and the present time, the question has been repeatedly raised and dropped; but although the project has often lain in abeyance for lengthened periods, it has never been altogether abandoned.

2. When the construction of a canal between the Adiyar and the Palar rivers* was sanctioned by the Court of Directors, it became evident that this part of the navigation could never be successful in a pecuniary point of view until it was extended into Madras, and connected with the northern navigation. I have lately read nearly the whole of the very voluminous correspondence and other records connected with this project, and I find that, with one exception, that of the Right Honorable Sir Charles Wood, this favorable opinion of the Junction Canal has been held by every one who has had occasion to consider the subject: By Engineers and non-professional men, by every Government in Madras, from that of His Excellency Lord Harris up to the present time, and by the Government of India, the construction of a Junction Canal has not only been approved of, but advocated; and the wonder is that a work so universally acknowledged to be necessary, should, at the end of more than twelve years' discussion, still be in the preliminary stage of being reported on.

3. The Government appear to have ever been desirous of pressing this work forward; but besides the difficulty of procuring money, and that of the general restrictive order regarding new works in 1857, by which order many useful projects of this kind were delayed for years, they had the perplexing difficulty of differences of opinion amongst their professional advisers. Some would carry the

* This is generally called the SADRAS CANAL, by which name, for the sake of brevity, I shall hereafter designate it.

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canal on the west side of Madras, to avoid going through valuable property: others would carry it right through Madras, because it would pass through, or close to, valuable property. Some advocated a sea level salt water canal, similar to the rest of the navigation; others objected to this on account of supposed damage to the wells in its vicinity. Some proposed a *high level salt water* canal, to be independent of the proposed water-supply to Madras, and to save deep excavation; but this was met by a host of objectors, who considered it would be more destructive than the sea level canal, so far as the wells were concerned.

During this discussion the idea of a *high level of fresh water* canal was gaining supporters, and the latest decision of the Government is in its favor: But as this idea originated with Colonel O'Connell's scheme for supplying the southern part of Madras with water from the Pammal tank when restored, and as no other reservoir besides the Red Hill Lake is likely to be required for this purpose, and as there is no reason why the navigation and water-supply should be connected, but many reasons why they should not be, it is probable that the supporters of the sea level canal will have another hearing before the question is finally decided.

4. Considering that it would be useful to the Government to have before them all the facts connected with this scheme, in case it should be further discussed, I have gone carefully through all the records in the East Coast Canal Office, and the following is a brief history of the project.

20th September 1854.

Lieutenant (now Colonel) Chambers of the Engineers, "*Superintendent of the East Coast Canal*," sent up the estimates for the Sadras canal to the Board of Revenue. This project was sanctioned by the Court of Directors either late in this year or early in 1855, and the Junction Canal was then considered a necessity.

April 1855.

A survey made by Captain Rawlins, under the direction of the Military Board, was examined and generally approved of by Lieutenant Chambers.

This appears to have been the first actual survey made.

24th December 1855.

Chambers' design No. 1.

5. Two plans were sent up to the Chief Engineer by Lieutenant Chambers.

Both followed the same line which had been surveyed by Captain Rawlins. See the line marked A, B, C, D, on sheet No. 1.

Starting from the head of the Sadras canal at A, the Adiyar was followed to Home's Gardens, where the line left the river and ran straight across the Mount Road into Mylapore tank, cutting across the south-west corner of Sir Henry Rawlinson's (now Sir Adam Bittleston's) compound.

It ran through the tank nearly to the old Poonamallee road, whence it passed down, through Nungumbakkam, to the Kuam, at a point about 500 yards above the Commander-in-Chief's bridge.

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One design was to build a dam across the Adiyar, *just below* the head of the Sadras canal, so high as to raise the river and canal to about the level of high water of spring tides or a little higher.* No figures are given, but the dam would, probably, have been 2 or 2½ feet above mean sea level. No locks were provided by this design, but the channel was to be cut down to about the level of low water; the average depth of excavation being about 20 feet.

In connection with this design, the Kuam and Black Town ditch were to be deepened, to connect the navigation with the Basin on Cochrane's canal.

In the Adiyar dam at the Sadras canal, a lock was to be built to allow boats to descend to the lower Adiyar, for the convenience of St. Thomé. A dam was to be erected across the Kuam, *above* the point where the canal entered, for the purpose merely of keeping back silt from the mouth of the canal.

The estimate for this plan was 2,68,000 Rupees, not including compensation for damage to property.

Chambers' second design.

6. The second design was the same as the first in all respects, except that the canal was to be raised by a double lock at each river about 20 feet above mean sea level; and to be supplied with fresh water from the Pammal tank, when restored, as proposed by Colonel O'Connell.

The estimate for this design was 2,15,000 Rupees, exclusive of compensation for damages, which Lieutenant Chambers estimated at 36,000 Rupees.

Lieutenant Chambers says (paragraph 3) that he originally thought that a *coast low level canal* from the Kuam at the Marine Villa to the Adiyar by St. Thomé, would be the best line; but that further consideration led him to confidently assert that it was not so practicable as either of the plans submitted.

7. The two plans had been returned to Lieutenant Chambers on account of their incompleteness; * and, on this

15th April 1856.

date, he re-submitted No. 2, to which he adhered, and explained it in detail. It depended altogether for a supply on the restoration of the Pammal tank; from which he expected to get 75,000 cubic yards of water a day for lockage, waste, and evaporation.

The estimate was 1,68,000 Rupees, excluding damages, but including about 40,000 Rupees for deepening the Kuam and the town ditch to the Basin. Lieutenant Chambers admits that this canal being so very circuitous would never become a passenger line.

Captain Collyer's design.

8. About this time Captain Collyer, of the Engineers, who was then Superintending Engineer of the Southern Circle, proposed a modification of Lieutenant Chambers' plan, for the purpose of avoiding the destruction of valuable property in Nungumbakkam.

* Dams were to be built across the back waters at Covelong, Sadras, and the Palar, to the same height, so as to raise the whole Sadras canal above the level of high water. Materials for some of these dams were prepared. Sheddankuppam lock, on Cochrane's canal, was intended to keep the water up at the north end. If this idea had been carried out, the Sadras, the Junction, and Cochrane's canals, and the Kuam river, would all have been raised two to three feet above mean sea level, and the water would have been brackish. There was no provision made for damming the Kuam, which, I presume, was an oversight.

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He proposed to follow the line of the Kuam up to Chetput, where the river approaches close to Nungumbakkam tank, up into which he proposed to lock, and thence to follow the deep bed of the tank and Chambers' line to the Adiyar, where another lock would be built. See the line marked A, B, E, F, D, on sheet No. 1.

This plan was approved of by Colonel Lawford and Captain Johnson, Superintending Engineers; and was surveyed by Lieutenant Sankey, who succeeded Lieutenant Chambers as "*Superintendent of the East Coast Canal*" in October 1856.†

It was proposed to excavate the canal on the south side of the bed of the Kuam to Chetput; to place a lock with a lift of $4\frac{1}{2}$ feet at the College bridge; one with $2\frac{1}{2}$ feet lift at Munroe's bridge; and one of $9\frac{1}{2}$ feet to lift the canal into Nungumbakkam tank. The locks to be placed in side cuttings at the bridges. The lock at the Adiyar should have had a lift of about 17 feet.

As this line was $1\frac{1}{2}$ miles longer than Chambers', Lieutenant Sankey preferred the latter. There is no estimate of this design in the Canal Office.

January 1857.

9. The Government submitted all the plans for the opinion of Colonel

Arthur Cotton, then Commandant of Engineers, who, in a Memorandum dated 27th January 1857, reviewed the several propositions, and disapproved of them all.

He laid down the principle that, "Whatever the cost may be, we ought to 'carry the canal where it is wanted.'"

He proposed that it should follow the most direct and shortest line from the Kuam to the Adiyar, at the head of the Sadras canal.

His line is the blue one marked A, G, H, on sheet No. 1. It passes through Pugh's gardens at the Adiyar, through the fields and gardens on the east side of Mowbray's road, through Mr. Ritchie's (now Mr. Swinton's) compound, through the middle of Royapetta, by the Club Chambers at Patter's gardens, through the houses on the north of the Begum's garden, on the east side of the road from Waller's stables to the Club, across the Mount Road at Shaw's shop, and into the Kuam near the Mahomedan burying ground. One line is drawn through Waller's stables and into the Kuam at the rear of Richardson's shop.

Colonel Cotton proposed that the canal should be independent of the intended water-supply; that it should be raised 10 feet above mean sea level by a lock 150 feet $\times$ 12 feet at each end; and that water for lockage, waste, evaporation, &c., should be supplied by a pump worked by a 10-H. P. steam engine.

A rough estimate of this project amounted to 2,93,000 Rupees, including 1,00,000 Rupees for compensation for damage to houses and land, and 22,000 Rupees for deepening the Kuam and the town ditch.

May 1857.

10. The Government, by their Order No. 439, dated 7th May 1857, directed that this subject should be referred to the Committee which had been appointed to scrutinize and verify Colonel O'Connell's project for supplying Madras with water.

