

Charles W. Hummer, Jr.

The Panama Canal: A Look Back, A Look Forward



Charles W. Hummer, Jr.

Charles Hummer is a technical author, consultant on dredging and environment, and book reviewer for *Terra et Aqua*. Born in Panama, he worked there until 1979 when he left his position as Assistant Chief of the Panama Canal Dredging Division and went to the Headquarters of the U.S. Army Corps of Engineers Dredging Division in Washington, D.C. He is past president and chairman of WEDA and WODA. In 1989 he retired from the Corps and from 1989-94 he lived in The Netherlands and was active in the Environmental Committee of CEDA. He is the editor of the book *Dredging for Development*, published by the IADC. He is cofounder and presently president of the Panama Canal Museum in St. Petersburg, Florida, USA.

Abstract

This year 2003 marks the centennial celebration of the signing of the Treaty by U.S. Secretary of State John Hay and M. Bunau-Varilla, appointed minister to Washington DC, in which Panama, newly liberated from Colombia, gave the United States the rights to build a canal on the Isthmus. The canal officially opened in 1914 and the large labour force necessary to operate it was primarily American. Eventually this led to unrest in the Panamanian government, which in turn led to the signing of the Carter-Torrijos Treaties of 1977 that set in motion the complete transfer of the Panama Canal to the Republic of Panama by the end of the 20th century. Since this transfer the "new" Panamanian Panama Canal Authority has undertaken several extensive studies to improve the Canal and bring it up to the requirements of the present-day post-Panamax fleets.

This article was prepared drawing directly and indirectly from historical records of the Panama Canal

Commission, the references listed, from the Panama Canal Authority Official Website and as a result of meetings with the Panama Canal Authority staff during July 2001 through March 2002. The Panama Canal Authority Office of International Communications kindly provided many of the graphics.

Introduction

The narrow 50-mile Isthmus of Panama was recognised as a key potential link between the Atlantic and Pacific oceans and the maritime trade flowing between those seas as early as 1524, when Spanish King Charles V commissioned the first study of a canal to connect the two oceans (Figure 1). On the way back to Spain, slaves and mules carried tonnes of gold from Peru across the narrow Panama isthmus.

The first mechanised trans-isthmian transportation bridge was the Panama Railroad constructed in 1855. The railroad met the pressing need for transport from the eastern coast of the United States following the California Gold Rush. The savings in time and distance from this shortcut were compelling. The Panama Railroad's success explicitly indicated the demand for use of the Isthmus as a travel shortcut. American interests soon focused on the proposed utility and economic return a canal would provide. Surveys during the 1870s to select the best route for a canal resulted in both Panama and Nicaragua being presented as the proper location. The United States did not act upon these recommendations.

The French then took the initiative by purchasing construction rights from Colombia in 1879. Construction of a sea-level canal across the narrowest part of the Isthmus began in 1881. Ferdinand de Lesseps, who played a major role in building the Suez Canal in 1869, directed the Compagnie Universelle Du Canal Inter-oceanique de Panama. Time and mileage would be dramatically reduced when travelling from places on the Atlantic Ocean to places on the Pacific Ocean and vice versa. For example, a total of 7873 miles would be saved on a trip from New York to San Francisco. Clearing the jungles, excavating, and dredging

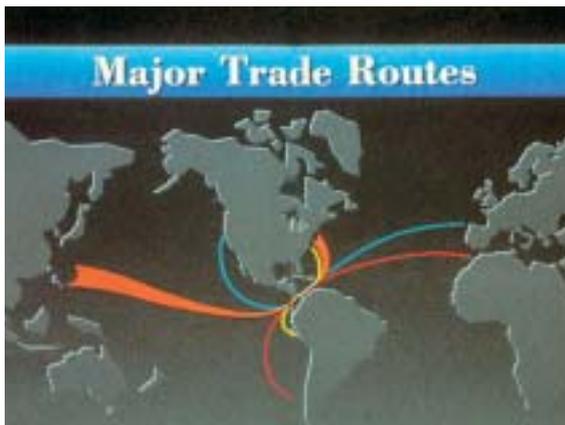


Figure 1. Since 1524 when Charles V of Spain commissioned a study for a canal to connect the two oceans, the canal has been a focal point of maritime trade.

– combined with poor sanitation and rampant disease – took a huge toll on the workforce. By the time the French canal effort ended in 1889, more than 20,000 lives had been lost, and no canal was in place.

