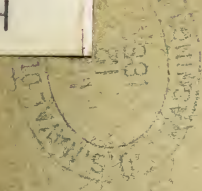


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A COMPARATIVE VIEW
OF THE
PANAMA AND SAN BLAS ROUTES
FOR AN
INTEROCEANIC CANAL.

BY
SIDNEY F. SHELBOURNE.

NEW YORK, MARCH, 1880.

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Comparative view of the Panama and
San Blas routes for an inter-oceanic canal
H. H. B. S. S. F.

INTRODUCTION AND GENERAL ARGUMENT.

For which of you, intending to build a tower, sitteth not down first, and counteth the cost, whether he have sufficient to finish it?

Lest haply, after he hath laid the foundation, and is not able to finish it, all that behold it begin to mock him,

Saying, this man began to build, and was not able to finish.

ST. LUKE, XIV, 28 et seq.

"Aperire terram gentibus" aut tenebras argento.—SCRIPT.

After the dreams and speculations of more than three centuries, civilization and progress have at last reached a generation in which an inter-oceanic canal, through the American Isthmus, is destined to be an accomplished fact.

Before us, for solution, is the grave question of where, how, by whom, and at what cost this work is to be achieved? A distinguished and honored citizen of France thinks he has already answered this question, and has put himself at the head of a scheme for its realization. Indeed, so confident is he, that at a recent banquet in his honor he said: "Science has declared in favor of this (Panama) canal. I am Science, or rather I follow Science." This Napoleonic declaration, however aptly it may illustrate the situation at Suez when that project was undertaken, has no fitting accord with the circumstances of to-day.

At Suez, there was but one way and one project possible. Science, therefore, could make no mistakes at Suez, and the followers of science had nothing to do but to look straight before them. The opposition at Suez was necessarily directed *against* science and civilization and progress, and was bound to fail; it was an opposition, not to a particular choice of a canal, but to *any* canal. It is to be feared that success at Suez against great and prolonged opposition has given an unwarranted confidence and self-resolution to the promoter of that enterprise. That scheme was proposed and launched with the rising sun and glory of Napoleon III. Paris was being rehabilitated and adorned with works of private utility and public grandeur under the administration of the energetic Baron Hausmann. France was swept, from her capital to her borders, by an awakened impulse of ambition and glory. Her new Emperor, as one of the allies against Russia, was even then reaping for her a questionable share of military glory in the East.



The French people had not forgotten the political ambitions of the first Napoleon in Egypt and Syria, nor the scientific results of his expedition thither. In that attempt England had been the enemy of France, and even to the recent day of the Paris Exposition and the war with Germany, a chronic animosity has pervaded the French people against the English. Here was Egypt, the next door neighbor of the French across the Mediterranean to the East and South, while the island seat of Britain was on the opposite side of France, across the sea to the North. What better or greater or surer victory was there for the French people, against the opposing English, than to fall in behind the banner of science and glory, borne by the sturdy hand of Lesseps, and march with their francs and their centimes in the honored service of peace through the desert wastes where the Pharaohs had left their crowns.

But we turn to the American Isthmus and find a different problem. The French and the people of the United States are old-time allies and friends. This is a new world of physical and political geography. It is marked by traversing a great curve of the earth across a mighty ocean. France, in the days of her early friendship and magnanimity, sold to us her continental possessions on our borders and gathered herself, where the hearts of all Frenchmen return, to her Gallic home. And, if her Napoleons, whose ambition the half of the earth could not bound, did essay their schemes to occupy and govern on our southwestern borders, chastened and republican France may not be charged with the wrong to-day. There has not been, nor can there be, discovered in the French people, as a mass, any self-born disposition to address their political schemes or their financial attentions towards the States or the projects of our new world. The political intuitions, the financial caution, and the economic methods of the French people will cause them to examine very carefully into the disposition of their savings in any project so far from their customary investments, and so exposed to dangers, before they will consent to part with them.

We shall not, however, here discuss the Monroe doctrine, nor the complications which may arise with reference to it. We shall not inquire what nation will guard this channel to our Pacific coasts and its adjacent seas in time of war, nor what government will assume to adjust the disputes which may arise between the Columbian Government and its concessionaires; nor by what laws and courts, or where located, the canal company, and the commerce using its highway, will settle their inevitable disputes. It is enough for us to consider that the French people will be depended upon by M. de Lesseps to provide the substantial capital for his Panama project, on the basis of his present assumed scientific solution. If the French alone were concerned in this problem, we would leave them to their studies and conclusions. But, as the problem stands to-day, the commerce of France has an interest in this transit of less than seven per cent. of the whole. Indeed, it is admitted by M. de Lesseps that the United States has an interest paramount to that of all the other nations combined. The question, then, whether M. de Lesseps "is science, or follows it," is one of vital importance to us as a commercial nation. To this branch of the subject, therefore, will the facts and arguments here presented be chiefly directed.

