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The Terminal Lake Canal.

BY LINDON W. BATES.

Much prominence has been given to the Minority Report of five members dissenting from the sea-level proposition in favor of an eighty-five-foot canal. It has not been so generally noted that the Terminal Lake Canal, with a summit level of sixty feet, was supported by a vote of nine to four in the Board of Consulting Engineers as the best lock type for the Panama Canal. The main features of this canal, which are very simple, may be shortly described.

On the Atlantic the canal cut begins near the head of Limon Bay. A low dam at Gatun, or preferably at Mindi, impounds Lake Chagres at a level of about thirty feet, entered by the first lock. This lake submerges the terminal swamps adjoining the canal and gives free open sailing as far as the second dam and lock, which makes the summit level lake at an elevation of sixty feet. At Gamboa, where the Chagres meets the canal, a

sluice dam guards the canal from floods. The regulated flow of the river enters the canal and is divided, part going to the Atlantic and part of the Pacific. This is the system accepted likewise for the Board's Sea-level plan. At Pedro Miguel the third lock marking the Pacific end of the summit level lowers the vessel into Terminal Lake Panama at twenty-six feet level. The fourth lock in the Acon-Sosa saddle lowers the ship into the Pacific.

This sixty-foot-level canal warrants attention, not alone from its endorsement by the nine eminent engineers whose votes were cast for it as the best lock canal, but because of its conformity to three principles which amount to engineering axioms, each of which the higher lock canal of the Minority violates.

The first of these relates to dimensions—with the growth of ship sizes, the maximum usable dimensions of locks should be 1000' by 100' by 40', and there should be room at lock sites for even greater dimensions. The canon of lock dimensions is violated by the minority in that their locks as planned are of but 900 by 90 feet usable dimensions. The locks designed and adopted for the latest of Europe's national undertakings of this nature,—the Grand Coupure of Antwerp,—will take a vessel 984 feet long. The lock dimensions voted in the Board of Consulting Engineers by 11 to 2 before the division as to type took place, were 1000' by 100' of usable length. The length of 900 feet is too meagre a limitation to put on the size of vessels passing through the canal.

Still more significant is the inability to lengthen these locks to the full 1000 feet and have these vital structures founded in solid strata. The Gatun Hill is too low and too narrow for longer locks to be founded in rock. Their sides would project from forty to sixty feet above the rock line and would have to be built up to, with massive concrete structures. The whole flight instead of being securely buried in the rock, would be perched on the hill like three great boxes propped by concrete buttresses.

The sixty-foot canal obeys the canon of lock dimensions and lock foundation. The lock at Mindi, that at Gatun (or Bohio), the third at Pedro Miguel and the fourth at the Ancon-Sosa saddle are all of full 1000 feet length and founded in solid strata.

A second axiom is:—the hazards of over-running lock gates should eliminate from consideration the arrangement of locks in flight, one above the other. The experience of the Manchester Canal gives some idea of how fatal a defect is this scheme of locks in flight. No less than three times has a vessel crashed through its locks—with relatively small damage because the difference in levels was but eight to nine feet. The Minority violates the canon against lock flights in their three at Gatun and their two at Sosa. By the law of averages it is certain that at some time sooner or later a signal will be mistaken, an engineer pull the wrong lever, or the steering gear break at a critical time and an accident happen to a lock gate. Should this occur at an upper gate where the vessel starts to go down the ladder of three locks, the result would be inevitable and appalling. The enormous momentum of a great ship, with the mass of 40,000 tons of steel and cargo, could, though going at greatly reduced speed, crush the massive gates like matchwood, as the French liner went through the North River pier not long ago. The current would sweep the vessel over the lower gates and a released lake eighty-five feet high would pour out through the lock opening, wiping out like an avalanche everything below and making a loss to the canal itself irreparable for years.

The sixty-foot lock canal has no locks in flight, all are separated. An accident would loose at most thirty feet of water, and this would go into a broad lake below to be discharged with a minimum of damage through a large number of safety sluices. Further, with locks far apart, there can be put a middle gate in the lock for use with all except the comparatively rare, very great ships. With this, two closed gates could always intervene between the upper and lower levels and these would be 300 to 400 feet apart.

