

SELECTIONS  
FROM THE  
PUBLIC CORRESPONDENCE  
OF THE  
PUNJAB GOVERNMENT

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VOL. IV., NO. 2.

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Correspondence regarding the passage of the Indus  
at Attock.

La h o r e :

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1860.



(COPIES.)

**NO. 5,792.**

FROM

**The Chief Engineer, Punjab,**

TO

**R. TEMPLE, ESQUIRE,**

*Secretary to the Chief Commr., Punjab.*

*Dated LAHORE, the 15th December, 1858.*

SIR,

IN compliance with instructions contained in Civil General. your letter No. 1,832, of the 11th ultimo, I have the honor to submit herewith Major A. Robertson's report on the subject of the establishment of a Steam Ferry on the Indus at Attock.

2nd.—A copy of the correspondence has been sent to Captain Henderson, with reference to the 4th para. of your letter under acknowledgment, and a copy of that officer's report, when received, will be forwarded.

3rd.—Captain F. S. Taylor, in his letter, No. 319, of the 2nd instant, informs me that, having prepared a project of his own at the Chief Commissioner's request, he has forwarded it direct to your address.

4th.—I do not venture to give any opinion myself on the feasibility or otherwise of Major Robertson's project, as I am unacquainted with the locality where it is proposed to establish this Steam Ferry, and which possesses several peculiarities and local dangers, with which the officers whose opinions have been called for are best acquainted.

I have, &c.,

(Sd.) **E. L. OMMANNEY, LIUT.-COL.,**

*Officiating Chief Engineer, Punjab.*

*Report upon the subject of the establishment of a Steam Ferry, on the Indus at Attock; prepared in accordance with the Chief Commissioner's instructions, conveyed in letter, No. 1,832, of the 11th current, and Chief Engineer's letter, No. 5,006, of the 13th idem.*

In considering this matter, I have found it convenient to divide the subject into several heads, as follows :—

*1st.*—The style of boat suited to the river, with reference to the high velocity of the Indus in flood, about 19 feet per second, or 13 miles an hour nearly; the rocky banks and obstructed channel; and the great variation of surface level, in ordinary seasons, ranging to, speaking generally, a difference of 50 feet between the cold and high hot weather level; and as part of this general heading, the tonnage, length, draught of water, power, mode of propulsion, nature of engine, condensing or high pressure, and material of which the vessel is to be built.

*2nd.*—The number of boats necessary for the efficient working of the ferry.

*3rd.*—The means of landing and embarking passengers, stores, guns, horses, &c., &c.

*4th.*—The ordinary means of securing the boats at night; and the means of securing them against the effects of great floods, such as occurred in August 1858, and to which the Indus is subject at uncertain intervals.

*5th.*—The fuel to be employed, and from whence to be obtained.

*6th.*—The establishment for working, repairs, &c., &c.

*7th.*—The cost, under the head of original outlay, and maintenance.

*8th.*—The other means available for securing the same or similar objects, contemplated by the establishment of a Steam Ferry, and the probable cost.

*1st.*—Under the first head, with a current of 13 miles an hour to contend with, it would not be safe, in the situation, to use a boat that could not work up stream against the full force of the current; as, otherwise, she might at any time be carried on the rocks by

unskilful management. The boat should, therefore, be capable of being worked up to a speed of 17 miles an hour, and her ordinary speed should not be under 15, and 16 would be a safer speed, as no doubt in certain bends of the river at Attock, in high flood, the velocity exceeds the rate I have named.

*2nd.*—We have now to consider the conditions attached to this high speed, and we may assume these generally as great length in proportion to beam for the boat, and high power in proportion to tonnage, for the engines. Being at a distance from my head-quarters, and having unfortunately but few books of reference with me, I am unable to refer to the dimensions, power, &c., &c. of the steamers that have attained the highest speed; but the details of the “Fairy” belonging to the Royal Navy will suit my purpose.

*3rd.*—The “Fairy” is an iron Screw Steamer; her tonnage, old measurement, 312 tons. Nominal horse power 128. Length 144·67. Extreme breadth 21·1. Draught of water, light 4 feet 10 inches, and rigged and fully equipped 5 feet 10 inches. Of these dimensions we may note, that the breadth is to the length as about 1 to 7; and the horse power is to the tonnage as 1 to 2·43, or about 1 horse power for every 2½ tons burthen. Now, this vessel in light trim, with a displacement of only 168 tons, that is, the total weight of vessel, engines, stores, &c. being only equal to this, and the engines working up to an indicated power of 36½ horse power, only attained a speed of 13·32½ miles per hour; and be it observed, she only attained this velocity when her nominal horse power was equal to 1 H. P. to 1½ displacement, nearly, while her indicated power was upwards of 2 H. P. to 1 ton displacement.

When fully equipped, drawing 5 feet 10 inches, and a displacement of 196 tons, she only attained a speed of 11·891.

*4th.*—Now, for the Indus, we not only want high speed, but we must have a vessel, handy, and manageable in the stream, and capable of being turned easily, and quickly, and in small space; and this evidently forbids great length. We should, therefore, I think, limit our boat to 100 feet extreme length. The next point is the

draught of water, and this should be as small as possible, as the river shallows towards the left bank, especially when falling in the autumn. I should like to limit the draught to 2 feet 6 inches, but I fear we cannot get the necessary burthen with this, and must go up to 3 feet. Now, one of the elements of speed being length in proportion to breadth, we cannot count upon greater breadth than the proportions of the "Fairy," viz., 7 feet, this would give about 14 feet. With these proportions, viz., length 100, extreme breadth 14, draught of water 3 feet, the boat would probably be a little over 100 tons measurement, but would not give a displacement of more than 50 to 55 tons; and with this displacement we cannot count on the speed required with engines of less power than 50 H. P., or 2 engines of 25 each; and, as economy in both space and weight is absolutely necessary, these engines should be high pressure. The displacement due to hull and engines with the day's fuel on board, should not exceed 35 to 38 tons; leaving, as available for cargo, about 15 tons, which should suffice, though I fear not up to what may have been looked for from the adoption of a Steam Ferry.

