The **Panama Canal** – a true engineering marvel that stands as a testament to human ingenuity.

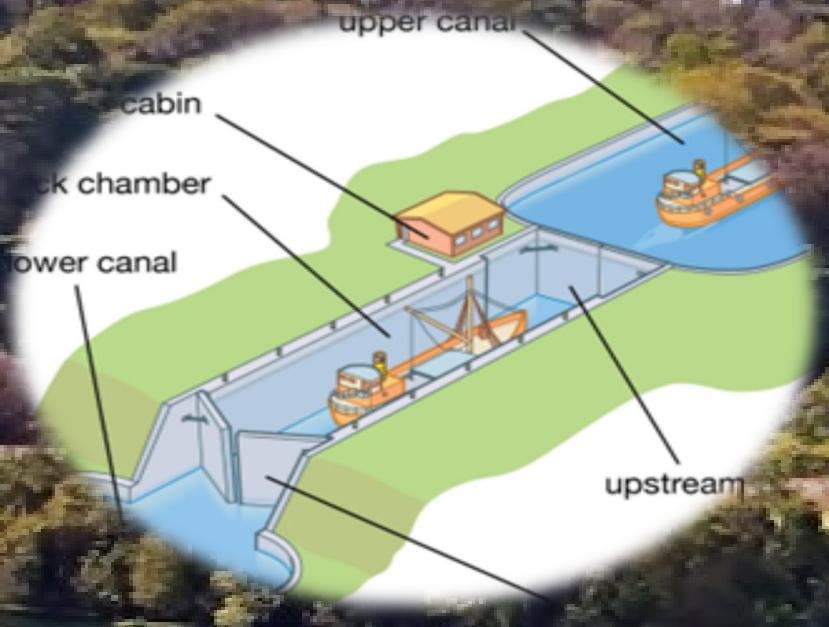
The idea of the Panama Canal dates to **1513**, when Spanish conquistador Vasco Núñez de Balboa first crossed the Isthmus of Panama.

The Panama Canal is considered the ***deadliest*** construction project in history

NOTE: the numbers in this presentation are **all** **extreme**!

Panama is a Central American country located just north of the Equator.

It connects more than 144 maritime routes & serves around 1,700 ports globally



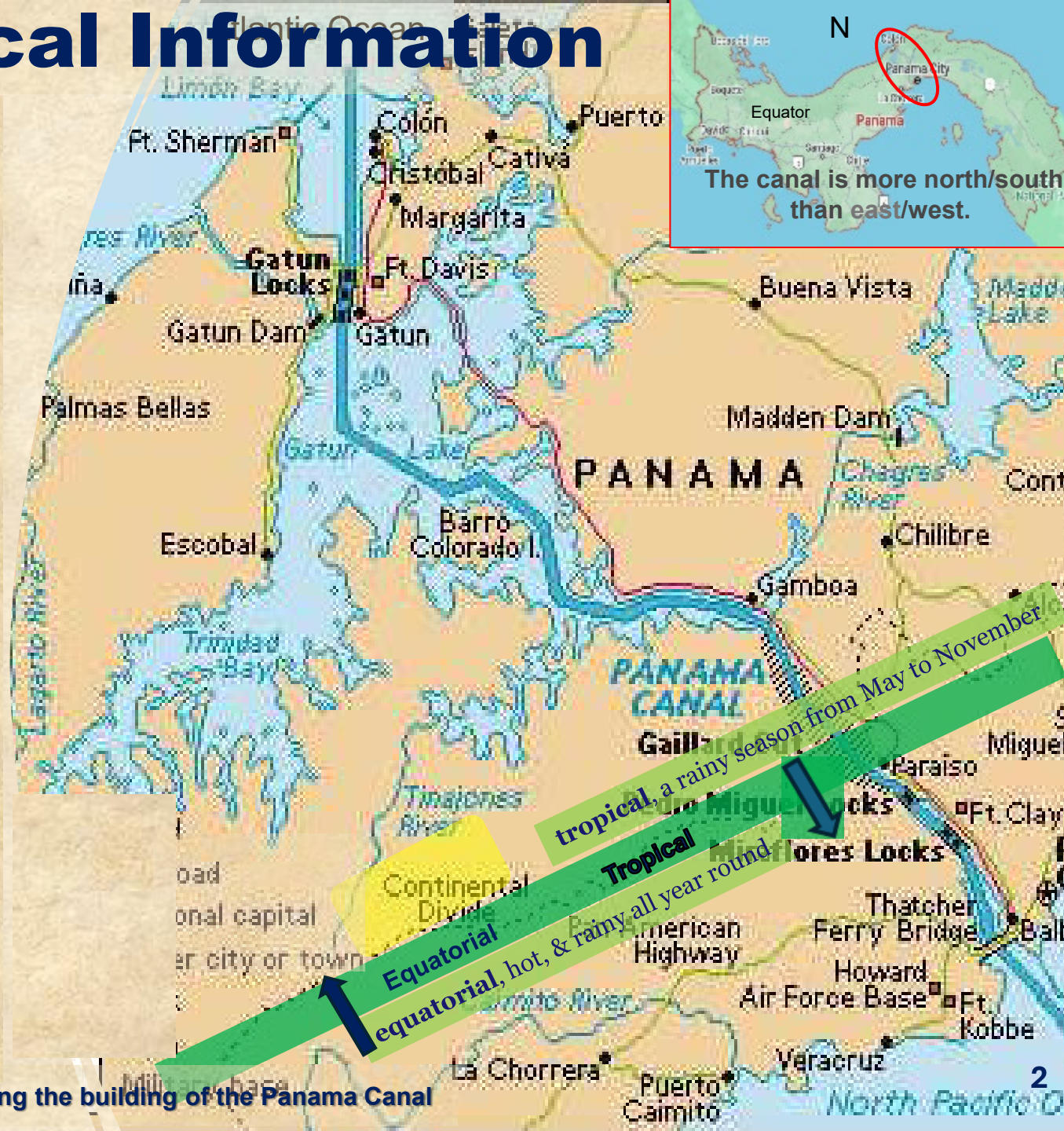
The Health &Safety Challenges of Building the Panama Canal