With France out of the picture, Congress and President William McKinley continued investigating canal possibilities in Panama and Nicaragua. The only impediment to U.S. canal construction was Colombia, which refused to agree to the deal. This problem was resolved through the establishment of an independent Panama, separate from Colombia. Several times during the 19th century, Panama had briefly seceded from Colombia, only to rejoin it. The first years of the 20th century saw an independence movement again gathering steam.

U.S. President Theodore Roosevelt, who became president after McKinley was assassinated, fully supported a canal through Panama rather than the Nicaraguan route favoured by many in the United States and had successfully obtained congressional approval to construct a canal through Panama on June 19, 1902 for \$40 million. With his encouragement, in the autumn of 1903 several prominent Panamanians, including Dr. Manuel Amador Guerro, were involved in plotting the course of a Panamanian revolution. The revolution succeeded and three days later the United States formally recognised the new republic.

On 18 November 1903, the Hay-Bunau-Varilla Treaty granted the United States “in perpetuity the use, occupation, and control” of a 10-mile wide area of land across the Isthmus to construct and defend a canal, with “all the rights, power and authority within the zone ... which the United States would possess and exercise as if it were the sovereign of the territory”. The United States agreed to pay Panama \$10 million in compensation and an annuity of \$250,000 per year after canal completion. In addition, the United States

also agreed to pay Colombia \$25 million over disputes from the rather controversial “Panamanian Revolution”, and allowed specified Colombian ships free transit. Initially, normal tolls for the Canal were \$1.20 per cargo tonne.

BUILDING THE CANAL

The French property on the Isthmus was officially turned over to the United States on May 19, 1904. Colon and Panama City were outside the Canal Zone. The first task was cleaning up. Poor sanitation contributed largely to the number of malaria cases present in the work force, and a more deadly yellow-fever epidemic began in early 1905. Chief Sanitary Officer William C. Gorgas targeted mosquitoes carrying yellow fever for eradication through proper sanitation. Gorgas was given 4,000 workers and an unlimited budget for supplies. Panama City and Colon were fumigated house by house, provided with running water, and streets were cleaned and paved. Entire new communities were established. By the end of 1905 the yellow fever epidemic had stopped, and construction resumed.

From 1904 until its opening August 15, 1914, the Canal had cost \$352 million and 5,609 workers died. Labourers did not come to the Canal Zone in sufficient numbers during the early years, necessitating recruiting offices in Europe, the West Indies, and the United States. A total of 43,000 men were imported under contract with the Commission, from 1904 to 1910, and it was thought that the labour problem had been solved. However in July, August, and September 1911, it became necessary to import 1,300 labourers to fill up the ranks depleted by the migration of employees to other Central and South American fields (Figure 2).

Figure 2. The spot where the U.S. Canal intersects the old French Canal on the Atlantic coast, June 1912.



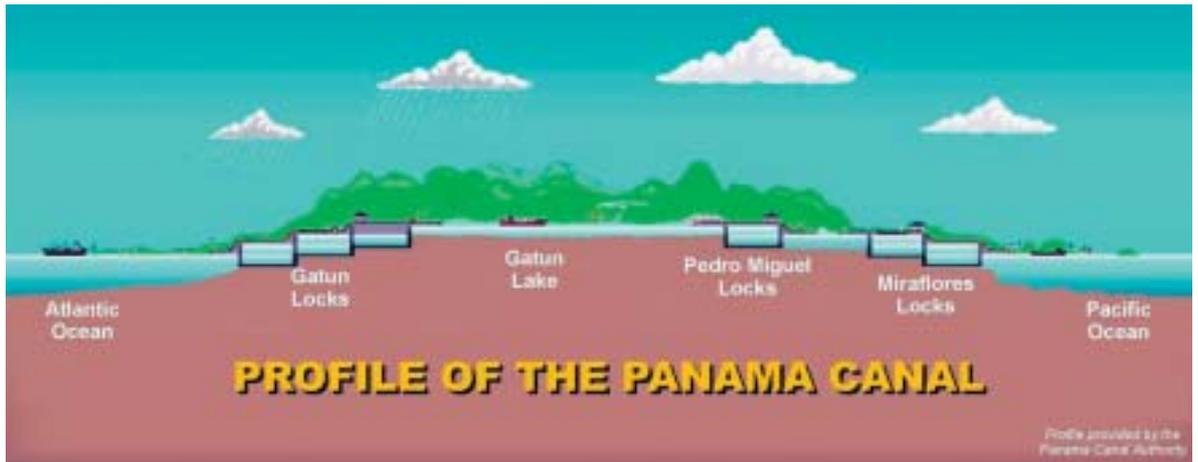


Figure 3. Profile of the Panama Canal, showing the locks and lakes that connect the two oceans.