5th.—There can, I think, be no doubt that the material used in the construction of the hull should be iron; that the boat should be built in England, and sent out in convenient sections to be put together at Attock.

6th.—The actual form of the boat, and power of the engines, should be left in the hands of the constructor; the length and draught of water being given him, with the amount of load to be carried as freight; he should engage to furnish the vessel for a fixed amount, guaranteeing the speed, and in case of failure in any particular the vessel to be rejected. As the vessel is liable to get aground, she should be strong, and flat in the floor.

7th.—The last point we have to consider with reference to the boat, is the mode of propulsion. Could we adopt the principle in common use in Europe, all difficulties about the matter would at once disappear, and we might use any form, or size, of boat we required. The mode to which I refer, is a boat moving along a chain laid down in the bed of the river. The strength of the

current in the Indus is against the adoption of this plan ; but we might get over that by crossing obliquely, but the real bar is the quantity of sand and shingle brought down by the river, and the rapid way in which masses of it are moved about, which would at once bury the chain far beyond the power of the vessel to raise. The great depth of the Indus in high flood would also be a serious objection, from the weight of chain to be raised by the vessel ; but I need not go on to enumerate difficulties, as I think it will be at once admitted that the principle is inapplicable. We have, therefore, only a choice between the screw and paddle ; and I recommend the paddle, as, with a long narrow boat, the paddle will give a certain amount of stability, and check rolling, and this is very necessary, as when the river is falling, the waves in the Indus sometimes are high.

8th.—I will only add on the subject of the boat, that she should be as low as possible, and have the deck perfectly clear, as all cargo must of course be carried on deck.

9th.—The number of boats required is the next point to be taken up ; and I do not consider this can be fixed lower than three, supposing one to be able to work the ferry ; should it be found necessary to work two on the ferry, then I consider the number of boats maintained should be four.

10th.—The reasons for fixing this number are as follows :—

1st.—It may be assumed that one boat will always be in need of repair of some kind, cleaning, painting or alteration, so that there must be a relief. 2nd. In such a river as the Indus, and considering the numerous dangers of the ferry at Attock, we cannot hope to escape an occasional accident, entailing the complete or partial destruction of a boat ; and with only one spare boat this would stop the ferry in case of the most trifling repair being needed to the boat in use.

11th.—The 3rd point for consideration is the means of communication with the shore, that is, how guns, horses, &c., &c. are to be transferred from the bank to the ferry boat, or from the boat to the bank. This is a point of considerable difficulty, on account of

the constantly changing surface level of the river. Had we an ordinary river to deal with, a wharf or pier would provide for all that was required, and the steamer could at once run alongside it; but, with a river rising and falling within a limit of 50 feet, this is out of the question; we cannot beach the boat, or lay her alongside of the bank, as we can with a light ferry boat;—as not only would the boat be knocked to pieces, but once aground we could not easily get a heavy boat off again, and certainly not if the river was falling.

12th.—The only system that seems to me suitable, is to use a floating stage; that is, a large boat or barge, of light draught, or two such boats connected by a platform, anchored near the shore in a suitable spot, alongside of which the steamer could run. This stage, being of the same height as the steamer's deck, the guns, &c., &c. would pass over it, and reach the shore by a swing-bridge attached to the platform, and lowered on to the beach.

13th.—Iron would be the most suitable material for these platform boats, or stages. They should be strongly constructed, as they will be subject to considerable wear and tear, from the steamer lying alongside, and being secured to them. The stages would of course be moved about to suit the state of the river.

14th.—The next point to be considered is the means of securing the boats in use during the night, and also the spare boats; and this is a point of serious difficulty. This season, in the great flood of August 10th, 5 boats were secured in the bay of Jullallea, and with a little care were preserved uninjured; but a higher rise of the river, sending a strong current with drift into the bay, would have of course seriously endangered them, and it could not be considered a place of safety in any great flood, though it might suit for securing boats in ordinary seasons; but I do not think it would give accommodation for three boats, and it is objectionable from being on the Khariabad side of the river. On the Attock side, I know no convenient shelter; and though no doubt, with care and attention, the boats might be moored near the Attock bank, where the ferry boats are kept, yet they would always be exposed



to risks of injury by striking against rocks, and of grounding during the night by a fall of the river, and not being available when required. But before we go further, it would be well to consider what position the steam ferry is to assume. Is it to be a mere accessory to facilitate the passage of troops, stores, &c. in the hot weather? or is it to supersede all other means of communication on the Indus at Attock, and to be our sole trust and means of communication, both in the hot season and the cold?

15th.—If the former only, I think it would be advisable to run the risk, not only of ordinary injury, but of extraordinary floods, rather than incur the cost of constructing a secure haven. With fair warning of any great flood, which we are likely to get, the spare steamers could be either taken down the river, or up the Cabul river, and pretty fairly secured; and the boat in use, with her steam up, would be pretty safe if well managed; and while the flood was expected, it would only be necessary to incur the expense of keeping steam up all night, and the crew on board and alert. But if the steam ferry is to supersede all other means of communication, then the preservation of the boats from the slightest risk we can guard against, becomes of vital importance; and this must be carried out at whatever cost. The breaking up of the Attock establishment would of course disperse the men in search of a livelihood; so that if we lost our steamers, our communication would be entirely cut off, at least as far as military operations are concerned, as the few native boats and crews we might be able to collect on an emergency would go for very little.

