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A NEW PLAN OF TUNNELLING, calculated for opening a Roadway under the Thames.

By M. J. BRUNEL, Esq. C.E. F.R.S.

To discover convenient and efficacious means for opening a spacious subterraneous communication between the shores of a great river, without occasioning any obstruction to the navigation, has long been a desideratum of considerable importance with the public, and in the estimation of scientific engineers. The difficulties which have opposed themselves to every attempt that has hitherto been made to execute a Tunnel under the bed of a river, have been so many and so formidable as to have prevented its successful termination in those instances where the attempts have been made.

To propose therefore the formation of a Tunnel after the abandonment of these several attempts, may appear somewhat presumptuous: on inquiring, however, into the causes of failure, it will be found that the chief difficulty, to be overcome, lies in the inefficiency of the means hitherto employed for forming the excavation upon a large scale.

In the case of the drift-way made under the Thames at Rotherhithe, in 1809, the water presented no obstacle for 930 feet; and when a great body of quicksand gave way, and filled the drift, the miners soon overcame this obstruction, and were able to proceed until they were stopped by a second irruption, which, in a few minutes, filled it. Nothing comes more satisfactorily in support of the system that is adopted here, than the result of the operations that were carried, under that circumstance, to an extent of 1011 feet, and within 130 feet from the opposite shore.

It is to be remarked that at the second irruption, on examining the bed of the river, a hole was discovered 4 feet diameter, 9 feet deep, with the sides perpendicular;—a proof that the body of quicksand was not extensive; but what is most remarkable, is, that this hole could be stopped merely by *throwing from above, clay partly in bags and other materials:* and after pumping the water out under a head of 25 feet of loose ground and 30 feet of water, the miners resumed the work, and proceeded a little further; but finding the hole at the first irruption increased, and the *filling* over the second very much sunk, the undertaking was abandoned.

The character of the plan before us consists in the mode of effecting the excavation, by removing no more earth than is to be replaced by the body of the Tunnel, retaining thereby the surrounding ground in its natural state of density and solidity.

In order so to effect an excavation 35 feet in breadth by 20 feet in height, the author of this plan proposes to have the body of the Tunnel preceded by a strong framing of corresponding dimensions, as represented in the accompanying drawings. The object of this framing is to support the ground, not only in front of the Tunnel, but to protect at the same time the work of excavation on all sides. The body of the Tunnel, which is to be constructed in brick, is intended to be fitted close to the ground; and in proportion as the framing is moved forward, so the brick-work is made to keep pace with it. But as this framing could not be forced forward, all in one body, on account of the friction of its external sides against the surrounding earth, it is composed of twelve perpendicular frames, which admit of being moved singly and independently of each other, in proportion as the ground is worked away in front. These several frames are provided with such mechanism as may be necessary to move them forward as well as to secure them against the brick-work, when they are stationary. It is to be observed, that six alternate frames are stationary, while the six intermediate ones are left free for the purpose of being moved forward, when required; these, in their turn, are made stationary for relieving the six alternate ones, and so on. Thus the progressive movement of the framing can be effected.

In order that a sufficient number of hands may be employed together with effect and security, each frame is divided into three small distinct apartments, which may properly be denominated cells. By this disposition, the twelve frames form thirty-six cells, in which the men are to operate for excavating the ground. It is to be observed that the ground in front of each cell is kept from falling in, by means of a powerful shield consisting of small boards, strongly secured by the frames. It is from within these cells that each workman is to cut out the ground, just in the way that he would do if he were to cut out a recess into a wall for the purpose of fitting a closet into it; but, with this precaution, that he is to remove each board, one after the other, and replace each in succession as he cuts the portion of the ground corresponding with it. When he has thus gained from 3 to 6 inches over the whole surface. (an operation which it is expected may be made in all the cells nearly in the same time,) the frames are

moved forward, and so much of the brick-work added to the body of the Tunnel. Thus intrenched and secure, 36 men may be made to carry on an excavation which is 630 feet superficial area, in regular order and uniform quantities, with as much facility and safety as if one drift only of 19 feet square was to be opened by one man.

The drift carried under the Thames in 1809, which was about the size of one of these cells, proceeded at the rate of from 4 to 10 feet per day. In the plan now proposed, it is not intended the progress should exceed 3 feet per day, because the work should proceed with mechanical uniformity in all the points together.

With regard to the line of operation, if we examine the nature of the ground we have to go through, we observe under the third stratum, which has been found to resist infiltrations, that the substrata to the depth of 86 feet are of a nature that present no obstacle to the progress of a Tunnel; we are informed that little water was met there. It is therefore through these substrata that it is proposed to penetrate, and to carry the line that is to cross the deep and navigable part of the river, leaving over the crown of the Tunnel a head of earth of from 17 to 25 feet in thickness, quite undisturbed.