It is well understood that M. de Lesseps is a steadfast advocate of a sea-level canal. This preference, from the first, has been that of the great majority of thinking men who are acquainted with the subject. Even at a cost of fifty millions of dollars greater than that of a lock-canal, as through Nicaragua, it is judged that a sea-level canal would still be the most economical and advantageous. If, therefore, a sea-level canal were only possible at Panama, and a lock canal through Nicaragua, the favor to be given the one or the other of these routes would be determined, the other elements being balanced, by the comparative question of cost. But when it is recognized that there is a sea-level route other than the Panama, there justly and fairly arises a contest of merits which demands our consideration and judgment. No sincere and upright man, free from a bias of material interest, could admit other than the choice of a route, all things considered, absolutely the cheapest and the best. One canal commenced on the American Isthmus by the present generation would prevent the undertaking of another for a century to come; and a mistake now, at the beginning, would involve incalculable consequences to the world. But to return to the material argument from a national point of view. The preponderating concern of the commerce of the United States in such a canal has a right to demand that it shall be built in a manner and place which shall most adequately guarantee the smallest tax upon our commercial industries, and the greatest safety and convenience to our shipping. Has M. de Lesseps sought out and regarded these considerations thus far in the developments of his American enterprise? If the political considerations held to be of grave importance to the United States, were blown aside as the veriest chaff, would there not still remain for earnest national inquiry this question of the vital interests of our commerce? Why was the tea thrown overboard in Boston harbor, and the American Revolution commenced? Could we not have bought the tea taxed without our consent, or have let it alone? Cannot our commerce either use this canal, built by the money of Europe without us or in spite of us, or let it alone? No! Only one canal is possible. Civilization and commerce demand it for the present generation and chiefly, as admitted, for American interests. If, therefore, by one route, a canal, at the sea-level, will cost two hundred millions, and by another, equally as good or better, one-half that sum, it is the duty of this nation, on its admitted interest, to see that the cheapest and best is chosen. Our commerce should not be compelled to pay a burdensome tax that a needlessly profligate investment may have its recompense. As a nation we should foresee that the tolls required to pay an adequate interest upon the one capital could be reduced by one-half and still pay the same dividends on the smaller one. But M. de Lesseps assures us that the tonnage dues are limited by the concession, and he promises us, in advance of his company, that they shall be fifteen francs, or three dollars per ton. It cannot be understood how any other authority than the stockholders of the future company can give guarantees of limit to the tolls. The concession of the Columbian Government practically does not do it, for it provides for a measurement of vessels extraordinary enough to compass a tax as large as eight dollars per registered ton. This measurement is the cubic contents of a parallelopiped determined by the length and greatest width of a vessel at the water-line, multiplied by its

greatest draft of water, at the time of transit. Thus, under the concession, the steamship "Arizona" could be assessed a toll for a single transit of *thirty thousand and fifty dollars*, while her net registered tonnage is but 2,928 tons; thus showing, in this case, a limit, by the concession, reaching to above *ten dollars* per registered ton.

Notwithstanding, therefore, any promises in advance, it may be safely prejudged that the practicable scale of revenue will be crowded to its utmost to provide adequate dividends upon the investment involved. In the light of the argument presented we come, therefore, to inquire what M. de Lesseps has done to determine, by comparative examination or study, the route which should be chosen. It is gratifying to be able to quote M. de Lesseps himself on this point. He has told us through the public press, since his arrival in New York, what he said months before the Paris Congress, and when the surveys of the Panama route, made by the United States Government, were not yet before him. He says: "I told Messrs. Wyse and Réclus, when they made their report on the Darien route, that there could be no other route than the railroad. If you come back with a favorable report of a sea-level canal on that route I shall favor it." Here was a route determined upon by M. de Lesseps in advance of any adequate surveys or any sufficient study or examination of other possible routes. Hence, M. de Lesseps can justly say: "I am science, or rather I follow it."

After the report of Lieut. Wyse and M. Réclus the Paris Congress was called by M. de Lesseps. Instead of constituting that body on the representative principle of the national commerce involved, its composition was made up of seventy-three members from France alone, with her two colonies, Algeria and Martinique, and sixty-two members from *all other countries*, twenty in number, great and small, while of these foreign delegates many did not enter into the discussions or even attend the Congress. A large number of the Frenchmen in that Congress were the personal friends and *collaborateurs* of M. de Lesseps. It is not surprising, therefore, that of those who gave the affirmative vote in favor of the Panama route a decisive majority were members from France. It follows, therefore, that since the Paris Congress was a scientific assemblage, and, by its vote, *constituted as it was*, it gave its indorsement to the Panama route, there is a second conclusive reason why M. de Lesseps, referring to its decision, may say, "I am science, or rather I follow it." The San Blas route was still, as now, but partially and indefinitely surveyed. The Chiriqui region, said to be only fifty miles across, remains to-day an unknown wilderness to the possibilities of canalization. But, notwithstanding these facts, it is assumed by the supporters of M. de Lesseps to be conclusive in favor of the Panama route, and enough to slaughter every competing proposition, to merely refer to the decision of the Paris Congress as though it was the *ultima ratione* of science. The Paris Congress, however, did not vote "after it the deluge," and its constituent elements returned whence they came.

To make definite this project of a canal, and to explain away any possibilities of mistake or impracticability, it remained to call "the Superior International Technical Commission" to formulate, on the Isthmus, in the immediate presence of the obtrusive facts, the plans of a predetermined success.

The leading members of this commission are men of honorable character and scientific reputation. All of them well knew M. de Lesseps' wishes and determinations. He called them and constituted them *his* commission. They were bound, so far as their honest convictions would let them, to pay deference to his views. M. de Lesseps himself has just told us that "if they (the commission) had reported in favor of a lock canal, he would have put on his hat and gone home." In fact, the question of a lock canal was not before them. It was purely and solely "the Panama sea-level canal"—can it be built, and how much will it cost? M. de Lesseps himself also explained this when he said, at the reception before the Society of Civil Engineers: "I did not go to the Isthmus to examine other routes. I went simply to carry out the decision of the Paris Congress." This, then, was his purpose, and the object of the "Superior Commission" he took with him. The decision of the Paris Congress was embodied in the following resolution: "Resolved, That the International Congress is of the opinion that the construction of an inter-oceanic canal of continuous level, so desirable in the interests of commerce and navigation, *is possible*, and that the maritime canal, to respond to the indispensable facilities of access and usefulness which a passage of this kind would offer, should proceed from the Gulf of Limon to the Bay of Panama."

