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3.0 PROJECT DESCRIPTION

In order to identify and evaluate the possible environmental impact of this Project and then define the mitigation measures that may be necessary to ensure its environmental viability, it is of the utmost importance to understand the actions needed for the construction of the works required for the Canal expansion and its subsequent operation.

This chapter provides an integrated view of the Canal Expansion – Third Set of Locks Project, and describes the main activities that will be conducted in the Project design, planning, construction, and operation phases. It also includes information on the benefit of the Project's implementation for the Republic of Panama, the framework of standards and regulations the Project must comply with in order to show its environmental feasibility, the cost of the works to be performed, and their implementation schedule.

It is important to point out that the Canal Expansion – Third Set of Locks Project is an addition to an infrastructure that already exists, and not a new Project starting from zero (Figure 3-1). The construction of the Panama Canal was completed in 1914, and the waterway has been operating continuously for more than 90 years. The current Canal is the geographic, economic, and social center of the Republic of Panama, around which a great number of communities are located. From the point of view of the assessment and analysis of the impacts, it should be noted that they are to occur mainly in an area that has been totally intervened for more than a century and is under the exclusive administration of ACP, the Project Promoter.

3.1 Project Objectives and Justification

The Canal plays a very important role in the Panamanian economy, as it provides nearly 7% of the Gross Domestic Product (GDP) and more than 120,000 direct and indirect jobs through the multiplying effect (Intracorp, quoted by ACP, 2006). Therefore, any reduction in Panama Canal contributions would have a significant negative effect in the income level and the living conditions of all Panamanians. On the other hand, with the proposed expansion, it is expected that the Canal will continue to play a major role in the economy of Panama.

The Canal Expansion Project seeks a long range increase in the value of the shipping route through Panama that will generate higher sustainable revenues and benefits for the country. The main element to expand Canal capacity is a Third Set of Locks larger in size than that of the existing locks.

3.1.1 Background

The Canal is a very unique complex of structures that operates mainly on the basis of renewable energy, since the use of fossil fuels and other non renewable sources of energy is limited for the total effort of raising ships and moving them from one ocean to the other. The main sources of energy are the sun and gravity. Solar energy and heat evaporate ocean water and deposit it back when it rains on the watershed that feeds the Canal. Gravity makes the water flow toward the reservoirs and then, through locks and channels to the ocean, thus facilitating the movement of ships up and down, between the two oceans.

All the initiatives to define a scheme for the expansion of the Canal have coincided in that the most effective and efficient option to provide a greater capacity to the shipping route through Panama is the construction of a Third Set of Locks of a size larger than the locks built in 1914. Among such initiatives, there are the studies made in the 1930's by the United States, those conducted by the Tripartite Commission (Panama, Japan and the United States) in the 80's, and more recently, the studies made by the Government of Panama through ACP, as an integral part of the effort to prepare its Master Plan for the period 2005-2025. In fact, in 1939 the United States had started the excavation of access and navigation channels, and of sites where new locks would be located to allow the passage of merchant and war ships of a size that exceeded that of the 1914 locks. However, the Third Locks construction work was stopped by the United States in 1942 when it joined World War II, after a significant progress in the project works[1].

[1] By a Directive issued on May 25, 1942, the U.S. Secretary of War suspended indefinitely the work on the third set of locks, in order to join the war effort. As a results of this directive, the U.S. Government work force was released to the Armed Forces, and the building equipment was assigned to military duties.

3.1.1.1 Infrastructure of the Existing Canal

The major components of the Panama Canal are the locks, the navigation channels, the anchorages, and the reservoirs. All these components have been modified and improved to a certain extent after the initial opening of the waterway in 1914, for the purpose of adapting the Canal to the requirements of the demand for transportation. Nonetheless, the size of the locks imposes a physical limitation on the size of the ships that can transit through this system.

Locks

There are three lock complexes at the Panama Canal: Miraflores, Pedro Miguel, and Gatun. These locks are organized in two parallel lanes of very similar size, all of them with miter gates. However, they are different in their mode and operation times, which affect their capacity to transit ships. On the Atlantic end, ships are raised or lowered from sea level to Gatun Lake by means of a single lockage operation at Gatun locks, which have three contiguous chambers.

On the Pacific end of the Canal there is a different situation, as ships are raised or lowered between the Pacific Ocean and Gatun Lake by means of two lockage operations at Pedro Miguel and Miraflores locks, separated by Miraflores Lake. Ships transit between Miraflores Lake and the Pacific Ocean through Miraflores locks, which have two contiguous steps of lanes. At the south end of Gaillard Cut, the transit between Miraflores Lake and Gatun Lake is done through Pedro Miguel locks, equipped with a single chamber per lane.

Navigation Channels

The complex of navigation canals and channels includes approximately 72 kilometers of route between the Atlantic and Pacific anchorages. Because of their diverse geographic and geologic features, the Panama Canal navigation channels are divided in three categories: sea water channels (sea entrances), the channels in Gatun Lake and Miraflores Lake, and the Gaillard Cut channels. To ensure navigation safety, the physical features of the channels in each of these categories require different designs and restrictions, which in turn have a direct impact on their operational flexibility and maintenance and improvement costs.

The channels require a continuous dredging process to keep them at the minimum width and depth needed to ensure the safety of navigation (Figure 3-2). This dredging program is necessary to mitigate the natural silting process that takes place throughout the entire Canal navigation channel system. There is a breakwater with a length of 6.4 kilometers (4 miles) on the Atlantic end of the Canal, and a 2.4 kilometer (1.5 mile) causeway on the Pacific end, both of which protect the navigation channels that connect the sea entrances with the locks. Gaillard Cut, the total length of which is 12.7 kilometers between the north end of the Pedro Miguel locks and the Chagres Crossing, is the narrowest section of the navigation channel system.

<u>Anchorages and Tie-Up Stations</u>

Anchorages are a critical component in maintaining Canal capacity, as they act as a dampening element that absorbs the variations in transit time and ship arrival patterns. They exist and are used to allow the system to continue operating even when bottlenecks or delays occur at a component, thereby substantially minimizing the impact a specific problem may have on the capacity of the entire system.

The Canal operating system includes 15 anchorages. Of these, nine are used for all purposes, four are reserved for hazardous cargo, and two are used for smaller craft. For operational reasons, there are internal anchorages and tie-up stations that increase transit scheduling flexibility and allow the Canal to handle a greater number of ships. They also serve as waiting areas for transiting ships, until restrictions such as weather, time of the day or resources (tugboats, locks locomotives) are taken care of or made available.

<u>Reservoirs</u>

There are three reservoirs within the Canal structure complex: Gatun, Alhajuela, and Miraflores, which feed navigation routes and/or supply the fresh water needed for the transit of ships. Water supply for the cites of Panama and Colon. During the original construction, the Chagres River and other minor water streams were dammed to facilitate the creation of the Canal. Thus, Gatun and Miraflores Lakes were formed first. Subsequently, Alhajuela Lake was created by damming the Chagres River again some 16 kilometers upstream beyond Gamboa, for the dual purpose of minimizing the impact on Canal operations of the swells of the Chagres River, as well as increasing the capacity to store water for municipal usage and transits during the dry season.

Gatun Lake has a surface of approximately 423 square kilometers at a mean elevation of 26 meters over sea level, and a useful storage volume estimated at 766 million cubic meters. Its waters are used to supply the Miraflores Water Filtration Plant on the Pacific Side and the Mount Hope and Sabanitas Water Filtration Plants on the Atlantic Side, and for the transit of ships as well as for hydropower generation. A third water intake was added recently on the west side of the Lake for the Laguna Alta Water Filtration Plant, which provides water to the Panama West Region. The useful volume of Gatun Lake is restricted by its minimum operating level, which allows a maximum draft of 12.0 meters, and by the maximum safe level at its dam. During high rainfall periods, the level of the Lake is controlled by spilling water through the Gatun Dam spillway or through the Gatun and Pedro Miguel locks culverts.

In turn, Alhajuela Lake occupies a surface of approximately 44 square kilometers at its mean elevation of 73 meters above sea level. At its safe reservoir elevation (80 masl), it has a useful storage volume of 651 million cubic meters. This water is destined in the first place to supply drinking water to the city of Panama through the Chilibre Water Filtration Plant, and in the second place, to complement the availability of water in Gatun Lake for the operation of the Canal. When water is transferred from Alhajuela Lake to Gatun Lake, it usually generates electricity at the Power Plant located at the foot of Madden Dam.

Finally, Miraflores Lake was created by building a small dam to contain the Rio Grande, Cocolí, Pedro Miguel, Caimitillo and Camaron Rivers, which flowed into the Pacific Ocean. It is approximately 3.94 square kilometers in size and has a mean elevation of 16.5 meters. Its water storage volume at that elevation is 2.46 million cubic meters, and its maximum level is controlled by spilling water through the Miraflores Dam spillway or the culverts at Miraflores locks.

3.1.1.2 Improvement and Modernization of the Existing Canal

Throughout its history, the Canal has been kept in a state of constant transformation, which has included the adaptation of its infrastructure to the needs of the shipping trade and world shipping technologies. To achieve this, various administrations have made successful and systematic investments on training, capacity, and technology, all of which has allowed the Canal to handle on a timely manner the growing cargo volume and transit demands, as well as to respond to the evolution of the markets served by the Canal and to the size of the ships being used, thus consolidating its advantageous competitive position. This is how the Canal has been able to achieve a sustained competitiveness in the international context.

As part of this transformation and the adaptation of the Canal to the growing and changing demands of the shipping trade, the following are examples of projects that have been carried out with positive results:

- The construction of Madden Dam between 1930 and 1936. This project was designed for the purpose of increasing the water capacity of the Canal and controlling the historic swells of the Chagres River;
- The lock lighting projects of 1964 and 1977, for the purpose of increasing the capacity of the Canal to handle nighttime lockages;
- The replacement of the locks locomotive fleet which started in 1964, for the purpose of improving its reliability and increasing Canal operating capacity by reducing lockage times and allowing the safe routine transit of Panamax size ships;
- The widening of Gaillard Cut between the years 1957 and 1971, from 91.5 meters (300’) to 152 meters (500’), in response to the increase in Panamax ship transits, and its subsequently expansion to 192 meters (630’);
- The deepening of the navigation channels in the 70´s, for the purpose of maintaining the competitiveness of the route, providing the proper drafts required by users with a high reliability; and
- The widening of Gaillard Cut between the years 1992 and 2001, to 192 meters (630’) in its straight sections and to 213 meters (700’) in its curves.

For the purpose of increasing its capacity to handle the continuous increase in ship transits and ship size over the last ten years, the Canal has implemented an integrated modernization, updating, and improvement program. To date, approximately US$1,400 million have been invested in the Canal modernization program, and additional investments continue to be made to maximize the capacity of the existing infrastructure, for the purpose of providing better service and meeting the growing demand and rapid migration of shippers to larger ships. In addition to the widening of Gaillard Cut already mentioned above, the locks locomotive track system was replaced, the locks locomotive fleet was replaced and increased with more modern and powerful units, and the tugboat fleet was expanded and modernized.

Despite such improvements, there are still a series of limitations that impede the maximum utilization of the waterway, which can be identified by the level of service the Canal provides to its users. Two indicators are used to monitor the service quality level it renders to its users: (1) the time a ship must wait to transit the Canal and (2) the average transit time, which are jointly known as Canal Waters Time (CWT). The average CWT trends and their dispersion or variability provide the best indicator of the reliability of the service provided by the Canal. In fiscal year 2005, the average Canal Waters Time was of 16.5 hours for ships with transit booking, and 34.5 hours for ships without transit booking.

Due to the existing limitations on the transits of large ships (Panamax), the number of ships requesting a transit booking increases as the average ship size increases. In response, the Canal has made the efforts described above to provide the service level its users expect. Despite this, with the continuous rise in demand, it is expected that, if the required increases in Canal capacity are not achieved, Canal service levels will rapidly suffer, causing a significant and irreversible reduction in the value of its route for its users.

The limitations that restrict the transit capacity are of a diverse nature, and mainly include:

- Inadequate lighting for the use of the locks for Panamax ships at night;

- The physical limitations of Gaillard Cut, which restrict nighttime traffic to one way for all types of ships and for larger ships (Panamax) in the daytime;
- Visibility limitations caused by fog in Gaillard Cut; and
- Limitations on the volume of cargo carried by ships, due to the 12 meter maximum draft.

The investment proposed to solve these limitations and increase the capacity of the existing Canal to a maximum is estimated at US$496 million, and include the following ten major activities:

- **Improve the lock lighting system.** This will allow nighttime lockages for Panamax ships, which are currently limited to daytime transits. The Canal capacity at nighttime will thus be improved and daytime lockages will be balanced with nighttime locks usage.

- **Straighten Gaillard Cut curves and widening its reaches to 218 meters (715’).** This will improve navigation safety and operating flexibility, and will allow the maximization of the use of the Pacific locks, especially Pedro Miguel locks.

- **Build tie-up stations north of Pedro Miguel locks.** This will allow maximization of the use of the locks on the Pacific Side, particularly of Pedro Miguel locks.

- **Implement a merry-go-round operating mode at Gatun locks.** This will increase the sustainable capacity of Gatun Locks and will provide more operating flexibility to the Canal.

- **Modernize and increase the tugboat fleet.** This will allow the tugboat fleet to assist the larger ships transiting the Canal efficiently and safely.

- **Improve the ship transit scheduling system.** This will allow an improvement of the available capacity by reducing any system inefficiency and adjusting transit schedules to operational variations.

- **Increase Canal maximum draft to 12.3 meters (40.5’).** This will allow an increase in the value of the Canal route for clients who are currently limited by the maximum draft, by allowing the full utilization of the cargo carrying capacity of Panamax ships. Therefore, even if this Project does not increase Canal capacity by the number of transits, it will increase the volume of the cargo ships can carry through the Canal.

- **Deepen the Atlantic and Pacific entrances.** This will allow the entrance into Canal waters of ships with a larger draft without tide interference, as well as the use of port infrastructures by larger draft ships, with additional gains for the Republic of Panama.

- **Deepen Gatun Lake navigation channels to a 10.4 meter (34') PLD level.** This will allow a better utilization of the water storage capacity of Gatun Lake, without having to reduce the draft allowed to Canal users. This program is also intended to provide the water needed for human consumption and for Canal operations beyond fiscal year 2025.

- **Mitigate the hazards in Gatun Lake caused by floods.** This will adapt the operation of Gatun Lake to the highest world safety standards in reservoir management, will mitigate flood hazards, and will enable a maximum utilization of water storage at Gatun Lake.

Once these investments and required operational changes are made, the Canal will reach its maximum sustainable capacity, which will be approximately 20% greater than its current capacity. With such capacity, the Canal will be able to handle a maximum annual volume of 330 to 340 million PC UMS tons[2] for a significant increment over the current 280 to 290 million tons. However, despite all these improvements, any increase in capacity will be limited by the size of the locks.

Potential demand forecasts show that the Canal may reach its maximum volume sometime between fiscal years 2011 and 2012. Nevertheless, the projected demand level for a 20 year horizon, that is, until the year 2025, suggests that the most probable volume would be in the order of 525 million tons, which would leave approximately 35% of the demand unattended.

3.1.2 Objectives

[2] Tonnage measurement unit (in tons) of the space available for cargo and passengers, on the basis of the Panama Canal Universal Measurement System.

The fundamental purpose of the Canal Expansion - Third Set of Locks Project is to maintain the competitiveness and value of the Canal route by generating higher revenues and benefits for the Republic of Panama over the long range in a sustainable manner. To this end, it is proposed that the Canal be provided with the capacity necessary to meet the growing demand with competitive service levels and increase the value of the Canal route by allowing the transit of Post Panamax ships.

At the present time, the Canal has increasing opportunities as a global transportation hub. ACP visualizes that it is possible to take advantage of these opportunities to benefit the people of Panama. However, the interoceanic waterway is nearing its maximum capacity with high operating and maintenance costs. The challenges are complex and of an interdependent nature, and require handling with an integrated long range proposal. This points to the need of a Master Plan with a timely and coherent proposal that focuses on well defined objectives.

For the purpose of resolving the short and long range limitations, the Master Plan includes investments to optimize the current Canal, as previously described (section 3.1.1.2). However, to take advantage of the opportunities over the long range, a Canal Expansion - Third Set of Locks Project is proposed. Its specific objectives for the latter are:

- **Maintain Canal profitability and its contributions to the Republic of Panama over the long range**. The Third Set of Locks is a profitable project that will ensure growing contributions to Panama, and will stimulate the growth and development of the service conglomerate. Without the expansion, the Canal will cease to be the country's sustainable growth engine, and will be relegated to getting a reduced portion of the trade routes it serves. The Third Set of Locks opens up the option of Canal growth through permanent improvements to the waterway, thus ensuring the continuity of its contributions to the country..
- **Maintain the competitiveness and value of the route**. The construction of a Third Set of Locks will allow the Canal to maintain its competitiveness and will reaffirm the long range value of the route. The launching of the operation of an expanded Canal may dissuade possible new competitors, and will strengthen the position of the Canal to take on the

existing competition. However, to maintain its competitiveness after the Third Set of Locks starts its operations, ACP will have the responsibility of continuing the implementation of timely improvements to the entire Canal infrastructure, as well as of maintaining the constant process of analysis of its competitive situation and continuing its maintenance program.

- **Increase the capacity to meet the growing demand for transits with adequate levels for each segment.** The Third Set of Locks will provide the Canal with the necessary capacity to meet the demand with competitive service levels, a high degree of safe navigation and high draft reliability. The Canal will thus be able to provide good service to all market segments indiscriminately, and keep a diversified base of clients and users.
- **Allow the transit of ships larger than Panamax, in order to increase Canal productivity.** Allowing the passage of Post Panamax ships will have the positive effect of reducing the number of transits needed to transport forecasted cargo volumes. This will in turn reduce operating costs and water consumption relative to the existing locks, and keep some room in its capacity over a longer period. Likewise, Canal users may be able to use ships to achieve more appropriate scale economies over their routes. The Canal will then be able to maintain its route competitiveness, especially in view of the strong competition it gets from the U.S. intermodal system and the Suez Canal.
- **Add room in the operating capacity to perform maintenance work that requires prolonged lane outages in the current Canal.** As the Canal operates nearer to its maximum sustainable capacity, lane maintenance outages will become more difficult and costly, and will affect the quality of the service to users. The Canal needs operating room for maintenance work requiring more efficient lane outages and a minimal negative impact on the quality of service. This aspect is becoming more critical as the existing systems age.

3.1.3 Justification

The expansion of the Canal by means of the construction of a Third Set of Locks and its auxiliary works is fully and completely warranted because of the contributions the Canal makes to the economy of Panama. The Canal is the main economic activity of the country and its expansion constitutes a fundamental step for the continuous development of a services conglomerate that makes good use of the country's geographic location, which has made Panama a connecting hub for world trade, transportation, and logistics. An expansion in Canal capacity will also ensure the integrated and sustainable growth in maritime activities that take place in Panama in compliance with its National Maritime Strategy, and will give impulse to the domestic economy and result in a better quality of life for its people.

The growing demand for transits is evident in the increase in cargo volumes as well as in the size of the ships that use the Panama route. In this regard, a Canal equipped with a Third Set of Locks will be able to handle the traffic demand forecasted beyond the year 2025, and by that year could achieve total revenues adjusted for inflation of more than US$6.2 billion. Without the expansion, even after the Canal is optimized, it would only accommodate 65% of the projected demand. However, revenues might be less than 65% because, by not providing an adequate service, many users would opt for changing their routes and Canal traffic would drop.

The benefits associated with a Canal expansion through the construction of a Third Set of Locks and its auxiliary works which warrant the implementation of the Project include, mainly, the following:

1. **More Transportation of Cargo**. From the year 2015 to 2025, an expanded Canal could handle a total of more than 4,850 million PC/UMS tons, while an unexpanded Canal would only be able to handle approximately 3,600 million tons during the same period. Therefore, during its first eleven years of operation, the Third Set of Locks would allow `the Canal to handle an additional cumulative traffic volume of more than 1,250 million PC/UMS tons, which would not be possible if it is not expanded. This is equivalent to a 35% increase in the cumulative volume of cargo over said period.
2. **More Revenues for Panama**. During this same period, the increase in traffic volume will result in additional revenues from tolls in the order of US$10,000 million, as well as from other maritime services for US$2,650 million that would not happen if the Canal is not expanded. In total, during the period 2015-2025, the expanded Canal will provide some US$12,650 million more in total revenues than without a Canal without a Third Set

of Locks. This is equivalent to an additional US$1,150 million per year that would not be earned if the Canal were not expanded. It is obvious that if the comparison period were extended, the difference would be even more dramatic and the justification even more evident.

3. **Increase in Efficiency and Productivity**. The Third Set of Locks will also allow the Canal to increase its efficiency and productivity. Scale economies with the use of larger size ships allow the transit of more PC/UMS tonnage on relatively less ships. For example, by the year 2025, the expanded Canal would handle a ship mix with an average size of 33,800 PC/UMS tons per transit. This would represent an increase of more than 50% over the average ship size in 2005, which were of approximately 22,000 PC/UMS tons. In addition, it is expected by the year 2025 more than 50% of the PC/UMS tonnage will be carried on Post Panamax ships.
4. **Increase in Net Profits**. It is precisely these scale economies that will allow an expanded Canal to substantially increase its productivity measured in net profit per PC/UMS ton. Projections show that the Third Set of Locks will allow the Canal to achieve by the year 2025, a net profit per PC/UMS ton of more than four times that of 2005. With the Third Set of Locks, net Canal profits will grow to more than US$4,310 million or more by the year 2025, equivalent to an average annual growth of more than 11.6%.
5. **Increase in the Contributions to the Panama National Treasury**. In the year 2025, the expanded Canal will be able to provide total contributions to the Panama National Treasury up to US$4,190 million, which will consist of approximately US$670 million in fees per net ton and utility rates, and up to approximately US$3,520 million in surpluses, after making provisions for any necessary investments. Moreover, in cumulative terms, the expanded Canal will be able to contribute to the Panama National Treasury during the first 11 years of the operation of the Third Set of Locks, US$8,500 million more than what the Canal would contribute if it were not expanded; and this amount, by itself, exceeds the amount of the investment in the Project.
6. **Multiplying Effect on Domestic Economy.** The Canal expansion will produce benefits beyond those directly derived from its operation. This is due to the fact that the Canal is the engine driving a conglomerate of interrelated services and activities that complement each other and generate a whole range of contributions to the domestic economy by

making the most of Panama's privileged geographic location. This means that the benefits of the Canal expansion will not only come from the direct revenues the waterway will generate, but from the level of economic activity of the entire conglomerate. It is estimated that the Canal expansion will allow the Canal's economic system exports to increase threefold by the year 2025. In addition, the Canal expansion will fuel an increase of 40% in the investments of the rest of the conglomerate, and by the year 2025 they will have reached some US$1,100 million per year. By 2025, the Canal expansion will have allowed Panama to achieve a gross domestic product of US$31,700 million in 2005 dollars. This will be almost 2.5 times the country's gross domestic product in the year 2005, and is equivalent to an average growth rate of more than an annual 5% over the next 20 years.

3.1.4 Analysis of Project Alternatives

ACP reviewed the alternatives considered above as well as a series of additional alternatives until it achieved a configuration for the proposed Canal Expansion Project and the technologies selected for its main components, especially the locks and the water saving mechanisms. In general terms, the alternatives and technologies under consideration included, in addition to a sea level canal and innovative possibilities, a Canal with new locks similar to the current ones, operating in conjunction with the existing locks and channels with one, two or three steps, and a series of combinations of water saving basins (none, one, two, three, four, or five basins per chamber).

When evaluating the possibility of building a sea level canal, it was concluded that, in order to achieve the same transit capacity, it would be more profitable and environmentally preferable to develop an integrated system of locks that would share channels and other current Canal resources, than to manage two separate systems, one at sea level, and one with locks. It was also determined that all the sea level Canal options can cause permanent and irreversible adverse environmental impacts to both land and marine[3] ecosystems, as well as to the population and

[3] The environmental impact on the marine ecosystem and the fishing industry with the migration of species from one ocean to the other with a sea level canal would be immeasurable.

human activity.[4]

3.1.4.1 Alternatives Studied

The following is a summarized listing of some of the alternatives and technologies studied, with a brief description of their features and the reasons why they were not selected.

Generic Proposals for a Sea Level Canal

All Canal expansion possibilities with sea level channels would result in two channels with a separation between them: a new one at sea level, and the other being the current one. All its variations were rejected because of their adverse ecologic impact, mixing of interoceanic biota, high cost, and environmental mitigation many times higher than that of a Canal with locks sharing the navigation channels with the existing Canal. If the possibility of the sharing of resources by the current Canal and the new system were eliminated, the operating costs would be higher than those of the other alternatives.

The conclusions of ACP's analysis of the Canal alternatives agree with those of the 1993 Tripartite Study on Alternatives to the Panama Canal, which analyzed and ruled out the proposal for a sea level canal.

Sea level Canal with Inlets

The proposal submitted to ACP by engineer Demostenes Vergara is a variation of a sea level canal with inlets analyzed in the 1993 Study on Alternatives to the Panama Canal. It proposes the construction a sea level canal for ships of more than 250,000 DWT as a solution to the problem of the Canal expansion. The new Canal would have a length of 65 kilometers from Puerto Caimito on the Pacific to the Lagarto River on the Atlantic, and would include a sea inlet of 30,000 hectares on the Pacific entrance and a smaller inlet on the Atlantic entrance, without the use of tidal gates. The proposed navigation channel would initially be 300 meters wide, and

4 The towns of Puerto Caimito, La Chorrera, and other adjacent townsites would be among those affected by the construction of a sea level Canal as proposed in one of the options studied.

450 meters long for two way traffic, and would have a depth of 23 meters. The proposal would require the excavation of 2 billion cubic meters of material.

In addition to the significant socioenvironmental impact that could not be mitigated, the proposal was rejected partly because a sea level canal with inlets would have currents of more than two knots in its channels due to the tidal differences between the two oceans. This would create an unacceptable safety hazard to navigation. Thus, this option would require the use of tidal gates, as recommended for other sea level canal options.

Another important aspect that caused this option to be ruled out was the fact that, as was the case of a separate Canal along the Bayano-Carti route, a sea level canal with inlets was not compatible with the focus on the development of the Panama route, because its location would be too far detached from the transit conglomerate and could not be integrated to the current system.

Lock Canal along the Bayano-Carti Route

This proposal, submitted by engineer Jorge Young, recommended the construction of a lock Canal through Lake Bayano. Its proposed size would allow the transit of ships up to 250,000 DWT. It would be 60 kilometers long and 400 meters wide in its channels, would have a draft of 19 meters, and an elevation of 22 meters over sea level. To build it would require the excavation of nearly 2,700 billion cubic meters, and a construction cost of more than US$10,000 million. This proposal also recommends that the Project be financed by means of an administrative concession.

This proposal was rejected partly because of its poor economic returns and the dramatic socioenvironmental impact it would create. In view of the distance between the proposed route and the existing Canal, there would be less possibility of sharing resources, generating synergies or optimizing costs, and it would result in two separate canals with little benefits in scale or scope. The main reasons for its lack of viability are that a canal as proposed would not be a system integrated with the current Canal, and due to its separation from the conglomerate of transit services, it would not be compatible with the focus on the development of the Panama shipping route. Also, larger tankers do not constitute a significant segment in the market projections made.

Proposal for Revolving Locks with Rotating Gates

A proposal submitted by Engineer Renaud of STI Engineering was also considered in ACP's analysis. It consisted of single lift revolving locks with four radial chambers each. This proposal includes the use of automated trolleys that would assist in the positioning of ships in the chambers, and a system for transverse filling , as well as the use of air bags to reduce the use of water.

It was concluded that the use of revolving locks would require significant study, trials, and testing to develop them to a prefeasibility stage. Some of the uncertainties of this proposal included aspects such as the feasibility of construction, operability, durability, technology, capacity, redundancy, safety, and cost. It would have required high investment costs and a great number of resources for its implementation.