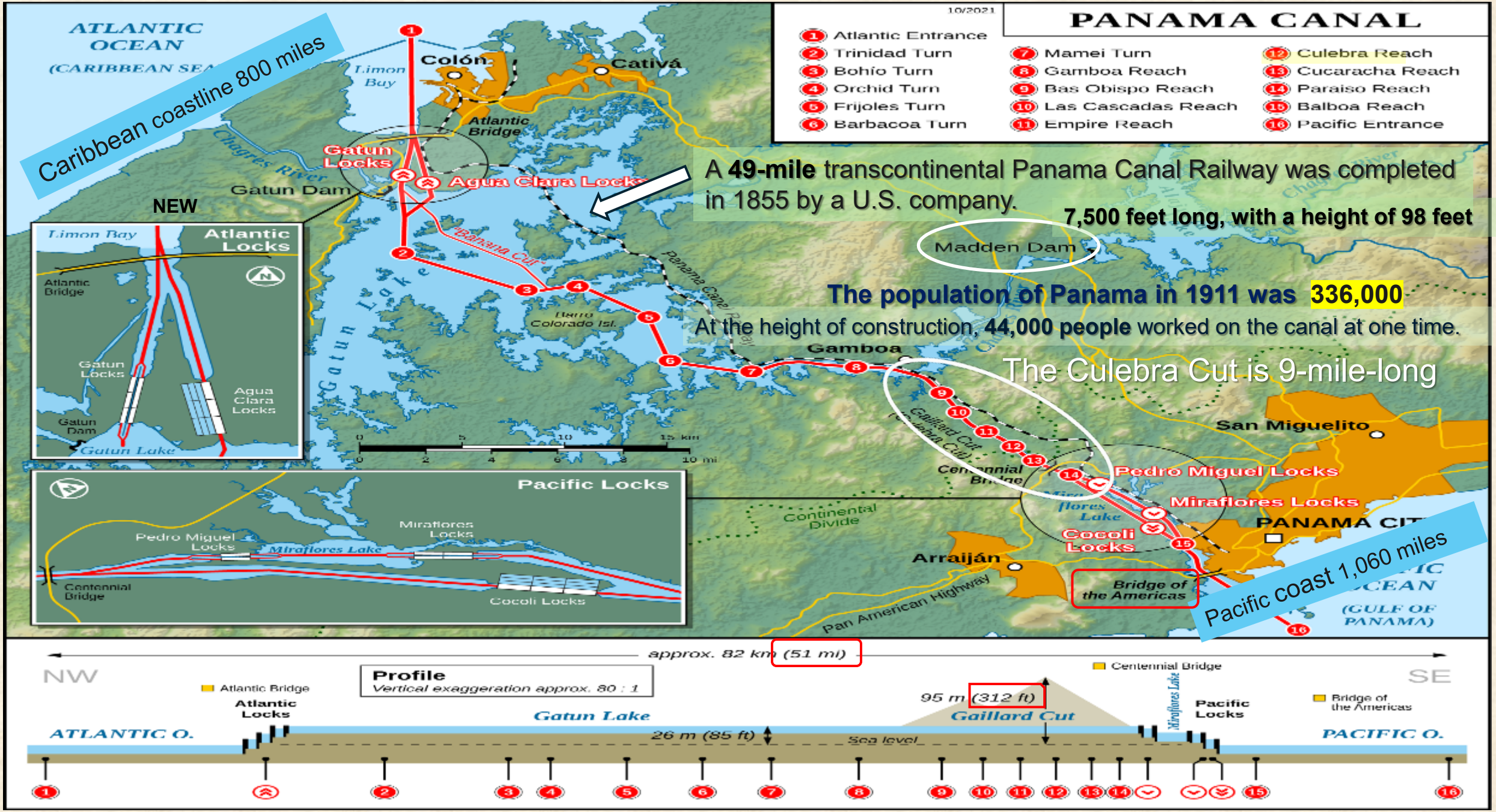
The impact of "Imperial" America on working conditions

From the outset, the Canal project was supposed to cash in on the exceptionalism of American power & ability. Political ***chicanery, military power & racial bias*** were used to acquire the "right" for the US to build the canal. U.S. citizens who worked in the Zone, known as "***Zonians***", had ***colonial attitudes***. {A belief that it was the white man's burden to lift, civilize, & sanitize the natives.}

Important Geographical Information

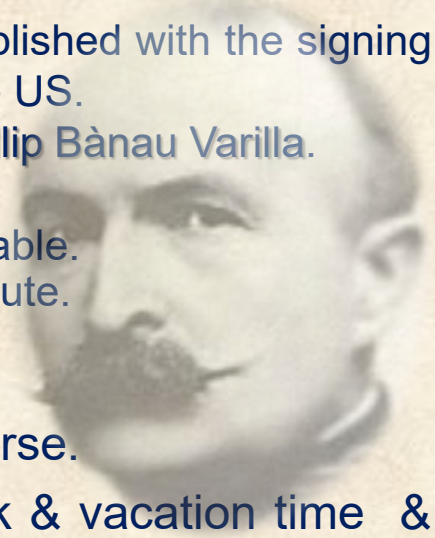
- The Panama Canal allows ships to travel the 50-mile Isthmus of Panama, between the Pacific & Atlantic oceans, shortening the voyage by about **8,000** nautical miles.
- There were several reasons to choose Panama. Among them, the canal would be shorter by more than 100 miles than in Nicaragua.
  - The Nicaragua canal site is only **20** mi. from an active volcano. In May 1902, the *Nicaraguan* volcano ***Momotombo*** erupted.
- Mean sea level is the same on the Atlantic & Pacific sides. The Caribbean coast sits approximately **85** feet higher than the Pacific Ocean. **Tides** are much more pronounced on the Pacific side. The differential between high & low tide is less than 4‘ on the Atlantic side. On the Pacific side, it is between 10 & 20‘.
- The Panama Canal raises ships approximately 85 feet above sea level at its highest point, using a system of locks to navigate the elevation change.
- The Panama Canal’s average depth is 43’
- Throughout its length, the canal has a minimum bottom width of 500 feet, to allow 2 ships to pass.
- A 2020 proposed new reservoir on the Indio River would sit southwest of Lake Gatun to provide additional water




PANAMA CANAL
10/2021
1 Atlantic Entrance
2 Trinidad Turn
3 Bohío Turn
4 Orchid Turn
5 Frijoles Turn
6 Barbacoa Turn
7 Mamei Turn
8 Gamboa Reach
9 Bas Obispo Reach
10 Las Cascadas Reach
11 Empire Reach
12 Culebra Reach
13 Cucaracha Reach
14 Paraiso Reach
15 Balboa Reach
16 Pacific Entrance
ATLANTIC OCEAN
(CARIBBEAN SEA)
Caribbean coastline 800 miles
Limon Bay
Colón
Cativá
Atlantic Bridge
Gatun Locks
Agua Clara Locks
Chagres River
Gatun Dam
Gatun Lake
Panama Canal Railroad
Barro Colorado Isl.
Gamboa
Gaillard Cut
Centennial Bridge
Continental Divide
Pedro Miguel Locks
Miraflores Locks
Miraflores Lake
Cocoli Locks
San Miguelito
PANAMA CITY
Arraiján
Bridge of the Americas
Pan American Highway
Pacific coast 1,060 miles
(GULF OF PANAMA)
A 49-mile transcontinental Panama Canal Railway was completed in 1855 by a U.S. company.
7,500 feet long, with a height of 98 feet
Madden Dam
The population of Panama in 1911 was 336,000
At the height of construction, 44,000 people worked on the canal at one time.
The Culebra Cut is 9-mile-long
NEW
Atlantic Locks
Pacific Locks
0 5 10 15 km
0 2 4 6 8 10 mi
approx. 82 km (51 mi)
Profile
Vertical exaggeration approx. 80 : 1
NW
SE
Atlantic Bridge
Atlantic Locks
Gatun Lake
ATLANTIC O.
26 m (85 ft)
Sea level
95 m (312 ft)
Gaillard Cut
Centennial Bridge
Pacific Locks
Bridge of the Americas
PACIFIC O.

