

## THE NEW PANAMA CANAL.

The delays and risks experienced in bringing the "Oregon" eastward from the Pacific Coast, at the outbreak of the war with Spain, have drawn the attention of the whole country to the importance of an early construction of a ship-canal across the isthmus now obstructing free communication between our Atlantic and Pacific coasts. The route by Cape Horn is entirely too long to meet present demands, either commercial or military.

But, while a canal is so urgently demanded, it is equally true that it should be, in respect to facilities of transit, security of operation, and cost and time of construction, *the best canal possible*. The work will be a gigantic engineering feat; and no mistake in selecting the route should be made at the outset.

Unfortunately, the American public has been led to believe, by the collapse of the old sea-level project at Panama, that there is only one really practicable route for a canal; viz., that by Nicaragua. The elaborate investigations which have been in progress at Panama during the past eight years are little known or appreciated in America; having been conducted quietly (especially during the last four years) by the new company, with a view to determine the best and most economical solution of the problem before making public the information obtained.

The writer, being a member of the Comité Technique, invited to assist the new Panama Canal Company in directing its investigations and forming its conclusions, has had exceptional advantages for understanding the subject in its present aspects. The Comité is international in composition, and includes French, English, German, Russian, and American engineers—among them the chief engineers of the Manchester and Kiel maritime canals. It may be added that, in this respect, it reflects the view of the Company that the work should be broadly international in character, a benefit to the whole world, and not simply a French construction. Last spring the writer visited the Isthmus of Panama with other engineers, and personally examined the route in detail. He has had for many months free access to the elaborate records of surveys, borings, experimental excavations, river gaugings, and researches of every kind conducted by the Company, and is therefore qualified to present the subject in its true aspects, which may be found to differ widely from the popular impressions now existing in America.

When the idea of constructing a sea-level canal at Panama was definitely abandoned, there remained three important difficulties to consider: (1) The regulation of the water-supply, and control of the floods of the Chagres River; (2) the serious caving which had occurred at the Culebra; and (3) the ill effects of the climate upon the health of the employees. The present conclusions as to each will be given in turn.

(1) The studies of the region of the Chagres have been most elaborate; including water-levels, automatically recorded since 1883; frequent measurements of the discharge at crucial points; the collection and discussion of data respecting all the historical floods (five in number, of which one was carefully measured); rain records at points well distributed along the route of the Canal, aggregating fifteen years on the Atlantic Coast, thirteen years on the Pacific Coast, and thirty-two years in the interior; and, finally, a collation of all this

material, and the elaboration of projects perfectly providing for controlling the floods, for the supply of the summit-level with water during the dry season (January, February, March, and April), and for ample hydraulic power at the dams, transmitted by electricity, for operating the locks and lighting the Canal at night. It may safely be affirmed that the Chagres River is no longer an element of danger, but is rather a useful friend whose assistance will be of great value to the Canal in its operation.

(2) The question of caving in the deep central cut has been studied in the most thorough manner; involving not only many borings and pits to determine the material to be encountered, but also a tunnel excavated throughout the troublesome region along the axis of the Canal, having a projected width at bottom of  $32\frac{3}{4}$  feet, with slopes of about 45 degrees, and a projected elevation above sea-level varying from 128 feet to  $157\frac{1}{2}$  feet. This work, together with a tunnel 689 feet long and  $9\frac{3}{4}$  feet wide, pierced, at an elevation of  $134\frac{1}{2}$  feet above sea-level, at the spot which had given the most trouble on the whole route, combined with the evidence afforded by the borings and pits at greater depth, leads to the conviction that, at Culebra, where the deepest cutting is required, the excavation has already passed through the strata subject to caving, and that the remainder traverses an indurated argillaceous schist, changing to compact rock, where no fears of yielding to pressure need be entertained. At Emperador, where the cutting required for the Canal is much less, the indications are similar, except that the material at present reached is less resisting; but with proper precautions in the way of drainage, which were wholly neglected by the contractors of the old company, little or no difficulty from serious caving need be apprehended. This work of experimental excavation has been continued for more than three years; involving the removal of about 3,924,000 cubic yards. It was projected, partly to determine the proper inclination for the side slopes, and partly to estimate the unit cost. The results are highly satisfactory; and the old bugbear of a sliding mountain divide has been proved to be imaginary.