I am uncertain whether the Committee ever reported on the Junction Canal, and from the Proceedings of the Madras Government, from the 17th to 23rd September 1859, it appears that no such report was on record in the Chief Engineer's Office.

† When sending up the plans, Lieutenant Chambers said that he did not think the Chief Engineer would approve of either, as they were merely intended to raise discussion on the subject amongst others.

* This survey was probably made in November 1856; but as Lieutenant Sankey's letter is only partially entered in the letter book, and bears no date, I am uncertain of all the details of the proposed design.

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July 1857.

11. The records of the Canal Office show that on the 13th July 1857, the Committee instructed Mr. Kennedy to prepare plans and estimates in accordance with Colonel Cotton's suggestion.

September 1857.

A sketch and estimate were submitted in September 1857, the latter amounting to 2,83,000 Rupees, including a sum of 75,000 Rupees as compensation for damages.

Mr. Kennedy followed the line sketched by Colonel Cotton, and proposed a lock of 12 feet lift at each end, and a 30-H. P. steam engine to raise water for lockage, &c.

Mr. Kennedy's proposal for a sea level canal. 12. It is evident from the latter part of Mr. Kennedy's report, that this high level salt water canal did not meet with his approval; and that his opinion was in favor of a sea level canal in the same line.

As it is important that his views on this subject should be recorded, I here give an extract from this part of his report:—

"Para. 18. Having gone over the estimates upon this plan [the sea level canal], also, I feel I would not be fulfilling my duty were I not to lay before the Committee a few remarks upon this view of the question.

"19. Supposing the excavation carried down to 4 feet below mean tide, without an increase of breadth at surface, or alteration of slopes, giving a surface of water of 47 feet, it would cost for excavations, including removal of spoil as in the other case, Rupees 50,000 extra, and would cost under 20,000 Rupees additional for land, for increased space required for spoil—in all 70,000 Rupees.

"20. This additional expenditure would probably be balanced by very considerable advantages—

"1st.—The bridges might be constructed with the roadways level with the country.

"2nd.—There would be no necessity for locks, which alone would cost the greater part of that additional outlay, and, thirdly, there would be no necessity for an engine to raise the water, and this combined with that of the permanent establishment required to work the locks, would be the greatest saving of all. We might moderately estimate the permanent establishment as follows:—

"For each lock one Gumastah	Rs. 8		Rs.
"4 Lascars	...	20	
	Rs. 28	2 Locks	56

"Fuel for engine working fifteen hours at 40 Rs. per day	1,200
"Engineer, Drivers, and sundries	200

Monthly ... 1,456

Yearly ... 17,472

"Representing a capital at 5 per cent. of	3,49,440
"To which add for engine-house, engine, &c.	25,000
"And for two locks	35,000

Total ... 4,09,440

"A much larger amount, independent of tear and wear, than is required to make the canal to the full depth, enabling it to be worked at all hours without obstruction and without delay. The decrease of breadth might be an objection, but I think that with the necessary basins at the depôts, there would be no accumulation of boats on the canal proper, to derange the current traffic.

"21. I submit these latter remarks not without hesitation, knowing my inability to do justice to the subject, and as it leads to a result in some measure opposed to the view taken by Colonel A. Cotton; at the same time I am certain that gentleman would not thank me for withholding what seems to me correct deductions, deprecating as he does in his report any further reliance on his rough estimate than what may serve as a guide to a detailed one."

June 1859.

13. By a letter (No. 1,765, dated 17th June 1859) from Colonel Bell, Chief

Engineer, to Mr. Bourdillon, Secretary to Government, it appears that Mr. Kennedy's proposition was submitted to Colonel Cotton, who returned it without comment. It was re-submitted for his opinion in March 1859, when he approved generally of the high level design, but suggested the substitution of fresh water for salt, getting the supply from the Pammal tank by a high level canal made for that purpose.

He also again recommended the construction of two branch canals. One from the Kuam near the Medical College to the light-house esplanade, and one from the present basin along the north side of Black Town to the beach.

14. The following portion of Colonel Bell's letter, paragraphs 8 and 9, will show what he thought of the main project, and how it should be carried out:—

"Para. 8. I need not enter into the details of Mr. Kennedy's project, which is simple and easy of execution, either by taking a high level and using locks, or by sinking the whole line to an adequate depth for navigation below mean tide. The junction to be effected by this canal is essential to the utility of the Southern Canal; and this being granted, the next thing is to render the junction line as useful and profitable in itself as is possible under the circumstances.

"As far as the Government is concerned, there could be no doubt of the necessity of immediate attention to the Junction Canal, if it were not for the restriction which fetters every good project of public improvement. But the canal and the proposed extensions are strictly city works, and ought to be executed from municipal funds raised for the purpose.

"9. I would, therefore, strongly recommend that a capital of five lacs be immediately raised under the sanction of Government, and with a guaranteed interest added to a half share of the profits; and that a further portion of capital be raised, as it may be required, to the extent of ten lacs in all. But nothing should be guaranteed upon a less amount than five lacs to start with. I cannot venture to say by what authority the guarantee should be given; but when it is so, the works should be planned in detail, under the direction of a Committee of Officers, acting in communication with the municipality and some of the principal residents of the city."

15. Colonel Bell's letter, and all the papers connected with the canal and several collateral subjects, were reviewed, at great length, by His Excellency Sir Charles Trevelyan, who in paragraphs 3 to 6 made the following remarks:—

"Para. 3. The Madras Junction Canal, between the Kuam and the Adiyar, is a work of so beneficial and productive a character, and is so well calculated to mitigate the great and increasing dearth at the Presidency capital of firewood and all the other necessities of life, that it ought to be undertaken without delay; but I am of opinion that it should be constructed by the direct action of the Government, and not through the medium of a private company.

"4. Upwards of 60 miles of canal on the north, and 40 miles on the south of Madras, have already been made by the Government; and the whole of this long line of navigation will be rendered more useful and remunerative by the construction of this connecting link, which will be only three miles and 1,007 yards long.

"'Nothing,' Colonel Cotton observes, 'can be more contrary to sound judgment, than to cut a canal of 40 miles in length, and then not connect it with the point to which its traffic would proceed, and it is most lamentable to see the public money thus lost. Probably in the four years that have elapsed since the Southern Canal was cut, 500,000 tons of goods have been carried along the southern road, at an expense of 4 Rupees a ton, for 40 miles, or 20 lacs of Rupees, because the canal was connected with nothing at either end.' The northern canal, His Excellency proceeds, 'is already a profitable work, because it terminates at Madras; but it would be more productive if it became the medium of a through traffic to the south. The estimated cost of the Junction Canal, including the purchase of the ground, is only three lacs of Rupees. It is not right that the State, that is the public, should lose the benefit of its large previous outlay, for want of the small additional expenditure required to connect the existing lines of navigation on the north and south of Madras.

"5. Convenience and economy of management, and the proper adjustment of the tolls, require that the canal, from one end of it to the other, should belong either to the State or to a private company. After the pains which were taken to establish a single toll on the Indus, and to abolish the chokes on the Ganges, we ought not to create a divided jurisdiction on the East Coast Canal. I am of opinion that it is most for the advantage of the community that the State should retain the great lines of internal navigation in its own hands; but, however that may be, it is a fact, that, in this case, upwards of one hundred miles of the line of navigation already belong to the Government; and, in order that the whole may be under one management, the remaining three miles must be added to the hundred which are in the hands of the Government, or the whole hundred and three must be handed over to a private company."

"6. Two cuts are recommended to be made to connect the canal with the beach: one, which has been under discussion for many years, from the basin at the north-west end of Black Town to Clive's Battery; and the other, which has been lately proposed, from the Medical College, at the south-east end of Black Town, to the light-house. As this last will furnish an extraordinary amount of accommodation for passengers and goods, compared with the shortness and

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"cheapness of the line (the estimate is only 60,000 Rupees), it ought to be immediately undertaken. It will also complete the outer line of defence of Fort St. George. The estimate for the north-east cut is 1,00,000 Rupees."

The Honorable Mr. Morehead supported His Excellency's views in the following remarks:—

"The necessity for joining the Northern and Southern Canals is obvious, and formed a part of the scheme contemplated when the portion of the Southern Canal now finished, was commenced upon. If funds can be obtained as suggested, the work should be executed as soon as possible. The extension of the canal to the light-house will be a fair experiment, and as it can be effected at a small cost, should be, in my opinion, carried out."

20th September 1859.

16. The following is the Government Order on these papers. It is dated 20th September 1859, No. 2,262:—

"Para. 1. The Government resolve to transmit to the Chief Engineer a copy of the Honorable the President's Minute above recorded, and to request that he will take immediate steps for the preparation of the necessary working plans and estimates for the projects referred to therein to be undertaken at the cost of the State, viz., the Junction Canal between the Kuam and the Adiyar, and the canal from the Medical College at the south-east end of Black Town to the light-house. The Chief Engineer will submit these plans and estimates as soon as possible."

"2. The Government also request that Colonel Bell, will without waiting for these details, and without any delay, report the probable amount which might be expended on these works within the current official year, in the event of sanction to them being obtained at an early date."