16th.—The only means I can devise for securing the boats beyond all risk from floods, &c., is the formation of a basin, or wet dock, under the protection of the fort; and this could be most conveniently constructed below the fort. It would be necessary to excavate the dock, so as to secure a depth of 4 feet of water at the lowest level of the river; and to form the sides by scarping the rock, and thereby carrying up substantial masonry beyond the heights of any known flood. In such a dock the boats would of course be properly secured and float in safety, in any rise of the river.

Means of closing the entrance of this dock could also be provided to prevent its being silted up, or currents setting into it ; and thus secured, the boats should be safe ; but this security would be gained at a heavy cost.

17th.—The 5th point for consideration is the fuel to be employed. General Cotton refers to the Kalabagh coal as available, but I doubt its efficiency as a fuel to keep up steam ; and the point should be at once tested before taking any further steps in the matter of the ferry. A portion of the Kalabagh coal should be sent to Kotree, and there tested by the Indus Flotilla. The reason I recommend this as a first step, is that the furnaces of the boats should be arranged according to the nature of the fuel to be used, coal or wood.

18th.—A small quantity of the Kalabagh coal was sent to the Rawul Pindee Godown ; it was not found fit for iron forging by itself, but was useful mixed with charcoal. I think it probable that better veins than the one hitherto worked may be found, and the mines should be examined. If the coal is not found suitable for maintaining the necessary pressure of steam, then we must fall back on wood ; and I fear at Attock this fuel would be expensive, and the supply also found to be limited.

19th.—We now come to the 6th point, viz., the establishment to be maintained for working, repairs, &c. The first consideration under this head, is the skilled Europeans necessary ; and I think this should not be fixed lower than one first class Engineer, and three second class. One of these men must of course always be on board the boat ; and the others, when available, could be employed in the workshop ; but to maintain an efficient European at all times on board the boat, and allow for sickness, considering the nature of the work, and climate of Attock, I do not think 4 men an excessive establishment. The native establishment is next to be considered ; there should be two Assistants under the Engineer, as engine drivers ; and to afford a fair relief, would require 6, and with one to each spare boat, would make a total of eight. Stokers, or firemen, come next ; and I think we might fix six as the num-

ber required. The rest of the crew would be Attock boatmen, so that this point need not be at present considered.

20th.—A small workshop for repairs is of course absolutely necessary, but the number of mechanics (natives) would not be large.

21st.—The cost, under the heads of original cost and maintenance, next comes to be considered ; and I roughly estimate it as follows :—

Hull and fittings of steamer, ... ..	15,000	
Engines and boilers, ... ..	16,000	
Bringing out, and carriage up river,...	10,000	
Putting together, and fitting up, ...	10,000	
	51,000,	for 3=1,53,000
<b>2</b> floating landing stages, each, ...	10,000	20,000
Machinery, planing, cutting and drilling machines, lathes, small engine and other tools, ... ..		12,000
Workshop, and quarters for establishment, ... ..		10,000
Wet dock for securing steamers,...		1,50,000
	Total original cost,	3,45,000

**MAINTENANCE.**

<b>1</b> head Engineer, per annum, ... ..	3,000	
<b>3</b> Assistants, do. do., ... ..	6,000	
<b>8</b> Native Assistants, do., ... ..	1,120	
Workshop establishment, ... ..	2,400	
Fuel for steamers, ... ..	4,000	
Firemen and Crew, ... ..	2,400	
Contingencies, ... ..	2,000	
	20,920,	Or at 5 per cent,
equal to a capital of Rupees, ... ..		4,18,400
		7,63,400

No allowance is here made for tear and wear, and general renewal of boats, &c.

22nd.—The 8th or last point I propose to consider is whether the object sought cannot be attained by other means, at a more moderate cost?

23rd.—I am of opinion, that a wire suspension foot bridge (on masonry piers and abutments, constructed so as to be suitable for a full cart roadway suspension bridge) might be constructed across the Indus for about two lakhs of rupees; and I consider that a foot bridge would be the first great step towards what we eventually must have, if we retain the Trans-Indus territory, a permanent bridge over the Indus.

(Sd.) **A. ROBERTSON, MAJOR,**  
*Offg. Superintendent*  
*Lahore and Peshawur Road.*

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(C O P Y.)

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**NO. 6,734.**

To

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**R. H. DAVIES, ESQUIRE,**  
*Secy. to Govt. Punjab Provinces.*