The Socioeconomic & Political Challenges

- The U.S. government tried to broker a deal with Colombia, which controlled the land needed for construction. When that failed, the U.S. backed Panama's separatist rebellion & quickly signed an agreement with **the new country**, allowing America to take full control of a **10-mile-wide Canal Zone.**
  - The battle for Panama lasted only a few hours. The U.S.S. Nashville cruised off the Panamanian coast as a show of support. On November 3, 1903, the nation of Panama was established.
  - **The Panama Canal Zone** was created on **November 18, 1903**, from the territory of Panama; it was established with the signing of the ***Hay–Bunau-Varilla Treaty***, allowing the construction of the Panama Canal within the territory by the US.
  - The Panama Canal treaty was signed by US Secretary of State ***John Hay*** & a ***French engineer***. **Jean Phillip** Bànau Varilla. There were **NO** Panamanian signers.
  - With a drop in sugar prices, the Caribbean was in a deep economic depression so cheap labor was available.
- William Cromwell, a prominent American lawyer, heavily lobbied the US Congress to choose the Panama route.
- The Panama Canal was built by thousands of contract workers, mostly from the Caribbean. They lived like 2nd class citizens, subject to a ***Jim Crow-like regime***, with bad food, long hours, & low pay. There were scandals over living conditions, **but** injuries were accepted as stuff of course.



- White U.S. citizens were paid on the "**gold roll**," (gold coins). These workers earned paid sick & vacation time & the mostly **Black, West Indian** migrants were paid on the "**silver roll**", which was equivalent to ½ of the gold roll wages
  - The *gold roll* was a payroll category for workers who were paid in gold-backed U.S. dollars. The silver roll was a separate payroll category for workers paid in **Balboas**, a local Panamanian silver-backed currency. *More on the pay rate later*.
  - White workers had better housing with screens. Caribbean workers lived in hovels. Mess halls for black workers had no tables or chairs & fed 8,000 men a day with unappealing, simple food.
- At the outset, in 1904 the U.S. government had essentially no legislation in place to protect the tens of thousands of foreign workers from Barbados, Jamaica, Spain, & elsewhere from injuries & *no WC in the USA until 1911*.

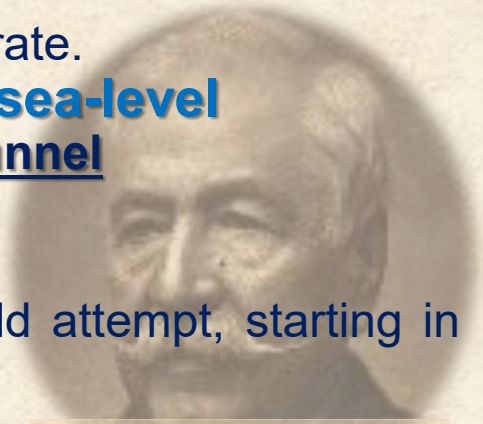
Climate & Environmental Challenges

- Crews had to work in a snake-infested jungle also populated by *Vampire bats, tarantulas, crocodiles, black widows & brown recluse spiders* & grass that could slice into your skin. Most vegetation removal was done by hand with a machete.
  - Panama has 148 species of snakes; *26 are venomous*. The most dangerous snake is the Fer-de-lance, which has venom that can be fatal to humans.
- The average temperature of 80^0 F with 105 inches of rainfall a year.
  - The blistering tropical heat that *could reach up to **120°F*** (***NOTE**: an extreme **HRI** exposure*)
  - *50 to 70 inches of rain* on the Pacific coast & can reach nearly double that amount on the Caribbean coast, with some areas receiving up to 130" of rain annually
- In the wet season, torrential downpours transformed the flood-prone *Chagres River* into raging rapids. Before the Panama Canal, the *Chagres River* was about 40 feet above sea level but could **rise by 20** feet at flood stage.
- Flooding regularly submerged equipment, & the unstable ground could give way at any instance. The work of months or
- even years might be blotted out by an avalanche of earth.
- A steam engine typically produces sound levels from *90 to 110 decibels* when operating. The US had 102 of them.
- In one incident, lightning hit a dynamite cap, causing a 12-ton charge to explode prematurely.
- The replacement chief engineer, self-taught railroad engineer ***John Stevens***, reasoned that the canal could **only be done by a well-housed,** well-fed, disease-free labor force. Stevens began work **not by digging, but by cleaning.**
- *Alcoholism* significantly impacted the construction of the Panama Canal
- The spread of *sexually transmitted diseases* (STDs) was a significant problem at the Canal. Two contributing factors were the **legal prostitution** industry in Panama & the significant transient population associated with the Canal.
- An early attempt to eliminate floating plants in Lake Gatun was to use white ***arsenic*** & mix it with soda bicarbonate & water This mixture was then sprayed on floating plants. The arsenic desiccated & killed the water plants & the residues sank to the bottom of the Lake.

RECENTLY: The canal has had to restrict traffic in recent years due to low water levels, caused by climate change. This has caused delays & increased costs for shipping companies. If the water crisis continues, it could eventually force the canal to close. A plan to eliminate the effect of droughts is to add a new reservoir on the *Indio River*. With help from the U.S. Army Corps of Engineers, the canal authority has planned to dam the Indio River & divert some of its water into *Gatun Lake*. The Indio runs roughly parallel to the canal, through the isthmus. The proposed dam, at Digna, Olegario is set to rise 80.5 meters, which would amass 1.25 billion cubic meters of water. The new dam would displace people in 37 tiny villages affecting more than 2,260 & would cost approximately **$1.6 billion** & could be completed in 5 years. Interim measures like water recycling are being implemented to bridge the gap.