17. Without waiting for the preparation of detailed plans, the Madras Government, on this date, forwarded the papers to the Government of India, and requested general sanction to an expenditure of one lac of rupees in the current year on the canal and branches, pending the submission of detailed estimates."

27th September 1859.

See Mr. J. D. Bourdillon's letter to Colonel Baird Smith, C. B., No. 2,314.

14th November 1859.

the letter of Colonel H. Yule to J. D. Bourdillon, Esq., No. 7,668.

"Para. 2. As regards project 1, [the Junction Canal,] the Government of India consider the proposed junction as a desirable completion of a very important line of navigation, and fully approve of the scheme on its professional merits."

"3. The views of the Madras Government, in reference to the expediency of completing the work under consideration at Government expense and by Government agency, are fully concurred in by the President in Council; the course proposed being evidently the most convenient one, since the hundred miles of navigation to be connected by this short link are already the property of Government."

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"4. But, I am to remark, that the expenditure involved in this project being about four lacs, it is beyond the competency of the Government of India to give a general sanction to it, and it will be necessary to refer the scheme to the Home Government for orders."

"This, however, cannot be done till explicit plans and detailed estimates for the work are submitted, those accompanying the reference being very incomplete."

12th December 1859.

On this letter the Order of the Madras Government, No. 2,876, is as follows:—

"Para. 1. Ordered that this letter be forwarded to the Chief Engineer, with the request that he will submit to Government at the earliest practicable date, the working plans and estimates called for in Proceedings dated 20th September 1859, No. 2,262, for the proposed Kuam and Adiyar Junction Canal, and the branch from the Medical College to the light-house."

"2. Looking at all the circumstances, the Honorable the Governor in Council is of opinion that this work does not yield in importance to any that could be proposed, and that measures ought to be adopted to secure its early commencement."

"The project will therefore be included in the Budget of 1860-61; and the Chief Engineer is requested to specify the amount which it may probably be practicable to lay out upon it with advantage in that year."

"3. Ordered that the whole of the correspondence on the subject be reported to the Home Government."

14th February 1860.

19. In January 1860 the detailed plans, prepared by Mr. Kennedy, were submitted to the Government."

The proposition, this time, was for a sea level canal in the line which had previously been surveyed for a high level one. The surface breadth was to be 60 feet, and the depth 4 feet below mean sea level. A wharf at the Kuam, and five landing places along the line of canal were to be constructed. The estimate, including 76,000 Rupees for damage to houses and lands, was 3,59,300 Rupees.

The Government approved of these plans, and ordered that the amount of the estimate should be entered in the Budget of 1860-61.

4th April 1860.

20. By the order of the Madras Government of this date and No. 701, the reply of the Right Honorable the Secretary of State was communicated to the Chief Engineer. It is dated 20th February 1860, and is as follows:—

"Para. 2. I am not altogether convinced of the reality of the advantages expected to accrue from connecting the two canals which enter Madras from the north and south. For the special purpose for which the canals were designed, viz., that of bringing supplies to Madras, it is sufficient that they should terminate at convenient points within or near the town. A Junction Canal, uniting the terminal points, might be very serviceable to whatever through traffic is carried on between the districts lying immediately to the north and south of Madras, but there is nothing to show that any such traffic exists, of sufficient importance to warrant an expenditure of three lacs of rupees for its accommodation. As, however, your Government are unanimous in approving of the

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"project, and as the Government of India also regard it as one which ought to be executed as soon as funds can be made available for it, I shall offer no obstacle to its adoption. It will be for you to determine whether the requisite funds can be spared from the amounts to be hereafter annually placed at your disposal for expenditure on Public Works."

25th April 1860. Government Order No. 848.

23rd May 1860, No 1,075.

1,50,000 Rupees was placed at his disposal for expenditure during the current year; the plans and estimates having been approved of by the Government of India in their despatch dated 2nd May 1860, No. 2,235.

3rd July 1860, Government Order No. 1,406.

21. The Government sanctioned an advance of 20,000 Rupees to enable Mr. Kennedy to commence operations; and by the Order No. 1,075, a sum of 1,50,000 Rupees was placed at his disposal for expenditure during the current year; the plans and estimates having been approved of by the Government of India in their despatch dated 2nd May 1860, No. 2,235.

22. The project had so far progressed, and I believe Mr. Kennedy had actually commenced to clear the line for final marking out, when some one suggested that a better line could be had nearer to the sea; and in the order noted in the margin, the Chief Engineer was requested to report on the merits of this suggestion.

This led not only to a re-investigation but to an indefinite postponement of the subject.

August 1860.

In his letter dated 21st July 1860, No. 2,902, the Chief Engineer (Colonel Horsley, R. E.) reported most unfavorably of the suggested coast line; but the Government considered this report unsatisfactory, and in paragraph number 2 of their Order No. 1,751, dated 17th August 1860, They say:—

"2. The report is a very summary one, and has been written without actual examination of the ground. The Governor in Council believes that Mr. Kennedy's estimate for the purchase of the land by the route proposed by him is much understated. He is of opinion that before a final decision is made, a more detailed examination of the coast line should be made by some one who has not already committed himself to the approval of one or other of the proposed plans. The Chief Engineer is accordingly requested to have this examination made by a competent officer, whose report should be laid before Government, accompanied by any remarks which Colonel Horsley, on further consideration of the subject, may wish to offer."

June 1861.

23. The first officer available was Mr. Dopping, Covenanted Civil Engineer, who, having just returned from leave in England, was considered to be free from bias in favor of either line, and he was appointed to prepare the necessary plans.

Mr. Dopping submitted his plans, estimate, and report, and also a comparative statement of the cost of the inland and coast lines in June 1861; but Colonel Horsley did not submit them for the consideration of the Government until the month of October of the same year.

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Mr. Dopping's plans and detailed estimates are not to be found in any of the offices in Madras, so that I am uncertain as to the exact line he proposed to adopt; but as it is described in his report to Colonel Boileau, R. E., Deputy Chief Engineer, I have been enabled to lay it down with tolerable accuracy on sheet No. 1 by the line drawn thus —| —| —| — and lettered A. J. K.

24. Mr. Dopping's project was for a *sea level canal* on the same scale as that proposed for the inland line, the bottom of each being 4 feet below mean sea level. Mr. Dopping's line left the Kuam near the Marine Villa, passed in front of and close to Chepauk palace; by the rear of the ice house, and of Capper House Hotel; across Mylapore main street, into the back-water on the east side of the South Beach road, to which it ran parallel until it came close to the Adiyar, which it entered a few hundred yards on the east of Brodie Castle. Thence to the terminus of the Sadras canal the Adiyar river was followed, which was to be dredged to render it fit for navigation.

The Kuam was also to be deepened to its junction with the Northern Canal.

Twelve bridges and three inverted syphon sluices for drainage were proposed to be erected.

25. Mr. Dopping's estimate appears to be—

	RS.
1. Earth-work, including basins, and deepening the Kuam and Adiyar	58,594
2. Twelve bridges	99,810
3. Three syphon sluices	61,300
	2,22,704
4. Compensation for damages	56,200

Total... 2,78,904

Mr. Dopping states the whole amount of his estimate to be 2,81,810 Rupees, but there is an error of nearly 3,000 Rupees in the calculations in paragraph 34 of his report, which error has been repeated by Colonel Horsley in his statement.

26. In a subsequent letter Mr. Dopping gives his estimate for the inland line, assuming it to be a sea level one, and that all the works were to be on the same scale as those he had proposed for the coast line.

Leaving out the cost of the proposed carriage roads, he estimated this line at 4,36,975 Rupees, or 1,58,071 Rupees more than the estimated cost of the coast line.

27. This is the result of his comparison of the two lines, the works being reduced to the same standard on both, so far as I can make it out from his papers; but Colonel Horsley, who reviewed them in October 1861, makes it appear, in paragraph 9, that the inland line would cost 3,86,000 Rupees, and the coast line 5,00,000 Rupees, showing a difference of 1,14,000 Rupees in favor of the former.

It is not explained how he arrives at five lacs of Rupees as the probable cost of the coast line; but he is evidently strongly opposed to this route, and expresses an opinion in favor of the inland line, but as a *high level fresh water canal*.

28. In the absence of Colonel Boileau the papers were referred to Colonel Randall, R. E., who reviewed the whole question from the beginning.

*Proceedings of the Madras Government, Public Works Department,
21st January 1868.*

He makes no comparison of the rival projects; condemns the coast line; is in favor of the inland line, as it goes through the heart of the city; would make it a high level fresh water canal, to be supplied from the Pammal tank, which, he says, could be restored at a cost of 1,10,056 Rupees.

He summarizes the advantages of such a canal thus:—

"Para. 23. (1).—The fundamental point of an ample supply of fresh water for drinking purposes.

"(2).—The foundation for a system of water-supply to the city for domestic purposes and for cleansing the drains.

"(3).—The rivers Adiyar and Kuam being kept full of fresh water all the year round.

"(4).—All the cultivated lands and compounds of Madras could be supplied to a certain extent with water during the dry season.