Upon this resolution M. de Lesseps sought to obtain his capital and failed. The Paris Congress declared that the Panama canal "*is possible*." This was not enough for the capitalists. The "Superior Technical Commission" is thereupon called to fix the details to the "possible," and to reckon up the cost. As faithful engineers, they have performed simply an engineer's duty, and have reported that the "possible" can be accomplished, with such and such details, at an engineering cost of so many francs. To M. de Lesseps, apparently, the problem seems now conclusive, and triumph is assured. He may now say: "This commission has made the project definitive for the capitalists. They will surely receive these *facts* with enthusiasm."

A brief review will show a consecutive line of logical events. First, that long before the Paris Congress M. de Lesseps had determined in favor of the Panama route, and, before any definitive or comparative surveys were available, had said to Messrs. Wyse and Réclus, on their starting for the Isthmus: "If you come back and report in favor of the route by the railroad I will support you." Hence, arose his first title to his banquet declaration: "I am science, or rather I follow it."

Second. That the Paris Congress was called by M. de Lesseps, and composing it were seventy-three Frenchmen to sixty-two members of all other nations; that upon general considerations, and without any detailed plans of the Panama project before it, but only shifting propositions, it arrived at the very conclusion of M. de Lesseps. A sea-level canal "is possible," and the place is Panama. Hence, is due his second title to the declaration: "I am science, or rather I follow it."

Third. The work and the report of M. de Lesseps' "Superior Technical Commission," declaring an engineer's "possibility" at a determinate cost, based upon (comparative?) science, which is to be the grand and triumphant salute to the capitalists. In this arises the third title to the declaration: "I am science, or rather I follow it."

Thinking men may reasonably inquire whether M. de Lesseps, during his long residence in Egypt and Syria, has not developed unconsciously into a magic producer of the apples of Sodom—that Dead-Sea fruit so fair and beautiful—and whether he is not now holding up to his own fancy, and toying the vision of his friends with a specimen of that product rare in size and rich and perfect in its color and smoothness? If such is the case it would be a rude and ungracious work to probe beneath the fair surface of a fruit so comely to the eye, were it not that the bearings of the subject in hand are too important to permit of any sentiment upon surface, or even to regard the courtesies usually due to the claims of a clever magician. Let us, therefore, try to find the meat beneath the magnificent rind “the commission” has polished upon this Panama scheme.

It has been already said that the report of the “commission,” which, after all, is the only tangible fact of the entire American effort of M. de Lesseps, is merely a declaration of quantity and price, and that the commission intended to limit itself to this alone. It may be profitable to observe how this appears, from the declarations of some of the members of the commission, when giving their opinions as men unharnessed from the yoke of their profession. In an interview reported in the *New York Herald*, August 10th, 1879, Col. G. M. Totten replied to questions with reference to the Panama route, as follows:

Ques. “Do you regard this as a practicable route?”

Ans. “While it is generally understood that a sea-level canal is impracticable by the Nicaragua route, it is not so well known that the Chagres River, and its tributaries, present insuperable obstacles to a sea-level canal by the Panama route.”

Ques. “What is the most feasible route, in your judgment?”

Ans. “The San Blas route is the most feasible known sea-level route?”

Gen. Wright, in an elaborate article over his own signature, reported in the *Herald* of October 22d, 1879, says of the Panama route:

“The plan of building without lift-locks is the one I advocated *before making a thorough investigation of the subject*; but since then I have abandoned it on account of two almost insuperable obstacles which presented themselves, namely—first, *the great cost of construction*; and, second, *the almost impossibility of maintaining such a canal*. The feasible plan, then, is to use lift-locks on both sides of the summit.”

Upon their arrival in New York from the Isthmus, both Herr. Dirks and Gen. Wright were interviewed by representatives of the press. One of the questions to Mr. Dirks was as follows: Ques. “Will European capitalists invest in such a vast work?” Ans. “Ah! You ask something which is not in my province as an engineer.”

Among others, the following question was put to Gen. Wright: Ques. “Do you think the canal will be profitable at the estimated cost?” Ans. “That is something which we, as engineers, were not called upon to answer, nor say; it will take so long to build and will cost so much.”

It will be seen, therefore, in the light of the foregoing, that the foundation of *practicability* in the Panama scheme is chiefly, if not entirely, the hope and resolution of M. de Lesseps himself.

We have come, then, to the solution of the question we have already propounded, namely: What M. de Lesseps has done to determine exhaustively the route which should be chosen? It is to be regretted that the reply must be—absolutely nothing. He has not addressed himself, from first to last, to any comparative surveys. He has not seemed to care that they should be made, even by others, for his words to Messrs. Wyse and Réclus were in effect a suggestion that they should abandon other routes for the one he had predetermined. He has pursued, from ignorance through what light may have come to him of Isthmus topography, the one set resolution—his first and fixed determination that he will have nothing else but the Panama route.

But, while he has done nothing towards *the choice* of a route, the world is still largely indebted to him for such an exposition of the Panama route for a sea-level canal as will enable those familiar with the comparative methods of science to place before the capitalists of the world the scheme of M. de Lesseps on the basis of its real merits; and that, too, with the advantage of using his own figures in the showing.

PHYSICAL FEATURES AND ESTIMATES.

FIRST—LENGTH.

The Panama route, as determined by M. de Lesseps' commission, will be forty-five miles long from sea to sea. The San Blas route has a total length of thirty miles, or only two-thirds that of Panama.

