FINAL

Environmental Evaluation of Selected Water Supply Projects for the Canal Capacity Study (Task Order 002) Under Contract CC-3-544

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Autoridad del Canal de Panama

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The description of the environmental setting is based on field observations made while conducting field reconnaissance throughout Gatun Lake, specifically the Lower Rio Trinidad and Rio Indio areas with ACP personnel. Autoridad Nacional del Ambiente (ANAM), ACP, Asociacion Nacional para la Conservacion de la Naturaleza (ANCON), Electrical Transmission Agency, Smithsonian Tropical Research Institute (STRI), and Directorate of Mineral Resources personnel were interviewed to gain information on site characteristics and potential activities that could affect the project. In addition, extrapolations of the 2000 census data were used, and a review of the Informe de Cobertura Boscosa 1992 were used to determine the extent of forest cover.

Environmental Setting

This alternative combines three projects, the Lower Rio Trinidad (lake level 22.9 - 30.5 m) and Rio Indio (lake level 50 - 80 m). This project will provide additional storage of water for Gatun Lake and 17.29 additional lockages per day on a continual basis. The project area consists of 19,613 ha within Gatun Lake and 5,600 ha within the Rio Indio watershed. The area near Gatun Lake is sparsely populated and has a topography consisting of rolling hills, low regions near Gatun Lake. Near Rio Indio, the area is sparsely populated with terrains and a topography consisting of steep hills as well as coastal regions. The Lower Rio Trinidad and Rio Indio are west of the Panama Canal and flows northward from the Continental Divide into Gatun Lake. The watershed above Lower Rio Trinidad and the Rio Indio dam projects covers approximately 741 km^2.and 381 km^2respectively. The incremental impoundment area which covers approximately 3,968 consists of approximately 50 percent of forested land, 30 percent of pasture land (used by ranchers), 10 percent of cropland, and 10 percent of newly slashed and burned land. Gatun Lake's normal pool level is 26.7 m. The lake level during field observations (August 2001) was approximately 25.4 m.

LAND USE

The Lower Rio Trinidad project area encompasses the southwestern portion of Gatun Lake and areas along its shores. The areas to be flooded or partially flooded include the village of Escobal (population – 1,653), Nuevo Provenir (population – 121), Cuipo (population – 249), Ciricito (population – 72), La Arenosa (population – 242), La Garterita (population – 138), La Gartera (population – 348), and a few small isolated developments.

Some areas along the shores of the Lower Rio Trinidad have been deforested. Approximately 65 percent of the lakeshore areas are forested, mostly with secondary growth. Farms and ranches of various sizes as well as plantations of teak and African mahogany occupy the remaining land. Farm crops include maize, rice, beans, sugar, coffee, mangos, pineapples, and tobacco. Ranchers raise cows, horses, chickens, hogs, and tilapia. Some of the farmers and ranchers operate commercial enterprises, others rely on cash crops and subsistence farming. No significant ore deposits or mineral resources are located in the project area.

Approximately 2,300 people inhabits the Rio Indio project area; they live in the towns of Tres Hermanas (population – 200), Los Cedros (population – 80), El Coquillo (popoulation – 150), El Limon (population – 140), Los Uveros (population – 140), and La Boca de Uracillo (population – 110), and in nearly 30 smaller settlements. Downstream from the dam site at El Limon there are 14 communities with a combined

population of approximately 600. The largest of these is La Boca del Rio Indio with a population of more than 150.
Farms and ranches of various sizes, as well as some teak plantations, occupy approximately 60 percent of the land in the Rio Indio project area. Farm crops include maize, rice, beans, sugar, coffee, and tobacco. Ranches raise horses, cows, chickens, and hogs. Some of the farmers and ranchers run small commercial enterprises, or rely on cash crop and subsistence farming.

INFRASTRUCTURE

During site investigations in the Lower Trinidad area, the town of Escobal was the largest settlement visited. Escobal has businesses, schools, churches, cemeteries, medical centers, residences, and paved roadways of good condition. A new and improved roadway (Highway 35) is adjacent to the project area near Escobal. Other establishments in the project area - Nuevo Provenir; Cuipo; Ciricito; La Arenosa; La Garterita; La Gartera - and a few small isolated establishments have elementary schools, small cemeteries, churches and meeting centers, medical clinics, and a few small businesses (i.e. general stores). The towns and villages depend on Gatun Lake or groundwater wells for their potable water supply. Each community also had docks, small ports, and other boat access facilities. Goods are transported from one town to another by boat. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach the Lower Rio Trinidad portion of Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners; some homes have septic tanks, while others have an outdoor latrine (a hole in the ground). There are some health problems, such as hepatitis, dysentery, dermatitis, intestinal parasites, and respiratory illnesses, which are attributable to the present waste disposal methods. No major industries or poultry or beef processing plants are located in the project area. The project area is traversed by unpaved horseback riding trails that link the various communities and by unpaved roads used by the ACP for maintenance. Because of the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

In the Rio Indio project area, towns of El Limon, El Silencio, San Cristobal, and Piedra Amarilla have elementary schools. Several towns have cemeteries, churches, and medical centers. All these towns obtain water from rivers or groundwater wells. Some have electricity (from small generators) and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it might eventually reach Rio Indio and its tributaries. Disposal of domestic waste is the responsibility of individual homeowners; each home has an outdoor latrine. There are some known health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses which are attributed to the present waste disposal methods. No known major industries or poultry or beef processing plants are located in the project area. The only roads in the project area are unpaved and poorly maintained, and are usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Because of the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

TERRESTRIAL HABITAT

The terrestrial habitat in the Lower Rio Trinidad project area of Gatun Lake consists of tropical forest ecosystems, mostly secondary growth forests with patches of primary forest. About 65 percent of the land along the Lower Rio Trinidad of Gatun Lake is forested and probably supports diverse wildlife populations. The Lower Rio Trinidad areas of Gatun Lake also contain islands inhabited by wildlife. Some of the wildlife species do not interact with species on the mainland; others migrate between the island and the mainland. The species interrelationships are of great interest to scientists studying tropical ecosystems. Slash and burn activities have opened tracts of land for farming and cattle grazing; however, the majority of the lakeshore is forested to the edge of the water. Terrestrial areas are used by migratory species as wintering, breeding, and feeding grounds. The complex and diverse tropical ecosystems offer

habitat to connect a variety of wildlife communities and may provide critical wildlife habitat to many native species.

In Rio Indio, forests along the river that could support diverse wildlife populations cover about 90 percent of the areas along the Rio Indio and its tributaries. The forests also extend to the mountainous areas above the Rio Indio impoundment. As a result of slash and burn activities, there are no large contiguous tracts of forests at lower elevations in the impoundment.

ANIMALS ON ENDANGERED LIST

ANAM, Resolution 002-80, enacted on June 7, 1995, declared 33 mammals, 39 birds, and 11 reptiles and amphibians as being in danger of becoming extinct in Panama. Although their presence has not been confirmed to date, some of the species on the threatened list might be found in the project area. The manatee is an aquatic mammal known to inhabit Gatun Lake around the Barro Colorado Island; however, it has not been sighted in the project area.

AQUATIC HABITAT

Gatun Lake, one of the world's largest manmade lakes, was created during the construction of the Panama Canal. The lake's water depth and quality vary widely. Aquatic habitat ranges from inundated forests to clear water in areas distant from shipping lanes. The Lower Rio Trinidad areas of Gatun Lake provide habitat for a variety of wildlife species, both resident and migratory, as well as for both native and introduced fish and other aquatic species.

Rio Indio in the project area has characteristics typical of streams in mountainous regions. Its water is clean and cool, and its bottom ranges from sand to boulders, with numerous riffles, runs, and pools. Tributaries to Rio Indio include four major streams: Rio El Torno, Rio Uracillo, Rio Teria, and Rio Riacito, and 20 smaller streams. The river is approximately 16 km long, its width ranges from 3 m (in the dry season) to 10 m. The tributaries appear to support some fish communities; however, information about these is limited.

WETLANDS

Areas that contain hydric soils and hydrophytic plant communities, and that are subject to hydric conditions are termed wetlands. Wetlands occur in topographic areas where water remains pooled long enough to produce hydric soil conditions and wetland plant communities. Wetlands in the Lower Rio Trinidad project area consist of shallow water habitat and lands subject to frequent flooding. Shallow water areas along the banks of the Lower Rio Trinidad area of Gatun Lake receive sunlight to approximately 1 m. Sunlight stimulates growth of submergent, emergent, or floating mats of aquatic vegetation. Wetlands in the project area are stressed as a result of sediments, municipal waste, agricultural runoff, and other debris carried in the runoff.

Wetlands in the Rio Indio project area consist of forested riparian habitat and are limited by their relatively steep topography. The width of the riparian habitat within the impoundment area varies from approximately 5 to 50 m. Approximately 90 percent of the streams both above and below the dam site along the Rio Indio and its tributaries are bordered by forested riparian habitat.

AIR QUALITY

Air quality in the project area is generally good, except during the slash and burn activities. At the end of the dry season in March or early April, areas of forest and secondary growth are burned and cleared for agricultural use. During this period, the air is filled with smoke and ash, which may be transported by winds to the Lower Rio Trinidad area of Gatun Lake. Based on observations in the Rio Indio project area,

approximately 10 percent (or 400 ha) of forested land is burned annually. Air quality monitoring has not been implemented within the project area.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

Barro Colorado Island is an international center for tropical research and one of the first biological reserves established in the Neotropics. From 1923 through 1940, a scientific committee of the U.S. National Academy of Sciences administered the biological reserve/laboratory. In 1940, by an Act of the United States Congress, the facility was renamed the Panama Canal Zone Biological Area, and in 1946, the responsibility for its maintenance was assigned to the Smithsonian Institution. With the Panama Canal Treaty Implementation in 1977, the island was granted the category of National Monument and to date it continues to be managed by the Smithsonian Institute. It should also be noted that most of the Atlantic region of Panama is within the interest and objectives of the Mesoamerican Biological Corridor, an international project to conserve biodiversity.

In the pre-Columbian period, Rio Indio was a language frontier; that is, the inhabitants on each side of the river spoke a different native language. During the Spanish colonial period, the river served as a political boundary; thus, the project area has a high potential to be rich in archaeological and historical remains.

Environmental Impacts

TERRESTRIAL HABITAT

The impacts of the project on terrestrial habitat in the Lower Rio Trinidad area of Gatun Lake could be substantial. The boundary between two types of habitats, in this case between a forest and a lake, is called an ecotone. Ecotones are inhabited by a variety of species from neighboring habitats, and are unique, with high species diversity. Considering the proposed operating levels for both impoundments, between 22.9 - 30.5 m, as the normal zone of operation, erosion of the shoreline may be substantial as pool levels rise and fall. Terrestrial habitat that would be inundated above the 26. 7 m (existing level) to the 30.5 m proposed normal pool level consists of 18,169 ha for the Lower Rio Trinidad project. The placement of a dam structure, access roads, and pump stations would permanently impact terrestrial habitat. Wildlife species that are able to relocate to suitable areas will compete with similar species for resources. Wildlife species that are not able to relocate will not survive. As a result, competition for natural resources in surrounding habitat areas will increase. This is considered a secondary impact to terrestrial habitat outside the proposed zone of inundation and construction.

The terrestrial impacts of the Rio Indio project, which is located in area of relatively high quality forest habitat, would be substantial. With the creation of the lake, the migratory routes of some species could be adversely affected. Forested areas along lower elevations would be lost as a result of the impoundment. The only forests that would remain near the Rio Indio reservoir and its drainage basin would be confined to the higher elevations, where the vegetation and species may be completely different from those found on lower elevations. Natural communities are linked together by complex interactions and relationships among various species, therefore impacts to upper forested areas may occur resulting from the inundation of the lower forests.

ANIMALS ON ENDANGERED LIST

The severity of impacts on endangered species cannot be determined at this time, because although it is expected that some of the listed species are found in the region, it is not known which of the listed species inhabit the proposed project area. Some endangered and/or threatened species may use the Lower Rio Trinidad areaa of Gatun Lake during some or all parts of their life cycle.

WATER QUANTITY

The impacts of the Lower Trinidad project on water quantity would be substantial. The increase in the volume of water could have negative impacts to lakeshore communities as well as on existing ecosystems. The same is true if the lake level is lowered and maintained at 22.9 m.

The impacts of the Rio Indio project area on water quality would also be substantial. The volume of water will increase, making fresh water available in the surrounding areas during the dry season. The impacts downstream from the dam would be significant. Sediment loads would be deposited upstream from the dam as water velocity slows. Downstream from the dam the water will be released at an increased velocity, causing erosion of banks and river bottoms. Seasonal flooding could be significantly reduced. It would also be possible to periodically release water in appropriate amounts to avoid problems with water quality and temperature downstream. The cumulative impacts downstream from the dam site depend on the amount of water being released.

WATER QUALITY

Project impacts on water quality are not known. Damming the Lower Rio Trinidad could increase the amounts of nutrients and debris in this portion of Gatun Lake. A pilot plant tilapia farm is in the project area and may affect water quality. The rate at which nutrients and debris enter the lake will determine the severity of the impact on water quality. Project implementation could cause an increase in turbidity, which would interfere with photosynthesis and deprive plants and other aquatic species from sunlight. Aquatic plants and organisms serve to maintain water quality. The dam would interfere with the circulation of freshwater throughout the Gatun Lake environment. Species inhabiting specific depths could be impacted when lake depth increases to 30.5 m and/or decreases to 22.9 m.

The impacts of the Rio Indio project on water quality could be positive. The people living downstream from the dam and around the impoundment would have access to a water supply of higher quality. Water quality in the impoundment area would differ from water released downstream from the dam. If the water in the impoundment area does not circulate or turn over periodically, it could become anoxic. A change in temperature, dissolved oxygen, turbidity, or pH could change water quality.

DOWNSTREAM AQUATIC FAUNAL HABITAT

The impacts of the project on aquatic faunal habitat could be substantial. The project may affect the breeding and nursery habitat of many aquatic species. Impacts to fish spawning areas may be detrimental when turbidity, nutrient content, and depth of the water suddenly increase or decrease, by altering the conditions needed for a successful fish hatch. Plant populations may decrease as a result of fluctuating water depths, clarity, and quality. Invertebrate populations may decline, which could reduce the food supply for fish and other aquatic species.

Impacts to downstream aquatic faunal communities in the Rio Indio project area could be substantial, because the dam structure will prevent their migration throughout the riverine habitat. The dam structure would be designed for multi-level releases to maintain a water level downstream from the dam site. The dam should act as a large sediment trap; thus, the released water would have low turbidity, which would result in better visibility and increased predation on the fish species. Aquatic faunal habitats downstream would be deprived of the beneficial nutrients and silts that were transported in the sediment. Native riverine fish species may be negatively impacted as a result of the project; the extent of the impact is not known.

FUTURE LAKE AQUATIC PLANT COMMUNITY

The impacts of the project on future aquatic plant communities depend on water quality and stability of water levels. Plant species in the Lower Rio Trinidad portion of Gatun Lake could be impacted by fluctuating water levels. Aquatic plant communities could be impacted during project implementation; however, they could re-establish themselves after conditions stabilize.

The severity of impacts from the Rio Indio project will depend on water level fluctuations. Since water levels are anticipated to fluctuate widely, large portions of the shores would be covered with mud, where neither aquatic nor terrestrial plants could thrive.

AQUATIC FAUNA INHABITING AFFECTED AREAS

The proposed project impacts could have some unavoidable, adverse environmental impacts on aquatic fauna in the Lower Rio Trinidad and associated rivers and tributaries. These impacts should be identified and minimized with appropriate mitigation measures to be discussed in a feasibility level study. Gatun Lake has populations of peacock bass and tilapia, both introduced species that have adapted well. However, several native riverine species that formerly occupied the impoundment have disappeared.

The impacts of the Rio Indio project on aquatic fauna in the Rio Indio and its upstream tributaries could be substantial, since the habitat area would change from riverine to lacustrine. Some aquatic species would continue to inhabit the area; however, non-native fish species would become dominant in the impoundment area and native riverine species would be pushed upstream or extirpated. Other manmade lakes in the Republic of Panama have been stocked with peacock bass and tilapia, both of which have adapted well. The impoundment area would probably be stocked with these species to promote sport fishing and to provide the local communities with fish for food.

WETLANDS

The impacts to wetlands could be significant. Inundation of wetlands could cause them to become aquatic habitat. The changes in water depth caused by the project may lead to increased or decreased sedimentation and turbidity which could hamper the biological processes in the wetlands and decrease their productivity. Such impacts could be detrimental to the health and sustainability of the Lower Rio Trinidad area of Gatun Lake. Fish and other aquatic species use shallow water areas as spawning grounds as well as habitat for their juvenile aquatic species, that survive in the shallow waters of the wetlands until they are large enough to venture into deeper water. These wetlands are vital to the sustainability of this portion of Gatun Lake, including the Lower Rio Trinidad area.

The impacts to wetlands both upstream and downstream from the Rio Indio project area could be significant. Owing to the topography of the project area, a number of wetlands could be impacted. It is possible that although the reservoir level will fluctuate, new wetlands could develop in the littoral zones. Downstream from the dam site, wetlands along the minimal flow zone would survive; however, wetlands that depend on seasonal flooding for survival may be adversely affected.

AIR QUALITY

During project implementation, emissions from construction equipment, as well as from the slash and burn activities could cause deterioration of air quality. After project implementation, the air quality may be impacted by the operation of the power generation facility and the pumping stations.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

The potential impacts on cultural resources and historic properties from the Rio Indio project can be defined and mitigated, in particular, in the La Boca de Uracillo area, which is near previously identified

archaeological sites. The project area is relatively large and is known to contain pre-Columbian sites; therefore, the presence of cultural resources and historic properties is highly probable. Prior to construction, surveys to locate cultural resources and historic properties would be conducted, and the important sites would be preserved or salvaged as appropriate.

SOCIO-ECONOMIC IMPACTS

The socio-economic impacts of the project could be substantial. The relocation of the towns and other small communities along the lakeshore would be an important issue. The average monthly income of families in the project area ranges from less than $100 to $200 per month. No indigenous groups are known to reside in the impact area. Land use would be greatly impacted by the inundation of pastures and agricultural lands to expand the impoundment. The relocation of agricultural and ranching activities would be an important issue, because approximately 10 percent of the land in the impoundment area is used for farming and ranching. After the water level is raised, additional agricultural land could be lost as a result of creation of islands that were once isthmuses. The incremental surface area of the proposed Lower Trinidad lake is 3,968 ha; another 1,066 ha from the Lower Trinidad project and 760 ha from the Rio Indio project will be occupied by the dam and construction areas, including permanent disposal areas.

During construction, the influx of workers could create a temporary demand for additional housing, which could result in an increase in housing values near the dam site. However, after completion of the project, the workers could leave, the housing demands could drop, and the housing values could return to pre-construction levels. Currently, all residents have access to public schools and health centers. During construction, these services should continue to be available, and additional public and community services may be offered. After construction, these services would return to the normal level.