As the concept submitted called for a single lift lock and, as determined by ACP from extensive studies. the performance of a single lift lock would be less than that of two or three lift locks, it was concluded that the option of revolving locks would not warrant continuing its development.

Lock Canal with Stacked Water Saving Basins

This proposal, submitted by engineer Paul Folberth, consists of a single lift lock system to move ships between Gatun Lake and sea level, with water saving basins stacked one over the other parallel to the lock chamber. ACP's analyses of this proposal showed that single lift level locks would use more water, introduce more salinity into the Lake, and have more technological hazards than locks with two or more lifts, even when equipped with water saving basins.

Therefore, ACP ruled out the option of single lift locks in favor of more in depth studies of complexes with two or more lift locks. Through an analysis of alternatives, it was determined that the proposal of a canal with single lift locks presents disadvantages when compared to two or three lift locks.

Ship Lift Basin

This proposal, suggested by Van Driel Mechatronics, consists of a large mechanic lift that holds a basin filled with water, which would, in turn, lift ships between sea level and the level of Gatun Lake. The concept calls for the use of a concrete pier or basin 470 meters (1,541') long, hung from concrete towers with steel cables. Ships would enter the filled basin and the basin would move on an inclined plane between sea level and Gatun Lake level. The concrete basin, similar to that of a lock chamber, would have gates on each end and would be weighted to keep the basin horizontal when the tower goes up or down the ramp.

The analysis conducted revealed that this proposal presents structural, and operational challenges and a highly uncertain technology, especially with regard to cycle speed and average time between breaks in order to determine the durability and capacity it would contribute to the system. In conclusion, this proposal is a high risk pioneering option with engineering challenges that are significant when compared to other lower risk technology options evaluated by ACP.

Ship Conveyor Lift

This proposal, submitted by Seahawk, suggests the use of a conveyor belt or band transporter similar to that generally used at marinas to remove boats from the water and provide dry maintenance or protect them outside the water, for the purpose of moving small craft between Gatun Lake level and sea level. This system would be used to avoid having to schedule transits of smaller craft in tandem lockages with larger ships.

The analysis showed that this proposal does not furnish any additional capacity to the current system for the transit of large draft vessels, as smaller craft currently transit as space becomes available on lockages of larger ships. In conclusion, conveyor belts would not provide any relevant increment to Canal capacity, and were therefore ruled out as a viable option to expand Canal capacity.

Water Saving Air Cushions at the Locks

This proposal, submitted by Saso Turk in the year 2004, suggests the use of air or water cushions installed inside the lock chambers to lift or lower ships within the chambers. The proposal has the purpose of reducing or even eliminating the use of water from the lakes to perform lockage operations. This proposal was submitted at a basic conceptual level without enough analysis of the key variables to support its viability, and has a high degree of uncertainty and risk in significant variables, such as:

- the power needed to inflate the cushions;
- the risk of cushions being perforated by ship propellers;
- the ship lifting support capacity;
- the impact of the inflating and deflating cycles on the operations ;
- the useful life of the cushions and their maintenance cycles; and
- the possible intrusion of salt water into Gatun Lake.

In conclusion, the air cushion proposal requires more analysis, a prolonged testing period, and models in order to reach a feasibility stage that can rigorously determine its technical and operational viability. In view of the inherent risk of this proposal and the uncertainty as to the benefits it would provide, ACP concluded that it was more convenient to focus the analysis on other water saving options with a proven feasibility.

Electromagnetic System for Ship Positioning

The proposal of an electromagnetic system for the positioning of ships was submitted by engineer Felipe Len-Rios, who recommended a system of electromagnets to position ships within the lock chamber. The Canal uses lock locomotives to assist, guide, and position ships inside the chambers during lockage operations. In other locks around the world, tugboats are used to assist and position ships for lockages.

In 1999, ACP commissioned Texas A&M University to evaluate innovative ideas to assist and position ships in the locks. The electromagnet system proposal was evaluated along with other 40 proposed technologies. Studies showed that the proposed magnet system would develop variable and high intensity magnetic fields with high power requirements. These magnetic fields could affect Canal and vessel electronic systems, and could even affect any cargo sensitive to magnetic fields. The system would only work with iron hull ships.

The Texas A&M study recommended only 6 of the 41 alternatives analyzed for further study, and the electromagnetic positioning system was not included among them. This decision was made partly because of the high risk of unidentified costs due to the degree of uncertainty and the possible impact such magnetic fields would have on the health of persons working within their range.

Table 3-1 summarizes the alternatives studied for the development of the Project.

Table 3-1

Evaluated Alternatives

Alternative	Disadvantages
Generic sea level canal proposal	- Mixing of interoceanic biota. - High investment and environmental mitigation costs.
Sea level canal with inlets	- Significant socioenvironmental impacts. - Unacceptable safety hazards to navigation.
Locks canal along the Bayano - Carti route	- No economic returns. - Significant socioenvironmental impacts.
Revolving locks with rotating gates	- Lower performance than other evaluated alternatives.
Single level locks with stacked water saving basins	- Require a larger volume of water. - Intrusion of more salinity to the Lake. - Higher technological risks.
Ship lift basin	- Uncertain structural, operational, and technology aspects. - High risks.
Conveyor belt ship lift	- Would not increase capacity for ships with a larger draft
Air cushions to save water at the locks	- More analysis, testing, and models are required to determine their technical and operational feasibility. - High risk. - Uncertain benefits.
Electromagnetic system for ship positioning	- High risk due to unidentified costs, including uncertain and possible adverse effects on health.

Source: URS Holdings, Inc., with information provided by ACP.

Water Supply and Saving Alternatives

The need to complement the Canal expansion program with a water supply and savings program that would amply meet the needs of the population and of the Canal with a Third Set of Locks led to the study of a great number of possible alternatives. In view of the high water volume potential of the Canal watershed, a total of 29 water supply alternatives were identified initially. After several evaluation processes to study their level of feasibility, they were reduced to nine.

The evaluation of the nine options included an analysis of their technical feasibility, construction and operating costs, water production, environmental and social impacts, and the possibility of indirect benefits. These options concentrated on improving Canal water yield, saving lockage water, and. establishing additional water sources from other parts of the Watershed. Table 3-2 below shows the features of the evaluated alternatives.

Table 3-2

Analysis of Water Supply and Saving Alternatives

Decision Criteria	Water saving basins			Water Recycling	Raising Gatun Lake level to 89'	Deepening Channels to 30' PLD	Trinidad Option *	Alto Chagres Option *	Rio Indio Option *
	1 Basin*	2 Basins*	3 Basins*						
Technical and Cost Aspects									
Water production (with 99% of volume reliability)	3-5 lockages	5-9 lockages	6-11 lockages	10-12 lockages	3-5 lockages	7-10 lockages	7 lockages	5 lockages	16 lockages
Investment cost (in million US$)	250	315	480	210	30	150	700	330	290
Social and Environmental Aspects									
Impacts on water quality (the possibility of salt water intrusion)	Limited	Limited	Limited	Significant	Significant	None	None	None	None
Affected Persons (number of persons)	None	None	None	None	N/S	None	1,640	263	1,750
Directly affected surface (in hectares)	N/S	N/S	N/S	N/S	400	None	2,100	1,300	4,600
Impact on biodiversity (high – medium – low)	None	None	None	Little	None	None	Loss of forest areas	Loss of primary forests	Loss of forest areas
Socio–economic impact (high – medium – low)	None	None	None	None	Adaptation of structures	None	Impact on rural and semi-rural areas	Impact on native indigenous reserve areas	Impact on rural areas

N/S = No significant impact

*Options ruled out in the final analysis

Source: Panama Canal Master Plan. ACP, 2006.

By itself, none of these alternatives has the capacity of meeting the entire required water demand, and implementation of a combination of the alternatives with a great viability is required.

The recycling option, which consists of accumulating used lockage water in a basin built at a level lower than that of the lock for pumping through pipes to a pond located at a higher level for further use in other lockages, was ruled out due to the high environmental impact from salt water intrusion into Gatun Lake, as well as the high construction and operating costs associated with this option.

As for the Trinidad option, which contemplated the construction of a dam 4.3 kilometers long near the townsites of Escobal and Lagartera in combination with a pumping system to transfer water to and from Gatun Lake, it was ruled out because it presented a series of technologic and construction risks, including the length of the required dam and the need to build it on an unstable underwater foundation. In addition, there was the environmental and social impact from the increase in the level of Gatun Lake due to the loss of forest areas and its effect on more than 1,500 people. Another important aspect in ruling out this option was its high cost (more than US$700 million), and its low water yield.

The Alto Chagres option was ruled out due to its high socioenvironmental impact and poor water yield (five additional lockages) in comparison with the high investment cost its construction would require (US$307 million).

The Rio Indio option, despite its high water production, was ruled out due its related high socioenvironmental impacts, which included the need to relocate up to 1,600 persons and flood secondary forest areas.

Of the remaining options, i.e., raising the level of Gatun Lake, deepen its navigation channels, and use water saving basins, a series of analysis were done to evaluate any possible combinations. The final analysis of the alternatives is shown on the following Table 3-3, following:

Table 3-3

Combination of Water Supply and Water Saving Alternatives in the Final Analysis

Selection Criteria	Social and Environmental Impact (40%)						Water Supply (40%)				Investment Amount (20%)
	Number of Persons Affected	Water Quality (maximum salinity ppt)	Affected Surface Areas (hectares)	Lost or Affected Infrastructures (in US$)	Production Loss (in US$)	Loss of Forest Areas (hectares)	Water Production (in additional equivalent lockages)	Reliability of draft (14m/46' TFW)			NPV of the investment (in millions of US$)
								FY 2015	FY 2020	FY 2025	
Alternative 2 - Raise Gatun Lake level FY 2015 - Deepening FY 2015 - 2 Basins FY 2015	N/S	0.29 ppt	400	25 million	None	N/S	26	99%	98%	97%	305
Alternative 3 - Deepening FY 2015 - Raise Gatun Lake level FY 2015 - 3 Basins FY 2015	N/S	0.34 ppt	400	25	None	N/S	29	99%	98%	98%	407
N/S = No significant impact											

Source: Panama Canal Master Plan. ACP, 2006.

The most favorable alternative to supply and save water for the expanded Canal, became alternative, which includes the use of 3 water saving basins. This alternative will be explained in greater detail in later sections.

3.1.4.2 Non-Implementation Alternative

A non-implementation alternative would keep the status quo, which would cause a gradual loss of competitiveness of the present system. With the challenges posed by a dynamic, globalized world in the future, and the pressing needs of trade through more rapid and efficient routes for the world maritime fleet, not doing anything would augur a somber financial outlook over a medium and long range.

Baed on this, Management made a calculated risk decision of the Third Set of Locks expansion, after considering all the parameters involved to present to the world an innovative technological and environmentally sustainable proposal.

3.1.5 Selected Alternative

As was described above, the analysis of the alternatives showed that an integrated system provides more capacity per investment unit than the alternative of two separate systems or canals. With an adequate maintenance program, the current Canal will continue to be a useful and profitable asset for many years, as demand studies show that all the market segments that operate in the shipping routes through Panama will continue using ships that can transit the current locks. It is estimated that with the expanded Canal, nearly 60% of the transit demand will consist of Panamax size or smaller vessels. For this reason, the expansion should be understood as an addition integrated with the current Canal for the purpose of multiplying the synergies between the current and new infrastructures.

After the appropriate evaluations, it was determined that the option with chambers larger than the existing ones is the alternative that:

- Provides the necessary capacity to meet cargo volume demand as well as ship size demand,
- Shows the most efficient cost/benefit ratio, and
- Have minor environmental and easily mitigated impacts.

The details of the components of the Canal Expansion - Third Set of Locks Project are described and duly supported in the Panama Canal 2005-2025 Master Plan and in the studies and research conducted for such purpose (Figure 3-3). In short, the Canal Expansion - Third Set of Locks Project includes three main components: i) the locks themselves (larger than the existing ones) with their corresponding access channels; ii) a series of improvements to the current navigation channels to synchronize them with the dimensions of the new locks and adjust them to the navigation requirements of larger (in length, beam, and draft) ships; and iii) a series of actions to adjust the water supply to the new requirements, including an increase in the water storage capacity of Gatun Lake and the incorporation of water saving basins. A summary of each one of these major Canal Expansion components appears below, with the criteria that led to the final selection of its physical features and operating schemes.

3.1.5.1 Lock characteristics

It is proposed to add a third lane with the construction of two lock complexes, one on each end of the Canal, that will be connected by means of new channels for access to them. Each new locks complex will be a set consisting of three (3) chambers or consecutive steps to move ships between sea level and the level of Gatun Lake. The new locks and their access channels will form a transit and navigation system that will be integrated with the current locks and channels.

With regard to the locks, several aspects were analyzed in detail prior to reaching the final proposal that was included in the Master Plan and submitted to the people of Panama in the 2006 Referendum. The following are worth noting:

- The dimensions of the chambers;
- The number of chambers in each lock;
- The location of the locks;

- The type of locks; and
- The ships positioning system inside the lock chambers.

<u>Lock Chamber Dimensions</u>

Lock chambers will be 427 meters (1,400') long by 55 meters (180') wide and 18.3 meters (60') deep. To establish the size of the lock chamber, the reference used was a ship with a length of 366 meters (1,200'), a beam of 49 meters (160'), and a maximum draft of 15 meters (50') in tropical fresh water (TFW). This ship has been identified as the largest Post Panamax container ship that shippers would use routinely with the highest volume and intensity over the routes that use the Canal most frequently. It accommodates up to 19 rows of containers stowed across its width, and has a nominal capacity to carry up to 12,000 TEUs of cargo. This new ship would have up to 2.5 times the cargo capacity of a current Panamax ship (Figures 3-4 and 3-5). The dimensions of the proposed locks would also be able to handle *Capesize* dry bulk ships as well as *Suezmax* size tankers with a displacement of 150,000 to 170,000 tons.

<u>Number of Chambers in each Lock</u>

The number of chambers per lock is important because it affects the number of ships that can transit each lock per unit of time, the water volume required per ship, the amount of the investment, and the risk of salt water intrusion in Gatun Lake. The analyses made included one, two, and three chamber locks, and it was determined that the three chamber lock is the one that maximizes the benefits to the system.

<u>Location of the Locks</u>

Regarding the organization of the general scheme of the Atlantic lock chambers, the lock structure is similar to that of the existing Canal lanes in that it will have three consecutive chambers. This same structure is being proposed for the locks on the Pacific Side, where an important change is introduced with regard to the current distribution. The Pacific locks will be directly connected to the south end of Gaillard Cut by means of an access channel that will surround Miraflores Lake. This design was selected because it allows a more efficient lockage operation than the current one, which has two separate lock complexes.

Type of Gates

All types of gates were studied for the new locks, and it was determined that the rolling type is the best option. Like the current ones, the new locks will have two gates on each end of each chamber or step. Each rolling gate operates from an attached recess perpendicular to the lock chamber (Figure 3-6). With this gate configuration, each recess is a dry dock, which in turn allows on site gate maintenance without removing them or requiring major outages in lock operations. Therefore, the new locks would continue operating with backup gates during maintenance. The construction cost of hinged gates is similar to the cost of the rolling gates, after including the cost of the recesses required for the latter.

As the recommended rolling gates do not require lock outages for their maintenance, they increase the capacity and flexibility of lock operations by allowing a shorter maintenance period at a lower cost.

Vessel Positioning System in the Chambers

Many systems for positioning ships in the lock chambers were evaluated and compared. It was determined that there is no proven technology for such positioning by means of electromechanic systems, such as devices equipped with electromagnets or vehicles, with the capacity, safety, and performance necessary for a reliable handling of the ship size and configuration of Post Panamax ships. After conducting studies, it was determined that the use of tugboats to position ships during lockages is the most suitable option.

This ship positioning system is a proven technology with an ample availability of manufacturers, components, and spare parts, which would also become a natural extension of the Canal tugboat fleet operations. To confirm its viability, ACP has conducted successful trials with tugboat assisted lockages in the current locks, and has confirmed the viability of similar operations at other locks.

3.1.5.2 Access and Navigation Channels

The features of the access and navigation channels are also defined mainly by the dimensions of the Post Panamax ship used as reference for the locks. The Project proposes that the channels that provide access to the new locks should allow one way traffic of Post Panamax ships with a beam of 46.3 meters, a length of 366 meters, and variable drafts up to 15.2 meters in tropical fresh water (TFW), with a Lake level of 25.9[5] meters. On the basis of the recommendations made by PIANC (Permanent International Association of Navigation Congresses), and the experience of ACP, it was determined that the channels that provide access to the new locks will have a minimum width of 218 meters.

On the Pacific Side, the access channel north of the lock that connects it to the South end of Gaillard Cut has a length of 5.8 kilometers, while the channel that provides access to the south of the lock has a length of 1.3 kilometers and connects it with the existing sea entrance (Figures 3-7 and 3-8). In turn, there is an access channel on the Atlantic Side north of the lock with a length of 3.2 kilometers that connects with the sea entrance of the current Canal (Figures 3-9 and 3-10).

The size of the existing navigation channels is consistent with the physical limitations that the existing locks impose on the size (length, beam, and draft) of the ships that transit the present Canal. Therefore, in view of the fact that the new locks will allow the passage of larger ships, it is necessary to adjust the navigation channels to the new dimensions. To this end, the Project proposes the deepening and widening of the existing navigation channels. The factors that determine the operational features and restrictions of the navigation channels include the maximum allowable draft, the maximum ship beam for one way channels, the maximum combined beam for two way channels, and the speeds allowed to ships with the maximum draft.

<u>Navigation Channel Draft</u>

The maximum ship draft is determined by the depth of the water and the under keel clearance (UKC), which has been set by ACP at 1.52 meters. Therefore, the draft will be determined by

[6] This includes 9.2 meters from the bottom of the channel + 15.2 meters from the ship + 1.52 meters from UKC = 25.92 meters

the level of Gatun Lake and the channel bottom. Differently from the current Canal, the draft will vary during the year depending on the level of the water in Gatun Lake. The deepening of the navigation channels in Gatun Lake and Gaillard Cut will take them to a level of 9.2 meters PLD; therefore, the maximum draft will be 15.2 meters TFW with the level of Gatun Lake at an elevation of a 25.9[6] meters, but with a Gatun Lake elevation of 24.7 meters, the draft will be of only 14 meters TFW. The depth of the navigation channels at the sea entrances will be of 15.5 meters at the lowest tide.

Width of Navigation Channels

With regard to the width of the channels, there is a direct relationship between ship beam and curve radius. In segments with two way traffic, the combined beam dimension is used.

It has been established that traffic in Gaillard Cut and the new locks approach channel will be one way only for Post Panamax ships, that navigation channels require a minimum width of 4.7 times the beam size, and that the effective channel width size will be 218 meters. In turn, it will be necessary to allow two way traffic in Gamboa Reach, and in the navigation channels at the sea entrances, traffic will be of one Post Panamax ship with Panamax ships or smaller vessels, with a combined beam of 75 meters. In such case, the necessary width of the channel will be 225 meters. Finally, in Gatun Lake navigation channels, it is necessary to allow two way traffic of Post Panamax ships, which requires a width of not less than 280 meters in the reaches and 366 meters in the curves.

3.1.5.3 Measures to Ensure the Water Supply

The third component of the selected Canal expansion alternative deals with the need to ensure the water supply in order to meet the demand imposed by the increase in transits. With regard to the matter of the water supply, ACP made a detailed analysis of the alternatives, including the construction of new dams west of Gatun Lake. As part of this analysis, a full assessment of the possible social and environmental impacts was made for each alternative under consideration.

After a detailed analysis, two components were selected that complement each other well to ensure a reliable supply of water for the system, one to achieve water savings per ton of cargo moved through the Canal (the water saving basins), and the other to increase the existing regulation capacity (raising the maximum operating level of Gatun Lake).

3.1.5.3.1 The Panama Canal Watershed

With regard to the water supply strategy and the components selected for the Project, it is important to note that the amount of water available as well as the regulation capacity is determined by rainfall over a surface of approximately 340 thousand hectares known as the Panama Canal Watershed.

The Canal Watershed is located in the central part of the country in the provinces of Panama and Colon; it covers seven districts[7] and 39 *corregimientos*. According to the 2000 census, there are approximately 144,000 residents of the Canal Watershed. The population density is 43 per kilometer^2. The illiteracy rate in the region is 4.7%, and 95% of the homes on the Transisthmian corridor have electricity and a concrete floor[8].

Canal Watershed runoff cannot be fully utilized due to limited reservoir storage. Considering the data collected over a period f 10 years (1994- 2003), it can be established that in a typical year, the average rainfall over the eastern region of the Panama Canal Watershed is 2,667 millimeters. From the total annual rainfall (8,904 Mm^3), approximately 41% (3,641 Mm^3) returns to the atmosphere through the evaporation and transpiration processes. Only 59% of the rain falling in the Watershed reaches the Canal lakes, with a gross runoff of 5,263 Mm^3 in an average year. Approximately 9% of this runoff evaporates directly from the surface of water bodies (473 Mm^3), and only 91% (4,790 Mm^3) is theoretically available to supply water for human consumption and to ensure Canal operation.

7 The districts of Panama, Arraijan, La Chorrera, and Capira (in the Province of Panama); Colon, Portobelo, and Chagres (in the Province of Colon)

8 Canal Watershed Master Plan, 2000; Intercarib -Nathan Associates, 1997; Office of the Comptroller General of the Republic of Panama, 2000.

However, due to the marked seasonality of the rain, there are periods of the year when the water volume reaching the lakes is larger than the lake storage capacity. When this happens, ACP must spill the excess into the sea to prevent overflow and flooding that would affect the neighboring townsites and Canal operations. During the same period of 10 years, (1994-2003), due to a lack of storage capacity, the Canal spilled an average of 12% of the water exclusively for the purpose of regulating water levels, and an average of 4,203 Mm^3 of water remained available for use by the population and Canal operations.

Part of the water that cannot be stored is used to generate electric power at the Gatun Plant. The average water volume used to generate hydroelectric power during the same 10 year period was 1,414 Mm^3 per year, meaning that the total water volume used for the drinking water supply and ship transits was 2,789 Mm^3 during an average year of this period. Of this volume, some 290 Mm^3 were used to provide drinking water, and 2,499 were used for Canal transits.

With the current Canal configuration, each complete lockage (raising and lowering the level of Gatun Lake) consumes approximately 208 thousand cubic meters of water. That is, the water available would be enough for approximately 12,014 lockages[9]. However, with an increase in the size of the locks to accommodate Post Panamax ships, the demand would be 480.5 thousand cubic meters approximately[10]. Thus, if water saving measures were not included, the number of lockages would be severely limited.

3.1.5.3.2 Water saving basins

Each chamber will have three lateral water saving basins, or nine basins per lock complex and a total of 18 basins (Figures 3-11 and 3-12). In the same manner as at the existing locks, the filling and emptying of the new locks along with their basins will be by gravity, without the use of pumps.

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9 The number of transits is normally higher than the number of lockages, because two or more small vessels can be accommodated in a single lockage.

10 This demand also takes into account an increase in household use due both to an increase in population, as well as in the percentage of homes, which, due to quality of life improvements, could be provided with drinking water service.

Water saving basins store water next to the lock chambers and are connected to them by means of culverts regulated by shutoff valves to move water in both directions. These basins will temporarily store water from the lock chambers, which would otherwise be spilled into the sea. The water stored in the basins will be later returned again into the lock chambers during the filling process. The effectiveness of the water savings with the use of basins depends on the number of basins used. However, with more basins, the water saved would decrease and lockage times would increase, with a negative impact on the total capacity of the system. For example, one parallel basin represents a savings of 33% of the total lock consumption, and two basins represent a total savings of 50% of the total lock consumption, while three basins save nearly 60% of the total lock consumption. ACP calculations and simulations show that the benefit obtained from increasing the number of basins, in comparison with their cost, does not warrant the construction of more than three water saving basins per chamber.

With the incorporation of the three water saving basins per chamber at both the Atlantic and Pacific side locks, each complete lockage (raising and lowering the level of Gatun Lake) would consume approximately 193.5 thousand cubic meters. This is approximately 14.5 thousand cubic meters less than the existing locks, meaning that with the expanded Canal, 7% less water will be used for the passage of a ship with approximately twice the cargo capacity.

3.1.5.3.3 Raising the maximum operating level of Gatun Lake

The raising of Gatun Lake by approximately 0.45 meters (1.5') from its current level, in conjunction with the deepening of the navigation channels, will increase its usable water reserve capacity and will allow the Canal water system to supply an average of 165 million additional gallons of water per day (625 million liters), without affecting the availability of the water that is supplied for human consumption and other human activities from the water stored in Gatun and Alhajuela Lakes. The volume of additional useful storage to be added to Gatun Lake with this change is of approximately 220 million cubic meters.

3.1.5.4 Atlantic Vehicle Crossing

ACP also evaluated the technical, environmental, and economic viability of developing a vehicular crossing on the Atlantic end of the Canal, such as a tunnel or a bridge, in the context of the Third Set of Locks study. During the Project implementation, the necessary studies will be completed to identify the most suitable option for a vehicular crossing by means of a bridge or tunnel on the Atlantic end of the Panama Canal. The construction of this vehicular crossing should start not later than immediately after the Third Set of Locks is completed, and the cost of its works must be covered by the Panama Canal Authority. This is a commitment ACP acquired under Law 28 of July 17, 2006, which "approves the proposal for the construction of a Third Set of Locks in the Panama Canal, as submitted by the Executive Branch, and issues other provisions."

3.2 Geographic Location of the Project

The Panama Canal is located in the central part of the Republic of Panama and has a length of approximately 80 kilometers. It traverses the narrowest strip of land in the continent of the Americas, between the Pacific and the Atlantic oceans, in a southeasterly-northeasterly direction from the Pacific. Figure 3-13 shows the Project's geographic location on a scale of 1:50,000, in compliance with the provisions of Decree N° 209.

The coordinates of the Project outline, with reference to the farthest points where the various work sites and material disposal sites will be located, are as follows:

North:	X=615906	Y=1037767
South:	X=660616	Y=977634
East:	X=660623	Y=981213
West:	X=615915	Y=1036359

3.2.1 Location and Extension

The works will be located along the entire length of the Panama Canal, although most of them will concentrate at the Canal entrance on the Atlantic side next to the Gatun locks, at Gatun Lake, in Gaillard Cut, next to Pedro Miguel and Miraflores locks, and at the Canal exit on the Pacific Side. The total Direct Impact Area of the Project covers a surface of 12,074 hectares.

3.2.2 Description of Canal Expansion Project Works

As mentioned above, the Project under this Study has three major components: (i) the construction of two lock complexes and their related water saving basins and respective access channels; (ii) the deepening and widening of the existing navigation channels; and (iii) the raising of the maximum operating level of Gatun Lake.

3.2.2.1 General Outline of the Works

The Canal Expansion - Third Set of Locks Project involves the movement of approximately 133 million cubic meters (Mm^3) (83 Mm^3 excavated, 50 Mm^3 dredged) of material. This is practically twice the volume of earth displaced during the previous modernization works (during the period 1950-2005), and approximately half of the volume extracted during the original Canal construction. The Project is mainly an open pit excavation and dredging, in a studied and cleared geologic area. The Project does not involve underground or underwater construction work.

The construction of the locks will take between five or six years and should begin in 2008, after the designs are completed. The raising of the maximum level of Gatun Lake will start in the second half of the construction period, that is, in the year 2011, for which both the existing locks as well as Canal facilities on the banks of Gatun Lake must be adapted, and all of this will be done in approximately four years, ending in the year 2014.

Locks and Water Saving Basins

Each new locks complex will be a set consisting of three consecutive chambers or steps to move ships between sea level and the level of Gatun Lake. Each chamber will be equipped with three lateral basins to save water, and the filling and emptying of the new locks and its basins will be done by gravity, as it is done at the existing locks. Both lock complexes will be located within ACP property next to the existing locks, and will form an integrated transit and navigation system along with the existing locks and channels.

The alignment of the Post Panamax lock complex on the Pacific Side will be located southwest of the current locks. It has been named the Pacific Moncayo-Delgado (PMD) alignment, after the two engineers who directed their analysis, Gilberto Moncayo and Rigoberto Delgado.

