SUMMARY

This series of papers has now reviewed the Panama Canal in its three aspects—financial, executive and technical. The facts have been set forth and the necessary conclusions deduced from them. A general summary of what the evidence proved is in order.

The foreword recalled that we are no longer a small band of colonies separated from the Old World by dividing oceans. We have become nation of nations, with wide seas, binding, not sundering. We are possessed in these latter days of an Oriental domain which we must defend. The southern half of our westland continent is stirring in the great living impulse of growth. We must weave and knit our national ideas and influences as we lead the mighty march to the goal. Again we have become Mother Earth’s greatest producers, and our prosperity demands not a limited but a universal market.

Because the Panama Canal is indissolubly part of America’s power, of her chance, of her race-right, of her duty, it must be built at whatever cost and sacrifice.

The waterway is one of the specialized undertakings whose success or failure depends primarily upon the right technical judgment. Good managers or bad managers may be important, but they do not carry the very existence of the enterprise in their decisions. Engineering, however, lies at the sources of its being; it is the very well spring of the canal’s life. So essential is right engineering to its vital possibility that no man can be considered a friend who intrusts its destinies to the wrong order of technical mind. Its whole execution and its entire future of service away upon these verdicts, and the loyalty of each and every official must be measured directly in his fearless elimination of the wrong men from its affairs.

The technical decisions unto which the Panama Canal has been committed have been shown for what they are. When these are measured and are understood, then and then only shall deliverance be worked out for the waterway.

For purposes of comparison the characteristics of the lock-flight project with the summit level set at 85 ft. above mean sea-level, are contrasted with those of the Three-Lake plan with its summit lake at 92.5 ft.

1.—LIMON BAY SECTION.

85-Ft. Lock-Flight Project.

1.—Approach Entrance. The Atlantic end of the approach is too close to submerged Manzanillo Reef off Colon.

2.—Terminal City. Colon, a foreign city, the terminal for shipping. Over ramp, filthy and a focus of disease.

3.—Seven miles from first lock.

1.—Breakwaters. Breakwaters of experts and commission, totaling 6¼ miles in length, extend seaward in northerly direction and converge at entrance.

2.—No explorations or borings under east arm one mile, none under west arm 8½ miles.

3.—Mud and hard bottom depths unknown.

4.—No guess possible as to volume or depth of breakwaters.

5.—Estimates fictitious and conjectural.

6.—Twenty-ton concrete or stone blocks for breakwaters imperative on account of high wave exposure.

7.—Such unavailable. Argosies of ships needed to carry materials, and stupendous cost.

92.5-Ft. Three-Lake Plan.

1.—Approach Entrance. Seaward end of approach is set one mile to westward of reef, affording ample sea-room.

2.—Terminal City. Colon abandoned except for use during construction. Terminal city on Mindi Hills. American, high, clean and sanitary from start.

3.—Adjacent to first lock.

1.—Breakwaters. Eight hundred foot entrance between east and west arms, which extend from Mindi Point westward 6,000 ft.

2.—Explorations and borings show formation and depth to rock.

3.—Mud and hard bottom depth known.

4.—Volume and depth of breakwaters known.

5.—Estimates closely approximated.

6.—Normal construction and rock of proper size available along canal and lakes made.
8.—Alignment of breakwaters obsolete, bad in "northerns." 8.—Location correct to best withstand waves.
9.—Cost much over the $5,800,000 estimated. 9.—Cost less than one-fifth Board system.
10.—Remaining four engineers turn down their own and minority breakwaters and next show none at all. Breakwaters indispensable, hence Atlantic harbor arrangements cannot be a finality. Radically wrong.

**No Breakwaters.**

1.—Channel in Limon Bay being wholly unprotected by breakwaters, it results:

(a) That it is impracticable to dredge inner mile from Mindi Point to Mindi on account of lee shore, shoal and constant rough water from trade winds.

(b) Material too light to deposit in hopper dredges and sea always too rough in inner mile at head of bay for smooth water dredges.

2.—On inner mile, if channel existed, it would have nothing to defend it from rapid resiliing by "northerns," heavy gales and from constant agitation of mud bottom by waves of on-shore trade winds.

3.—No outer salt water harbor. No haven or refuge anywhere near entrance to canal.

4.—No reclamation on shore.

5.—Channel for inner mile of approach subject to sudden resiliing from storms.

6.—High wave motion in narrow lee-shore channel from Mindi Point to Mindi destroys safe steering, and passing of steamers is hazardous.

7.—High waves on starboard quarters of steamers create, in this mile stretch, liability for ships to sheer and go ashore.

8.—No outer harbor suitable for naval base.

9.—No outside anchorage for merchant or naval ships.

10.—Silt jelly from Limon Bay provided as a sliding cushion for heart of Gatun dam.

**CONCLUSION.**

"Northerns" are of such hurricane violence that all admiralties notify ships to keep steam up in readiness to put to sea. The coming of storms cannot be predicted. Breakwaters from Mindi Point westward are absolutely indispensable. The Lake canal's Atlantic approach, breakwaters and outer harbor are technically correct, and are readily created and maintained. Government project vitally defective and inadequate for commerce.

**II.—MINDI-GATUN SECTION.**

85-Ft. Lock-Flight Project. 82.5 Ft. Three-Lake Plan.

1.—No suitable inner harbor affording protected naval station and haven for shipping.

1.—Inner harbor bordering new terminal city on Mindi and Jama- millo Hills; perfectly protected from
SUMMARY.

2.—Navigation and mooring in a constricted channel.

3.—Eleven million cu. yds. of dredging, of which at least one-third, 3,667,000 cu. yds. is clay rock, costing millions to excavate.

4.—Swamp of quicksands needlessly and unfortunately preserved, and hence not sanitized, and impossible to redeem other than by drowning morasses.

5.—Superficial 8-minute examination of Mindi site by “experts” in driving rain.

6.—Favorable reports ignored.

7.—Most favorable sites for lock and dam on whole canal, those at Mindi and on lower Chagres unutilized.

III.—BATES REEF ACROSS LOWER CHAGRES.

85-Ft. LOCK-FLIGHT PROJECT.

1.—Simple meager reconnaissance without instruments, no knowledge of reef, none sought. No maps, no profiles, no data of any value obtained in three years as to Chagres river below Gatun, nor as to crestline west of Jaramillo Hill, when, in fact, at least three dam sites exist of a favorable character below Gatun.

2.—The proposers and defenders of the lock-flight project are indifferent to this reef, the most important fact in the whole geology of the Isthmus. Ignoring its supreme advantage they commit the country to the deplorable Gatun dam and lock-flight, and violate every axiom of conservative and safe engineering and of navigation.

3.—High Lake Gatun cannot be created until huge dam and spillway are completed—in ten years or more.