To construct the dam, some existing roads would be improved and some new roads would be built. However, some paved and unpaved roads within the impoundment area would be eliminated, which would change traffic patterns and could cause some communities to lose overland transportation, communication, cohesion, and commerce with other communities. During construction, the traffic volumes over both new and existing roads systems would increase; however, following completion of construction, the traffic volumes could decline. Noise levels would temporarily increase during construction and could negatively impact noise-sensitive receptors, however, after construction noise levels may remain elevated as a result of the power generation facility and pump stations.

The communities that receive people displaced by the project could be negatively impacted by overcrowding and by competition for jobs, land, and working areas. Construction of the dams would permanently displace people and disrupt community cohesion through the division of communities, separation of families, and loss of livelihood. Following completion of the impoundment, tourism trade in the affected region, including sport fishing and ecotourism, could increase.

Additional Environmental Information Required

This section identifies the subject areas for which additional data are required to evaluate in further detail, the scope and magnitude of the potential effects of the Lower Rio Trinidad and Rio Indio alternative. The subject areas are discussed by impact category.

SOCIO-ECONOMIC IMPACTS

- Conduct a SIA. The SIA would consist of three tasks: scoping, assessment, and mitigation and monitoring. The following information should be developed:
  - Business, Industrial, and Agricultural Activities;

- Employment;
- Land Use;
- Property Values;
- Public and Community Facilities and Services (including utilities and schools);
- Transportation;
- Housing;
- Health (vector routes);
- Population;
- Community Cohesion; and,
- Recreational Resources.

TERRESTRIAL AND AQUATIC HABITAT

- Prepare site-specific habitat maps to ensure that the major types of aquatic habitat are identified and quantified.
- Conduct field studies to locate rare and unique habitats such as wetlands, primary forests, roosting sites, foraging areas, old growth, and migration flyways.
- Determine the present quality and ecosystem value of existing habitats within the Gatun Lake project area.
- Coordinate with local experts to identify and evaluate aquatic and terrestrial habitat areas.
- Prepare species inventory lists for each site area, identifying their status as native or exotic and whether they are threatened and/or endangered species.
- Conduct additional research into water currents and estimated turbidity levels to evaluate impacts to the shallow areas along Barro Colorado Island.
- Address cumulative effects caused by natural flow diversions.

ANIMALS ON THE ENDANGERED LIST

- Compile habitat maps to assess the availability and quality of suitable habitats for the animals on the endangered and/or threatened species list.
- Establish field methodology to assess wildlife habitat values.
- Conduct site surveys to determine the presence of selected species or their habitats.
- Develop candidate mitigation measures for the appropriate project alternatives to be considered in the Conceptual Phase.
- Coordinate with local experts on the presence of endangered species.

WATER QUALITY

- Since limited water quality data are available for the Gatun Lake area, compile information on total suspended solids, conductivity, total dissolved solids, dissolved oxygen, nutrients, pH, and coliform bacteria.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

- Information regarding cultural resources and historic properties in the project area is incomplete. Additional evaluation studies should be completed to identify any such resources and/or properties.

Evaluation Matrices

Table 37 - 1 Environmental Effects

Item	Measure [1]	Importance [2]	Composite [3]
Terrestrial Habitat	3	8	24
Animals on Extinction List	2	10	20
Water Quantity Impacts – Lake	8	10	80
Water Quantity Impacts – Downstream	4	7	28
Water Quality	5	10	50
Downstream Aquatic Fauna Habitat	3	8	24
Future Lake Aquatic Plant Community	6	8	48
Aquatic Faunal Inhabiting Affected Area and Upstream Tributaries	4	5	20
Potential for Fishing on Lake	6	6	36
Wetlands	3	4	12
Air Quality	5	3	15
Cultural Resources and Historic Properties	3	10	30
Total			387

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

Table 37 - 2 Socio-Economic Effects

Item	Measure [1]	Importance [2]	Composite [3]
Land Use	1	7	7
Relocation of People	2	10	20
Relocation of Agricultural/Ranching Activities	2	6	12
Post-Construction Business	6	5	30
Post-Construction on Existing Employment	6	5	30
Property Values During Construction	7	4	28
Property Values Post-Construction	5	5	25
Public/Community Services During Construction	6	4	24
Public/Community Services Post-Construction	5	8	40
Traffic Volumes over Existing Roadway System During Construction	3	5	15
Traffic Volumes over New Roadway System Post-Construction	5	5	25
Noise-Sensitive Resources or Activities	4	4	16
Communities Receiving Displaced People	1	8	8
Community Cohesion	1	8	8
Tourism	6	5	30
Total			318

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SECTION 38 – LOWER RIO TRINIDAD 22.9m to 30.5m, UPPER RIO INDIO 50m

Socio-Economic Impacts

The description of the environmental setting is based on field observations made while conducting field reconnaissance throughout Gatun Lake, specifically the Lower Rio Trinidad and Rio Indio areas with ACP personnel. Autoridad Nacional del Ambiente (ANAM), ACP, Asociacion Nacional para la Conservacion de la Naturaleza (ANCON), Electrical Transmission Agency, Smithsonian Tropical Research Institute (STRI), and Directorate of Mineral Resources personnel were interviewed to gain information on site characteristics and potential activities that could affect the project. In addition, extrapolations of the 2000 census data were used, and a review of the Informe de Cobertura Boscosa 1992 were used to determine the extent of forest cover.

Environmental Setting

This alternative combines two projects which would function in tandem with Gatun Lake, The Lower Rio Trinidad (lake level 22.9 - 30.5 m) and Upper Rio Indio (lake level 50 m). This project would provide additional storage of water for Gatun Lake and 7.06 additional lockages per day on a continual basis. The structures for the proposed Lower Trinidad portion of the project would consist of a rockfill dam, a pumping station, a gated spillway, and access/maintenance roads. The project area consists of 18,169 ha within Gatun Lake. The area near Gatun Lake is sparsely populated and has a topography consisting of rolling hills, low regions near Gatun Lake. The Rio Indio portion of the project would consist of a rock fill dam, outlet works, unregulated spillway, an interbasin transfer tunnel, two hydropower facilities, and required access and maintenance roads and power transmission lines. The project area would require approximately 1,898 ha along the eastern leg of the Upper Rio Indio. Near Rio Indio, the area is sparsely populated with terrains and a topography consisting of steep hills as well as coastal regions. The Lower Rio Trinidad and Rio Indio are west of the Panama Canal and flows northward from the Continental Divide into Gatun Lake. The watershed above the Lower Rio Trinidad and the Rio Indio dam project covers approximately 741 km^2 and 256 km^2 respectively. The incremental impoundment area, which covers approximately 3,968 ha, consists of approximately 50 percent forested land, 30 percent pasture land (used by ranchers), 10 percent cropland, and 10 percent newly slashed and burned land. Gatun Lake's normal pool level is 26.7 m. The lake level during field observations (August 2001) was approximately 25.4 m.

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Some areas along the shores of the Lower Rio Trinidad have been deforested. Approximately 65 percent of the lakeshore areas are forested, mostly with secondary growth. Farms and ranches of various sizes as well as plantations of teak and African mahogany occupy the remaining land. Farm crops include maize, rice, beans, sugar, coffee, mangos, pineapples, and tobacco. Ranchers raise cows, horses, chickens, hogs, and tilapia. Some of the farmers and ranchers operate commercial enterprises, others rely on cash crops and subsistence farming. No significant ore deposits or mineral resources are located in the project area.

Approximately 2,300 people inhabits the Rio Indio project area; they live in the towns of Tres Hermanas (population – 200), Los Cedros (population – 80), El Coquillo (popoulation – 150), El Limon (population – 140), Los Uveros (population – 140), and La Boca de Uracillo (population – 110), and in nearly 30 smaller settlements. Downstream from the dam site at El Limon there are 14 communities with a combined population of approximately 600. The largest of these is La Boca del Rio Indio with a population of more than 150.

Farms and ranches of various sizes, as well as some teak plantations, occupy approximately 60 percent of the land in the project area. Farm crops include maize, rice, beans, sugar, coffee, and tobacco. Ranches raise horses, cows, chickens, and hogs. Some of the farmers and ranchers run small commercial enterprises, or rely on cash crop and subsistence farming.

INFRASTRUCTURE

During site investigations in the Lower Trinidad area, the town of Escobal was the largest settlement visited. Escobal has businesses, schools, churches, cemeteries, medical centers, residences, and paved roadways of good condition. A new and improved roadway (Highway 35) is adjacent to the project area near Escobal. Other establishments in the project area are - Nuevo Provenir; Cuipo; Ciricito; La Arenosa; La Garterita; La Gartera - and a few small isolated establishments. These communities have elementary schools, small cemeteries, churches and meeting centers, medical clinics, and a few small businesses (i.e. general stores). The towns and villages depend on Gatun Lake or groundwater wells for their potable water supply. Each community also had docks, small ports, and other boat access facilities. Goods are transported from one town to another by boat. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach the Lower Rio Trinidad portion of Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners: some homes have septic tanks, while others have an outdoor latrine (a hole in the ground). There are some health problems, such as hepatitis, dysentery, dermatitis, intestinal parasites, and respiratory illnesses which are attributable to the present waste disposal methods. No major industries or poultry or beef processing plants are located in the project area. The project area is traversed by unpaved horseback riding trails that link the various communities and by unpaved roads used by the ACP for maintenance. Because of the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

In the Rio Indio project area, towns of El Limon, El Silencio, San Cristobal, and Piedra Amarilla have elementary schools. Several towns have cemeteries, churches, and medical centers. All these towns obtain water from rivers or groundwater wells. Some have electricity (from small generators) and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it might eventually reach Rio Indio and its tributaries. Disposal of domestic waste is the responsibility of individual homeowners; each home has an outdoor latrine. There are some known health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses which are attributed to the present waste disposal methods. No known major industries or poultry or beef processing plants are located in the project area. The only roads in the project area are unpaved and poorly maintained, and are usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Due to the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

TERRESTRIAL HABITAT

The terrestrial habitat in the Lower Rio Trinidad project area of Gatun Lake consists of tropical forest ecosystems, mostly secondary growth forests with patches of primary forest. About 65 percent of the land along the Lower Rio Trinidad of Gatun Lake is forested and probably supports diverse wildlife populations. The Lower Rio Trinidad areas of Gatun Lake also contain islands inhabited by wildlife.

Some of the wildlife species do not interact with species on the mainland; others migrate between the island and the mainland. The species interrelationships are of great interest to scientists studying tropical ecosystems. Slash and burn activities have opened tracts of land for farming and cattle grazing; however, the majority of the lakeshore is forested to the edge of the water. Terrestrial areas are used by migratory species as wintering, breeding, and feeding grounds. The complex and diverse tropical ecosystems offer habitat to connect a variety of wildlife communities and may provide critical wildlife habitat to many native species.

In Rio Indio, forests along the river that could support diverse wildlife populations cover about 90 percent of the areas along the Rio Indio and its tributaries. The forests also extend to the mountainous areas above the Rio Indio impoundment. As a result of slash and burn activities, there are no large contiguous tracts of forests at lower elevations in the impoundment.

ANIMALS ON ENDANGERED LIST

ANAM by its Resolution 002-80 on June 7, 1995 declared 33 mammals, 39 birds, and 11 reptiles and amphibians as being in danger of becoming extinct in Panama. Although their presence has not been confirmed to date, some of the listed species of interest on the threatened list might be found in the project area. The manatee is an aquatic mammal known to inhabit Gatun Lake around the Barro Colorado Island; however, it has not been sighted in the project area.

AQUATIC HABITAT

Gatun Lake, one of the world's largest manmade lakes, was created during the construction of the Panama Canal. The lake's water depth and quality vary widely. Aquatic habitat ranges from inundated forests to clear water in areas distant from shipping lanes. The Lower Rio Trinidad areas of Gatun Lake provide habitat for a variety of wildlife species, both resident and migratory, as well as for both native and introduced fish and other aquatic species.

Rio Indio in the project area has characteristics typical of streams in mountainous regions. Its water is clean and cool, and its bottom ranges from sand to boulders, with numerous riffles, runs, and pools. Tributaries to Rio Indio include four major streams: Rio El Torno, Rio Uracillo, Rio Teria, and Rio Riacito, and 20 smaller streams. The river is approximately 16 km long, its width ranges from 3 m (in the dry season) to 10 m. The tributaries appear to support some fish communities; however, information about these is limited.

WETLANDS

Areas that contain hydric soils and hydrophytic plant communities, and that are subject to hydric conditions are termed wetlands. Wetlands occur in topographic area where water remains pooled long enough to produce hydric soil conditions and wetland plant communities. Wetlands in the Lower Rio Trinidad project area consist of shallow water habitat and lands subject to frequent flooding. Shallow water areas along the banks of the Lower Rio Trinidad area of Gatun Lake receive sunlight to approximately 1 meter. Sunlight stimulates growth of submergent, emergent, or floating mats of aquatic vegetation. Wetlands in the project area are stressed as a result of sediments, municipal waste, agricultural runoff, and other debris carried in the runoff.

Wetlands in the Rio Indio project area consist of forested riparian habitat and are limited by their relatively steep topography. The width of the riparian habitat within the impoundment area varies from approximately 5 to 50 meters. Approximately 90 percent of the streams both above and below the dam site along the Rio Indio and its tributaries are bordered by forested riparian habitat.

AIR QUALITY

Air quality in the project area is generally good, except during the slash and burn activities. At the end of the dry season in March or early April, areas of forest and secondary growth are burned and cleared for agricultural use. During this period, the air is filled with smoke and ash, which may be transported by winds to the Lower Rio Trinidad area of Gatun Lake. Based on observations in the Rio Indio project area, approximately 10 percent (or 400 hectares) of forested land is burned annually. Air quality monitoring has not been implemented within the project area.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

Barro Colorado Island is an international center for tropical research and one of the first biological reserves established in the Neotropics. From 1923 through 1940, a scientific committee of the U.S. National Academy of Sciences administered the biological reserve/laboratory. In 1940, by an Act of the United States Congress, the facility was renamed the Panama Canal Zone Biological Area, and in 1946, the responsibility for its maintenance was assigned to the Smithsonian Institution. With the Panama Canal Treaty Implementation in 1977, the island was granted the category of National Monument and to date it continues to be managed by the Smithsonian Institute.It should also be noted that most of the Atlantic region of Panama is within the interest and objectives of the Mesoamerican Biological Corridor, an international project to conserve biodiversity.

In the pre-Columbian period, Rio Indio was a language frontier; that is, the inhabitants on each side of the river spoke a different native language. During the Spanish colonial period, the river served as a political boundary; thus, the project area has a high potential to be rich in archaeological and historical remains.

Environmental Impacts

TERRESTRIAL HABITAT

The impacts of the project on terrestrial habitat in the Lower Rio Trinidad area of Gatun Lake could be substantial. The boundary between two types of habitats, in this case between a forest and a lake, is called an ecotone. Ecotones are inhabited by a variety of species from neighboring habitats, and are unique, with high species diversity. Considering the proposed operating levels for both impoundments, between 22.9 - 30.5 m, as the normal zone of operation, erosion of the shoreline may be substantial as pool levels rise and fall. errestrial habitat that would be inundated above the 26. 7 m (existing level) to the 30.5 m proposed normal pool level consists of 18,169 ha for the Lower Rio Trinidad project. The placement of a dam structure, access roads, and pump stations would permanently impact terrestrial habitat. Wildlife species that are able to relocate to suitable areas will compete with similar species for resources. Wildlife species that are not able to relocate will not survive. As a result, competition for natural resources in surrounding habitat areas will increase. This is considered a secondary impact to terrestrial habitat outside the proposed zone of inundation and construction.

The terrestrial impacts of the Rio Indio project, which is located in area of relatively high quality forest habitat, would be substantial. With the creation of the lake, the migratory routes of some species could be adversely affected. Forested areas along lower elevations would be lost as a result of the impoundment. The only forests that would remain near the Rio Indio reservoir and its drainage basin would be confined to the higher elevations, where the vegetation and species may be completely different from those found on lower elevations. Natural communities are linked together by complex interactions and relationships among various species, therefore impacts to upper forested areas may occur resulting from the inundation of the lower forests.

ANIMALS ON ENDANGERED LIST

The severity of impacts on endangered species cannot be determined at this time, because although it is expected that some of the listed species are found in the region, it is not known which of the listed species inhabit the proposed project area. Some endangered and/or threatened species may use the Lower Rio Trinidad areaa of Gatun Lake during some or all parts of their life cycle.

WATER QUANTITY

The impacts of the Lower Trinidad project on water quantity would be substantial. The increase in the volume of water could have negative impacts to lakeshore communities as well as on existing ecosystems. The same is true if the lake level is lowered and maintained at 22.9 m.

The impacts of the Rio Indio project area on water quality would also be substantial. The volume of water will increase, making fresh water available in the surrounding areas during the dry season. The impacts downstream from the dam would be significant. Sediment loads would be deposited upstream from the dam as water velocity slows. Downstream from the dam the water will be released at an increased velocity, causing erosion of banks and river bottoms. Seasonal flooding could be significantly reduced. It would also be possible to periodically release water in appropriate amounts to avoid problems with water quality and temperature downstream. The cumulative impacts downstream from the dam site depend on the amount of water being released.

WATER QUALITY

Project impacts on water quality are not known. Damming the Lower Rio Trinidad could increase the amounts of nutrients and debris in this portion of Gatun Lake. A pilot plant tilapia farm is in the project area and may affect water quality. The rate at which nutrients and debris enter the lake will determine the severity of their impact on water quality. Project implementation could cause an increase in turbidity, which would interfere with photosynthesis and deprive plants and other aquatic species from sunlight. Aquatic plants and organisms serve to maintain water quality. The dam would interfere with the circulation of freshwater throughout the Gatun Lake environment. Species inhabiting specific depths could be impacted when lake depth increases to 30.5 m and/or decreases to 22.9 m.

The impacts of the Rio Indio project on water quality could be positive. The people living downstream from the dam and around the impoundment would have access to a water supply of higher quality. Water quality in the impoundment area would differ from water released downstream from the dam. If the water in the impoundment area does not circulate or turn over periodically, it could become anoxic. A change in temperature, dissolved oxygen, turbidity, or pH could change water quality.

DOWNSTREAM AQUATIC FAUNAL HABITAT

The impacts of the project on aquatic faunal habitat could be substantial. The project may affect the breeding and nursery habitat of many aquatic species. Impacts to fish spawning areas may be detrimental when turbidity, nutrient content, and depth of the water suddenly increase or decrease, by altering the conditions needed for a successful fish hatch. Plant populations may decrease as a result of fluctuating water depths, clarity, and quality. Invertebrate populations may decline, which could reduce the food supply for fish and other aquatic species.