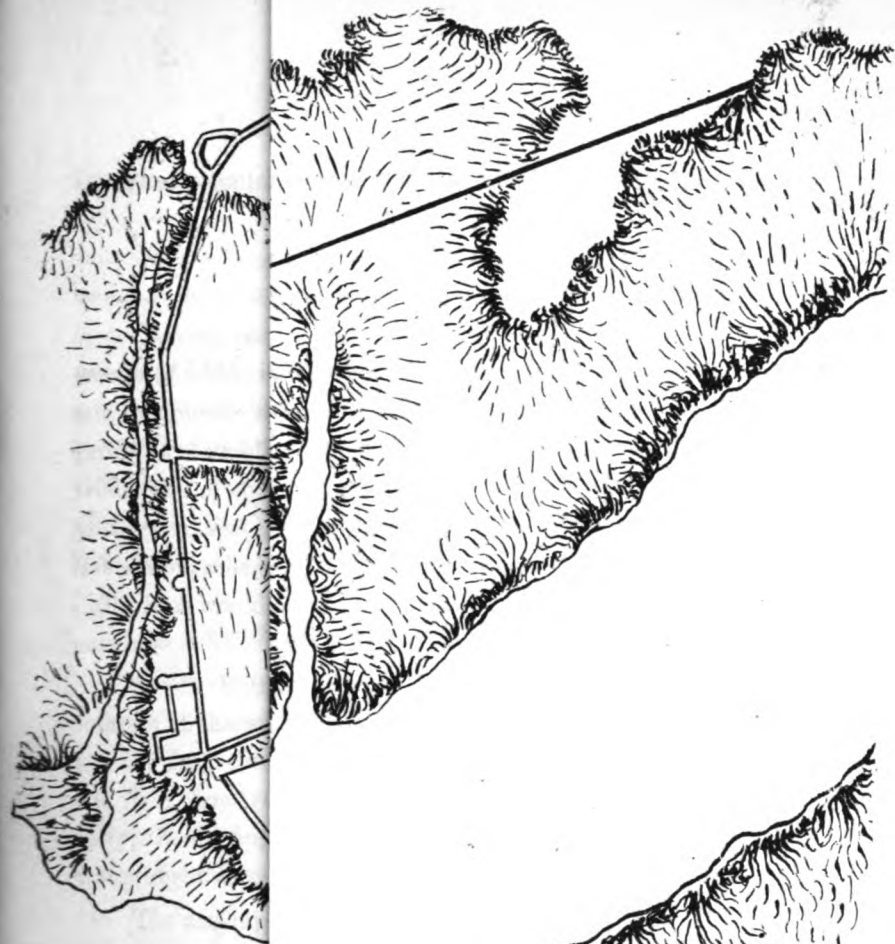
*Dated LAHORE, 20th January, 1859.*

SIR,

IN continuation of this office letter, No. 6,702, Civil. General. of the 19th instant, I have the honor to submit Captain Taylor's report on a Steam Ferry for Attock, together with a description of the new Indian gun-boats.

I have, &c.,

(Sd.) **E. L. OMMANNEY, LIEUT.-COL.,**  
*Officiating Chief Engineer, Punjab.*



JULALEEA ROCK  
VERY DANGEROUS



BRIDGE OF BOATS  
SITE,



**Project for improving the Indus passage at Attock, by Captain  
F. S. Taylor, Engineers.**

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Having resided at Attock during the greater part of the hot season of 1858, it has struck me that the ferry, now so difficult and dangerous during 4 months of the year, might be greatly improved at a small expense, and without risk of failure, by the introduction of steam as an auxiliary. I would not attempt anything on a grand scale, and in fact my scheme could be in full play next hot season, whereas the unsettled state of the country and financial difficulties would be serious obstacles in the way of any grand scheme.

2.—A bridge-of-boats is maintained at Attock for 7 or 8 months of the year, and no improvement whatever is then required; but the ferry during the hot months is both tedious and dangerous; the river, however, during these months is admirably adapted for a ferry, there being extensive backwaters on each side, with deep water right across.

The accompanying sketch illustrates this:—

The usual number of boats plying on the ferry is six, of about 5 tons burden, propelled by two sweeps in the bow, manned by about 6 men each. A laden boat can be rowed from the starting point obliquely across the river so as to catch the tail of the opposite backwater, but the propelling power is obviously insufficient to make sure of this, and accidents occur whenever the boat misses.

4.—After each trip, the boat has to be tracked up stream in the slack water 200 yards. The whole business being clumsy and laborious, a boat makes on an average only four trips per diem. But still the ferry is generally sufficient for the traffic, and it is only when an emergency calls for sudden passage of troops, or during unusually bad weather, that serious delay occurs.

5.—I propose not to interfere with the present establishments, but simply to build, in addition, two small steamers of 30 or 40 tons burden, propelled by screw, worked by engines of 20 or 30 horse power. They should ply on the common ferry line, and their power would be amply sufficient to fetch across the river in all weathers, for even square headed boats with clumsy sweeps can generally succeed in this.

They would never be called on to stem the main stream; in fact, this would be beyond the power of the finest boat, but still, in event of being carried accidentally down stream, they could be navigated securely into the nearest creek.

6.—These boats should be short, and broad in the beam; their draught need not exceed  $2\frac{1}{2}$  feet, the deck should be a simple flush platform  $2\frac{1}{2}$  feet above water line; the engine should be placed midships, in the bottom of the boat, railed off securely, with good accommodation for working; a beam engine, if procurable, would probably be the best.

I prefer the screw to paddles, as the noise would not frighten horses, and greater beam could be given to the boat.

7.—These boats could be built at Attock at a probable cost of Rs. 4,000 each. An engine would cost in Bombay £100, it could



be sent up in pieces with the necessary apparatus to Mooltan, for transport by cart to Attock; two boats could thus be built and fitted by June next, at a cost of Rs. 12,000.

8.—To work these boats, one experienced Marine Engineer would be required, and one second class hand, on the salary of Supervisor and Overseer, Rs. 150 and Rs. 80 respectively; they should bring with them half a dozen natives, but I feel convinced that the Attock boatmen would soon produce admirable coxswains and drivers.

9.—For the first season little need be attempted, except on emergency, but the boats should gradually be brought into play so as eventually to supersede the ancient system.

The furnaces should be adapted for burning wood, which is abundant and tolerably cheap.

10.—The European superintendence need not be confined to driving the steamers; a resident Manager is wanted for the Indus passage, as the road officials now in charge are about to resume work on the road, and he would supervise the whole concern all the year round.