French try to build a sea-level canal

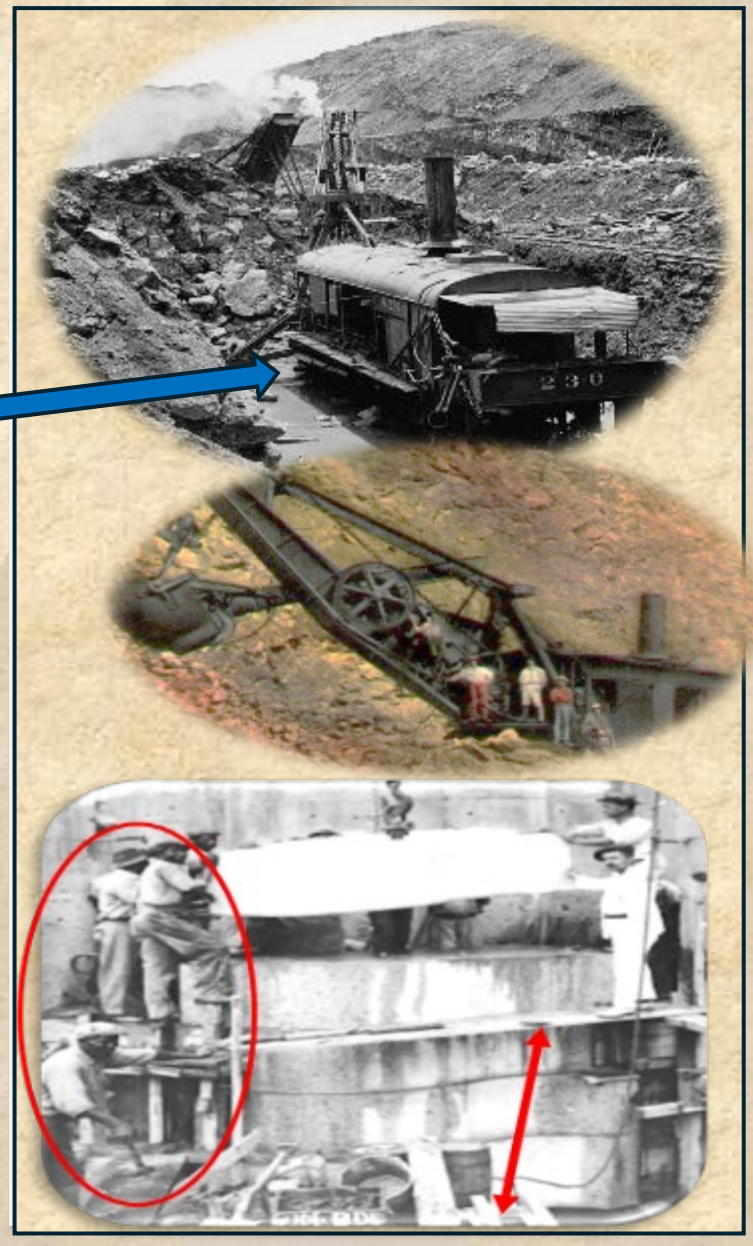
- **Fourteen proposals** for sea-level canals at Panama were presented before the French Congress, including the ***de Lesseps*** plan of Wyse & Réclus, 2 French navy lieutenants.
- Following the success of the Suez Canal, *Compagnie Universelle du Canal Interoceanique* was incorporated under French law on March 3, 1881.
- Ferdinand de Lesseps, the builder of the **Suez Canal** in Egypt, formed this private conglomerate.
- The French began excavating in **1880.** ***Ferdinand de Lesseps*** first planned to construct a **sea-level** canal. The route would closely parallel the Panama Railroad & require a **25,330-foot-long tunnel** through the Continental Divide at Culebra.
  - The tunnel was to be, 79 ft wide &,112 ft. above the water line.
- The **French company** would use these concepts as a basis for the lock canal they would attempt, starting in 1887 following the failure of their sea-level attempt.
- A ***hurricane*** wiped out most of the construction at the Canal's east end in **1888**.

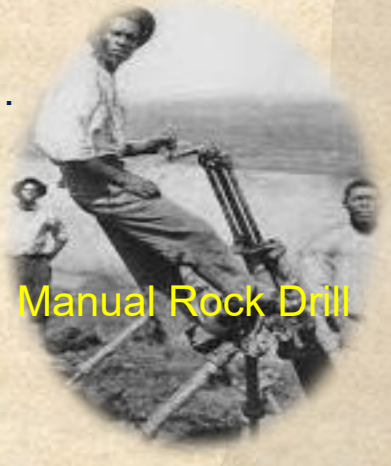

age 74

- It was estimated that **30-40 workers died each day** during the wet seasons in 1882/83 from yellow fever & malaria.
- Malaria, yellow fever, & other tropical diseases conspired against the de Lesseps campaign. They failed to get more than **10 miles** from the Atlantic Ocean in **8** years. After **9** years & a loss of approximately ***20,000 lives***, the French attempt went bankrupt. Roughly **$287 million** had been spent by the French company.
- The French canal excavations then ***lay dormant*** from **1895 to 1903**.
- On **June 19, 1902**, the US Senate approved a single Panama route, (originally there were **5** potential routes for a canal across Central America) & the purchase of the French company, including all the equipment & buildings for **$40,000,000.** Most of the money ***never*** made it to Panamanians, ***it was stolen by de Lesseps, Cromwell & J.P. Morgan***
- The US used very little of the French dig. 29.9 million yards^3 of the French excavated soil is still useful today.

Construction Equipment

- The American construction of the Canal included 3 distinct construction divisions: the Atlantic Division; the Central Division; & the Pacific Division.
- The French equipment was 16 years old when taken over by the USA
- In 1907, the construction fleet included **560 drills**, more than **50 cranes**, **20** dredges, giant hydraulic rock crushers, cement mixers, & pneumatic power drills; nearly all were manufactured to include the latest US Technology.
  This type of crane was normally mounted on rail trucks
- American purchased 102 new, railroad-mounted steam shovels
  - **Bucyrus-Erie** supplied 77 of the **102 steam shovels**.
    - The 95-ton model with a **5-cubic-yard bucket** could move **8** tons of material.
    - The shovel ran on rails & had a 5-man crew
    - Bucyrus shovels had 3 times the capacity of the existing French shovels
- Preparation for rock blasting was carried out by drills run on compressed air piped from three plants **5 miles away**. Operating in sets of up to 12, set between 6-16 ft apart, the drills cut to 27 ft. Workers used picks & shovels to move the rocks & trees. ***MSD'S?***
  - A variety of rock drills, including steam-powered, air-powered & hydraulic track drills. A 50 lb. rock drill is capable of 2,100 BPM.
  - The operation of these drills produces A-weighted noise levels in the range of ***100 to 120 dB*** at the operator location.
- In November 1906, ***Teddy Roosevelt*** himself visited the canal, the 1st President to travel outside the USA while in office.
- Workers building the Panama Canal lacked the **current standard PPE**, such as *hard hats, respirators, & hearing protection*.
  - **Note**: the scaffolding





Manual Rock Drill

Amazing Inventions in Canal Equipment

Track Shifter

Lingerwood Unloader

About 160 loaded trains went out of the cut daily & returned empty. A total of ***320 trains a day***, or a train every minute & a half!