Impacts to downstream aquatic faunal communities in the Rio Indio project area could be substantial, because the dam structure will prevent their migration throughout the riverine habitat. The dam structure would be designed for multi-level releases to maintain a water level downstream from the dam site. The dam should act as a large sediment trap; thus, the released water would have low turbidity, which would result in better visibility and increased predation on the fish species. Aquatic faunal habitats downstream

would be deprived of the beneficial nutrients and silts that were transported in the sediment. Native riverine fish species may be negatively impacted as a result of the project; the extent of the impact is not known.

FUTURE LAKE AQUATIC PLANT COMMUNITY

The impacts of the project on future aquatic plant communities depend on water quality and stability of water levels. Plant species in the Lower Rio Trinidad portion of Gatun Lake could be impacted by fluctuating water levels. Aquatic plant communities could be impacted during project implementation; however, they could re-establish themselves after conditions stabilize.

The severity of impacts from the Rio Indio project will depend on water level fluctuations. Since water levels are anticipated to fluctuate widely, large portions of the shores would be covered with mud, where neither aquatic nor terrestrial plants could thrive.

AQUATIC FAUNA INHABITING AFFECTED AREAS

The proposed project impacts could have some unavoidable, adverse environmental impacts on aquatic fauna in the Lower Rio Trinidad and associated rivers and tributaries. These impacts should be identified and minimized with appropriate mitigation measures to be discussed in a feasibility level study. Gatun Lake has populations of peacock bass and tilapia, both introduced species that have adapted well. However, several native riverine species that formerly occupied the impoundment have disappeared.

The impacts of the Rio Indio project on aquatic fauna in the Rio Indio and its upstream tributaries could be substantial, since the habitat area would change from riverine to lacustrine. Some aquatic species would continue to inhabit the area; however, non-native fish species would become dominant in the impoundment area and native riverine species would be pushed upstream or extirpated. Other manmade lakes in the Republic of Panama have been stocked with peacock bass and tilapia, both of which have adapted well. The impoundment area would probably be stocked with these species to promote sport fishing and to provide the local communities with fish for food.

WETLANDS

The impacts to wetlands could be significant. Inundation of wetlands could cause them to become aquatic habitat. The changes in water depth caused by the project may lead to increased or decreased sedimentation and turbidity which could hamper the biological processes in the wetlands and decrease their productivity. Such impacts could be detrimental to the health and sustainability of the Lower Rio Trinidad area of Gatun Lake. Fish and other aquatic species use shallow water areas as spawning grounds as well as habitat for their juvenile aquatic species, that survive in the shallow waters of the wetlands until they are large enough to venture into deeper water. These wetlands are vital to the sustainability of this portion of Gatun Lake, including the Lower Rio Trinidad area.

The impacts to wetlands both upstream and downstream from the Rio Indio project area could be significant. Owing to the topography of the project area, a number of wetlands could be impacted. It is possible that although the reservoir level will fluctuate, new wetlands could develop in the littoral zones. Downstream from the dam site, wetlands along the minimal flow zone would survive; however, wetlands that depend on seasonal flooding for survival may be adversely affected.

AIR QUALITY

During project implementation, emissions from construction equipment, as well as from the slash and burn activities could cause deterioration of air quality. After project implementation, the air quality may be impacted by the operation of the power generation facility and the pumping stations.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

The potential impacts on cultural resources and historic properties from the Rio Indio project can be defined and mitigated, in particular, in the La Boca de Uracillo area, which is near previously identified archaeological sites. The project area is relatively large and is known to contain pre-Columbian sites; therefore, the presence of cultural resources and historic properties is highly probable. Prior to construction, surveys to locate cultural resources and historic properties would be conducted, and the important sites would be preserved or salvaged as appropriate.

SOCIO-ECONOMIC IMPACTS

The socio-economic impacts of the project could be substantial. The relocation of the towns and other small communities along the lakeshore would be an important issue. The average monthly income of families in the project area ranges from less than $100 to $200 per month. No indigenous groups are known to reside in the impact area. Land use would be greatly impacted by the inundation of pastures and agricultural lands to expand the impoundment. The relocation of agricultural and ranching activities would be an important issue, because approximately 10 percent of the land in the impoundment area is used for farming and ranching. After the water level is raised, additional agricultural land could be lost as a result of creation of islands that were once isthmuses. The incremental surface area of the proposed lake is 3,968 ha; another 1,044 ha from the Lower Trinidad project and 634 ha from the Rio Indio project will be occupied by the dam and construction areas, including permanent disposal areas.

During construction, the influx of workers could create a temporary demand for additional housing, which could result in an increase in housing values near the dam site. However, after completion of the project, the workers could leave, the housing demands could drop, and the housing values could return to pre-construction levels. Currently, all residents have access to public schools and health centers. During construction, these services should continue to be available, and additional public and community services may be offered. After construction, these services would return to the normal level.

To construct the dam, some existing roads would be improved and some new roads would be built. However, some paved and unpaved roads within the impoundment area would be eliminated, which would change traffic patterns and could cause some communities to lose overland transportation, communication, cohesion, and commerce with other communities. During construction, the traffic volumes over both new and existing roads systems would increase; however, following completion of construction, the traffic volumes could decline. Noise levels would temporarily increase during construction and could negatively impact noise-sensitive receptors, however, after construction noise levels may remain elevated as a result of the pump station.

The communities that receive people displaced by the project could be negatively impacted by overcrowding and by competition for jobs, land, and working areas. Construction of the dams would permanently displace people and disrupt community cohesion through the division of communities, separation of families, and loss of livelihood. Following completion of the impoundment, tourism trade in the affected region, including sport fishing and ecotourism, could increase.

Additional Environmental Information Required

This section identifies the subject areas for which additional data are required to evaluate in further detail, the scope and magnitude of the potential effects of the Lower Rio Trinidad and Rio Indio alternative. The subject areas are discussed by impact category.

SOCIO-ECONOMIC IMPACTS

- Conduct a SIA. The SIA would consist of three tasks: scoping, assessment, and mitigation and monitoring. The following information should be developed:
  - Business, Industrial, and Agricultural Activities;
  - Employment;
  - Land Use;
  - Property Values;
  - Public and Community Facilities and Services (including utilities and schools);
  - Transportation;
  - Housing;
  - Health (vector routes);
  - Population;
  - Community Cohesion; and,
  - Recreational Resources.

TERRESTRIAL AND AQUATIC HABITAT

- Prepare site-specific habitat maps to ensure that the major types of aquatic habitat are identified and quantified.
- Conduct field studies to locate rare and unique habitats, such as wetlands, primary forests, roosting sites, foraging areas, old growth, and migration flyways.
- Determine the present quality and ecosystem value of existing habitats within the Gatun Lake project area.
- Coordinate with local experts to identify and evaluate aquatic and terrestrial habitat areas.
- Prepare species inventory lists for each site area, identifying their status as native or exotic and whether they are threatened and/or endangered species.
- Conduct additional research into water currents and estimated turbidity levels to evaluate impacts to the shallow areas along Barro Colorado Island.
- Address cumulative effects caused by natural flow diversions.

ANIMALS ON THE ENDANGERED LIST

- Compile habitat maps to assess the availability and quality of suitable habitats for the animals on the endangered and/or threatened species list.
- Establish field methodology to assess wildlife habitat values.
- Conduct site surveys to determine the presence of selected species or their habitats.
- Develop candidate mitigation measures for the appropriate project alternatives to be considered in the Conceptual Phase.
- Coordinate with local experts on the presence of these species.

WATER QUALITY

- Since limited water quality data are available for the Gatun Lake area, compile information on total suspended solids, conductivity, total dissolved solids, dissolved oxygen, nutrients, pH, and coliform bacteria.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

- Information regarding cultural resources and historic properties in the project area is incomplete. Additional evaluation studies should be completed to identify any such resources and/or properties.

Evaluation Matrices

Table 38 - 1 Environmental Effects

Item	Measure [1]	Importance [2]	Composite [3]
Terrestrial Habitat	3	8	24
Animals on Extinction List	2	10	20
Water Quantity Impacts – Lake	8	10	80
Water Quantity Impacts -- Downstream	4	7	28
Water Quality	5	10	50
Downstream Aquatic Fauna Habitat	3	8	24
Future Lake Aquatic Plant Community	6	8	48
Aquatic Faunal Inhabiting Affected Area and Upstream Tributaries	4	5	20
Potential for Fishing on Lake	6	6	36
Wetlands	4	4	16
Air Quality	5	3	15
Cultural Resources and Historic Properties	3	10	30
Total			391

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

Table 38 - 2 Socio-Economic Effects

Item	Measure [1]	Importance [2]	Composite [3]
Land Use	1	7	7
Relocation of People	2	10	20
Relocation of Agricultural/Ranching Activities	2	6	12
Post-Construction Business	6	5	30
Post-Construction on Existing Employment	6	5	30
Property Values During Construction	7	4	28
Property Values Post-Construction	5	5	25
Public/Community Services During Construction	6	4	24
Public/Community Services Post-Construction	5	8	40
Traffic Volumes over Existing Roadway System During Construction	3	5	15
Traffic Volumes over New Roadway System Post-Construction	5	5	25
Noise-Sensitive Resources or Activities	4	4	16
Communities Receiving Displaced People	1	8	8
Community Cohesion	1	8	8
Tourism	6	5	30
Total			318

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

SECTION 39 – LOWER RIO TRINIDAD 22.9m to 30.5m, RIO CANO QUEBRADO 22.9m to 30.5m, RIO INDIO 50m to 80m

Socio-Economic Impacts

The description of the environmental setting is based on field observations made while conducting field reconnaissance throughout Gatun Lake, specifically the Lower Rio Trinidad and Rio Indio areas with ACP personnel. Autoridad Nacional del Ambiente (ANAM), ACP, Asociacion Nacional para la Conservacion de la Naturaleza (ANCON), Electrical Transmission Agency, Smithsonian Tropical Research Institute (STRI), and Directorate of Mineral Resources personnel were interviewed to gain information on site characteristics and potential activities that could affect the project. In addition, extrapolations of the 2000 census data were used, and a review of the Informe de Cobertura Boscosa 1992 were used to determine the extent of forest cover.

Environmental Setting

This alternative combines three projects, the Lower Rio Trinidad (lake level 22.9 - 30.5 m) with Rio Caño Quebrado (lake level 22.9 - 30.5 m), and Rio Indio (lake level 50 - 80 m). This project will provide additional storage of water for Gatun Lake and 19.47 additional lockages per day on a continual basis. The project area consists of 22,400 hectares within Gatun Lake and 5,600 ha within the Rio Indio watershed. The area near Gatun Lake is sparsely populated and has a topography consisting of rolling hills, low regions near Gatun Lake. Near Rio Indio, the area is sparsely populated with terrains and a topography consisting of steep hills, as well as coastal regions. The Lower Rio Trinidad, Rio Caño Quebrado, and Rio Indio are west of the Panama Canal and flow northward from the Continental Divide into Gatun Lake. The watershed above the Lower Rio Trinidad with Rio Caño Quebrado and the Rio Indio dam project covers approximately 1,052 km^2 and 381 km^2 respectively. The incremental impoundment area, which covers approximately 6,577 ha, consists of approximately 50 percent of forested land, 30 percent of pasture land (used by ranchers), 10 percent of cropland, and 10 percent of newly slashed and burned land. Gatun Lake's normal pool level is 26.7 m. The lake level during field observations (August 2001) was approximately 25.4 m.

LAND USE

The Lower Rio Trinidad project area encompasses the southwestern portion of Gatun Lake and areas along its shores. The areas to be flooded or partially flooded include the town of Escobal (population – 1,653), Nuevo Provenir (population – 121), Cuipo (population – 249), Ciricito (population – 72), La Arenosa (population – 242), La Garterita (population – 138), La Gartera (population – 348), and a few small isolated establishments.

The Rio Caño Quebrado project proposes to maintain the impoundment at pool levels between 22.9 and 30.5 m. The normal pool level is 26.67 m. La Laguna (population 246) and Pueblo Nuevo (population 47) are the only towns on the Rio Caño Quebrado arm. The lake is also used for fishing, bathing, and transportation. Houses in La Laguna and Pueblo Nuevo are constructed of forest products and/or of concrete.

Some areas along the shores of the Lower Rio Trinidad and Rio Caño Quebrado have been deforested. Approximately 65 percent of the lakeshore areas are forested, mostly with secondary growth. Farms and

ranches of various sizes, as well as plantations of teak and African mahogany, occupy the remaining land. Farm crops include maize, rice, beans, sugar, coffee, mangos, pineapples, and tobacco. Ranchers raise cows, horses, chickens, hogs, and tilapia. Some of the farmers and ranchers operate commercial enterprises, others rely on cash crops and subsistence farming. No significant ore deposits or mineral resources are located along the Rio Caño Quebrado arm of Gatun Lake.

The Rio Indio project area is inhabited by about 2,300 people, residing in the towns of Tres Hermanas (population – 200), Los Cedros (population – 80), El Coquillo (popoulation – 150), El Limon (population – 140), Los Uveros (population – 140), and La Boca de Uracillo (population – 110), and in approximately 30 smaller settlements. Downstream from the dam site, at El Limon, are 14 communities with a combined population of approximately 600. The largest of these is La Boca del Rio Indio with a population of more than 150.

Approximately 60 percent of the land in the project area is occupied by farms and ranches of various sizes as well as some teak plantations. Farm crops include maize, rice, beans, sugar, coffee, and tobacco. Ranches raise horses, cows, chickens, and hogs. Some of the farmers and ranchers run small commercial enterprises, or rely on cash crop and subsistence farming.

INFRASTRUCTURE

During site investigations in the Lower Rio Trinidad area, the town of Escobal was the largest settlement visited. Escobal has businesses, schools, churches, cemeteries, medical centers, residences, and paved roadways of good condition. A new and improved roadway (Highway 35) is adjacent to the project area near Escobal. Other establishments in the project area are - Nuevo Provenir; Cuipo; Ciricito; La Arenosa; La Garterita; La Gartera - and a few small isolated establishments, which all have elementary schools, small cemeteries, churches and meeting centers, medical clinics, and a few small businesses (i.e. general stores). The towns and villages depend on Gatun Lake or groundwater wells for their potable water supply. Each community also had docks, small ports, and other boat access facilities. Goods are transported from one town to another by boat. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach the Lower Rio Trinidad portion of Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners: some homes have septic tanks, while others have an outdoor latrine (a hole in the ground). There are some health problems, such as hepatitis, dysentery, dermatitis, intestinal parasites, and respiratory illnesses, which are attributable to the present waste disposal methods. No major industries or meat processing plants are located in the project area. The project area is traversed by unpaved horseback riding trails that link the various communities and by unpaved roads used by the ACP for maintenance. Due to the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

In the Caño Quebrado project area, La Laguna and Pueblo Nuevo have access to cemeteries, churches, and medical centers, and rely on Gatun Lake or groundwater wells for their drinking water supply. Most homes have electricity and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it likely reaches Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners: some have a septic system or an outdoor latrine. There are some health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses that are attributed to the present waste disposal methods. No known major industries or meat processing plants are located in the project area. La Laguna is accessible by a poorly maintained unpaved road that is usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Pueblo Nuevo is accessible only by an unpaved trail. Due to the relatively isolated location of the project area, these roads and trails are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

In the Rio Indio project area, towns of El Limon, El Silencio, San Cristobal, and Piedra Amarilla have elementary schools. Several towns have cemeteries, churches, and medical centers. All these towns obtain

water from rivers or groundwater wells. Some have electricity (from small generators) and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach Rio Indio and its tributaries. Disposal of domestic waste is the responsibility of individual homeowners; each home has an outdoor latrine. There are some known health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses that are attributed to the present waste disposal methods. No known major industries or poultry or beef processing plants are located in the project area. The only roads in the project area are unpaved and poorly maintained, and are usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Due to the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

TERRESTRIAL HABITAT

The terrestrial habitat in the Lower Rio Trinidad and Rio Caño Quebrado project areas of Gatun Lake consists of tropical forest ecosystems, mostly secondary growth forests with patches of primary forest. About 65 percent of the land along the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake is forested and probably supports diverse wildlife populations. The Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake also contain islands inhabited by wildlife. Some of the wildlife species do not interact with species on the mainland; others migrate between the island and the mainland. The species interrelationships are of great interest to scientists studying tropical ecosystems. Slash and burn activities have opened tracts of land for farming and cattle grazing; however, the majority of the lakeshore is forested to the edge of the water. Terrestrial areas are used by migratory species as wintering, breeding, and feeding grounds. The complex and diverse tropical ecosystems offer habitat to connect a variety of wildlife communities and may provide critical wildlife habitat to many native species.

In Rio Indio, forests along the river that could support diverse wildlife populations cover about 90 percent of the areas along the Rio Indio and its tributaries. The forests also extend to the mountainous areas above the Rio Indio impoundment. As a result of slash and burn activities, there are no large contiguous tracts of forests at lower elevations in the impoundment.

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ANAM, Resolution 002-80 enacted on June 7, 1995 declared 33 mammals, 39 birds, and 11 reptiles and amphibians as being in danger of becoming extinct in Panama. Although their presence has not been confirmed to date, some of the listed species of interest on the threatened list might be found in the project area. The manatee is an aquatic mammal known to inhabit Gatun Lake around the Barro Colorado Island; however, it has not been sighted in the project area.

AQUATIC HABITAT

Gatun Lake, one of the world's largest manmade lakes, was created during the construction of the Panama Canal. The lake's water depth and quality vary widely. Aquatic habitat ranges from inundated forests to clear water in areas distant from shipping lanes. The Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake provide habitat for a variety of wildlife species, both resident and migratory, as well as for both native and introduced fish and other aquatic species.

Rio Indio in the project area has characteristics typical of streams in mountainous regions. Its water is clean and cool, and its bottom ranges from sand to boulders, with numerous riffles, runs, and pools. Tributaries to Rio Indio include four major streams: Rio El Torno, Rio Uracillo, Rio Teria, and Rio Riacito, and 20 smaller streams. The river is approximately 16 km long, its width ranges from 3 m (in the dry season) to 10 m. The tributaries appear to support some fish communities; however, information about these is limited.

WETLANDS

Areas that contain hydric soils and hydrophytic plant communities, and that are subject to hydric conditions are termed wetlands. Wetlands occur in topographic area where water remains pooled long enough to produce hydric soil conditions and wetland plant communities. Wetlands in the Lower Rio Trinidad and Rio Caño Quebrado project areas consist of shallow water habitat and lands subject to frequent flooding. Shallow water areas along the banks of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake receive sunlight to approximately 1 m. Sunlight stimulates growth of submergent, emergent, or floating mats of aquatic vegetation. Wetlands in the project area are stressed as a result of sediments, municipal waste, agricultural runoff, and other debris carried in the runoff.

Wetlands in the Rio Indio project area consist of forested riparian habitat and are limited by their relatively steep topography. The width of the riparian habitat within the impoundment area varies from approximately 5 to 50 m. Approximately 90 percent of the streams both above and below the dam site along the Rio Indio and its tributaries are bordered by forested riparian habitat.