11.—While the bridge is up, the steamers might be usefully employed in plying on the river, and at all seasons their value would be incalculable in guarding the river line, and enabling us to throw a body of troops across the river at a day's notice any where between Torbeyla and Khoosialghur.

12.—In fact, if I may venture to give such an opinion, I consider that such a ferry would be more useful (except for ordinary merchandise) than a permanent bridge; for, while enabling us to cross our troops at any point, it could never serve as a stepping stone to an enemy, thus compelling its destruction,—and this might be the fate of a noble suspension bridge in event of a temporary reverse, a fate which might have met a bridge had there been one in 1857.

Peshawur holds a strong force, but it is the furthest point of our dominions, and were our flank turned from one of the other passes in the Derajat, a retreat might be necessary for a time.

(Sd.) **F. S. TAYLOR.** CAPTAIN,  
*Executive Engineer, Nowshera.*

Since writing this, I accidentally met with the accompanying description of the new gun-boats sent out from home; these are the very boats for the purpose, and answer the requirements for Indus ferry boats in every particular; a flush platform would be substituted for the deck cabins, projecting 4 feet over the gunwale. It is not impossible that some of these gun-boats may now be lying at Calcutta, and could be made available at once.

(Sd.) F. S. TAYLOR.

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**Gun-Boats for India.**

The East India Company, seeing the advantage which would result from having a flotilla of gun-boats, of small dimensions, and light draught of water, in keeping the water communication completely in the possession of the Indian Government, have ordered Messrs. George Rennie and Sons to construct several small gun-boats on their patent principle.

The dimensions of these vessels are as follows, namely, length 70 feet, beam 11 feet, draught of water 2 feet forward, and 2 feet 6 inches aft, with from five to six tons of coal on board.

There are two engines, each of ten horse power, horizontal and direct acting, each engine being entirely independent of the other, and driving a separate screw propeller, one under each quarter the intended number of revolutions of which are 320 per minute. The gun is a long brass 12-pounder, 18 cwt., and pivoted so as to allow the gun to traverse in a circle, and thus command both sides of the river.

During the last month several trials and experiments have been made with the first of these vessels, under the superintendence of a Government Engineer; the average speed of six runs was found to be nine knots, or  $10\frac{1}{2}$  miles, the engines making an average number of 350 revolutions per minute, the indicated power being 76 horses, pressure in boiler 50 to 60 lbs.

The vessels were found to turn in a very narrow compass, from the facility of backing or stopping one engine while the other went

ahead, which it is considered will be of great advantage in some of the small creeks and narrow parts of the upper rivers.

These vessels are divided into three water tight compartments, the after part being fitted with a deck house, adapted for the hot climate of India, in which the crew, as well as the Captain—who has a separate cabin, are accommodated; the fore part of the vessel is arranged for the powder magazine, shell room, store rooms, and cooking galley, &c., and the centre part for the engine, boiler and coals.

Several of these vessels are now in course of shipment; and from the facility of putting the parts together, it is expected that in a few days after their arrival in India, they will be fit for service.

A few of these boats would be of infinite service up the narrow creeks and turnings of the river beyond Canton; and we think that the Government would do well in sending some such boats out before the China war is over, more especially as we see the President of the United States mentions in his message the intention of his Government to send out ten gun-boats of shallow draught for the Chinese service. For the above particulars of Messrs. Rennies gun-boats we are indebted to the January number of the *Artizan*. Extract from *Illustrated London News*.

(Sd.) **F. S. TAYLOR, CAPTAIN.**

To

**C h i e f E n g i n e e r, P u n j a b.**

MEMO. No. 3,778.

MOOLTAN, 17TH JANUARY, 1859.

20th January 1859.

I see no reason why this project should not be tried, especially if a gun-boat be available; and I am told that one is about to be sent to Mooltan to be placed at the disposal of the Naval Officer stationed there. This might be sent up the Indus for the experiment.

(Sd.) **H. R I G H Y, LIEUT.-COL.,**  
*Superintending Engineer, 1st Circle.*

NO. 137.

NO. 28.

To

**The Secretary to Government of India,***Public Works Department.**Dated LAHORE, 21st January, 1859.*

SIR,

I AM directed by the Honorable the Lieu-

tenant-Governor to

Chief Engineer's, No. 6,280, dated 8th January, 1859,  
and enclosures.

submit copies of the

Plan of country about Attock.

correspondence, not-

ed in the margin, forwarded by the Chief Engineer, with the following remarks :—

2.—Various schemes for the passage of the Indus at Attock have been discussed, but their execution has been prevented by the difficulties of the river. To a steam ferry there is the objection of enormous expense, owing to the velocity of the river, requiring engines of extraordinary horse power; to a suspension bridge there is also the objection of expense, caused by the wear and tear from vibration, for owing to the height of the periodical floods, such a bridge must be raised to a great elevation. There is also the military objection that it would be exposed to an enemy's fire from the hills, and the financial one that the accidents of war might necessitate its destruction. Other projects have been suggested but with no happier issue.

3.—Major Robertson, Officiating Superintendent Lahore and Peshawur Road, now proposes to pass the river by a tunnel, sunk under its bed. For this plan, there appear to be some natural facilities. Unlike the loamy clay with which Brunel had to contend in sinking the tunnel under the Thames, the substratum of the Indus at Attock is a compact slate rock, apparently uninjured by fissures. The velocity of the current, and the dangerous floods, now cease to be difficulties. The delay and expense in procuring machinery or materials from England are at once got rid of.

Through a tunnel an army might pass unmolested: and it might be adapted hereafter to the requirements of a railway. The main work of excavation can be done by native labourers, or our own sappers and miners.