- Nothing in the Canal Zone was moved by truck. For the shortest, even temporary hauls, ties & rails for trains were laid.
- Even the steam shovels in the cuts were on rails, & as they moved forward, the old tracks had to be torn up & new ones laid ahead of the shovel.
- An ingenious rail mover was developed that picked up an entire section—rails, ties, & all & moved it to the desired spot.
- With one such rig, fewer than a ***dozen men*** could move a mile of track daily, a task that would have taken **six hundred men** working by hand.

- A specialized unloading mechanism used on wooden flatcars to dump large quantities of excavated dirt.
- It utilized a mechanism with a cable & a **plow-like device** at the rear of the train to sweep the dirt off the flatcars, unloading large volumes of material.
- The plow was hauled rapidly forward & the whole **twenty-car train** was unloaded with a single sweep, all in about **ten minutes**. One such machine could do the work of **three hundred men** under the old method of unloading by hand.
- It was followed by the **dirt spreader** to level the dirt for the next load.

The dam was the largest ever built at the time

The capacity of the spillway is 140,000 cu ft per second

Building the Gatun Dam

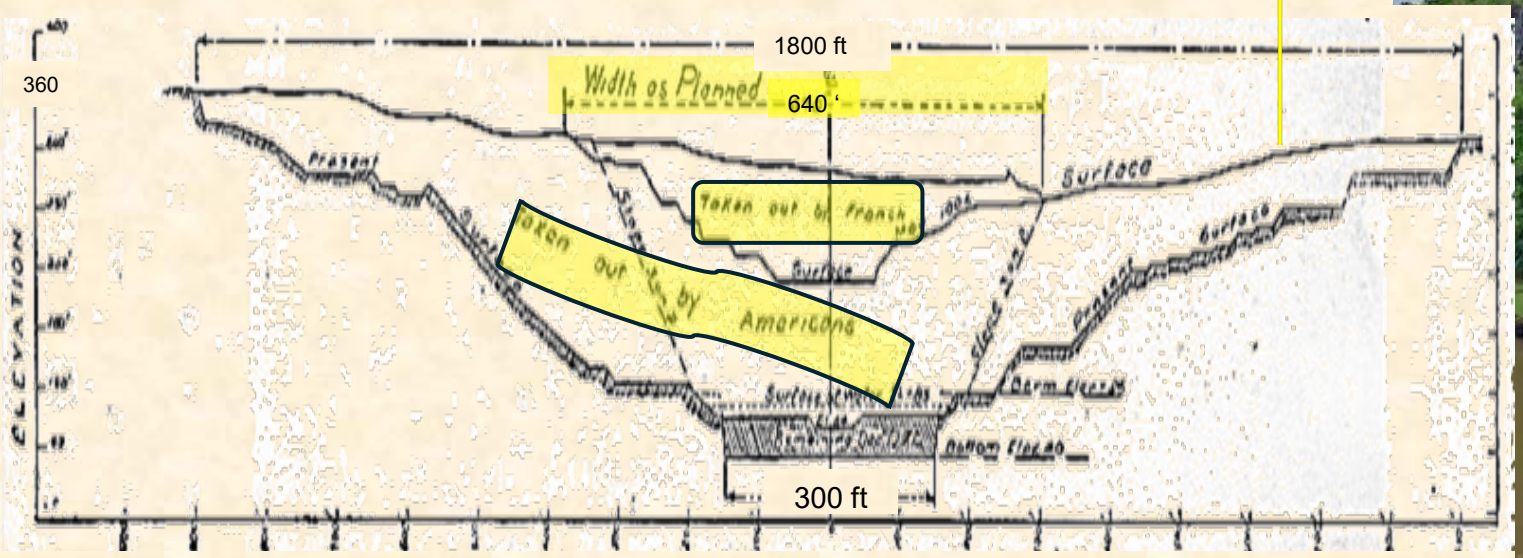
- The Gatun Dam serves two important purposes: it controls the ever-varying *Chagres River* and creates *Gatun Lake*.
- The hills bordering the valley of the Chagres form a gap just over 1.2 miles wide, with a natural rocky hill in the center. The gap is filled by an earth dam, **2,100 feet** thick at the base, **7,500 feet** long along the top, **397 feet thick** at the water level, and **98 feet** thick at the top, which is 30 feet above the normal lake level.
- The **spillway** dam is topped by **14 gates**, supported by concrete piers each **46** feet wide by **20** feet high. These gates, which are electrically operated, are raised or lowered to control the flow of water; with the lake level at **87** feet, its planned maximum level, The huge scale of the dam required massive rock & dirt fill that was provided by about 100 trainloads of waste rock deposited into 2 parallel walls of waste rock about *2,700 feet apart daily for several years* from the Gaillard Cut.
- Water from the lake generates electricity & feeds the locks at Gatun to the north & flows through Gaillard Cut to fill Pedro Miguel & Miraflores locks to the south. It took about 3 years for Gatun Lake to reach its final **85 feet**.
- The construction of the Gatun Locks, a key part of the Gatun Dam in Panama, used over 2 million cubic yards of concrete.

The "Culebra Cut," AKA the Gaillard Cut

It is a crucial part of the Canal, essentially a deep artificial valley that cuts through the Continental Divide, connecting Gatun Lake (Atlantic) to the Pacific Ocean via the Pedro Miguel & Miraflores locks; Key details :

- **Length:** Around 8 miles
- **Depth:** Lowered from a summit elevation of 194‘ to 39’ > sea lev
- **Excavated material:** *Over 100 million cubic yards* by the US
- **Construction period:** Primarily between 1907 & 1913
- *Six thousand men* worked in the cut, in the American effort

In the nine-mile section in a single 12-month period, a total of **16,386,000 cubic yards** of material was removed in the American effort.



Cross section of Culebra cut showing the effect of slides

The digging of the cut took **16** years in total

Where ships will sail through the famous Culebra Cut, it has a finished depth of **300 ft**.

During the French effort there was a workforce of about **2,000** at work in Culebra Cut, The French excavated almost **19 million cubic yards**

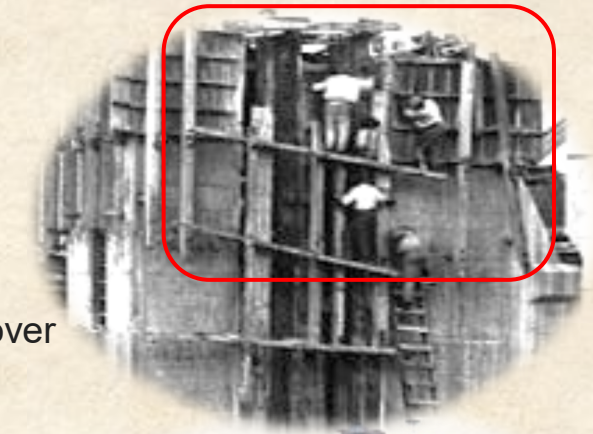
Landslides & Unexpected Explosions

From 1907 - 1914, the Canal experienced 100 slides. Some without warning, burying workers & equipment & blocking the Canal.