“northerns” and large enough for all navies. Naval station pre-eminently safe, protected by encircling hills and adjacent to outer salt water harbor.

2.—Open navigation on Lake Chagres from Mindi lock No. 1 to Gatun lock No. 2.

3.—On account of lake, very little dredging. What exists is in upper soft strata. No rock excavation.

4.—Swamps submerged, hence section sanitized. Submergence to be effected as a first step in programme of execution of canal.

5.—Rock foundations for Mindi barrage and locks.

6.—Rock foundations nearest to surface of any on Isthmus.

7.—The pervious and artesian strata of Gatun geologic gorges cut off at Mindi.

68.5-Ft. THREE-LAKE PLAN.

1.—At Bates Laja Reef the writer has made known the results of accurate surveys demonstrating the existence of a reef complete across the Chagres joining the extension of Jaramillo Hill and the hills on the west side of the Chagres. This affords the only known place on river below Gamboa where a dam to bedrock is feasible.

2.—Pervious and artesian strata are cut off at Bates Reef across lower Chagres. Foundations at reef for solid barrage on rock only 8,000 ft. long.

8.—Dispositions of low barrage and first lock at Mindi and second barrage at the Bates Laja Reef secures a number of vital and valuable betterments:

(a) Do away with lock flights and substitute single separate locks.

(b) Do away with high dams and substitute low dams.

(c) Do away with high lakes and substitute lakes, low, yet ample for navigation and of equal value for transit.

(d) Enable floating plant to be employed from Mindi to Obispo and to attack the central massa.

(e) Enable a small net head dam to be placed at Gatun.

(f) Dangers of undermining are eliminated by rock founda-
RETRIEVAL AT PANAMA.

(5) By their adoption and construction as a first step the width of the Isthmus can be narrowed in a year to 18 miles, and in 2 to 5 miles. This narrowing will as a sanitary measure save many millions and many lives; as a construction measure it solves the labor problem, and it greatly facilitates and expedites execution. Gatun Lake can be created at end of second year.

CONCLUSION.

Setting first barrage and lock at Mindi, and barrage at Reef, interposing terminal Lake Chagres, insures to this section a canal with single separate locks, safe, low dams; the longest water area for navigation, the best sanitation, the easiest and cheapest construction.

IV.—GATUN DAM AND FOUNDATIONS.

85-Ft. LOCK-FLIGHT PROJECT.

GATUN DAM.
1.—Unnecessary high lake at 85 ft. fills hill bowl to the brim and necessitates raising of rim in several places up Trinidad Valley. Requires locks in flight and six locks.

2.—Unnecessary high dam with 85 ft. head containing 21,200,000 cu. yds.

3.—Alluvial foundations.

4.—Geologic gorges filled with pervious and artesian strata.

5.—Pervious strata subject to erosion found from 81 ft. to a depth of 204 to 288 ft.

6.—Water under hydrostatic pressure rises from 8 to 17 ft. above river.

7.—Impounding lake increases artesian stresses.

8.—Underground Chagres enormous in volume.

9.—Subterranean conduits focus down Chagres.

10.—Pervious strata impossible to curtain off to the rock.

11.—Experts and Commission directed that this be done preliminary to building dam.

12.—Net head on dam, 85 ft.

13.—Pressure on lake or reservoir bottom up to 40 lbs. per sq. in., creating serious hazards as to undue percolation and erosion through per-
SUMMARY.

meable strata under dam and at lock-
site.
14.—Gatun Lake covers all av-

V.—CONSTRUCTION

85-Ft. Lock-Flight Project.
1.—Hydraulic method for con-
struction impracticable.
2.—Task set is lifting to 50 and
80 ft. heights after pumping
thousands. Highest yet attained is
lift of 55, after pumping distance
of 2,000 ft. Hydraulic machines
separated by minority for cutting
clay-rock now declared frivolous
proposition.
3.—Difficulty of access for any-
thing but cars.
4.—No estimate for opening lateral
approach canals.
5.—If excavated by other dredges
and brought by barges construction
method still experimental.
(a) Silt jelly provided for dam
from approach cannot be barged—it
is too light.
(b) Clay brought will be largely
in chunks, requiring granulation.
(c) Pumping this melange by
relays never achieved.
6.—Prescribed process counted in
no such incidents.
7.—Estimates were based upon
hydraulic cutting and lifting.
8.—Excess cost inevitable.
If material be brought down from
Culebra and lifted into the dam;
9.—Cost much beyond hydraulic
method prescribed.

10.—Time much greater—600
15-cu. yd. carloads required every
day for 10 years to bring material
to dam. Tremendous rail equip-
ment demanded.
11.—Enormous amount of labor.

62.5 Ft. Three-Lake Plan.
1.—Construction brought within
mechanical limits of this process.
2.—Dredging of clay-rock all
eliminated.
3.—Dam-site accessible to dredges
and tugs, barges and cars.
4.—Dredges and barges can be
extensively used, thus relieving
Panama Railway and reducing cost.
5.—No silt jelly to be used. All
put ashore to make valuable ter-

6.—All difficulties are resolved
by low net head dams, lower lake
and rock foundations.

8.—Amount required but one-
fourth or less.

9.—Material is right at hand in
locksite and on shores of 83.5-ft.
lake, whence it can be brought by
scows, which can navigate freely
from Ohispo to Mindi.
10.—Floating equipment exten-
scively used.
Minimum possible time.

VI.—DANGERS TO

85-Ft. Lock-Flight Project.
1.—Subsidence owing to its
weight upon soft upper clays and
saturated permeable under strata.
Settlements and fissures, particu-
larly at the four points of cross-
ings from surface soils to sandy
gorge formations.

82.5 FTS. THREE-LAKE PLAN.
1.—Has but one-quarter the vol-
ume and far less weight, hence dan-
gers from subsidence, fissure, settle-
ment, breach, percolation eliminated.
Dangers also eliminated by low
head and lower lake and the fact
that Chagres and Mindi barrages
are on rock and so curtain under-
flow.
2.—No danger from overtopping
because of smaller volume and great
facility of repair and because all
flood currents are stopped many
miles away by the 83.5-ft. lake.
RETRIEVAL AT PANAMA.

3.—Percolation under the dam and erosion of sand veins from high pressure.
4.—Earthquakes.—The canal is in the earthquake zone.
5.—Particular difficulties of repair:
   (a) Culebra material will have been removed.
   (b) Construction track system and equipment will have been removed.
   (c) Height makes dredging from swamp bottom by hydraulic machines impossible.
   (d) Car-fill system must be re-established at large cost and delay.
   (e) Available material hard to supply again from Culebra and very expensive and time consuming.
6.—Charges bed 58½ ft. deep, below and parallel to foot of dam probably exposes permeable strata. Impounded high-lake increases under-flow.
7.—Vertical pressure of lake brought right at hand much greater than flow down hydraulic incline gradient.
8.—Frictional resistance diminished, underground hydrostatic pressure increased.