In the case of the Post Panamax complex on the Atlantic Side, the selected location is known as Alignment A-1, east of Gatun locks. This location will take advantage of a significant portion of the Third Set of Locks Project started by the U.S. Government in 1939, a situation that will reduce excavation needs and thus, construction costs.

In both cases, the selected alignments are the result of a thorough diagnosis of possible options and many optimization trials. The selected sites maximize the use of the existing navigation channels, take advantage of the topography and geology of the area, minimize the volume and the cost of the excavation and civil works, reduce the environmental impact, and minimize the impact on Canal operations.

The locks will operate by transferring water by gravity from Gatun Lake to the upper lock chamber; between the upper, middle, and lower chambers; and from the lower lock chamber to the Pacific or Atlantic Ocean through two main culverts that will run alongside each lock wall with openings in the lower portion of the chamber. Some 20 openings two meters high by two meters wide per wall are estimated. The average discharge volume at the locks will be of some 48,000 m^3/min. The water saving basins will have a surface equal to or approximately that of the lock chamber, but with depths of 4 to 5.5 meters.

Navigation Channels

The Project includes the excavation of new navigation channels to connect the new locks with the existing channels, and the deepening and widening of part of the existing channels. To connect the new locks on the Atlantic Side with the current Canal sea entrance, a channel approximately 3.2 kilometers long will be built. To connect the existing channels with the new Pacific locks, two new channels will be built. The northern channel that will connect the locks with Gaillard Cut south of the Centennial Bride running parallel to Miraflores Lake, will be 5.8 kilometers long. The channel south of the new locks will be 1.3 kilometers long and will connect the locks with the existing Pacific sea entrance. The new channels will be 218 meters (715') wide, which will allow one way traffic of Post Panamax ships in those channels.

The Borinquen dikes will be built as part of the construction of a new access channel connecting the new locks on the Pacific Side with the Gaillard Cut area. They will be needed to separate the waters of the access channel at the same surface elevation as the elevation of Gatun Lake (~ 26 meters PLD), from Lake Miraflores, which has a surface elevation of 16.5 meters PLD.

The works on the existing navigation channels include the deepening of the Gaillard Cut channels and of the sea entrances of the Panama Canal on the Atlantic and the Pacific. The deepening of Gaillard Cut and Gatun Lake will be done to a level of 9.20 meters (30') PLD, in order to provide a maximum draft of 15.20 meters (50') in tropical fresh water (TFW). The sea entrances will be deepened to 15.5 meters (51') at the lowest tide. The widening of Gatun Lake will make the navigation channel not less than 280 meters (920') wide on the reaches, and 366 meters (1,200') on the curves, and will allow two way traffic of Post Panamax ships or smaller vessels, while at the sea entrances the width will be 225 meters (740'), and will allow two way traffic of Post Panamax ships along with Panamax or smaller size ships.

Raising the Maximum Operating Level of Gatun Lake

The maximum operating level of Gatun Lake will be raised by approximately 0.45 meters (1.5'), from the current level of 26.7 meters (87.5') PLD, to a level of 27.1 meters (89') PLD. This Project component will increase the useful reserve capacity of Gatun Lake, and will allow the

Canal water system to supply an average of 165 million gallons of additional water per day. This additional volume of water is enough to provide water for an average of approximately 1,100 additional lockages per year, or the equivalent of approximately 75% of the annual current water consumption of the population supplied from Madden and Gatun Lakes. This component consists of the modification and adaptation of some ACP operating structures, such as the upper Gatun locks, the northern part of Pedro Miguel locks, the docks at Gatun Lake, and other structures along the banks of Gatun Lake that will need to be modified.

3.2.2.2 Pacific Side Works

In addition to the construction of lock chambers, the water saving basins, and the access channels, it will be necessary to perform a series of preparatory activities and tasks. These activities are important to facilitate the execution of the construction strategy visualized for the Project.

3.2.2.2.1 Preliminary Works

The works required prior to the construction of the locks, basins, and access channels include a series of tasks to control or keep water courses away from excavation sites, set up storage and work areas, and build and/or maintain access roads. The most significant include:

- A temporary cofferdam at the Pacific entrance. It will be 654 meters long and 13.5 meters high, and will consist of a 192,600 cubic meter (m^3) backfill with flat sheet piles in its middle. The cofferdam is needed to allow dry construction of the Pacific locks.
- Construction of a dock 800 meters long and 45 meters wide that will allow the handling of Contractor construction equipment and materials, and once the construction phase is completed, it will support Canal operations.
- Clearing and preparation of the T6 excavated material disposal site area.
- Drainage of artificial ponds formed by the 1939 excavation.
- Removal of approximately 500,000 m^3 of material not suitable for backfill from past maintenance (dredging) work on the Miraflores lock access channel.

- Relocation of Borinquen highway.
- Permanent relocation of twelve 230 KVA power transmission towers (power line from the Fortuna hydroelectric power plant) located on the western portion of the access channel leading to the lock.
- Relocation of public utility infrastructures.
- Construction of a dam and the Cocoli River diversion to the Pacific Ocean.
- Diversion of the southern branch of the Rio Grande River with its affluents, Conga Creek and Sierpe River, to Gaillard Cut.

3.2.2.2.2 Lock and Water Saving Basins

The new Pacific locks, including the approach walls from the access channel on the north side, will be located in the Cocoli area, approximately between stations 6K+000 and 8K+400. The three chambers will be built on land with elevations up to 23 meters above mean sea level, located some 2,000 meters southwest of the existing Miraflores locks. The nine water saving basins will be located east of the new locks on land with similar elevations, taking advantage of the excavation for the 1939 project for a third lane of locks. The lock and water saving basin construction area will be of approximately 73 hectares.

ACP must acquire approximately 23.2 hectares in the Cocoli Area that belong to the Panama Ministry of Economy and Finance, for the facilities required by the Contractor on the Pacific side such as offices, work shops, storage, and infrastructures. According to the agreements for the use of the area, ACP has the right to use lands without the need to pay the concessionaire. Within these areas, the Contractor will be responsible for determining the final location of facilities such as concrete plants; rock crushing plants; ice, chilled water, sewage treatment plants; materials storage; and offices, on the land designated for such use.

Likewise, ACP will have field offices located on the opposite side of Bruja Road to the west. The purpose of these field offices will be to follow up on the works, with room for approximately 70 persons including those in charge of various disciplines such as: engineers, safety specialists, inspectors, environmental protection specialists, and geotechnical and electrical engineers. Field offices will also have a soils laboratory and an area for surveyors. These facilities will be equipped with electricity, communications, and drinking water, all supplied from the existing utility network administered by ACP. Sewage (exclusively household) produced by these offices will be discharged into the existing sewerage in the Cocoli area. Other waste such as the household trash generated by human activity at these offices will be placed in plastic bags and disposed of in containers for collection by the Contractors.

The main access to this site will be through the Inter-American highway, through the Bruja-Borinquen Road, and then into the Cocoli area. An access alternative, with certain restrictions, could be through the Centennial Bridge on the west side of the alignment, or crossing the existing Miraflores Bridge toward the east side of the new lock.

To the east of the location where the water saving basins will be built, a communications tower and shed will be built on the highest point of Aguadulce Hill, where surveillance cameras and related equipment will be installed. One of the requirements of these structures will be the capacity to transmit video images on real time that may allow the viewing of the progress of the works. This video signal ` be accessible from the ACP website. The antenna will also be for the purpose of providing security and additional control of the works by allowing the monitoring of the Pacific Side work area.

There is another antenna on Aguadulce Hill at the present time, which is used for communications. The antenna to be built as part of the Canal Expansion Project will be located approximately 50 meters north of the existing one, where it will occupy an area of approximately 20 x 30 meters. The major activities associated with this communications tower and shed are listed below:

- Paving the current access road to Aguadulce Road.
- Clearing and clean up of an area of 0.5 hectares that is by covered by brush at the present time.
- Construction of a concrete base for the tower.
- Construction of a shed to protect electronic equipment (radios, cameras, etc.).

- Installation of a cyclone fence (20 m x 30 m) to protect the site against vandalism.
- Excavation along the existing roadway to provide power to the site with underground lines, and create a grounding network system adequate for the site, against electrical discharges.

3.2.2.2.3 Northern Approach Channel for the Pacific locks

Access from Gatun Lake to the Post Panamax locks on the Pacific Side will be through an open channel connecting Gaillard Cut with the new locks. This channel will be built on the west side of the existing channel and will extend from Paraiso Hill northwest of the Pedro Miguel locks to the new locks in the Cocoli area.

This northern approach channel will be excavated west of Miraflores Lake as an extension of Gaillard Cut. The maximum level of the channel will be the same as the maximum level of Gatun Lake, that is, +27.13 meters (89.0 feet) PLD. The channel bottom will be at a level +9.14 meters (30.0 feet) PLD. Miraflores Lake will remain at a stationary level of +16.45 meters (54.0 feet) PLD.

In addition to the excavation, the construction of the northern access channel requires the four dikes known as Borinquen dikes. The two main dikes on the east side of the channel, called by their relative location as dike 1E (2730 meters long) and 2E (1390 meters long), separate the channel from Miraflores Lake. Other minor dikes known as 1W (560 meters de largo) and 2W (240 meters long) are needed to contain water in the channel at the level of Gatun Lake (Figure 3-14).

The central axis of the east bank dikes has a slight curve at station 1+000. Dike 1E extends from the fence south of Paraiso Hill to the northern base of Fabiana Hill, over a distance of 2.7 kilometers. The dike crosses a previously filled zone west of the Pedro Miguel lock, between stations 0+000 and 1+000. From station 2+100 to station 2+700, the dike traverses a floodplain with vegetation that reaches Miraflores Lake precisely. The areas traversed by the two dike segments are filled with dirt and Canal maintenance dredged material. Dike 2E goes from south of Represa Hill to station 3+250 located on the northern wall of the new locks.

Due to the difference between the level of Miraflores Lake and the maximum level of the access channel, as well as the topographic features of the area, it will be necessary to build two dividing dams to close up the low points between the two bodies of water. They will minimize filtrations from Miraflores Lake to the excavation area, and will act to shut off and retain the water in Gatun Lake during the filling and the operation of the Canal; therefore they will become structures of great importance and care in the Panama Canal.

3.2.2.2.4 Access Channel South of the Pacific Access Channel

The other channel will be 1.3 kilometers long and will connect the new locks with the existing Pacific Ocean entrance, on a southwesterly direction. Similarly to the northern channel and all the other approach channels, this channel will be 218 meters (715') wide, which will allow one way transit of Post Panamax ships.

3.2.2.2.5 Navigation Channel at the Pacific Ocean entrance

In addition to the lock chambers, the water saving basins, and the approach channels, it will be necessary to widen the navigation channel from its start at Buoy 1 to the Y1 intersection, for a maximum of 225 meters wide and a draft of 15.5 meters at the lowest tide. This is required to sustain two way traffic of Post Panamax ships with Panamax or smaller vessels 24 hours a day. This Project component has been included in the Environmental Impact Study for the Widening and Deepening of the Panama Canal Pacific Entrance Navigation Channel.

3.2.2.3 Atlantic Side Works

A new locks on the Atlantic Side and their water saving basins will be located east of the existing Gatun Locks. The locks will be built on land with an elevation of up to 50 meters over mean sea level, and the water saving basins will be built west of the new locks, and east of the main road of the former Gatun townsite.

3.2.2.3.1 Preliminary Works

In the case of the Atlantic Side end of the Panama Canal, the preliminary works to be performed prior to the construction of the lock chambers and water saving basins will include:

- Construction of a dock 800 meters long and 45 meters wide to allow the handling of Contractor construction equipment and materials. Once the construction phase is completed, it will serve to support Canal operations.
- Drainage of the artificial pond made for the 1939 excavation.

3.2.2.3.2 Lock and Water Saving Basins

The 1939 excavations will also be used for the construction of the Atlantic locks. The lock and water saving basin construction area would cover some 70 hectares located some 1,200 meters east of Gatun Locks.

For the facilities needed by the Contractor, such as offices, work shops, and infrastructures on the Atlantic Side, it is proposed that the Contractor use the area of the former Gatun townsite that belongs to the ACP. These lands will be made available for use by the Contractor, and are shown on Figure 3-9. Within the areas designated for its use, the Contractor will be responsible for determining the final location of concrete and rock crushing plants; ice or chilled water plants; sewage treatment plants; materials storage; and offices.

ACP will also have field offices located just south of the Contractor area on Bolivar Street. At the present time, the area is a vacant lot used to park vehicles.

The purpose of these field offices will be to administer the works, and will have a capacity for approximately 70 persons, including those in charge of various disciplines such as: engineers, safety specialists, inspectors, environmental protection specialists, geotechnical and electrical engineers. Field offices will also have a soils laboratory and an area for surveyors. These facilities will be equipped with electricity, communications, and drinking water, all supplied from the existing utility network. Sewage (exclusively domestic) produced by these offices will be discharged into the existing sewerage in the Gatun area. Other waste generated by human activity, such as household trash, must be placed in plastic bags and disposed of in containers for collection by the Contractors.

The main access to the Project site will be from neighboring areas through Bolivar Road. An access alternative could be by train from the city of Panama. The current Panama Railroad Company railway that connects the city of Panama and Colon runs east of the new locks alignment.

3.2.2.3.3 Access Channel North of the Atlantic Side Lock

To connect the new Atlantic Side locks with the current Canal sea entrance, the existing 1939 excavation channel will be widened and deepened. It is approximately 3.2 kilometers long north of the lock in a north-northeast direction. This lock approach channel will also be 218 meters (715') wide to allow one way passage of Post Panamax ships.

3.2.2.3.4 Deepening of the Navigation Channel at the Atlantic Ocean entrance

To connect the new Atlantic Side locks with the current Atlantic Ocean entrance, an access channel approximately 3.2 kilometers long will be needed. The new channel will be 218 meters (715') wide on its reaches. The existing navigation channels at the entrances will be widened to a width of not less than 225 meters (740'), and deepened to a depth of 15.5 meters (51') below the average low tide level.

3.2.2.4 Gaillard Cut and Gatun Lake Works

The works at Gaillard Cut and Gatun Lake consist mainly of the expansion and deepening of the existing navigation channels, with works distributed along their entire length. Also, it will be necessary to modify some ACP operations structures and other private facilities, mainly docks and water supply systems, for the purpose of adapting them to the new maximum operating level.

The deepening will change the lower level of the Gatun Lake navigation channel from 10.4 meters (34') PLD to 9.1 meters (30') PLD. By raising the maximum operating level of Gatun Lake from 26.7 meters (87.5') to 27.1 meters (89') PLD, that is, 0.45 meters, the useful storage capacity of Gatun Lake will be increased and will allow the Canal water system to provide an average of an additional 165 million gallons of water per day. This additional water volume is enough to provide water for an average of approximately 1,100 additional lockages per year.

The deepening of the Gatun Lake channel, including Gaillard Cut, to 9.1 meters (30') PLD, will allow ensure Canal users a maximum draft of 14 meters (46') in tropical fresh water with a high degree of reliability and a minimum operating level. In the meantime, with the raising of the maximum operating level of Gatun Lake to 27.1 meters, reservoir water capacity and the hydrologic reliability of the Canal will increase.

Some infrastructures in the areas adjacent to Gatun Lake may have to be modified, relocated, or adapted, such as the Gatun and Pedro Miguel locks, the existing Gatun spillway, the auxiliary dams, some Dredging Division facilities at Gamboa, and some Canal operations docks. This also includes the structures of third party facilities that will be affected, such as the railway foundations crossing Gatun Lake, Smithsonian Institution infrastructures on Barro Colorado Island, such as the main and floating docks and external and storage facilities and boat ramp belonging to the Gamboa Rainforest Resort. This Project component could also affect some nine houses on the banks of the Lake, which are below 27.13 meters (89') PLD, as well as on land belonging to ACP. The infrastructures to be affected by the rise of the level of Gatun Lake is covered in the chapter relative to the socioeconomic impacts.

3.2.2.5 Excavated and Dredged Material Disposal Sites

The strategy proposed by ACP is supported by the premise that the dry material from the new locks and access channel excavation will be deposited at the disposal sites known as T6 and Cocoli Sites (1, 2, 4 and 5), on the Pacific Side (Figure 3-15), and at Tanque Negro and Monte Lirio North on the Atlantic Side (Figure 3-16). Likewise, the strategy includes disposal sites for excavated and dredged material from the new and existing navigation channels works, to be disposed of at a series of aquatic and land sites. This strategy takes into account the fact that the distances between the work areas and the excavated material disposal sites affect the transportation cost and logistics of such material.

Table 3-4 shows the disposal sites proposed by ACP for the disposal of materials derived from these activities. It is important to note that some of these disposal sites have been historically used as Canal operating areas, and therefore, their use during the Project construction phase prevents the use of other unperturbed zones.

Table 3-4

Disposal Sites Proposed by ACP for Excavated and Dredged Materials

Areas		Dredging (Mm^3)	Excavation (Mm^3)	Dredged Material Disposal Sites		Excavated Material Disposal Sites	
				Area	Capacity (Mm^3)	Area	Capacity (Mm^3)
1	Atlantic Ocean entrance navigation channel [1]	6.95	0.00	Northwest Breakwater	8.2		
2	Northern Post Panamax Atlantic approach channel	6.55	0.90	Tanque Negro	10	Mindi	0.87
3	Atlantic Side northern plug	0.61	0.16	Tanque Negro	10	Mindi	0.87
4	New Atlantic Post Panamax locks	0.00	18.00			Monte Lirio North	32.00
5	Atlantic Side southern plug at 9.14 meters PLD	0.79	0.40	Monte Lirio North	32.00	Monte Lirio Norte	32.00
6	Gatun Lake widening to 280 meters and 366 meters at 9.14 meters PLD	16.03	0.00	Areas for timed basting along the Navigation Channel (cutter suction dredges)[2].			
7	Deepening and widening of Gaillard Cut to 218 meters at 9.14 meters PLD	6.03	2.50	Frijoles Peña Blanca West and East	11 22.3 42.2	Site T4 Site T2 Sites T3 & T5	21.70 23.83 21.31
8	Northern approach channel on the Pacific Side, north of the Gaillard Cut plug, 9.14 meters PLD	2.82	7.18	Frijoles Peña Blanca West and East	11 22.3 42.2	Site T6	77.04
9	Gaillard Cut plug or north of the Pacific locks	0.39	0.17	Frijoles Peña Blanca West and East	11 22.3 42.2	Site T6	77.04
10	Northern approach channel on the Pacific between the Gaillard Cut plug and the intermediate plug, 9.14 meters PLD	0.00	46.78			Site T6 and Cocolí South Sites 2 to 5	77.04 17.04
11	Intermediate plug on the Pacific	0.30	0.13	Frijoles Peña Blanca West and East	11 22.3 42.2	Site T6 and Cocolí South Sites 2 to 5	77.04 17.04
12	New Pacific locks	0.00	3.44			Cocoli South Site 2 to 5 Utilization of excavated material as aggregate for concrete, dike construction, and filling of the 1939 pond south	17.02
14	Pacific southern plug	0.63	0.00	Velasquez Farfan	2.29 3.66		
15	Southern approach channel on the Pacific	2.51	0.00	Tortolita Tortolita Sur Palo Seco	7.59 9.56 1.02		
16	Pacific entrance navigation channel	6.51	0.00	Tortolita Tortolita South Palo Seco	7.59 9.56 1.02		
	TOTAL	**50.12**	**79.66**				

Source: Technical Analysis of Disposal Sites for the Construction Works for Post Panamax Navigation and New Panama Canal Locks. ACP, 2006.

1. The northwest breakwater disposal site could be expanded to accommodate the total volume resulting from the widening and deepening to 225 meters and a draft of 13.7 meters.
2. This refers to the existing sites historically used for routine maintenance activities along the banks of Gatun Lake.

3.3 Study Area

The study area (Figure 3-17), a concept necessary to identify the possible effects of a project on physical/biotic and social areas, is defined as the area where the impacts generated by construction, operation, and maintenance activities may occur. In practice, an area must be defined to obtain the information needed for the analysis of socioenvironmental impacts. An Environmental Study Area (ESA – Figure 3-18) and a Socioeconomic Study Area (SESA – Figure 3-19) were designated because of their proximity and relationship with the activities mentioned. The summary of both areas (without overlapping areas) is the Total Study Area (TSA) of the Project (Figure 3-19). The difference between ESA and SSA must be established due to the varying nature of environmental impacts with respect to the socioeconomic ones. While most of the environmental impacts happen at Project development sites and their surrounding areas, socioeconomic aspects may have a less localized interaction.

It was also deemed convenient to designate a Project General Study Area (GSA), a Specific Study Area (SSA) and a Direct Impact Area (DIA). With this arrangement, the environmental baseline is better defined with regard to previous studies conducted both for the Canal Watershed as well as for the sites next to the Project development zones, and it serves to facilitate the analysis of environmental impacts in view of their peculiarities.

The alignments proposed by ACP and their possible effects on the socioeconomic and environmental aspects were taken into account to determine the boundaries of these areas from the implementation (construction) phase to the operations and maintenance phases. The Total Study Area includes 564,033 hectares, of which 82.6% (466,051 hectares) correspond to land 4.0% (22,595 hectares) to aquatic area in the Atlantic Ocean; 5.7% (32,308 hectares) to aquatic area in the Pacific Ocean; and 7.6% (43,079 hectares) to fresh water area in the Panama Canal system reservoirs[11]. The Environmental and Socioeconomic Study Areas are described below.

3.3.1 Environmental Study Area (ESA)

[11] Values have been rounded.

The ESA (Figure 3-17) includes the Panama Canal Watershed, the areas outside the Watershed on both sides of the Canal axis on the Atlantic and Pacific Sides, and the marine portion (Atlantic and Pacific), as they are considered highly vulnerable to environmental interactions with the Project. This area covers 421,868 hectares and has been divided in three categories: A General Study Area (GSA), covering the east and west sectors of the Canal Watershed; the Specific Study Area (SSA), covering the east and west sectors of the Canal Watershed; the Specific Study Area (SSA); and the Direct Impact Area (DIA).

The following Table shows the surface distribution of the Environmental Study Areas, followed by a description of the criteria used to determine the boundaries of such areas.

Table 3-5

Environmental Study Area Surface Distribution[12]

Environmental Study Area	**Surface (in hectares**
General Study Area	267,190
Specific Study Area	142,604
Direct Impact Area	12,074
Environmental Study Area	***421,868***

Source: URS Holdings, Inc. with ACP and URS data bases.

12 Numbers have been rounded off.

It must be pointed out that for the purposes of determining the corresponding study area surfaces and to avoid duplicate tallying, the Specific Study Area does not include the Direct Impact Area. Nonetheless, the Direct Impact Area is geographically part of the Specific Study Area. Likewise, the General Study Area (for the purpose of determining its surface) does not include the Specific Study and Direct Impact Areas. When evaluating physical and biologic aspects relative to the surface, such as vegetative cover, it is important to keep in mind that the areas have been counted in this manner.

3.3.1.1 General Study Area (GSA)

The General Study Area consists mainly of the area that is inside the Panama Canal Watershed, but outside the Specific Study Area. The reason for including it, even though the area where the Project is concentrated is much smaller, is to consider in context the items discussed in the chapters describing the existing conditions, and in the chapter where the impacts are identified and assessed. This means that, even when the Project area is within a well defined Canal operating area, a general outlook is considered necessary to enable consideration of the various environmental items in context. The General Study Area covers an area of 267,190 hectares.

3.3.1.2 Specific Study Area (SSA)

The Specific Study Area has been defined on the basis of the possible indirect effects of the Project, and adds a strip adjacent to the Canal of approximately five kilometers on each side of the navigation channel. In the marine areas of the Atlantic and Pacific Sides, the SSA extends five kilometers around the anchorage area currently being used for the operation of the Panama Canal. In the Gatun Lake Area, and its banks and main affluents, the SSA includes the surface of these bodies of water (Figure 3-18). It does not include an additional zone beyond the banks, as these areas are distant from the activities involved in the Project. The SSA covers a geographic region of 142,604 hectares and it contains several protected areas, such as the Cruces Road National Park, the Soberania National Park, the Gatun Lake Recreational Area, and the Barro Colorado Island Natural Monument.

For the purposes of this study, the SSA has been subdivided in 6 zones. This subdivision was used as reference in previous ACP studies, and enables a more detailed evaluation of the environmental components of each one of these sub zones, instead of analyzing the entire zone as a whole. The criteria for the determination of the sub zones are based mainly on the type of work to be developed in each one. Thus, Zone 1 – the Atlantic Zone, corresponds to the Atlantic sites where work will take place for marine or coastal widening or deepening, and the disposal sites. Zone 2 – Gatun Locks, corresponds to the work that will take place mainly on land for the construction of the Atlantic Side lock. Zone 3 – Gatun Lake includes the work areas in the lake environment also for widening and deepening, as well as for the disposal of material. Zone 4 – Gaillard Cut refers to land and lake work areas for widening and deepening. Zone 5 – Pacific locks, pertains to the work on land for the construction of the lock in this area, approach channels, and sites on land for the disposal of material. Zone 6 – the Pacific Coast pertains to marine type work for the widening and deepening of the navigation channel and the aquatic sites for the disposal of material. Table 3-6 below shows the distribution of each specific study zone.

Table 3-6

Distribution of Specific Study Area Zones

Zone	Land Area (hectares)	Ocean Area (hectares)	Lake Area (hectares)	Total Area (hectares)
Zone 1 – Atlantic Coast [1]	12,925	22,209	0	***35,134***
Zone 2 – Gatun Locks [2]	302	4	0	***306***
Zone 3 – Gatun Lake	20,170	0	34,133	***54,303***
Zone 4 – Gaillard Cut	10,515	0	30	***10,545***
Zone 5 – Pacific Locks [2]	6,638	9	152	***6,800***
Zone 6 – Pacific Coast [1]	7,325	28,191	0	***35,516***
TOTAL	***57,876***	***50,412***	***34,315***	***142,604***

Source: URS Holdings, Inc., with ACP and URS data bases.

Notes:

1 - The ocean areas correspond to marine zones mainly in the Atlantic and Pacific coastal zones (Zones 1 and 6).

2- The ocean areas in Zones 2 and 5 correspond to the aquatic areas beyond the geographic boundaries of Gatun and Miraflores Lakes.

3.3.1.3 Direct Impact Area (DIA)

This is defined as the sum of the Project works, traffic, construction, operation, and maintenance areas. Based on interdisciplinary studies and analyses, this area was set up to include the navigation channel in Gatun Lake and its banks, the disposal sites to be used for the development of the Project, and the Atlantic and Pacific prisms where the deepening work is to be performed (Figure 3-18). The Direct Impact Area appears as a continuous area including some beyond the "footprints" of the works. The logic behind this concept is to include the areas of traffic of trucks as well as vessels and barges, which could add to the impact on the environment. It is important to note that when some of the impacts such as the loss of vegetation are tallied, it includes only the "footprints" of Project physical works and not the entire DIA. This area covers 12,074 hectares and is mostly limited to the areas belonging to and being administered exclusively by, ACP.

On the Pacific Side, the DIA includes the footprints of the locks, the approach channels north and south of the new locks, the navigation channel and the truck and vessel traffic areas at land and water disposal sites; and covers a surface of approximately 5,904 hectares. On the Atlantic alignment, the DIA covers a surface of approximately 1,172 hectares. It also covers 1,074 hectares in the area of Gaillard Cut, which correspond to disposal sites, the navigation channel, and adjacent areas. At Gatun Lake, the DIA covers 3,923 hectares, which correspond to the navigation channel, the disposal sites, and their adjacent areas.

The DIA also includes the areas of temporary and permanent works, both during the construction phase as well as during maintenance activities in the operations phase. These include sites for borrow materials, excavation areas, the sources of various materials, closed working areas, and equipment yards for work shops and storage, disposal sites for excavated and dredged material, and access roads and highways. It also includes areas directly affected by the construction, deepening, and widening of the navigation channels at the sea entrances.

The former town of Gatun[13], which is part of the Canal operating area, is within the DIA alignment for the construction of the new locks on the Atlantic Side. On the Pacific Side, the DIA includes the former town of Cocoli, which has conditions of use and occupation similar to those of the former town of Gatun[14].