Admitting that in descending to or in ascending from that line we should come to a body of quicksand, such as that which was found within about 200 feet from the shore, it is then we should find in the combinations of the framing, before described, the means that are necessary for effecting, upon a large scale, what is practised, on a very small one, by miners when they meet with similar obstacles. Indeed, were it not for the means of security that are resorted to on many occasions, mines would inevitably be overwhelmed and lost.

Notwithstanding we may encounter obstacles that may retard the daily progress, it is with satisfaction we contemplate that every step we take tends to the performance and ultimate completion of the object; and if we consider that the body of the Tunnel must exceed the length of Waterloo Bridge, it must be admitted that, if, instead of two years, three were necessary to complete the undertaking, it would still prove to be the most economical plan practicable for opening a land communication across a navigable river.

No notice is taken here of the mode of constructing the descents or approaches into the Tunnel; because whatever form or direction it may be found necessary to adopt, it is obvious that no difficulties oppose themselves to the accomplishment of that

part of the work, the expense of which is however taken into account in the estimate.

Nature of the Ground under the Bed of the River at Rotherhithe in a line contiguous to that now proposed for opening the Tunnel.

Nineteen Bores having been made in that line, the result was as follows :—

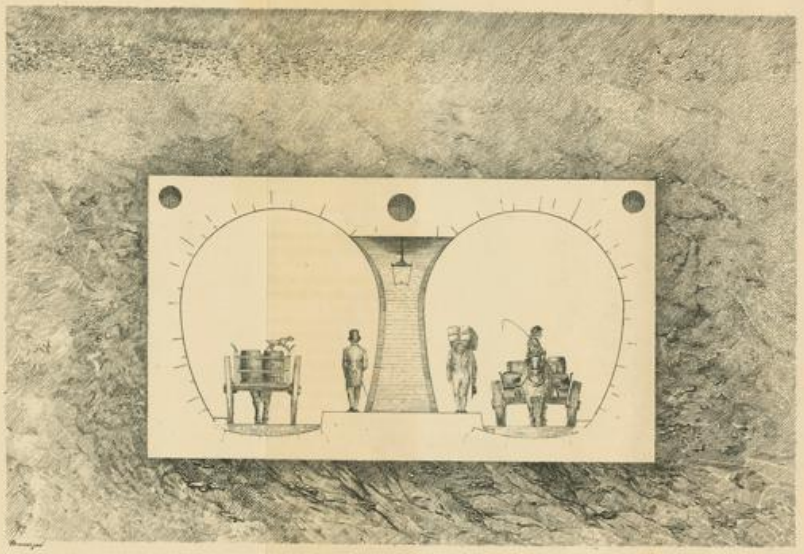
	Feet.	Inches.
Greatest depth of water at high-water - -	34	0
The bottom of the River consists of a bed of gravel and sand, the thickness of which is about - -	4	0
Clay mixed with sand - - - - - -	2	0
Stiff clay - - - - - - - -	37	0
	77	0

The Boring Tools have been forced into it to various depths, but they have been broken on several attempts to penetrate deeper.

It is expected, from the result of other borings made on shore, that the ground is nearly the same to a considerable depth.

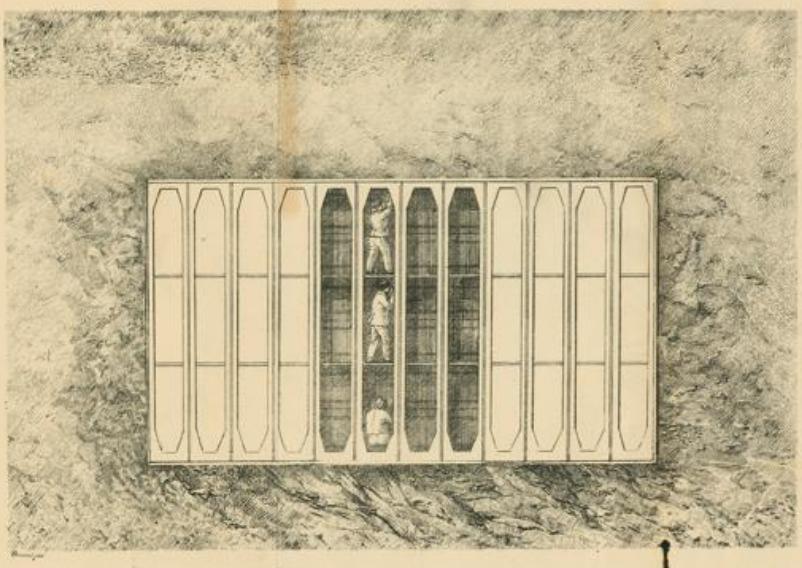
**** £200,000 have been raised by transferable shares of £50 each for carrying the above project into effect.*

Printed by Richard Taylor,
Shoe-Lane, London.