CONCLUSION.

That the massive high dam upon such foundations and under an 85-ft. head should be abandoned, and the dam of one-quarter the volume and about one-third the head should be incorporated instead.

VII.—THE GATUN SPILLWAY.

85-FT. LOCK-FLIGHT PROJECT.

1.—Spillway capacity 140,000 cu. ft. per sec., which is discharge past Bohio. Discharge past Gatun is nearly 200,000 cu. ft. per sec., hence, spillway is inadequate to cope with known floods of 1879 and 1906, and there should be provision for worse floods.
2.—Lake fills Trinidad valley to brim and ridge saddles require extra works and safeguards.
3.—Tobogean converging spillway design of Experts very dangerous. Water under 10 ft. head over crest 70 ft. falls in converging slide into shallow trough through marshes. Fall is 70 ft. in 287½ ft. Spillway channel debouches to Pool. Volume and velocity sufficient to begin eroding and back-cutting, menacing dam.

CONCLUSION.

That the constricted spillway imperiling dam construction leading to pool and inviting erosion be abandoned and the ample sluices discharging into lake below the dam be installed.

3.—Low pressure, no danger.
4.—Relatively small loss possible from earthquake.
5.—Repair easy by dredges and material available.
6, 7, 8.—Pool covered by lake. Upper lake increase of subterranean flow mostly neutralized by lower lake, and no undue stress brought upon strata under dam.
VIII.—THE LOCKS AT GATUN.

LOCKS IN FLIGHT AT GATUN—85 FT.
Lock-Flight Project.

FOUNTAIN.

1.—Originally located on “four borings or rather three” for data by experts.
2.—Axis adopted cannot be changed on account of ravine.
3.—Upper lock today has inadequate data.
4.—Underneath all the tier, the clay-rock which is really caked volcanic mud, overlies a mixed formation of “sand and gravel and clay.”
5.—Soft rock blanket varies from 18 to 66 feet in thickness.
6.—Upper right guide wall overhangs rock and is founded partly on sand and gravel and clay.
7.—Under uppermost lock-works rock blanket must be cut away, hence, upper gate chamber and guide walls will rest on pervious stratum.
8.—Rock blanket nearly pierced at lock gate chamber between upper and middle lock.
9.—Rock blanket quite cut through, under gate chambers between middle and lower set of locks. Center and side walls rest on “clay and sand.”
10.—Bottom of lowest gate must be upbuilt from mud-rock. Rock at lower lock 60 to 60 ft. below sea level, 60 to 70 ft. below morass.
11.—North end of lock for from 300 to 350 ft. must be upbuilt.
12.—All lower lock and part of middle lock are in the swampa.
13.—Both approach walls to lowest set of locks on north are for full length in swamp.
14.—No data for rock location under north approach wall, but dip apparently very deep.
15.—Indurated clay is caked volcanic mud-tufa.

1.—INTERPOSITION OF LAKE CHANGES CONDITIONS.

2.—Hydrostatic pressure due to high lake may halve factor of safety in lock wall.
3.—Overturning forces become greater because angle of repose is changed by saturation.
4.—Clays especially unreliable; moderately moist they stand at 60 degrees; saturated, they subside at 10 degrees.
5.—Clayey earths most susceptible to deterioration, and admixture of sand accentuates this.

SEPARATE LOCK—82.5 FT. THREE-LAKE PLAN.

FOUNTAIN.

One single, separate lock alone is installed at Gatun.
One long lock can be all founded in the tufa stratum.
No upbuilding.
Approaches are all on firm foundations and are built not of cribs on pile, but of concrete.
Room in hill for right safety device—bear-trap dam plan.

1.—INTERPOSITION OF LAKE CHANGES CONDITIONS. Since no masonry rests upon pervious layers these changes are not endangering.

2.—Since sides are imbedded, saturation does not menace.
RETRIEVAL AT PANAMA.

6.—Boils and springs likely to develop during construction and after lake is filled.
7.—North approach walls on piles must be pressed by saturated morass.
8.—South approach walls on piles in 85 ft. lake are flimsy and inadequate.
9.—No foundation for safe bear trap dam to keep lake from emptying in case of lock accidents, because lock-site hill is too short.
10.—No foundations for extension of lock chamber to reach site of proper safety dam for same reason.
11.—To get in lock flight, swamp must be invaded, mud-rock sheet followed, deeply dipping under morass and substantial approaches at both ends of flight sacrificed.

IX.—ELEMENTS OF SPECIAL PERIL IN FLIGHTS.

85-Ft. Lock-Flight Project.
1.—Lock flight particularly difficult to negotiate, especially for battleships.
2.—Inadequate lock width must soon make dimensions hazardous for large craft.
3.—Fall from upper lock to second lock, 28 1-3 ft. (1 ft. in 40), or 3 1/3 times the fall of Whirlpool Rapids at Niagara (1 ft. in 100).
4.—Fall from upper lock to empty second lock, 58 2-3 ft. (1 ft. in 50), over five times rate of fall in Whirlpool Rapids.
5.—Depth at Gatun greater than in Rapids.
6.—Velocities and tumult in accident greatest at and near entrance to upper lock, where appliances are designed to be set. No safety appliances should be set in or near upper lock, but well away from it.
7.—No canal has escaped accidents.
8.—Majority figured frequency for Panama, upon especially favorable Soo record, and single, separate locks, at two a year. With tiers casualties are much increased, as they point out.
9.—The Soo basis shown by them to be inapplicable because of Panama conditions. Ore carriers who mostly use the Soo are familiar with the route. Closed for five months a year, when it can be overhauled and repaired.
10.—Panama frequency rate inferentially much less favorable.
11.—Six locks multiply risks.
12.—Lock tiers pronounced by Majority of International Board “the most dangerous feature proposed for any canal. Perilously near

6.—No boils or springs during construction, since the bottom is in tufa layer above water plane.
7.—North approach is of masonry, concrete, not piles.
8.—South approach not in lake bottom, but in hill formation.
9.—Good foundations for extension of chamber and for safety dam, because hill adequate when only one twin lock installed.
10, 11.—Plenty of room for everything in hill.

68.5-Ft. Three-Lake Plan.
1.—No tiers, hence accidents minimized.

3.—Fall from upper lake is into large lower lake. There is no empty second lock, as locks are widely separated.

6.—Safety appliances 1,250 ft. away from lock.

11.—Four locks in place of six diminish risks by one-third.
impracticability for the passage of battleships."

13.—Recorded by Minority itself:
"If gates should be carried away
results would be very serious in-
deed."