Finally there is the canon of the head of water to be allowed on impounding structures. Theoretically a dam can be built as high as one pleases if percolation is blanketed by a long enough backing to it. As a matter of actual practice there is a more or less well defined limit beyond which a conservative engineer does not go. On the alluvial foundations of the Isthmus no dam should be made with a greater head than forty feet to keep within the most assured limits of engineering security.

The minority's eighty-five-foot lake violates this by imposing a full eighty-five-foot head.

The sixty-foot plan keeps within the bounds of conservatism by making no head over thirty-six feet. The main dam has sixty feet of water in Lake Gatun-Bohio above and thirty feet in Lake Chagres below. The head producing percolation which is the difference in levels, is thus but thirty feet, which is absolutely safe and unquestionable.

Balboa Harbor: Proposed Terminal City of Balboa, having an inner Fresh Water Harbor on Lake Chagres and an Outer Salt Harbor at the head of Limon Bay. The new sanitary city built on hill on American Territory, Colon on its marsh being abandoned.

So significant are these deficiencies and inferiorities of the Minority's plans; its limitation of vessel size; its imposition of a monstrous and experimental dam; and its perilous arrangement of locks in flight, that the writer considers it rightfully eliminated as against the sixty-foot lock plan.

The superiority of the latter is in fundamentals and is inherent in the sixty-foot canal, either as originally proposed by the writer, or as modified by the Board in their final proposal.

As given forth by the Board, two sites are selected which were offered as second choice instead of first when the writer's Terminal Lake Canal was laid before them. Bohio is taken by the Majority as their site for a summit level dam and Gatun for the lower level, while the original plan preferred Gatun as the summit level site, because seventy-five per cent. more water flows past it, giving a greater lockage capacity, and Mindi as the lower dam site because it gives three more miles of lake navigation and submerges three more miles of swamps. One further item defines the latest official plan. The Majority propose at Gamboa one high dam impounding a permanent lake. The original plan was for a Gamboa dam of similar nature, but of less height, and a duplicate at Alhajuela, thus averaging the control over two low dams rather than concentrating it on one high dam. But these are obviously matters of detail only.

Having weighed the sixty-foot plan against the Minority's Gatun Dam Lock flight scheme, the final comparison is with the Sea-level.

Before, however, making the comparison, the writer desires to complete the description of the sixty-foot canal by including his unadopted provisions for terminal harbors. In none of the Board reports are full plans made for the future canal ports. Only at the Atlantic terminus were any proposals relative to them advanced. These consisted in five miles of breakwater at depths and on foundations undetermined, whose cost must vastly exceed the large estimate, and designed to make a port at swamp-founded Colon. There was submitted in the writer's project an inner harbor making a protected anchorage at the head of Limon Bay. It was proposed to abandon Colon with its miserable wooden shanties built on stilts over Manzanillo Marsh on Panama territory, and to establish a new city on American territory near the Mindi canal entrance. Here, where the first lock enters Lake Chagres can be built a sanitary terminal on a rocky hill. In front will be the salt harbor in the head of the bay. Behind it a clean fresh water lake submerging all the festering swamps under thirty feet of clear water. The inner fresh water harbor would be free from tide and current and would be sheltered from all storms and waves. Under the hill on the lake can be established a

The Panama Bay Front : It is proposed to reclaim the tidal flats with Culebra spoil, much of which would otherwise be wasted at sea. The hill is Ancon, behind which, on Lake Panama, could be made an impregnable naval station.

naval station which could not be reached by hostile cannon. This is the port of Balboa, which is proposed for the Atlantic terminus.