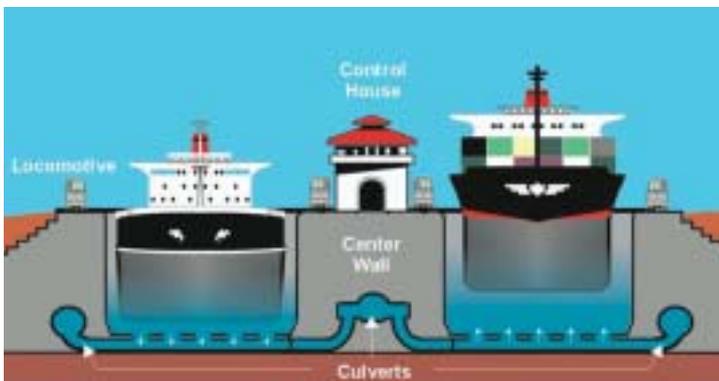


Figure 4. A cross-section of the Canal locks.

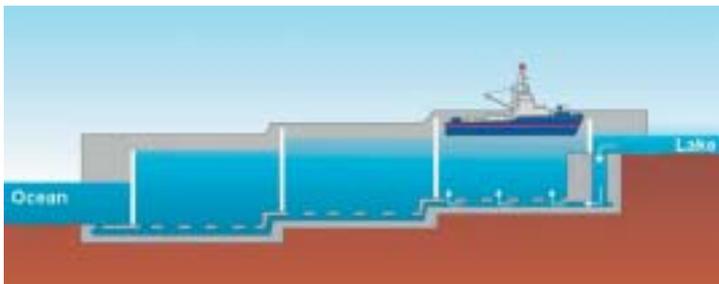


Figure 5. Elevation of the Canal locks chambers.

Spain furnished the largest number of European labourers to the canal until the government of that country, in 1908, forbade further emigration to Panama. The Spaniards also proved to be the most satisfactory common labour employed by the Commission. Out of a total of 11,797 European workers imported in 1910, 8,222 were Spaniards, and the others came principally from Italy, France, and Armenia.

Black labour predominated in the Canal Zone and was obtained from the islands of the West Indies. Barbados furnished the largest number, 19,448; Martinique, 5,542; Guadeloupe, Jamaica, Trinidad, St. Kitts,

Curacao, Fortune Islands, etc., 4,677 – a grand total of 29,667. Costa Rica, Colombia and Panama furnished 1,493; unclassified, 2,163. The largest immigration for one year was in 1907, when 14,942 laborers were imported, while in 1906, 12,609 arrived.

The American effort had excavated over 177 million cubic metres (232 million cubic yards) which when added to the 57 million cubic metres (75 million cubic yards) of the French effort came to 234 million cubic metres (307 million cubic yards). This is over three times the quantities that had been required for the building of the Suez Canal (Figure 3).

Operation and maintenance

Rather than the sea level canal attempted by the French, the American canal was a lock-type canal that involved an intermediate lake some 27 metres above sea level (Figures 4 and 5). Ships are raised in three lifts from sea level to the level of Gatun Lake, and then lowered in three steps on the opposite end of the canal. The locks are in pairs so that ships may transit in both directions at the same time, or two vessels may transit in the same direction at the same time in separate lanes. Initially the locks at Gatun had been designed as 28.5 metres wide. In 1908 the United States Navy requested that the locks should be increased to have a width of at least 36 metres. This would allow for the passage of U.S. naval ships. Eventually a compromise was reached and the locks were to be constructed to a width of 33.5 metres.

Each lock is 305 metres long with the walls ranging in thickness from 15 metres at the base to 3 metres at the top. The central wall between the parallel locks at Gatun has a thickness of 18 metres and stands in excess of 24 metres in height. The lock gates are made from steel and measure an average of 2 metres thick, 19.5 metres in length and stand 20 metres in height. The locks operations involve the gravity filling and draining of the lock's chambers to raise and lower the

vessels. Some 196,841 cubic metres (52 million gallons) of fresh water are used for each transit. The availability of a stable supply of fresh water was inherent to the successful operation of the canal.

After a slow start as a consequence of the aftermath of World War I, canal transits steadily grew both in numbers and size of vessels (Figures 6 and 7).