(3) The health of the *personnel* formerly caused trouble; coolies and other races not well suited to hard labor under a tropical sun being employed. With negroes from the British Antilles, little difficulty is now experienced. This matter was carefully investigated during the investigation last spring; American engineers and employees on the Canal and on the Panama Railroad being questioned, the fine hospital near Panama—where the Company provides for its sick—being visited, and the views of the medical officers and of the Sisters of Charity, acting as nurses, being obtained. All agreed that the dangers resulting from the climate have been much exaggerated. The surgeon in charge of the hospital, Dr. Lacroisade, who has resided on the Isthmus since 1887, after presenting full statistics covering the sick-reports for the past year of a force of about 3,800 agents and laborers under employment, said:

"Among the diseases attributable to the climate the most numerous are simple marsh fevers, which have not occasioned a single death. Two diseases only belonging to the epidemic type have appeared—the beriberi, of which there is no longer any question

(it was imported with negro laborers brought from Africa as an experiment, and disappeared when they were sent back), and yellow fever. The latter, after having been absent from the Isthmus for at least six years, was imported in 1897, and continued about six months, from March to August, when it again disappeared after very light ravages (only six deaths). Thus it cannot be considered that this pest is really epidemic on the Isthmus. From the other infectious epidemics, such as variola, typhoid fever, diphtheria, etc., the Isthmus appears to be almost entirely exempt. From the foregoing we may conclude that life on the Isthmus scarcely incurs more dangers than elsewhere, even for Europeans, who, after the blacks of the British Antilles, appear to resist the climate best. Residence here, then, offers nothing alarming, were it not for a constant feeling of fatigue and uneasiness, due to a temperature always high, and an atmosphere saturated with moisture."

There appears, therefore, to be no danger of serious mortality in the construction of the Canal, if due care be taken to benefit by past experience in selecting the laborers.

The three old spectres barring the route being thus laid at rest, it remains to consider the present project for the Canal. This has been most carefully elaborated. No less than sixteen projects (not including the older proposals) have been worked out in detail, including estimates of cost and of the time needed for construction.

The entire length of the Canal is 46 miles, of which about 15 miles on the Atlantic side and  $7\frac{1}{2}$  miles on the Pacific side, or about one-half of the whole distance, will be at sea-level. Of this distance 18 miles, or about two-fifths of the entire route, is today essentially completed, so that at a moderate outlay for dredging it will be made at once serviceable. We have, therefore, only to consider the  $23\frac{1}{2}$  miles between Bohio, on the Atlantic side, and Miraflores, on that of the Pacific. Two excellent harbors, which will demand no outlay for protection, are available; and the Panama Railroad skirts the Canal throughout its entire route to be availed of in construction. Ample quarters, in fair condition, for the increased force of laborers are already prepared at many sites. These advantages are immense where time is of so much importance.

There is another advantage, in my judgment scarcely less valuable. By careful technical studies, the Company has succeeded in provisionally adjusting the project so that a choice between the best three different summit-levels may be reserved, to be decided by actual experience in conducting the work upon a grand scale. These projects are designated as "Level  $96\frac{3}{4}$  feet," "Level 69 feet," "Level  $32\frac{3}{4}$  feet"; the figures indicating the elevation in feet of the bottom of the Canal at its highest level above mean tide, which is found at practically the same absolute level in both oceans, although the tidal range at Colon is only a few inches, while at Naos it may at times reach 20 feet. A comparison of the estimated cost of construction, properly so-called, has established that, as between larger excavation, on the one hand, and more locks and higher dams, etc., on the other, there will be nearly a balance of expenditure. The cost of either of the plans is estimated at about \$100,000,000. It is not the same, however, when the element of time is considered. This time will vary with the amount of ex-