SECOND—LENGTH OF CANALIZATION.

The Panama route will require an artificial cutting for the whole forty-five miles. The San Blas route for only 24 miles, thus reducing the actual *canal* to nearly *one-half* the length of the Panama. The Bayano River already affords ship navigation for six miles on the Pacific side at San Blas.

THIRD—HARBORS.

The Panama route has indifferent harbors on both sides of the Isthmus. The destruction of ships at Aspinwall last November illustrates this point. Here it is proposed to wall in a harbor by an immense breakwater, more than a mile and a quarter long, at a cost of two million dollars. This expense is entirely avoided on the Atlantic side at San Blas, where there is an inclosed natural bay and harbor of nine square miles of secure anchorage.

On the Pacific side the Panama route ends in the open ocean bay of Panama, with a cutting of submarine rock to reach deep water. The cutting of the Pacific end of the San Blas route ends in the Bayano river, which affords for six miles an anchorage ground, two miles of which has a width of half a mile. The Island of Chepillo, two and a half miles off, in the Bay of Panama, from the mouth of the Bayano, affords a perfect protection against the stormy violence of the sea.

FOURTH—INTERFERING CHANNELS OF NATURAL DRAINAGE.

On the San Blas route there are absolutely none. On the Atlantic side the canal commences at Mandinga Harbor, and extends five miles through a gradual upward slope to the mouth of the proposed tunnel—on the Pacific side from the opening of the tunnel through an easy downward slope to the Bayano river, a distance of twelve miles. On both sides of the mountain the small streams run parallel with the proposed canal. The Panama route presents the situation of an extensive system of river drainage, of which the Chagres occupies the central and most prominent position. Crossing the line of the proposed canal, and emptying into this river on the one side, are twenty-one smaller rivers and streams between the two points of Matachin and Gatun. Between Gatun and Limon Bay the river Mendi and its principal branch are crossed. Between Matachin and the Bay of Panama the Obispo and the Rio Grande, both important rivers, with their several branches, are encountered. This situation of water courses presents, indeed, the most stupendous problem of engineering as connected with this route. It involves a gigantic dam costing twenty millions of dollars. It requires an artificial channel for these various rivers on the one side and the other of the central ship canal—in fact *three* canals side by side to be created by the hand of man.

With these features in view, the determination between a sea level canal at San Blas or at Panama ought to be easy enough. There is yet to be found a single American engineer who will stake his personal reputation upon the declaration that a sea-level canal at Panama is possible in the present generation at a *practicable* cost. There are doubtless scores of engineers who, with Col. Totten and Gen. Wright, will be able to tell us *how* the canal can be built with drill and spade and masonry, and how much it will cost; the determinations, therefore, in favor of this route are not yet complete. Capitalists, who are the shrewd and calculating judges of *practicability*, have yet to give their decision.

FIFTH—WIDTH OF CANAL.

It will be seen that M. de Lesseps has confined the width of his proposed canal to the minimum. This was doubtless necessary, in his mind, to keep its cost within the limits of the banker's arithmetic. A compromise was expedient to bring the "possible" somewhere near at least to the appearance of the practicable. This method of reduction towards practicability becomes interesting in view of the fact that Col. Totten, while on the Isthmus, gave to the correspondent of the New York *Herald* an estimate of the cost of a sea-level open-cut canal at Panama, of a width on the bottom of 106 feet in earth and 120 feet in rock, at *four hundred and twenty-nine million dollars*. But the width at bottom assigned by the report of the commission is only seventy-two feet, except in the deep rock cutting of the Culebra section, where it is 78.75 feet.

In the calculations hitherto and elsewhere made for the San Blas route, the writer has estimated for a tunnel 100 feet wide and 168 feet high, and for an open cutting of 100 feet wide on the bottom. It becomes, therefore, now necessary, in giving a just comparison between the two routes under consid-

eration, to reduce the proportions of the line by San Blas to those just assigned by the de Lesseps commission for the Panama route. The following are the dimensions assigned by the commission for the Panama route:

1. Between Colon and kilometre 36 (the Atlantic division), and between kilometre 61 and Panama (the Pacific Division):

Width at bottom.....	22 metres
Width at water line.....	50 "
Depth.....	8.50 "

2. Between kilometres 36 and 61 (the Culebra or Summit division):

Width at bottom.....	24 metres
Width at water line.....	28 "
Depth.....	9 "

The dimensions herein following, therefore, for the San Blas route, while about the same for the earth sections, give the canal for the rock sections a width at bottom of 1.25, and at the water line of two feet, greater than those for the Panama route.

SIXTH—QUANTITIES.

The quantities reported by the commission for the Panama canal sum up a total of seventy-five million cubic metres. A cubic metre = 1,308+ cubic yards; therefore, the total is 98,100,000 cubic yards. This enormous total does not include the excavation necessary to provide new channels for the rivers on each side of the canal, and for which, without giving quantities, the commission assigned a cost of seventy-five million francs. We must, therefore, necessarily leave out from our comparison of quantities a considerable and important element. And yet of this total for the central canal the rock alone equals the entire total of both rock and earth excavation for the San Blas route, being 35,345,000 cubic metres, or 46,231,260 cubic yards; while the earth is an addition of 39,655,000 cubic metres, or 51,868,740 cubic yards.

The rock excavation in a single division of the Panama route (the Culebra or Summit section) amounts to 33,789,564 cubic yards, which is within a fraction of being *twice* the whole amount of the seven miles of tunnel excavation on the San Blas route; and yet M. de Lesseps holds up this tunnel as something enormous and difficult to excavate. But while M. de Lesseps says this, men like Walter Shanly, whose life long experience has been in tunneling work, say that each cubic yard of it, when once the small heading is driven, is only equivalent to a cubic yard in M. de Lesseps's project, with the advantage that there is always a roof over the work in progress, and, unhindered by storms or night, it may proceed through every hour of the year.