Constant maintenance and improvements marked the history of the canal. The entrance channels and the portion of the canal running through the continental divide, the 13.6 kilometre (8.5 mile) Gaillard Cut, required routine dredging to maintain navigation depths. Historically the canal, using its own dredgers, removed over 2.3 million cubic metres (3 million cubic yards) of material each year.

The widening of the narrow 76.3 metres (250 foot) wide Gaillard Cut commenced almost as soon as the canal was completed. Again in 1979 the Cut was widened to 164 metres (500 feet). This made the transit of the largest vessels safer. The number of so-called Panamax vessels grew rapidly in the 1990s and continues to grow at a steady rate (Figures 8 and 9).

The storage in Gatun Lake and the later-built Lake Alajuela (Madden Lake) proved satisfactory to meet the high demand for water to operate the canal. As transit levels and size of vessels continued to rise, the canal was faced with restricting the 13 metre (39.5 foot) operating draft during periods of dry weather as the lakes drew down. This proved particularly problematic in the late 1990s when the major impacts of El Niño were felt. Deepening of the Gaillard Cut began in the late 1970 as a measure to increase the usable volume of the lake for use by transiting vessels.

Labour force as the key

The smooth operation of the canal was dependent on a skilled work force and a commitment to constant maintenance and improvement of the equipment and the channels. The canal administration established a training programme to provide a constant supply of trained personnel to handle the large variety of jobs required for this labour-intensive type operation. As late as 1974, this work force was made up of 16,000 people (10,000 of them were American). As time and the availability of a trained Panamanian work force grew, the number of Panamanian employees continued to grow. But it was the tendency to reserve the best jobs for American employees that helped feed the long-simmering move by Panama to increase its participation in the canal and the benefits of its geographical position as a center for maritime trade.

Ultimately, this led to the signing of the Carter-Torrijos Treaties of 1977 that set in motion the complete transfer of the Panama Canal to the Republic of Panama by

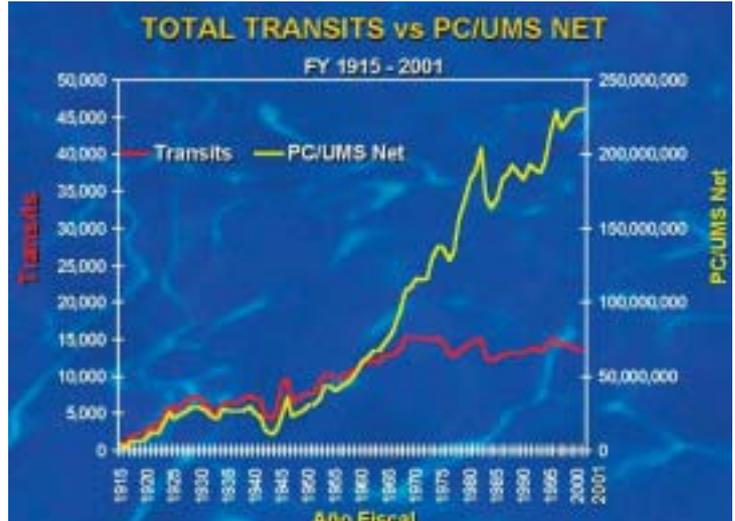
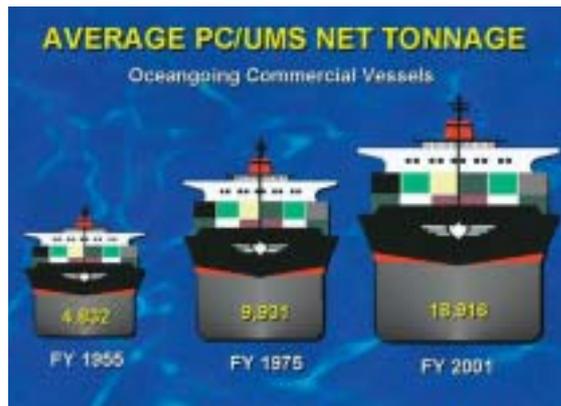


Figure 6. The number of transits from the Canal's opening (1915) to the present (2001).

Figure 7. The growth of vessel sizes from 1955 to 2001.



the end of the century. The history of the canal was punctuated with many attempts to negotiate treaties to increase Panamanian presence and participation. The 1977 treaties were the culmination of this long-standing objective by Panama. With the shedding of the civil government activities of the American operation, the Panamanian canal work force stabilised at 9,000.