14.—Upper lake would empty into
channel, and probably de-
stroy everything to the sea, in-
cluding tier and dam.

14.—Upper lake protected in ad-
dition to safety dam by five gates of
divided lock. Amount that
could escape before bear-trap dam
was set would be caught in lower
lake and be harmless to lower works
at Mindi, where adequate sluices
and another dam give further
security.

X.—LOCK WALLS AT GATUN.

85-Ft. LOCK-FLIGHT PROJECT.

DEFECTS—HEIGHT OF WALLS ABOVE
ROCK.—LOCKS SHOULD BE SAFELY
INTEGRATED IN HILL ITSELF
WITHOUT EXCESSIVE BACKFILL
NECESSARY TO LOCK FLIGHT.

1.—Walls of upper lock in Secs.
2 and 3 extend above present hill,
85 ft.

2.—Walls of upper lock but 5 ft.
above proposed lake.

3.—Walls of middle lock in Sec.
6 rise 40 ft. above surface.

4.—Walls of lower lock rise 28
ft. above swamp.

5.—Walls of lower lock in Sec.
6½ drawn by Expert incorrectly
setting them 61.67 ft. above datum
instead of 53.38 ft.

XII.—LOCK DIMENSIONS.

85-Ft. LOCK-FLIGHT PROJECT.

1.—First Experts' Lock designs
incorrectly drawn as to lock lengths.
Originally shown on drawings as
700, 790 and 820 ft. when safety
gates are closed.

2.—Expert and Commission pro-
sals abandoned, and locks now
ordered 1,000 ft.—Good.

3.—Width now but 100 ft.: (a)
Newest express steamers
show beam increasing relatively to
length.

(b) Battleships markedly greater
in beam relatively to length.

4.—Very doubtful if lock will ac-
commodate steamers longer than
900 ft.

5.—Very doubtful if lock will
pass 10 years hence our newest
battleships.

6.—Locks should be 115 ft. in
width, not 100.

7.—Forty ft. on lock sill in fresh
water. Owing to difference in den-
sity, a vessel drawing 38 ft. at sea,
may draw 39 ft. 4 in. in fresh
water.

8.—Locks will pass ships whose
loadline is 38 ft. at sea, with only
9-in. margin of water under keel.
9.—Locks at Sosa only 27 1/2 ft.
lift, hence will lock vessels of maxi-
mum draught but half the time.
Depth over lower sill only 80 ft. at
low tide. Range of tide overlooked
and canal throttled.

XII.—PROVISIONS FOR SAFEGUARDING SHIPS.

85-Ft. LOCK-FLIGHT PROJECT.
1.—Prohibited from entering
locks under steam. (Officially as-
serted and denied.)
2.—Means of locomotion pro-
vided: Commissioner—Pushing cap-
stans;
Expert—Tug pushing behind;
3.—Double gates 80 ft. apart—insufficiency deduced:
(a) Manchester accident—small
steamer struck one; others gave way.
(b) Welland accident—small
steam barge went through 8 gates.
4.—No such situation as at Gatun
and Sosa flights ever before set;
hence no appliances ever tried, let
alone proved.
5.—Experts gave provision up,
while expressing belief something
would be found. Allotted $4,000,000
—a mere guess.
6.—All leading types of dams ex-
amined. Bear-trap dam alone offers
security. Not proposed by Experts
or Commission. Requires bottom
width and length on rock. Site of-
fers no available foundation. Can-
not be incorporated. All other types
of safety dams applicable to low
heads only.
7.—Newest Commission proposals:
Barrel, sectors and segments. Quite
unavailing for tier conditions.
8.—All safety appliances to be set
within or immediately adjacent to
upper locks.
9.—Locks cannot be protected by
such devices.
10.—No safety dam for Sosa
flight proposed by Experts.

XIII.—LOCK FLIGHTS—SEPARATE LOCKS.

85-Ft. LOCK-FLIGHT PROJECT.

NATURE OF DISASTER AT LAKES GATUN
AND SOSA, FIRST AS TO LOCKS—SECOND
AS TO GATUN DAM.
1.—If ship overrides lower gate
to upper lock, before upper gates are
closed; five minutes are figured for
setting safety devices; velocity at-
tained by falling water would reach
30 miles an hour.
2.—Weight of 500,000 tons, in-
cluding ship, would be precipitated
into middle lock. Cumulative vol-
umes striking third set of gates

62.5-Ft. THREE-LAKE PLAN.
1.—Vessels’ power and shore
winches.

3.—Double end gates and one ad-
ditional gate set midway of lock.
Smaller vessels have 400 ft. of dis-
tance before striking second set.
Large steamers have 150 ft. instead
of 80.

62.5-Ft. THREE-LAKE PLAN.

1.—Three-lake canal no flights.

2.—All single, separate locks.
would release its waters with accelerated speed, would overwhelm last set in maestrom rush, down the 83-ft. slope.

3.—SHIP. Ship and millions of pounds of steel gates, and millions of tons of water would tear everything to pieces, bury wreckage in fathomless gorge in marshes and plow a devastating way to sea.

4.—LOCKS. Locks must be eroded by lake torrent flowing through and around them.

5.—OTHER VESSELS. Every vessel in upper lake would be swept down or stranded. Every vessel in waiting basin and in channel hurled to annihilation.

6.—BUILDINGS, ETC. Everything in path of the flood would be carried to the far sea.

7.—REPAIRS. Would require years and vast cost. To fill lake alone would demand a year.

8.—"Locks in flight should be prohibited."

9.—The Gatun dam could scarcely escape destruction in case of accident.

XIV.—UNSAFE LOCK SITES—SAFE LOCK SITES.

83-Ft. LOCK-FLIGHT Project.

UNSAFE LOCK SITES.

1.—Lock flights have maximum of peril.

2.—Locks No. 1, 2 and 3 constitute Gatun flight:

Rock under only part of the flight.

3.—Rock at unknown depth north approach. Rock too deep at south approach.

4.—No rock available for proper safety dam at Gatun.

5.—No. 4 lock at Pedro Miguel site has been recently shifted in search of rock.

6.—Locks Nos. 5 and 6 constitute Sosa flight. Site too short for two locks and safety dam. Rock for safety dam and chamber extension very deep and great works must extend into 55 ft. lake. Yet to install one is imperative. Vast cost and very problematic. Divided lock system not applicable to lock flights.

SAFE LOCK SITES.

1.—Single separate locks have maximum of safety.

2.—No. 1 lock Mindi:

Ample rock for one long lock.

Ample rock for concrete approaches.

Ample rock for bear-trap dam as safety device to

3.—No. 2 lock Gatun Hill:

Clay rock or tufa ample for one full-length lock.

Clay rock or tufa ample for masonry concrete approaches.

Clay rock or tufa ample for bear-trap dam safety device.