"(5).—A line of navigation through the heart of Madras, extending eventually to the Mount and Palaveram, and connecting the north and south canals, and thus admitting all the traffic to every part of the city hereby clearing the roads of traffic greatly, saving their wear and tear, and consequently diminishing the expense of their maintenance.

"(6).—Stone could be brought to all parts of Madras at one-fourth of its present cost, a matter of considerable importance especially with reference to the improvements of the port.

"(7.) A supply of water-power equivalent to 300 horses for driving pun-kahs or other purposes. The expense of a steam horse power in Madras being about 2 Rupees per day, a charge of 8 annas might be made on all water supplied for that purpose."

5th November 1861.

29. All these papers are given in the Proceedings of the Madras Government, under date the 5th of November 1861, and it is impossible to read them without being impressed with the feeling that the coast line, indeed the question of a sea level canal altogether, received very little consideration; and that the splendid idea of having a fresh water canal through the heart of Madras, prevented its advocates from perceiving that there was no necessary connection between the joining of the north and south navigations, and the supplying of the city with fresh water. If people's minds had not been carried away by this idea, would any one ever have imagined that the contents of a still-water canal over which ten thousand people, of not the most unexceptionable habits, were transported during the day and part of the night, would be used for "drinking purposes."

With the exception of Colonel Rundall's memorandum, the papers themselves are not easily understood; and taking into account the conflicting opinions, and the uncertainty which seemed to have again enveloped the whole question, it is not surprising that the Government Order on these papers, No. 2,046, was simply "Ordered to lie over."

5th of December 1861.

30. On this date the Government considered again the papers alluded to above, and recorded the following Order No. 2,235:—

*Proceedings of the Madras Government, Public Works Department,
21st January 1868.*

"1. The Government have read all the papers connected with the several schemes suggested for a Junction Canal through Madras, between the Adiyar and Kuam rivers, and they are prepared to advocate the design first proposed in 1856 by Lieutenant Chambers, late Superintendent of the East Coast Canal, viz., a High Level Fresh Water Canal, as that in every way best adapted to the wants of Madras; provided it be possible to secure an adequate supply of fresh water for the south-end of Madras, and for the navigation and waste of the canal. This scheme is dependant on the restoration of the Pombel tank near Palaveram, and the Government think, therefore, that the safest plan will be energetically to undertake the repair of the Pombel tank, as a work which will be sure to pay even should the supply be insufficient for the canal; and should it be ascertained that by throwing the waste water of the Palar into the tank a sufficient supply of fresh water could be maintained for the canal, then to complete this according to the proposed plan. Should it, however, be proved that the supply of water would not be sufficient for the navigation, then it will be considered whether the low level salt water canal is to be adopted; but the Government are not certain that in such a case the line nearer the sea might not be the best. The injury done to the wells in the vicinity of a salt water canal is a serious objection. The Government consider that it might be possible, should there be an ample supply of water in the Pombel tank, to fill the upper part of the Kuam river above the Commander-in-Chief's bridge, and to keep the Adiyar also well supplied with water.

"2. The first and most important matter is, however, the supply of water for Madras. The Chief Engineer will be requested to report at once what provision can be made for the repair of the Pombel tank in next year's budget, and to arrange for the immediate preparation of the necessary plans and estimates."

In compliance with this order the survey of the Pammal tank was proceeded with; several surveying parties were employed on it from time to time, but so far as I have been able to ascertain, no plans of any value were ever prepared.

June 1862.

31. The subject of the Junction Canal was revived by His Excellency Sir William Denison in May or June 1862; and, what was considered to be, the final Order of the Government, No. 1,431, was passed on the 24th of June.

This order is in favor of a High Level Fresh Water Canal, and goes into considerable detail regarding the several works necessary to accomplish the object required; but a grave misconception pervades the whole.

Mr. Kennedy was instructed to consider and report fully on the suggestions.

September 1862.

32. Mr. Kennedy prepared no plans nor estimates, but in September 1862 he gave, in a letter to the District Engineer, a description of the several works he would recommend for carrying out the intention of the Government Order. He proposed to adhere to Colonel Cotton's line, running through Royapetta, but, of course, to make it a high level fresh water canal. To place a dam across the Adiyar just above the entrance to the Sadras canal, and a dam across the Kuam at the rear of Taylor's stables.

These dams were to be four feet above mean sea level, which would have also been the level of the surface of the canal, and of the Kuam and Adiyar rivers for some distance up-stream. The small height of four feet was adopted for the purpose of avoiding damage to low lands along the Adiyar.

At each end, probably in the dams, a lock was to be built to pass boats to the level of the north and south canals.

In connection with this scheme Mr. Kennedy proposed to keep the Mylapore and Nungumbakkam tanks constantly full from the proposed Pammal tank; and, from those two tanks to supply the southern part of Madras with pure water through some 30 miles of brick conduit, with 200 dipping wells placed at intervals. He also proposed to construct a dam across the Adiyar at the Little Mount, as proposed by Colonel O'Connell, and to erect there a water-wheel to raise water to the south side of the river for irrigation; and wind-mills were also proposed for raising water for the same purpose, and for supplying Government House at Guindy with an ample supply of water during the hot season.

All these works were roughly estimated at 7,50,000 Rupees; but those which belonged to the Junction Canal alone were estimated at 3,27,000 Rupees, or 72,000 Rupees less than his estimate for a sea level canal in the same line.

33. I believe that no order was passed on this letter, and that the question was allowed to stand in abeyance, until a chance expression in a communication from the Madras to the Supreme Government, dated the 18th January 1864, No. 188, again drew attention to the subject.

15th April 1864. In their reply the Supreme
Colonel Strachey's letter, No. 1,230, dated Government say:—
15th March 1864.

"The Government of India would be glad to be informed what are the obstacles that exist to the carrying out of the sanctioned extension from the Adiyar to the Kuam."

34. In May 1864, on Mr. Kennedy's return to England, the East Coast Canal was transferred to my charge, and, on the 8th of March 1865, I was directed by the Government Order No. 647, to consider the construction of a High Level Fresh Water Canal between the Adiyar and the Kuam, in connection with other collateral schemes; two of which, the Madras Water Works, and the enlargement of Chembrambakkam tank, have since been reported on, the former being under execution. The surveys were proceeded with along with those of the other projects, which extend over a large area west of Madras; but on the approach of the famine in 1866, the preparation of the plans of the Junction Canal was hastened for the purpose of supplying unskilled labor for the people who were expected to crowd into Madras.

It was, however, subsequently considered that unless an ample supply of fresh water could be obtained the canal would be a nuisance, and the preparation of the plans was ordered to be suspended.

On the 22nd of May last I was directed to complete the plans and submit them with estimates without delay.

35. I have thus gone through the history of the Junction Canal for the purpose of placing before the Government, in a concise form, the facts connected with it; and the arguments and opinions of the successive Governments and Officers who have had occasion to consider the project. I believe that the time occupied in searching through and reading, for this purpose, an immense mass of badly kept and deficient records, will not be considered lost, as the Government will probably deem it necessary to make further enquiry as to which is the best plan for connecting the north and south navigations, a high level fresh water canal with locks, or an unimpeded navigation at the level of the sea. This is the only question to be considered; for the supplying of fresh water for either household purposes or irrigation to the southern part of Madras, is altogether independent of the question of forming a junction between the two existing canals.

36. I now come to describe the plans I have prepared for a High Level Junction Canal in accordance with the general scheme finally approved of by the Government. It was considered desirable to have as much as possible of the lower part of the Adiyar filled with fresh water, and principally for this reason it was decided to place the dam at the lowest possible point, which is just above the entrance to the Sadras canal.

The proposed dam across the Kuam, at the rear of Taylor's stables, was abandoned, as it was thought not desirable to break the tidal reach of that river, which extends from the bar to the College bridge.

The project then resolves itself into the following works:—

- I. A dam across the Adiyar at the mouth of the Sadras canal.
 - II. A high level fresh water canal in the best line between the two rivers.
 - III. A lock at each end.
 - IV. Subsidiary works, such as public and private road bridges; drainage and irrigation tunnels; landing steps, and basins.
- To these may be added—
- V. The formation of a public road along each side of the canal, from the crossing of the Mount Road on the north, to that of Chamier's road on the south.

37. The following plans are furnished with this report:—

SHEET No. 1.—INDEX PLAN showing the several rivers, canals, tanks, &c., alluded to in this report.

On this map the several lines described in previous paragraphs are shown thus:—

- I. The line A, B, C, D, is the one originally proposed by Colonel Chambers.
- II. The line A, E, F, D, the one proposed by Colonel Collyer, Colonel Lawford, &c.
- III. The line A, G, H, the one sketched by Colonel Sir Arthur Cotton, and surveyed by Mr. Kennedy.
- IV. The line A, J, K, the coast line surveyed by Mr. Dopping; and,
- V. The red line A, D, the one now proposed for a High Level Fresh Water Canal.

SHEET No. 2.—DETAILED MAP AND SECTION of the red line.—It was considered necessary to prepare a map on this ~~subject~~ account of the value and intricacy of the property through which the line runs.

No. 3.—DAM ACROSS THE ADIYAR. Plans and sections.