AIR QUALITY

Air quality in the project area is generally good, except during the slash and burn activities. At the end of the dry season in March or early April, areas of forest and secondary growth are burned and cleared for agricultural use. During this period, the air is filled with smoke and ash, which may be transported by winds to the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Based on observations in the Rio Indio project area, approximately 10 percent (or 400 hectares) of forested land is burned annually. Air quality monitoring has not been implemented within the project area.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

Barro Colorado Island is an international center for tropical research and one of the first biological reserves established in the Neotropics. From 1923 through 1940, a scientific committee of the U.S. National Academy of Sciences administered the biological reserve/laboratory. In 1940, by an Act of the United States Congress, the facility was renamed the Panama Canal Zone Biological Area, and in 1946, the responsibility for its maintenance was assigned to the Smithsonian Institution. With the Panama Canal Treaty Implementation in 1977, the island was granted the category of National Monument and to date it continues to be managed by the Smithsonian Institute. It should also be noted that most of the Atlantic region of Panama is within the interest and objectives of the Mesoamerican Biological Corridor, an international project to conserve biodiversity.

In the pre-Columbian period, Rio Indio was a language frontier; that is, the inhabitants on each side of the river spoke a different native language. During the Spanish colonial period, the river served as a political boundary; thus, the project area has a high potential to be rich in archaeological and historical remains.

Environmental Impacts

TERRESTRIAL HABITAT

The impacts of the project on terrestrial habitat in the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake could be substantial. The boundary between two types of habitats, in this case between a forest and a lake, is called an ecotone. Ecotones are inhabited by a variety of species from neighboring habitats, and are unique, with high species diversity. Considering the proposed operating levels for both impoundments, between 22.9 - 30.5 m, as the normal zone of operation, erosion of the shoreline may be substantial as pool levels rise and fall. Terrestrial habitat that would be inundated above the 26. 7 m

(existing level) to the 30.5 m proposed normal pool level consists of 18,169 ha for the Lower Rio Trinidad project. The permanent raising of the water level in Rio Caño Quebrado Lake will impact wildlife habitat as approximately 2,609 ha of additional land will be inundated. The placement of a dam structure, access roads, and pump station would permanently impact terrestrial habitat. Wildlife species that are able to relocate to suitable areas will compete with similar species for resources. Wildlife species that are not able to relocate will not survive. As a result, competition for natural resources in surrounding habitat areas will increase. This is considered a secondary impact to terrestrial habitat outside the proposed zone of inundation and construction.

The terrestrial impacts of the Rio Indio project, which is located in an area of relatively high quality forest habitat, would be substantial. With the creation of the lake, the migratory routes of some species could be adversely affected. Forested areas along lower elevations would be lost as a result of the impoundment. The only forests that would remain near the Rio Indio reservoir and its drainage basin would be confined to the higher elevations, where the vegetation and species may be completely different from those found on lower elevations. Natural communities are linked together by complex interactions and relationships among various species, therefore impacts to upper forested areas may occur resulting from the inundation of the lower forests.

ANIMALS ON ENDANGERED LIST

The severity of impacts on endangered species cannot be determined at this time, because although it is expected that some of the listed species are found in the region, it is not known which of the listed species inhabit the proposed project area. Some endangered and/or threatened species may use the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake during some or all parts of their life cycle.

WATER QUANTITY

The impacts of the Lower Rio Trinidad and Rio Caño Quebrado projects on water quantity would be substantial. The increase in the volume of water could have negative impacts to lakeshore communities as well as on existing ecosystems. The same is true if the lake level is lowered and maintained at 22.9 m.

The impacts of the Rio Indio project area on water quality would also be substantial. The volume of water will increase, making fresh water available in the surrounding areas during the dry season. The impacts downstream from the dam would be significant. Sediment loads would be deposited upstream from the dam as water velocity slows. Downstream from the dam the water will be released at an increased velocity, causing erosion of banks and river bottoms. Seasonal flooding could be significantly reduced. It would also be possible to periodically release water in appropriate amounts to avoid problems with water quality and temperature downstream. The cumulative impacts downstream from the dam site depend on the amount of water being released.

WATER QUALITY

Project impacts on water quality are not known. Damming the Lower Rio Trinidad and Rio Caño Quebrado could increase the amounts of nutrients and debris in this portion of Gatun Lake. A pilot plant tilapia farm is in the project area and may affect water quality. The rate at which nutrients and debris enter the lake will determine the severity of their impact on water quality. Project implementation could cause an increase in turbidity, which would interfere with photosynthesis and deprive plants and other aquatic species from sunlight. Aquatic plants and organisms serve to maintain water quality. The dam would interfere with the circulation of freshwater throughout the Gatun Lake environment. Species inhabiting specific depths could be impacted when lake depth increases to 30.5 m and/or decreases to 22.9 m.

The impacts of the Rio Indio project on water quality could be positive. The people living downstream from the dam and around the impoundment would have access to a water supply of higher quality. Water quality in the impoundment area would differ from water released downstream from the dam. If the water

in the impoundment area does not circulate or turn over periodically, it could become anoxic. A change in temperature, dissolved oxygen, turbidity, or pH could change water quality.

DOWNSTREAM AQUATIC FAUNAL HABITAT

The impacts of the project on aquatic faunal habitat could be substantial. The project may affect the breeding and nursery habitat of many aquatic species. Impacts to fish spawning areas may be detrimental when turbidity, nutrient content, and depth of the water suddenly increase or decrease, by altering the conditions needed for successful fish hatching. Plant populations may decrease as a result of fluctuating water depths, clarity, and quality. Invertebrate populations may decline, which could reduce the food supply for fish and other aquatic species.

Impacts to downstream aquatic faunal communities in the Rio Indio project area could be substantial, because the dam structure will prevent their migration throughout the riverine habitat. The dam structure would be designed for multi-level releases to maintain a water level downstream from the dam site. The dam should act as a large sediment trap; thus, the released water would have low turbidity, which would result in better visibility and increased predation on the fish species. Aquatic faunal habitats downstream would be deprived of the beneficial nutrients and silts that were transported in the sediment. Native riverine fish species may be negatively impacted as a result of the project; the extent of the impact is not known.

FUTURE LAKE AQUATIC PLANT COMMUNITY

The impacts of the project on future aquatic plant communities depend on water quality and stability of water levels. Plant species in the Lower Rio Trinidad and Rio Caño Quebrado portions of Gatun Lake could be impacted by fluctuating water levels. Aquatic plant communities could be impacted during project implementation; however, they could re-establish themselves after conditions stabilize.

The severity of impacts from the Rio Indio project will depend on water level fluctuations. Since water levels are anticipated to fluctuate widely, large portions of the shores would be covered with mud, where neither aquatic nor terrestrial plants could thrive.

AQUATIC FAUNA INHABITING AFFECTED AREAS

The proposed project impacts could have some unavoidable, adverse environmental impacts on aquatic fauna in the Lower Rio Trinidad, Rio Caño Quebrado, and associated rivers and tributaries. These impacts should be identified and minimized with appropriate mitigation measures to be discussed in a feasibility level study. Gatun Lake has populations of peacock bass and tilapia, both introduced species that have adapted well. However, several native riverine species that formerly occupied the impoundment have disappeared.

The impacts of the Rio Indio project on aquatic fauna in the Rio Indio and its upstream tributaries could be substantial, since the habitat area would change from riverine to lacustrine. Some aquatic species would continue to inhabit the area; however, non-native fish species would become dominant in the impoundment area and native riverine species would be pushed upstream or extirpated. Other manmade lakes in the Republic of Panama have been stocked with peacock bass and tilapia, both of which have adapted well. The impoundment area would probably be stocked with these species to promote sport fishing and to provide the local communities with fish for food.

WETLANDS

The impacts on wetlands could be significant. Inundation of wetlands could cause them to become aquatic habitat. The changes in water depth caused by the project may lead to increased or decreased sedimentation and turbidity, which could hamper the biological processes in the wetlands and decrease

their productivity. Such impacts could be detrimental to the health and sustainability of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Fish and other aquatic species use shallow water areas as spawning grounds, as well as habitat for their juvenile aquatic species that survive in the shallow waters of the wetlands until they are large enough to venture into deeper water. These wetlands are vital to the sustainability of this portion of Gatun Lake, including the Lower Rio Trinidad and Rio Caño Quebrado areas.

The impacts to wetlands both upstream and downstream from the Rio Indio project area could be significant. Owing to the topography of the project area, a number of wetlands could be impacted. It is possible that although the reservoir level will fluctuate, new wetlands could develop in the littoral zones. Downstream from the dam site, wetlands along the minimal flow zone would survive; however, wetlands that depend on seasonal flooding for survival may be adversely affected.

AIR QUALITY

During project implementation, emissions from construction equipment, as well as from the slash and burn activities could cause deterioration of air quality. After project implementation, the air quality may be impacted by the operation of the power generation facility and the pumping stations.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

The potential impacts on cultural resources and historic properties from the Rio Indio project can be defined and mitigated, in particular, in the La Boca de Uracillo area, which is near previously identified archaeological sites. The project area is relatively large and is known to contain pre-Columbian sites; therefore, the presence of cultural resources and historic properties is highly probable. Prior to construction, surveys to locate cultural resources and historic properties would be conducted, and the important sites would be preserved or salvaged as appropriate.

SOCIO-ECONOMIC IMPACTS

The socio-economic impacts of the project could be substantial. The relocation of the towns and other small communities along the lakeshore would be an important issue. The average monthly income of families in the project area ranges from less than $100 to $200 per month. No indigenous groups are known to reside in the impact area. Land use would be greatly impacted by the inundation of pastures and agricultural lands to expand the impoundment. The relocation of agricultural and ranching activities would be an important issue, because approximately 10 percent of the land in the impoundment area is used for farming and ranching. After the water level is raised, additional agricultural land could be lost as a result of creation of islands that were once isthmuses. The incremental surface area of the proposed lake is 6,577 ha; another 1,504 ha from the Lower Trinidad Rio Caño Quebrado project; and 760 ha from the Rio Indio project will be occupied by the dam and construction areas, including permanent disposal areas.

During construction, the influx of workers could create a temporary demand for additional housing, which could result in an increase in housing values near the dam site. However, after completion of the project, the workers could leave, the housing demands could drop, and the housing values could return to pre-construction levels. Currently, all residents have access to public schools and health centers. During construction, these services should continue to be available, and additional public and community services may be offered. After construction, these services would return to the normal level.

To construct the dam, some existing roads would be improved and some new roads should be built. However, some paved and unpaved roads within the impoundment area would be eliminated, changing traffic patterns and may cause some communities to lose overland transportation, communication, cohesion, and commerce with other communities. During construction, the traffic volumes over both new and existing roads systems would increase; however, following completion of construction, the traffic volumes could decline. Noise levels would temporarily increase during construction and could negatively

impact noise-sensitive receptors; however, after construction noise levels may remain elevated as a result of the power generation facility and pump stations.

Overcrowding and competition for jobs, land, and working areas could negatively impact the communities receiving people displaced by the project. Construction of the dams would permanently displace some people and disrupt community cohesion through the division of communities, separation of families, and loss of livelihood. Following completion of the impoundment, tourism trade in the affected region, including sport fishing and ecotourism, could increase.

Additional Environmental Information Required

This section identifies the subject areas for which additional data are required to evaluate in further detail, the scope and magnitude of the potential effects of the Lower Rio Trinidad, Rio Caño Quebrado, and Rio Indio alternative. The subject areas are discussed by impact category.

SOCIO-ECONOMIC IMPACTS

Conduct a SIA. The SIA would consist of three tasks: scoping, assessment, and mitigation and monitoring. The following information should be developed:

- Business, Industrial, and Agricultural Activities;
- Employment;
- Land Use;
- Property Values;
- Public and Community Facilities and Services (including utilities and schools);
- Transportation;
- Housing;
- Health (vector routes);
- Population;
- Community Cohesion; and,
- Recreational Resources.

TERRESTRIAL AND AQUATIC HABITAT

- Prepare site-specific habitat maps to ensure that the major types of aquatic habitat are identified and quantified.
- Conduct field studies to locate rare and unique habitats such as wetlands, primary forests, roosting sites, foraging areas, old growth, and migration flyways.
- Determine the present quality and ecosystem value of existing habitats within the Gatun Lake project area.
- Coordinate with local experts to identify and evaluate aquatic and terrestrial habitat areas.
- Prepare species inventory lists for each site area, identifying their status as native or exotic and whether they are threatened and or endangered species.
- Conduct additional research into water currents and estimated turbidity levels to evaluate impacts to the shallow areas along Barro Colorado Island.
- Address cumulative effects caused by natural flow diversions.

ANIMALS ON THE ENDANGERED LIST

- Compile habitat maps to assess the availability and quality of suitable habitats for the animals on the endangered and/or threatened species list.

- Establish field methodology to assess wildlife habitat values.
- Conduct site surveys to determine the presence of selected species or their habitats.
- Develop candidate mitigation measures for the appropriate project alternatives to be considered in the Conceptual Phase.
- Coordinate with local experts to determine on the presence of endangered species.

WATER QUALITY

- Since limited water quality data are available for the Gatun Lake area, compile information on total suspended solids, conductivity, total dissolved solids, dissolved oxygen, nutrients, pH, and coliform bacteria.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

- Information regarding cultural resources and historic properties in the project area is incomplete. Additional evaluation studies should be completed to identify any such resources and/or properties.

Evaluation Matrices

Table 39 - 3 Environmental Effects

Item	Measure [1]	Importance [2]	Composite [3]
Terrestrial Habitat	2	8	16
Animals on Extinction List	2	10	20
Water Quantity Impacts – Lake	8	10	80
Water Quantity Impacts -- Downstream	4	7	28
Water Quality	5	10	50
Downstream Aquatic Fauna Habitat	3	8	24
Future Lake Aquatic Plant Community	6	8	48
Aquatic Faunal Inhabiting Affected Area and Upstream Tributaries	4	5	20
Potential for Fishing on Lake	6	6	36
Wetlands	2	4	8
Air Quality	5	3	15
Cultural Resources and Historic Properties	3	10	30
Total			375

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

Table 39 - 4 Socio-Economic Effects

Item	Measure [1]	Importance [2]	Composite [3]
Land Use	2	7	14
Relocation of People	1	10	10
Relocation of Agricultural/Ranching Activities	1	6	6
Post-Construction Business	6	5	30
Post-Construction on Existing Employment	6	5	30
Property Values During Construction	7	4	28
Property Values Post-Construction	5	5	25
Public/Community Services During Construction	6	4	24
Public/Community Services Post-Construction	5	8	40
Traffic Volumes over Existing Roadway System During Construction	3	5	15
Traffic Volumes over New Roadway System Post-Construction	5	5	25
Noise-Sensitive Resources or Activities	4	4	16
Communities Receiving Displaced People	1	8	8
Community Cohesion	1	8	8
Tourism	6	5	30
Total			309

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

SECTION 40 – LOWER RIO TRINIDAD 22.9m to 30.5m, RIO CANO QUEBRADO 22.9m to 30.5m, UPPER RIO INDIO 50m

Socio-Economic Impacts

The description of the environmental setting is based on field observations made while conducting field reconnaissance throughout Gatun Lake, specifically the Lower Rio Trinidad and Rio Indio areas with ACP personnel. Autoridad Nacional del Ambiente (ANAM), ACP, Asociacion Nacional para la Conservacion de la Naturaleza (ANCON), Electrical Transmission Agency, Smithsonian Tropical Research Institute (STRI), and Directorate of Mineral Resources personnel were interviewed to gain information on site characteristics and potential activities that could affect the project. In addition, extrapolations of the 2000 census data were used, and a review of the Informe de Cobertura Boscosa 1992 were used to determine the extent of forest cover.

Environmental Setting

This alternative combines three projects, the Lower Rio Trinidad (lake level (22.9 - 30.5 meters) with Rio Caño Quebrado (lake level 22.9 - 30.5 meters), and Upper Rio Indio (lake level 50 meters). This Lower Trinidad Dam project will provide additional storage of water for Gatun Lake and 8.32 additional lockages per day on a continual basis. The structures for the proposed project would consist of a rock fill dam, a pumping station, a gated spillway, and access/maintenance roads. The project area consists of 22,397 ha within Gatun Lake and 1,898 hectares within the Rio Indio watershed. The area near Gatun Lake is sparsely populated and has a topography consisting of rolling hills, low regions near Gatun Lake. Near Upper Rio Indio, the area is sparsely populated with a terrain and a topography of steep hills, as well as coastal regions. The Lower Rio Trinidad, Rio Caño Quebrado, and Upper Rio Indio are west of the Panama Canal and flow northward from the Continental Divide. The watershed above the Lower Rio Trinidad with Rio Caño Quebrado and the Upper Rio Indio the dam project covers approximately 1,052 km^2 and 256 km^2 respectively The incremental impoundment area, which covers approximately 6,577 ha, is approximately 50 percent forested land, 30 percent pasture land (used by ranchers), 10 percent cropland, and 10 percent newly slashed and burned land. Gatun Lake's normal pool level is 26.7 meters MSL. The lake level during field observations (August 2001) was approximately 25.4 meters MSL.

LAND USE

The Lower Rio Trinidad project area encompasses the southwestern portion of Gatun Lake and areas along its shores. The areas to be flooded or partially flooded include the town of Escobal (population – 1,653), Nuevo Provenir (population – 121), Cuipo (population – 249), Ciricito (population – 72), La Arenosa (population – 242), La Garterita (population – 138), La Gartera (population – 348), and a few small isolated establishments.

The Rio Caño Quebrado project proposes to maintain the impoundment at pool levels between 22.9 and 30.5 m. The normal pool level is 26.67 m. La Laguna (population 246) and Pueblo Nuevo (population 47) are the only towns on the Rio Caño Quebrado arm. The lake is also used for fishing, bathing, and transportation. Houses in La Laguna and Pueblo Nuevo are constructed of forest products and/or of concrete.

Some areas along the shores of the Lower Rio Trinidad and Rio Caño Quebrado have been deforested. Approximately 65 percent of the lakeshore areas are forested, mostly with secondary growth. Farms and

ranches of various sizes, as well as plantations of teak and African mahogany, occupy the remaining land. Farm crops include maize, rice, beans, sugar, coffee, mangos, pineapples, and tobacco. Ranchers raise cows, horses, chickens, hogs, and tilapia. Some of the farmers and ranchers operate commercial enterprises, others rely on cash crops and subsistence farming. No significant ore deposits or mineral resources are located along the Caño Quebrado arm of Gatun Lake.

Approximately 2,300 people inhabits the Upper Rio Indio project area; they live in the towns of Tres Hermanas (population – 200), Los Cedros (population – 80), El Coquillo (popoulation – 150), El Limon (population – 140), Los Uveros (population – 140), and La Boca de Uracillo (population – 110), and in nearly 30 smaller settlements. Downstream from the dam site at El Limon there are 14 communities with a combined population of approximately 600. The largest of these is La Boca del Rio Indio with a population of more than 150.