4.—Major Robertson's scheme provides for masonry lining, ventilation by large air shafts raised above the flood line, lighting, &c. ; but into these details it is not now necessary to enter. Two impediments may be found, namely, the occurrence of strong land springs, and percolation of water from the river. But the primary operation is the excavation of a leading or drift gallery through the rock, and this would prove if such obstacles will present themselves. The expense of the gallery is estimated at Rupees 9,634.

5.—The Lieutenant-Governor, adverting to the great importance of the object in view, the difficulties which surround other projects, and the apparent facilities for the execution of Major Robertson's, recommends that the sum of Rupees 10,000 be granted for the drift gallery, as an experiment, which will prove if the tunnel be practicable or not; and also that a party of the 24th Punjab Pioneers, now on their way to Peshawur, be placed at Major Robertson's disposal to carry on the work.

I have, &c.,

(Signed) **R. H. DAVIES,**  
*Secretary to Government Punjab.*

**NO. 6,280.**

FROM

**THE CHIEF ENGINEER,**  
*PUNJAB,*

TO

**R. TEMPLE, ESQUIRE,**  
*Secy. to the Chief Commr., Punjab.*

*Dated LAHORE, 8th January, 1859.*

SIR,

IN continuation of my letter No. 5,792, dated 15th **Civil General.** ultimo, forwarding Major Robertson's report on the feasibility of establishing a steam ferry across the Indus, I have the honor to submit a further report from this officer, upon

- 1.—Section of the river, shewing the proposed tunnel.
- 2.—Sections of tunnel.
- 3.—Two sheets, plan and elevations of air shafts.
- 4.—Details of retaining wall at east end of tunnel.
- 5.—Entrance front of tunnel.
- 6.—Plan of the river at the point of crossing.

the best means of effecting the passage of the river, together with an estimate, amounting

to Rs. 4,86,079, and drawings, as per margin.

2nd.—Major Robertson now proposes to drive a tunnel under the bed of the river, and through rock, at a probable cost of about 5 lakhs of rupees.

The time of execution, he calculates, would not exceed 4 years.

3rd.—In order to test the feasibility of the tunnel, he proposes to run a small drift gallery under the bed of the river, at a cost of Rs. 9,634, the size of the gallery being 6 by 3, and 1,600 feet in length, and the shafts at each end being 9 feet in diameter, and 160 feet deep.

4th.—I see no objection to a trial being made at this moderate cost; it would be necessary to increase very much the dimensions of the air shaft, that will be surrounded even in ordinary floods by a depth of 20 feet of water, running at a rate of 15 or 17 miles an hour, to prevent its being turned over.

5th.—The party of Pioneers and Royal Engineers, alluded to in the 24th para. of Major Robertson's report, would not, I imagine, be available for some time to come.

I have, &c.,

(Signed) E. L. Gimmanney, LIEUT.-COL.,  
*Officiating Chief Engineer, Punjab.*

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*Estimate framed by Major A. ROBERTSON, Officiating Superintendent Lahore and Peshawur Road, of the probable expense of constructing a tunnel for ordinary traffic under the bed of the river Indus.*  
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#### SPECIFICATION.

The tunnel to be 24 feet wide, and 20 feet high, to have ventilating shafts at intervals of 600 feet, except under the bed of the river,—where the interval will be about 1,500 feet, to be lighted throughout with oil gas. The section of the tunnel under the river

to be lined with sound brick masonry, 2 feet thick, laid in hydraulic mortar, and to have a 3 foot culvert under the roadway running the whole length of the section, and terminating in a well under the pumping shaft on the Attock bank. The cart roadway to be of shingle metal, 18 feet wide and 1 thick, and the footway to be raised 1 foot above the line of road, and to be 6 feet wide. The culvert to be excavated in the rock, and arched over with brick masonry 1 foot 6 inches thick.

The sections of the tunnel, from the lowest point to the low water level of the river, to be lined with sound brick masonry, 1 foot 6 inches thick,—the remainder of the tunnel, while in rock, to be simply excavated in the rock, and not lined, but in clay to be lined with brick masonry as above—1½ thick.

The air shafts to be 9 feet internal diameter, and lined with 1 foot thick of masonry.

The tunnel under the river to have an inclination of 1 in 300 to the Attock side, for drainage purposes. The pumping shaft to be 10 feet internal diameter, and to terminate in a well as shown in the sections.

The culvert under the centre of the roadway to be continued throughout, or for such distance as in the excavation of the work may be found necessary.

A steam engine of 10 horse power to be provided for keeping the works dry, and suitable apparatus for the manufacture, storing and distribution of gas.

The execution of the work to be as follows:—the vertical shafts to be sunk, and the drift gallery throughout to be opened before the general construction of the tunnel is commenced. The drift to be 6 feet by 3, and to be first run under the bed of the river; on the completion of this, should no serious obstacles in the way of water be encountered, the difficulties of the undertaking may be considered as over, the remainder being a mere matter of time.

All the other details are shewn in the drawings.

(Sd.) **A. ROBERTSON, MAJOR,**  
*Offg. Supdt. Lahore and Peshawur Road.*

**General Report on the best means of effecting the passage of the  
River Indus at Attock.**

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*1st.* On my first visiting Attock, as Officiating Superintendent of this road, the subject of the crossing of the Indus became a point of discussion between Captain Henderson and myself; and the result we arrived at was that the project, already submitted, was too expensive, and that at first something of less pretensions should be attempted. That when the time came for bringing forward such a project, which, from the state of the finances, we did not consider as then favorable, a wire suspension bridge, for foot passengers only, should be proposed, to be in time replaced on the same masonry piers and abutments by a full cart roadway.