But that each one who chooses may make, in detail, the comparisons for himself, the quantities estimated for the San Blas route are here given:

ATLANTIC DIVISION.

FIRST SECTION OF TWO MILES.

Commencing at Mandinga Harbor, Gulf of San Blas. Average surface elevation above mean low water, 20 feet. Excavation: earth. Composi-

tion—alluvium and clay of decomposition; ferruginous. Width at bottom, 72 feet. Slopes, below water, $1\frac{1}{2}$ to 1; above, 1 to 1.

FORMULAS OF CALCULATION.

$$\left. \begin{array}{l} \text{Excav. below water.} \\ \frac{72+72+3(28)}{2} \times 28 \times 5280 \times 2 \quad \left. \vphantom{\frac{72+72+3(28)}{2}} \right\} +27 \\ \text{Excav. above water.} \\ \frac{156+156+2(20)}{2} \times 20 \times 5280 \times 2 \quad \left. \vphantom{\frac{156+156+2(20)}{2}} \right\} +27 \end{array} \right\} = 2,625,138 \text{ c. yds. earth.}$$

SECOND SECTION OF TWO MILES.

Average surface elevation above the sea, 80 feet. Excavation: rock and earth. Average layer of earth, 20 feet. Width at bottom, in rock, 80 feet. Slopes, in rock, $\frac{1}{4}$ to 1; in earth, 1 to 1.

FORMULAS OF CALCULATION.

$$\left. \begin{array}{l} \text{For the rock.} \\ \frac{80+80+(88+2)}{2} \times 88 \times 5280 \times 2 \quad \left. \vphantom{\frac{80+80+(88+2)}{2}} \right\} +27 = 3,510,613 \text{ c. yds. rock.} \\ \text{For the earth.} \\ \frac{80+44+2(20)+124}{2} \times 20 \times 5280 \times 2 \quad \left. \vphantom{\frac{80+44+2(20)+124}{2}} \right\} +27 = 1,126,400 \text{ c. yds. earth.} \end{array} \right\}$$

THIRD SECTION OF ONE MILE TO THE MOUTH OF THE TUNNEL.

Average elevation above the sea, 162 feet. Conditions as to rock and earth in second section.

FORMULAS OF CALCULATION.

$$\left. \begin{array}{l} \text{For the rock.} \\ \frac{80+80+(170+2)}{2} \times 170 \times 5280 \quad \left. \vphantom{\frac{80+80+(170+2)}{2}} \right\} +27 = 4,072,445 \text{ c. yds. rock.} \\ \text{For the earth.} \\ \frac{80+85+2(20)+165}{2} \times 20 \times 5280 \quad \left. \vphantom{\frac{80+85+2(20)+165}{2}} \right\} +27 = 723,556 \text{ c. yds. of earth.} \end{array} \right\}$$

Total for the division—rock, 7,583,058 c. yds; earth, 4,475,094 c. yds.

NOTE.—The elevations for this division have been taken at 10 per cent. above the approximate calculable maximum.

MIDDLE DIVISION.

THE TUNNEL THROUGH THE CORDILLERAS.

Length, 7 miles Width at bottom and surface of water, 80 feet. Height from bottom, 168 feet; above water, 140 feet. Area of vertical section by planometer, on scale drawing of 10 feet to 1 inch, 12,402 sq. feet, or 1,378 sq. yds.

Therefore, $12,402 \times 5280 \times 7 \div 27 = 16,976,960$ cubic yards, the total excavation for the middle division.

PACIFIC DIVISION.

FIRST SECTION OF ONE MILE.

Commencing at Pacific end of tunnel. Average elevation above low sea in Gulf of San Blas—the datum level of construction—122 feet. Conditions of rock and earth as in second section, Atlantic Division.

FORMULAS OF CALCULATION.

$$\left. \begin{array}{l} \text{For the rock.} \\ \frac{80+80+(130 \div 2)}{2} + 130 \times 5280 \end{array} \right\} \begin{array}{l} \text{c. yds. rock.} \\ \div 27 = 2,860,000 \end{array} \\ \left. \begin{array}{l} \text{For the earth.} \\ \frac{80+65+2(20)+145}{2} \times 20 \times 5280 \end{array} \right\} \begin{array}{l} \text{c. yds. earth.} \\ \div 27 = 626,815 \end{array} \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{Total, 3,486,815 c. yds.}$$

SECOND SECTION, SEVEN MILES.

Average elevation above low sea, 37.75. Conditions of rock and earth as in second section, Atlantic Division.

FORMULA FOR DEPTH OF CUTTING,

$$\frac{67.5+8+2(28)}{2} = 65.75.$$

FORMULAS OF CALCULATION.

$$\left. \begin{array}{l} \text{For the rock.} \\ \frac{80+80+(45.75 \div 2)}{2} \times 45.75 \times 5280 \times 7 \end{array} \right\} \begin{array}{l} \text{c. yds. rock.} \\ \div 27 = 5,726,426 \end{array} \\ \left. \begin{array}{l} \text{For the earth.} \\ \frac{80+(45.75 \div 2)+2(20)+102,87}{2} \times 20 \times 5280 \times 7 \end{array} \right\} \begin{array}{l} \text{c. yds. earth.} \\ \div 27 = 3,360,622 \end{array} \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \begin{array}{l} \text{Total c. yds.} \\ = 9,087,048. \end{array}$$

THIRD SECTION OF FOUR MILES TO BAYANO RIVER.