The first landslide under the American effort occurred at Cucaracha on October 4, 1907, when **500,000 cubic yards** of material moved into the Cut after several days of heavy rain. For 10 days the slide moved at 14 feet every 24 hours.

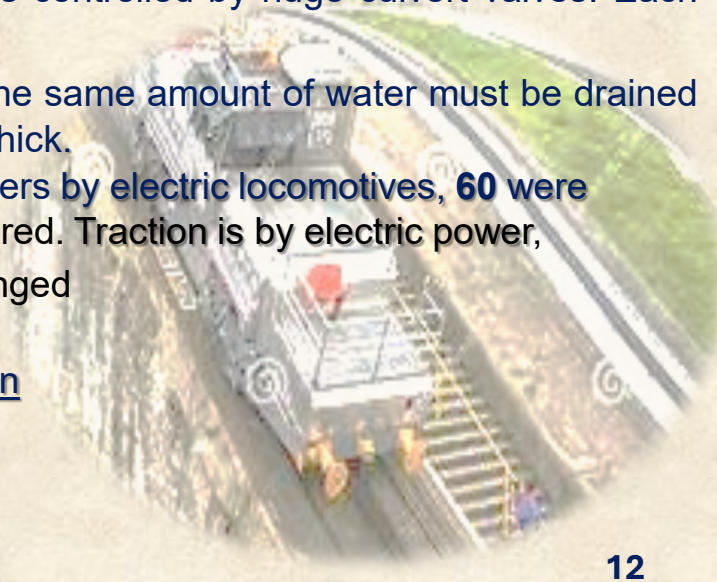
- Working with *explosives was one of the most dangerous occupations* on the Canal. Chief Engineer ***Goethals*** blamed the frequent accidents on worker incompetence. Still, explosives could become unstable because of the climate, lightning could ignite a blast, & steam shovels sometimes hit unexploded charges. A phenomenon known as "***hot rock***", caused by sulfurous blasts of hot air from iron pyrite oxidation or water vapor from moving rock, could also ignite charges.
- Canal engineers were completely unprepared for & confounded by this unexpected slide activity.
- On December 12, 1908, shortly after 11 am, 2 explosions at Bas Obispo unexpectedly set off **44,000 tons of dynamite**, throwing men & steam shovels across the Culebra Cut. Almost **60,000 cubic yards** of rock filled the Canal, 20-30 feet deep.
- The Galliard cut required cutting a channel 194 feet below the level of the land. With every rainy season, the soil would become saturated with water & mud would flow into the ditch. The builders recognized that they did not know at what angle of inclination the soil would be stable. Americans had lowered the summit of the cut from 194 to 39 ft above sea level, at the same time widening it considerably, eventually a slope of 1 to 5 was used.
- They kept digging & digging in the same trench & continued to dredge the canal after it was open as new mud flowed into the canal. Landslides caused the canal to close multiple times, including for seven months in 1915.

Dangers during the Building of the Locks



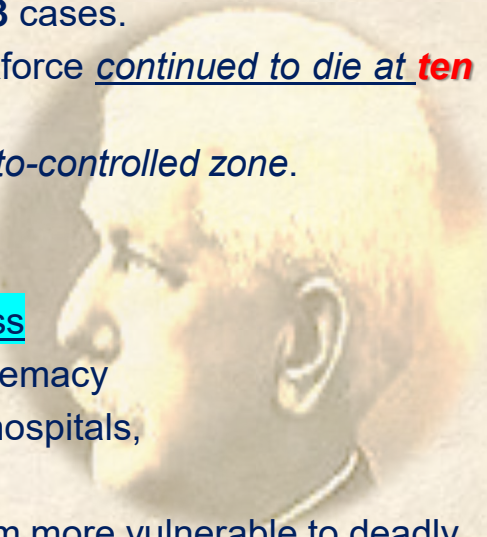
- Construction of the locks began with the pouring of concrete at Gatún in August 1909.
  - At the Gatun Locks on the Atlantic side, workers poured enough concrete *to build a wall 8' wide, 12' high & 133 miles long*. Built in pairs, with each chamber measuring 110 feet wide by 1,000 feet long, the locks were embedded with 18-foot diameter culverts that leveraged gravity to raise & lower water levels.
  - The most dangerous job was the ***165 rivet gangs*** who worked on scaffolds without fall protection, driving over ***6,000,000*** *rivets into the gates*
- Three locks along the canal route lifted ships 85 feet above sea level, to the man-made Gatún Lake in the middle.
  - Lake Gatún is an artificial lake in Panama & is 163 mile² lake is *the largest man-made lake on earth!*
- Hollow, buoyant lock gates were also built, varying in height from 47 to 82 feet. The entire enterprise was powered by electricity. Lock operations required *1022 electric motors generating* ***28,290 horsepower***, & all controls were electric.
  - Each lock gate weighs 700 tons yet can be moved by a single 40 HP motor.
  - 50 US steel mills, foundries, & machine shops churned out the rivets, bolts, nuts, girders, & other steel pieces the canal builders needed.
  - The *SS Ancon* & her sister ship, the *S.S. Cristobal*, had hauled millions of 94 lb bags of cement & hundreds of workers from NY to Panama in 1909 to construct the canal. *(Can you imagine the ergonomic issues?)*
- Water in the Panama Canal is released from the rain-fed Lake Gatun. The *water is moved by gravity* & is controlled by huge culvert valves. Each cross culvert is independently controlled. A lock chamber can be filled in as little as ten minutes.
- Each lock chamber requires ***26,700,000*** *US gal of water to fill it* from the lowered to the raised position; the same amount of water must be drained from the chamber to lower it again. The gates range from 47 to 82 ft high, depending on position, & are 7 ft thick.
- An *important safety feature is that ships are not under internal power* but are guided through the lock chambers by electric locomotives, **60** were provided by General Electric in Schenectady, N.Y, known as *mules*, run on rack tracks to which they are geared. Traction is by electric power,

  Each Mule is just under 32 feet long by 8 feet wide and 10 feet high & **weighs 42 tons**. It runs on four flanged wheels like railroad wheels. When in service, they move at **2** MPH.
- These mules are used for side-to-side & braking control in the locks. With large ships, there are two mules on each side at the bow, & 2 on each side at the stern, eight in total, allowing for precise control.
- In **1956**, the Panama Canal Company awarded ***R.G. LeTourneau***, Inc. a contract to modernize how ships are moved through the Canal. This was a major modernization since 1914.