For Panama, breakwaters were designed, whose arms were to enclose the whole harbor and La Boca and to terminate at the rocky harbor islands. These breakwaters would encircle and create the safest, largest and best harbor of the South Pacific, with scarcely more cost than would be required to get rid of the material by wasting it at sea. Within them the whole of the Culebra can be placed out of reach of erosive currents and can serve the splendid future of Panama. Here is the best and closest site upon which to deposit Culebra spoil rather than waste it at sea or spread it over the swamps at a heavy toll of life. And by this a new and greater Panama is created with an inner fresh harbor on Lake Panama matched by an outer harbor protected by the breakwaters, a combination unequalled in the water reaches of the globe.

As these inner fresh harbors and all the advantages they give cannot be available to a Sea-level canal, which is all salt water, they furnish one most vital point of preference over it. The Board did not include any harbor arrangements save the long Colon breakwater on the plea of cost. They state,—

“Much more *elaborate harbor constructions* and the more costly character of *their appurtenant works* chiefly account for the excess of the estimated cost of Mr. Bates’s project over that of the sixty-foot summit level lock plan of the Board.”

Since, however the proposer figured on contract prices rather than government execution prices, costs may not be so high as the Board estimates.

In the comparison of this lock and lake canal with the Sea-level, its far better terminal facilities of the sixty-foot canal are one point of superiority. Beyond this, however, every canal plan must be judged by the way it measures up against the elemental standards of security, cost and time of execution, convenience to navigation. It must stand or fall by the adequacy with which it meets these demands.

The first measuring rod for any canal is fundamentally the one of safety. The Sea-level scheme when it was presented to the Board included a three and a-half mile tunnel along whose

walls of volcanic conglomerate the eroding Chagres discharge was to tear, a disposition of the greatest danger. The revised Sea-level plan has not this objection. The adoption of the writer's Chagres flood solution has obviated this peril. The incorporation of a Gamboa sluice dam from which the regulated discharge, being divided, passes into the canal prism and thence goes to either ocean, has taken away the menace of the Chagres torrents for all normal conditions. But for a deviation from the normal, the Sea-level is still an unsafe canal and in an earthquake-visited tropic land this factor dare not be discounted. There is no guarantee against a repetition of the

Sea Level Dam vs. Assuan Type : The Sea-level dam is much higher and sustains a permanent lake. The Bates dam impounds no water, save in time of great floods.

series of shocks which opened a gap across the main street of Colon and destroyed the Cathedral tower at Panama. The great permanent lake above Gamboa, on the latest Sea-level plan and the three others at Cano, Giganté and Gigantito, in the light of such possibilities, are three perpetual dangers.

Each dam holds back a deep lake at an elevation of from 55 to 170 feet above the canal. A breach in any of these three through an earthquake or subsidence, or fissure, or any of the other causes which make dams fail, would let loose a wave from 55 to 170 feet high to sweep destruction down the canal. As against this element of danger the sixty-foot canal as planned with the empty basin system has no high dams or high heads of

water like those four of the Sea-level. At Gamboa and Cano and at Alhajuela the sixty-foot canal has low dams, and instead of a permanent lake, the valley behind them is normally empty and no water is impounded save at floods. Only when an exceptionally heavy torrent comes are the sluices partly closed and water impounded, and this only for a maximum duration of fifty-six hours. The rest of the time the river flows quietly through the sluices. Five times in thirty years alone would it have been necessary to impound water behind the writer's proposed dams, for there were only five floods which could not have been allowed to pass the sluices. An earthquake, to have injured seriously the canal protected by these sluice dams with normally empty valleys behind, would have had to destroy the dam during one of the fifteen days in thirty years when there was water behind it. Any time during the remaining twenty-nine years, three hundred and fifty days, these dams could be shaken without finding any volume of water there to release. Three large deep lakes imminent and vulnerable every day in the year in the Sea-level plan as against three basins with water in them only five times in thirty years, is the measure of comparative safety afforded by the two canals in this respect.

A second point which should be considered in the two channels is, which will be the best from the navigator's standpoint? Very many railway engineers have been asked their opinion as to the canal, but very few of the principal navigators who will be called upon to take their ships through. But it is surely important for a waterway, which is built for the highest service to commerce, to know what sort of a canal a commander, anxious to score well with Lloyds and the ship owners, would prefer. First of all, he would want a straight entrance, clear of reefs and well protected. He would want a mooring place and a wharf space where he could have plenty of room. The harbor and the harbor entrances would be his first thought.