Average elevation above low sea, 16 feet; or 23.5 above low water in the Bay of Panama. Excavation: earth. Width and slopes as in first section, Atlantic Division.

FORMULAS OF CALCULATION.

$$\left. \begin{array}{l} \text{Excav. below water.} \\ \frac{72+72+3(28)}{2} \times 28 \times 5280 \times 4 \end{array} \right\} \div 27 \\ \left. \begin{array}{l} \text{Excav. above water.} \\ \frac{72+3(28)+2(16)+156}{2} \times 16 \times 5280 \times 4 \end{array} \right\} \div 27 \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} = 4,649,529 \text{ c. yds. earth.}$$

Total excavation, Pacific Division—Rock, 8,686,426; earth, 8,536,966.

NOTE.—The elevations are calculated on the basis of a rise and fall of tide of two feet in the Gulf of San Blas, and of seventeen feet in the Bay of Panama.

RECAPITULATION.

Atlantic Division.....	<i>Rock</i> , 7,583,058	<i>Earth</i> , 4,475,094 c. yds.
Middle " 	" 16,976,960	" "
Pacific " 	" 8,586,426	" 8,636,966 "
<hr/>		
Grand total.....	33,146,444	13,112,060 "
Combined total.....		46,258,504 "

The quantities here estimated for the San Blas route have been arrived at after carefully collating all the accessible data of this route, and by calculations entirely independent of any hitherto made, and their justness and yet liberality is shown by the fact that they exceed by about two million cubic yards the quantities assigned for this route by Messrs. Wyse and Réclus in their presentation of it before the Paris Congress.

It may be of value to present here that the quantities estimated for the Nicaragua route are 59,833,557 cubic yards, adopting the cross section of the surveys; but, taking the cross section assumed by the Paris Congress, to equalize the calculations for the several routes, the quantities are 70,781,555 cubic yards. Therefore, to the fact that the San Blas route is by far the shortest of all possible routes, must be added the second great fact, that the *quantities* of excavation are far less than those of any other route, *even to being less than half the quantities of the Panama route.*

In so important a matter these facts will not fail of attention.

SEVENTH—COMPARISON OF COST.

It will not be necessary here to reduce to exact dollars and cents every detail of the estimates in francs for the Panama route. It is enough to say that the engineer's total, *as an engineer's estimate*, was 843 million francs, or \$168,600,000, and that this sum is wholly absorbed in engineering items. But M. de Lesseps is committed to pay the shareholders five per cent. interest on their money advanced, until one year after the completion of the canal. This item alone will add \$37,935,000 to the above sum. Then there is \$14,000,000, at least, to be paid for the Panama Railroad by the time of the completion of the canal. Again, there must be added \$2,000,000 to Lieut. Wyse and his associates, on account of the concession. Also \$2,000,000 to M. de Lesseps himself, for his advances as deposits for the Columbian Government, and for the surveys and studies now in progress on the Isthmus. We see, then, that if the engineer's estimate is high enough, and all goes well with the work, and bankers and agents get nothing as commissions for their part, the capitalization of this scheme, at the completion of the canal, upon which dividends must be earned, is the enormous sum of \$224,535,000.

But M. de Lesseps says his Commission estimated too high. Why not say, on the contrary, too low? If M. de Lesseps is to have his own judgment or speculation about it, why have had the Commission at all? The writer has hitherto estimated open cut rock excavation on the Isthmus at \$3 per cubic yard; but M. de Lesseps' Commission, adopting the figures for-

mulated by a Committee of the Paris Congress, has placed the cost at twelve francs per cubic metre, which is only \$1.77 per cubic yard.

But it is not the purpose to criticize the prices fixed by the de Lesseps Commission, but simply to apply them in comparison to the quantities for the San Blas route.

Here is the schedule of the Commission, affixed to the quantities for the Panama route, in its general statement:

	FRANCS.
1st. Earth, 27 350,000 c. m., at 2.50 francs, approximately	68,760,000
Rocks of mean hardness, 825,000 c. m., at 7 francs	5,775,000
Hard rocks, 27,734,000 c. m., at 12 francs	332,808,000
Excavation of rocks where pumping is necessary, 6,409,000 c. m., at 18 francs.....	115,362,000
Dredging and excavation under water, mud and alluvial soil, 12,005,000 c. m., at 2.50 francs.....	30,500,000
Hard soil, capable of being dredged, 300,000 c. m., at 12 francs.....	3,600,000
Excavations of rocks under water, 377,000 c. m., at 35 Francs.....	13,195,000
2d. Dam at Gamboa, length, 1,600 m., maximum height, 40 m.	100,000,000
3d. Channels for discharging the water of the regulated Chagres, the Obispo, and the Trinidad	75,000,000
4th. Tide lock, on the Pacific side.....	12,000,000
5th. Breakwater, at the Bay of Limon	10,000,000
	<hr/>
6th. Add for contingencies.....	767,000,000
	<hr/>
Total..... (francs)	843,000,000

It will be observed that there are three items in the above schedule—namely, the second, third and fifth—involving an estimate, with the percentage for contingencies, of a large total of 203,500,000 francs, which have no relation or application to the estimates for the San Blas route. Therefore, this large sum must afford a further illustration of the declaration of M. de Lesseps “I am science, or rather I follow it.”