Farms and ranches of various sizes, including some teak plantations, occupy approximately 60 percent of the land in the Upper Rio Indio area. Farm crops include maize, rice, beans, sugar, coffee, and tobacco. Ranches raise horses, cows, chickens, and hogs. Some of the farmers and ranchers run small commercial enterprises, or rely on cash crop and subsistence farming.

INFRASTRUCTURE

During site investigations in the Lower Rio Trinidad area, the town of Escobal was the largest settlement visited. Escobal has businesses, schools, churches, cemeteries, medical centers, residences, and paved roadways of good condition. A new and improved roadway (Highway 35) is adjacent to the project area near Escobal. Other establishments in the project area Nuevo Provenir; Cuipo; Ciricito; La Arenosa; La Garterita; La Gartera; and a few small isolated establishments have elementary schools, small cemeteries, churches and meeting centers, medical clinics, and a few small businesses (i.e. general stores). The towns and villages depend on Gatun Lake or groundwater wells for their potable water supply. Each community also had docks, small ports, and other boat access facilities. Goods are transported from one town to another by boat. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach the Lower Rio Trinidad portion of Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners: some homes have septic tanks, while others have an outdoor latrine (a hole in the ground). There are some health problems, such as hepatitis, dysentery, dermatitis, intestinal parasites, and respiratory illnesses that are attributable to the present waste disposal methods. No major industries or meat processing plants are located in the project area. The project area is traversed by unpaved horseback riding trails that link the various communities and by unpaved roads used by the ACP for maintenance. Due to the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

In the Rio Caño Quebrado project area, La Laguna and Pueblo Nuevo have access to cemeteries, churches, and medical centers, and rely on Gatun Lake or groundwater wells for their drinking water supply. Most homes have electricity and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it most likely reaches Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners: some have a septic system or an outdoor latrine. There are some health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses that are attributed to the present waste disposal methods. No known major industries or meat processing plants are located in the project area. La Laguna is accessible by a poorly maintained unpaved road that is usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Pueblo Nuevo is accessible only by an unpaved trail. Due to the relatively isolated location of the project area, these roads and trails are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

In the Upper Rio Indio project area, towns of El Limon, El Silencio, San Cristobal, and Piedra Amarilla have elementary schools. Several towns have cemeteries, churches, and medical centers. All these towns

obtain water from rivers or groundwater wells. Some have electricity (from small generators) and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it might eventually reach Rio Indio and its tributaries. Disposal of domestic waste is the responsibility of individual homeowners; each home has an outdoor latrine. There are some known health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses that are attributed to the present waste disposal methods. No known major industries or meat processing plants are located in the project area. The only roads in the project area are unpaved and poorly maintained, and are usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Due to the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

TERRESTRIAL HABITAT

The terrestrial habitat in the Lower Rio Trinidad and Rio Caño Quebrado project areas of Gatun Lake consists of tropical forest ecosystems, mostly secondary growth forests with patches of primary forest. About 65 percent of the land along the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake is forested and probably supports diverse wildlife populations. The Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake also contain islands inhabited by wildlife. Some of the wildlife species do not interact with species on the mainland; others migrate between the island and the mainland. The species interrelationships are of great interest to scientists studying tropical ecosystems. Slash and burn activities have opened tracts of land for farming and cattle grazing; however, the majority of the lakeshore is forested to the edge of the water. Terrestrial areas are used by migratory species as wintering, breeding, and feeding grounds. The complex and diverse tropical ecosystems offer habitat to connect a variety of wildlife communities and may provide critical wildlife habitat to many native species.

In Upper Rio Indio, forests along the river that could support diverse wildlife populations cover about 90 percent of the areas along the Rio Indio and its tributaries. The forests also extend to the mountainous areas above the Rio Indio impoundment. As a result of slash and burn activities, there are no large contiguous tracts of forests at lower elevations in the impoundment.

ANIMALS ON ENDANGERED LIST

ANAM, Resolution 002-80 enacted on June 7, 1995, declared 33 mammals, 39 birds, and 11 reptiles and amphibians are in danger of becoming extinct in Panama. Although their presence has not been confirmed to date, some of the listed species of interest on the threatened list might be found in the project area. The manatee is an aquatic mammal known to inhabit Gatun Lake around the Barro Colorado Island; however, it has not been sighted in the project area.

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Areas that contain hydric soils and hydrophytic plant communities, and that are subject to hydric conditions are termed wetlands. Wetlands occur in topographic area where water remains pooled long enough to produce hydric soil conditions and wetland plant communities. Wetlands in the Lower Rio Trinidad and Rio Caño Quebrado project areas consist of shallow water habitat and lands subject to frequent flooding. Shallow water areas along the banks of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake receive sunlight to approximately 1 m. Sunlight stimulates growth of submergent, emergent, or floating mats of aquatic vegetation. Wetlands in the project area are stressed as a result of sediments, municipal waste, agricultural runoff, and other debris carried in the runoff.

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AIR QUALITY

Air quality in the project area is generally good, except during the slash and burn activities. At the end of the dry season in March or early April, areas of forest and secondary growth are burned and cleared for agricultural use. During this period, the air is filled with smoke and ash, which may be transported by winds to the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Based on observations in the Upper Rio Indio project area, approximately 10 percent (or 400 ha) of forested land is burned annually. Air quality monitoring has not been implemented within the project area.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

Barro Colorado Island is an international center for tropical research and one of the first biological reserves established in the Neotropics. From 1923 through 1940, a scientific committee of the U.S. National Academy of Sciences administered the biological reserve/laboratory. In 1940, by an Act of the United States Congress, the facility was renamed the Panama Canal Zone Biological Area, and in 1946, the responsibility for its maintenance was assigned to the Smithsonian Institution. With the Panama Canal Treaty Implementation in 1977, the island was granted the category of National Monument and to date it continues to be managed by the Smithsonian Institute. It should also be noted that most of the Atlantic region of Panama is within the interest and objectives of the Mesoamerican Biological Corridor, an international project to conserve biodiversity.

In the pre-Columbian period, Upper Rio Indio was a language frontier; the inhabitants on each side of the river spoke a different native language. During the Spanish colonial period, the river served as a political boundary; thus, the project area has a high potential to be rich in archaeological and historical remains.

Environmental Impacts

TERRESTRIAL HABITAT

The impacts of the project on terrestrial habitat in the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake could be substantial. The boundary between two types of habitats, in this case between a forest and a lake, is called an ecotone. Ecotones are inhabited by a variety of species from neighboring habitats, and are unique, with high species diversity. Considering the proposed operating levels for both impoundments, between 22.9 - 30.5 m, as the normal zone of operation, erosion of the shoreline may be substantial as pool levels rise and fall. Terrestrial habitat that would be inundated above the 26.67 m (existing level) to the 30.5 m proposed normal pool level consists of 18,169 ha for the Lower Rio Trinidad project. The permanent raising of the water level in Rio Caño Quebrado Lake will impact wildlife habitat

as approximately 2.609 ha of additional land will be inundated. The placement of a dam structure, access roads and pump stations would permanently impact terrestrial habitat. Wildlife species that are able to relocate to suitable areas will compete with similar species for resources. Wildlife species that are not able to relocate will not survive. As a result, competition for natural resources in surrounding habitat areas will increase. This is considered a secondary impact to terrestrial habitat outside the proposed zone of inundation and construction.

The terrestrial impacts of the Upper Rio Indio project, which is located in area of relatively high quality forest habitat, would be substantial. With the creation of the lake, the migratory routes of some species could be adversely affected. Forested areas along lower elevations would be lost as a result of the impoundment. The only forests that would remain near the Rio Indio reservoir and its drainage basin would be confined to the higher elevations, where the vegetation and species may be completely different from those found on lower elevations. Natural communities are linked together by complex interactions and relationships among various species, therefore impacts to upper forested areas may occur resulting from the inundation of the lower forests.

ANIMALS ON ENDANGERED LIST

The severity of impacts on endangered species cannot be determined at this time, because although it is expected that some of the listed species are found in the region, it is not known which of the listed species inhabit the proposed project area. Some endangered and/or threatened species may use the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake during some or all parts of their life cycle.

WATER QUANTITY

The impacts of the Lower Rio Trinidad and Rio Caño Quebrado projects on water quantity would be substantial. The increase in the volume of water could have negative impacts to lakeshore communities as well as on existing ecosystems. The same is true if the lake level is lowered and maintained at 22.9 m.

The impacts of the Upper Rio Indio project area on water quality would also be substantial. The volume of water will increase, making fresh water available in the surrounding areas during the dry season. The impacts downstream from the dam would be significant. Sediment loads would be deposited upstream from the dam as water velocity slows. Downstream from the dam the water will be released at an increased velocity, causing erosion of banks and river bottoms. Seasonal flooding could be significantly reduced. It would also be possible to periodically release water in appropriate amounts to avoid problems with water quality and temperature downstream. The cumulative impacts downstream from the dam site depend on the amount of water being released.

WATER QUALITY

Project impacts on water quality are not known. Damming the Lower Rio Trinidad and Rio Caño Quebrado could increase the amounts of nutrients and debris in this portion of Gatun Lake. A pilot plant tilapia farm is in the project area and may affect water quality. The rate at which nutrients and debris enter the lake will determine the severity of their impact on water quality. Project implementation could cause an increase in turbidity, which would interfere with photosynthesis and deprive plants and other aquatic species from sunlight. Aquatic plants and organisms serve to maintain water quality. The dam would interfere with the circulation of freshwater throughout the Gatun Lake environment. Species inhabiting specific depths could be impacted when lake depth increases to 30.5 m and/or decreases to 22.9 m.

The impacts of the Upper Rio Indio project on water quality could be positive. The people living downstream from the dam and around the impoundment would have access to a water supply of higher quality. Water quality in the impoundment area would differ from water released downstream from the dam. If the water in the impoundment area does not circulate or turn over periodically, it could become anoxic. A change in temperature, dissolved oxygen, turbidity, or pH could change water quality.

DOWNSTREAM AQUATIC FAUNAL HABITAT

The impacts of the project on aquatic faunal habitat could be substantial. The project may affect the breeding and nursery habitat of many aquatic species. Impacts on fish spawning areas may be detrimental when turbidity, nutrient content, and depth of the water suddenly increase or decrease, by altering the conditions needed for successful fish hatching. Plant populations may decrease as a result of fluctuating water depths, clarity, and quality. Invertebrate populations may decline, which could reduce the food supply for fish and other aquatic species.

Impacts to downstream aquatic faunal communities in the Upper Rio Indio project area could be substantial, because the dam structure will prevent their migration throughout the riverine habitat. The dam structure would be designed for multi-level releases to maintain a water level downstream from the dam site. The dam should act as a large sediment trap; thus, the released water would have low turbidity, which would result in better visibility and increased predation on the fish species. Aquatic faunal habitats downstream would be deprived of the beneficial nutrients and silts that were transported in the sediment. Native riverine fish species may be negatively impacted as a result of the project; the extent of the impact is not known.

FUTURE LAKE AQUATIC PLANT COMMUNITY

The impacts of the project on future aquatic plant communities depend on water quality and stability of water levels. Plant species in the Lower Rio Trinidad and Rio Caño Quebrado portions of Gatun Lake could be impacted by fluctuating water levels. Aquatic plant communities could be impacted during project implementation; however, they could re-establish themselves after conditions stabilize.

The severity of impacts from the Upper Rio Indio project will depend on water level fluctuations. Since water levels are anticipated to fluctuate widely, large portions of the shores would be covered with mud, where neither aquatic nor terrestrial plants could thrive.

AQUATIC FAUNA INHABITING AFFECTED AREAS

The proposed project impacts could have some unavoidable, adverse environmental impacts on aquatic fauna in the Lower Rio Trinidad, Rio Caño Quebrado, and associated rivers and tributaries. These impacts should be identified and minimized with appropriate mitigation measures to be discussed in a feasibility level study. Gatun Lake has populations of peacock bass and tilapia, both introduced species that have adapted well. However, several native riverine species that formerly occupied the impoundment have disappeared.

The impacts of the Upper Rio Indio project on aquatic fauna in the Rio Indio and its upstream tributaries could be substantial, since the habitat area would change from riverine to lacustrine. Some aquatic species would continue to inhabit the area; however, non-native fish species could become dominant in the impoundment area and native riverine species could be pushed upstream or extirpated. Other manmade lakes in the Republic of Panama have been stocked with peacock bass and tilapia, both of which have adapted well. The impoundment area would probably be stocked with these species to promote sport fishing and to provide the local communities with fish for food.

WETLANDS

The impacts to wetlands could be significant. Inundation of wetlands could cause them to become aquatic habitats. The changes in water depth caused by the project may lead to increased or decreased sedimentation and turbidity, which could hamper the biological processes in the wetlands and decrease their productivity. Such impacts could be detrimental to the health and sustainability of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Fish and other aquatic species use shallow water areas as spawning grounds, as well as habitat for their juvenile aquatic species that survive in the shallow

waters of the wetlands until they are large enough to venture into deeper water. These wetlands are vital to the sustainability of this portion of Gatun Lake, including the Lower Rio Trinidad and Rio Caño Quebrado areas.

The impacts to wetlands both upstream and downstream from the Upper Rio Indio project area could be significant. Owing to the topography of the project area, a number of wetlands could be impacted. It is possible that although the reservoir level will fluctuate, new wetlands could develop in the littoral zones. Downstream from the dam site, wetlands along the minimal flow zone would survive; however, wetlands that depend on seasonal flooding for survival may be adversely affected.

AIR QUALITY

During project implementation, emissions from construction equipment, as well as from the slash and burn activities, could cause deterioration of air quality. After project implementation, the air quality may be impacted by the operation of the pumping stations.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

The potential impacts on cultural resources and historic properties from the Upper Rio Indio project can be defined and mitigated, in particular, in the La Boca de Uracillo area, which is near previously identified archaeological sites. The project area is relatively large and is known to contain pre-Columbian sites; therefore, the presence of cultural resources and historic properties is highly probable. Prior to construction, surveys to locate cultural resources and historic properties would be conducted, and the important sites would be preserved or salvaged as appropriate.

SOCIO-ECONOMIC IMPACTS

The socio-economic impacts of the project could be substantial. The relocation of the towns and other small communities along the lakeshore would be an important issue. The average monthly income of families in the project area ranges from less than $100 to $200 per month. No indigenous groups are known to reside in the impact area. Land use would be greatly altered by the inundation of pastures and agricultural lands to expand the impoundment. The relocation of agricultural and ranching activities would be an important issue, because approximately 10 percent of the land in the impoundment area is used for farming and ranching. After the water level is raised, additional agricultural land could be lost as a result of creation of islands that were once isthmuses. The incremental surface area of the proposed lake is 6,577 ha; another 1,219 ha from the Lower Trinidad and Rio Caño Quebrado projects, and 634 ha from the Upper Rio Indio project will be occupied by the dam and construction areas, including permanent disposal areas.

During construction, the influx of workers could create a temporary demand for additional housing, which could result in an increase in housing values near the dam site. However, after completion of the project, the workers could leave, the housing demands could drop, and the housing values could return to pre-construction levels. Currently, all residents have access to public schools and health centers. During construction, these services should continue to be available, and additional public and community services may be offered. After construction, these services would return to the normal level.

Constructing the dam would require some existing roads to be improved and some new roads to be built. However, some paved and unpaved roads within the impoundment area would be eliminated, which would change traffic patterns and could cause some communities to lose overland transportation, communication, cohesion, and commerce with other communities. During construction, the traffic volumes over both new and existing roads systems would increase; however, following completion of construction, the traffic volumes could decline. Noise levels would temporarily increase during construction and could negatively impact noise-sensitive receptors, however, after construction noise levels may remain elevated as a result of the power generation facility and pump stations.

The communities that receive people displaced by the project could be negatively impacted by overcrowding and by competition for jobs, land, and working areas. Construction of the dams would permanently displace people and disrupt community cohesion through the division of communities, separation of families, and loss of livelihood. Following completion of the impoundment, tourism trade in the affected region, including sport fishing and ecotourism, could increase.

Additional Environmental Information Required

This section identifies the subject areas for which additional data are required to evaluate in further detail, the scope and magnitude of the potential effects of the Lower Rio Trinidad, Rio Caño Quebrado, and Upper Rio Indio alternative. The subject areas are discussed by impact category.

SOCIO-ECONOMIC IMPACTS

Conduct a SIA. The SIA would consist of three tasks; scoping, assessment, mitigation and monitoring. The following information should be developed:

- Business, Industrial, and Agricultural Activities;
- Employment;
- Land Use;
- Property Values;
- Public and Community Facilities and Services (including utilities and schools);
- Transportation;
- Housing;
- Health (vector routes);
- Population;
- Community Cohesion; and,
- Recreational Resources.

TERRESTRIAL AND AQUATIC HABITAT

- Prepare site-specific habitat maps to ensure the major types of aquatic habitat are identified and quantified.
- Conduct field studies to locate rare and unique habitats, such as wetlands, primary forests, roosting sites, foraging areas, old growth, and migration flyways.
- Determine the present quality and ecosystem value of existing habitats within the Gatun Lake project area.
- Coordinate with local experts to identify and evaluate aquatic and terrestrial habitat areas.
- Prepare species inventory lists for each site area, identifying their status as native or exotic species, and whether they are threatened and or endangered species.
- Conduct additional research into water currents and estimated turbidity levels to evaluate impacts to the shallow areas along Barro Colorado Island.
- Address cumulative effects caused by natural flow diversions.

ANIMALS ON THE ENDANGERED LIST

- Compile habitat maps to assess the availability and quality of suitable habitats for the animals on the endangered and/or threatened species list.
- Establish field methodology to assess wildlife habitat values.
- Conduct site surveys to determine the presence of selected species or their habitats.

- Develop candidate mitigation measures for the appropriate project alternatives to be considered in the Conceptual Phase.
- Coordinate with local experts on the presence of endangered species.

WATER QUALITY

- Since limited water quality data are available for the Gatun Lake area, compile information on total suspended solids, conductivity, total dissolved solids, dissolved oxygen, nutrients, pH, and coliform bacteria.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

- Information regarding cultural resources and historic properties in the project area is incomplete. Additional evaluation studies should be completed to identify any such resources and/or properties.

Evaluation Matrices

Table 40 - 1 Environmental Effects

Item	Measure [1/]	Importance [2/]	Composite [3/]
Terrestrial Habitat	2	8	16
Animals on Extinction List	2	10	20
Water Quantity Impacts – Lake	8	10	80
Water Quantity Impacts -- Downstream	4	7	28
Water Quality	5	10	50
Downstream Aquatic Fauna Habitat	3	8	24
Future Lake Aquatic Plant Community	6	8	48
Aquatic Faunal Inhabiting Affected Area and Upstream Tributaries	4	5	20
Potential for Fishing on Lake	6	6	36
Wetlands	3	4	12
Air Quality	5	3	15
Cultural Resources and Historic Properties	3	10	30
Total			379

[1/] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2/] Importance - 1 to 10 increasing in importance.
[3/] Composite - the product of the measure and importance.