For the operations phase the DIA includes, in addition to the locks, all navigation channels as well as the top surface of Gatun Lake (the area covered by the water of the Lake, for the new maximum operating level) and its banks (for the management of the Lake level). Populated areas within the DIA include community elements (infrastructures) located near the banks of Gatun Lake, which would be affected by the increase in the Lake maximum operating level.

3.3.2 Socioeconomic Study Area (SESA)

The SESA consists of the sections that may be positively or negatively affected in a socioeconomic context, and covers a geographic region slightly larger than the one used in the environmental structure (Figure 3-18). This area was created by an interdisciplinary group in the Consultant's team, and it considered as the ACP contribution on the matter. The criteria used were the following: population density, proximity to Gatun Lake, and proximity to the Transisthmian Corridor. The results were six specific zones that include:

- Pacific East Zone – the *corregimientos* in the districts of San Miguelito and the city of Panama, except Chilibre.
- Pacific West Zone – the *corregimientos* in the districts of Arraijan and La Chorrera, which are along the Pacific shoreline, slopes.
- Taboga – Taboga corregimiento
- Gatun Lake and Colon Costa Abajo Zone – Several *corregimientos* belonging to the districts of Arraijan, La Chorrera and Capira that are along the Atlantic shoreline slopes,

[13] Currently abandoned, it was mainly used by ACP or other Panama Government agencies. With the exception of some houses, its occupancy is discussed in greater detail in the baseline and socioeconomic impact sections.

[14] There are some infrastructures in this site that are leased by ACP to third parties. This is discussed in greater detail in the baseline and socioeconomic impact sections.

within the Panama Canal Watershed. This zone also includes the *corregimientos* in the districts of Chagres and Colon, along the banks of Gatun Lake.

- Transisthmian Corridor Zone – *corregimiento* of Chilibre and several *corregimientos* in the Colon district, along the Transisthmian Highway.
- Atlantic Urban Zone – the *corregimientos* of Barrio Norte and Barrio Sur in the district of Colon.

The SESA covers a surface of 454,050 hectares (see Table 3-7).

Table 3-7

Coverage of the Socioeconomic Study Area, Showing the Six Zones of Concern

Pacific East Urban Zone - 61,650 hectares

District/*Corregimiento*	Hectares
Panama	56,640
Ancon	19,390
Bella Vista	450
Betania	830
Curundu	120
El Chorrillo	60
Juan Diaz	3,400
La Exposicion or Calidonia	160
Las Cumbres	10,430
Parque Lefebre	680
Pedregal	2,830
Pueblo Nuevo	310
Rio Abajo	390
San Felipe	30
San Francisco	610
Santa Ana	80
Tocumen	6,530
Las Mañanitas	2,460
24 de Diciembre	7,880
San Miguelito	5,010
Amelia Denis De Icaza	380

Pacific West Urban Zone - 42,670 hectares

District/*Corregimiento*	Hectares
Arraijan	59,270
Arraijan (Cabera)	6,810
Juan D. Arosemena	4,090
Veracruz	4,990
Vista Alegre	3,060
Burunga	5,190
Cerro Silvestre	1,930
La Chorrera	16,600
Barrio Balboa	790
Barrio Colon	1,480
El Coco	1,500
Feuillet	1,920
Guadalupe	2,480
Playa Leona	5,280
Puerto Caimito	3,150

Taboga Zone - 850 hectares

District/*Corregimiento*	Hectares
Taboga (Cabecera)	850

Gatun Lake and Costa Abajo Zone - 207,230 hectares

District/*Corregimiento*	Hectares
Colon	87,010
Ciricito	6,640
Cristobal	72,230
Escobal	8,140
Chagres	44,550
Nuevo Chagres	590
Achiote	4,040
El Guabo	5,340
La Encantada	13,440
Palmas Bellas	7,590
Piña	2,930
Salud	10,620
Capira	9,470
Ciri De Los Sotos	9,470
Arraijan	17,520
Nuevo Emperador	11,490
Santa Clara	6,030
La Chorrera	48,680
Amador	21,010
Arosemena	3,170
El Arado	5,630

Transisthmian Corridor Zone - 141,410 hectares

District/*Corregimiento*	Hectares
Colon	50,310
Buena Vista	11,450
Cativa	2,210
Limon	7,490
Nueva Providencia	1,730
Sabanitas	1,160
San Juan	4,130
Santa Rosa	2,690
Salamanca	19,450
Panama	91,100
Chilibre	91,100

Atlantic Urban Zone - 240 hectares

District/*Corregimiento*	Hectares
Colon	240
Barrio Norte	120
Barrio Sur	120

Pacific East Urban Zone - 61,650 hectares		Pacific West Urban Zone - 42,670 hectares		Gatun Lake and Costa Abajo Zone - 207,230 hectares		Transisthmian Corridor Zone - 141,410 hectares	
District/*Corregimiento*	**Hectares**	**District/*Corregimiento***	**Hectares**	**District/*Corregimiento***	**Hectares**	**District/*Corregimiento***	**Hectares**
Arnulfo Arias	740			Iturralde	7,860		
Belisario Frias	430			La Represa	4,350		
Belisario Porras	400			Mendoza	6,660		
Jose Domingo Espinar	710						
Mateo Iturralde	100						
Omar Torrijos	1,100						
Rufina Alfaro	950						
Victoriano Lorenzo	200						

Source: URS Holdings, Inc., taken from Information Bulletin Nº10 (Office of the Comptroller General of the Republic of Panama).

3.4 Legislation and Technical and Environmental Standards Applicable to the Sector and the Project

Due to the nature of the Project and of the Promoter, the applicable environmental regulations and standards include those based on the environmental laws of the Republic of Panama, those developed by ACP, those derived from international agreements and conventions, as well international finance organization guidelines. The latter include, mainly, those associated with the Principles of Equator, adopted to a great extent by international banking.

3.4.1 Relevant Panamanian Environmental Legislation

Panama has an extensive environmental legislation characterized by a sequential historical evolution from the perspective of human health, environmental health, the management of natural resources, and the protection of the natural environment, which finally led to the current integrated legislation that covers concepts such as sustainable development, pollution, the role of the citizenry, environmental control, environmental services and other related aspects.

The current **Constitution** of the Republic in Panama and the **General Environmental Law 41 of July 1, 1998**, establish that the administration of the environment is an obligation of the Government, and is therefore necessary for its protection, conservation, and restoration.

Law 41 of June 1, 1998, empowered the National Environmental Authority (ANAM) to regulate the process of Environmental Impact Assessment through the Executive Branch. The General Environmental Law, in its Title IV, Chapter II, defines the process of Environmental Impact Assessment and determines the stages such assessment must cover. According to this law, any activities, works, or public or private projects whose features, effects, location, or resources may generate an environmental hazard, will require an Environmental Impact Study before the Project starts.

Other regulations are established in Chapter 7, Title III of the Constitution of Panama; Articles 118 through 121 define the ecologic regime. Article 118 provides that the population must live in an environment that is healthy and pollution free, where air, water, and food meet the requirements for the adequate development of human life. Article 119 establishes that "the Government and all the inhabitants of the national territory have the duty of promoting a social and economic development that prevents environmental pollution, maintains a balance, and prevents the destruction of the ecosystems." Articles 120 and 121 assign to the Government of Panama the responsibility for regulating, monitoring, and applying the necessary measures to implement this policy. The contents of the preceding articles show that on environmental matters, the Government of Panama maintains criteria for a sustainable development of resources to ensure their sustainability and prevent their exhaustion.

Moreover, Article 289 of the Constitution of Panama provides that the Government must regulate an adequate use of the land according to its potential use and national development programs, for the purpose of ensuring its optimal utilization. This article does not limit land use to given projects, but rather establishes as the sole condition that the utilization of the land be done according to its potential use and according to national development programs.

Due to its nature and importance for the Panama Canal, the legal framework under Title XIV of the Political Constitution of Panama guarantees ACP's financial autonomy, its own patrimony, and the right to administer it. The Political Constitution establishes that ACP has the exclusive right to administer, operate, conserve, maintain, improve, and modernize the Canal and its related activities and services. It also assigns to ACP the responsibility for the administration, maintenance, use, and conservation of the water resources in the Panama Canal Watershed.

In addition to the above mentioned laws, there are various laws, decrees, regulations, and agency resolutions with provisions relative to environmental protection, such as the Health Code.

The following sections describe the major regulations that govern the Canal Expansion – Third Set of Locks Project.

3.4.2 Executive Decree on the Environmental Impact Assessment Process

In the year 2000, once the country's agency in charge of environmental matters was properly established and structured, the following step for the construction of an environmental model was the issuance of standards and regulations. On March 16, 2000, the Government of Panama decreed the Regulations for the Environmental Impact Assessment Process.

This decree was superseded recently by **Executive Decree Nº 209 of September 5, 2006**, which is now in force and is the legal instrument on environmental assessment that governs this document. The recent decree includes new concepts such as the ISO 14001 environmental certifications and others relative to the financial aspects of environmental costs, and seeks the management of environmental externalities. This Decree is currently being consulted and revised for its future amendment.

3.4.3 Other Pertinent Panamanian Regulations

Other regulations in force in Panama which apply to a diversity of cases and situations relative to this Project are:

Fauna:

Law Decree Nº 35 of September 22, 1966, on the use of Waters, established the protection of some wildlife elements in Panama.

The main regulatory body for the protection of fauna is **Law Nº 24 of June 7, 1995**, *"whereby legislation is established for the protection of wildlife in Panama."* It establishes that wildlife is part of Panama's natural patrimony and declares its protection, conservation, restoration, research, and management, and the development of genetic resources as well as rare and varied species of wildlife as responsibilities in the public domain, for the safeguarding and protection of natural ecosystems. In addition to such public responsibility for the protection of wildlife, Law Nº 24 imposes penalties for crimes against wildlife.

The above mentioned Law is complemented by **Resolution Nº AG-0172-2004 of May 19, 2004,** *"whereby matters relative to species of fauna and flora that are threatened and in danger of extinction are regulated, and other provisions issued."*

Flora:

The main regulation on the flora appears in **Law 1 of February 3, 1994**, whereby forestry legislation is established. This Law governs the protection, conservation, improvement, increase, education, research, management, and utilization of the forest resources in the Republic of Panama, to promote their rational and sustainable management and utilization. Its purpose is also to prevent and control soils erosion, protect and manage watersheds, control streams, restore mountain slopes, conserve forested lands and stabilize soils.

Land Use:

Law No. 21 of June 2, 1997 adopts the Regional Plan for the Development of the Interoceanic Region, and the General Plan for the Use, Conservation and Development of the Canal Area as instruments to regulate the territory of the Interoceanic Region and legal framework to incorporate the reverted assets of the Canal to the country's development, in accordance with **Law 5 of 1993**, as amended by **Law 7 of 1995**. This law regulates the use of the Canal Watershed lands in the Interoceanic Region.

Executive Decree Nº 283 of November 21, 2006, *"whereby Article 21, Chapter I, Title IV, Law 41 of July 1, 1998 is regulated,"* was recently issued and defines the criteria to organize the territory and regulate on such matters.

Quality Standards and Use of Waters:

Law No. 66 of November 1947, *"whereby the Health Code is approved"* (see Articles 88, 200, 202, 204, 206, 207 and 208), is relevant, as it pertains to the quality of water.

Law 21 of July 9, 1980, *"whereby regulations are issued relative to the pollution of sea and navigable waters,"* prohibits the discharge from ships, aircraft, and marine or land facilities connected or associated with said waters, of any polluting substance into navigable waters and the territorial seas of the Republic of Panama.

Law Decree N° 35 of September 22, 1966, *"whereby regulations are issued on the use of waters,"* regulates the use of this vital resource throughout the entire national territory. Its first three Articles, it establishes that all river, lake, marine, underground, and atmospheric waters within national, continental, and insular territory are assets in the public domain. The issues in this law decree are about public responsibility and social interest, and cover the use of water for household, public health, agriculture, farming, and industrial purposes, as well as for any other activity**.** In turn, Article 15 provides that water rights may be acquired only by means of a permit or concession for useful purposes, and establishes the priorities among the various uses.

Decree N° 70 of July 27, 1973, *"whereby permits for water use and concessions are regulated,"* (see Articles 7 and 8), issued by the Ministry of Agricultural Development, refers to the granting of water use permits and concessions.

Technical Regulation DGNTI-COPANIT 35-2000, on *"the discharge of liquid effluents directly into surface and underground bodies and masses of water,"* has the purpose of preventing the pollution of surface and underground bodies and masses of water in the Republic of Panama by means of the control of the discharge of liquid effluents from household, commercial, and industrial activities.

This Technical Regulation establishes the maximum permissible limits for the discharge of liquid effluents generated by the activities mentioned above into surface and underground bodies and masses of water according to the legal provisions in force in the Republic of Panama. This regulation also establishes specifications for sampling, discharge control frequency, and maximum permissible limits.

Technical Regulation DGNTI-COPANIT 39-2000, on the discharge of liquid effluents directly into sewerage systems, establishes the requirements to be met for discharges of liquid effluents from household, commercial, and industrial activities into the sewerage, according to the legal provisions in force in the Republic of Panama, to prevent adverse effects on sewage water treatment processes such as damage to sewerage networks (due to corrosion, scale or obstruction), the generation of unpleasant smells, the formation of toxic or explosive gases, and the interference with the biologic treatment of sewage water. This Regulation also establishes specifications for sampling, discharge control frequency and maximum permissible limits.

Waste Disposal Regulations:

There are very few regulations and standards existing in Panama on waste disposal. However, international regulations have been adopted, such as Law 21 of December 6, 1990, whereby the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and its Disposal, and the Transboundary Agreement on Hazardous Waste of the Montreal Protocol, of which Panama is a signatory, are approved.

Among the general regulations that establish the principles of waste management are the **Panama Health Code**, the **General Environmental Protection Law**, and the **Law on Municipal Administration**.

Technical Regulation DGNTI-COPANIT 47-2000, on the Use and Final Disposal of Sewage Sludge, governs sewage management and disposal treated waste. It defines the maximum pollutant limits to be met for sludge, according to its proposed use. Likewise, it establishes acceptable treatment methods according to the type of sludge, containment requirements, and the need for sampling.

Emissions and Air Quality Regulations:

The Panamanian regulations on emission and inmissions are specifically for the power sector, and apply only to plants with liquid fuel combustion; therefore, they may not be directly applicable to the proposed Project. In the absence of local regulations, there are applicable international standards that environmental organizations such as the World Bank use with regard to these matters.

While Panama air quality regulations do not apply to the proposed Project, the limits established for these regulations are used as reference for other industrial sectors. In this regard, they are included in the reference framework.

Resolution DG-0025-98 of June 30, 1998, "*whereby Emission and Inmission Standards are adopted for Environmental Control at the Power Generation, Transmission, and Distribution Installations of the Panama Institute of Hydraulic Resources and Electrification (IRHE)*," was issued when the power service was under the control of the Panamanian Government. It establishes permissible emission levels and the environmental standards on total suspended particles (TSP), sulphur oxides (SOx), and nitrogen oxides (NOx), for thermal power plants using liquid fuel. Article 2 of this resolution was amended by **Resolution No. 0020-98 of November 11, 1998** issued by the Panama National Environmental Authority (ANAM), to issue new standards on permissible emission levels. The established inmission criteria (environmental standards), as well as the amended criteria for emissions, are shown below on Table 3-8.

Table 3-8

Panama Ambient Air Quality and Pollutant Air Emissions Regulations – Applicable to Thermal Power Plants

Pollutant	Air Quality Concentration		Pollutant Emissions
	24 hour Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)	Annual Average
PM (as TSP) [(a)]	360	90	0.07 lbs per MMBtu
NO_2	---	100	0.3 lbs per MMBtu
SO_2	400	120	100 tons per day

Source: Resolution No. 0020-98 and Resolution No. DG-0025-98
[(a)]TSP: Total Suspended Particles.

The **Draft Bill on Ambient Air Quality** (still in the discussion phase), *"whereby Ambient Air Quality Standards are issued,"* has the objective of establishing primary air quality standards for the pollutants Nitrogen Dioxide (NO_2), Carbon Monoxide (CO), Breathable Particulate Matter (P_{10}), Sulphur Dioxide (SO_2) and Ozone (O_3), as well as the guidelines for their application, for the purpose of protecting the health of the population and the environment in general. The established maximum levels are:

Table 3-9

Primary Air Quality Standards
(Draft bill in the discussion phase)

Pollutant	Unit	Standard Values	Average Sampling Time
Breathable Particulate Matter (PM_{10})	$\mu g/m^3N$	50	Annually
		150	24 hours (98%)
Sulphur Dioxide (SO_2)	$\mu g/m^3N$	80	Annually
		365	24 hours (99%)
Carbon Monoxide (CO)	$\mu g/m^3N$	10 000	8 hours
		30 000	1 hour
Nitrogen Dioxide (NO_2)	$\mu g/m^3N$	100	Annually
		150	24 hours (99%)
Ozone, (O_3)	$\mu g/m^3N$	157	8 hours
		235	1 hour

Source: National Environmental Authority (www.anam.gob.pa). 2007.
Compliance: PM_{10}= 98 percentile; SO_2 and NO_2= 99 percentile in 24 hour averages.

With regard to the Draft Bill on Environmental Protection Standards on Emissions from Fixed Sources (still in the discussion phase), *"whereby the Environmental Protection Standards on Emissions from Fixed Sources are issued,"* its objective is to establish maximum permissible limits on emissions into the air produced by fixed sources, for the purpose of protecting population health, natural resources, and environmental quality, from atmospheric pollution. This draft bill proposes the establishment of maximum permissible limits of emission from fixed sources, as shown on Table 3-10 below:

Table 3-10[16]

Maximum Permissible Limits of Air Emissions from Fixed Sources[15]
(Draft bill in the discussion phase / World Bank Reference Guide, 1998)

Activity (CIIU)	Maximum Permissible Limits (mg/Nm^3, unless another unit is shown)[a]		
	Total Particulates	Sulphur Oxides	Nitrogen Oxides
Thermal Power Generation[b] (4101)	50[c, d]	0.2 tpd/MW (up to 500 MW) 0.1 tpd/MW (increments over 500 MW) May not exceed 2000 mg/Nm^3 or 500 tpd	Coal: 750[e] Petroleum: 460 Gas: 320
Thermal Power Generation With Gas Turbines (4101)			Gas: 125 Nº 2 Diesel: 165 Nº 6 Bunker and others: 300
Other Activities[i]	50[f] 100[g]	2000[h]	Coal: 750 Petroleum: 460 Gas: 320

Source: National Environmental Protection Authority (www.anam.gob.pa). 2007.
a. 13 millibars of pressure (1 013 mbar) or one hundred and one with three kiloPascals (101.3 kPa) and a temperature of 0 °C or 273.15 ºK, on a dry base, corrected to 15% oxygen, are considered as normal conditions.
b. In the case of thermal power plants with internal combustion engines, a maximum of NOx of 2000 mg/Nm^3 will be allowed for those installed after the year 2000, and 2,300 mg/Nm^3 for those installed prior to that date.
c. The limit applicable to plants with a capacity of less than 50 MW is 100.
d. To rehabilitate existing plants, the limit is 100.
e. For coal with less than 10% volatile matter, the applicable limit is 1500.
f. For installations with the same capacity or more than 50 MW.
g. For installations with a capacity of less than 50 MW.
h. Expressed as SO_2
i. Refers to activities not included in this Table.

Other regulations relative to emissions are **Law Nº 36 de 1996**, *"whereby controls are* established to prevent environmental pollution caused by fuel and lead," that requires the use of emission control devices and

15 Only the maximum permissible limits that pertain to activities that may be of interest for this Project are shown..

regulates the use of leaded gasoline, and **Executive Decree Nº 255 of 1998,** that establishes emission levels from moving sources (currently in the revision phase).

Noise Abatement Ordinances:

Executive Decree N° 306 of September 4, 2002, *"whereby regulations are adopted for the abatement of noise in public spaces, household or residential areas, as well as in the workplace,"* establishes maximum admissible sound levels of continuous noise for persons on eight hour shifts at their workplace, as follows:

For jobs with constant and intense mental activity, 50 decibels (dB)
For office jobs and similar activities, 60 decibels (dB)
In other places (such as factories, industries, work shops), 85 decibels (dB)

All these values will be measured at the areas where operators usually perform their duties. The organization is also required to take worker audiometric readings periodically every six months.

Moreover, Article 7 of this Decree prohibits the exceeding of the noise intensity levels outside residences or the premises of factories, industries, work shops, stores, bars, restaurants, discotheques, commercial establishments, households, other locations or residences where the activity generates noise, in the vicinity of buildings or houses destined for residence or housing, according to the following parameters established by **Executive Decree No. 1 of January 15, 2004**, which amended Article 7 of that Decree:

Schedule	Maximum Sound Level
From 6:00 a.m. to 9:59 p.m.	60 decibels (dB)
From 10:00 p.m. to 5:59 a.m.	50 decibels (dB)

The measurement of noise to determine violations of such an ordinance will be taken at the various residences or rooms of those affected. When the background or ambient noise in factories, industries, work shops, stores, bars, restaurants, discotheques, commercial establishments, housing, other locations, or permanent activities exceeds the minimum sound levels in these ordinance, noise will be abated as follows:

> For residential areas or areas in their vicinity, the level of background or ambient noise in the zone may not be raised.
>
> For industrial or commercial areas, without prejudice to residences, only a 3 dB increase may be allowed over ambient noise.
>
> For public areas, without prejudice to residences, an increase of 5 dB over background or ambient noise may be allowed.

Worker Safety and Health Standards:

With regard to standards, **Technical Regulation DGNTI-COPANIT 44-2000,** *"Safety and Health Conditions in Working Environments where Noise is Generated,"* establishes measures to improve safety and health conditions at workplaces where the features, levels, and exposure time of the noise generated are capable of affecting worker health, as well as the correlation between the maximum permissible noise levels and the maximum exposure time per work shift.

It is important to note that this regulation pertains to the permissible exposure levels during an eight hour work shift.

Permissible Noise Exposure Levels

Maximum Exposure Time (during an eight hour shift)	Permissible Noise in dB(A)
8 hrs	85
7 hrs	86
6 hrs	87
5 hrs	88
4 hrs	90
3 hrs	92
2 hrs	95
1 hrs	100
45 minutes	102
30 minutes	105

Maximum Exposure Time (during an eight hour shift)	Permissible Noise in dB(A)
15 minutes	110
7 minutes	115

Source: Technical Regulation DGNTI-COPANIT 44-2000.

Workers exposed to noise levels over those established in the above Table will be required to use personal protection equipment (hearing protectors, plugs or both, as the case may be).

Concerning vibrations exposure , **Technical Regulation DGNTI-COPANIT 45-2000,** on *"Industrial Safety and Health Conditions in Working Environments where Vibrations are Generated,"* has the objective of establishing measures to protect worker health and improve safety and health at workplaces where vibrations that are generated or transmitted at a level and over exposure times capable of affecting worker health. It also seeks to establish the correlation between the maximum permissible levels and the maximum exposure time per work shift. The most important item in this Regulation is the table showing the admissible local vibration levels on the various octave bands.

Vibration Exposure Levels

Band center frequency (Hz)	Admissible vibration acceleration value (m/s^2)
8	1.4
16	1.4
31.5	2.7
63	5.4
125	10.7
250	21.3
500	42.5
1000	85

Source: Technical Regulation DGNTI-COPANIT 45-2000.

Another regulation on health and safety conditions at the workplace is **Technical Regulation DGNTI-COPANIT 43-2001,** on "*Industrial health and safety. Health and safety conditions for the control of atmospheric pollution in the work environment, produced by chemical substances,"* that establishes measures to prevent and protect worker health and improve the health and safety conditions at work sites where chemical substances are produced, stored, or handled at concentrations and exposure times capable of polluting the work environment and affecting worker life or health; and also specifies the maximum permissible concentration levels of such substances, according to the type of exposure.

The most important items of the regulation and its applicability are:

Requirements, meaning the controls and assessments to prevent workers health alterations; **Duties**, dealing with the obligation of explaining to workers the possible health effects of exposure to chemical substances; **Recognition,** the identification of the products that can generate environmental pollution; and **Qualitative Hazard Assessment**. The regulation limits the maximum exposure levels for various substances, over the short and long range.

Panama Fire Department Regulations:

Resolution Nº 03-96, C.O.SE-P.I. of April 18, 1996, and Resolution CDZ-00-3/99 of February 11, 1999, *"whereby Resolution Nº CDZ-10/98 of May 9, 1998 is clarified, and the Technical Fuel Safety Manual for the installation, storage, handling, distribution, and transportation of petroleum derived products is amended,"* which updates and standardizes the regulations and specifications governing private, industrial or other types of manufacturing, elaborate, approval, construction, and inspection of installations that sell and store petroleum derived products.

Chapter IX on **Compressed Gases** has the object of protecting the life and properties? of persons from hazards from the manufacture, bottling, sale, and use of compressed gases; and specifies minimum mandatory requirements and practical recommendations, without necessarily being the maximum safety conditions from a point of view of convenience and effectiveness.

The following regulatory Articles are worth mentioning: **70-9**, which establishes the color of the cylinders according to their contents; **89-9**, whereby instructions are provided for the handling of compressed gas cylinders, **95-9** and **108-9 Paragraph**, which establishes the conditions of the locations where compressed gas may be stored, and the types of lamps and switches.

Chapter XIX on **Extinguishers** establishes the minimum requirements for every type of fire extinguisher. This chapter is quite extensive; however, it is necessary to point out some articles, the compliance of which is of vital importance: **Number and Type of Extinguishers, Classification of Various Types of Hazards**, and **Obligations, items #2 and #3.** These articles establish the obligations of the extinguishers owners and provide a fire extinguisher maintenance reference table.

National Historic Patrimony:

ANAM has issued Resolution **Nº AG 363-2005** for the preservation of historic patrimony that establishes the mandatory recording of national historic and archaeological finds. This Resolution is in support of Law 14 de 1982, known as the Historic Patrimony Law.

Ecologic Compensation:

Resolution ANAM **Nº 235-2003** establishes "payment of ecologic compensation, the issuance of permits for clear-cut or clearing undergrowth or grassy formations, as required for the execution of development, infrastructure and building projects."

Other regulations:

Title V of **Cabinet Decree N° 7036-03 of September 17, 2003**, "*whereby a national policy is established on hydrocarbons in the Republic of Panama, and other measures are taken*," deals with matters relative to issuance of facilities for private installation, yard pumps, transportation, and safety. Title XI describes articles on installation safety and environmental protection.

3.4.4 *Autoridad del Canal de Panama* – ACP (Panama Canal Authority)

The legal framework of the Republic of Panama consists of the Political Constitution, national legislation, international treaties, Cabinet and Executive Decrees, and Municipal and City Hall Agreements, Decrees, and Ordinances. Title XIV of the Political Constitution of Panama establishes that the Canal is an inalienable patrimony of the Republic of Panama, and may not be sold, conveyed, mortgaged, or otherwise encumbered or transferred. It also created the *Autoridad del Canal de Panama - ACP* (Panama Canal Authority) and established it as an autonomous, legal entity under public law.

ACP is different from other Panama Government agencies in that it operates in accordance with Title XIV of the Political Constitution, Law No. 19 of June 11, 1997 (the Organic Law) and the regulations approved by the ACP Board of Directors. According to Article 134 of the Panama Canal Organic Law, this Organic Law takes precedence over other regulations. As such, the autonomy of the Panama Canal is exercised primarily on its administrative, financial and operating scope.

The responsibility for the conservation and management of Canal water resources has been assigned to ACP by means of legislative provisions. As a result of this legal mandate, ACP has acquired a more active and participative role with regard to the integral management of the Panama Canal Watershed.

Due to the nature and importance of the Canal for the Republic of Panama, its legal framework guarantees ACP's financial autonomy, its own patrimony, and the right to administer same. This framework establishes that ACP is exclusively responsible for the management, operation, conservation, maintenance, improvement, and modernization of the Canal and its related activities and services. It also assigned to ACP the responsibility for the management, administration, maintenance, use, and conservation of the water resources in the Panama Canal Watershed.