*2nd.* The eagerness with which a proposal for a steam ferry was taken up, and the suggestion I made in my report upon the subject, at once determined me to take up seriously the matter of the communication across the Indus, and to investigate the subject with reference to the preparation of a design, all previous discussion having only been of a general nature.

*3rd.* A report from Captain Henderson upon the very favorable state of the river for getting in foundations at the site he had originally pointed out to me as the one he deemed most suitable, and in which selection I fully concurred, also seemed to point to the present time as the period when an effort should be made to secure some satisfactory provision for this river.

*4th.* When the subject comes to be minutely examined, it presents many difficulties. The suspension principle is open to great objection from the vibration to which bridges on this construction are liable, from the passage of a variable load, the effects of high winds, the marching of troops, &c., &c., and the great risk of injury to the structure arising from this vibration. Attempts have been made in various ways to reduce vibration. Strong framed railings, extending for some distance below the roadway, have been of some service. But the most effectual mode is by ties attached to favorable points below the bridge. But here we are met by our next



difficulty, the floods to which the Indus is liable at uncertain intervals. The flood of the 10th August last rose about 80 (eighty) feet above the cold weather level of the river, and from the most authentic information we can obtain, the flood of 1841 was about 92 feet. It becomes evident, therefore, that a roadway, to be even in moderate safety, could not be placed lower than 100 (one-hundred) feet over low water mark, and even this would give only 8 feet clear of a known flood, and allow no space for ties; height increases expense very much, not only in masonry but in approaches. Large spans are objectionable from vibration, and small spans from the number of piers and expense, and difficulty of establishing them in such a river as the Indus.

5th. In a military point also, the subject had to be considered, and I found great difficulty in arriving at a satisfactory conclusion, or in making out a design which I could recommend with perfect confidence.

6th. The other means of spanning large openings, were then duly considered. Tubes are objectionable in this country from the cost and difficulty (in the case of the Indus) in floating to the spot and raising.

7th. Hollow arched ribs of iron, &c., &c., all had a fair consideration, and I was still in difficulty when it occurred to me that while only looking at the subject from one point of view, we had overlooked the real means by which the difficulties of the Indus are to be overcome, viz:— by passing under its bed by a tunnel.

8th. The banks of the Indus at Attock are of a compact slate rock, and this also extends across the bed. The rock is easily worked, and apparently not broken up by any great fissures, which might endanger the work. In fact, the situation is most favorable for a tunnel, and such a work meets all our difficulties; the floods and velocity of the river cease to be matters to be taken into account, further than placing the entrances well beyond all risk. The military objections to an exposed bridge, within reach of the cover of the hills, disappear; and we secure a safe concealed means of crossing, with every facility of closing it against an enemy, without being forced

to destroy or injure an important and expensive work. Once completed, we have a permanent work available for the passage of railway or any other traffic, and free from the expense, or wear and tear of any bridge or similar structure. The expense and difficulty attending the obtaining from Europe of the materials for a bridge, and the machinery for erection, which after use on the one point become almost valueless, are all avoided,—and we only require the ordinary labour of the country, or our own sappers and miners.

9*th*. The dangers and difficulties and expense of the Thames tunnel, are likely to occur to all; but we must remember that this work was carried through the loam and silt of the bed of the river, or the upper part of the London clay, while we have a solid compact rock to deal with, and run no risk from the principal difficulty that beset the Engineer of the Thames tunnel.

10*th*. I will now proceed to consider the details of the scheme. The bed of the river has been carefully sounded and examined, and the detail is shewn in the accompanying sections. The deepest part of the river is under the right bank; here I have reached the rock at two points at depths of 28 feet and 31 feet 8 inches, but at an intermediate point between them, I could not make sure of being on rock at 34 feet 8 inches. In the stream under the left bank, I could not get a rod down, as the bed is of large shingle; but I think we have sufficient data to show that the rock is at no point 40 feet under the low cold weather surface of the river; and allowing a safe thickness of rock between the roof of the tunnel and bed of the river, I fix the upper level of the excavation at 60 feet under low water mark. The dimensions I propose for the tunnel inside, are 24 feet wide by 20 feet in height, and a lining under the river of brick masonry 2 feet thick. This places the formation level of the roadway 82 feet under the low level; and placing the entrances 100 feet above this level for safety, we have 182 feet to descend and ascend.

11*th*. The gradient I propose is 1 in 20; this is rather steep for railway traffic, but offers no difficulties to ordinary traffic, and I think we ought not to sacrifice largely in present expense to provide for a probability only, which I consider a railway to Peshawur.

12*th*. The width of the river bed at the point I have selected for the tunnel, is 1,216 feet, and this portion I propose should be nearly horizontal, having only an inclination sufficient for drainage towards the Attock bank. It would be more convenient, as the deepest channel is on the left bank, to have the inclination to this side; but I think it important, that all the works connected with the tunnel should be on the Attock side under the protection of the fort.

13*th*. The ascending gradients commence from each bank of the river, and for the height, 182 feet on the left bank, gives a distance of 3,640; and for 186 on the right bank (allowing a fall of 4 feet for the drainage) we have a distance of 3,720 feet; but deducting from these distances 660 and 700 feet respectively, for open cuttings, we get for the tunnel 2,980, and 3,020 feet, or a total length of tunnel of 7,215 feet.

14*th*. I propose to line the tunnel with brick masonry, 2 feet thick under the river, and with masonry  $1\frac{1}{2}$  feet thick from the bottom of the ascent up to the low water level, or for 1,640 feet on the left bank, and 1,720 feet on the right; beyond this I think the lining may be dispensed with on the right bank or Attock side, and on the Khairabad side as far as the rock extends, and for this I have estimated; in the clay on the Khairabad side of course the lining must be continued.