As to the canal proper, his demand again would be, plenty of room for steerage purposes, that there need be no danger of sheering against the sides or colliding with passing ships and plenty of water under his keel. Measure with such a standard as this and the superiority of the sixty-foot lock-and-lake canal,

Terminal Swamp : These will be submerged under twenty-five feet of water, giving open sailing and making great sanitary improvement.

with the terminal harbors as elaborated, is not hard to demonstrate.

The Sea-level plan offers him, at Colon, a salt water bay whose approach is immediately to windward of Colon Reefs. At Panama it furnishes him nothing beyond the tide harried roadstead with an entrance directly across the San José Reefs. The harbors and harbor entrances of the writer's lake canal would be the best in the world, in the combination of a commodious outer harbor and inner water basin, free from tides, where the fresh water will kill barnacles and the ship worm, is ideal. The entrance contours are well beyond the reefs on each side and lead straight to the canal entrance without a curve.

On entering the canal proper, the navigator would, in the sea-level, start on his forty-six-mile passage through a constricted rock-flanked cut with the certitude that he would have to lay up for repairs if his vessel struck its walls. He must, all along the route, tie up in the pockets cut alongside the channel, and wait while other vessels passed him. He must move at very reduced speed in rounding all curves and so lose steerage way for two-thirds of the line. He must endure all the torment of the poison-laden swamps flanking him. At Culebra he would be deep down in an artificial gorge with the imminent clay-conglomerate towering above him on either side. Here and there he would have to squeeze by a dredge, clearing away the sediment brought down by the rain-swollen streams. The prospect to the navigator of insuring safe passage in a Sea-level canal at Panama would not be the most alluring.

The alternative which the sixty-foot canal holds out to him is open lake navigation for twenty-six and a-half miles, in which he could move at twice the speed which he could be allowed in a constricted channel. Other vessels could be seen for miles ahead, be allowed for and readily passed. There would be no sheering against banks, since ample steering room would be given. He would have no dredges to dodge, for all slit would be deposited where the streams enter the lakes, miles away from the canal, or be localized in special slit traps. For only nine miles through the Culebra would a channel exist such as the sea-level proposes for its entire length. But here the banks on either side would be much lower and so less dangerous as to

The Aucun-Sosa Saddle : The Pacific Lock is located here. It will lift a vessel about twenty-seven feet into Lake Panama.

land-slides. Because of the doubly greater speed, which a large ship could be allowed in a lake, its time of transit, counting in the lock passage, would be reduced by three hours. The ability to pass other ships, when the traffic of the future has become great, would be of incalculable benefit.

It has been testified that a certain Sea-level plan has less curvature than a lake canal. But such a statement as this is most misleading. When a vessel changes her course in a lake waterway the pilot does not reduce speed; in a Sea-level canal he must slow down. Applying this principle, it is the simple truth that a lake canal has but a third to a quarter of the curvature *affecting navigation* that the Sea-level scheme has.

Another standard for comparison is the time for construction. All other things being equal, a canal which can be traversed in eight or nine hours and can be available in eight years is better than one which demands three hours longer for a large vessel and which will not be ready for sixteen years.

Just when can a Sea-level canal be completed? Ten years is the latest figures of the ex-Chief Engineer for a canal forty feet deep. The Commission of 1901, making a careful estimate, gave twenty years as the minimum, and they were calculating upon only a thirty-five foot channel. Nine months ago the official figure for a thirty-five foot channel was given as sixteen years. The Commission now estimates eighteen years. Who, then, is to judge when doctors so disagree? Allowing themselves grace in the Majority's official figure, a forty-foot Sea-level channel across the Isthmus is to be, they claim, available in, at most, thirteen years. But it is only a much qualified estimate, based upon no guarantee whatever.