THE TRANSITION PERIOD

The treaties provided for a transition period of 20 years, during which portions of the American controlled lands and facilities were gradually moved to Panamanian control. At the same time, training of Panamanians to take over the skilled labour, technical and managerial positions necessary to run an efficient waterway would be accelerated. The programme to continue improvements to the canal continued through the transition period at a level of nearly \$100 million annually. This meant continuing the widening and deepening of



Figure 8. A Panamax vessel going through a lock with very little room to spare.

Figure 9. The number of Panamax vessels has grown in the last 35 years.



Gaillard Cut, major channel improvements on the Pacific terminus of the canal, and the addition of new electric towing locomotives, towboats and structural improvements to the ageing locks.

This transition was felt at all levels. The board of directors of the canal operation first became bi-national, then with a majority of Panamanian members, and at last, with the final turnover, completely Panamanian. Likewise, the senior management was transformed into a completely Panamanian work force. By the time Panama assumed complete control over the Panama Canal on December 31, 1999, the American workers had been reduced to less than 300 from the earlier total of 10,000. During this transition period, canal operations and service were not only maintained, but improved transit times were experienced in the face of increasing numbers of larger vessels (Figure 10).

Figure 10. Canal Waters Times improved from 1999 to 2001, during the Canal's transition from U.S. to Panamanian control.

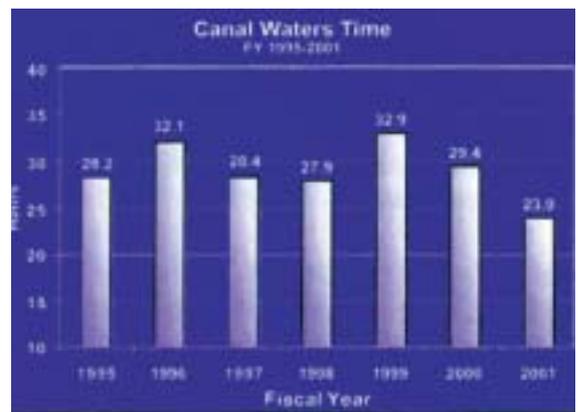


Table I. Panama Canal toll rates from 1914 to the present¹. Charges by net tonne ².

Laden		Ballast Displacement		% Change
1914-1938	\$1.20	\$0.72	\$0.50	0.0%
March 1, 1938-1974	\$0.90	\$0.72	\$0.50	-25.0%
July 8, 1974-1976	\$1.08	\$0.86	\$0.60	19.7%
November 18, 1976-1979	\$1.29	\$1.03	\$0.72	19.5%
October 1, 1979-1983	\$1.67	\$1.33	\$0.93	29.3%
March 12, 1983-1989	\$1.83	\$1.46	\$1.02	9.8%
October 1, 1989-1992	\$2.01	\$1.60	\$1.12	9.8%
October 1, 1992-1997	\$2.21	\$1.76	\$1.23	9.9%
January 1, 1997-1998	\$2.39	\$1.90	\$1.33	8.2%
January 1, 1998-present	\$2.57	\$2.04	\$1.43	7.5%
Total increase since 1914	\$1.37	\$1.32	\$0.93	114.2%

¹ In general, vessel tolls are calculated based on their volumetric capacity, measured in net tonnes of 100 cubic feet; and other floating craft, including dredgers, floating dry docks and warships, are calculated based on their displacement. The only differentiation in the current tolls system is that vessels in ballast pay less than laden vessels.

² The net tonne concept has changed throughout the history of the Panama Canal. The current measure in effect is the PC/UMS net tonne implemented in October 1994. Minimum tolls implemented in 1998 for small vessels are not shown.

The tolls for transiting vessels increased for the first time in 1974 and thence at regular intervals to reflect the increasing cost of operations and improvements. Table I shows the canal toll rates over the course of 85 years.

As of August 2002, the Panama Canal Authority (ACP) announced a change in the tolls structure for the Canal. The new structure includes factors for size of vessels, commodities and whether the vessel is laden or in ballast.

THE NEW ERA: PANAMA TAKES OVER

By the time the canal was placed under Panamanian control, the senior Panamanian managers had been successfully at the helm for a period necessary to allow the canal customers to face the future with confidence. Where the United States had George Goethals to bring its effort to a successful conclusion, Panama has Alfredo Aleman, the Canal Administrator to lead them into the future. Aleman has been at the helm since 1996 when he became the first Panamanian Administrator. He assembled a team of skilled technocrats and Panamanian managers to carry on the tradition of an efficient and innovative waterway operation. The Panamanian law that established the new Panama Canal Authority provided for an autonomy that maintains the political separation and integrity of the operation. Annex I is a description of the nature of the Panama Canal Authority.