Table 40 - 2 Socio-Economic Effects

Item	Measure [1]	Importance [2]	Composite [3]
Land Use	2	7	14
Relocation of People	1	10	10
Relocation of Agricultural/Ranching Activities	1	6	6
Post-Construction Business	6	5	30
Post-Construction on Existing Employment	6	5	30
Property Values During Construction	7	4	28
Property Values Post-Construction	5	5	25
Public/Community Services During Construction	6	4	24
Public/Community Services Post-Construction	5	8	40
Traffic Volumes over Existing Roadway System During Construction	3	5	15
Traffic Volumes over New Roadway System Post-Construction	5	5	25
Noise-Sensitive Resources or Activities	4	4	16
Communities Receiving Displaced People	1	8	8
Community Cohesion	1	8	8
Tourism	6	5	30
Total			309

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

SECTION 41 – LOWER RIO TRINIDAD 22.9M TO 33.5M, RIO CANO QUEBRADO 22.9m to 33.5m

Socio-Economic Impacts

The description of the environmental setting is based on field observations made while conducting field reconnaissance throughout Gatun Lake, specifically the Lower Rio Trinidad and Rio Indio areas with ACP personnel. Autoridad Nacional del Ambiente (ANAM), ACP, Asociacion Nacional para la Conservacion de la Naturaleza (ANCON), Electrical Transmission Agency, Smithsonian Tropical Research Institute (STRI), and Directorate of Mineral Resources personnel were interviewed to gain information on site characteristics and potential activities that could affect the project. In addition, extrapolations of the 2000 census data were used, and a review of the Informe de Cobertura Boscosa 1992 were used to determine the extent of forest cover.

Environmental Setting

This alternative combines two projects, the Lower Rio Trinidad (lake level 22.9 - 33.5 m) and the Rio Caño Quebrado (lake level 22.9 - 33.5 m). The Lower Rio Trinidad project will provide additional water storage for Gatun Lake and 12.16 additional lockages per day on a continual basis. The Rio Trinidad project area covers 23,630 ha within Gatun Lake. This area is sparsely populated and includes rolling hills, as well as low regions near Gatun Lake. The Lower Rio Trinidad is located west of the Panama Canal, and flows northward from the Continental Divide into Gatun Lake. The Lower Rio Trinidad with Rio Caño Quebrado watershed above the dam covers approximately 1,051.5 km^2. The incremental impoundment area covers approximately 7,712 ha and consists of approximately 50 percent of forested land, 30 percent of pasture land (used by ranchers), 10 percent of cropland, and 10 percent of newly slashed and burned land. Gatun Lake's normal pool level is 26.7 m. During field observations (August 2001) the pool level was approximately 25.4 m.

The Rio Caño Quebrado project consists of a rockfill dam in two distinct sections and a gated spillway. The project area covers 3,629 ha within Gatun Lake. This area is sparsely populated, with terrain similar to that in the Lower Rio Trinidad project area. The Rio Caño Quebrado project area is located within the Panama Canal area, and flows northward from the Continental Divide into Gatun Lake. The Rio Caño Quebrado watershed above the dam covers approximately 1,052 km^2. The impoundment area, which would cover an additional 3,443 ha, consists of approximately 50 percent of forested land, 30 percent of pastureland (used by ranchers), 15 percent of cropland, and 5 percent newly slashed and burned land. The lake water elevation will fluctuate from 22.9 - 33.5 m. The project may impact unpaved roadways and paths in the area. Any impacts will be evaluated and minimized where possible.

LAND USE

The Lower Rio Trinidad project area encompasses the southwestern portion of Gatun Lake and the adjacent shores. The area to be fully or partially flooded encompasses the villages of Escobal (population – 1,653), Nuevo Provenir (population – 121), Cuipo (population – 249), Ciricito (population – 72), La Arenosa (population – 242), La Garterita (population – 138), La Gartera (population – 348), and a few small isolated establishments.

The Rio Caño Quebrado project proposes to maintain the impoundment at pool levels between 22.9 - 33.5 m. The normal pool level is 26.7 m. La Laguna (population 246) and Pueblo Nuevo (population 47) are the only towns on the Rio Caño Quebrado arm. The lake is also used for fishing, bathing, and transportation. Houses in La Laguna and Pueblo Nuevo are constructed of forest products and/or of concrete.

Some areas along the shores of the Lower Rio Trinidad and Rio Can Quebrado have been deforested. Approximately 65 percent of the lakeshore areas are forested, mostly with secondary growth. Farms and ranches of various sizes, as well as teak and African mahogany plantations, occupy the remaining land. Farm crops include maize, rice, beans, sugar, coffee, mangos, pineapples, and tobacco. Ranchers raise cows, horses, chickens, hogs, and tilapia. Some farmers and ranchers operate commercial enterprises, others rely on cash crops and subsistence farming. No significant ore deposits or mineral resources are located along the Caño Quebrado arm of Gatun Lake.

INFRASTRUCTURE

The town of Escobal was the largest community visited during site investigations. Escobal has businesses, schools, churches, cemeteries, medical centers, several houses, and paved roadways in good condition. A new and improved roadway (Highway 35) is in the project area near Escobal. Other settlements in the project area - Nuevo Provenir; Cuipo; Ciricito; La Arenosa; La Garterita; La Gartera - and a few small isolated establishments have elementary schools, small cemeteries, churches and meeting centers, medical clinics, and a few small businesses (general stores). The towns and villages depend on Gatun Lake or groundwater wells for their potable water supply. Each community also has docks, small ports, and other boat access facilities. Goods are transported from one town to the next by boat. No wastewater treatment is provided. Wastewater from showers and washing is discharged into the environment; some of it may reach the Lower Rio Trinidad portion of Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners: some homes have septic tanks, others have an outdoor latrine (a hole in the ground). Health problems, such as hepatitis, dysentery, dermatitis, intestinal parasites, and respiratory illnesses are attributable to the present waste disposal methods. No major industries or meat processing plants are located in the project area. The project area is traversed by unpaved horseback riding paths that link the various communities by unpaved maintenance roads used by the ACP. Due to the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

La Laguna and Pueblo Nuevo have access to cemeteries, churches, and medical centers, and rely on Gatun Lake or groundwater wells for their drinking water supply. Most homes have electricity and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it is likely to reach Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners; some have a septic system, or an outdoor latrine (a hole in the ground). There are some health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses attributed to the present waste disposal methods. No known major industries or meat processing plants are located in the project area. La Laguna is accessible by a poorly maintained dirt road that is usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Pueblo Nuevo is accessible only by a dirt trail. These roads and trails are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities because of the relatively isolated location of the project area.

TERRESTRIAL HABITAT

The terrestrial habitat observed along the Lower Rio Trinidad and Rio Caño Quebrado project areas of Gatun Lake consists of tropical forest ecosystems, mostly secondary growth forests with patches of primary forest. About 65 percent of the land along the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake is forested and probably supports diverse wildlife populations. These also contain islands inhabited by wildlife. Some of the wildlife species do not interact with species on the mainland; others

migrate between the island and the mainland. The species interrelationships are of great interest to the scientists studying tropical ecosystems. The slash and burn deforestation has opened tracts of land for farming and cattle grazing; however, the majority of the lakeshore is forested to the edge of the water. Terrestrial areas are used by migratory species as wintering, breeding, and feeding grounds. The complex and diverse tropical ecosystems offer habitat to connect a variety of wildlife communities and may provide habitat to many native species.

ANIMALS ON ENDANGERED LIST

ANAM, Resolution 002-80 enacted on June 7, 1995, declared 33 mammals, 39 birds, and 11 reptiles and amphibians to be in danger of becoming extinct in Panama. Although none have been identified to date, some of the species of interest on the threatened list might be found in the project area. The manatee is an aquatic mammal known to inhabit Gatun Lake around the Barro Colorado Island; however the probability of its presence in the project area has not been determined.

AQUATIC HABITAT

Gatun Lake, one of the world's largest manmade lakes, was created during the construction of the Panama Canal. The lake's water depth and quality vary widely. Aquatic habitat ranges from inundated forests to clear water in areas distant from shipping lanes. The Lower Rio Trinidad areas of Gatun Lake provide habitat for a variety of wildlife species, both resident and migratory, as well as for both native and introduced fish and other aquatic species.

WETLANDS

Areas that contain hydric soils and hydrophytic plant communities, and that are subject to hydrologic conditions are termed wetlands. Wetlands in the Lower Rio Trinidad and Rio Caño Quebrado project areas consist of shallow water habitat and lands subject to frequent flooding. In the shallow water zones along the banks of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake, sunlight penetrates to a depth of approximately 1 m. Sunlight stimulates growth of submergent, emergent, or floating mats of aquatic vegetation. Wetlands occur in terrain where water remains pooled long enough to allow development of hydric soil conditions and wetland plant communities. The wetlands in the project area are stressed by runoff that carries sediments, municipal waste, agricultural runoff, and debris from slash and burn sites.

AIR QUALITY

Air quality in the project area is generally good, except during slash and burn activities near the end of the dry season, in March or early April, when portions of forest are burned and cleared for agricultural use. During this period, the air is filled with smoke and ash, which may be carried by winds to the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Air quality monitoring has not been implemented within the project area.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

Barro Colorado Island is an international center for tropical research and one of the first biological reserves established in the Neotropics. From 1923 through 1940, a scientific committee of the U.S. National Academy of Sciences administered the biological reserve/laboratory. In 1940, by an Act of the United States Congress, the facility was renamed the Panama Canal Zone Biological Area, and in 1946, the responsibility for its maintenance was assigned to the Smithsonian Institution. With the Panama Canal Treaty Implementation in 1977, the island was granted the category of National Monument and to date it continues to be managed by the Smithsonian Institute. It should also be noted that most of the Atlantic region of Panama is within the interest and objectives of the Mesoamerican Biological Corridor, an international project to conserve biodiversity.

Environmental Impacts

TERRESTRIAL HABITAT

The impacts of the project on terrestrial habitat in the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake could be substantial. The boundary between two types of habitats, in this case between a forest and a lake, is called an ecotone. Ecotones are inhabited by species from neighboring habitats, and are unique, with high species diversity. Considering the proposed normal operating levels for both impoundments, between 22.9 and 33.5 m, erosion of the shoreline may be substantial as pool levels rise and fall. Terrestrial habitat areas that would be inundated above the 26.7 m (existing level) to the proposed normal pool level of 33.5 m consist of 20,778 ha for the Lower Rio Trinidad project. The permanent raising of the water level in Rio Caño Quebrado Lake will inundate approximately 4,577 ha of additional wildlife habitat surrounding the lake. The construction of a dam structure, access roads and pump stations would permanently impact terrestrial habitat. Wildlife species that are able to relocate to other suitable areas will compete with similar species for resources. Wildlife species that are not able to relocate will not survive. As a result, competition for natural resources in the surrounding areas will increase. This is considered a secondary impact to terrestrial habitat outside the proposed zone of inundation and construction.

ANIMALS ON ENDANGERED LIST

The severity of the impacts to endangered species cannot be determined at this time, because it is not known which of the listed species live within the proposed project area. It is expected that at least some of the species on the endangered list will be found in the region. Some endangered and/or threatened species may use the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake during some or all parts of their life cycle.

WATER QUANTITY

The impacts of the project on water quantity would be substantial. The increase in the volume of water could have negative impacts to lakeshore communities as well as on existing ecosystems. The same is true if the lake level is lowered and maintained at 22.9 m.

WATER QUALITY

Project impacts on water quality are unknown. Damming the Lower Rio Trinidad and Rio Caño Quebrado could increase the amounts of nutrients and debris in this portion of Gatun Lake. A pilot tilapia farm is in the project area and may be affecting water quality. The rate nutrients and debris enter the lake will determine the severity of the impact on water quality. Project implementation could cause an increase in turbidity and interfere with photosynthesis. The increase in turbidity could deprive plants and other aquatic species from necessary sunlight. Aquatic plants and other organisms serve to maintain water quality. The dam would interfere with the circulation of freshwater throughout the Gatun Lake environment. Species inhabiting specific depths could be impacted when lake depth increases to 33.5 m and/or decreases to 22.9 m.

DOWNSTREAM AQUATIC FAUNAL HABITAT

The impacts of the project on aquatic faunal habitat could be substantial, especially on the breeding and nursery habitat of the many juvenile aquatic species. Fish spawning areas may be adversely affected by sudden changes in turbidity, nutrient content, and depth of the water, which alter the conditions needed for successful hatching. Plant populations may decrease as a result of fluctuations in water depth, clarity, and

quality. Invertebrate populations may decline, which could reduce the food supply for fish and other aquatic species.

FUTURE LAKE AQUATIC PLANT COMMUNITY

The impacts of the project on future aquatic plant communities depend on water quality and stability of water levels. Plant species in the Lower Rio Trinidad portion of Gatun Lake could be impacted by fluctuating water levels. Aquatic plant communities could be impacted during project implementation; however, they could eventually re-establish after conditions stabilize.

AQUATIC FAUNA INHABITING AFFECTED AREAS

Impacts of the proposed project on aquatic fauna inhabiting the Lower Rio Trinidad, Rio Caño Quebrado and associated rivers and tributaries could be substantial. The unavoidable, adverse environmental impacts should be identified and minimized using appropriate mitigation measures (to be addressed in a feasibility level study). Gatun Lake has populations of peacock bass and tilapia, both of which are introduced species that have adapted well. However, several native riverine species that formerly occupied the impoundment have disappeared.

WETLANDS

The impacts to wetlands could be significant. As wetlands are inundated, they could become aquatic habitat. Project activities may lead to increased and/or decreased water depth, sedimentation, and turbidity which could hamper the biological processes of the wetlands and decrease their productivity. Such impacts could be detrimental to the health and sustainability of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Fish and other aquatic species use the shallow waters as spawning grounds. The juveniles survive in shallow water wetland areas until they are large enough to venture into deeper water. Each area is vital to the sustainability of this portion of Gatun Lake, including the Lower Rio Trinidad and Rio Caño Quebrado areas.

AIR QUALITY

During project implementation, emissions from construction equipment, along with slash and burn activities, could cause deterioration of air quality in the project area. After project implementation, the air quality may be impacted by the normal operation of the power generation facility and pumping stations.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

The potential impacts on cultural resources and historic properties cannot be identified. Before project implementation, surveys should be conducted to locate cultural resources and historic properties, and the important sites should be preserved or salvaged as appropriate.

SOCIO-ECONOMIC IMPACTS

The socio-economic impacts of the project could be substantial. The relocation of the town of Escobal and other small communities along the lakeshore would be an important issue. The average monthly income of families in the project area ranges from less than $100 to $200 per month. No indigenous groups are known to reside in the impact area. Land use would be greatly impacted by the inundation of pastures and agricultural lands to expand the impoundment. The relocation of agricultural and ranching activities would be an important issue, because approximately 10 percent of the land in the impoundment area is used for farming and ranching. After the water level is raised, additional agricultural land could be lost as islands are created from isthmuses. The incremental surface area of the proposed lake is 11,155 ha; another 1,504 ha will be used for the dam and construction sites, including permanent disposal areas.

During construction, the influx of workers could create a temporary demand for additional housing, which could result in an increase of housing values near the dam site. However, after completion of the project, the workers could leave, the housing demands could drop, and the housing values could return to pre-construction levels. Currently, all residents have access to public schools and health centers. During construction, these services should continue to be available, and additional public and community services may be offered. After construction, these services would return to the previous levels.

To construct the dam, some existing roads would be improved and some new roads would be built. However, some paved and unpaved roads within the impoundment area would be eliminated, which would change traffic patterns and could cause some communities to lose overland transportation, communication, cohesion, and commerce with other communities. During construction, the traffic volumes over both new and existing roads systems would increase; however following completion of construction, the traffic volumes could decline. Noise levels would temporarily increase during construction and could negatively impact noise-sensitive receptors; however, after construction noise levels may remain elevated as a result of the power generation facility and pump stations.

The communities that receive people displaced by the project could be negatively impacted by overcrowding and by competition for jobs, land, and working areas. Construction of the dams would permanently displace people and disrupt community cohesion through the division of communities, separation of families, and loss of livelihood. Following completion of the impoundment, tourism trade in the affected region, including sport fishing and ecotourism, could increase.

Additional Environmental Information Required

This section identifies the areas for which additional data are required to evaluate the scope and magnitude of the potential effects in further detail of the Lower Rio Trinidad and Rio Caño Quebrado alternative. The subject areas are discussed by impact category.

SOCIO-ECONOMIC IMPACTS

Conduct a SIA. The SIA would consist of three tasks scoping, assessment, and mitigation and monitoring. The following information should be developed:

- Business, Industrial, and Agricultural Activities;
- Employment;
- Land Use;
- Property Values;
- Public and Community Facilities and Services (including utilities and schools);
- Transportation;
- Housing;
- Health (vector routes);
- Population;
- Community Cohesion; and,
- Recreational Resources.

TERRESTRIAL AND AQUATIC HABITAT

- Prepare site-specific habitat maps to ensure that the major types of aquatic habitat are identified and quantified.
- Conduct field studies to locate rare and unique habitat features, such as wetlands, primary forests, roosting sites, foraging areas, old growth, and migration flyways.

- Determine the present quality and ecosystem value of existing habitats within the Gatun Lake project area.
- Coordinate with local experts to identify and evaluate aquatic and terrestrial habitat areas.
- Prepare species inventories lists for each site area, identifying their status as native or exotic, and whether they are threatened or endangered or both.
- Conduct additional research into water currents and estimated turbidity levels to evaluate impacts to the shallow areas along Barro Colorado Island.
- Address cumulative effects caused by natural flow diversions.

ANIMALS ON THE ENDANGERED LIST

- Compile habitat maps to assess the availability and quality of suitable habitats for the animals on the endangered and/or threatened species list.
- Establish field procedures for assessing wildlife habitat values.
- Conduct site surveys to determine the presence of selected species or their habitats.
- Coordinate with local experts on the presence of endangered species.
- Develop candidate mitigation measures for the appropriate project alternatives to be considered in the Conceptual Phase.

WATER QUALITY

- Since limited water quality data are available for the Gatun Lake area, compile information on total suspended solids, conductivity, total dissolved solids, dissolved oxygen, nutrients, pH, and coliform bacteria.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

- Information regarding cultural resources and historic properties in the project area is incomplete. Additional evaluation studies should be completed to identify any such resources and/or properties.