The Board of Directors is in charge of managing the ACP and has 11 Board Members empowered by the Political Constitution and Organic Law to approve regulations for the purpose of developing the general policies of ACP. The Panama Canal Register is the publication used to post the regulations approved by the ACP Board of Directors.

The regulations and decisions of the Board of Directors are developed by means of internal ACP manuals, standards, and procedures, such as the ACP Environmental Assessment Manual and the occupational, industrial health, and marine safety standards. The text of the Organic Law, in its chapter on the environment, reads as follows:

Chapter VII

Environment and the Canal Watershed

1. To manage the water resources for the operation of the Canal and the supply of water for consumption by surrounding communities.
2. To safeguard the natural resources of the Canal watershed, especially in critical areas, for the purpose of preventing a reduction in the indispensable supply of water to which the above paragraph refers.

Article 121. *The regulations adopted by the Authority shall consider, among other matters, the following:*

a. The protection, conservation, and maintenance of the water resources of the Canal watershed in coordination with competent authorities.

b. The protection, conservation, maintenance, and improvement of the environment in Canal operations areas of compatibility and its system of lakes, in coordination with competent authorities.

Regulation (Agreement) 116 of July 27, 2006, *"whereby the Regulations on the Environment, Canal Watershed, and the Interagency Commission on the Panama Canal Watershed"*, includes important precepts, such as: (1) prevention of environmental pollution; (2) protection of natural, cultural, and paleontological resources; (3) administration, use, and conservation of water resources; (4) the evaluation of environmental impacts, and (5) environmental health.

The areas under ACP environmental responsibility, as specified in Agreement 116, are:

- Areas belonging to ACP and under its exclusive administration, including the waterway, its anchorages, landings, and entrances; its lands and ocean, lake, and river waters; the existing locks and auxiliary dams; dikes and water control structures. Also, Gatun and Madden (Alhajuela) Lakes, over which ACP has exclusively management rights up to 100 and 260 feet PLD, respectively;

- Canal operation compatibility areas: geographic areas that include lands and waters described in Annex A of the ACP Organic Law, where only activities compatible with the Canal operation may be conducted.

In addition to the provisions mentioned above, ACP has developed a series of standards, rules, and manuals that regulate the various environmental aspects. The main complementary tools developed by ACP relative to environmental control include:

- ESM-101 Ambient Noise Reduction
- ESM-102 Environmental Regulations for the Protection of Biodiversity and Cultural Resources
- ESM-103 Oil Handling and Utilization
- ESM-104 Handling of 55 Gallon Drums
- ESM-105 Storage Tanks
- ESM-106 Metal Waste Recovery and Handling
- ESM-107 Handling of Solid Waste
- ESM-109 Ambient Air Quality Standard[16]
- ESM-110 Fixed Source Emission Environmental Standard[17]

16 This standard establishes control parameters and values similar to those defined in the ANAM draft bill on Air Quality.
17 This standard establishes control parameters and values similar to those defined in the ANAM draft bill on fixed source emissions in thermal power generation.

3.4.5 The Panama Canal in the International Context

The Panama Canal, by virtue of the Neutrality Treaty in the 1977 Torrijos-Carter treaties, has opened doors to all nations. The Neutrality Treaty establishes that the Canal, being an international transit waterway, will be permanently neutral and will remain open to the transit by the vessels of all nations without any discrimination. It also provides that both in times of war and of peace, it shall remain safe and open for the peaceful transit of vessels of all nations in terms of full equality.

3.4.5.1 International Standards and Guidelines

International directives and standards on environmental, social, and economic matters are key aspects to be considered for any of the country's important national projects. In order to understand the international standards relative to environmental, social, and economic matters that also apply to any Project requiring private financing, it is necessary to know the International Finance Corporation (IFC) Performance standards. It is important to note that the environmental and social directives of the IFC and the World Bank, although not identical, are consistent and totally aligned.

Due to the fact that IFC standards affect the directives and requirements of many other national and international credit organizations that could have participation in the financing of the Expansion Project, they merit some discussion here:

- The Equator Principles are consistent and refer to IFC policies that have been agreed upon and ratified by several national and international banks for the financing of projects[18]. All project clients in this category must adhere to such project planning, implementation, and dismantling principles.

[19] Project Finance has been defined by the signatories of the Equator Principles "a method of funding in which the lender looks primarily to the revenues generated by a single project, both as the source of repayment and as security for the exposure....'

- IFC social and environmental policies are a set of operational policies and guidelines to which all IFC (a branch of the World Bank for private sector investment[19]) clients must adhere.

- IFC policies and the Equator Principles have recently been revised. In 2006, the Board of Directors of IFC adopted new social and environmental guidelines known as Operational Policies and Guidelines for Social and Environmental Sustainability[20].

3.4.5.2 Bilateral, Multilateral, and Regional Treaties and Agreements

The Panama Canal is the object of the Treaty Concerning the Permanent Neutrality and the Operation of the Panama Canal subscribed between the United States and Panama, which became effective on October 1, 1979, continues to be in force, and has been adhered to by 40 countries. This Treaty establishes that the Canal must be administered efficiently, subject transit conditions and regulations that must be fair, equitable, reasonable, and limited to those necessary for the safe navigation and efficient and sanitary operation of the Canal. This treaty establishes that tolls and other transit service and related fees shall be fair, reasonable, equitable, and consistent with the principles of international law.

In addition, ACP adhered to the U.N. Global Compact in December 2002, and to the World Bank Council for Sustainable Development known as WBCSD in August 2002.

It must noted that Panama is a signatory to a series of International agreements and conventions on environmental protection, which requires it to adopt, as a country, measures and procedures on matters of world interest. The major international agreements and procedures are:

- Rio Declaration on Environment and Development
- Convention on Biological Diversity
- United Nations Convention on Climate Change and Kyoto Protocol

[20] FAQs on IFC Policies and Guidelines.
[21] These guidelines were previously known as 'Social and Environmental Protection' guidelines.

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes
- Montreal Protocol on Substances That Deplete the Ozone Layer
- Stockholm Convention on Persistent Organic Pollutants
- Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
- ILO 148 Working Environment Convention

3.5 Description of Project Phases

This section on the phases of the Project includes the Planning and Design, Construction of the Works for the Canal Expansion, and the Operation of the Expanded Canal. It does not actually contemplate the abandonment of the existing Canal or of the expanded Canal. The subject of the dismantling or abandonment of the working areas during the construction is considered relevant and necessary, and is included as part of the abandonment phase. The following is a description of the major tasks and activities, by phase.

3.5.1 Planning Phase

It can be said that the planning phase was already being implemented during the years when the Panama Canal Master Plan was still being drafted. Part of this planning phase has consisted of all the technical, environmental, social, economic, and financial studies conducted as part of the process of formulating the Plan.

During this planning stage, the basic information on the Project was collected through field visits, (such as sampling and surveying), and the existing secondary information was revised. A general description of the Project was also made, including the parameters to be followed in the specifications of the contracts for each one of the Project activities.

The works schedule still pending for the Canal expansion includes a series of preliminary construction activities that qualify as part of the planning and design of the Project. They include the preliminary designs, models, specifications, and contracts, and finally, the awarding of contracts to builders. This first phase will take two to three years with respect to the lock component. The proposed Project planning, which consists of the necessary preliminary work to start the construction of the northern approach channel on the Pacific Side, has run parallel to the Canal Expansion Project, and at this time is in the preconstruction phase.

The Environmental Impact Study is an important component of this planning phase.
It identifies the environment and social conditions of the areas that will be affected by the proposed Project, and the possible impacts its activities may have. This phase has been undertaken on the basis of the existing information available at ACP, and has been complemented with field visits and meetings with the ACP staff. This phase is included in the EIS, and will be submitted to ANAM for evaluation prior to the start of the Third Set of Locks construction work.

3.5.2 Construction Phase

The construction phase includes dry excavation and the dredging of the new access channels; the concurrent implementation of the construction of both locks with its water saving basins; the construction of the dikes required for the northern access channel on the Pacific Side; the dry excavation and the dredging to widen the existing navigation channels at Gatun Lake, Gaillard Cut, and the sea entrances; and the raising of the maximum operating level of Gatun Lake. The dry excavation and the dredging will start in the year 2007, and will require approximately seven years.

The raising of the maximum operating level of Gatun Lake will start in the second half of the construction period. For such purpose, both the existing locks as well as the Canal installations along the banks of Gatun Lake will need to be adapted over a period of approximately four years, for completion in the year 2014. Due to the fact that the Project consists of multiple components, it is expected that the construction of some elements will start while the preconstruction of other components is carried out. Thus, it is expected that dredging activities, specifically to be conducted by ACP, will begin immediately after the Project is approved. Other activities, such as mobilization, infrastructure, site construction preparation, and dry excavation and dredged material disposal sites, will begin first and may be completed while lock design advances. Construction activities will not affect normal Canal operations.

3.5.2.1 General Strategy

The strategy for the construction of the locks and water saving basins is to conduct a competitive selection of an international Contractor according to the design and construction scheme. This Contractor will be also responsible for the access channel on the Atlantic Side, and the access channel south of the Pacific Side lock. The construction of the access channel north of the Pacific locks will include a combination of responsibilities.

The Borinquen dikes will be designed by an independent Contractor. The construction of dikes 2E, 1W, and 2W, as well as the connection with the locks will be the responsibility of the Contractor hired for the design and construction of the locks. The rest of this access channel, including dike 1E, will be the object of five contracts for the excavation, construction, and production of material for backfill and aggregates. The deepening and widening of the existing navigation channels and the raising of the maximum operating level of Gatun Lake will be done with a combination of works performed directly by ACP, with specific contracts for design, dredging, excavation, and construction.

The construction phase includes mobilization and construction of the temporary facilities for the works; temporary and permanent access roads; clearing, stripping, and grubbing; excavation and backfill; blasting, slope stabilization and cutting, dredging, deepening and dredging of channels; management of excavated and dredged material disposal sites; construction of locks and water saving basins; construction of the Borinquen dikes; the raising of the level of Gatun Lake; and construction of mechanical and electromechanical work shops, and of the control and navigation systems.

On the Pacific area, it will be necessary to divert Cocoli River and the southern branch of the Rio Grande River. Cocoli River will be permanently diverted to the sea; while the Rio Grande River will be permanently diverted to Gaillard Cut. The material excavated on the Pacific Side that is not be used for the production of concrete aggregates, lock backfill, or earth dam construction will be deposited in the Cocoli River valley, downstream from the diversion dam.

In the areas to be excavated on the Atlantic Side there are no good sources of material, and it has been proposed that materials for use as aggregates, backfill, and foundation layers be taken from the excavation on the Pacific Side access channel. This material will be processed and transported to the Atlantic Side by rail. There is also the alternative of moving it by barge. The material from the Atlantic locks excavation will go to Gatun Lake, outside the navigation channel; and the material from the northern plug will go to the Mindi disposal site. Finally, it is expected that an alternate route will be built for traffic requiring access to the west bank.

3.5.2.2 Mobilization and Construction of Temporary Support Facilities

The tasks pertaining to this activity item are related to the construction and/or conditioning of the working areas that are closed off to Contractor workers, and to the installation of construction support infrastructures.

Once Contractors are selected for the works, they must submit for consideration by ACP their specifications for the temporary support infrastructures and facilities they intend to use, which must be adapted to meet environmental and safety requirements according to the regulations in force, or good acceptable practices.

3.5.2.2.1 Infrastructure support installations

Construction support installations will include a diverse series of structures and components to facilitate access and transportation of materials and equipment, their proper maintenance and the manufacture of aggregates, concrete, etc., the most important of them being:

Docks: A dock is required to unload construction equipment and materials both on the Pacific as well as on the Atlantic side, on an area of approximately 3 hectares each, including a section to be used as needed, for some seven (7) 1,200 ton silos to unload and store cement. On the Pacific Side, this dock would be located southwest of the new locks. On the Atlantic Side, such a dock would be located northwest of the new locks. Both docks would continue to be used once the construction phase is completed, in order to move workers by boat to transiting vessels and to dock tugboats.

Crushing Plant: A crushing plant will be installed on the Pacific Side to process the basalt rock material obtained from the excavation of the upper and intermediate chambers of each of the new locks for the production of gravel to be used in the manufacture of the concrete required for the chambers, water saving basins, backfill, and roads. The operation of this plant requires some 750 m^3 (200,000 gallons) of raw water per day.

Concrete Plants: At least two plants are being considered (one on the Atlantic Side, and one on the Pacific Side), each with a production of 2 million cubic meters of concrete for the construction of the locks, water saving basins, and buildings around the locks. Gravel and sand stacks, water, and silos for cement and additives will be kept in the vicinity of the locks. The approximate area each plant would occupy, with its corresponding storage sites, would be 15 hectares. The concrete works will require the cooling of one or more components; water, the easiest to cool, must be refrigerated or chilled with ice or liquid nitrogen. A quality control laboratory will be required to test the concrete and control components prior to and after pouring the concrete.

Ice and Chilled Water Plants: Chilled water plants are needed to process the aggregate and the ice for the concrete plants. They use raw or treated water and require an area of approximately two hectares each within the 15 hectares of the corresponding concrete plant. On the Atlantic, water may come from Gatun Lake, while the sources on the Pacific Side could be wells, the Cocoli River, or Gaillard Cut.

Sewage Treatment Plants: The Contractor will install water treatment systems for the construction phase in working areas (Atlantic and Pacific), and sewage treatment plants for the operations phase. These systems must include the management of household sewage, as well as the water for the processes. Like consideration will be given to the proper management of runoff, so that it will not become a source of pollution. The specifications for these plants will be prepared according to the regulations in force.

Heavy equipment parking areas: Both locks locations require a special parking area with a surface of approximately 14 hectares for heavy equipment, maintenance shops, and spare parts and fuel storage.

3.5.2.2.2 Temporary structures

The required temporary buildings include concrete block, one-slab, one-story, single row buildings for offices, work shops, first aid stations, mess halls, employee pickup stations, and soils laboratories. Worker camps were not considered due to the fact that Project locations are near to the major urban hubs in the country and that worker transportation will be provided. An area of 0.05 kilometers^2 (5 hectares) is contemplated for vehicle parking lots, field offices, mess halls, lockers, and restrooms for the administrative and construction staff.

General areas designed in advance will be used for these temporary structures for Contractor use, allowing the Contractor to organize the type that most suits its needs, within established limits. During the establishment process, actions such as the following are expected: earth leveling; land clearing; construction of offices, sheds with restroom facilities (for security and surveillance employees), galleys and mess halls, and sanitation infrastructure (water and drainage); and preparation and construction of an equipment storage yard that would include storage facilities for items such as fuel, lubricants and other supplies, machine shops, and mechanical repair shops.

The proposed sites have been selected due to their location with regard to the areas of the work to be performed, as each one must provide the basic services needed for a proper operation, such as access, electricity, piped-in water, drainage, commercial and supply services, basic medical and security (police), etc., within the Canal operating area and under the authority of ACP.

Determination of the final working areas and equipment storage yards will depend on the number of equipment, workers, and materials the Contractor must keep on hand to perform the Project. Nonetheless, an area of two hectares with the following features has been estimated: little vegetation without an apparent use, preferably on flat land, at a minimum distance of 250 meters from any superficial water course and/or water extraction wells or water supply sources.

The Contractor must provide sanitary facilities for personal hygiene and change of work clothes, equipped with toilets, lavatories, and showers; in addition, in the event the area lacks sewerage infrastructures, it must provide separate facilities for men and women.

3.5.2.3 Borrow Materials and Manufacture of Aggregates

The material for backfill, impervious screens for dikes, and the manufacture of aggregates will be obtained mainly from the actual excavation and processed at the plants described above. Nonetheless, with the challenges posed by the Canal Expansion Project many investment areas have been identified because of a large demand for products. Products required by the Expansion Project include: *construction materials, forms, steel, crushed rock,* and *cement.* ACP has decided that the materials to build this Project will be obtained from sources that provide the best products and conditions, and comply with the required quality, delivery, and service standards.

3.5.2.4 Construction of Temporary and Permanent Access Roads

Rehabilitation and preparation of several roads leading to the various working areas will be required and will serve to haul materials. Temporary access will be needed for earth movement, construction, relocation, or rehabilitation of access roads to the sites, offices, and work shop areas. The work to be performed includes clearing, grubbing, leveling, and excavation. Driveways, parking lots, fences, and access booths will be built. In addition, the Contractor will be responsible for providing the necessary maintenance to temporary and permanent access roads.

On the Pacific Side, the existing Borinquen Road that provides access to the west side of the Miraflores, Pedro Miguel, and Miraflores locks, as well as Gaillard Cut, must be relocated to the west of the new access channel and the new locks. This road is approximately eight (8) kilometers long from the main access to the Project site. During construction, a temporary haul road must be built across the dam to be erected between Miraflores Lake and the new access channel. This road will be used to haul materials during the construction of the new lock, and will continue as operational access to the existing Pedro Miguel lock.

On the Atlantic Side, the rehabilitation of approximately 1 kilometer of the existing road will be needed to provide access to the east side of the Project area, as well as two kilometers of new road parallel to the lock alignment for 58 ton trucks. Moreover, it is assumed that the concrete aggregate will come from the Pacific locks excavation, and carried to the site by rail. To do so would require the rehabilitation of the railroad tracks that run across the southern plug and then to the former Gatun town, or the construction of a branch from the existing railroad track. With such a configuration, the concrete mixing plant could be placed at the southeast end of the alignment, near Gatun Lake. Finally, it would also be necessary to build a road to haul excavated material from the lock to the area where a dock would be constructed to collect waste material at the disposal site on the banks of Gatun Lake.

Construction of Roads for Heavy Equipment

Temporary roads will be built for heavy equipment that will haul excavated material and rock for processing or use in the construction area. These would be temporary roads made of a base layer of crushed rock, 20 meters wide and 8 kilometers long on the Pacific Side, and 5 kilometers on the Atlantic Side. They will be located within the locks area and will lead to the disposal sites.

Construction of Permanent Roads

On the Pacific Side, roads must be built on both sides of the access channel and the locks to replace Borinquen Road, as well as for the maintenance and operation of the locks. The roads on both sides of the access channel and the locks would be 7 meters wide and the length of each would be 6.5 kilometers. On the Atlantic Side, it will be necessary to construct or rehabilitate a road to connect both the new and the existing locks.

3.5.2.5 Clearing, Stripping, and Grubbing

The first activity that must be performed in the construction phase is the removal and clearing of the first layer of the soil in the study area, which consists mainly of vegetative cover and organic matter. This activity is required both for the leveling of Cartagena Hill, the realignment of the new Borinquen Road, and the relocation of the power transmission lines, the preparation of the disposal site at T6 and, if required, of the other auxiliary infrastructures and temporary structures.

Clearing, stripping, and grubbing and/or cleanup at the construction sites at the new Pacific and Atlantic locks alignment will need to be done. This also includes the preparation of the access roads to borrow material sites (quarries), excess materials (storage), closed work areas and equipment storage yards, as well as detour roads as needed to prevent vehicle traffic jams on the main roadways or the local roads that serve to provide maintenance to the Canal.

The following is a brief description of the land through which the Pacific side lock alignment will run:

Table 3-13

Pacific Side Lock Alignment

Alignment	Description
Pacific Side Lock	This alignment is very close to the west side of Miraflores and Pedro Miguel locks. It traverses a surface of 255.9 hectares over practically firm terrain next to the former town of Cocoli (to the south) and over Paraiso Hill (to the north). The basin area is located over the two artificial ponds created by the 1939 excavation. On the basis of the above, it is estimated that the land use distribution will be as follows: 34% water, 12% intermediate secondary forest, 2% mangrove, and the remaining 51% will be grassland, undergrowth, and for urban use.

Source: URS Holdings, Inc. with ACP and URS data bases.

The following is a brief description of the land through which the Atlantic Side locks alignment will run:

Table 3-14

Atlantic Side Locks Alignment

Alignment	Description
Atlantic Side Lock	This option has a surface of 141.8 hectares, mostly across an artificial pond created by an old excavation known as the 1939 Third Set of Locks that was never completed. However, the basin construction area will affect areas of the former Gatun town covered with grass and for urban use. On the basis of the above, it is estimated that the land use distribution will be as follows: 49% water, 15% intermediate secondary forest, and the remaining 36% will be grassland, undergrowth, and urban use.

Source: URS Holdings, Inc. with ACP and URS data bases.

3.5.2.6 Runoff Control and Diversion

During the construction of both locks, a drainage system must be installed that will operate during most of the construction phase to keep water away from the excavation area. It will also be necessary to divert the waters of the Cocoli and Rio Grande Rivers on the Pacific Side.

3.5.2.6.1 Diversion of the Cocoli River

The Cocoli River represents one third of the Miraflores Lake Watershed, and its own watershed covers 2,770 hectares. ACP Engineering Division estimates have determined that the design volume of this river over a return period of 20 years is of 300 m^3/s; this is the volume used to determine the dimensions of the diversion infrastructure. Therefore, in order to perform the dry excavation of the access channel from Gatun Lake, and the Pacific locks and water saving basins, the Cocoli River must be diverted to the ocean.

In addition, control of the river flow will require the construction of a dam to manage flooding without the need to build a reservoir. This would be a permanent structure, and would divert the river to an open channel flowing south to the Pacific approach channel. The channel has a length of 2,575 meters and will be 10 meters at the base, requiring the excavation of approximately

450,000 m^3. The concrete slab will have a thickness of 0.30 meters, with 1.5H:1.0V rock protected side slopes.

3.5.2.6.2 Diversion of the southern branch of the Rio Grande River

The southern branch of the Rio Grande River, along with Conga and Sierpe, its tributaries, must be diverted toward Gaillard Cut. This river's watershed is smaller than that of the Cocoli River, and will require a shorter diversion channel (1,650 meters long). The diversion will be done by redirecting the Magallon creek toward Gaillard Cut. The headwaters of this stream are between the North 1 and North 3 disposal sites, and it will flow on a northerly course into Gaillard Cut south of the Centennial Bridge. The diversion channel will be excavated on land with elevations up to 50 meters PLD, and will take water by gravity into Gaillard Cut.

3.5.2.7 Excavation and Backfill

The Canal Expansion Project involves the movement of approximately 133 million cubic meters of material (83 Mm^3 excavated and 50 Mm^3 dredged), somewhat less than twice the earth volume displaced during the prior modernization works (1950-2005), and approximately half of the volume extracted during the original Canal construction. In view of the fact that the excavated material occupies more volume upon dumping, such a volume would increase to 174 Mm^3.

3.5.2.7.1 Excavation of the Pacific Side lock and water saving basins

The Post Panamax locks on the Pacific Side, including the approach walls of the access channel on the northern side, are located in the Cocoli area, approximately between stations 6K+000 and 8K+400. The total excavation for the construction of the locks, including the access channel (between the intermediate plug and gate No. 1 of the upper chamber, and the approach channel from the Pacific to gate No. 4 of the lower chamber), the water saving basins, and the conduits between the basins and the chambers, will be of approximately 14.2 thousand cubic meters. Of this total, 26% is cover material, 32% is soft (La Boca type formation) and meteorized rock, and the remaining 42% is basalt rock.

Excavation can start on three fronts simultaneously: the Pacific exit area, the lower chamber, and the water saving basins for the lower chamber. After the lower chamber, the excavation will continue for the middle and upper chambers. Gate recesses will be excavated at the same time as the excavation for the corresponding chamber. Excavation for the north entrance to the locks must begin prior to the completion of the excavation for the Pacific exit. Excavation for the water saving basins would continue from the bottom ones to the top ones in the same sequence as their respective chambers. Total excavation would be completed in 20 months.

On the basis of the available geologic information, it has been assumed that the excavation at the entrance of the north span of the locks and the access channel will be partly on basalt and partly on La Boca type formation. The middle and upper chambers, the recesses for gates 1 and 2, and the water saving basins of the middle and upper chambers will be excavated on basalt. The lower chamber and the recesses for gates 3 and 4 would be excavated on La Boca type formation. The approach walls on the southern side and the water saving basins for the lower chamber would be excavated on basalt and La Boca type formation.

According to the last version of the conceptual design, the excavation of the middle and upper chambers would be on basalt, with vertical slopes in the first 12 meters from the bottom of the excavation, and then with 1H:2V slopes to the cover material. The total necessary extension of the excavation bottom is 87 meters. To prevent disrupting the rock mass effort, controls must be applied when using explosives for vertical gate recess cuts and for the water saving basins feed conduits. Precuts would be used along the slopes, and protected with wire mesh and sprayed with concrete to prevent accidents from possible falling rock. In the lower chamber where the La Boca formation would be present, slopes have been designed as 2H:1V on the bottom of the excavation, for a total width of 89 meters.

On the Pacific Side, almost all basalt from the excavation would be used to produce concrete aggregates and as processed backfill material behind the lock walls. In the water saving basin area, and to level off the low areas south and north of the Pacific locks, soft La Boca formation rock and part of the cover material would be used as backfill. The remaining material, mainly the cover material, would be used as backfill for the 1939 lock project excavated area. The total backfill volume would be approximately 7.4 million cubic meters (Mm^3), of which 4.3 Mm^3 would be material processed for use as structural backfill, and 3.0 Mm^3 would be ordinary excavation material used to fill the 1939 excavation. The average hauling distance is 1 kilometer.

3.5.2.7.2. Excavation of the access channel north of the Pacific lock

The dry excavation of this channel has an approximate length of 3,800 meters between the northern plug and the southern plug. The total dry excavation volume of the channel between the plugs is 46.8 million cubic meters. Part of the material from the channel excavation will be used to build the dividing dams between the access channel and Miraflores Lake, and as concrete aggregate material for the Atlantic lock. The unused material will be hauled and dumped at the T6 disposal site, west of Paraiso Hill. For the purpose of making the excavation volumes attractive to local firms, the total excavation has been divided into five possible contracts, as shown on Table 3-15.

Table 3-15

Contracts for the Excavation of the Access Channels north of the Pacific lock

Contract No.	Comments	Stations		Excavation Level (PLD, m)	Dry Excavation (m^3)
1	Excavation	0+000	2+075	46.00	7,400,000
	Borinquen Road 1				1,300,000
2	Excavation	–4+395	5+275	30.00	7,960,000
		5+275	6+675	17.00	
	Borinquen Road 2				
	Cocoli				
3	Excavation	–0+000	2+075	27.50	7,750,000
	Excavation	2+075	2+225	27.50	12,540,000
		–2+225	3+075	20.00	
		3+075	5+275	17.00	
	East Dam Nº 1E				230,000
4	Magallon Creek Diversion				200,000
5	Excavation	1+285	5+275	9.14	9,400,000
				Total	46,780,000

Source: InfoConference Program, Panama Canal Expansion. General Excavation Plan for the Pacific Approach Channel (www.pancanal.com).

It is estimated that the entire access channel excavation will take approximately 72 months, between the years 2007 and 2013. Almost all contracts will cover two dry seasons.

3.5.2.7.3 Excavation of the Atlantic Side lock and water saving basins

The Post Panamax lock on the Atlantic Side, including the approach walls, will be located in the Gatun area, east of the existing lock, approximately between stations 11K+000 and 12K+900. The total excavation for the construction of the locks, including the access channel (between the northern plug and No. 4 gate recess in the lower chamber, and the southern plug), the water saving basins, and the feed conduits between the basins and the chambers, will be of approximately 18.06 Mm^3. Of this total, 37% will be cover material and Atlantic mud, and the remaining 63% will be soft rock (Gatun type formation).

The lock axis has been displaced some 38 meters west of the axis designed in 1939, to excavate only on the west bank of the excavation where the land is lower and there is less vegetation, although it impacts part of the infrastructure of the former town of Gatun, but staying north of the natural existing plug. The existing excavation will need to be widened and deepened, and most of the material is Gatun type formation. It is assumed that explosives will not be used for the excavation.

The excavation could start simultaneously on four fronts at the same time: the Atlantic exit area, the lower chamber, the upper chamber, and the area of the exit to Gatun Lake, including the water saving basins of the upper and lower chambers. The middle chamber excavation would follow after the excavation of the lower chamber, including the basin excavation. The total excavation may be completed in 26 months.