Sensitive to the perception of Latin American governments being branded as corrupt, the senior canal officials have been rigorous in establishing and maintaining an image of transparency and honesty that marked the canal since its inception. They have also stepped up the search for improvements to all aspects of the canal necessary to keep it competitive and in touch with maritime needs. In short, the Panamanian Era has been brought in with determination, commitment and a move towards making the operation an example of a successful business model.

Canal improvements

The Canal Improvements Programme has been elevated to the highest management levels within the Canal administration. Deputy Administrator Ricuarte Vasquez is now tasked with direct oversight of the improvements programme and the programme is headed by Augustin Arias, an engineer with over twenty years of canal experience. The Department of Engineering and Projects has been given the resources and management responsibilities to push the programme with deliberation and expertise. The Canal Improvements Programme covers such diverse projects as:

Panama Canal Facts

- From the Atlantic Ocean the Panama Canal runs south for 16 km (10 miles) and then eastward 64 km (40 miles) to the Pacific Ocean.
- When the French abandoned the project they had spent over twenty years and \$260 million.
- When the Panama Canal opened to traffic in 1914, the United States had spent \$352 million on construction.
- A train of flat cars needed to carry all the excavated material from the canal would circle the earth four times at the equator.
- The total soil excavated from the canal would build a pyramid 4,200 feet (1,280 metres) high.
- The project consumed as much as twelve million pounds of dynamite per year.
- Gatun Lake, the highest part of the canal, is about 26 metres (85 feet) above sea level.
- At the height of construction 9,000 workers were busy excavating Culebra Cut.
- The Commissary Department provided food for the entire work force and baked as many as six million loaves of bread, 650,000 rolls, and 250,800 kilos (114,000 pounds) of cake per year.
- Passage of the first ship through the canal took 9 hours and 40 minutes.
- When the canal opened tolls were set at \$1.20 per tonne for freight and \$1.50 per tonne for passengers. A freighter carrying a cargo of 4,500 tons paid a toll of \$5,400.
- More than 850,000 vessels have used the waterway.
- The fastest transit was made by the US Marine hydrofoil, Pegasus, which passed from Miraflores through Gatun Locks in two hours and 41 minutes in June 1979.
- Upon completion of its maiden voyage on December 3rd, 2001, Panama Canal authorities confirmed that the luxurious passenger ship *Norwegian Star* paid \$208,653.16 in tolls, breaking the toll record set earlier this year by the *Radiance of the Seas* with \$202,176.76.

- Enhanced Vessel Traffic Management System
- The Channel Deepening Project,
- Tugboat Augmentation Programme,
- Locks Towing Locomotive replacement and modernisations,
- Long-Term Water Supply Requirements, and project options for meeting traffic demand increases.

These are truly major improvement projects that are in the same league as the building of the canal at the outset.



Figure 11. The Gatun Lock as it is today, January 2003.

Post-Panamax studies

Currently the canal has contracts in place to study the possible alignments of a new large set of locks on both ends of the canal (Figure 11). These projects can result in construction costs of \$4-12 billion. The deepening of the terminals is now being studied and could result in projects with excavation quantities of 30.6-53.5 million cubic metres (40-70 million cubic yards) of dry excavation and 11.5 million cubic metres (15 million cubic yards) of underwater excavation on the Pacific terminus and 11.5 million cubic metres (15 million cubic yards) of dredging on the Atlantic terminus. In all cases, the disposal of the excavated material is a major hurdle to be addressed. The canal plans to investigate such innovative disposal alternatives as an offshore island with an aim to make this area a commercial venture in and of itself.

The Panama Canal Authority has been working on canal expansion studies for several years and came to

Figure 12. The watershed which presently serves the Canal.



a preliminary conclusion that new locks should be designed for large 12,500 TEU container vessels. Presently, only 4,500 TEU container ships can transit the waterway. Authority officials say that the dimensions of post-Panamax locks would be 61 metres wide by 427 metres long and by 18.3 metres of clearance (compared to the existing 33.5 m by 305 m by 12.5 m), but depending on the results of the marketing investigation, post-Panamax lock dimensions may be adjusted.