Disease, Sanitation & Logistical issues

- Many of the deaths were due to tropical diseases, particularly *Yellow Fever & Malaria*.
- An estimated ***12,000*** *workers died* during the construction of the Panama Railway.
- It has been estimated that *80% of the workforce was hospitalized* during 1906 for Malaria.
- *Respiratory ailments* were the leading early cause of death **(33%),** with *pneumonia* in **844** cases & *tuberculosis* in **743** cases.
- While disease reduction dramatically improved the health of white workers, black majority workers of the canal workforce *continued to die at* ***ten times*** the rate of white workers in 1906.
  - Housing was not provided to black workers, many of whom had to live in tents & tenements ***outside*** *the mosquito-controlled zone*.
- By June 1905, three-quarters of the original American contingent had fled the isthmus.
- The American sanitary campaign in Panama, led by ***William C. Gorgas***, is celebrated as one of the great achievements of the era. Gorgas's work is credited with saving at least 71,000 lives & some 40 million days of sickness
- Gorgas's racism is rarely discussed, but his work on yellow fever and malaria perpetuated colonialism and white supremacy
- PHS physicians managed quarantine operations, oversaw the eradication of rats & mosquito larvae, superintended hospitals, attended patients, & staffed laboratories.
- For workers *partially deafened* as a side effect of ***drinking quinine*** to ward off malaria, the inability to hear made them more vulnerable to deadly railroad accidents.



- The United States implemented several strategies that improved upon the French efforts in building the Panama Canal:
  1. Effective use of railroads: Unlike the French, who piled up excavated dirt, the US used railroads to transport the dirt away on Lidgerwood flat cars, each capable of hauling approximately l9 cu. Yards. This method reduced landslides & improved overall efficiency.
  2. Malaria prevention: The United States prioritized malaria prevention by implementing mosquito control measures
  3. As uniformed officers, PHS officers were treated as equals by their ICC counterparts & could operate in an unhindered fashion & without the frictions among local, state, and federal public health agencies
  4. Large quantities of food items were imported from the United States & other nearby countries for the canal laborers. The immense logistical problems involved in providing life's necessities can be demonstrated by noting that meals for the workforce required the annual baking of more than 60,000 rolls & 6 million loaves of bread.

Conquering Worst Disease –Yellow Fever

- The yellow fever virus & its vector both migrated to the Americas from West Africa, likely in the middle of the seventeenth century, because of the slave trade.
- American sanitarians entered Panama with a crucial edge over their French predecessors: they were the beneficiaries of the ***Reed Commission's*** work in Havana in 1900 confirmed that the ***Aedes aegypti*** mosquito spread yellow fever.

- In Panama, "***Yellow Jack***" **yellow fever** control involved managing urban environments & the disease ecologies that thrived within them. *Yellow fever control was* ***an exercise in getting a population largely immune to the disease to alter its habits*** *so that a large nonimmune workforce could flood the Canal Zone without stoking an epidemic*.
  - The symptoms of yellow fever are terrifying: fever, headaches, back pain, extreme thirst, & black vomit from internal bleeding.
  - Even more damaging was its ability to ***recur after a patient had recovered***.
- ***4,000*** Sanitarians **fumigated houses** where cases had developed, to eliminate infective mosquitoes. They put screens on windows to prevent mosquitoes from entering.
- The 2 basic causes of vector ubiquity: how urban Panamanians provisioned themselves with water & the absence of municipal trash collection. Panama's cities were littered with tin cans & containers that collected rainwater & supported *A. aegypti* larvae. **Remove the trash-remove the breeding**.
- Americans achieved yellow fever control by reengineering urban Panama, & by intrusively policing the habits of urban residents to achieve public health benefits.
- The last reported case of yellow fever on the isthmus came in November 1905.

Conquering the Pandemic Disease – Malaria

- The cumulative investigations of **Charles Louise Alphonse Laveran**, **Ronald Ross**, & Giovanni Battista Grassi, & his collaborators proved that the female Anopheles mosquito transmits the disease-causing parasite that causes malaria.
  - ***Plasmodium falciparum*** is a parasite that gets into the red blood cells in the body.
- *Gorgas's* sanitary workers drained, or covered with kerosene, all sources of standing water to prevent mosquitoes from laying their eggs & larvae from developing;
  - Fumigated areas infested with adult mosquitoes; isolated disease-stricken patients with screening & netting; & constructed quarantine facilities.
  - Gorgas orders *$90,000* worth of copper screening to protect workers from mosquito bites.
- The US *government's* *$20 million* investment in the sanitation program also provided free medical care & burial services to thousands of employees. In addition, Gorgas's sanitation department dispensed
  - Crews went throughout Central America spreading light oil on any stagnant or still water.
  - About *700,000 gallons of oil* & *124,000 gallons of larvicide* were used on the project.
  - **120 tons** of pyrethrum, 300 tons of sulfur, & 50,000 gallons of kerosene per month.
  - Approximately one ton of prophylactic quinine each year at 21 dispensaries along the Panama Canal
    - Quinine works by killing the parasite or preventing it from growing. This medicine may be used alone or given together with one or more medicines for malaria.
  - Added hospital cars to trains that crossed the Isthmus.
  - Each year, hospitals treated approximately 32,000 workers, & 6,000 were treated in sick camps.
  - **TRIVIA**: Around **705** Chinese laborers arrived in Panama on the ship "Sea Witch" in 1854 to work on the *Panama Railroad*. The Commissary stocked **opium** for the Chinese workers, which eventually became a problem. Opium had long been valued in China as a medicine that could ease pain, assist sleep & reduce stress. When the company commissary stopped stocking opium, many workers committed suicide.

Traumatic Injuries Ranked Number Two

- The Panama Canal was the world's deadliest construction project. It killed **40%** of its workforce.
- Slides were not the only danger. Racing trains, swinging cranes, explosions, drowning, & falls from scaffolds were just some of the ways a man could die or be maimed at the Canal. Surrounded by the noise, dust, & smoke from locomotives, steam shovels, blasting, & hundreds of rock drills, staying alert was not easy. Flooding, sweltering heat, 200 kinds of snakes & leftover French construction equipment that was too light for the job.
- The total workforce added 12,000 from the US, 16,000 from other Caribbean islands, & 8,000 from Europe & Latin America to the 20,000 Barbadians. A tenth of them died during construction – **5,609 people, including 4,290 Caribbean workers** – of yellow fever, malaria, landslides, explosions, railway accidents, & other illnesses. Workers fell from scaffolding, racing trains, & swinging cranes
  - Men were blinded & deafened, fingers, hands, & arms were lost, & hundreds of legs were amputated.
  - In 1914, **44** employees were killed by *railroad accidents*.
- The Canal Commission's 1910 report, as a typical example, records **548** employee deaths, including **376** from disease (especially yellow fever & malaria, despite energetic efforts to control breeding), & **164** from industrial accidents, including dynamite explosions, railroad accidents, electrocutions, drownings, and "accidental traumatisms, various."
- So many Panama Canal workers were maimed during the construction that artificial limb makers competed for highly coveted contracts with the canal builders. By 1912, A.A. Marks

No one knows how much "expendable labor" was sacrificed in those accidents. Most historians figure death tolls at thousands more than official statistics — not to mention the maimed.