On the basis of the available geological information, it was determined that the excavation at the entrance of the north span of the lock will be in Atlantic formation mud. The lock entrance areas, the three chambers, the gates recesses and the water saving basins would be excavated on Gatun formation. According to the latest version of the conceptual design, excavation for the chambers will have 1H:6V slopes to a berm of 4 meters, and then 1H:3V slopes to the cover material. The total extension on the bottom of the excavation is 101.5 m. The final slopes would be protected from the elements with a wire mesh and sprayed with concrete to prevent accidents from possible falling rock. Most of the material resulting from the excavations would be hauled to the Monte Lirio disposal area located in the deep waters of Gatun Lake, approximately three kilometers east of the south entrance of the new lock.

3.5.2.7.4 Excavation in access and navigation channels

Dredging and excavation work will be needed along the existing access and navigation channels as part of the Canal Expansion Project, from the northern end of the Atlantic entrance to the southern end of the Pacific entrance. Similar work will also be required on the new lock alignments or access channels.

Work on the navigation channels will consist of a combination of excavation, drilling, blasting, and dredging work. ACP has estimated that 50% of the dredging will be done by ACP personnel, while the other 50% will be performed by outside Contractors. It is estimated that ACP will do all the drilling and blasting within Gatun Lake and Gaillard Cut, while 100% of the dry excavation will be done by outside Contractors.

Table 3-16 summarizes the drilling, blasting, and dredging volumes required to modify the existing channel and create new approach channels. The major drilling, blasting, and dredging areas are described in the following sections.

3.5.2.8 Blasting

Drilling and blasting activities are needed to facilitate the excavation or dredging of rocky areas, and to extract materials for aggregate production. Due to the nature of the work to be done, drilling and blasting will be necessary on open land, as well as in water covered areas.

To estimate the drilling and blasting volumes on Table 3-16, the latest bathymetric and surveying information available, and the INROADS computerized engineering program were used. Underwater drilling and blasting volumes have been estimated at 1.83 meters (6 feet) below the tolerance line, or 2.44 meters (8 feet) below the design elevation of the channel bottom.

Table 3-16

Estimated Excavation, Drilling, Blasting, and Dredging Volumes of the Navigation Channel[21] Works in Mm^3

Area	Draft (m)	Channel Width (m)	Scenario at 9.14 meters PLD		
			Dry Excavation	Drilling and Blasting	Dredging
Atlantic entrance navigation channel	13.7	225 a 260			6.95
Northern approach channel on the Atlantic Side	13.7	218	0.90		6.55
Northern plug on the Atlantic Side	13.7	218	0.16		0.61
New Atlantic locks		55			
Southern plug on the Atlantic Side	13.1 a 15.2	218	0.40		0.79
Gatun Lake	13.1 a 15.2	280 a 366		3.35	16.03
Gaillard Cut	13.1 a 15.2	218	2.50	2.62	6.03
Northern approach channel on the Pacific Side, north of the Gaillard Cut plug	13.1 a 15.2	218	7.18	3.23	2.82
Gaillard Cut plug or north of the Pacific locks	13.1 a 15.2	218	0.17	0.62	0.39
Northern approach channel on the Pacific Side between the Gaillard Cut plug and the intermediate plug	13.1 a 15.2	218			
Pacific intermediate plug	13.1 a 15.2	218	0.13	0.50	0.30
New Pacific locks		55			
Southern plug on the Pacific Side	13.1 a 15.2	218		0.73	0.63
Southern approach channel on the Pacific Side	13.7	218		1.41	2.51
Navigation channel at the Pacific entrance	13.7	225 a 366		4.36	6.51
Total channel work volume (Mm^3)			**11.44**	**16.82**	**50.12**

Source: Technical Analysis of Post Panamax Navigation Channels proposed for the Panama Canal - ACP, March 2006 (Spanish translation).

Notes: 1. The excavation and dredging volume is taken from the study of the new locks works.

2. These volumes do not include dredging programs under way, such as the deepening of Gatun Lake and Gaillard Cut to 10.4 meters PLD, Cut straightening, Cut widening to 218 m, the deepening of the Pacific entrance to a draft of 12.61 meters, or the widening of the Atlantic entrance to 198 m.

Drilling and Blasting on Land

ACP proposes the use of available Canal drilling and blasting equipment, including rotary percussive drilling. On the basis of previous experience in the Canal, the approximate productivity rate for the land drilling and blasting equipment is 54,000 bank cubic meters per week, with a schedule of 2 shifts per day, 5 days a week.

[21] Source: ACP. Technical Analysis of the Post Panamax navigation channels proposed for the Panama Canal. March 2006 (Spanish translation).

This productivity could increase during the dry season and decrease during the rainy season, and the preparation of the work schedule will depend of outside contractors' resources and the completion date set by ACP.

Underwater Drilling and Blasting

ACP proposes the use of the new Drill barge Baru for the underwater drilling and blasting operations. Drill barge Baru's productivity in the new north access channel on the Pacific Side would be of almost 30,000 bank cubic meters per week with a full schedule of three eight hour shifts each seven days a week, for an increase of 30% compared to the production of the Thor[22] in Gaillard Cut.

3.5.2.8.1 Southern approach channel on the Pacific Side

For the southern plug, ACP proposes the use during low tide of the available Canal land drilling and blasting equipment, such as rotary percussive drills. The estimated productivity of the land drilling and blasting equipment is low, 30,000 bank cubic meters per week, due to the fact that it is subject to tide variations in the Pacific entrance.

For the approach channel, ACP proposes the use of the available Canal land drilling and blasting equipment, such as barge mounted rotary percussive drills. The average productivity rate for this semi aquatic equipment could be of 20,000 bank cubic meters per week.

3.5.2.8.2 Gatun Lake

It is estimated that 10% of the Gatun Lake channel area will require drilling and blasting prior to its widening (918 and 1,200 feet), and deepening (9.14 meters PLD). Drilling and blasting volumes in Gatun Lake are estimated at 3.35 million cubic meters.

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[22] An ACP Drilling and Blasting Barge

3.5.2.8.3 Gaillard Cut

Gaillard Cut drilling and blasting estimates to 9.14 meters PLD have been separated into two volume estimates. One estimate was made for the drilling and blasting volume in the existing navigation channel, and another estimate was made for the drilling and blasting volume for the widening areas. The total drilling and blasting volume required to lower the bottom of Gaillard Cut is estimated at 2.62 million cubic meters, which includes 1.83 million cubic meters in the channel, and 792,000 cubic meters in the widening areas.

3.5.2.8.4 Northern approach channel on the Pacific Side

It is expected that most of the northern approach channel on the Pacific Side will require drilling and blasting mainly with land equipment, up to 2.44 meters (8 feet) below the design elevation of the channel bottom. There are several sections in this channel that warrant a separate discussion:

- The drilling and blasting volume for the span of this channel north of the Gaillard Cut plug is estimated at 3.23 million cubic meters for the 9.14 meters PLD scenario. This work will be performed entirely with land equipment.
- The drilling and blasting volume at the Gaillard Cut plug is estimated at 620,000 cubic meters for the 9.14 meters PLD scenario, and would be performed using land drilling equipment.
- The drilling and blasting volume at the intermediate plug located north of the base area of the new Pacific Side locks is estimated at 495,000 cubic meters for the 9.14 meters PLD scenario, and would be performed using land equipment.

3.5.2.8.5 Pacific Entrance

It is expected that to deepen the Pacific entrance, approximately 30% of its area would require drilling and blasting, which would involve 4.36 million cubic meters.

3.5.2.9 Slope and Cut Layout

This pertains to the excavation, slope cuts, and earth movement either with heavy equipment or with the use of explosives. According to the Project geological reports, the following can be found on the Atlantic Side within the alignment area for the construction of the new set of locks:

- Atlantic organic mud. This material is well distributed on the Atlantic side and fills old stream channels in Gatun Lake. It is uniformly soft and weak; it is composed predominantly of small sediments in their natural state, with a high degree of dampness.

- Alluvial and beach deposits. These have the same age as the Pacific and Atlantic organic mud, from the Quaternary age. Along the Canal area there are deposits of fine sand, clay, alluvium, and gravel, and they have reached the most pronounced development in open valleys and in stream courses draining into the area; the exception is the extensive gravel deposit in the Chagres River, beyond Gamboa.

- Gatun Formation. This is the largest continuous sedimentary formation in the Canal area. It is located between Limon Bay and Tigre Island, and dates from the Paleocene. It consists of granular, sandy, medium to fine material, and alluvium. Its main elements are somewhat calcareous, and have small volcanic agglomerates and a clayish matrix. The sandstone contains numerous green and black volcanic rock grains. Conglomerate and low fragility rock are a small part of the formation. There is basalt in older formations in the Gatun Lake area, but no intrusions are known in the Gatun formation; this is the one with more fossils in the Canal area.

According to ACP information, the excavation material volume estimate for the Atlantic Side lock alignment with an average width of 200 meters and a length on land of 3,125 m, is approximately 26.1 Mm^3, 12.10 Mm^3 in the navigation channel, and 14.0 Mm^3 in the lock footprint[23]. A portion of this volume will be used as backfill in the same works, or for any other use that may benefit the Project.[24]

On the other hand, the Pacific Side geological information shows that the following types of materials are found along the alignment for the construction of the new set of locks:

- Basalt: This basalt, sometimes referred to as "plaster basalt," is a very hard rock with fine to thick grains, a vitreous matrix, occasionally porphydic, close to moderately joined, with occasional columnar jointing.
- Pedro Miguel Formation: This is a pyroclastic material with a thick texture; it is generally of a hard to medium hard, dense, dark grey, single to moderately joined mass, with fine to thick grains with small angular fragments to large basalt masses in a sandy matrix of small conglomerates, well cemented with secondary calcite and some zeolite. It is found to the west and north of the Pedro Miguel locks and at Cartagena Hill.
- La Boca Formation: This is a sedimentary formation of volcanic origin composed of sandstone, alluvium, limestone, and shale agglomerates and small volcanic agglomerates from the high Miocene. It is located west of the Pedro Miguel and Miraflores Locks, in the proposed alignment.
- Cucaracha Formation: The Cucaracha consists of a weak, dark green to red material, and plasters materials (predominantly clay), and is a land deposit of volcanic remains derived from an intense volcanic activity. A characteristic feature is the presence of minimal irregular and disoriented fractures. It is located northwest of the Pedro Miguel locks and north of the Miraflores lock.

Both alignments, with an average width of 200 m., would generate a volume of excavated material estimated at 50 Mm^3 (90% of the 50 Mm^3 mentioned in ACP reports, since the remaining 10% will be dredged[25]).

23 Summary of Atlantic Entrance Excavation and Dredging Volume Estimates. ACP, March 2004.
24 Environmental Studies on Possible Dredging and Excavation Material Disposal Sites at the Panama Canal. Moffatt & Nichol Engineers, The Louis Berger Group and Golder Associates. 2003 – 2004.
25 Panama Canal Long Range Capacity Study Plan. Canal Capacity Study Division; January – 2004.

3.5.2.10 Navigation and Access Channel Dredging and Deepening

The working areas for the improvements to the navigation channels will be the Atlantic entrance, Gatun Lake, Gaillard Cut, the Pacific entrance, and the new locks approach channels. In addition to the volumes (Table 3-16), the diverse and complex geological composition of the Canal area was considered for the planning of the dredging work in the various areas, which can be divided in five major types of materials (Table 3-17). The key premises for the planning of these activities are as follows:

- Slope parameters used for the dredging of Gaillard Cut were 1H:1V or 2H:3V, depending on the geological conditions along this navigation channel.
- Dredging and excavation volume estimates for the new locks approach channels include the same parameters of the slopes used to estimate Gaillard Cut volumes.
- All dredging volumes include 0.61 meters (2 feet) of tolerance below the channel bottom design, and a horizontal tolerance of 7.62 meters (25 feet) for each channel, except in the narrow area near the Bridge of the Americas at the Pacific entrance.
- Several plugs will be required to perform the dry construction phase of the new approach channels and the new lock infrastructures. These will also be excavated and dredged in phases once certain channel and lock components are ready to be filled with water. These plugs will be built with dirt taken from the site, or if necessary, strengthened by using competent material taken from the dry excavation.
- Two plugs will be required on the Atlantic Side to perform the dredging and the excavation of the new locks approach channel and of the new lock base areas, while three plugs will be required on the Pacific Side due to the additional length of the northern approach channel.

3.5.2.10.1 Atlantic entrance navigation channel

Due to the type of material found in the bottom of the Atlantic entrance channel, it is proposed to widen and deepen this channel by using a hopper dredge with an estimated productivity of 110,500 bank cubic meters per week with a full, three eight hour shift work schedule, seven days a week. A cutter suction dredge similar to the Holland's J.F.J., with a higher production rate (approximately 170,000 bank cubic meters per week) could also be chartered. Being self propelled, the hopper dredge can carry the dredged material to the disposal site west of the Atlantic breakwater; it is capable of an annual production of 4.6 million cubic meters per year. In general, the excavation work in the Atlantic entrance channel area could be completed in 2.5 years.

Table 3-17

General Geological Features of the New locks Navigation and Approach Channels

Areas	Sediment, clay, mud, and sand	Gravel and clay	Soft rock <15MPa	Medium hard rock 15 to 50 MPa	Hard rock >50MPa
Atlantic entrance navigation channel	X				
Northern approach channel on the Atlantic Side			X		
New Atlantic locks			X		
Southern approach channel on the Atlantic Side			X		
Gatun Lake, up to Juan Grande Reach		X		X	
Gaillard Cut, Gamboa, and Chagres Crossing			X	X	X
Northern approach crossing on the Pacific Side				X	X
New Pacific locks				X	X
Southern approach crossing on the Pacific Side				X	X
Pacific entrance navigation channel			X	X	X

Source: URS Holdings, Inc., with data from ACP.

3.5.2.10.2 Northern approach channel on the Atlantic Side

A medium size cutter suction dredge with a 2,000 to 3,000 kV rock cutter is being proposed to dredge the Gatun formation and the Atlantic mud in the new Atlantic lock approach channel, which can achieve an estimated productivity of 60,000 bank cubic meters.

The mean cutter suction dredge production in this area would be 60,000 m^3 per week on a full work schedule of three eight hour shifts (seven days a week); therefore, the dredging work would be completed in 2.75 years. In general, it is estimated that the Atlantic area excavation and dredging work would be finished in 3 years.

3.5.2.10.3 Gatun Lake navigation channel

ACP proposes the use of a medium size cutter dredge to widen and deepen most of the Gatun Lake navigation channels. It is estimated that one of these dredges with a 2,100 kV cutter head, working on a full schedule of three eight hour shifts a day, seven days a week in Gatun Lake, can dredge 67,500, (35% more than the Mindi) and 37,500 bank cubic meters per week in gravel and medium to hard material, respectively.

It is assumed that the cutter suction dredge Mindi will dredge Gatun Lake during this period at an average of 50,000 bank cubic meters per week. The use of conventional equipment (excavators and trucks) is proposed to perform the required excavation in Gaillard Cut, with an average weekly production of 34,600 bank cubic meters per week, or an average of 150,000 bank cubic meters per month.

3.5.2.10.4 Gaillard Cut navigation channel

Dredging in Gaillard Cut would cover a distance of 18 kilometers (11.2 miles) from the north of Gamboa Reach to the north access to the new Pacific lock, and would lower the existing navigation bottom from 10.4 meters (34 feet) PLD to the design level of 9.14 meters (30 feet) PLD.

Approximately 50% of the hardness of the material in the Gaillard Cut sub-bottom reaches RH3, and the remaining 50% is over RH3. Therefore, the use of a cutter suction dredge with a cutter head of 2,000 to 3,000 kV is being proposed to dredge the material with a hardness of less than RH3, without the need to drill or blast, with an estimated productivity in the order of 37,500 cubic meters per week on a full work schedule of three eight hour shifts, seven days a week. Dredging of the rest of the material would then continue with ACP's Rialto M. Christensen (RMC) dipper dredge, after the drilling and blasting operations.

On the basis of the performance of the RMC dipper dredge in the current dredging program, it is expected to achieve a production of 28,000 cubic meters per week for the Canal Expansion Project, on a full work schedule of three eight hour shifts, seven days a week.

In order to assist the dipper dredge and the cutter suction dredge, and transfer the dredged material to the designated underwater disposal sites, support equipment (tugboats, work boats, dump barges, hydrography boats, and passenger boats) would be required in the case of the dipper dredge. In general, it is estimated that the work to deepen the Cut to 9.14 meters PLD could be completed in approximately 5 years.

3.5.2.10.5 Northern approach channel on the Pacific Side

Dredging operations from land would be required in this channel to remove the surface ground cover that constitutes 20% of the total material to be dredged north of the Gaillard Cut plug. With the removal of this layer, a backhoe dredge can efficiently remove nearly 50% of the dredging material. It is estimated that a backhoe dredge would achieve a production of 25,000 cubic meters per week.

The dredging operation would take place in three phases. The first phase would consist in the use of land dredging equipment to excavate 20% of the material. The second phase would consist of the use of a backhoe dredge to remove 50% of the dredging material at a productivity rate of 20,000 cubic meters per week, on a work schedule of three eight hour shifts, six days a week. The RMC hopper dredge, with a greater reach than a backhoe dredge, would remove the remaining 30% of the dredging material, at a productivity rate of 28,000 cubic meters per week.

3.5.2.10.6 Southern approach channel on the Pacific Side

For the southern plug, ACP proposes the use of a backhoe dredge at a rate of 20,000 bank cubic meters per week on a full work schedule of three eight hour shifts, six a week. The backhoe dredge would remove most of the previously blasted basalt.

To remove the La Boca formation from the southern approach channel without the need for prior drilling or blasting, the use of a medium size cutter dredge is proposed, with a rate of 37,500 cubic meters per week and a full schedule of three eight hour shifts, seven days a week. The same backhoe dredge used for the southern plug would be used for the basalt with a productivity of 20,000 bank cubic meters per week on a work schedule of three eight hour shifts, six days a week. The basalt would be blasted prior to removing it with the backhoe dredge.

3.5.2.10.7 Pacific entrance navigation channels

The performance of the RMC hopper dredge at the Pacific entrance is of 16,500 cubic meters per week for hard material, while the Mindi cutter suction dredge has a history of an average rate of 69,000 cubic meters of soft material per week.

The use of a medium size cutter dredge is proposed to dredge soft material and medium to hard material at a rate of 60,000 and 37,500 bank cubic meters per week, respectively, on a full work schedule of three eight hour shifts, seven days a week. No drilling and blasting has been scheduled for the soft or medium to hard material. A dredge with a cutter head of 2,000 to 3,000 kV could dredge the medium to hard material without the need for prior drilling or blasting.

A hydraulic backhoe dredge would be used for the very hard material, at a rate of 20,000 bank cubic meters per week on a full work schedule of three eight hour shifts, six days a week. Prior drilling and blasting would be required prior to an effective performance by the backhoe dredge.

It is estimated that with the use of a drilling and blasting barge and two dredges, the Pacific entrance widening and deepening project would take a total of some 3.5 years.

3.5.2.11 Preparation and Management of Disposal Sites

ACP has studied 29 possible sites for the disposal of excavation material. Most of them have been and are being used by the Canal for the disposal of such material by the Canal since its construction. New sites have also been evaluated for their potential to produce usable land or add land reclaimed from the sea, by marine or land fills. Due to the lower hauling cost, it is proposed to dump excavation material in the sites nearer to the excavation and dredging works. After the pertinent evaluations and analyses, 23 sites have been selected, 16 of which are on the Pacific Side and seven are on the Atlantic Side (Figures 3-15 and 3-16). All the sites recommended for the disposal of excavation material are within ACP operating areas.

ACP develops environmental assessments for every one of the sites it uses, and keeps them up to date. It also keeps them permanently under an environmental management plan. Once each Project phase is completed, ACP will follow up on the environmental recovery and sustainability of the land sites where the excavation material has been deposited. Prior to and during the construction, ACP will continue to evaluate the opportunities for an economic exploitation of the excavated material.

Site T6, a very important one for the disposal of excavated material in the Pacific area, is located on part of the former Emperador Firing Range, and therefore requires special measures for its use (including the munitions and explosives of concern - MEC, it has a surface of approximately 300 hectares). The special measures for this site are included in the Category II Cerro Cartagena Earth Movement and Leveling Environmental Impact Study, and in the Category 1 Environmental Impact Study for the Preparation of the T6 Disposal Site.

3.5.2.12 Construction of locks and water saving basins

Each new locks complex will be an integral set of three consecutive chambers with three lateral water saving basins per chamber, making up nine basins per lock complex, and an overall total of 18 basins. Both the locks as well as the water saving basins will operate hydraulically with the water flowing by gravity, and without the use of pumps (Figures 3-8, 3-10 and 3-11).

As in the current locks, the new locks will have two gates on each end of each chamber. Rolling gates will operate from an attached recess perpendicular to the lock chamber. This configuration will allow on site maintenance of the gate without disrupting lock operations, as the lock would continue operating with a backup gate.

The locks are divided in four major components: approach walls, chamber walls, gate recesses, and water saving basins. Concrete pouring would begin one year after the contract is awarded. By that time, the excavation of chamber 3 will have been completed, while the excavation of chambers 1 and 2 and the approach walls will have advanced between 50% and 75%.

Lock Wall Culverts

The equipment to be used for the construction of the culverts in the walls of chamber 3 consists of two conveyor belt cranes and two Link-Belt type, 110 ton cranes. These cranes would handle the steel rebar, forms, and concrete pouring. There would be two sets of collapsible forms that will require a surface to allow them to be moved over tracks along the culvert. For this purpose, the culvert floor will be built first as part of the lock wall foundations. Once the construction of the chamber 3 culverts is completed, the equipment and the forms will be moved to chamber 2, and lastly, to chamber 1.

Water Saving Basins, Valve and Conduit Monolith

In order to schedule the excavation and backfill works, the water saving basin conduits were divided in two groups: the conduits across the chambers, and the conduits running under the basins. The conduits across the chambers will be constructed by using a 20 ton crane and an 8 inch concrete pump. Once the construction of the chamber 3 conduits is completed, the equipment and the forms will be moved to chamber 2. The chamber 1 conduits will be started after the chamber 2 conduits. It was assumed that the construction of the conduits that run under the water saving basins would start in chamber 3, and would then continue in chambers 2 and 1. The construction of the basin walls would start once backfilling over the conduits is completed. The construction of the floors will be the last concrete pouring activity to be performed in each chamber, and would start in the basins of chamber 3, continuing on to those of chamber 2, and ending with those of chamber 1. Three 20 ton cranes and three concrete pumps will be used for this work. The valve monoliths would be built by using a crawler crane, and are scheduled to start after the conduits are completed. The construction sequence would be similar to that of the conduits across the chambers.

Gate recesses

The construction of the recess for gate 3 will start one year after the contract is awarded. A Link-Belt type crane will be used on each recess for the handling of the steel rebar and forms, as well as a conveyor belt crane for pouring concrete. The gate 4 recess would start one month later, using the same equipment used for the gate 3 recess. Once the work on recesses 3 and 4 is completed, the equipment used in the construction of these structures will be moved to recesses 1 and 2, respectively, where the same procedure will be followed.

Lock Walls

Construction of the chamber walls and their abutments would be done using pumps to pour concrete, and Link-Belt cranes to handle the placement of the steel rebar and forms. Construction of the walls will begin with chamber 3, continuing with chamber 2, and ending with chamber 1.

Approach Walls

The conceptual design contemplates the construction of approach walls on both ends of the lock. The southern approach wall would begin once the foundations of chamber 1 are completed. Construction of the wall foundations would be done using two conveyor belt cranes to pour concrete, and two Link-Belt cranes to handle the steel rebar and forms. The wall concrete will be poured with pumps, while the Link-Belt cranes will continue to handle the steel rebar. Once this wall is completed, the equipment will move to the northern approach wall to perform the same operation.

Machinery and Cable Galleries

The above mentioned construction of the lock and approach walls does not include the construction of galleries. The construction of the walls and their abutments as well as the backfill behind the walls must be completed first in order for this work to begin, as the gallery floors must be supported by backfill material. The equipment to be used for the construction of the galleries will be located on the backfill. In this way, there will be no need to occupy the chamber and this will allow the start of the chamber flooding and gate installation. The pouring of the galleries would be done with pumps, while the steel rebar and forms would require a 20 ton crane. The construction of the galleries would start in chamber 3, continuing with the southern approach wall of chamber 2, and the northern approach wall, and ending with chamber 1.

Chamber Floors

The conceptual design includes roller compacted concrete (RCC) floors for chamber 3 and the northern and southern entrances to the lock. The pouring of these floors would start at the southern entrance, continuing on to chamber 3, and ending at the northern entrance.

3.5.2.13 Construction of the Borinquen Dikes

The access channel from Gatun Lake to the Post Panamax Pacific lock will be excavated west of Miraflores Lake as an extension of Gaillard Cut. This channel will start at Station 1k+700 and end near Station 8 k+000. The Panama Canal maximum level will be the same as the maximum level of Gatun Lake, that is, +27.13 meters (89.0 feet) PLD. The bottom of the channel will be at a level of +9.14 meters (30.0 feet) PLD. Miraflores Lake will remain at a stationary level of +16.45 meters (54.0 feet) PLD. In the final stage of the channel excavation, the level of Miraflores Lake will be approximately 7.3 meters higher than the bottom of the channel, and after it is filled and is eventually operating, the maximum level of the access channel will be 10.7 meters over the level of Miraflores Lake. Due to these conditions and the topographic features of the area, it is necessary to build dikes to close the low points between the two bodies of water. During construction, these dikes will have the function of minimizing under seepage from Miraflores Lake to the excavation area, and during the flooding and operation of the channel, they will act to close off and contain Gatun Lake, whereupon they will become structures of the utmost importance and the object of great care in the Panama Canal (Figure 3-14).

The four water containment structures, Borinquen Dikes 1E, 2E, 1W and 2W will be built, and will become part of the Pacific Approach Channel (PAC), so known because of its geographic location. The total backfill dike volumes, following the ACP conceptual design, are 2.96 Mm^3 for dike 1E, and approximately 2.96 Mm^3 jointly for dikes 2E, 1W, and 2W.

3.5.2.14 Raising of the Level of Gatun Lake

Due to the fact that Gatun Lake is used for Canal navigation, the water volume it can store and can be used is determined by the minimum depth it must maintain to provide the necessary draft for transiting vessels. The amount of water it can store is also subject to the maximum elevation it can achieve without causing overflows at Gatun Dam, or at Gatun or Pedro Miguel locks. This is what allows Gatun Lake to operate at the present time at elevations between 24.84 meters (81.5’) and 26.67 meters (87.5’) PLD (Precise Level Datum).

- The maximum operating level of Gatun Lake will be raised by approximately 0.45 meters (1.5'), increasing the current level of 26.67 meters (87.5') PLD, to a level of 27.1 meters (89') PLD. This process will require the modification and adaptation of some ACP operational structures on the banks of Gatun Lake, including the upper chambers of Gatun lock, the northern part of Pedro Miguel lock, the Gatun spillway, and Gatun Lake docks.

During the rainy season, which lasts approximately eight months of the year, the Panama Canal Watershed receives abundant rainfall. Conversely, rainfall is significantly reduced during the four months of the dry season. If enough water were not available due to either a low rainfall volume or a high water consumption, the level of Gatun Lake could drop beyond the minimum level required for the normal operation of the Canal. This special situation would require a reduction in the maximum draft allowed the ships transiting the Canal and, consequently, would limit their cargo capacity. In fact, ACP has had to impose draft limitations to ships during severe drought periods, as was the case during the weather phenomenon of El Niño in 1997-1998.

3.5.2.15 Mechanical and Electromechanical Facilities

A series of control and safety equipment is needed for the safe operation of the locks, and it is what would allow water to flow through the conduits that would fill and empty the lock chambers and the water saving basins. This would happen in synchronization with the opening and closing of the gates for the transit of ships through the locks. Likewise, other power and lighting control equipment is required.