As part of the studies to determine the viability of expanding the waterway, the Panama Canal Authority awarded a contract for the conceptual design of the post-Panamax locks to the Belgium-French consortium Tractebel Development Engineering, Coyne-et-Bellier, Technum N.V., and Compagnie Nationale du Rhone. The bidding was open to the international community, and eleven proposals were received.

The contract, for \$1,597,000, was awarded after considering the financial and technical aspects of the proposals received from American, British, German, Belgium-French, Brazilian, and Russian companies.

The conceptual design of the post-Panamax locks is a key element of the study plan for the expansion of the Panama Canal. The Authority decided to proceed with the conceptual design by means of two independent contracts to develop four different locks configurations and to identify the best option for the transit of post-Panamax vessels through the Canal. The winning consortium will develop the conceptual design for one and three-level locks on the Pacific. The Authority is simultaneously negotiating a second contract with the U.S. Army Corps of Engineers to develop two and three-level locks on the Atlantic. Both conceptual design efforts will include the use of water conservation systems, and both are due to be submitted during the course of 2003.



Figure 13. Drillboat Thor working in the Gaillard Cut on the next phase of deepening the cut to increase water storage in Gatun Lake. Six-inch holes are drilled, filled with dynamite and blasted. The fractured rock is then removed by the dipper dredger Rialto M. Christensen.

Channel deepening/water storage increases

The goal of the Gaillard Cut Deepening project is to increase the water storage capacity of Gatun Lake by 45 percent and augment the Canal's watershed output by 113,550 cubic metres (300 million gallons) of water per day (Figure 12). Deepening will directly benefit Canal customers by providing more efficient draft administration and reducing the impact of water shortages requiring draft restrictions on shipping. Additional storage will also permit meeting long-term demand for potable water for the metropolitan area that depends entirely on sharing the two lakes used for canal operations.

Approximately 6.7 million cubic metres (8.7 million cubic yards) will be dredged. Although the deepening will only be done along the navigational channel, it will, in effect, increase the lake's entire surface storage area, which represents a much greater volume than what will be excavated. The deepening will augment the Canal's total water reservoir volume, which includes Gatun and Alhajuela (Madden) Lakes.

The Authority is implementing more rigorous water conservation and management measures given the increasing demands caused by growing populations adjacent to the Canal watershed and anticipated long-term traffic growth. Current water storage of Gatun Lake is 2 metres (6 feet), from its maximum 26.7 metres (87.5 feet) above sea level up to its minimum operating level of 24.8 metres (81.5 feet).

The Panama Canal navigational channel has a width between 192 and 305 metres. The bottom of the navigational channel is currently at elevation 11.3 metres

(37 feet), but when the deepening work is completed, it will be at 10.4 metres (34 feet). To guarantee that the channel bottom elevation is above 10.4 metres, it will be dredged to an elevation of 9.8 metres (32 feet), known as *dredging tolerance*.

The deepening will be completed using available Authority resources. The project will require drilling and blasting for rock material. For this project, the Authority's drillboat *Thor*, hydraulic dredge *Mindi* and dipper dredge *Rialto M. Christensen* will be employed (Figures 13 and 14).

Figure 14. Dipper dredger Rialto M. Christensen working on the channel deepening project at the Gaillard Cut.



Improvement Spectrum

The Department of Engineering and Projects now has 125 separate projects underway. Many of them are under contract to consultancies and have the potential result of becoming new sets of locks which will accommodate the larger vessels commonly used in the worldwide fleet. There are studies underway to look at the construction of three new major dams to create the additional water storage required to meet the projection of 26,000 annual transits or double the current number within the next 50 years.

The first major part of tying these improvements together is the development of a long-term master plan that will address capacity limitations and identify viable options. The plan is intended to be a progressive time-phased programme of project implementation to

parallel traffic (and revenue) growth. It will provide for continuous and expanded service to the canal customers and do so at competitive costs to the user fleets.

Conclusions

As the Panamanian Panama Canal looks to the future, its customers are being assured that their interests and satisfaction remains a paramount consideration. To do this, the canal will continue to rely on a widely diverse range of skills of consultancies and contractors with worldwide experience. Under the present Panamanian leadership, there is certainly optimism for the canal user and those that supply the canal with consultancy and construction contracting services. In an effort to

ANNEX I

The Panama Canal Authority (Autoridad del Canal de Panama)

The Republic of Panama assumed full responsibility for the administration, operation, and maintenance of the Panama Canal at noon, Eastern Time, December 31, 1999. Panama complies with its responsibilities through a governmental entity, designated as Panama Canal Authority, created by the Political Constitution of the Republic of Panama, and organized by Law 19 of June 11, 1997.