The truth of the whole matter is that no one knows at all, or can possibly know, when such a canal will be finished. If one goes over the list of the world's canals, having excavations of mixed materials and takes their rates of excavation, the result is surely a warning for the sanguine advocates of the Sea-level. The Chicago Drainage Canal was dug in one-mile sections by private contract, getting intimate personal supervision of the most interested kind and employing the most modern machinery. It was excavated at the rate of five and a-half million yards per annum. At this output a Panama Sea-level canal would require forty-seven years for its completion. Yet this

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(Bates)

The Assuan Dam : A masonry dam of exactly this height and nature is proposed at Allajuela and Gamboa to control the Chagres.

Chicago canal was dug in the temperate zone under none of the tropical conditions that will prevail at Panama. It had competent white labor. The Chairman of the Commission testified that Isthmian labor averaged one-quarter northern efficiency. The downpours, the lack of adequate labor, the rapidity of rot and rust, the illness and deaths, these may set the time for completion anywhere between fifteen and fifty years.

With the sixty-foot lock-and-lake canal, on the contrary, the time is not subject to the uncertainties involved in this huge mass of excavation. To make three low earth dams of standard type across the river valleys is easy and straightforward and an actual work of but few months. By making them, twenty-six and a-half miles of the canal's total land length of forty miles is turned into lake, needing incidentally but a small amount of soft dredging. An ocean steamer could then steam up to either end of the Culebra cut. The much smaller volume taken from the Culebra would be attacked by dredges or Lobnitz machines from either end, with water transportation for the spoil and by land plant with rail transportation as well. With such a program as this a minimum time may be realized and the canal can be contracted for under bond in at most eight years.

There is finally the extremely important question of cost. Assuredly no one wishes an inferior canal, be it cheap or dear. But dearness is in itself an element of inferiority, if the same or a better waterway can be had for less money. The fact that money is not the first and most important element is far from being a reason why it should be disregarded utterly. It is an axiom of political as well as business economy that the sacrifice entailed should not exceed the good gained. The good to be secured by an Isthmian canal may be measured fairly and accurately by the use which will be made of it. The Commission of 1907 made a minute investigation of the commerce that would reasonably be expected to use the canal if constructed. They figured that, so regarded, the Panama justified as a national investment about the sum of \$145,000,000 for its construction. Considering it as capitalized at this amount, and allowing ten years for its construction, the canal would thus just about repay interest and cost and yield enough for maintenance.

On the basis of these figures, Congress rejected the Nica-

rauguan proposition and invested \$50,000,000 to secure title to Panama. Now the Sea-level proposition is brought forward, proposing a construction cost of at least \$247,000,000. Sanitation and Zone Government, which were not included, bring the figure up to \$263,000,000. This is to be paid out with no return for thirteen years and probably with some fifty years of deficits in income to follow that. The whole balance and equilibrium of the first conservative proposal is destroyed. It is not even claimed to be worth while as an investment. In bright generalities our astonished Congress is called upon to vote \$128,000,000 more than was ever bargained for and to undertake a Sea-level canal with DeLesseps' technical and financial failure staring them in the face, and with each of its different advocates making conflicting estimates of time and cost.

Consider the figure set by the Board of Consulting Engineers, \$247,021,200. The price of this revised Sea-level scheme is scaled to the lowest possible, leaving out items of great import in order to bring the figures down. The Panama Port Works, heretofore rated at \$10,000,000, were omitted. Sanitation and Zone Government were omitted, though they are certainly indispensable and every previous plan included them as a matter of course. These features of sanitation and zone government must cost at least \$16,000,000 more in thirteen years construction time. Add these items and the proper total becomes at least \$273,021,200 on the Board's own unit prices. Is there any guarantee that this sum will not be exceeded? None whatever. The figure itself is simply an approximation. Detailed designs for engineers estimates under the new tropic conditions are not forthcoming. There is no assurance that the cost will not be more than \$300,000,000, with a century's deficit in the canal's operation.