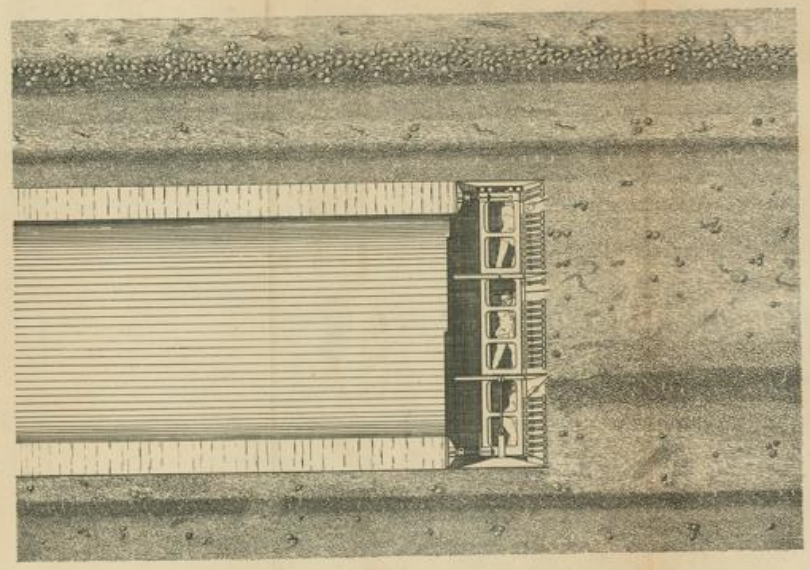
Transverse Section of the body of the Tunnel, shewing the double Archway.

W. Mulready Lith.



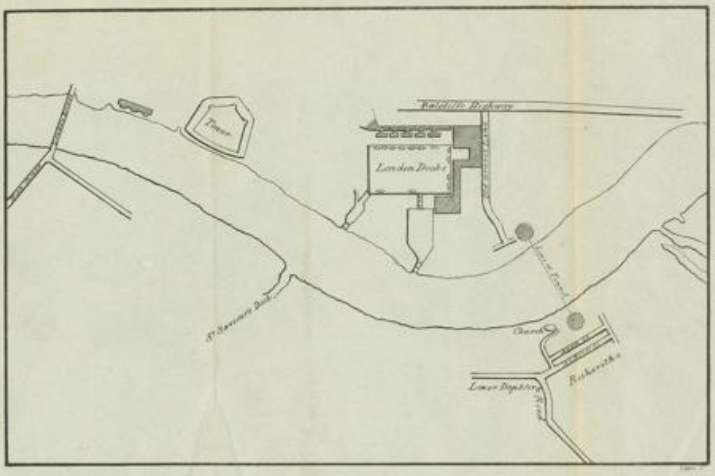
Elevation of the Tanning showing the Cells in three of which the Workmen are represented in operation.

W. Hotchkiss Lithr.



Longitudinal Section of the Tunnell.