No. 4.—CROSS SECTION OF THE CANAL, and longitudinal and cross sections of under-tunnels.

No. 5.—Plans and sections of water shoots and landing steps.

No. 6.—LOCKS. Plan and section.

No. 7.—Do. Plan and details of gates.

No. 8.—BRIDGES. General plan and section, with details.

No. 9.—BASINS AND LANDING WHARVES. Plans and sections.

33. The first question to be considered was the best line for the canal. Mr. Kennedy's line through Royapetta has the disadvantage of not being the shortest between the two rivers, and of passing through a great extent of very valuable property; that, for instance, in the neighbourhood of the Club, Mr. Garrett's and Mr. Waller's, and the houses on the west of the Mount Road. I had this line levelled, and also every other line likely to turn out favorably; and, on comparing them all, as regards length, depth of cutting, damage to property, and convenience, I selected the one drawn in red.

It is the shortest line that can be had between the two rivers, being 5,077 yards or 2 miles, 7 furlongs and 17 yards in length, and is 1,341 yards or more than three-fourths of a mile shorter than Mr. Kennedy's line.

It interferes to a very slight extent with house property, passing, for more than two-thirds of its length, through ordinary cultivated lands.

Compared with Mr. Kennedy's line, it is, in one respect, unfavorable in point of cost, namely, the land along it is generally $2\frac{1}{2}$ feet higher; so that, for a canal on the same level, it would require that increased depth of excavation; but this additional height is, in another point of view, a great advantage, as it enables us to get the head room required for the bridges without having to alter the level of the roads. Raised or embanked approaches to these bridges, would, I have no doubt, be considered a great evil.

39. I will now describe the several works, beginning at the Adiyar. For a detailed description of their construction I would refer to the specification.

Adiyar dam.

My desire was to raise this dam eight feet above mean sea level, which would have enabled us to make the Adiyar navigable, at very small expense, up to the crossing of the Poonamallee road near St. Thomas' Mount. I found, however, that a rise of 8 feet in the lower part of the Adiyar would, during floods, seriously affect a considerable area of low ground along the margin of the river, and I was obliged to reduce the height to six feet. This, however, is two feet higher than Mr. Kennedy proposed. It may be, that after the experience of a year or so (should the work be ever executed), the owners of the adjacent land would not object to the dam being raised temporarily to the height originally intended, after the monsoon floods had passed away.

The length of the dam has been fixed at 600 feet. A shorter dam would meet most of the objects required, but the great advantage of a long discharging line in keeping the floods down is, in this case, so important, that I consider the extra cost of little moment in comparison.

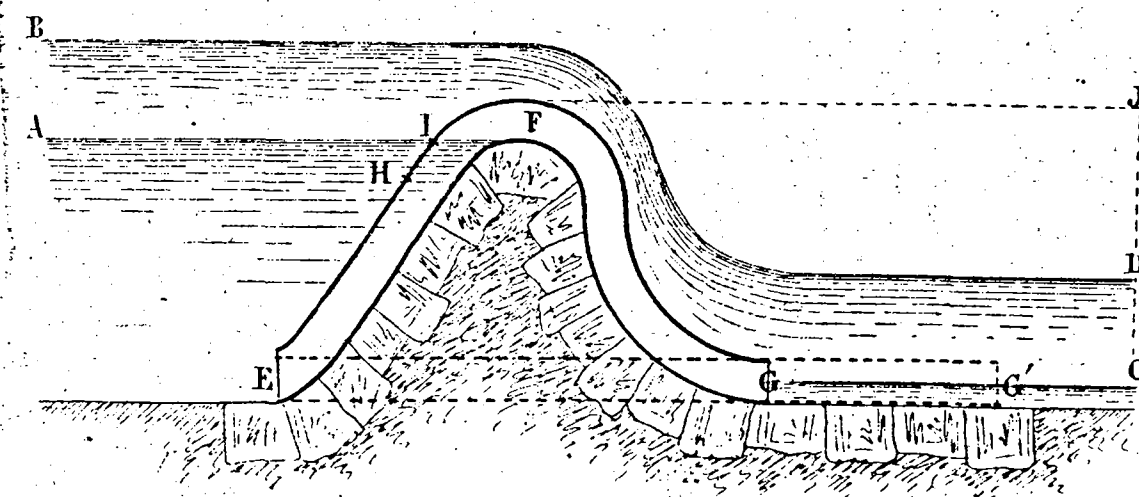
Having no observations on the quantity of water discharged, during a given time, by the Adiyar when in high flood, it is impossible to calculate how high the water is likely to rise over the dam on these occasions: but, taking it for granted that a large portion of the flood water that now passes away to the sea will be stored in Chembrambakkam tank before this dam is erected, I am of opinion that the floods will not over-top it by more than three feet. At this height, nine feet above mean sea level, the water would swamp a good deal of low land along the river between the dam and the Little Mount, but it would be only for a few days in the year, and the extent would not much exceed that laid under water by the present high floods which rise more than eight feet above mean sea level.

With a free fall of three feet the dam will discharge 667,200 cubic feet of water per minute, or over $35\frac{1}{2}$ millions of cubic yards in a day. The discharge could be increased by the addition of sluices, which I do not propose to provide in this case. At the best they are very ugly; they weaken the dam; and are awkward and difficult to manage during floods, unless there is a roadway over them.

40. In this instance I would recommend the adoption of syphons over the dam, both to increase the discharge and to prevent the accumulation of sand. Any extent of the dam may be covered with these syphons, but I have estimated for sixty feet or one-tenth of the length only.

They are self-acting, and act only when wanted, simple and cheap in construction, and, having no movable parts, are incapable of being deranged. A few words regarding their action may be necessary, as their use for the purpose of increasing the discharge over weirs is, I believe, novel in India.*

The following sketch will illustrate what I have to say:—



Let this sketch represent the section of a dam. A, the level below which it is desirable the water shall not fall; B, the flood level; C and D the heights of the respective tail-waters; E, F, G, the syphon. The syphon may be a cylindrical tube, or a tube of any shape; but when it is used on the large scale, as in

* There is nothing new in the use of the syphon for this purpose. In the year 1843 I proposed, in my report on the improvement of the river Camlin, Longford, the use of extensive syphons for increasing the discharge over a weir where the space was limited by buildings on both sides.

It is an old contrivance of the French Engineers who, however, formed the syphon within the body of the dam. The merit of introducing the contrivance to the notice of modern Engineers is altogether due to Mr. Robert Mallet, C. E., who, in 1843, brought the idea to the notice of Sir John F. Burgoyne, K. T., then President of the Board of Public Works. I know that, at that time, Mr. Mallet was not aware of the previous use of the syphon in this way.

the present case, it would be a rectangular tube, made with thin boiler plates rivetted together, and extending any required number of feet along the dam.

In the present instance I contemplate having three syphons, each of twenty feet in width, one near each end, and one in the centre of the dam. If the syphon were intended to discharge water only, the upper arm would extend only to about II; but, as in this case it is intended to pass sand as well as water, the upper arm is brought down nearly to the bottom of the river. This affects the discharge only so far as friction is increased by lengthening the tube.

At the point marked I (in this case the level of the dam) a line of air holes is made across the syphon.

The top of the syphon may rise up to the level of high floods, but I propose to limit it to two feet; then, the syphon tube would be twenty feet broad, two feet high, and twenty-five feet in length from E to G.

It is evident that as the water rises upon the dam, it will rise in the syphon as well; that when it reaches the top of the dam the air holes will be closed; that as the water rises, it will be discharged through the syphon as it would be over any other part of the dam; and that when it rises so high as to fill the tube the latter immediately begins to act as a syphon, discharging with a velocity due, not to the mere depth of water over the dam, but to the effective head J C. As the water increases in height the discharge through the syphon will increase so long as the tail-water remains at the same level, and when the latter rises above the tail of the syphon, as to the level of D for example, it will go on discharging in the ratio of the $\sqrt{}$ of the head, the effective head being always the height from one water surface to another.

It has been found by Mr. Mallet's experiments that the discharge through such a syphon is practically equal to that through a straight tube (E G) of the same dimensions laid through the dam at the level of the discharging end of the syphon.

The velocity of the water through the syphon, and of course its power to carry sand, &c., through, will depend on the head. In the case of the Adiyar during high floods we should probably have, for some hours every tide, an effective head of five or six feet.

Having seen syphons with smaller heads than this carry sand and fine gravel through, I have no doubt but that the proposed syphons will act as effectively as ordinary sluices in keeping the bed of the river free from accumulations of sand. For the mode of construction see the specification.

Line of canal.

41. The line of canal is shown on the detailed plan, sheet No. 2. At the bottom of the sheet a section of the ground in that line is given.

I will describe it briefly, beginning at the Adiyar end. The portion tinted with a dark shade represents the bottom of the canal, ten yards wide; the parallel strip shaded on each side shows the slope of two to one from the bottom to the towing path.

The towing path is shown by two close parallel lines, and the shaded portions above these show the cutting to the surface of the ground. The average width of the excavation at the ground level will be 23½ yards.