Evaluation Matrices

Table 41 - 1 Environmental Effects

Item	Measure [1]	Importance [2]	Composite [3]
Terrestrial Habitat	4	8	32
Animals on Extinction List	5	10	50
Water Quantity Impacts – Lake	9	10	90
Water Quantity Impacts -- Downstream	5	7	35
Water Quality	5	10	50
Downstream Aquatic Fauna Habitat	5	8	40
Future Lake Aquatic Plant Community	7	8	56
Aquatic Faunal Inhabiting Affected Area and Upstream Tributaries	5	5	25
Potential for Fishing on Lake	5	6	30
Wetlands	4	4	16
Air Quality	5	3	15
Cultural Resources and Historic Properties	5	10	50
Total			489

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

Table 41 - 2 Socio-Economic Effects

Item	Measure [1]	Importance [2]	Composite [3]
Land Use	4	7	28
Relocation of People	4	10	40
Relocation of Agricultural/Ranching Activities	4	6	24
Post-Construction Business	6	5	30
Post-Construction on Existing Employment	5	5	25
Property Values During Construction	5	4	20
Property Values Post-Construction	5	5	25
Public/Community Services During Construction	6	4	24
Public/Community Services Post-Construction	5	8	40
Traffic Volumes over Existing Roadway System During Construction	4	5	20
Traffic Volumes over New Roadway System Post-Construction	5	5	25
Noise-Sensitive Resources or Activities	5	4	20
Communities Receiving Displaced People	5	8	40
Community Cohesion	5	8	40
Tourism	7	5	35
Total			436

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

SECTION 42 – LOWER RIO TRINIDAD 22.9m to 33.5m, RIO INDIO 50m to 80m

Socio-Economic Impacts

The description of the environmental setting is based on field observations made while conducting field reconnaissance throughout Gatun Lake, specifically the Lower Rio Trinidad and Rio Indio areas with ACP personnel. Autoridad Nacional del Ambiente (ANAM), ACP, Asociacion Nacional para la Conservacion de la Naturaleza (ANCON), Electrical Transmission Agency, Smithsonian Tropical Research Institute (STRI), and Directorate of Mineral Resources personnel were interviewed to gain information on site characteristics and potential activities that could affect the project. In addition, extrapolations of the 2000 census data were used, and a review of the Informe de Cobertura Boscosa 1992 were used to determine the extent of forest cover.

Environmental Setting

This alternative combines two projects, the Lower Rio Trinidad (lake level (22.9 - 33.5 m) and Rio Indio (lake level 50 – 80 m). This combination will provide additional storage of water for Gatun Lake and 23.27 additional lockages per day on a continual basis. The project area consists of 23,630 ha within Gatun Lake, which is sparsely populated and has a topography of rolling hills and low regions near Gatun Lake and 5,600 ha within the Rio Indio watershed. The Rio Indio project would include a rock fill dam,an ungated spillway, outlet works, an interbasin transfer tunnel and two hydropower plants. Near Rio Indio, the area is sparsely populated with terrain and topography of steep hills, as well as coastal regions. The Lower Rio Trinidad and Rio Indio are west of the Panama Canal and flow northward from the Continental Divide. The watershed above the Lower Rio Trinidad and the Rio Indio the dam project covers approximately 1,052 km^2 and 381 km^2 respectively. The incremental impoundment area, which covers approximately 7,712, consists of approximately 50 percent of forested land, 30 percent of pasture land (used by ranchers), 10 percent of cropland, and 10 percent of newly slashed and burned land. Gatun Lake's normal pool level is 26.7 m. The lake level during field observations (August 2001) was approximately 25.4 m.

LAND USE

The Lower Rio Trinidad project area encompasses the southwestern portion of Gatun Lake and areas along its shores. The areas to be flooded or partially flooded include the town of Escobal (population – 1,653), Nuevo Provenir (population – 121), Cuipo (population – 249), Ciricito (population – 72), La Arenosa (population – 242), La Garterita (population – 138), La Gartera (population – 348), and a few small isolated establishments.

Some areas along the shores of the Lower Rio Trinidad have been deforested. Approximately 65 percent of the lakeshore areas are forested, mostly with secondary growth. Farms and ranches of various sizes, as well as teak and African mahogany plantations, occupy the remaining lands. Farm crops include maize, rice, beans, sugar, coffee, mangos, pineapples, and tobacco. Ranchers raise cows, horses, chickens, hogs, and tilapia. Some of the farmers and ranchers operate commercial enterprises, while others rely on cash crops and subsistence farming. No significant ore deposits or mineral resources are located in the project area.

Approximately 2,300 people inhabit the Rio Indio project area; they live in the towns of Tres Hermanas (population – 200), Los Cedros (population – 80), El Coquillo (popoulation – 150), El Limon (population – 140), Los Uveros (population – 140), and La Boca de Uracillo (population – 110), and in nearly 30 smaller settlements. Downstream from the dam site at El Limon there are 14 communities with a combined

population of approximately 600. The largest of these is La Boca del Rio Indio with a population of more than 150.

Farms and ranches of various sizes, as well as some teak plantations, occupy approximately 60 percent of the land in the Rio Indio project area. Farm crops include maize, rice, beans, sugar, coffee, and tobacco. Ranches raise horses, cows, chickens, and hogs. Some of the farmers and ranchers run small commercial enterprises, or rely on cash crop and subsistence farming.

INFRASTRUCTURE

During site investigations in the Lower Rio Trinidad area, the town of Escobal was the largest settlement visited. Escobal has businesses, schools, churches, cemeteries, medical centers, residences, and paved roadways of good condition. A new and improved roadway (Highway 35) is adjacent to the project area near Escobal. Other establishments in the project area Nuevo Provenir; Cuipo; Ciricito; La Arenosa; La Garterita; La Gartera; and a few small isolated establishments have elementary schools, small cemeteries, churches and meeting centers, medical clinics, and a few small businesses (i.e. general stores). The towns and villages depend on Gatun Lake or groundwater wells for their potable water supply. Each community also had docks, small ports, and other boat access facilities. Goods are transported from one town to another by boat. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach the Lower Rio Trinidad portion of Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners: some homes have septic tanks, while others have an outdoor latrine (a hole in the ground). There are some health problems, such as hepatitis, dysentery, dermatitis, intestinal parasites, and respiratory illnesses, which are attributable to the present waste disposal methods. No major industries or meat processing plants are located in the project area. The project area is traversed by unpaved horseback riding trails that link the various communities and by unpaved roads used by the ACP for maintenance. Due to the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

In the Rio Indio project area, towns of El Limon, El Silencio, San Cristobal, and Piedra Amarilla have elementary schools. Several towns have cemeteries, churches, and medical centers. All these towns obtain water from rivers or groundwater wells. Some have electricity (from small generators) and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach Rio Indio and its tributaries. Disposal of domestic waste is the responsibility of individual homeowners; each home has an outdoor latrine. There are some known health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses that are attributed to the present waste disposal methods. No known major industries or meat processing plants are located in the project area. The only roads in the project area are unpaved and poorly maintained, and are usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. These roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities because of the relatively isolated location of the project area.

TERRESTRIAL HABITAT

The terrestrial habitat in the Lower Rio Trinidad project area of Gatun Lake consists of tropical forest ecosystems, mostly secondary growth forests with patches of primary forest. About 65 percent of the land along the Lower Rio Trinidad of Gatun Lake is forested and probably supports diverse wildlife populations. The Lower Rio Trinidad areas of Gatun Lake also contain islands inhabited by wildlife. Some of the wildlife species do not interact with species on the mainland; others migrate between the island and the mainland. The species interrelationships are of great interest to scientists studying tropical ecosystems. Slash and burn activities have opened tracts of land for farming and cattle grazing; however, the majority of the lakeshore is forested to the edge of the water. Terrestrial areas are used by migratory species as wintering, breeding, and feeding grounds. The complex and diverse tropical ecosystems offer

habitat to connect a variety of wildlife communities and may provide critical wildlife habitat to many native species.

In Rio Indio, forests along the river that could support diverse wildlife populations cover about 90 percent of the areas along the Rio Indio and its tributaries. The forests also extend to the mountainous areas above the Rio Indio impoundment. As a result of slash and burn activities, there are no large contiguous tracts of forests at lower elevations in the impoundment.

ANIMALS ON ENDANGERED LIST

ANAM, Resolution 002-80 enacted on June 7, 1995 declared, 33 mammals, 39 birds, and 11 reptiles and amphibians are in danger of becoming extinct in Panama. Although their presence has not been confirmed to date, some of the listed species of interest on the threatened list might be found in the project area. The manatee is an aquatic mammal known to inhabit Gatun Lake around the Barro Colorado Island; however, it has not been sighted in the project area.

AQUATIC HABITAT

Gatun Lake, one of the world's largest manmade lakes, was created during the construction of the Panama Canal. The lake's water depth and quality vary widely. Aquatic habitat ranges from inundated forests to clear water in areas distant from shipping lanes. The Lower Rio Trinidad areas of Gatun Lake provide habitat for a variety of wildlife species, both resident and migratory, as well as for native and introduced fish and other aquatic species.

Rio Indio has characteristics typical of streams in mountainous regions. Its water is clean and cool, and its bottom ranges from sand to boulders, with numerous riffles, runs, and pools. Tributaries to Rio Indio include four major streams: Rio El Torno, Rio Uracillo, Rio Teria, and Rio Riacito, and 20 smaller streams. The river is approximately 16 km long, its width ranges from 3 m (in the dry season) to 10 m. The tributaries appear to support some fish communities; information about these communities is limited.

WETLANDS

Areas that contain hydric soils and hydrophytic plant communities, and that are subject to hydric conditions are termed wetlands. Wetlands occur in topographic area where water remains pooled long enough to produce hydric soil conditions and wetland plant communities. Wetlands in the Lower Rio Trinidad project area consist of shallow water habitats and lands subject to frequent flooding. Shallow water areas along the banks of the Lower Rio Trinidad area of Gatun Lake receive sunlight to a depth of approximately 1 m. Sunlight stimulates growth of submergent, emergent, or floating mats of aquatic vegetation. Wetlands in the project area are stressed from excessive sediments, municipal waste, agricultural runoff, and other debris carried in the runoff.

Wetlands in the Rio Indio project area consist of forested riparian habitat and are limited by their relatively steep topography. The width of the riparian habitat within the impoundment area varies from approximately 5 to 50 m. Approximately 90 percent of the streams both above and below the dam site along the Rio Indio and its tributaries are bordered by forested riparian habitat.

AIR QUALITY

Air quality in the project area is generally good, except during the slash and burn activities. At the end of the dry season in March or early April, areas of forest and secondary growth are burned and cleared for agricultural use. During this period, the air is filled with smoke and ash, which may be transported by winds to the Lower Rio Trinidad area of Gatun Lake. Based on observations in the Rio Indio project area, approximately 10 percent (or 400 ha) of forested land is burned annually. Air quality monitoring has not been implemented within the project area.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

Barro Colorado Island is an international center for tropical research and one of the first biological reserves established in the Neotropics. From 1923 through 1940, a scientific committee of the U.S. National Academy of Sciences administered the biological reserve/laboratory. In 1940, by an Act of the United States Congress, the facility was renamed the Panama Canal Zone Biological Area, and in 1946, the responsibility for its maintenance was assigned to the Smithsonian Institution. With the Panama Canal Treaty Implementation in 1977, the island was granted the category of National Monument and to date it continues to be managed by the Smithsonian Institute. It should also be noted that most of the Atlantic region of Panama is within the interest and objectives of the Mesoamerican Biological Corridor, an international project to conserve biodiversity.

In the pre-Columbian period, Rio Indio was a language frontier; the inhabitants on each side of the river spoke a different native language. During the Spanish colonial period, the river served as a political boundary. The project area has a high potential to be rich in archaeological and historical remains.

Environmental Impacts

TERRESTRIAL HABITAT

The impacts of the project on terrestrial habitat in the Lower Rio Trinidad area of Gatun Lake could be substantial. The boundary between two types of habitats, in this case between a forest and a lake, is called an ecotone. Ecotones are inhabited by a variety of species from neighboring habitats, and are unique, with high species diversity. Considering the proposed operating levels for both impoundments, between El. 22.9 - 33.5 m MSL, as the normal zone of operation, erosion of the shoreline may be substantial as pool levels rise and fall. Terrestrial habitats that would be inundated above the El. 26. 7 m MSL (existing level) to the El. 30.5 m MSL proposed normal pool level consists of 21,912 ha for the Lower Rio Trinidad project. The placement of a dam structure, access roads and pump stations would permanently impact terrestrial habitat. Wildlife species that are able to relocate to suitable areas will compete with similar species for resources; species that are not able to relocate will not survive. As a result, competition for natural resources in surrounding habitat areas will increase. This is considered a secondary impact to terrestrial habitat outside the proposed zone of inundation and construction.

The terrestrial impacts of the Rio Indio project, which is located in area of relatively high quality forest habitat, would be substantial. With the creation of the lake, the migratory routes of some species could be adversely affected. Forested areas along lower elevations would be lost as a result of the impoundment. The only forests that would remain near the Rio Indio reservoir and its drainage basin would be confined to the higher elevations, where the vegetation and species may be completely different from those found on lower elevations. Natural communities are linked together by complex interactions and relationships among various species, therefore impacts to upper-forested areas may occur resulting from the inundation of the lower forests.

ANIMALS ON ENDANGERED LIST

The severity of impacts on endangered species cannot be determined at this time, because although it is expected that some of the listed species can be found in the region, it is not known which of the listed species inhabit the proposed project area. Some endangered and/or threatened species may use the Lower Rio Trinidad area of Gatun Lake during some or all parts of their life cycle.

WATER QUANTITY

The impacts of the Lower Trinidad project on water quantity would be substantial. The increase in the volume of water could have negative impacts to lakeshore communities, as well as on existing ecosystems. The same is true if the lake level is lowered and maintained at 22.9 m.

The impacts of the Rio Indio project area on water quality would also be substantial. The volume of water will increase, making fresh water available in the surrounding areas during the dry season. The impacts downstream from the dam would be significant. Sediment loads would be deposited upstream from the dam as water velocity slows. Downstream from the dam the water will be released at an increased velocity, causing erosion of banks and river bottoms. Seasonal flooding could be significantly reduced. It would also be possible to periodically release water in appropriate amounts to avoid problems with water quality and temperature downstream. The cumulative impact downstream from the dam site depends on the amount of water being released.

WATER QUALITY

Project impacts on water quality are not known. Damming the Lower Rio Trinidad could increase the amounts of nutrients and debris in this portion of Gatun Lake. A pilot plant tilapia farm is in the project area and may affect water quality. The rate nutrients and debris enter the lake determines the severity of the impact on water quality. Project implementation could cause an increase in turbidity, which would interfere with photosynthesis and deprive plants and other aquatic species sunlight. Aquatic plants and organisms serve to maintain water quality. The dam could interfere with the circulation of freshwater throughout the Gatun Lake environment. Species inhabiting specific depths could be impacted when lake depth increases to 33.5 m and/or decreases to 22.9 m.

The impacts of the Rio Indio project on water quality could be positive. The people living downstream from the dam and around the impoundment would have access to a higher quality water supply. Water quality in the impoundment area would differ from water quality released downstream from the dam. If the water in the impoundment area does not circulate periodically, it could become anoxic. A change in temperature, dissolved oxygen, turbidity, or pH could change water quality.

DOWNSTREAM AQUATIC FAUNAL HABITAT

The impacts of the project on aquatic faunal habitat could be substantial. The project may affect the breeding and nursery habitats of many aquatic species. Impacts to fish spawning areas may be detrimental when turbidity, nutrient content, and depth of the water suddenly increase or decrease, altering the conditions needed for successful fish hatching. Plant populations may decrease due to fluctuating water depths, clarity, and quality. Invertebrate populations may decline, which could reduce the food supply for fish and other aquatic species.

Impacts to downstream aquatic faunal communities in the Rio Indio project area could be substantial, because the dam structure will prevent their migration throughout the riverine habitat. The dam structure would be designed for multi-level releases to maintain a water level downstream from the dam site. The dam should act as a large sediment trap; thus, the released water would have low turbidity, which would result in better visibility and increased predation on the fish species. Aquatic faunal habitats downstream would be deprived of the beneficial nutrients and silts that were transported in the sediment. Native riverine fish species may be negatively impacted as a result of the project; the extent of the impact is not known.

FUTURE LAKE AQUATIC PLANT COMMUNITY

The impact of the project on future aquatic plant communities depends on the water quality and the stability of water levels. Plant species in the Lower Rio Trinidad portion of Gatun Lake could be impacted by fluctuating water levels. Aquatic plant communities could be impacted during project implementation; however, they could re-establish after conditions stabilize.

The severity of impact due to the Rio Indio project will depend on water level fluctuations. Since water levels are anticipated to fluctuate widely, large portions of the shores would be covered with mud, allowing neither aquatic nor terrestrial plants could thrive.

AQUATIC FAUNA INHABITING AFFECTED AREAS

The proposed project impacts could have some unavoidable, adverse environmental impacts on aquatic fauna in the Lower Rio Trinidad project area and associated rivers and tributaries. These impacts should be identified and minimized with appropriate mitigation measures to be discussed in a feasibility level study. Gatun Lake has populations of peacock bass and tilapia, both introduced species that have adapted well. However, several native riverine species that formerly occupied the impoundment have disappeared.

The impacts of the Rio Indio project on aquatic fauna in the Rio Indio and its upstream tributaries could be substantial, since the habitat area would change from riverine to lacustrine. Some aquatic species would continue to inhabit the area; however, non-native fish species would become dominant in the impoundment area and native riverine species would be pushed upstream or extirpated. Other manmade lakes in the Republic of Panama have been stocked with peacock bass and tilapia. The impoundment area would probably be stocked with these species to promote sport fishing and to provide the local communities with fish for food.

WETLANDS

The impacts to wetlands could be significant. Inundation of wetlands could cause them to become aquatic habitat. The changes in water depth caused by the project may lead to increased or decreased sedimentation and turbidity, which could hamper the biological processes in the wetlands and decrease their productivity. Such impacts could be detrimental to the health and sustainability of the Lower Rio Trinidad area of Gatun Lake. Fish and other aquatic species use shallow water areas as spawning grounds, as well as habitat for juvenile aquatic species that survive in the shallows until large enough to venture into deeper water. These wetlands are vital to the sustainability of this portion of Gatun Lake, including the Lower Rio Trinidad area.

The impacts to wetlands, both upstream and downstream, from the Rio Indio project area could be significant. Owing to the topography of the project area, a number of wetlands could be impacted. It is possible that although the reservoir level will fluctuate, new wetlands could develop in the littoral zones. Downstream from the dam site, wetlands along the minimal flows zone would survive; wetlands that depend on seasonal flooding for survival may be adversely affected.

AIR QUALITY

During project implementation, emissions from construction equipment, as well as from slash and burn activities, could cause deterioration of air quality. After project implementation, the air quality may be impacted by the operation of the power generation facilities and the pumping station.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

The potential impacts on cultural resources and historic properties from the Rio Indio project can be defined and mitigated, particularly in the La Boca de Uracillo area, which is near previously identified

archaeological sites. The project area is relatively large and is known to contain pre-Columbian sites; therefore, the presence of cultural resources and historic properties is highly probable. Prior to construction, surveys to locate cultural resources and historic properties should be conducted, and the important sites should be preserved or salvaged as appropriate.