Applying the above schedule of prices to the quantities for the San Blas route, and giving items not identical for the two routes, a liberal estimate, the result will be as follows:

	DOLLARS.
1st. 8,207,858 c. yds. of rock where pumping is required, at 18 francs per c. m., or \$2.655 per c. yd.....	21,791,863
492,800 c. yds. rock, in tunnel heading, of section of 40 sq. yds. to 1 lineal, at \$9 per c. yd.....	4,435,200
24,445,786 c. yds. open cut rock in tunnel and outside, at 12 francs per c. m., or \$1.77 per c. yd.....	43,269,041
13,112,060 c. yds. alluvial soil, dredged from below water, and surface earth excavated above the rock, at 2.50 francs per c. m., or 37 cents per c. yd.....	4,851,462
2d. Tide lock, on the Pacific side.....	2,400,000
3d. Deepening bar and dredging, in Bayano River.....	600,000
4th. Sinking 3 shafts to tunnel	460,000
5th. Light house on Chepillo Island.....	15,000
	<hr/>
6th. Add for contingencies.....	\$77,822,566
	<hr/>
Total.....	\$85,604,822

For the purposes of this comparison, there is nothing to be added to the above estimates, except for the contingent cost of replacing an unstable natural arch with an artificial and safe one in portions of the tunnel. With tunnels already constructed, we know that the percentage is below one-sixth of the length. Therefore, a contingent assignment of four million dollars would meet the objection that we had not made an allowance for arching the tunnel.

The figures given, showing that, upon equal conditions, the cost of a sea-level canal by the San Blas route would be approximately only *one-half* that of the proposed Panama canal, can lead to but one conclusion. Half the cost of construction means *twice the profits*, or only *half the tolls*.

EIGHTH—AN IMPORTANT QUESTION OF DETAIL.

The situation of the Panama route, with its extended system of drainage channels, makes it absolutely necessary that the outflow to the sea of the drainage of the water sheds should be provided for in advance of the construction of the main ship canal. Of course, it is proposed to dig a new channel for the various streams on each side of the line of the main canal. Standing, then, at the Bay of Colon, we see before us the central depression of the valley of the Chagres—the line of ship transit. To the left we see an artificial channel cut for the “regulated” Chagres, the Obispo, the Gatun, and *eighteen* smaller streams. To the right we see a new artificial way for the Rio Baila Monos, the Trinidad, the Rio Mandingo, and many others of lesser note. If, in cutting these subsidiary channels, the material has been disposed of to the right and left of each respectively, as may, perhaps, be done, the next question which comes to be considered is the disposition of the material of excavation of the *main canal itself*. Is it possible to find an easier way of disposition than to carry every cubic yard of it to a distance *across the new rivers* on either side—and can there be found *room* for so large an excavation? The practical engineer will study with grave doubts, if not with nightmare, a problem so filled with the elements of delay, of difficulty, and of *cost*.

NINTH—FAIR WEATHER, AND WET AND DRY SLOPES.

All explorers of the Isthmus agree that the Pacific is the fair and dry side, and the Atlantic the stormy and wet side. While the change in the climate in passing from one side to the other, in a region so low of summit and broken in character as between Panama and Aspinwall, may not be clearly apparent, in other portions of the Isthmus, as at San Blas, where the mountain range is unbroken and the elevation much greater, the change is at once sudden and remarkable.

Of wet slope and Atlantic climate, the Panama route would have thirty-five miles—the San Blas route, five miles.

Counting the tunnel as neutral, the dry slope and Pacific climate of the San Blas route would be eighteen miles, while that of the Panama route would be only ten miles. Comparing the Atlantic slopes of the two routes, it will be seen that the disadvantage is as 7 to 1 against the Panama route.

How much this speaks, in dollars and cents, of workmen huddled in their huts, of doctors' chests, stacked spades, and swelling rivulets surprising each other through the new-dug earth, is a calculation too uncertain for office mathematics, and must be left to the arithmetic of the superintendent's note book.

The quick mind of the capitalist, however, can grasp this element, without figures, and give it proper weight in the problem to be solved.

TENTH—THE QUESTION OF TIME.

Much has been said by M. de Lesseps and others about the immense advantage they would gain in time of construction, as well as cost, by the use of the Panama Railroad. M. de Lesseps even gave to a reporter on the Isthmus, the statement that what they had accomplished towards the survey in little more than one month, would have taken a year without the transportation of the Panama Railroad. Such exaggerations do not bring either credence or friends to any cause. There can be no doubt that the Panama Railroad would be a material help in the construction of a canal, even so short as 45 miles; and the argument based on this fact is worth consideration when the opposing proposition is a canal of a length of 181 miles, as that through Nicaragua. But the argument has no application to San Blas. Here we have a magnificent harbor, perfectly protected, which does not need a costly breakwater as at Aspinwall. A pile wharf, the work of thirty days, would afford all the facilities for landing machinery. The opening to be made is immediately before us, and the mouth of the proposed tunnel only five miles distant. The work of providing this five miles with a railway for the transportation of machinery and supplies could be completed in the time it would take to construct the machinery and get it to the Isthmus.

On the Pacific side, the mouth of the tunnel is only eight miles from deep water navigation. And yet, notwithstanding these facts, the *entourage* of M. de Lesseps will persist in telling us that it will take twelve years to construct a canal by the San Blas route, *for want of transportation* and the difficulties of the tunnel. Transportation and the tunnel are their reiterated objections.

Moreover, M. de Lesseps himself has said that after the tunnel is built, ship owners would not use it. This is evidently merely the *opinion* of M. de Lesseps himself; but since he said at the Paris Congress that he embodied the public sentiment on the canal subject, and in New York that he is "science", and immediately telegraphed to Paris for publication that, "At the great banquet our enterprise was unanimously and enthusiastically adopted,"—"Une adhésion enthousiaste et unanime à notre entreprise a été exprimée,"—and later, from Washington, that the President's message assured the success of the (Panama?) canal, sound judging men must surely come to think that what M. de Lesseps says, feels, or perhaps even dreams, is the *vox populi*, if not the *vox Dei*.