3.5.2.15.1 Rolling gates

The rolling gates are steel structures fabricated with reinforced platens, internal structural frames, and floating chambers that close off the entire width of the lock and later retract into a recess located perpendicularly to the wall. These gates are used to shut openings of a considerable width. Rolling gates with a length of more than 55 meters as those required for the Post Panamax locks exist in several locks in Europe (the Berendrecht locks in Antwerp, Belgium have gates 68 meters long). A recess can be sealed to isolate it from the chamber and allow it to dry for gate maintenance or repair; it is fitted with a floating bulkhead and a pump system for drying.

Each three step lock requires a total of eight rolling gates. These gates are supported on upper and lower sliding trolleys in a "wheelbarrow" type arrangement that consists of a lower trolley sliding on tracks along a frame, and an upper trolley running on tracks supported by cantilevers projecting from the recess wall. The upper trolley is used to transmit the push to the sliding gate.

The gates in each set weigh a total of 20,674 tons. This weight includes:

- Two gates per recess;
- One sealing bulkhead per recess;
- Two lower support trolleys per recess;
- Two upper support trolleys per recess;
- A spare lower support trolley for recess 1;
- A spare lower support trolley for recesses 2, 3 and 4;
- Twelve support trolleys for maintenance of recess 1; and
- Twelve support trolleys for maintenance of recesses 2, 3 and 4.

The gates are operated with a winch system[26] connected to the upper trolley. The winch system consists of (1) two AC thrust motors, 300 kV each (one in operation and another as a spare), (2) an emergency 30 kV emergency motor, (3) a central gear panel, (4) two secondary gear panels, and (5) two cable reels approximately 2 meters in diameter. The two cables are connected to the upper support trolley with a set of pulleys, and to the reel on the other end. The new lock gates operate in acceleration – constant speed – deceleration cycles, and were designed to open and close in 4 to 5 minute periods.

The rolling gates will be built at a dry dock or at a heavy metal industry factory capable of producing the gates within the time required and according to the expected quality standards.

[26] Winch (pulley system)

Once completed, the gates will be transported to Panama on a heavy submersible lift vessel, on a barge, or floating vertically and guided by tugboats.

Upon their arrival in Panama, the gates will be tied up at the new entrance channels until the progress of the lock construction (including the installation of all culverts and conduits) allows the chambers to be filled. It is assumed that when this happens, the machinery buildings that would house the operational equipment will have already been completed, and that the winches, gear, and motors will have been installed and awaiting their final alignment and calibration, to be done when each gate is in place.

When the cofferdams on the Pacific and Atlantic Sides are removed and a segment of the marine plug has been excavated or dredged, the lock will be filled up to sea level, and the eight gates will be moved to the lower lock level, where they will be tied up. The first gates to be installed would the T4 pair. With a proper high tide, each gate would be placed in its recess assisted by tugboats, winches, windlasses, and the Titan floating crane (or additional pontoons), to achieve the required stability during the turning operation.

Once the gate is within its recess, its flotation would be increased to position the support trusses, and then the gate would be lowered onto these trusses. A 40 ton crane positioned over the recess would place the lower support trolley on its tracks and then, with diver assistance, it would be placed under the gate. This same crane would install the upper trolley, which would be connected to the gate structure. When this operation is completed, the gate would be floated again to remove the support trusses. The gate ballast would then be adjusted to sink it and distribute its weight between the lower and upper trolleys. This would allow the connection of the winch system steel cables to the upper trolleys. With the cables in place, gate testing can begin. One month has been allowed for the installation of these two gates.

The installation of gates T1, T2 and T3 presents a greater challenge because, even with a high tide, the water level is not enough to allow them to float and be set into their recesses. In order to start filling the chambers to allow the floating of gates T1, T2 and T3, at least one of the T4 pair gates should be in operation and capable of closing and containing the water coming from

Miraflores Lake. When the proper level of water is reached, the same procedure as described for the T4 gates would be applied to gates T1, T2 and T3. It is estimated that the installation of each pair of gates would take one month, and that the testing period of the system, which would start when the T1 gates are put in place, will take four months.

3.5.2.15.2 Culvert valves and conduits

Culverts, conduits, and valves are components of a lock filling and emptying system. The valves are located in the longitudinal culverts near the upstream and downstream ends of the chamber, and are used to control water flow. In systems that include the water saving basins, the valves located in the valve monolith adjacent to the lock wall control the water flow from and to the basins. The transverse flow culverts, called conduits to distinguish them from longitudinal flow culverts, connect the chamber to the basins. The designers of the filling and emptying system of the Pacific locks selected a rising stem valve operating system with wheels, operated by hydraulic cylinders similar to those used in the rising stem valves of the existing locks.

The three steps Pacific lock design requires 16 culvert valves, and 36 conduit valves.

Installation Procedure

Upon completion of the gate recess civil works (culvert valves), as well as those of the valve monoliths (conduit valves), (including the installation of all the built in metal, lower and upper seals, and vertical guides, etc.), valve installation can proceed in the recess with a 60 ton crane positioned over the gate recess or valve monolith.

Once in the closing position, the valve seals would be adjusted and the hydraulic cylinder would be positioned with the crane and secured to the concrete slab over the valve body. The cylinder stem would be extended and connected mechanically to the valve. The installation of the hydropower units and the power control panel would be completed in their respective valve rooms. These operations would be followed by equipment tests.

Valve installation would start with the chamber 3 valves, followed by chamber 2 conduit valves, recesses 4 and 3 conduit valves, chamber 1 conduit valve, and ending with recess 2 valves. It is estimated that the installation of each set of culvert valves would take two months, while each set of conduit valves would take three months.

3.5.2.15.3 Power equipment: lighting, distribution, and control

The installation of the following power equipment would also be necessary at the new lock: lighting (exterior and interior), distribution cubicles (high and low voltage), sectionalizing switches, emergency power plants, primary feed cables, local control panels, local and remote programmable logic controllers (PLC), computers, surge protectors (UPS), closed circuit television (CCTV), and control fiber optic circuits.

Lighting Equipment

Lamp posts 35 meters high would be installed once the upper slab of the gallery has cured. A 20 ton crane would position the posts into a prefab base, which would be part of the upper gallery slab, and would have the necessary built in bolts. Sodium lamps (HPS) would be installed by lowering the lamp hoop with a portable device.

The chamber reflector lamps, which will be placed in special recesses designed specifically to prevent any contact with ships, would be installed once the gallery construction work has been completed. When the gates have been installed, installation of the gate reflector lamps would follow. The building lighting would be installed according to the construction schedule for each structure. The power feeder for each lighting equipment would be connected to a distribution panel located in the technical gate room nearer to each gate.

Power Distribution Equipment

All distribution cubicles, transformer, sectionalizing switches, and emergency generators would be placed in their respective high voltage rooms with the aid of a 20 ton crane. These rooms would be next to the engine rooms. The time for the installation of such equipment will depend on the ability of the cranes to fit through the doors of this structure, or the equipment could be installed prior to the construction of the roof.

Cable trays, feeder circuits, the rest of the power cabling, and the compressed air pipes would run along the gallery on the top of the wall. The installation of this equipment may be done once the gallery has been built.

Power Control Equipment

Cable trays and fiber optic circuits can also be installed once the gallery is completed. The PLC controls would be placed in the local control panels of the gates and valves. The PLC must be cabled (fiber optic cables) and fed (power cables) at the same time as the winches or hydraulic power units. Any additional control equipment could be installed in the engine rooms once these structures have been completed.

The main computer, the PLC, screens, UPS, fiber optic modular trays, the CCTV, and the rest of the control equipment would be installed in the main control building. Once all the equipment is installed, the control building would be cabled to start testing the system.

3.5.3 Operations

During the lock operations phase, the Direct Impact Area is delimited by the navigation channel, and it includes the Pacific and Atlantic entrances, as well as the new Post Panamax locks with their approach channels, the navigation channel, and the material disposal sites, which will continue to be used for maintenance activities and throughout the entire extension of water of Gatun Lake and along its banks. The new locks operation areas have been subject to activities related to the operation and maintenance of the existing Canal during the last 90 years. The activities to be considered during the operation are:

- Operation of Post Panamax locks and their water saving basins;
- Management of the new Gatun Lake operating level;

- Maintenance of the locks and their water saving basins; and
- Maintenance of canals and channels.

In addition to the above, other items will include an increase in ACP floating equipment, an increase in marine traffic, the management of dredged material disposal sites, and maintenance of the signaling systems.

Once the Expansion Project is completed, the following dredging operations will be required :

- Cleanup of the siltation from the sea and rivers;
- Preventive maintenance for Canal navigation in the event of landslides in Gaillard Cut; and
- Maintenance of the anchorages in Limon Bay, and in the Lake near Gatun locks**.**

3.5.3.1 Routine Lockage Operations

These actions are associated with the start of the operations of the Third Set of Locks on the Pacific and Atlantic Sides.

In the Project operations phase, water use is among the greatest concerns, which environmentally translates into an impact on the water balance of the Panama Canal Watershed. The projected Canal Watershed water requirements appear on Table 3-18, according to the information provided by ACP. It has been generally concluded that, even with the operation of the Third Set of Locks with or without water saving basins (assuming conditions are constant), the growing demand of the population, and Canal operation requirements starting in 2006 (with the deepening of Gaillard Cut), the Canal Watershed has enough capacity to meet these new demands.

Table 3-18
Future Water Requirements (Mm^3)

Year	2000	2006	2010	2020	2030	2040	2050
For the population	4.0	5.0	6.4	7.0	7.6	8.1	8.4
For Canal Operation	35.0	40.0	40.0	40.0	40.0	40.0	40.0
Required water capacity (*)	39.0	45.0	46.4	47.0	47.6	48.1	48.4
Required increase		6.0	7.4	8.0	8.6	9.1	9.4
Watershed capacity	57.7						
Remaining capacity	18.7	12.7	11.3	10.7	10.1	9.6	9.3
	Remaining capacity w/ Expansion Project						
Third Set of Locks (w/o basins)	7.71	4.99	3.59	2.99	2.39	1.89	1.59
1 basin option (33% savings)	5.14	7.56	6.16	5.56	4.96	4.46	4.16
2 basin option (50% savings)	3.86	8.84	7.44	6.84	6.24	5.74	5.44
3 basin (60% savings)	3.08	9.62	8.22	7.62	7.02	6.52	6.22

Source: Panama Canal Long Range Capacity Study Plan. ACP, January 2004
These numbers are based on daily transits (each transit represents 55 meter gallons = 0.2 Mm^3)
Watershed capacity is estimated at 4,390 Mm^3/year, equivalent to 57.7 transits/day

3.5.3.2 Gatun Lake Management

Gatun Lake is regulated by a system of dams that allow the operation of the Canal, and it may have unusually higher or lower levels depending on weather contingencies such as large floods or droughts.

The historical extremes recorded in the period 1914 to 1996 have been 24.55 masl and 26.8 masl respectively; however, it must be pointed out that the minimum level in the year 1998 was lower than the minimum shown.

Even though the raising of the Gatun Lake operating level is within the limits established by ACP, there are some infrastructures in areas adjacent to Gatun Lake that would have to be modified, relocated, or adapted (the Gatun lock upper chambers, the northern part of Pedro Miguel locks, Gatun Lake docks, etc.). These infrastructures have been identified, and the extent of the expected alterations is being determined.

3.5.3.3 Lock Maintenance

ACP implements a continuous maintenance program for Canal structures, and this same program will continue in force once the Third Set of Locks construction works are completed. In fact, the maintenance program will be updated to include the new structures and the equipment added to the Canal as a result of the Project.

<u>Maintenance of the Lock Access Channel (Dredging) – Atlantic and Pacific Sides</u>

This activity involves tasks for the maintenance of the access to the locks, especially the dredging of the access channels and maintenance work for the prevention of landslides, which includes terracing, slope reforestation, etc.

For the purposes of a proper analysis, it was decided that this maintenance should be done every 12 months during the first three years starting on the day the locks start operating. After that date, maintenance work may be repeated approximately every six months due to the natural channel deterioration and sediment distribution resulting from lock operations.

With regard to corrective maintenance, it will be required depending on events such as landslides, or the like; that is, due to the occurrence of morphodynamic, geodynamic, and erosive processes of unknown periodicity; therefore, a specific amount of work cannot be forecasted. However, the work contemplated under this type of maintenance is of an intrusive nature (excavating, cutting, dredging, etc.), earth movement (dry or wet), or disposal of the excess (at land or marine sites).

3.5.3.4 Navigation and access channel maintenance

This activity involves maintenance tasks in the navigation channels of the Atlantic and Pacific entrances to the Panama Canal, particularly the dredging of the access channels to the existing locks as well as to the new locks, and of the navigation channels to the sea entrances, Gaillard Cut, and Gatun Lake. For the purposes of the analysis, it was deemed that such maintenance be done approximately every 12 months during the first three years, starting with the completion of the deepening. After that date, maintenance work will take place again every six months approximately, due to natural channel deterioration and sediment distribution as a result of the operation of the locks and the currents in Limon Bay and the Atlantic and Pacific Oceans.

With regard to corrective maintenance, it will be required depending on events such as landslides, or the like; that is, due to the occurrence of morphodynamic, geodynamic, and erosive processes of unknown periodicity; therefore, a specific quantity of work cannot be forecasted. However, the work contemplated under this type of maintenance is of an intrusive nature (excavating, cutting, dredging, etc.), such as earth movement (dry or wet), or disposal of the excess (at land or marine sites).

3.5.4 Abandonment Phase

As mentioned previously, Project abandonment is not expected during its construction or operations phases. The only abandonment expected is that of the Project construction works, as described below.

The demobilization and abandonment of the construction areas, as these terms indicate, will consist of withdrawal from the closed working areas and machinery yards, the abandonment of the sources of materials (quarries) and the storage of excess materials, once the construction phase is completed (on the Pacific and Atlantic Sides). The major actions will consist of area cleanup and restoration (considering soil scarification, removal of polluted soil or structures, placement of vegetative cover, revegetation and even reforestation).

Most of the effects generated by the withdrawal or abandonment of these areas represent a recovery and/or restoration from the damage caused during their installation and operation. Therefore, the actions for this item may be considered as restorative or generating positive impacts of a permanent nature (the elimination of polluting emissions, such as suspended particles and gases from moving and fixed sources; the elimination of sources that pollute water resources with accidental spills of fuel, lubricants, etc.; the elimination of noise emissions; the restoration of the landscape with the removal of construction equipment and machinery; the revegetation of occupied areas; and lastly, the restoration of animal specie habitats, a slow but incremental one).

The abandonment and restoration of the closed working areas must consider the original conditions of the ecosystem, and will have to be planned according to the final use to be given to the land; the infrastructure of these installations will be removed or demolished. The useful material (zinc and lumber sheets, etc.) may be donated to communities by means of prior agreements, and any deteriorated material will be stored in excess storage sites. Likewise, concrete floor slabs will be demolished and the rubble taken to disposal sites.

Occupied areas must be restored by creating conditions favorable for a natural revegetation process.

All machinery and equipment, whether operational or not, as well as all waste material, and in general, everything that has been used in the closed working areas during the construction process, will be removed from the sites.

In the event an early abandonment of the works[27] must happen, any installation that had been in progress must be dismantled and the entire area returned to its original condition before the Project started. All machinery, equipment, and material debris will be removed.

Any added infrastructure must be removed or demolished, and the area must be restored to the conditions that existed prior to the Project according to its original typology, by leveling the ground and creating favorable conditions for a revegetation process. Slopes requiring erosion protection must be seeded with grass, and the areas where it is possible to plant native species of trees must be reforested.

[27] It is very improbable that this situation will occur.

3.5.5 Flow Chart and Performance Schedule of Each Phase

The implementation of the Canal Expansion - Third Set of Locks Project will take between seven and eight years, and could start operations in the year 2014 (Figure 3-20). The Project Performance Schedule was developed on the basis of a thorough, detailed analysis of the feasibility of its construction, conducted in accordance with the industry's state of the art practices, taking into account the most suitable construction equipment, technology, and processes for the scope of the program and the type of project. The implementation plan, which served as the basis for the cost estimate, was evaluated with a rigorous risk assessment model and includes sufficient and appropriate time contingencies to cover the possible delays and setbacks. It also includes time enough to start the implementation, train personnel, conduct inspections, perform operation tests, and begin transit operations.

The implementation schedule is divided in two main phases: preconstruction and construction. Preconstruction will consist of the development of designs, models, specifications, and contracts, prequalification of possible contractors and, finally, their hiring. This first phase will have duration of two to three years with regard to the lock component. The dry excavation and channel dredging will start prior to the completion of the lock preconstruction phase, and immediately after the approval of the Project.

The construction phase includes the simultaneous construction of the two lock complexes with their water saving basins, the dry excavation of the new access channel on the Pacific Side, and the dredging both of the new lock access channels, as well as that of the navigation channels in Gatun Lake and the sea entrances. The dry excavation and the dredging will begin in 2007, and will require approximately seven years. The construction of the locks will take five to six years, and will begin in the year 2008, after the designs are completed.

In the second half of the construction period, that is, in the year 2011, the raising of the maximum operating level of Gatun Lake will begin, for which both the existing locks as well as the Canal facilities located along the banks of Gatun Lake must be adapted, all of which will take place in a period of approximately four years, ending in the year 2014.

Due to the fact that the Project consists of many components, it is expected that the construction of some elements will begin while preconstruction of other components is taking place. Thus, it is expected that dredging activities, specifically those to be conducted by ACP, will start immediately after the Project is approved. Other activities such as mobilization, infrastructure construction, and the preparation of construction sites and of dry excavation material disposal sites will also be started early, and may be completed to a significant extent while the design of the locks is being done. Project implementation activities will not affect the normal operation of the Canal.

The total time estimated for the construction of the Atlantic locks is 60 months. The excavation and the concrete and electromechanical works are the activities that will take most of the construction schedule. The mobilization for the excavation and concrete works will start as soon as the contract is awarded.

The total time estimated for the construction of the Pacific locks without delays due to contingencies, is of 58 months. Excavation, concrete, and electromechanic works are the activities with the most impact on the construction schedule. Mobilization for the excavation and concrete works will begin as soon as the contract is awarded.

3.6 Infrastructure and Equipment Required

The infrastructure to be developed for the Panama Canal Expansion – Third Set of Locks Project has been amply discussed in section 3.2.2 of this document.

The Project Contractor vehicle fleet will be moving daily to the designated areas and traveling on the predesignated accesses over safe areas where traffic regulations will be enforced by competent authorities such as Panama's National Traffic Bureau (ATTT). The main fueling and equipment maintenance facilities will be located in the Gatun and Cocoli Contractor zones; in some cases, temporary fueling facilities may be available at the work fronts.

3.6.1 Equipment to be used during Construction

The actual construction of the locks will require the installation of two (2) crushing plants for aggregates (one on the Atlantic Side and another on the Pacific Side), as well as the installation and operation of two concrete plants per lock with a production capacity of 300 m^3/hour each.

The excavation equipment used as a model due to its features consists of 8 m^3 CAT 988G front end loaders, D8R tractors, and 25 ton trucks for land clearing and stripping; CAT 385 excavators with a 6 m^3 bucket, and 58 ton capacity CAT 773E trucks for the cover material and Atlantic mud; D8 tractors with ripper, CAT 385 excavators with a 6 m^3 bucket, 8 m^3 CAT 988G front end loaders; and CAT 773E 58 ton capacity trucks. The number of each type of heavy equipment has not been determined at this time.

The excavation of basalt and Pedro Miguel formations will require drilling and blasting. The equipment used as model due to its features for the drilling and blasting activities consisted of CM470/YH70 track drills, compressors, 10 ton explosives trucks, drill bits and drilling and blasting accessories. It was assumed that the explosive (WRS) to be used will consist of 75% emulsion and 25% gel. The excavation of the blasted rock will be done with CAT 385 excavators with 6 m^3 buckets, assisted by D7R tractors and CAT 773E trucks to haul the material. To control underground water and runoff, water bailing systems with 6 inch diameter and 95 HP submersible pumps will be used.

CAT 16H motor graders, D7R tractors, 10 ton vibratory roller soil compactors, CAT 825G sheepsfoot roller compactors, and 10,000 gallon water tank trucks will be used to place and compact the material at the backfill areas of the dams. D8R tractors and 5,000 gallon water tank trucks will be used at disposal sites.

ACP has available specialized equipment for the dredging, drilling, and blasting required for the improvement and maintenance projects in the Panama Canal. This equipment consists of two dredges (Mindi and Rialto M. Christensen - RMC), three cranes (Hercules, Goliath and Titan), two drilling and blasting barges (Thor and Baru), tugboats, tractors, bathymetry launches and maintenance craft, etc.

Hydraulic hopper dredge Rialto M. Christensen was built by Hakodate Dock Corporation at a cost of US$6 million, and was commissioned in September 1977. It is one of the largest dredges of its type, and has a dredging capacity of 15 cubic yards (11.47 m^3) in its bucket to remove material from a depth of 60 feet (18.3 m.). It is the newest ACP dredge, and has been used in most Canal improvement projects.

Cutter suction dredge Mindi was built by Ellicot Machine Corporation in Baltimore at a cost of US$7 million, and was commissioned in 1943, operating by steam at the time. Between 1977 and 1979, it was refitted to operate with diesel and electricity. Dredge Mindi cuts and sucks material, pumps and deposits it through pipelines in disposal sites up to 10, 000 feet (3,048 m.) away. It is 400 feet (121.92 m.) long, 14 feet (4.27 m.) deep, and a has 72 feet (21.94 m.) cutter suction ladder.

Drill barge Thor is a floating drill. It is designed to drill the rocky hard Panama Canal substrata. Explosive munitions are placed into holes drilled in the substrata to break the rock prior to dredging. The Thor has an electronic system that controls all its operations. It has four towers and stands at the locations where prior studies have shown there is hard material. The head penetrates to an electronically set depth, fractures and breaks the material, and removes it from the site. The Rialto M. Christensen then arrives and takes the material away from the channel.

Drill barge Baru is ACP's newest drill barge.

In addition to dredges Rialto M. Christensen and Mindi, as well as drill barges Thor and Baru, the contracting of the services of additional dredging and drilling equipment is being considered for the construction period. It will be a diverse group, and it appears summarized on Table 3-19.

Table 3-19

Estimated Dredge/month and Drill/month for the Performance of the Post Panama Navigation Channel Works

Type of equipment	Scenario at 9.14 meters PLD	
	Dredge/month or drill/month	Number dredges/ drills required
Medium hopper dredge (5-10k m^3)	18.1	1
Cutter suction dredge (1 to 2k kw cutter)	56.7	1
Rock cutter dredge (2 to 3k kw cutter)	121.0	3
Land dredge	5.6	1
Rialto M. Christensen hopper dredge	41.5	1
Backhoe dredge for the Lake and access channels	33.7	1
Backhoe dredge for the Pacific entrance	48.0	1
Floating drills	73.9	2
Drills for shallow waters	20.1	1
Land drills	25.1	3 a 4

Source: Technical Analysis on the Proposed Panama Canal Post Panamax Navigation Channel. ACP, March 2006 (Spanish Translation).

3.6.2 Equipment Mobilization Frequency

The mobilization of the equipment will be done as the Contractors in charge of the various components join the Project, which in turn will be done in accordance with the Project implementation schedule discussed in section 3.5. The Project has been designed so that contractors will set up the equipment they require for the Project at the Contractor sites or at the work sites, and it is therefore expected that mobilization will take place mainly at the start of the performance of each contract.

3.6.3 Expected Vehicle Flow

It is assumed that the main access to the Pacific locks would be over the Bruja-Borinquen Road to the Cocoli area; as an access alternative with some restrictions, from new the Centennial Bridge, on the west side of the channel alignment; or crossing the existing Miraflores Bridge to the east side of the new lock.

The main access to the Atlantic locks site will be from the areas adjacent to the Bolivar Highway. An access alternative being considered is by railroad, from the city of Panama.

During the peak construction work years, it is estimated that more than 6,000 workers will access the construction areas daily. It must be noted that similar numbers of people have accessed these areas during time of the operation of the U.S. military bases. This matter is discussed in the Environmental Management Plan.

3.6.4 Mapping the Routes with the Heaviest Traffic

The routes most transited for the Canal Expansion Project have been designated according to the geographic location of the key elements of the Project. The spatial distribution of these elements (see Figures 3-7 and 3-9) will determine the need for the movement of both the human resources as well as the equipment needed for the construction work.

The routes to be used for the works may be classified as internal and external. Internal routes are those within the Panama Canal operating areas; and external routes are those belonging to the national public road network. The internal and external routes of the Project are described in the following paragraphs (Figures 3-21 and 3-22).

Internal Routes. Internal Project routes will be those that will allow access mainly to construction areas, Contractor areas, and disposal sites. On the Pacific Side, Borinquen Road, designated for the exclusive use of ACP, will serve to reach work fronts of the Pacific locks as well as the Borinquen dikes and the access channel excavation sites. This road is the continuation of Bruja Road, runs approximately on a northern-southerly direction, and connects the Cocoli area with the western access highway to the Centennial Bridge. As shown on the above mentioned Figures, there are other existing (unnamed) internal routes that can provide access to the materials disposal sites and may be used as it becomes necessary. On the Atlantic Side, the internal routes will be solely those needed to access the new locks construction sites from the Contractor area, and the materials disposal sites from the construction sites.

External Routes. External routes are those that allow access to the general Project area from the neighboring areas, and will be used mainly to transport workers to work sites. The main external routes on the Pacific Side are the Panama – Arraijan Highway, Bruja Road, the west and east access expressways to the Centennial Bridge, and Gaillard Highway. The Arraijan – Panama Highway will be especially important, as it is expected that a great number of workers will be using this route both from the city of Panama, as well as from Arraijan, to reach the Cocoli area where the Project Contractor sites will be located. In both cases, access would be through the existing Howard / Rodman intersection, continuing on Bruja Road. It is also expected that workers coming from La Chorrera, part of Arraijan, and the Tocumen, San Miguelito, and Chilibre areas will gain access to the works through the west and east access roads leading to the Centennial Bridge. The latter would access the Centennial Bridge through the access roads from the Northern Corridor, by way of Cerro Patacon and Gaillard Highway. It must be noted that at the present time there are public transportation routes serving these zones.

The main external routes on the Atlantic Side are the Boyd – Roosevelt Avenue for the area south of the city of Colon. Aminta Melendez and José D. Rossania Streets and mainly Bolivar Avenue would provide access from the city of Colon to the Project area. This avenue, at its junction with Jose Dominador Bazan, becomes Thelma King Street, and can provide access to the Contractor area and the new Atlantic locks construction site.

It has been estimated that the Canal Expansion Project as a whole, considering both worker transportation as well as transportation of the related population, would generate a total of **5,316** trips, of which **1,900** (36%) would be by private vehicle, and **3,146** (64%) would be on public transportation. These trips would be 1.1% of the total trips in the system by the year 2015; 0.9% of such trips by private vehicle, and 1.3% of them on public transportation. These trips represent 1,188 trips by private vehicle, and 68 public transportation vehicle units.

The Atlantic works front will attract 1,500 trips by individuals during the peak morning period, represent 480 trips by private vehicle and 300 automobiles; and 1,020 trips on public transportation, or 20 buses. The Pacific works front will attract 1,500 trips by individuals during the peak morning period, which represent 487 trips by private vehicle or 304 automobiles; and 1,013 trips on public transportation, or 20 buses. In addition, residents associated with Canal Expansion Project employment on the Atlantic Side will produce 289 trips by private vehicle, or 181 automobiles, and 616 trips on public transportation, or 12 buses. The residents of the Pacific Side will produce 644 trips by private vehicle or 403 automobiles, and 767 trips on public transportation, or 15 buses.

More details are provided on Project related transportation in the sections that discuss the existing socioeconomic conditions, those that describe the identification and assessment of impacts, and Annex 2.

Finally, water routes will also be used as part of the Project. These routes would be used mainly for the transportation of materials and equipment to the work sites, as well as for the disposal of dredged and excavated materials at aquatic disposal sites. These routes are all in the Panama Canal operating area.

3.7 Supplies Needed during Construction and Operations

The Panama Canal Expansion—Third Set of Locks Project will require a series of resources and services, both during its construction phase as well as during the operation of the expanded Canal. A brief description is made in this section of the basic services, the personnel, and the supplies that will be needed.