4.—No. 3 lock Pedro Miguel.

Rock site ample and right for every thing.

5.—No. 4 lock Sosa. Rock site ample and right for one lock, safety dam and approaches.

Incorporation of additional gate midway all locks gives small ships 400 ft. of distance instead of 80 before striking end gate.
CONCLUSION.

Locks in flight should be prohibited. They are on sites too small, and their debatable foundations and inherent peril and impracticability for merchant vessels and battleships make them a bane to the commerce of the world. Single separate locks should be incorporated instead.

XV.—THE LAKES.

85-Ft. Lock-Flight Project.

GATUN LAKE AT 85-FT. LEVEL.

1.—Offers sole provision for regulating Chagres floods.

2.—Compels high dam at Gatun over permeable gorges, whose strata are under great stress, and will become under greater stress from lake.

3.—Impels lock flights.

4.—Unprotected by suitable safety dam at Gatun and Pedro Miguel.

5.—Since it cannot be allowed to fill until Gatun dam is built, excavation in lake must be done in dry or must delay opening two or more years.

LAKE SOSA AT 55.

6.—Compels high Pacific dams.

7.—Compels lock flights.

8.—Work of excavation must be done in the dry, or delay canal.

9.—Dry excavation adds to estimates and was not figured.

62.5-Ft. Three-Lake Plan.

GATUN LAKE AT 62.5-FT. LEVEL.

1.—Provides for Chagres floods, but is supplemented by upper river regulation—normally empty basins.

2.—Admits of low Gatun dam with quarter volume.

3.—With Lake Chagres allows single separate locks.

4.—Protected by suitable safety dams at Gatun and Pedro Miguel.

5.—Satisfies navigation needs as fully. Owing to steepness of banks, is almost as large as 65-ft. lake.

LAKE PANAMA AT 26.5 FT. AND LAKE CHAGRES AT 35.5 FT.

6.—Gatun cut-off shortens route by 12.5-6 miles.

7.—Gatun cut-off reduces curvature between Bohio and Gatun.

LAKE PANAMA AT 26.5 FT.

9.—Economical hydraulic method available at dams.

10.—Does not interfere with railroad location, which requires but small work of raising.

11.—Low dams all on rock.

CONCLUSION.

To secure the supply of lockage water adequate to care for the commerce of the world, the summit level or lake must begin at Gatun or Mindi. A Gatun Lake at 62.5 ft. answers every necessary requirement and avoids the difficulties and risks inherent in a lake reached by the lock flight.

LAKE SOSA AT 55 FT.

1.—Summit lake above Pedro Miguel lock is inadequately safeguarded against accident to gates. No bear-trap dam installed.

2.—Overrunning these gates or breach of the Pedro Miguel dam would loose Gatun Lake, 171 square miles, into Lake Sosa, 8 square miles, and overtop dams. Breach of new Sosa-Corozal dam would wipe out the city of Panama unless the La Boca dam were dynamited or Sosa lock gates were opened. Latter sure to destroy lock-flight.

3.—Escape of Lake Gatun to Pacific sure to ruin channel through Culebra section in the greatest water-burst of time.

LAKE PANAMA AT 26.5 FT.

1.—Summit Lake—safeguarded by bear-trap dam and five gates at Pedro Miguel locks.

2.—No harm to City of Panama, as natural escape is at La Boca dyke, far to the westward, and Lake Panama at 26.5 ft. does not overtop city or hills or menace in any degree.

3.—Lake cannot escape on account of installation of proper safety dam.
SUMMARY.

CONCLUSION.

There should be no high lake overhanging the Pacific terminal city. Lake Sosa should be lowered to 85.5 ft., whereas it would be safe and equally serviceable for canal transit.

XVI.—DISTRIBUTION OF CULEBRA SPOILS.

85-Ft. Lock-Flight Project.

1.—Culebra precedence the system, and the steam shovel the adopted tool despite long French experience.

2.—Steam shovels through nine months so handicapped their output but fraction their capacity.

3.—At present scarcity of cars further limits output.

4.—Slides impeding as in French time. One following back half a mile, slowly advancing like glacier.

5.—Material going to nearby dumps.

6.—Board called transportation and deposit of Culebra spoil greatest difficulty, yet left it unsolved.

7.—No spoil should be deposited where it can be washed back into channels. Should not go on watershed.

8.—Must go to watershed of San Juan Díaz, 20 miles from Obispo, to avoid canal watershed, or to the sea.

9.—Taking spoil to sea by barges is costly and wasteful.

10.—Present dumps too low and inconveniently arranged.

11.—Chairman reports Culebra lowered 85 ft. Two narrow septa for cross-over trains alone removed. Work confined to widening and removing slides.

62.5-Ft. Three-Lake Plan.

1.—Special rainproof land plant should supplant shovels where possible.

2.—Building terminal barrages would enable water plant to come to assistance of Culebra excavation in the dry.

3.—Dredging method cheapest, quickest, most sanitary; uses smallest labor force.

4.—Rain does not impede dredge excavation.

5.—No spoil deposited on watershed where liable to return to channel.

6.—Best disposition:

(a) In making breakwaters essential to right Panama harbor.

(b) In reclaiming an area continuous with the town site of Panama.

(c) Land would be valuable and sanitary.

(d) Park system and plaza along the front would add to attractiveness of terminal.

(e) Ample docks, etc., and naval stations could be arranged for.

CONCLUSION.

Many years of experience at the Culebra mass has proved the need of protection to rain and of taking spoil to the Pacific, where there is the least annual rainfall. It should go to the water front and breakwaters to create a great south harbor for the Americas.

XVII.—PACIFIC TERMINAL LAKE AND DAMS.

85-Ft. Lock-Flight Project.

LAKE SOSA.

1.—Elevation of Lake Sosa set at 85 ft. above mean sea level is about 85.5 ft. above low tide. Lake Sosa must be reached by flight of two locks in Sosa Hill.

2.—There is not room at the site selected on west slope of hill for flight and proper lake approach and safety dam to safeguard lake level.

3.—Setting Lake Sosa at elevation 85 compelled Experts and Commission to plan three great dams and one small one:

62.5-Ft. Three-Lake Plan.

LAKE PANAMA.

1.—Elevation of Lake Panama set at 85.5 ft. above mean sea level, or 86 ft. above low tide. Lake Panama reached by one separate lock in Sosa Hill—the Ancon-Sosa saddle.

2.—There is ample room either side of Sosa Hill for one pair of parallel locks and proper approaches.

3.—For lake at 86.5 ft. only a small dam and sluice-barrage (adjacent to lock) are required.
RETRIEVAL AT PANAMA.