Here is a tunnel, the contents of which are less than 17 millions cubic yards of rocks. A single division of the Panama route has almost exactly

twice as much. Tunnel work in Europe is now proceeding at the rate of 13 feet per day in a single heading, and at one-third the cost of fifteen years ago. Every advance of a hundred feet of this heading will lay open the whole large floor-work in that distance of the great excavation. If, then, men enough can be found, the whole excavation can follow close upon the heading. The rainy season, the nights and the showers, will deter the work on the route of M. de Lesseps. The roof of the tunnel will make for San Blas one long season of progress, of even temperature, from the beginning to the end of the year. These facts considered, will any one be bold enough to say that it will take twelve years to perform at San Blas an excavation equal to *one-half* the work of a single division of the Panama route? Would it not rather be the compliment of sober sense to hold that if eight years are required for the work of the Panama Canal, the like construction at San Blas could be accomplished in six?

ELEVENTH—COST OF MAINTENANCE.

The whole of the Atlantic section of the Panama Canal would be a continual source of apprehension to shipowners using it. There would be the dangers of the loose and unstable soil which embanks, on either side, the new channels of the various rivers, and the irruption of these embankments into the main canal in times of floods. In the long rainy season, the insidious elements would be everywhere at work. There would be water everywhere—above—around—beneath. The softening, the settling, and sliding of everything built up, or held up, of earth, would be inevitable. To these conditions, in the mind of the sailor, there would be added the constantly impending danger of the giving way of the wall which holds back a Noah's flood of waters. There would be the washdown of the sides of the main canal itself which must necessarily receive the rainfall between the ridges of elevation on either side, separating it from its supplementary channels. In a word, there would be here a constant and powerful movement of nature to put again at the lowest levels what the shovels of the workmen had thrown up to the highest. The force necessary to continually watch and repair this effort of nature, operating in loose materials, would make the maintenance of this canal a most costly burden. At San Blas there would be a continuous rock-lined, rock-bound channel from one end of the cutting to the other, and no drainage rivers or sliding embankments to fear. Therefore, a comparison in this caption must put all the small figures on the side of San Blas, and all the large ones on that of Panama. How the problem actually stands no one can determine in advance, because no one can prejudge how much it will cost to maintain a sea-level canal on the Panama route. But, on the score of length alone, without considering the multitude of doubtful elements against the Panama route, the San Blas route has the clear advantage of one-third in its favor—or, as thirty to forty-five.

TWELFTH—TOWAGE AND USEFULNESS.

The processes of logic will find no difficulties with this topic. The cost of towage through a sea-level canal of thirty miles will only be two-thirds as

much as the same service through a similar sea-level canal of a length of forty-five miles. It follows, too, inevitably, that a proportionably larger number of ships per day can pass through the shorter canal than through the longer one, under the same conditions.

THIRTEENTH—PAYING TONNAGE.

It is not the purpose here to reckon up and present a statement of the tonnage which can be counted upon to pay tolls to a sea-level canal through the American Isthmus. Others have already, with too much haphazard, essayed this task. We shall be satisfied just now to point out the consideration that, an *existing* tonnage, which would mildew the investments of M. de Lesseps, might still pay a reasonable interest on a capital of half his ambition.

CONCLUSION.

It may be queried by those little acquainted with the problem of an inter-oceanic canal, whether this effort is not directed with unnecessary discourtesy towards M. de Lesseps. We reply that there is no motive of personality or ungracious criticism. M. de Lesseps deserves the thanks and the honor of all men of progress. In diplomacy and the Suez Canal he has achieved an enduring fame. We admire him, not so much for his active brain, as for those qualities found in most successful men, his courage and his tenacity of purpose. When these qualities were directed in the only possible channel of science through the desert Isthmus, there was a ready recognition of his progress and success by the American public. If success, and the fame it brought him, have also given him a giddy judgment and a self-assumed potency in his present attempt, he alone is responsible. We believe that M. de Lesseps, in his ambition towards the American Isthmus, has fallen into a grave mistake. The methods (shall we call them diplomatic) so long familiar to him in the East and in France have no chance of success with the hard practical sense of an Anglo-Saxon people.

He therefore miscalculates his problems and lives in a world of self-centred ideas, born of an ambition to add a last crowning glory to his life. We say, then, let us honor him for what he has already done, and place him, where he rightfully belongs, in the niches of fame. But let us not forget, also, that Nature has made the problem of a sea-level canal through the American Isthmus one that cannot be solved by a Napoleonic dash, nor will Science identify herself with any man, however great a diplomatist, who, caring nothing for the patient studious and toilsome ways of science, undertakes to make a *coup d' état* upon it and rule it, instead of being a servant of it.

If, therefore, in the few pages we have written, an unpleasant light has been thrown on some of the words and acts of M. de Lesseps, the fault is not in the light but in the subject it reveals to the judgment of men.

In what we have said there is due no allegiance of interest to any man.

The aim has been simply to present the facts. If M. de Lesseps shall fail, it will be because the facts are against him—facts of science—facts of his own methods—facts of political geography. Of all routes across the Isthmus for a ship canal the world wants, and means to have, the best. Individual interests and ambitions, whether of money or glory, must give way to this requirement.

To facilitate a careful comparative study of the merits of the *only two sea-level* canal routes through the American isthmus the present effort is made. There can be no doubt whatever as to the decision of the world upon the facts.

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