The Legacy of the Canal Construction

- After ***111 years*** the Panama Canal is recognized as a monument to human creativity & tenacity. Its influence on global trade & navigation has changed the worldwide economic landscape.
  - **Robert Dill** died in 1963 at the age of 104. He was the last member of the American team that built the **Panama Canal**.
- Mountains were moved, the land bridge between the North & South American continents was severed, & more than 150 sq miles of jungle was submerged under a new manmade lake.
- When combined with the deaths from the French venture, it is estimated that **500 lives** were lost for each mile of the canal. Their blood & bodies paid mightily for the dream of moving profitable goods & military might through a reluctant landscape.
  - The bombing of Hiroshima & Nagasaki in August 1945 shattered conventional concepts of protecting critical engineering facilities, like the Panama Canal, which turned out to be strategically useless, & indefensible.
  - Medals struck from scrap metal taken from abandoned French equipment were sent to the Philadelphia Mint.

    They were issued only to Americans who had worked for **2** years on either construction or the railroad.

    50,000 individually numbered bronze Panama Canal Completion Medals were awarded.

  - The history of U.S. sanitation in the Panama Canal reveals how PHS physicians helped to perpetuate a hierarchical health system structured starkly by racism can be intertwined with disturbing - & from today's standards, unethical – approaches to healthcare delivery.
- Eight distinct treaties. Each one plays a crucial role in shaping our shared agreements & fostering cooperation
- From 1950 through the 1970s, the Panamanian people wanted more access through the canal zone, which cut their country in two. Until 1963, there was no way across the canal except by ferry. In 1963, the US Corps of Engineers built the ***Thatcher Ferry Bridge*** (now called Puente de Las Americas) so Panamanians could drive from one side to the other.
- Panama tripled the canal's capacity with new lanes & much larger locks, a project that cost $6 billion. The new locks opened in 2016.
- See the locks live: https://multimedia.panama-canal.com/Webcams/Miraflores.html
- Due to ***environmental*** & safety & treaty provisions, the Panama Canal could **not** be built today!
- As Panama treads its delicate path forward, balancing environmental stewardship,
- Community preservation, & economic necessity will be critical.

Lessons Learned – Key Takeaways

My opinion

1. Adequate all-inclusive risk assessment is an essential **first** step.
   - Quantify all exposures to the greatest extent possible – noise, electrocution, ergonomic, etc.
2. Engineer with *Safety-by-Design* – take the time to do it right.
3. Obtain adequate finances.
4. Respect for everyone is essential – House, Feed, & pay equally.
5. Be transparent – communicate regularly & respond to contrary opinions.
6. Be honest in all personal dealings - no chicanery, or racial bias.
7. Understand the impact of all environmental issues – pesticides, rain, heat, & insects.
8. Assess exposures & provide all the essential PPE.
9. Plan for the adequate treatment of injured persons.
10. ? _____

Interesting Facts about the Canal

- Opened in 1855, the Panama Railway, built by the US, preceded the Panama Canal by half a century. The cross-Panama railway earned over $7 million in its first six years of operation.
- It takes about 8 hours to cross the Canal's 50 miles. That saves days. If a ship had to navigate down & around Cape Horn at the tip of South America & back up the other side, it would have to travel nearly **12,500** extra miles.
- More than **75,000 people** worked on the Canal & came from 50 countries. Between 1904 & 1916, over 45,000 Barbadians migrated to Panama to work on the canal, roughly 1/4 of the island's population. Only 1 in 5 stayed on the job longer than a year.
- **20,000** workers died during French efforts. **5,609** workers perished during the American phase.
  - **350** were white Americans and 4,500 were non-white, mostly West Indians.
- With a death rate of *408.12 per 1,000 workers, (41%)*
- English-speaking West Indian blacks were offered a contract for 500 working days at **10 cents/hour,** 10 hours a day, for 6 days a week with a repatriation option. Laborers moved 200 trainloads of spoil a day.
  - The average hourly wage in the United States in 1904 was **22 cents/hour**. In Barbados, it was **0.25 per day!**
- 268 million cubic yards of dirt were removed to build the Panama Canal. The French moved 78 million cubic yards of soil
- **60,000,000 pounds of explosives** were used. More than **600** holes filled with dynamite were fired daily. **(NOISE?)**
- The US took it over in 1904 & completed the project **ten** years later for **$400 million,** equivalent to about **$15.2 billion** in 2023.
- The first ship to officially pass through the Panama Canal was the *SS Ancon* on August 15, 1914.
  - In 1928, adventurer ***Richard Halliburton*** swam the canal, paying a toll of 36 cents based on his weight.
- The Panama Canal opened officially on ***August 15, 1914.*** The world scarcely noticed. The greatest engineering project in the history of the world had been dwarfed by the totality of **World War I**.
- **One** out of every **4,000** vessels traversing the canal has been involved in an accident. Five ships have sunk in the canal.
- Over 1 Million Vessels have transited the canal since it opened. The Panama Canal is a key source of revenue for the government. In 2019, the tolls made **$2.9 billion**

The Effect of Returning the Canal to Panama

- *Why, it's ours, we stole it fair and square."* – Senator Samuel Hayakawa, 1977.
- Most countries that trade with other countries use the Panama Canal, it saves a lot of time & money. Any country attempting to disrupt that trillion-dollar trade for its ends would be considered an aggressor. In 2019, 66 % of the cargo traffic transiting the Canal began or ended its journey at a U.S. port
- The US only had a lease, but no ownership of the Canal Zone. Carter continued the negotiations & in 1977 made the Carter-Torrijos treaty to return the canal zone to its owners.
- On **December 31, 1999**, final control of the Canal & its Zone reverted to Panama. The bottom line was the US never owned the canal, & the treaty served US interests in maintaining the canal as an international economic icon.
  - The United States, however, reserved the right to exert military force in defense of the Panama Canal against any threat to its neutrality.
- Administration of the canal has been more efficient under Panama than during the U.S. era, with traffic increasing 17% between fiscal years 1999 & 2004.
- Shipping prices have increased because of droughts last year, affecting the canal locks, forcing Panama to drastically cut shipping traffic through the canal and raise rates to use it.
- The Panama Canal Repurchase Act of 2025, introduced by U.S. Rep. Dusty Johnson, would authorize the president, *"to initiate & conduct negotiations with appropriate counterparts of the Government of the Republic of Panama to reacquire the Panama Canal"*
- A Hong Kong-based conglomerate has agreed to sell its subsidiary that operates ports near the Panama Canal to BlackRock Inc., The deal will give BlackRock control over 43 ports in 23 countries, including the ports of Balboa & Cristobal in Panama

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