15*th*. The drainage I have provided for by a culvert, 3 feet span, under the centre of the road, with suitable openings for the admission of the surface drainage of the open cutting, and for any percolation in the body of the tunnel. This culvert terminates in a well at the bottom of a shaft on the Attock side, and I propose to provide a ten-horse power pumping engine for the purpose of raising the water.

16*th*. The ventilation I propose to effect by means of ten shafts, 9 feet diameter, which will also be used as working shafts during construction. These shafts are 600 feet apart, except under the river: where the distance between the shafts on each bank is 1,500 feet. I have given the diameter of the shafts as 9 feet; this is the

case with all the shafts, but the one to be used for the pumps, &c., which is increased to 10 feet. These shafts are lined throughout with 1 foot thick of brick masonry, and where situated within the influence of the river flood are carried up in massy columns, formed as cut waters, on the up river side ; the tops of the shafts are covered with iron gratings, to prevent accidents from stones or other substances falling down them.

17th. In the cold weather, the ventilation will be very active ; but in the hot season, when the temperature in the tunnel will be generally lower than the external air, it may be necessary to apply artificial means, and this is provided for by a steam jet in the pumping shaft, and by gas burners in the others.

18th. The lighting I propose to effect by means of oil gas, manufactured on the spot, and distributed to lamps placed at intervals of 25 feet ; in general the lighting of every alternate lamp will be found sufficient.

19th. Detail sections and drawings of the various works are herewith submitted.

20th. I also submit a detailed estimate of cost, in which, I think, I have fully provided for every thing, and at safe rates ; the total amount is rupees 4,86,078·734 ; but as a very large amount of the work is mining, the pioneers and sappers might with advantage be employed, and thus materially diminish the cash outlay.

21st. The only contingency to which the work is liable is either the meeting with strong land springs, or finding the filtration from the river serious. The rock is compact, and free from fissures, and I think the risk from these causes is not great ; and as, of course, the first operation is running a heading or drift gallery through, the execution of this, which will cost but a small sum of money, and of which I attach a separate estimate, amounting to rupees 9,633·800, will set the matter at rest, and remove all doubt or difficulty, leaving the execution of the work a mere matter of time, while the cost becomes almost an absolute certainty.

22nd. The time of execution would not, I think, exceed four years if work was pushed on actively, and might be reduced to three years.

23rd. The main drift gallery under the river, with its two shafts, would occupy about 15 months to complete; but the other lengths, consisting only of 600 feet each, could be rapidly pushed through, and the main excavation carried on at the same time.

24th. Should this scheme meet the approval of Government, I would earnestly solicit that a party of Pioneers, with a few of the Royal Engineers, may at once be sent to Attock to sink shafts and run the drift gallery under the river bed. This successfully accomplished, the success of the scheme becomes certain, and its execution may be pushed on or deferred as deemed most expedient.

25th. As it may be found necessary to line the part of the tunnel in rock, which I at present propose to leave in its natural state, I deem it advisable, with a view of showing the utmost extent to which, as far as I can judge, the expense will go, to add an estimate for this work. It amounts to Rupees 32,873·623, and increases the total sum to Rupees 5,18,952·357.

(Sd.) A. ROBERTSON, MAJOR,  
*Offg. Superintendent Peshawur Road.*

No. 159.

NO. 32.

To

**THE SECRETARY TO GOVERNMENT OF INDIA**

*PUBLIC WORKS DEPARTMENT,*

F O R T W I L L I A M.

*Dated LAHORE, 24th January, 1859.*

SIR,

In continuation of my letter, No.  $\frac{28}{137}$  dated P. W. Dept. 21st instant, describing the project of Major Robertson for passing the Indus by means of a tunnel at Attock, I am now directed by the Hon'ble the Lieutenant-Governor to

transmit copy of a memorandum by Captain Taylor, Executive Engineer, Nowshera, in which that officer details a plan for the establishment of a steam ferry at the same point.

2. I am to say that the Lieutenant-Governor considers the advantages promised by a tunnel superior to those of a steam ferry,—and he would prefer the funds available being appropriated to the former project; but that, if as Major Rigny, the Superintending Engineer reports, it be the intention of the Supreme Government to station a steam gun-boat at Mooltan on the Jhelum, its removal to Attock is desirable, as it would afford the means of putting Captain Taylor's scheme to the proof without additional expense to Government.

I have, &c.,  
 (Signed) **R. H. DAVIES,**  
*Secretary to Government Punjab.*

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No. 1,219.

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FROM

*The Secretary to the Government of India,*

TO

*The Secretary to the Government of Punjab.*

**PUBLIC WORKS DEPARTMENT,**  
*Fort William, 5th March, 1859.*

SIR,

**Communications.** In reply to your letters, Nos. 28 and 32, dated respectively 21st and 24th January, I am directed to inform you that, with so many im-

**FERRIES.** portant unfinished works spread over the country, the Government of India is compelled to decline sanction to a work, which, however useful, is not of that emergent character that alone at this time would justify the requisite expenditure.

2. I am at the same time to express the approval of the Government of that portion of Captain Taylor's proposal which has reference to the experimental use of one of the new river gun-boats for the ferry at Attock.

3. A further communication will be made on the subject when it has been definitely ascertained, in this department, whether any of these gun-boats are available on the Indus.

4. The plans and estimate are returned herewith.

I have the honor to be,

Sir,

Your Most Obedient Servant,

(Signed) **H. Y U L E**, CAPTAIN,

*Secy. to the Govt. of India.*

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