With the sixty-foot canal the same elements that make time calculable make cost calculable also. The impounding structures, which mainly constitute it can be closely figured. The excavation of which the Sea-level chiefly consists cannot. In French times the unit cost per yard in the Culebra Cut varied from fifty-two cents to \$6.80. In the small digging which we have had, it has varied from 50 cents to \$1.54. Weather conditions, the amount of pumping, the difficulties attendant upon a huge force of crude labor, all are elements of hazard, far

greater in the Sea-level than in any other type of canal. The maximum price figured by the majority was \$176,000,000 as an engineer's estimate and \$146,666,667 as a contracting estimate for their sixty-foot canal as planned, and they were committed to the Sea-level, a rival type. With the single modification (decreasing excavation) of adopting the Mindi site, there can be fully constructed the sixty-foot canal at \$3,125,000 a mile, or a total of \$124,000,000 construction cost, making with sanitation and zone government \$135,000,000. The essence of the situation is that most of the Sea-level work is digging and this has a large element of uncertainty. Most of the lake-canal work is low structures of masonry, which has a very small element of uncertainty.

But assume that the Sea-level would cost \$263,000,000, which is the Board's figure, plus the very moderate figure of \$16,000,000 for sanitation and zone government. Take simply the difference that exists on the face of the estimates, \$128,000,000, and consider whether the American people want to spend that amount extra to get a canal thirteen years hence which it takes a great ship three hours longer and much more hazard to pass through.

Congress passes periodically a River and Harbor Bill to improve our American ports. If this extra \$128,000,000, which the Sea-level advocates assure us we can easily afford, were put into port works, what could be accomplished within our borders? The entrance channels to New York harbor, affecting every ship captain and owner doing business there, could be dredged out and established to forty feet, \$10,000,000; the Cape Cod Canal could be cut \$10,000,000; Portland, Oregon, could be made safely available to the largest vessels afloat, \$6,000,000; Charleston Bar could be better jettied and so permanently removed, \$7,000,000; the Mississippi Levees and port protections re-inforced, \$11,000,000; San Diego Harbor dredged and made available to the largest vessels, \$6,000,000; Chicago Harbor protected from northers by stone breakwater, \$7,000,000; the Sacramento leveed and dredged, \$5,000,000; Galveston Causeway to the mainland constructed, \$1,000,000; and still there is \$65,000,000 left for public buildings and improvements. This is what the spending of \$128,000,000 in terms of things.

What is the gain of the Sea-level? In only one feature has

Greater Panama : The breakwaters and new town-site reclaimed from Culebra rock are shown and Lake Panama made by two short embankments and entered by the Ancon Sosa Lock.

it any claim to a superiority; the apparent advantage one lock over four. But their cost is made insignificant by the cost of the Sea-level excavation. The expense of maintaining them will be passed by that of keeping silts out of the one-lock canal. Any risk of passing them is more than offset by the risk of navigating a winding constructed canal. The time lost is more than decompensated by the lakes and made three hours shorter for large vessels. Is it worth while to exchange this illusory advantage of one lock over four, for the real advantages that accompany the features of the Lake Canal?

This question is not simply one of academic interest to be looked at from afar off as though it concerned a canal on Mars. One of the canal plans must be adopted, the others rejected. One canal must bear for all the future the commerce of the world, while the other plans are relegated to the dusty tomes of engineering history. The plan which is to pass from lines upon paper to the mighty waterway that cleaves two hemispheres cannot be determined by a sentiment or an illusion. The facts and all the facts must be weighed, considered and then definitely and finally acted upon. The conclusion which is indelibly engraven on the very nature of the facts is that the advantage of a Sea-level's one lock over a sixty-foot canal's four is too dearly purchased, at the cost of peril in each passage through its constricted, rock-flanked cuts; of the slower transit in its lakeless channel; of an extra expenditure of at least \$128,000,000; of the retardation of completion by at least seven years.

There is a final matter which does not perhaps fall within the province of engineers called upon to face only mathematical possibility of harnessing the Chagres and piercing the Culebra, but which certainly does fall to the consciences of the nation commanding the work.