The belt of land colored red shows the entire width of 80 yards required for the canal and spoil banks.

It leaves the Adiyar river in the same right line as that of the Sadras canal, and bends to the left through Sir Colley Scotland's compound. About 200 yards above the lock, a branch, at the level of the canal, turns into the river above the dam. This branch would feed the canal from the river which would be supplied from Chembrambakkam tank.

Where the line crosses the low ground over which the monsoon floods occasionally sweep, the canal must be protected by a causeway or spit, so low as to present no obstacle to the passage of the floods. This causeway will run up to the tail of the lock, where a revetment in the continuation of the wing-wall of the dam will be constructed, as shown on the plan. Should it be considered that the line runs too close to Sir Colley Scotland's house, it could be removed to the alternative one marked, on the plan, by a red dotted line.

The line crosses Chamier's road about 140 yards west of the end of Mowbray's road, so as to keep clear of the compound now occupied by Colonel Priestley. Thence the line runs almost straight through paddy fields and plantain topos to Pulli-Tenampet, crossing Yeldam's road, opposite to the east end of that village.

It then enters Mr. Dale's (now Mr. Lushington's) garden, taking 80 yards in width of the west end; and, crossing Poe's road, bends to the right through a plantain tope; and, crossing the road again at the north-west angle of Mr. Brockman's compound, sweeps to the left, cutting a small angle off Mr. Shaw's compound; and then runs straight through a plantain tope and betel garden to the Cathedral road, which it crosses 40 yards to the east of the entrance to Mr. Shaw's house. On the north side of this road there is a native pukka built house, through which the line passes; and thence it runs nearly straight through the cocoanut tope on the east side of Vellalar-Tenampet, on the east of the Horti-Agricultural Garden (the cotton experiment garden), and by the west boundary of Mir Homyan Jah Bahadur's compound, and through his stables to Peter's road. This line runs straight to the centre of the mass of huts which lie on the east of the Thousand Lights. Through these huts, and without touching the sacred part of the buildings, it bends to the left, crossing the Mount Road at right angles about 43 yards to the south of the gate leading to Atkinson's Mount Road Hotel. Here it turns to the right, and runs straight to the Kuam river, which it enters at the north-west angle of the Amcer Bagh compound, just opposite to the General's Parachary in the Royal Hotel grounds.

It will be seen from this description that the proposed line interferes with very little house property; and that, so far as compensation for damages is concerned, it is as inexpensive as it is possible for any high level line to be between the two rivers.

Proposed roads along the canal.
Spoil banks.

42. The longitudinal section at the bottom of sheet No. 2 shows the depth of excavation at every place along the line. This and the cross section on sheet No. 4 will show what a very large quantity of spoil, or excavated earth, must be provided for. If this earth were put into the shape of a high narrow spoil bank on each side of the canal, so great a width of land as 80 yards would not be required; but I need hardly draw attention to the very serious objections that would be raised to

having two high earthen ridges running from north to south between the two rivers. It has, therefore, always been intended that the spoil banks should be kept as low as possible, and formed into two public roads, one on each side of the canal. These proposed roads are shown in section on sheet No. 4. The road sections are tinted red, and show the average height, 6 feet, they will be raised above the adjoining land. They are proposed to be 42 feet wide between the fences, 30 feet being gravelled. The fences are to be faced with stone on the road side, and made 3 feet in height, with turfed slopes of $1\frac{1}{2}$ to 1 on the outside. A line of trees to be planted at the foot of each slope. The cost of forming these roads is, of course, no part of the cost of the canal proper; but as they would run nearly midway between the Mount Road on the west, and Royapettah High Road and Mowbray's road on the east, they would, to a certain extent, be a public convenience, and otherwise be a decided improvement. It would probably be unnecessary to construct the roads farther than from the Mount Road on the north, to Chamier's road on the south: unless the old idea was revived of forming a road through Pugh's gardens and along the margin of the Adiyar to the south beach road at Elphinstone's bridge. This would be a favorite drive, and could be made through Government property the whole way.

Locks.

43. The only lock on the East Coast Canal at present is at Sheddiankuppam, 9 miles north of Madras. It is intended to keep the water as high as possible in the Madras reach of Cochrane's Canal. It is 150 feet in length and 20 feet in breadth. I do not know why a lock so large, especially so long as this, should have been constructed, as it is, with one exception, more than three times as long as any boat now used on the canal. This exception is one boat of 40 tons, which is 60 feet in length and 14 in breadth. There is a strong inducement to design the proposed locks on the same scale as the existing one, but I have deemed it best to recommend locks 75 feet long and 20 feet wide. These dimensions will require but one-half the quantity of water, and will pass the largest boat ever likely to be put on this canal, even though steam tugs of the largest size on such navigations should be made use of. If the traffic be sufficient to require it, we can adopt at these locks the system pursued at Sheddiankuppam to save water, namely, to pass a lockful of boats at the same time, and the locks now proposed will enable four or five boats of ordinary size to be passed together.

The plans of the locks are on sheets Nos. 6 and 7.

There is nothing peculiar in their construction, which is described in the specification.

Public bridges.

44. Of these there will be five on the following roads:—

- I.—Chamier's road.
- II.—Yeldam's road.
- III.—Cathedral road.
- IV.—Peter's road.
- V.—Mount Road.

The general design for these bridges and the details of construction are shown on sheet No. 8.

For the purpose of keeping the carriage-ways as low as possible, wrought iron lattice girder bridges are proposed; the roads to be placed at the bottom of the girders, which will thus form the parapets and hand-rails. The span of the bridges is proposed to be 44 feet, and the width of the road-way 20 feet with the exception of the Mount Road bridge, which will have a double carriage-way.

The height of the bottom of the girders from the standard water level, or the level of the Adiyar dam, is drawn at 12 feet. This height has been fixed on because the highest loads are about $10\frac{1}{2}$ feet above the water; and during the freshes the water would probably be from 1 to 3 feet above the level of the dam. It would be no great inconvenience, however, to the boatmen to confine their loads to 9 feet above the water level, and this would permit the lowering of the girders by 18 inches, which would enable us to cross all the public roads without altering their present level, with the exception of Chamier's road, which should be raised nearly 3 feet at the bridge. The details of the construction of these bridges is described in the specification and shown on the drawings. I will only mention here that they are designed to suit the description of iron which can now be procured at Madras; but I trust that when we come to build them there will be available the several descriptions of rolled iron, which will enable us to greatly simplify and cheapen their construction.

The Mount Road bridge.

45. It is proposed that the Mount Road bridge should have two carriage-ways of 20 feet in width each, separated by a centre girder of double strength. The centre girder would rise above the road-way, separating the traffic into two streams; but as it would be marked by a line of lamps at night, it is believed that no danger would result from this arrangement.

Private roads and bridges.

46. The first private road crossed is the approach to Sir Colley Scotland's house.

This I propose to divert along the west side of the canal, and make a new entrance on Chamier's road, as shown in red on sheet No. 2. If this is particularly objected to, we must build a bridge to suit the present approach.

Between Chamier's road and Yeldam's road, a distance of 1,200 yards, I propose to erect two bridges for the accommodation of the cultivators, whose lands will be severed, and for people passing between the adjacent villages.

The only other private roads crossed are Poe's road and the approach to the Mount Road Hotel. I propose to divert the latter road, giving an entrance on the west side of the canal as shown on sheet No. 2. The number of accommodation bridges may seem to be very small, but it must be remembered that except where the two private bridges are proposed, the public bridges are near to each other, and these with the proposed new roads along the sides of the canal, will give ready access to the severed land on both sides. It will be observed also by referring to the detailed Map, No. 2, that the line of canal has, wherever it was possible, been drawn upon or close to the boundaries of property for the purpose of avoiding severance.

Where the severance of small pieces is unavoidable, the best arrangement will be for the Government to purchase these severed pieces and sell them to the owners of the adjoining land.

Irrigation and drainage tunnels.

47. Of irrigation and drainage tunnels two descriptions are proposed to be constructed, one with a single opening of 3 feet, and another with two openings of 4 feet each. Of these a plan, longitudinal section, and cross sections are given on sheet No. 4; and for the details of construction I would refer to the specification. Seven single and two double tunnels are proposed. I think that these will be sufficient, as the area of land to be drained across the canal is only the narrow strip between it and Mylapore tank. The cultivators will have the privilege of drawing water from the canal for irrigation on their paying for the construction of the requisite works, which would be simply a small tunnel under the new road, opening into a well in the land to be irrigated, or a syphon tube of cast-iron laid in the slope of the canal, carried under the road, and descending into a well on the other side. By carrying them down so as to have the ends of both limbs constantly under water, the syphons would act perpetually, without trouble or attention on the part of the cultivators, and would keep the water in the well at the same level as that in the canal.

The drainage water need not be carried under the canal in all cases, it may at certain places be allowed to flow into the canal, by passing it through a silt trap and over a weir on the upper side.

Rain-water shoots and landing steps.

48. A plan and sections of the proposed rain-water shoots are shown on sheet No. 5. It is proposed to construct ten of these on each side of the canal. This will probably be sufficient, as they will have to discharge the rain-water from only half the width and the side slope of the road, and the berm at the top of the cutting. The water will have to run along the berm about 250 yards to reach one of the water-shoots.