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<td>La Boca</td>
<td>4,800</td>
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<td>2.</td>
<td>Sosa-Ancon</td>
<td>1,750</td>
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<td>Ancon-Corozal</td>
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<td>4.</td>
<td>San Juan</td>
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<td>12,650</td>
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*Estimated.

Note.—In place of dams 2 and 8 the retiring Chief Engineer and Commission have substituted one from Sosa to Corozal, September 6, 1906, without a boring. The boring party in the first hole 500 ft. from Sosa Hill had not found rock at 70 ft. below sea level early in February.

The tally with this change runs:

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*Estimated.

4.—Great dams—great cost, great hazards to canal, commerce and city.
5.—Long period of construction because car fill method is required. Height beyond mechanical limit of pumping dredges; hence, very long before swamps are covered by lake. On square mile is left a morass right below Ancon Hospital and adjacent to Panama.
6.—Floating plant precluded for many years, until great dams completed.

7.—Excavation saved by Lake Sosa does not compensate for extra lock and tremendous dams and allied works and risks.
8.—Lake overtops San Juan Hill rim.
9.—High lake forces rebuilding of Panama Railway at unneeded expense.
10.—High dams in event of disaster very difficult to repair and demand a long time.
11.—Lake navigation little over 5 miles. No advantage to canal transit in high lake.

CONCLUSION.

Lake Panama at 96.5 ft. should be restored, the high dams eliminated with their problems of construction and hazard. Low dams should be substituted, the lock-sitau at Sosa done away with, and a single separate lock installed. This change will save in the Pacific section over $4,000,000.
SUMMARY.

XVIII.—PACIFIC TERMINAL.

85-FT. LOCK-FLIGHT PROJECT.
Expert and Commission’s recommendation:
1.—Pacific channel shallower than Atlantic by a fathom.
2.—Old approach the worst of all.
3.—Sailing line prolonged passed directly over San Juan reef.
4.—Axial line wrong for ship.
5.—Channel so shallow that 830 days in the year had less than 27 ft.
6.—Remaining Commission Engineers discard Expert and Commission approach:
   (a) Abandon breakwaters.
   (b) Relocate line taking West Trough—second best approach.
7.—Channel undefended by breakwaters must constantly shoal from shore currents.
8.—Ebb and flood tide currents become at right angle to ship’s course.
9.—Swells entering harbor would strike ships on the quarter.
10.—New alignment planned to deepen channel 5 ft. Hence Atlantic channel still shallower than Pacific at mean low water.
11.—The governing plane of navigation the world over is mean low tide, not mean sea level, as Commission erroneously employ.
12.—Channel width 500 ft.
13.—Difficult to defend.

CONCLUSION.

Breakwaters are indispensable at Panama for the safety and convenience of navigation, to neutralize and prevent currents on beam entering and leaving; to create the nearest spoil area for Culebra; to prevent resulting of approach and endless dredging and to afford best military protection.

XIX.—ALIGNMENT AND TRANSIT TIMES.

85-FT. LOCK-FLIGHT PROJECT.
1.—Curvature affecting navigation, 140° 86′.
2.—Total curvature, 596° 40′.
3.—Length from deep water contour, 50.12 miles.
4.—Time of transit, 12.988 hours.
5.—Longest, most hazardous to traverse.

62.5-FT. THREE-LAKE PLAN.
1.—Approach away from reef.
2.—Approach full depth at mean low tide.
3.—Central trough is approach line direct to Sosa lock.
4.—Breakwater arms inclose large harbor area.
5.—Breakwater arms inclose large spoil area.
6.—Hold currents parallel to ship’s course entering and leaving.
7.—Waves entering harbor would be absorbed.
8.—Surges strike ship directly before or behind.
9.—Entrance straight and one of the easiest in the world to negotiate.
10.—Large harbor basin at foot of Ancon-Sosa lock.
11.—Depth of 44 ft. in harbor measured from low tide.
12.—Channel width 600 to 1,000 ft.
13.—Easy naval defense.

62.5-FT. THREE-LAKE PLAN.
1.—Curvature affecting navigation, 138° 40′.
2.—Total curvature, 580°.
3.—Length from deep water contour, 48 3/4 miles. Has advantage of Gatun cut-off.
4.—Two lock 10.586 hours. Transit time.
5.—Four lock, 11.027 hours.
6.—Lake canal terminal locks are passed during necessary stay at terminals. No other canal admits of this time economy.
7.—Shortest and most safe for ships.
RETRIEVAL AT PANAMA.

XX.—PANAMA RAILWAY.

86-FT. LOCK-FLIGHT PROJECT.
1.— Entire line to be relocated.

2.— Mount Hope to Gatun, length increased and line around Mindi Hills to gain Gatun summit, to be newly built.

3.— Gatun to Obispo all to be newly built, with greater embankments across arms of Lake Gatun, deep cuts, tunnels, bridges and viaducts—an ominous profile meaning many millions for a useless line.

4.— When canal is built from Obispo to Pedro Miguel a new line must be built on Culebra terrace, east side of canal.

5.— Line from Pedro Miguel to Panama and La Boca all to be newly built.

7.— Cost probably $10,000,000.

62.5-FT. THREE-LAKE PLAN.
1.— Relocated only between Obispo and Pedro Miguel.

2.— No change—grade raised.

3.— Substitutes fast steamer or car ferry from Gatun to Obispo, saving many millions.

4.— Obispo to Pedro Miguel, new line on terrace of Culebra section.

5.— No change of line except grade raising.

6.— Electric passenger line from Colon to Mindi and Gatun, steamer to Obispo, and electric car line from Obispo to Panama proposed. No need for carrying freight in cars when canal is finished.

7.— Cost not over one-twentieth, or $500,000.

THE RAILROAD.

Almost since its construction it has been at the mercy of the transcontinental roads, and steamship companies bound up in contracts in restraint of trade. Coming into government possession its shackles should have been broken.

It holds the key to transcontinental rates and could free Pacific commerce.

The un-American policy of the Secretary of War and the management keeps the anomaly of a Government-owned corporation fettering American navigation.

Utilized for covering purchases and business transactions pertaining to canal proper.

Road virtually superseded by canal when constructed.

CONCLUSION.

To expend any more money than is absolutely indispensable upon this road would be unwise. The Three-Lake Plan preserves the present alignment and calls for but some grade raising. The road might advisedly afford free transport to goods carried in American ships, thus building our needy merchant marine.

XXI.—PERSONNEL RESPONSIBLE FOR 85-FOOT PROJECT.

I.—COMMISSIONERS.

First. Advised sea level.

Second and Third. Bohio Advisers; dams located upon defective data; scheme collapsed. Condemned dams at Isthmus not founded on rock, now support huge Gatun dam on alluvium. Located Gatun dam with three borings under crest 8,640 ft.

Fourth and Fifth. Not engineers at all. One a successful Governor; one a railroad reorganizer.