Under the project which the writer has advocated one year of work and every swamp near the canal line will be drowned beneath twenty-five feet of clean water. The number of laborers that would be used in a Sea-level would be reduced by one-half and the work would be largely done by water-borne machines. The stygomia larvæ could not live under such a depth of water, and if they could oil spread over an open and accessible sheet of water would kill them, where it could not be applied to the myr-

Canal Entrance : Between Ancon and Sosa Hills is the Pacific entrance. Both of these hills can be fortified.

had isolated unreachable jungle pools. Terminal cities started *de novo* and begun rightly would supersede the old, around impregnated with filth germs from the garbage of half a century. New terminal cities on high ground, the fever swamps submerged, the use of floating dredges reducing the army of laborers—this is the supreme sanitary policy.

In that first Congress of 1879, where the foremost figure in the engineering world had swung his whole weight to the Sea-level waterway, one man rose up with his fatefully true prophesy against the great Frenchman's visionary ideal. This was Godin de Lepinay, the first man to propose terminal swamp-submerging lakes for the Panama Canal.

"All my conscience is intensely enlisted. I am the only French engineer a member of this Congress who has executed work in that country there. If I have not known how to make my advice triumph, I cannot let it be believed that I abandoned it, all unknown though I am. I shall have gone out of this assembly, as others have done, that I may not leave my name subscribed to a measure disastrous.

"Finally, and this is the greatest with me—me who has executed works in that tropical America; reducing these unsanitary works to their minimum, spares the life of more than 50,000 men, uselessly sacrificed for the execution of a sea-level project. To not charge my conscience with these unnecessary deaths and the loss of a considerable capital, I abstain, or I vote, No."

How true was his forecast the world knows too well.

A new generation of engineers now rallies to the old dream of De Lesseps,—forgetful of his silent buried cities. He, too, had great hospitals and disinfectants and new-built dwellings and a host of doctors. But could any sprinkling of chloride around camps, any screening of wires on windows, any water works or commissaries, any surface disinfection or spreading of cil remove the death that lurks in the steaming miles of jungle swamp that compass then round about?

For the greater part of its length, a canal dug at sea level must be cut down to its depth of forty feet below mean tide,

through the Isthmian morasses. To permanently drain these swamps is impossible. To fill them would be a labor of immortal gods, not of men. When the pioneers of the Panama Railroad undertook to drive one single line of railroad through to the foot-hills, it took them years and an appalling loss of life. What would be the price of life to fill them all, or to fill even a half mile strip along the canal? An army of doctors and "weeding engineers," with all the resources of modern science, could not kill the stygomia larvæ in the myriad isolated festering pools, and just so long as these swamps are allowed to breed death just so long will the Isthmus be the white man's grave. What must result when excavation begins in earnest and ground is newly broken all across the Isthmus, is not hidden. It can be read on the tombstones of Monkey Hill; in the tragedy of Matachin, "slain Chinese village;" in the cluster of drooping crosses behind Ancon, in the bitter legend of a lost man, warden of each rail of the Panama Railroad. Just as surely as the rising of the sun, a decision for a Sea-level canal dooms to death an army.

THE SALTON SINK.

A map representing parts of California and Mexico has recently been published by the United States Geological Survey which is of unusual interest at this time. The area covered is widely known as the Salton Sink, a great depression in the Colorado Desert which has been much discussed lately, owing to the threatened formation of a large inland sea where there is now a thriving community.

About 8000 people have settled in that part of the basin known as the Imperial Valley, and are raising excellent crops of barley and alfalfa. Stock farms are numerous and experiments in raising the date palm are in progress. The freight shipments from Imperial, a town only four years old, rival those of Los Angeles in value, and are said to exceed those of any other town in Southern California.

The existence of this peaceful community is, however, seriously endangered by Colorado River, which, strangely enough, is also the source of all its prosperity, as it is this stream which furnishes water for the irrigation system. The absence of any controlling work at the head of the main canal has resulted in diverting the river from its old channel and permitting the entire flood flow to enter the irrigating system. This is causing great damage to the ditches and crops, and is forming a large lake, which now