Engraved by J. Hollowchild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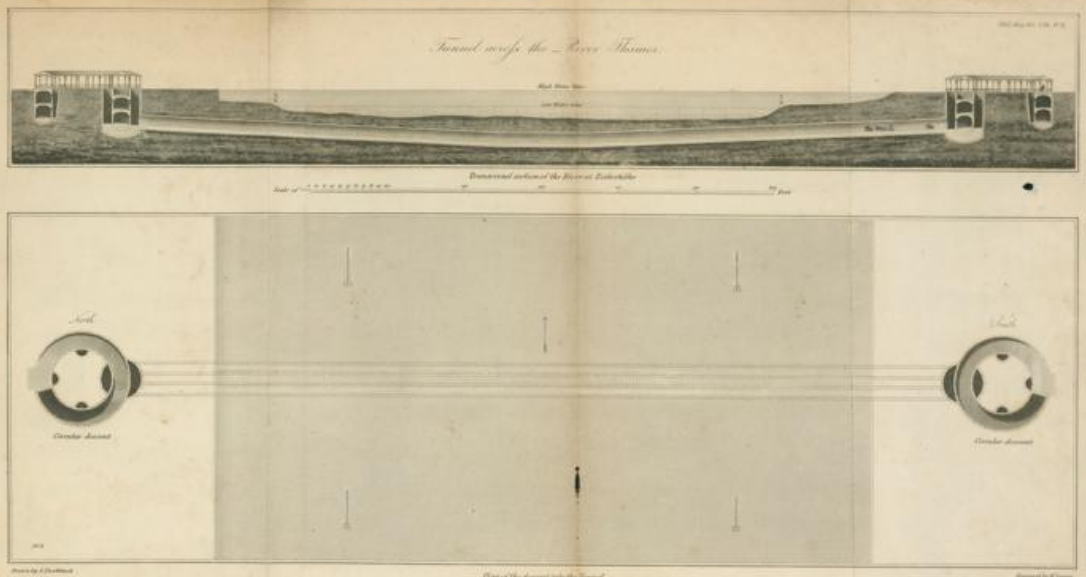
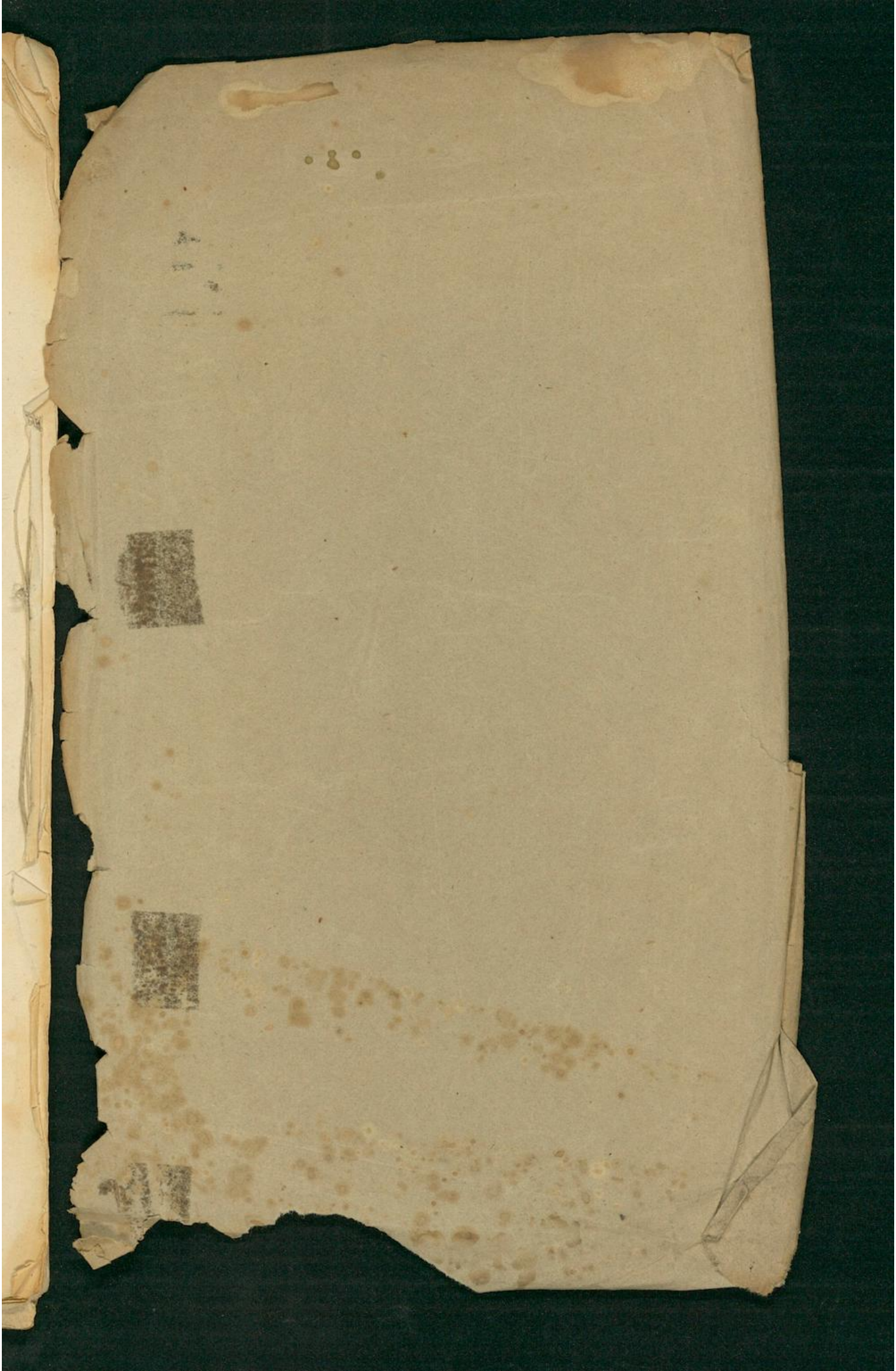
London Docks
Canal
Lower Deptford
Rotherhithe


Tunnel under the River Thames.
Transversal section of the River at Rotherhithe
Scale of
Feet
North
Circular descent
South
Circular descent
Drawn by J. Dredhault
Plan of the descent into the Tunnel
Engraved by W. Lowry



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