The Panama Canal Authority is the autonomous agency of the Government of Panama in charge of managing, operating, and maintaining the Panama Canal. The operation of the Panama Canal Authority is based on its organic law and the regulations approved by its Board of Directors.

Due to its nature and importance, the Panama Canal Authority enjoys financial autonomy, own patrimony, and the right to manage it. The Authority shall have the exclusive charge of operation, administration, management, preservation, maintenance, improvement, and modernization of the Canal, as well as its activities and related services, pursuant to legal and constitutional regulations in force, so that the Canal may operate in a safe, uninterrupted, efficient, and profitable manner.

The Panama Canal Authority is led by an Administrator and a Deputy Administrator, under the supervision of a Board of Directors integrated by 11 members. The Administrator is the Canal's chief executive officer, and legal representative of the Panama Canal Authority, and is responsible for its administration and the implementation of the policies and decisions of the Board of Directors. The appointment of the Administrator shall be for a seven-year term, after

which the person may be reelected for an additional term.

In accordance with the Political Constitution of the country and the Panama Canal Authority Organic Law, the Panama Canal Authority Board of Directors has the primary responsibility of establishing policies for the operation, improvement, and modernization of the Canal, as well as supervising its management. The 11 members of the Panama Canal Authority Board of Directors are appointed as follows:

- Nine Directors are appointed by the President of the Republic with the consent of the Cabinet Council and ratification of the Legislative Assembly by absolute majority of its members.
- A Director is designated by the Legislative Branch, who may be freely appointed and removed.
- A Director, who shall chair the Board of Directors and shall have the rank of Minister of State for Canal Affairs, is designated by the President of the Republic. The Minister for Canal Affairs shall have say and voting rights in the Cabinet Councils.

The appointment of the first Panama Canal Authority Board of Directors was done for staggered periods to guarantee its independence from any given government administration.

The Panama Canal constitutes an inalienable patrimony of the Panamanian nation; therefore, it may not be sold, assigned, mortgaged, or otherwise encumbered or transferred. The judicial regime established for the Panama Canal Authority has the fundamental objective of preserving the minimum conditions that make the Canal an enterprise at the peaceful and uninterrupted service of the maritime community and international commerce.

solicit the best expertise worldwide, the Authority Internet website (www.pancanal.com) has a full listing of advertised solicitations for all procurement of goods and services. The website also maintains and explains the objectives of the canal and the status of the operations and plans for the future.

References

Abbot, Willis J. (1914).

Panama and The Panama Canal in Picture and Prose.
New York, Syndicate Publishing Company.

Commemorative Album: *The Panama Canal Eightieth Anniversary - Providing Passage into the Twenty-First Century.*
Balboa Heights, Canal Zone. (August 1994.)

Department of the Army, Treaty Implementation Plan Agency (Undated.)

Implementation of the 1977 Panama Canal Treaty – An Overview.

Encore, Dr. Susan I.; Johnson, Suzanne P.; Pedrotty, Michael A.; and Webster, Julie L. RA. (September 1997).

Historical And Architectural Documentation Reports for Albrook Air Force Station and Howard Air Force Base, Former Panama Canal Zone, Republic of Panama.
Headquarters Air Combat Command.

Knapp, Herbert and Mary (1984.)

Red, White, and Blue Paradise: The American Canal Zone in Panama.
San Diego, CA: Harcourt Brace Jovanovich.

McCullough, David (1977.)

The Path Between the Seas: The Creation of the Panama Canal, 1870-1914.
New York, Simon and Schuster.

Shaw, James L. (1985.)

Ships of the Panama Canal.
Annapolis, MD, Naval Institute Press.

Errata

In *Terra et Aqua*, Number 89, December 2002, "Reclamation on Soft Subsoil by Spraying Thin Layers of Sand: The IJburg Project near Amsterdam", the following corrections should be noted:

François Mathijssen is presently a project engineer and geotechnical advisor at Hydronamic, the inhouse engineering department of Royal Boskalis Westminster nv. (page 10)

On page 18, first sentence, column 2 should read: The representation of the Attenberg limits in the plasticity chart in Figure 14 indicates that the very soft Holocene clay layer is high plasticity clay.

Figure 19 on page 22 should be amended as shown below:

Figure 19. Decision-tree for improving engineering properties.