3.7.1 Basic Services (water, power, sewerage, access roads, public transportation, etc.)

The basic services required during the construction of the Canal Expansion - Third Set of Locks Project, and subsequently during the operations of the expanded Canal include: water, sewerage, power, communications, road networks, transportation, health and education, etc.

3.7.1.1 Water

The drinking water required for the works of the Third Set of Locks will be supplied through the water pipeline system existing in the zone, and if the need arises, it will be stored in water storage tanks in order to supply the various areas and work fronts.

The utilization of water sources consists of obtaining water from the surface bodies within the Canal area for the work that requires it (compacting, concrete mixing, etc.). It bears mentioning in this case that Gatun Lake on the Atlantic Side would be the primary source, and Cocoli and the Rio Grande Rivers on the Pacific Side would be the secondary sources. The volume of water at these sources or rivers varies according to the season (rainy or dry); however, they are rivers with a steady flow during the entire year, with the capacity to provide this resource. The use of any of these sources requires ACP authorization, and Contractors must have the physiochemical properties of such sources tested.

The estimates of the water required for the Canal Expansion Project, both for industrial use as well as for human consumption during the construction phase, are shown below on Table 3-20:

Table 3-20

Construction Phase Water Demand Estimates

Area	Use	Activity	Demand (MGD)
Pacific	Industrial	Concrete mixing and joint preparation	0.95
		Aggregate washing	1.14
		Drilling and blasting	0.02
	Household	Human consumption	0.19
		Total	2.30
Atlantic	Industrial	Concrete mixing and joint preparation	0.95
		Aggregate washing	1.14
	Household	Human consumption	0.19
		Total	2.28

Source: URS Holdings, Inc., from data provided by ACP.

With regard to the water needs for the operations phase, and as noted in the section describing the selected alternative, the design recommending the use of three water saving basins will allow a savings of nearly 60% of the total water consumption at the locks. According to this scheme, each full lockage would consume 193.5 thousand cubic meters of water, an amount that contrasts with the current consumption of each lockage of 208 thousand cubic meters. Table 3-21 below shows the water demand estimates for the operations phase.

Table 3-21

Operations Phase Water Demand Estimates

	Water Demand (in million cubic meters per year)		
Year	**Population**	**Canal Operations**	**Total**
2005	371	2,398	2,769
2010	403	2,584	2,986
2015	434	2,597	3,031
2020	466	2,796	3,262
2025	498	2,948	3,446

Source: Panama Canal Master Plan. ACP, 2006.

3.7.1.2 Power

The supply of power, both for the construction as well as for the operations phase, will be done through the existing services in the area, as provided by ACP. Therefore, power supply to the areas next to the Project will not be affected.

Power generators will be used during the construction phase for the work that is distant from the zones with power transmission supply. Power requirements during the construction period have been estimated and included Table 3-22.

Table 3-22

Estimated Power Requirements During the Construction

Year	Atlantic 80 GWh	Pacific 120 GWh
2007	3 GWh with max. demand of 2 MW	4 GWh with max. demand of 2 MW
2008	10 GWh with max. demand of 4 MW	15 GWh with max. demand of 6 MW
2009	20 GWh with max. demand of 5 MW	30 GWh with max. demand of 8 MW
2010	20 GWh with max. demand of 5 MW	30 GWh with max. demand of 8 MW
2011	15 GWh with max. demand of 4 MW	25 GWh with max. demand of 7 MW
2012	12 GWh with max. demand of 4 MW	16 GWh with max. demand of 6 MW

Source: URS Holdings, Inc., from data provided by ACP.

For the operations phase, the power requirements will be met with ACP´s own power generation systems.

3.7.1.3 Sewerage

The construction of the Pacific and Atlantic locks includes the supply of sewage treatment plants to each one of these areas, for use by ACP personnel and Contractors, for the purpose of ensuring that sewage is properly treated during the construction period. It is estimated that these plants will also be used for the personnel involved in the construction of the access channels. Treatment plants will ensure that the effluents from Contractor and ACP facilities will not contain elements that can alter water quality beyond the recommended limits. Technical Regulation DGNTI-COPANIT 39-2000 on *"Water. Discharge of liquid effluents directly into sewage water collection system"* shall apply. In the event there is no sewerage system available, Contractors must comply with the provisions of Technical Regulation DGNTI-COPANIT 35-2000 on *"Water. Discharge of liquid effluents directly into surface and underground water bodies and masses."*

During the operations phase, the sewage generated will either be sent to the current sewerage and treatment systems, or an adequate treatment system will be provided.

3.7.1.4 Access Roads

As the conceptual designs do not include activities outside the locks, some assumptions have been made to estimate the work that will take place at the work sites. The clearing for the works will include the areas alongside the roads to be used for the disposal of materials, and any areas adjacent to the locks that the Contractors may use. The roads included in the work sites refer to the relocation of Borinquen Road and to other access roads.

The preparation of a disposal site at Cocoli for the lock excavation material will be required. Upon completion of the works, this disposal site must be restored to meet the requirement of leaving the site in acceptable conditions.

<u>Access and Haul Roads</u>

On the Pacific Side, the main access to the Project area is on the Inter-American Highway, through the Bruja – Borinquen Road, to the Cocoli area. The distance from the Inter-American Highway is nearly 3 kilometers. There will be other access alternatives with some restrictions, i.e., from the new Centennial Bridge to the west side of the access channel, and over Miraflores Bridge to the east side of the new locks. During construction, the Contractor will require the preparation of several roads to access the various work areas and haul materials. Most of the materials from the lock chamber excavation, the approach walls, and the water saving basins will be used for the aggregate production plant, the construction of temporary roads and cofferdams, backfill, and the filling of the 1939 excavation.

On the Atlantic Side, the main access to the site will be from the city of Colon through the Bolivar Highway. An alternate access will be by railroad from the city of Panama. The present Panama Railroad Company route connecting the cities of Panama and Colon runs east of the new locks alignment. From the main access road, the Contractor will need to restore existing roads or build new roads to access construction areas and move equipment and materials. To gain access to the Project from the east side, approximately one kilometer of the existing road is needed, and two kilometers of new roads must be built parallel to the alignment. An existing road that crosses over the northern plug will be used to access the west side of the alignment. It is assumed that concrete aggregate material from the excavation of the Pacific locks will be transported by rail to the site. To this end, it is necessary to rehabilitate the old railway that crosses over the southern plug in the direction of the former town of Gatun. The aggregate plant and the concrete plant could be located on the southwest end of the alignment near Gatun Lake.

For the operations phase, the main access roads to Project operation sites will be the same used during the construction phase. On the Atlantic Side, these will be Bolivar Highway, and on the Pacific Side, they will be the Inter-American Highway and Bruja Road.

3.7.1.5 Public Transportation

During the construction phase, it is expected that the Contractor will set up a special bus service to transport workers to the sites. It is estimated that during the peak construction years, more than 6,000 workers will access the construction areas daily. It bears noting that a similar number of persons accessed these areas during the time U.S. military bases were in operation in the area. In view of the fact that the traffic peaks last only one hour, in the hypothetic case that traffic problems arise, Contractors can establish times for the beginning and end of work shifts so that they will not coincide with peak traffic times.

With regard to the operations phase, due to the fact that labor requirements would be similar to the current ones, except for the additional personnel required to operate the new locks and for maintenance tasks, no requirement needs to be established to provide public transportation for Project workers.

3.7.1.6 Other Services

Other required public and social services required are a national telephone network (Movistar and Cable & Wireless); power; connections to the national sewerage (IDAAN) system; education; and health.

With regard to social services, especially medical assistance, the cities of Colon and Panama have enough capacity to meet these Project demands (in both the public as well as the private sector). There is also uncertainty as to the number of cases that may arise by reason of the implementation of the Project (possible illnesses and/or accidents). Nonetheless, the latter does not release construction companies from the responsibility of providing first aid treatment and accident prevention programs in coordination with national agencies such as the Ministry of Health, the Panama Social Security, IDAAN, and ACP.

Education

Regarding the education services required for the purposes of the Canal Expansion Project, it is important to mention that these needs are currently being met through the National Vocational Training Institute for Human Development (INADEH), which has a cooperation agreement with ACP.

Health

On the matter of health, and despite the fact that there are health centers and stations in the *corregimientos* adjacent to the areas where the Project will be developed, and hospitals in the most important cities (Panama and Colon) where any emergency or request for treatment could be handled during the construction works, it is expected that Project Contractors will provide ambulance service and primary medical treatment services at the work sites during the periods when there is a larger concentration of workers.

3.7.2 Labor

The Project construction will require a direct employment of approximately 17 million work hours. The labor estimate has been taken from the construction analysis made to estimate costs, and from the Project implementation schedule. It is expected that the direct labor demand for the Project will reach its most intense phase between the years 2010 and 2012, when the access channel excavation stages coincide with the construction of the locks and water saving basins.

Construction and Operations Phases - Specialties

For the preliminary infrastructure work, the excavation of the access channels and the construction of the locks, approximately 40 different technical and craft occupations have been identified and classified into four categories: (1) unskilled workers, (2) skilled craftsmen, (3) equipment operators and (4) leaders, foremen, and supervisors.

It has been estimated that during the most intense work period, approximately 1,500 unskilled workers will be hired between assistants and beginners; 1,550 skilled craftsmen and specialists, 600 equipment operators, and nearly 80 foremen, leaders, and field supervisors. To ensure the availability of qualified Panamanians with the necessary skills, ACP is working in coordination with INADEH to develop well in advance the training of personnel with the required skills, licenses, and certifications.

Table 3-23 shows the maximum number of direct workers estimated for the construction of the locks; it shows a summary of the lock construction support and administrative staff; as well as the estimated number of workers required for the excavation and dredging work on the navigation channels, which will vary between 700 and 1,600 per year during the period of 2007 to 2014. As may be observed, a great majority of these workers will be dredge and ACP support personnel. The estimated number of workers required for the work associated with the raising of the level of Gatun Lake is 200. The indirect labor includes all the supervisory personnel, office staff (clerks, secretaries, drivers), support personnel (nurses, physicians, accountants), and any other personnel that cannot be directly attributed to an activity of the works. This work force estimate should be taken as reference and not as an absolute value, as the number of workers can vary depending on the Contractor's construction methodology, and the time assigned to complete the Project.

Insofar as the operations phase, and as has been previously mentioned, labor will be similar to that used at the present time for the operation of the Canal, with the exception of the additional operator requirements for the new locks, and for maintenance.

Table 3-23

Direct Labor by Specialty, as Estimated in the Cost Analyses

Maximum Number of Manual Workers			
Carpenter	442	General Foreman	72
Electrician	48	Carpenter Foreman	33
Mason	430	Concrete Foreman	23
Mechanic	46	Drilling and Blasting Foreman	22
Explosives Handler	79	Excavation Foreman	71
Reinforcement Specialist	305	Plant Foreman	10
Rigger	89	Rigger Foreman	24
Welder	214	Pile Driving and Welding Foreman	1
General Driver	142	Assistant	692
Beginner	1075	Compressor Operator	63
Pump Operator	23	Greaser / Oiler	14
Truck Driver	252	Drill Operator	74
Loader Operator	27	Forklift Operator	25
Excavator Operator	68	Bulldozer Operator	15
Crane Operator	165	Roller Compactor Operator	57
Crawler Crane Operator	124	Plant Operator	14
Administrative and support personnel, as estimated in the cost analyses			
Activity	**Total**	**Activity**	**Total**
Management	146	Temporary facility maintenance	179
Purchases and storage	61	Facility security	101
Accounting and finance	38	Administrative support	181
Design and drawing maintenance	22	Logistical support	54
Engineering and surveying	67	Construction supervision	55

Number of persons involved in excavation and dredging jobs per year								
Personnel	**Fiscal Year**							
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Foreign personnel hired by dredging Contractors	150	247	333	480	286	190	369	345
ACP dredge personnel	336	460	521	614	586	355	538	507
ACP support personnel	228	292	338	504	440	376	338	228
TOTAL	**714**	**999**	**1192**	**1599**	**1312**	**920**	**1245**	**1080**

Source: Conceptual Costs and Schedule for Post Panamax Locks. ACP, February 2006.

3.7.3 Materials and Supplies Needed for the Works

The estimates of the Atlantic and Pacific locks included facilities for aggregates, sand, ice, and concrete plants; as well as metalworking and carpentry shops, steel rebar, and prefabricated concrete. The estimate for the construction of these facilities includes Project access roads, buildings, and power supply services, communications, drinking water, and sewerage systems. During construction, the Contractor must rehabilitate and maintain several access roads that will lead to various working areas and will also serve for the hauling of materials.

3.7.3.1 Cement

Portland cement is a product that is vulnerable to hydration damage, which limits the keeping of a large stock, even with the best product handling practices. In Panama, humidity can raise costs to unusual levels at times when the peak demand is at its highest.

In this regard, it is clear from interviews with cement companies and builders that Contractors could bring their own mixers to work at specific Project sites. There is a fluid temporary lease market for this equipment with the required specifications.

The cement demand estimated for the Project, depending on the year it is required, is shown below on Table 3-24:

Table 3-24

Estimated Cement Demand for the Canal Expansion Project

Year	2009	2010	2011
Canal Demand (in thousand metric tons)	334.8	490.5	241.8

Source: Panama Canal Expansion Project Impact on Domestic Inflation and Markets of some Supplies. Indesa, 2007.

3.7.3.2 Concrete

Table 3-25 below shows the total concrete volume for a lock with three water saving basins in each of the Atlantic and Pacific complexes.

Table 3-25

Concrete Volumes for a Lock with Three Water Saving Basins

Item	Quantities (m^3)					
	Reinforced Concrete		Rolled Compacted Concrete		Lean Concrete	
	Pacific	*Atlantic*	*Pacific*	*Atlantic*	*Pacific*	*Atlantic*
Approach walls and floors	169,590.00	126,740.00	8,330.00	8,850.00	6,580.00	3,790.00
Chamber walls and floors	671,140.00	679,090.00	4,170.00	80,460.00	61,980.00	16,680.00
Gate recesses	516,790.00	508,950.00	-	-	11,920.00	6,800.00
Water saving basins	391,880.00	367,860.00	244,260.00	244,260.00	171,890.00	145,180.00
TOTAL	**1,749,400.00**	**1,682,640.00**	**256,760.00**	**333,570.00**	**252,370.00**	**172,450.00**

Source: Task Order 30. Parsons Brinckerhoff, 2006 and Cases and Schedules for the Conceptual Design of Post-Panamax Locks. ACP, February 2006.

3.7.3.3 Steel Rebar

In the first year of lock construction, the Project will require 88,900 metric tons of steel rebars. This number is equivalent to 80.1% of the quantities imported by the country in 2004, the year of Panama's highest rebar imports. By the year 2010, steel rebar requirements will increase to 131,400 metric tons, 19.3% more than the 2004 imports. By the year 2011, the Canal Expansion Project will require 36,200 metric tons, one third of Panama's imports in 2004.

3.7.3.4 Fuel

The fuel for the Project construction activities will be mainly light diesel. The quantities to be used will depend on the intensity of the work and the equipment to be used, and according to the projections made (INDESA, 2007), consumption of light diesel for the year 2008 will be 6.7 million gallons, 20 million in 2009, 20 million in 2010, 13.3 million in 2011, 13.3 million in 2012, and 6.7 million in 2013. A comparison of these estimates with the highest fuel consumption year (20 million gallons), reveals that this figure will be 9.9% of the domestic fuel consumption for the year 2006.

For the operations phase, the main supply item required will be water for ship lockages; the consumption data appears in previous sections. The remaining supplies required will be those for maintenance activities.

3.8 Waste Management and Disposal in All Phases

3.8.1 Planning Phase Waste Management and Disposal

In this phase, no generation is expected of solid, liquid, or gas waste, except for that ordinarily generated by office work, which will be managed in the same way as at the present time, through the municipal waste collection service.

3.8.2 Construction Phase Waste Management and Disposal

A project of the size of the Third Set of Locks, which employs a great number of persons and requires of a significant number of supplies and services for its construction, will inevitably generate a flow of waste of a diverse composition. The main types of waste to be generated are described below, as well as the way in which they can be managed safely. It is important to point out that a Waste Management Program is included the Environmental Management Plan which provides additional guidelines for the management of waste. This description does not include excavation and dredged material, as it has already been discussed as part of the construction process.

3.8.2.1 Solid Waste

Waste generated during the construction phase such as wood, pieces of rebar, cardboard, paper, cans, plastics, etc., and household garbage generated by employees will be stored in adequate containers on site at an especially designated area in the premises and properly secured. The Contractor will be responsible for the final disposal of this waste, and must comply with the regulations in force in the country on this matter.

3.8.2.2 Liquid Effluents

The construction of the Pacific and Atlantic locks includes the supply of a sewage treatment plant in each one of these areas, which will be operated for use by ACP personnel and Contractors, in order to ensure that properly treated water is discharged during the construction period. It is estimated that such plants will be also used for the construction of the access channels.

The treatment plant will ensure that effluents from Contractor and ACP facilities will not contain elements that can alter the water quality beyond the recommended limits. For this purpose, the provisions of Technical Regulation DGNTI-COPANIT 39-2000. *"Water. Discharge of Liquid Effluents Directly into Sewerage Systems"* shall apply. In places without a sewerage system, Technical Regulation DGNTI-COPANIT 35-2000. *"Water. Discharge of Liquid Effluents Directly into Surface and Underground Water Bodies and Masses."*

In addition to the treatment plants, it will be necessary to set up portable toilets at the various work fronts to provide basic sanitary facilities for workers. The ratio of toilets to workers will be one per every 20 workers.

3.8.2.3 Gaseous emissions

In this type of activity, the generation of gases is reduced to gases resulting from the internal combustion of dredges and tugboats operating at the site, and the emission of suspended particles resulting from earth movement. It is estimated that there will be a much lower generation of emissions from vehicle traffic in the area, and that its effect will be temporary.

Other sources of emissions and/or particulate matter will be from the operation of small power plants, materials handling activities, concrete plant operations, the use of explosives, the storage of fuel, etc.

3.8.2.4 Hazardous Waste

Hazardous waste may result from equipment and machinery maintenance (used oil, solvents, paints, paint brushes, rags, rollers, empty cans, oily waters, metal waste, batteries, etc.). These items must be disposed of in properly labeled 55 gallon drums. The services of a company authorized for the treatment, handling, and/or final disposal of this waste may be obtained.

3.8.3 Operations Phase Waste Management and Disposal

Waste generated during the operations phase is mainly that resulting from maintenance work on the new locks and navigation channels, and to a lesser degree, to the household waste from Project employee activities.

3.8.3.1 Solid Waste

Solid waste generated during expanded Canal operations will consist of that generated ordinarily by office work, which will be managed in the same way as it is at the present time, through the municipal waste collection service.

Another solid waste that may be generated will be dredged material from navigation channel maintenance. It will be managed through disposal sites that will continue in use during Project operations.

3.8.3.2 Liquid Effluents

Liquid effluents from the use of sanitary facilities by Project personnel will be managed in the same manner as done presently, into the sewerage system where there is one, or into septic tanks.

3.8.3.3 Gaseous emissions

Gaseous emissions will be those from equipment with combustion engines that is used for maintenance work, and from the use of explosives. For their control, reduction, and prevention, the measures proposed in the Air, Noise, and Vibration Protection Program must be implemented.

3.8.3.4 Hazardous Waste

Hazardous waste consists of used oil, batteries, paint, solvents, and other waste resulting from the maintenance of equipment, machinery, and operational systems in the expanded Canal. This waste will be managed as specified in the ACP Materials and Waste Management Manual, which regulates the consumption, storage, and accumulation, reduction, reuse, and disposal of various materials and waste, including hazardous waste.

3.9 Compliance with the Land Use Plan

In this case, the analysis of the use of land must start with the 1972 Political Constitution of the Republic of Panama, as it provides the legal framework with the ideology and structure applicable to all matters relative to the Canal and the Panama Canal Watershed (Articles 309 to 317).

<u>Legal Basis</u>

The Regional Plan for the Development of the Interoceanic Region and the General Plan for the Use, Conservation, and Development for the Canal Area and the Panama Canal Watershed were approved by means of Panama Law 21 of July 2, 1997. This law included the Panama Canal compatibility areas and the use of land.

Likewise, Law 19 of June 11, 1997 defines the Area of Compatibility with Panama Canal Operations as: "A geographic area including its lands and waters as described in Annex A that for all its purposes is part of the Law, where activities may only be conducted that are compatible with Canal operations." Moreover, Agreement Nº 102 of August 25, *"whereby the Plan for the Use of Panama Canal Authority Land is adopted, and the Regulations for the Use of the Patrimonial Assets of the Panama Canal Authority is approved,"* regulates land use in the areas of compatibility with Canal operations.

Considering that the two (2) alignments proposed by ACP for the new locks and the Direct Impact Area (DIA) are within the area of compatibility with the operation of the Canal, it is concluded that the Project is in compliance with the Land Use Plan. Figures 3-23 and 3-24 show the land use planned (Law 21) for the Direct Impact Area of the Project.

3.10 Financial Study and Analysis

The Canal Expansion Project is self-financing and its implementation will not create a debt for the country. For this reason, its financing will not be part of the Panama's sovereign debt. Funds for the construction of the Third Set of Locks will be obtained from toll increases. Tolls will be the source for all Third Set of Locks investments, as well as for the payment of any financing obtained for such purpose. The Government of Panama will not back or guarantee any ACP financing. Any possible financing needs will be dictated by three considerations, to wit:

- The investment amounts required for the Project and the need to carry out the construction in the fastest way that may be technically and economically feasible, for the purpose of obtaining the generation of benefits as promptly as possible and recover the investment;
- Canal revenues that may result from traffic volume through the Canal, and from the price policy implemented by ACP according to its established price policies and rates; and
- The need to obtain outside resources on a timely basis to cover the peak construction periods.

The additional resources will be obtained from a combination of more revenues from toll increases made according to ACP pricing policy, and the credit and financing sources available in finance markets. In this regard, ACP will increase its tolls starting in 2007 to collect on an early basis a portion of the necessary resources to implement the Third Set of Locks Project, and to ensure that it maintains the competitiveness of the Panama shipping route in all its segments. To complement the increase in tolls and pay for the peak construction periods between the years 2009 and 2011 approximately, ACP must obtain temporary outside financing to be paid from toll revenues over a short period after the opening of the Third Set of Locks.

According to financial studies made, it is estimated that the Canal Expansion Project will allow total revenues of US$6,227 million in the year 2025, with profits in the order of US$4,310 million, which are equivalent to an annual growth of 11.6%.

On the basis of the most probable demand projection, the Project would generate an internal return rate of 12%, which makes it attractive for an infrastructure investment as proposed, because from a financial point of view it is a profitable and attractive investment (ACP, 2006).

3.10.1 Overall Investment Amount

The overall estimated cost of the construction of the Third Set of Locks is of approximately US$5,250 million. This estimate includes the direct and indirect costs of the design, administration, construction, tests, environmental mitigation, and implementation of the Project. The costs of the major components of the Panama Canal Expansion - Third Set of Locks Project are shown in Table 3.26.

Table 3-26

General Budget of the Panama Canal Expansion - Third Set of Locks Project, by Component

Project Component	Estimated Cost*
New Locks	
Atlantic locks	1,110
Pacific locks	1,030
Contingency for new locks**	590
Total New Locks	**2,730**
Water Saving Basins	
Atlantic Water Saving Basins	270
Pacific Water Saving Basins	210
Contingency for new locks**	140
Total Water Saving Basins	**620**
New Lock Access Channels	
Atlantic Access Channels (Dredging)	70
Pacific Access Channels (Dry Excavation)	400
Pacific Access Channels (Dredging)	180
Contingency for New Access Channels **	170
Total New locks Access Channels	**820**
Improvements to Existing Navigation Channels	
Deepening and Widening of the Atlantic Entrance	30
Widening of Gatun Lake Channel	90
Deepening and Widening of Pacific Entrance	120
Contingency for Navigation Channel Improvements **	50
Total Navigation Channel Improvements	**290**
Water Supply Improvements	
Raising Gatun Lake Maximum Operating Level 27.1 meters (89') PLD	30
Deepening Navigation Channels to 9.1 meters (30') PLD	150
Contingency for Water Supply**	80
Total Water Supply Improvements	**260**
Inflation During Construction Period***	530
Total Investment	**5,250 M***

Source: Proposal for Panama Canal Expansion - Third Set of Locks Project. ACP, 2006
*In millions of U.S. dollars, rounded to the nearest tenth
**Contingency includes possible component cost variations
**A general inflation of 2% per year was assumed over that included in the contingency

It is important to point out that this cost includes sufficient contingencies to cover risks and unexpected costs resulting from fortuitous events, design changes, price increases, possible delays, etc. The contingency level is adequate and sufficient for this type of Project, and for the advances in design of its conceptual stage. Finally, the estimated Project cost also includes the effect of the possible inflation during the construction period.

3.10.2 Financing Needs and Strategy

The complement between financing through toll increases and outside financing sources will take into account the conditions of the maritime transportation markets on the one hand, and the conditions of the financing markets, such as interest rates, terms and conditions, as well as other financing contract costs. More toll increases will result in less need for ACP to resort to financing markets, while less additional revenues from toll increases will require more outside financing resources. In this regard, according to the most conservative toll increase policy, that is, with increases of 3.5% per year, the outside financing to cover the Project's peak periods should not be more than US$2,300 million. If a less conservative toll increase policy were adopted during the first five years of the Project, the need for temporary outside financing to cover the peak construction period, would be even less.

The ACP financing approval processes require the authorization of the Panama Cabinet Council, as well as the defining of a financing policy according to the following economic criteria:\

1. _Legal framework of ACP financing_. The Panama Canal belongs to the Government of Panama. Nonetheless, by virtue of the constitutional title that established the Panama Canal Authority and the Organic Law that develops it, ACP finances are managed separately from those of the rest of the Panamanian Government. This separation will allow ACP access to financing sources under the best possible conditions.

2. _No Government guarantee or backing is used._ Panama does not provide any sovereign guarantee to any Canal financing. Therefore, Panama Canal financing contract will not be consolidated with the sovereign debt. In other words, in the same way Canal finances are

not consolidated with public sector finances, the financing for the construction of the Third Set of Locks is not consolidated with the country's public debt.

3. *Canal contributions to the Panamanian Treasury will increase.* With the implementation of the investment program for the construction of the Third Set of Locks, it is posited that the contributions of the Panama Canal to Panama's National Treasury will be more than those in fiscal years 2005 and 2006. During the construction of the Third Set of Locks, the total contributions by the Panama Canal to the National Treasury will be an average of more than US$750 million per year, and in the year 2015 they could be thrice more than those in 2005. It is estimated that by the year 2025, the total contributions by the Panama Canal to the National Treasury will be more than eight fold those of 2005.\

4. ***Different financing sources will be used.*** Due to the nature of the Project, ACP will use financing markets different from those used by the Government of Panama to finance its investment programs.

ACP will be able to obtain financing in very competitive terms, as the Panama Canal has outside sources of revenue, and financing capacity and its terms are dictated by the quality of Canal users, the route utilization levels, the fact that Canal services are collected in advance or handled by means of bank guarantees of the first order with a collection cycle of 48 hours, and that it is an ongoing business with a proven market. This condition allows financing costs and terms more favorable than Government debt contracts. For this reason, ACP proposes to make the most of the financial separation by achieving a higher risk rating than that of the Government.

To date, ACP has financed all its capital investments with its own resources and the approval of Panama's Executive and Legislative Branches. Due to the size of the Third Set of Locks works, it is prudent for ACP to seek outside financing resources in order to carry out the project on time according to the proposed schedule. This financing will bridge the construction period and in the same manner as other construction projects, will be paid with the additional revenues that warrant the Project's profitability.

The financing of the Third Set of Locks will be the result of combining a reasonable increase in tolls as soon as the Project implementation is authorized, with outside financing sources to meet the maximum needs for funding during the construction period. By virtue of the separation of ACP finances from the rest of the Government finances, the source for the payment of the investment will be the Panama Canal toll revenues.