These water-shoots from their construction may be used as steps to and from the canal, or as occasional landing places.

Landing wharves.

49. Besides the steps described above, it is proposed to construct four landing wharves, or boat basins, as shown on sheet No. 9. The best positions cannot be fixed now, but probably near to the four principal public roads would be the most convenient, viz., Chamier's road, Yeldam's road, Cathedral road, and the Mount road. A wharf on one side of the canal only is now estimated for, but, should the traffic demand it, a similar one can be constructed on the other side at any future time.

50. These are all the works it is considered necessary to describe, and the abstract of the detailed estimate on pages 120 and 121 shows their probable cost.

HIGH LEVEL DESIGN No. 2.

51. Having described the works necessary for a high level canal on the principle of constructing a dam across the Adiyar close to the mouth of the Sadras canal, it is right that I should submit, for the consideration of the Government, another design by which a high level canal can be constructed without damming the Adiyar, and which would be governed in its depth of excavation, not by the height to which that river might be raised without injury to the low lands along its banks, but simply by the depth which would be considered most suitable to the height and the undulating surface of the ground in which it is formed.

It is evidently not imperative that the canal should receive its supply through the Adiyar, and that a canal at any level, so long as it was in excavation, and made any where, between Mylapore tank and the sea, could be supplied from that tank, the water being obtained primarily from Chembrambakkam; or it could be supplied by an independent channel from Chembrambakkam tank, carried along the high ground on the north bank of the Adiyar.

To carry out a Junction Canal on this principle, every work necessary for the lower level canal would be required, with the exception of the dam across the Adiyar; but the designs should be modified to suit the altered level.

I will now describe the modifications necessary for the higher level canal, which, for the sake of brevity, I will call DESIGN No. 2, and the lower level, DESIGN No. 1.

Earth-work and water-level.

I. It is desirable that the water, which in this case is also proposed to be 4 feet in depth, should, as far as possible, be contained in the excavated channel. It matters not however if, in some low places, the standard water line be above the level of the land. I find that, keeping these two points in view, the most convenient depth will give an average excavation of 6 feet instead of 13 feet, as in design No. 1. The maximum cutting will be 9 feet, and the minimum 2 feet. Where the excavation is less than 4 feet, the sides must be embanked to a height of 2 feet above the water line which, in this case, will be less variable than in No. 1; for, being supplied from Mylapore tank, it will be unaffected by the fluctuations of the Adiyar, and can be kept at a uniform level. Any surplus water thrown in by rain can be discharged by side calingulahs or sluices at the low places. On some of the plans the modifications required for No. 2 are drawn in red lines, and on referring to sheet No. 2 it will be seen, by the section, that the bottom of the higher canal will be at the level of the towing path of the lower, and be thus 7 feet higher than the bottom of the canal in design No. 1.

Spoil banks and parallel roads.

II. The spoil banks would not be one-fourth the size of those of No. 1, and the parallel roads would rise only $2\frac{1}{4}$ feet above the land, instead of 6 feet as in the former design.

Land required.

III. For design No. 1 a breadth of 80 yards is required. For No. 2, 60 yards would be sufficient, making a saving in the whole length of nearly 21 acres.

Irrigation and drainage under-tunnels.

IV. The irrigation and drainage under-tunnels would be from 50 to 60 feet shorter than those required for design No. 1.

Water-shoots and landing steps.

V. These would hardly be required, as the passengers could step to or from the bank, and slopes so short as those of No. 2, would require but little protection from the effects of rain.

Landing wharves and basins.

VI. These would require no steps, except in the one at the Mount Road. The land for the wharf would merely require to be levelled, drained, and gravelled; and as the basins would in this case be so inexpensive, a large number of them might be constructed if the public convenience required them.

Locks.

VII. The locks would be more expensive than those on No. 1, as their height should be increased by about 6 feet, making the lift 13 feet instead of 6 feet. The quantity of water for lockage would be increased in the same proportion, as the two rivers would remain at their

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Bridges.

VIII. The cost of the bridges would be about the same as for those of No. 1, as they would be merely raised up 7 feet. The excavation and the unwatering of the foundations would cost a little less.

Roadways over the bridges.

IX. The great objection to No. 2 is, that all the public roads should be embanked at the bridges to a height of about 7 feet above their present level. Chamier's road should be raised 10 feet. Figure No. 4 on sheet No. 9 shows in red lines the difference between the two designs in this respect. I have drawn the approaches with an inclination of 1 in 40, up and down which horses can trot with ease and safety, but at the same time I must remark that there is scarcely a greater nuisance than embanked approaches to bridges where the traffic is considerable, and the greater part of it quick; and besides their inconvenience, they are to a certain extent always dangerous, unless very great care is observed in their maintenance.

Turfing.

X. In minor matters of estimate, such as turfing slopes, occasional pieces of revetting with stone, and such like, No. 2 will be cheaper than No. 1.

Maintenance.

XI. In the matter of future maintenance, No. 2 would cost much less than No. 1, the long slopes of which would be very expensive to keep in repair, and would require years to give them a permanent form and condition.

52. The following is an abstract of the estimate of design No. 2. No details of this estimate are given, as it has been prepared from the estimate for No. 1. For the sake of ready comparison, the two estimates are placed in juxtaposition.

Abstract of the Estimate for Designs Nos. 1 and 2.

No.	Description of work.	No.	Design No. 1.	Design No. 2.
			RS. A. P.	RS. A. P.
1	Earth-work in Mair Canal and branch to the Adiyar, including the forming and levelling the spoil banks	...	60,803 5 6	23,944 2 0
2	Turfing the slopes of the canal	...	6,001 9 0	2,523 13 3
3	Adiyar dam including three syphons over the dam	...	73,635 12 2	...
4	Locks, including gates and fittings	2	42,755 11 6	61,484 15 6
5	Irrigation and drainage under-tunnels	9	31,024 10 6	20,824 12 0
6	Water-shoots and landing steps	20	3,457 8 0	1,018 15 4
7	Public road bridges, 20 feet carriage way (No. 2 includes the raising of the approaches of three bridges.)	4	24,553 4 0	29,855 13 0
8	Mount Road bridge	1	11,412 0 1	14,507 10 1
9	Private road bridges, 12 feet road-way	3	15,188 1 0	18,932 5 9
10	Basins and landing wharves	4	23,753 0 0	6,592 12 0
11	Causeway at the Adiyar	...	3,261 14 6	3,261 14 6
12	Raising the approaches to Chamier's road bridge	...	403 10 0	3,117 7 0
13	Diversion of private roads	...	1,590 1 6	1,590 1 6
	Total	...	3,00,842 7 9	1,87,654 9 11
14	Compensation for damage to property	...	1,00,000 0 0	75,000 0 0
	Total	...	4,00,842 7 9	2,62,654 9 11
15	Contingencies and superintendence at 10 per cent.	...	40,084 8 3	26,235 6 1
	Total	...	4,40,927 0 0	2,88,920 0 0
16	Roads along the sides of the canal including fencing, forming, metalling, planting, and watering the young trees, and turfing for eighteen months	...	63,815 0 0	60,537 0 0
	Grand total	...	5,24,742 0 0	3,69,457 0 0

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In the above estimate the item for compensation for damages is based on a rough valuation made by the Tahsildar of Madras; I believe it will be found ample for the purpose, if the purchases are made judiciously. It will be seen from this estimate that, on the whole works proposed, design No. 2 is 1,55,285 Rupees cheaper than No. 1; and on the works proper to the canal only, it is cheaper by 1,52,007 Rupees.

53. From the preceding remarks it will, I think, be clear that if a high level fresh water canal be finally accepted by the Government, design No. 2 is the best one to adopt. In all respects, except the height to which the locks and bridges should be raised, the works would be simpler, cheaper, and more convenient than those of No. 1. The canal would be easy of access at all points; and, in the use of the water for irrigation, design No. 2 has greatly the advantage in having, at certain places, the water level above, and in the deepest cutting only 5 feet below, the level of the adjoining land.

Design No. 2 would, of course, be altogether dependent for its supply on the storage of water either in Chembrambakkam tank or elsewhere; and, in this respect, it would be less certain than No. 1, which would draw its supply from the Adiyar; down which river even in the driest period of the year, a certain quantity of water is always flowing. But if Chembrambakkam tank be enlarged, and its supply channels improved, as I have proposed in another report, there will be an abundance of water for both the canal and irrigation. If any doubt exist as to the sufficiency of Chembrambakkam, we have the restoration of the Pammal tank, and the construction of the Mount tank to fall back upon, both of which, in point of height, would command the level of the canal. In a professional point of view, and as regards the cost of future maintenance, it is desirable that the canal should have no direct connection with either the Adiyar or the Kuam.

Navigation to the Mount and Palaveram. 54. It may be asked, if design No. 2 be adopted, thus doing away with the dam across the Adiyar, how could that river be made navigable to the Mount.