Sixth. Moved adoption of sea level in Walker Commission.

II.—EXPERTS.

First. Designer of Lock Flight.—Condoned Bohio dam adviser. Located lock flight on four or rather three bores for data. "Did not know length of Gatun Hill." Locks announced as 900 ft. long measured in drawings 790, 790 and 820 feet.
SUMMARY.

Second. Lock Expert. Supported flight on four borings. Sent to Senate latest lock design with middle wall 28½ ft. too high. Neglected range of tide on Pacific in design. Owing to 27½ ft. lift at Sosa lock, canal can be used by large ships but half the time.

Third. Dam Expert. Located Gatun dam with three borings under its entire crest. Sent profile to Senate suppressing artesian revelations of gorge bores. Advised dam with proviso of cutting off all subterranean flow. Cutting off flow proving impossible, advised dam next without cutting off flow.

Fourth. Had within three months written a book emphasizing special dangers of 85-ft. project and supporting canal at 61½. Advised in 1902 Darien-Mandingo, tunneled lockless, as trans-American solution.

Engineers going with Secretary of War, March 20th, to advise or make final decisions regarding plan of canal.

They are—

No. 1.—Who designed the lock flights—Bobio Engineer. Whose lower Gatun lock walls were 28 1½ ft. too high. Whose Sosa lock’s 27½ ft. lift, neglected tide range and made canal inaccessible for largest craft half the time the year round.

No. 2.—Dam expert who provided for cutting off underground flow through geologic gorges at Gatun, which is impossible. They made the most deplorable guesses under grave responsibilities in all the annals of engineering. The prototype of their Panama dams, the Wachusett, failed in crucial mass, April, 1906.

III.—SECRETARY OF WAR.

Conclusion of Personnel.

If the canal design is to be made right it must be studied and settled by men unhostaged to the past, who will weigh plans by their innate fitness alone.

XXII.—CANAL PLANS.

High level and sea level evolution since 1879. Struggle continuous for supremacy. Both at each step incorporated all features sponsors knew and deemed good for types.

ABANDONED—

MAJORITY OF BOARD.

1.—Tunnel 3½ miles long, $5,000,000. Diversions 80 miles long, paralleling canal overhanging it in menace.

2.—Earth dam at Gamboa for upper Chagres regulation.

3.—Solid dam at Gamboa.

4.—Upper reservoir unlowerable below still of dam.

5.—Discharge of floods borne to Atlantic alone.

6.—Terminal lock site Miraflores.

7.—Width 150 ft.

8.—Depth 85 ft.

APPROPRIATED FROM THREE-LAKE PLAN—UNCREDITED.

MAJORITY OF BOARD.

1.—Divided Chagres. Use of canal bed for discharge.

2.—Masonry dam at Gamboa.

3.—Sluice dam at Gamboa.

4.—Reservoir to be lowered, hence empty basin principle.

5.—Discharge to both oceans in controllable volumes.

6.—Terminal lock site Ancon-Sosa.

7.—Width 200 ft.

8.—Depth 40 ft.

9.—Barrages at La Boca and Sosa. Terminal lakes for lock canal.

MINORITY.

10.—Terminal lock Miraflores.

11.—Terminal lake (assigned to M. Kleitz).

12.—Width 160 ft.

13.—Depth 35 ft.

14.—Experts approach via east trough.

Entire three-lake four-lock canal set forth by Majority as best lock canal for Panama. Its second choices of lock-sites presented. Mindi not examined.
Minority concedes superiority in the following:
1. — Its smaller head of water on dams.
2. — Smaller height of embankments.
3. — Reduction of locks from 6 to 4.
4. — Basin above Gamboa dam affords control of floods with least fluctuations of water in canal.

CONCLUSION.
The Three-Lake plan has in every principle received indorsement of both contending parties. It is the only safe, sufficient and right design for Panama.

XXIII.—SANITATION.
1. — Isthmian Repute of 400 years unsanitary.
2. — Eighty-five-ft. design preserves all swamps during construction. The Mindi-Gatun swamps permanently.
3. — Isthmus announced as sanitized throughout.
4. — French unsanitary conditions reported changed. Yellow fever not an abiding presence:
   (a) 1890, no yellow fever. (b) 1891, but 17 cases. (c) 1891 to 1896, but 3 cases. (d) Three intervals of French construction occupation with not a case. (e) Three consecutive years without a case. (f) Four other years with but a few sporadic cases. (g) Two of these last showed but one a year.
5. — Permanent disease is Chagres or malarial fever.
6. — No radical engineering programme to eliminate foci of disease.
7. — Disease of French times laid by Commission to conditions since removed:
   (a) "Times of orgy." (b) "For eight years, money, absinthe, champagne, rum, ran like water." (c) "Carnival of dissipation, disorder and crime." (d) "Mortality was great because of sanitary and social conditions."

Deceiving Announcements.—Isthmus announced as now sanitized by—Report supplied to Executive by sanitary officer, chairman in recent Kansas City and Chicago speeches, and by Commission reports.

Real Sanitary Facts.—Mortality rate and hospital record markedly lower under French than under Americans. Chief sanitary official uses as basis divisor total force. French used effectives only. Using similar basis for both gives: French annual death rate 6.83 per hundred. American 6.63, or 60 per cent. more than certified, which is 4.608. American record worse than French average over all their yellow fever years.
The 85-ft. scheme is inherently one of the least sanitary and most difficult to sanitize.

Official sanitary statistics are not true. Sudden gain of population in May, 1906, of 6,839, when excess arrivals over departures were but 3,716. Sudden gain in July, 1906, 14,515, when net arrivals were 1,479.

Low mortality and sick rate figured upon erroneous population statistics. Americans use as divisor full roll. French used mean effectives. Taking similar basis Americans lose 6.66, French 6.33 per hundred annually.

If population be taken from Quarantine and other records: American ratio is again 6.57. During ten months of 1906, 89 employees a day entered the hospital; 190 per cent per annum. During past ten months of 1906, including railroad employees, 150 per cent per annum.

Besides this hospital record a high percentage are treated by visits in quarters, and in addition the dispensary rate for treatment of malarial cases has been several times the hospital rate. (Vides Monthly Sanitary Records.)

Relative Expenditures for Quarters.—White (5,101) for quarters, hospitals, repairs, $1,537,696. Administration buildings, etc., double the investment. Negroes (22,108), $254,866. When conditions of labor are reckoned fifty times as much as has been done to safeguard the white as the colored employee, which in part accounts for the abnormally high hospital and death rate of the Zone. The mortality rate in the Zone is closely 90 per thousand, over 4 ½ times the normal.