The adoption of No. 2 would greatly simplify and cheapen this project:—In its natural condition the sea or tidal reach of the Adiyar extended to Marmalong bridge, which is built at about the limits of high water. But at the place marked x on sheet No. 1 there is, across the river, a rude stone and earthen dam which prevents the salt water extending beyond that point. All above this dam is now fresh water, and for the greater part of the year it stands about 12 inches higher than the present tidal reach.

If this dam were removed the salt water would extend to the foot of the fall at Marmalong bridge; and, with the water at mean sea level, which is its ordinary height, boats drawing not more than 3 feet could navigate the river up to that point.

These facts suggest the course which should be pursued in making this river navigable, viz.:—To remove every obstruction from the bed of the river up to the fall at Marmalong bridge. To build a dam across the river there, and a lock to pass boats up and down.

55. To make the river navigable to the proposed dam, nothing more is required than the removal of the present dam, and the widening and straightening of the present channel at a few places.

The banks of the river, between Marmalong bridge and the Mount, are generally so high that the proposed dam might have a height sufficient to make that reach of the river navigable by simply raising the water. A height of 11 feet above mean sea level, or 9 feet above the general bed of the river, would give a minimum depth of 4 feet up to the site fixed on for the Mount tank, which is 300 yards above the bridge on the Poonamallee road; but some natural and artificial obstructions would have to be removed, and the deep channel widened and straightened at a few places. To extend the navigation to Palaveram, a lock, probably a double one, should be built near the Mount.

A high dam at the site proposed might necessitate the re-building of Marmalong bridge, the arches of which are small and low. The dam might be erected above the bridge, and a channel excavated through two or more of the largest arches; but all this will be discussed in another report.

56. I shall not now speak of the many advantages which would be the result of opening a navigation between Madras and Palaveram, these will be discussed in my report on the Pammal and Mount tanks, and the navigation of the Adiyar, the plans for which are partly prepared. If the works sketched above were executed, a very complete navigation between Fort St. George and the Mount and Palaveram would be established; by cutting a channel (a part of it being tunnelled) from the Kuam to the Fort ditch: a wharf within the Fort, and a few cranes, would enable all heavy stores, ordnance, and so forth, to be transported to or from the Fort with great convenience and at small cost.

57. The fresh water which is kept up by the old dam at the point marked x is, at certain places, raised with pecottas for irrigating the land on both sides of the river. It is from this reach that the Sydapet Farm is supplied with water by a wind engine. If the dam were constructed, as proposed, a much more satisfactory mode of irrigation could be established, by cutting a supply channel from above the new dam and along each side of the river.

58. It is usual to conclude a report like this with a description of the advantages, pecuniary and otherwise, likely to be derived from the execution of the proposed works. In this case, however, such a course is unnecessary, as that part of the subject has been almost exhausted by previous writers. There are one or two points however to which I would draw especial attention.

Almost all have agreed, and from practical acquaintance with the subject I concur in the opinion, that the Sadras Canal can never pay until it is connected with the Kuam, and thus with the Northern Canal and the central part of Madras. Even in its present inconvenient condition there is a considerable amount of passenger traffic on the Sadras canal, quite enough to keep profitably employed about 100 "top" or passenger boats; but some idea of the inconvenience attending this traffic will be obtained from the following fact:—

About 25 miles from Madras (the Fort) and 2 miles west of the Sadras canal, there is the famous temple of Tirupalur, to which a pilgrimage is made once a month. It is probable that at least 40,000 pilgrims in the year are conveyed between Madras and this temple by the canal, but owing to the navigation being unconnected with Madras, the people are obliged to walk or drive from 8 to 11 miles to and from the lattice bridge, at which is the nearest boat station. This bridge is marked Y on sheet No. 1, and is about 8 miles from the Fort, and 2½ miles from

the Adiyar river. I have no doubt but that the traffic from this source alone would be more than doubled if the Sadras canal were connected with Madras.

59. The articles of produce at present conveyed by the Sadras canal are principally fire-wood, dressed and undressed stone from the Seven Pagodas, rice, cocoanuts, cocoanut and palm leaves, &c. But few of these articles are brought so far as the Adiyar, most of them being landed at the lattice bridge, from which there is a tolerably good road, by the Elphinstone bridge, into Madras. A considerable portion of the produce named above comes from the country lying to the south of the Palar river, whence it is carted to the canal; and I have no doubt that if it could be brought into the heart of the city, and disposed of without the cost of a second tedious carting, the trade would be largely increased; but at the same time I am of opinion from what I have seen, and the result of the inquiries I have made, that the traffic on the Sadras canal will never become fully developed until the navigation is extended to at least the back water at Linga Chetty Choultry, which is about 11½ miles south of the Palar.

Between the Adiyar and Palar rivers there is very little cultivated land near the canal, which, for the most part, has a belt of sand hills on one side, and a low swamp on the other. The extension to Linga Chetty Choultry, however, would be skirted on, at least, one side by cultivated lands, and, by the back water which is navigable for the greater part of the year, and which has a coast line of 18 to 20 miles, it would be brought into direct connection with a large number of well cultivated villages, which want only some outlet, such as this extension would afford, to send a large quantity of agricultural produce to Madras. This extension, with a few judiciously laid out lateral channels connecting the main navigation with groups of adjacent villages, would probably make this part of the East Coast Canal as productive, both in its passenger and goods traffic, as is the part north of Madras. The extension to Linga Chetty Choultry would also connect the Madras Salt Kotars with the Salt pans at Cheyoor, the produce of which is highly prized on account of the large size of its crystals.

60. Along the lower Adiyar, and the northern part of the Sadras canal, there are extensive beds of laterite stone, and gravel. These are largely used for the repairs of the Madras roads and other purposes, and, were the junction of the two rivers effected, they could probably be delivered all along the line of the Kuam and Cochrane's Canal, close to where they are wanted, at one-half of their present cost. The same remark applies to the gneiss rock, of which there is an abundance on the banks of the Adiyar, and the cheap transport of which would be most advantageous to Madras.

61. A salt depôt was established some years ago at Home's Gardens near Sydapet, under the idea that the sale of salt for transmission by country bandies towards the south-west would be very considerable. This depôt is supplied from the salt pans in the neighbourhood of Covelong; but owing to the sales at Home's gardens becoming gradually less year by year, these pans are now only partially worked; but if the Junction Canal were made, the salt could be boated to the northern Kotars, and be thus used to meet the scarcity which sometimes occurs.

62. I take it for granted that the Junction Canal has ceased to be considered a means of supplying the portion of Madras lying south of the Kuam with water for household purposes, and that it will be considered merely on its merits as a

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The High Level Fresh Water Canal according to design No. 2, would, however, be of great value as an irrigation project; as, from its elevation, it would command nearly all the land lying between it and the sea, and between the Kuam and Adiyar rivers. Branch channels could be carried from it to any part of the tract of land indicated, and as the greater number of these would be partly in excavation, and partly in embankment, the water could be allowed to flow out upon the lands, and thus would be rendered unnecessary the labor, at present expended, in lifting the water from both channels and wells. Some of the branch channels might be made wide enough for the passage of one boat, with lie-bys to allow two to pass, and thus bring the benefits of the navigation to Mylapore, St. Thomé, the southern part of Triplicane, Royapetta, &c.

This suggested extension of irrigation and navigation would be simple and inexpensive if design No. 2 is adopted; with design No. 1 the depth of excavation necessary would render the cost of such channels expensive.

63. The rates in the estimate are those which prevail at present in Madras. The estimate of the wrought iron lattice girders was prepared at the Presidency Workshop. As this estimate has been made on the supposition that the flanges of both main and cross girders are to be built up with plate and angle iron, it is very high; but as the Superintendent, Mr. F. L. Moncrieff, C. E., contemplates getting rolled iron from England for these purposes, it is probable that the estimate for the bridges will be reduced by one-third. The execution of the whole work would occupy from twelve to fifteen months.

64. I have excluded from this report a paragraph I had written about the advantages and disadvantages of a *Sea Level Junction Canal*, because, since writing it, I have received orders to investigate and report on that project. The plans are now under preparation and, with the report, will be submitted to Government immediately.

MADRAS,
November 1867.

(Signed) W. FRASER, C. E.,
Executive Engineer.

No. 419. ORDER THEREON 21st January 1868, No. 215.

CIVIL WORKS, No. 52.

Ordered to lie over, till the receipt of the plans and estimates for the Low Level Salt Water Canal, which Mr. Fraser promises to submit shortly.

(True Extract.)

(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government.

1 True copy

To the Superintending Engineer, 4th Division.
To W. Fraser, Esq., C. E., Executive Engineer.

Revenue Department

Chambers
Secretary to Government

Exd. S. T. Augustin

W-389
Comm. to the
Revenue Board

12th Feb/68

5 Copies to the P.W.D. with one to the Revenue Board

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Proceedings of the
P. M. V. 1868.

Dated 21st. Jan.
Received 10th. Feby.
1868.
H. 215.

Ordering that the
Report on the proposed
High level fresh water
Canal to connect the
Kuan and Adiyas
Rivers, be on a title
Receipt of the plans
& Estimates for the Low
Level Salt water
Canal -

With Order
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N: 221-222

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