Colloidal Evidences.—Steamer Whithall, from Colon, reaching New Orleans with but 2 of crew immune. Of 21 men, three died, and 10 were in hospital. U. S. S. Columbia, from Colon, of 298 officers and men, 215 had acute malarial paroxysms. Sanitizing cost, $6,500,000 to January 1st, 1907.
SUMMARY.

Three-Lake canal would first reduce land width to 8 miles, eliminating the other 30 miles from all need of sanitizing. The centers of disease-breeding would be drowned. The lake breezes would refresh and stimulate and perfect sewage would be secured. There would still be enough work left to make Mindi, Gatun, Culebra and Panama health resorts by the best that land skill can compass.

The Lake canal is the sanitary design which will save valuable lives and millions of money.

CONCLUSION.

Radical sanitary engineering by canal design is essential at Panama. By cutting the land width in the Isthmus to 8 miles, the right alliance is given the sanitary corps and the best safety to life and health secured.

XXIV.—LABOR.

Policy—bringing large forces prematurely. Plan of canal knocked out by Bohio dam fiasco. Present 85-ft. plan demands a proficiency of labor. Construction was to be preceded by sanitation. Construction was to be preceded by providing plant.

But large forces were sought and brought and came nevertheless from Jamaica, Barbados, Martinique, smaller islands, neighboring coasts. These forces set at: sanitizing, building, fighting vegetation (nearly 5,000); distributing riot of supplies, 6 to 16 per cent of force. Incidentally a little canal excavation “to determine unit costs” and supplementary railroad work.

In 1906 paying through passengers numbered 2,300. October 1, 1904, to September 30, 1906, arrivals and departures totaled 182,820. Movement of 160,000 due to labor propaganda. Immigrants there died, 1904 to 1906—From 5,500 to 6,100!

In Commission service (1906) Whites: Employed, 4,816; departed, 3,622; remained, 1,191; 41½ per cent. Engaged, 1,869; accepted, 3,983; reported for work, 3,862. 82 per cent failed to go to work. 60 per cent left. Islands one by one ceasing to supply labor.

Contract for Coolies.—If force of 15,000 are to be kept at the Isthmus, at least 96,000 must be brought; at least 9,500 will die; at least 10,500 will be invalided home; at least 68,500 will enter hospitals; at least 190,000 fares across the Pacific. Coolies stampede from fumigation and disease. 10 per cent is the death rate given in early statistics at Panama. Suicide under indenture conditions.

Seeking Spaniards and Italians. 81,000 additional men imperative at high French efficiency to finish 85-ft. canal in 8 years. Vast forces compelled by 85-ft. design: Gatun dam, $1,000,000 cu. yds. Pacific dams, 10,000,000 cu. yds. Lock flights. Eliminating all but 8 miles of land, leaves small forces at Mindi, Gatun dams. Sosa and reasonable force in Culebra. No need for Chinese labor in executing the Lake plan.

CONCLUSION.

The way to solve the labor problem is to adopt the most sanitary project, the one employing the most water-borne plant, and to install mechanisms invincible to rain. Then skilled white labor and machines will largely supplant colored labor and health consuming methods. The design which calls for the smallest labor forces is the wisest. The simplest canal in construction is the one which eliminates huge dams, and brings water-borne plant to replace labor and economize cost.

XXV.—FINANCIAL.

JANUARY 1, 1907.

1.—Appropriation, $145,000,000.
2.—85-ft. estimate, $139,750,000.
3.—Called to June 30, 1908, $27,500,000. June 30, 1909, $190,000,000.
4.—Remaining June 30, 1909, $25,000,000 to complete canal.
5.—If 1906 rate of call continues for eight years deficits will be $100,000,000.
6.—If past rate increases, deficits increase. Additions to $100,000,000 will accrue through:
   (a) WAGE—25,000 additional men announced in Message, 85,000 men, including railroad force engaged on collateral work, gives $99,-000,000 more than past rates in wage.
RETRIEVAL AT PANAMA.

(b) PLANT—Uter unpreparedness shown at every point and vast plant imperative before large execution possible.

c. 1. to excavate Atlantic approach; 2. dig Mindi clay rock; 3. excavate and transport spoil to Gatun; 4. construct lock flight; 5. spillways, excavate in lakes; 7. build Pacific dams; 8. construct Sosa flight; 9. excavate Pacific approach.

7.—MATERIALS AND SUPPLIES (including plant)—French rate yearly on small canal around $4,000,000. Saturnalia orders. Suppression of unvoucheded accounts for $7,750,000, as of January 1, 1907, in official announcements and speeches of Secretary of War and Chairman of Commission. American rate nearly $14,400,000 under last Commission. At past ratio $115,200,000 more will be required.

8.—EXCESS COST OF DELAY.—(a) One-sixth in earth turn over have been achieved in four years, all in soft upper deposits. Harder and more difficult materials untouched. (b) Concrete construction untouched. (c) French, with highest rate of canal building yet reached, finished but two-fifths of their small canal in ten years. (d) Unpreparedness precludes extensive advance of pace for at least one year. (e) Delay unquestionable. Excess cost incidental to delay.

9.—UNCOUNTED ITEMS.—(a) Additions from digging clay rock Mindi-Gatun section. (b) Building Gatun dam and Pacific dams largely by dry method. (c) Lengthening locks to 1,000 ft. and widening. (d) Equipping harbors and canal, making reception basins. And many other items.

10.—INTEREST.—(a) Two per cent 30-year bonds means of payment. (b) Interest on extra $100,000,000 is $6,000,000. (c) Excess cost and interest bring expenditure of 86-ft. lock-flight project to at least $900,000,000, and probably far more.

11.—INVESTMENT WARRANTED.—Congress authorized $145,-000,000. If appropriation not exceeded canal can be self-sustaining in 54 years.

12.—WASTE OF FUNDS AND REMEDY.—Of the millions already expended at least $30,000,000 from the standpoint of a correct design and programme of execution has been wasted. The only way to avoid or diminish further tremendous losses and vast deficits is to abandon the lock-flights and high dams and the programme which they entail and adopt the three-lake four-lock (or two-lock project) and execute it under a rational contract system.

FINIS.

Since to secure sufficient lockage capacity for all time the summit level must begin at Mindi or Gatun and the only lock sites then possible are at Mindi, Gatun, Pedro Miguel and Sosa-Ancon the simple formula to compel the abandonment of a sensible and safe plan of canal is the injunction, “LOCKS IN FLIGHT MUST BE PROHIBITED.”

When lock flights are prohibited everything else must follow, low safe dams, separated locks, and low head lakes.

In this single proviso is inherent the dispositions of the right canal—its supreme advantages to navigation and commerce, to construction, sanitation and labor; its solution of all the momentous problems, financial, technical and executive, which are involved in the nation’s work of opening to the world a waterway across the American Isthmus. The Panama Canal right, but right or wrong, the Panama Canal!