SOCIO-ECONOMIC IMPACTS

The socio-economic impacts of the project could be substantial. The relocation of the towns and other small communities along the lakeshore would be an important issue. The average monthly income of families in the project area ranges from less than $100 to $200 per month. No indigenous groups are known to reside in the impact area. Land use would be greatly impacted by the inundation of pastures and agricultural lands to expand the impoundment. The relocation of agricultural and ranching activities would be an important issue, because approximately 10 percent of the land in the impoundment area is used for farming and ranching. After the water level is raised, additional agricultural land could be lost due to the creation of islands from isthmuses. The incremental surface area of the proposed lake is 7,712 ha; another 1,318 ha from the Lower Trinidad project and 760 ha from the Rio Indio project will be occupied by the dam and construction areas, including permanent disposal areas.

During construction, the influx of workers could create a temporary demand for additional housing, which could result in an increase in housing values near the dam site. However, after completion of the project, the workers could leave, the housing demands could drop, and the housing values could return to pre-construction levels. Currently, all residents have access to public schools and health centers. During construction, these services should continue to be available, and additional public and community services may be offered. After construction, these services would return to the normal level.

To construct the dam, some existing roads must be improved and some new roads must be built. However, some paved and unpaved roads within the impoundment area would be eliminated, which may change traffic patterns and could cause some communities to lose overland transportation, communication, cohesion, and commerce with other communities. During construction, the traffic volumes over both new and existing roads systems would increase; however, following completion of construction, the traffic volumes could decline. Noise levels would temporarily increase during construction and could negatively impact noise-sensitive receptors; after construction, noise levels may remain elevated due to the power generation facility and pump stations.

The communities that receive people displaced by the project could be negatively impacted by overcrowding and by competition for jobs, land, and working areas. Construction of the dams would permanently displace people and disrupt community cohesion through the division of communities, separation of families, and loss of livelihood. Following the completion of the impoundment, the tourism trade in the affected region, including sport fishing and ecotourism, could increase.

Additional Environmental Information Required

This section identifies the subject areas for which additional data are required to evaluate in further detail, the scope and magnitude of the potential effects of the Lower Rio Trinidad and Rio Indio alternative. The subject areas are discussed by impact category.

SOCIO-ECONOMIC IMPACTS

Conduct a SIA. The SIA would consist of three tasks: scoping, assessment, and mitigation and monitoring. The following information should be developed:

- Business, Industrial, and Agricultural Activities;
- Employment;

- Land Use;
- Property Values;
- Public and Community Facilities and Services (including utilities and schools);
- Transportation;
- Housing;
- Health (vector routes);
- Population;
- Community Cohesion; and,
- Recreational Resources.

TERRESTRIAL AND AQUATIC HABITAT

- Prepare site-specific habitat maps to ensure that the major types of aquatic habitat are identified and quantified.
- Conduct field studies to locate rare and unique habitats such as wetlands, primary forests, roosting sites, foraging areas, old growth, and migration flyways.
- Determine the present quality and ecosystem value of existing habitats within the Gatun Lake project area.
- Coordinate with local experts to identify and evaluate aquatic and terrestrial habitat areas.
- Prepare species inventory lists for each site area, identifying their status as native or exotic and whether they are threatened and/or endangered species.
- Conduct additional research into water currents and estimated turbidity levels to evaluate impacts to the shallow areas along Barro Colorado Island.
- Address cumulative effects caused by natural flow diversions.

ANIMALS ON THE ENDANGERED LIST

- Compile habitat maps to assess the availability and quality of suitable habitats for the animals on the endangered and/or threatened species list.
- Establish field methodology to assess wildlife habitat values.
- Conduct site surveys to determine the presence of selected species or their habitats.
- Develop candidate mitigation measures for the appropriate project alternatives to be considered in the Conceptual Phase.
- Coordinate with local experts on the presence of endangered species.

WATER QUALITY

- Since limited water quality data are available for the Gatun Lake area, compile information on total suspended solids, conductivity, total dissolved solids, dissolved oxygen, nutrients, pH, and coliform bacteria.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

- Information regarding cultural resources and historic properties in the project area is incomplete. Additional evaluation studies should be completed to identify any such resources and/or properties.

Evaluation Matrices

Table 42 - 1 Environmental Effects

Item	Measure [1]	Importance [2]	Composite [3]
Terrestrial Habitat	3	8	24
Animals on Extinction List	2	10	20
Water Quantity Impacts – Lake	8	10	80
Water Quantity Impacts -- Downstream	4	7	28
Water Quality	5	10	50
Downstream Aquatic Fauna Habitat	3	8	24
Future Lake Aquatic Plant Community	6	8	48
Aquatic Faunal Inhabiting Affected Area and Upstream Tributaries	4	5	20
Potential for Fishing on Lake	6	6	36
Wetlands	3	4	12
Air Quality	5	3	15
Cultural Resources and Historic Properties	3	10	30
Total			387

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

Table 42 - 2 Socio-Economic Effects

Item	Measure [1]	Importance [2]	Composite [3]
Land Use	1	7	7
Relocation of People	2	10	20
Relocation of Agricultural/Ranching Activities	2	6	12
Post-Construction Business	6	5	30
Post-Construction on Existing Employment	6	5	30
Property Values During Construction	7	4	28
Property Values Post-Construction	5	5	25
Public/Community Services During Construction	6	4	24
Public/Community Services Post-Construction	5	8	40
Traffic Volumes over Existing Roadway System During Construction	3	5	15
Traffic Volumes over New Roadway System Post-Construction	5	5	25
Noise-Sensitive Resources or Activities	4	4	16
Communities Receiving Displaced People	1	8	8
Community Cohesion	1	8	8
Tourism	6	5	30
Total			318

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

SECTION 43 – LOWER RIO TRINIDAD 22.9m to 33.5m, UPPER RIO INDIO 50m

Socio-Economic Impacts

The description of the environmental setting is based on field observations made while conducting field reconnaissance throughout Gatun Lake, specifically the Lower Rio Trinidad and Rio Indio areas with ACP personnel. Autoridad Nacional del Ambiente (ANAM), ACP, Asociacion Nacional para la Conservacion de la Naturaleza (ANCON), Electrical Transmission Agency, Smithsonian Tropical Research Institute (STRI), and Directorate of Mineral Resources personnel were interviewed to gain information on site characteristics and potential activities that could affect the project. In addition, extrapolations of the 2000 census data were used, and a review of the Informe de Cobertura Boscosa 1992 were used to determine the extent of forest cover.

Environmental Setting

This alternative combines three projects, the Lower Rio Trinidad (lake level 22.9 - 33.5 m) and Rio Indio (lake level 50 m). This project will provide additional storage of water for to Gatun Lake and 12.62 additional lockages per day on a continual basis.. The project area encompasses the additional area to be flooded and surrounding areas and consists of 23,630 ha within Gatun Lake. The area near Gatun Lake is sparsely populated and has a topography of rolling hills, and low regions near Gatun Lake. The Upper Rio Indio portion of the project would consist of a rock fill dam, outlet works, unregulated spillway, an interbasin transfer tunnel, two hydropower facilities, and required access and maintenance roads and power transmission lines. The project area would require approximately 1,898 ha along the eastern leg of the Upper Rio Indio. Near Rio Indio, the area is sparsely populated with a topography of steep hills, as well as coastal regions. The Lower Rio Trinidad and Rio Indio are west of the Panama Canal and flow northward from the Continental Divide into Gatun Lake. The watershed above the Lower Rio Trinidad and the Upper Rio Indio dam project covers approximately 1,052 km^2 and 256 km^2 respectively. The incremental impoundment area, which covers approximately 7,712 ha, consists of approximately 60-50 percent of forested land, 20-30 percent of pasture land (used by ranchers), 10 percent cropland, and 10 percent newly slashed and burned land. Gatun Lake's normal pool level is 26.7 m. The lake level during field observations (August 2001) was approximately 25.4 m.

LAND USE

The Lower Rio Trinidad project area encompasses the southwestern portion of Gatun Lake and areas along its shores. The areas to be flooded or partially flooded include the town of Escobal (population – 1,653), Nuevo Provenir (population – 121), Cuipo (population – 249), Ciricito (population – 72), La Arenosa (population – 242), La Garterita (population – 138), La Gartera (population – 348), and a few small isolated establishments. communities

Some areas along the shores of the Lower Rio Trinidad of Gatun Lake have been deforested. Approximately 65 percent of the lakeshore areas are forested, mostly with secondary growth. Farms and ranches of various sizes, as well as teak plantations and African mahogany plantations, occupy the remaining land. Farm crops include maize, rice, beans, sugar, coffee, mangos, pineapples, and tobacco. Ranchers raise cows, horses, chickens, and hogs, and tilapia. Some of the farmers and ranchers operate commercial enterprises, while others rely on cash crops and subsistence farming. No significant ore deposits or mineral resources are located in the project area.

The Upper Rio Indio project area is inhabited by about 2,300 people, residing in the towns of Tres Hermanas (population – 200), Los Cedros (population – 80), El Coquillo (popoulation – 150), El Limon (population – 140), Los Uveros (population – 140), and La Boca de Uracillo (population – 110), and in approximately 30 smaller settlements. Downstream from the dam site, at El Limon, are 14 communities with a combined population of approximately 600. The largest of these is La Boca del Rio Indio with a population of more than 150.

Farms and ranches of various sizes, as well as some teak plantations, occupy approximately 60 percent of the land in the project area. Farm crops include maize, rice, beans, sugar, coffee, and tobacco. Ranches raise horses, cows, chickens, and hogs. Some of the farmers and ranchers run small commercial enterprises, or rely on cash crop and subsistence farming.

INFRASTRUCTURE

During site investigations in the Lower Rio Trinidad area, the town of Escobal was the largest settlement visited. Escobal has businesses, schools, churches, cemeteries, medical centers, residences, and paved roadways of good condition. A new and improved roadway (Highway 35) is adjacent to the project area near Escobal. Other establishments in the project area are: Nuevo Provenir; Cuipo; Ciricito; La Arenosa; La Garterita; La Gartera; and a few small isolated establishments. Most of the communities have elementary schools, small cemeteries, churches and meeting centers, medical clinics, and a few small businesses (i.e. general stores). The towns and villages depend on Gatun Lake or groundwater wells for their potable water supply. Each community also had docks, small ports, and other boat access facilities. Goods are transported from one town to another by boat. The town depends on Gatun Lake or groundwater wells for their potable water supply. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach the Lower Rio Trinidad portion of Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners; some homes have septic tanks, while others have an outdoor latrine (a hole in the ground). There are some health problems, such as hepatitis, dysentery, dermatitis, intestinal parasites, and respiratory illnesses, which are attributable to the present waste disposal methods. No major industries or meat processing plants are located in the project area. The project area is transversed traversed by unpaved horseback riding trails that link the various communities and by unpaved roads used by the ACP for maintenance. These roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities because of the relatively isolated location of the project area.

In the Upper Rio Indio project area, towns of El Limon, El Silencio, San Cristobal, and Piedra Amarilla have elementary schools. Several towns have cemeteries, churches, and medical centers. All these towns obtain water from rivers or groundwater wells. Some have electricity (from small generators) and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it might eventually reach Rio Indio and its tributaries. Disposal of domestic waste is the responsibility of individual homeowners; each home has an outdoor latrine. There are some known health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses that are attributed to the present waste disposal methods. No known major industries or poultry or beef processing plants are located in the project area. The only roads in the project area are unpaved and poorly maintained, and are usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Due to the relatively isolated location of the project area, these roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities.

TERRESTRIAL HABITAT

The terrestrial habitat in the Lower Rio Trinidad project area portion of Gatun Lake consistss of tropical forest ecosystems, mostly secondary growth forests with large secondary growth and patches of primary forest. About 60-65 percent of the land along the Lower Rio Trinidad of Gatun Lake is forested and probably supportscovered with forests that could support diverse wildlife populations. The Lower Rio

Trinidad areas portion of Gatun Lake also contains islands inhabited by wildlife. Some of the wildlife species do not interact with species on the mainland; others migrate between the island and the mainland. The species interrelationships are of great interest to scientists studying tropical ecosystems. Slash and burn activities have opened tracts of land for farming and cattle grazing; however, the majority of the lakeshore is forested to the edge of the water. Terrestrial areas are used by migratory species as wintering, breeding, and feeding grounds. The complex and diverse tropical ecosystems offers habitats to connect a variety of wildlife communities and may provide critical habitats to many native species.

In the Upper Rio Indio project area, forests along the river, which supports diverse wildlife populations, covers about 90 percent of the lands along the river and its tributaries. The forests also extend to the mountainous areas above the Upper Rio Indio impoundment. As a result of slash and burn activities, there are no large contiguous tracts of forests at lower elevations in the impoundment.

ANIMALS ON ENDANGERED LIST

ANAM, Resolution 002-80 enacted on June 7, 1995 declared 33 mammals, 39 birds, and 11 reptiles and amphibians are in danger of becoming extinct in Panama. Although their presence has not been confirmed to date, some of the listed species of interest on the threatened list might be found in the project area. The manatee is an aquatic mammal known to inhabit Gatun Lake around the Barro Colorado Island; however, it has not been sighted in the project area.

AQUATIC HABITAT

Gatun Lake, one of the world's largest manmade lakes, was created during the construction of the Panama Canal. The lake's water depth and quality vary widely. Aquatic habitat ranges from inundated forests to clear waterthe water is clear in areas distant from the shipping lanes. The Lower Rio Trinidad areas portion of Gatun Lake provides habitat for a variety of wildlife species, both resident and migratory, for native or introduced fish, and other aquatic species.

Upper Rio Indio in the project area has characteristics typical of streams in mountainous regions. Its water is clean and cool, and its bottom ranges from sand to boulders, with numerous riffles, runs, and pools. Tributaries to Rio Indio include four major streams: Rio El Torno, Rio Uracillo, Rio Teria, and Rio Riacito, and 20 smaller streams. The river is approximately 16 km long, its width ranges from 3 m (in the dry season) to 10 m. The tributaries appear to support some fish communities; however, information about these communities is limited.

WETLANDS

Areas that contain hydric soils and hydrophytic plant communities, and that are subject to hydric conditions are termed wetlands. Wetlands occur in topographic areas where water remains pooled long enough to produce hydric soil conditions and wetland plant communities. Wetlands in the Lower Rio Trinidad project area consist ofare shallow water habitats and are lands subject to frequent flooding. Shallow water areas along the banks of the Lower Rio Trinidad area portion of Gatun Lake receive sunlight to a depth of approximately 1 m. Sunlight stimulates growth of submergent, emergent, or floating mats of aquatic vegetation. Wetlands in the project area are currently stressed due to excessive sediments, municipal waste, agricultural runoff, and other debris carried in the runoff.

Wetlands in the Rio Indio project area consist of forested riparian habitat and are limited by their relatively steep topography. The width of the riparian habitat within the impoundment area varies from approximately 5-50 meters. Approximately 90 percent of the streams both above and below the dam site along the Rio Indio and its tributaries are bordered by forested riparian habitat.

AIR QUALITY

Air quality in the project area is generally good, except during the slash and burn activities. At the end of the dry season in March or early April, areas of forest and secondary growth are burned and cleared for agricultural use. During this period, the air is filled with smoke and ash, which may be transported by winds to the Lower Rio Trinidad area of and Gatun Lake. Based on observations in the Rio Indio project area, approximately 10 percent (or 400 ha) of forested land is burned annually. Air quality monitoring has not been implemented within the project area.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

Barro Colorado Island is an international center for tropical research and one of the first biological reserves established in the Neotropics. From 1923 through 1940, a scientific committee of the U.S. National Academy of Sciences administered the biological reserve/laboratory. In 1940, by an Act of the United States Congress, the facility was renamed the Panama Canal Zone Biological Area, and in 1946, the responsibility for its maintenance was assigned to the Smithsonian Institution. With the Panama Canal Treaty Implementation in 1977, the island was granted the category of National Monument and to date it continues to be managed by the Smithsonian Institute. It should also be noted that most of the Atlantic region of Panama is within the interest and objectives of the Mesoamerican Biological Corridor, an international project to conserve biodiversity.

In the pre-Columbian period, Rio Indio was a language frontier; the inhabitants on each side of the river spoke a different native language. During the Spanish colonial period, the river served as a political boundary. The project area has a high potential to be rich in archaeological and historical remains.

Environmental Impacts

TERRESTRIAL HABITAT

The impacts of the project on the terrestrial habitat in the Lower Rio Trinidad area portion of Gatun Lake could be substantial. The boundary between two types of habitats, in this case between a forest and a lake, is called an ecotone. Ecotones are inhabited by a mixture variety of species from the neighboring habitats, but and are unique, with high species diversity. Considering the proposed operating levels for both impoundments, between 22.9 - 33.5 m, as the normal zone of operation, there may be substantial erosion of the shoreline as pool levels rise and fall. Terrestrial habitats that would be inundated above the 26.7 m (existing level) to the 33.5 m proposed normal pool level consists of 21,912 ha for the Lower Rio Trinidad project. The placement of a dam structure, access roads and pump stations would permanently impact terrestrial habitat. Wildlife species that are able to relocate to suitable areas will compete with similar species for resources; species that are not able to relocate will not survive. As a result, competition for natural resources in surrounding habitat areas will increase. This is considered a secondary impact to terrestrial habitat outside the proposed zone of inundation and construction. Permanently raising of the Lower Rio Trinidad could impact the wildlife habitat of the project area.

The terrestrial impacts of the Rio Indio project, which is located in area of relatively high quality forest habitat, would be substantial. With the creation of the lake, the migratory routes of some species could be adversely affected. Forested areas along lower elevations would be lost as a result of the impoundment. The only forests that would remain near the Upper Rio Indio reservoir and its drainage basin would be found in higher elevations, where the vegetation and species may be completely different from those found on lower elevations. Natural communities are linked together by complex interactions and relationships among various species, therefore impacts to upper forested areas may occur due to the inundation of the lower forests.

ANIMALS ON ENDANGERED LIST

The severity of impacts on endangered species cannot be determined at this time, because although it is expected that some of the listed species may be found in the region, it is not known which of the listed species inhabit the proposed project area. Some endangered and/or threatened species may use the Lower Rio Trinidad area portion of Gatun Lake during some or all parts of their life cycle.

WATER QUANTITY

The impacts of the Lower Rio Trinidad project on water quantity would be substantial. The increase in the volume of water could have negative impacts to lakeshore communities as well as on existing ecosystems. The same is true if the lake level is lowered and maintained at 22.9 m.

The impacts of the Upper Rio Indio project area on water quality would also be substantial. The volume of water will increase, making fresh water available in the surrounding areas during the dry season. The impacts downstream from the dam would be significant. Sediment loads would be deposited upstream from the dam as water velocity slows. Water from the dam would be released at an increased velocity, which could cause erosion of banks and river bottoms. Seasonal flooding could be significantly reduced. Also, periodically releasing water, in appropriate amounts, would avoid problems with water quality and temperature downstream. The cumulative impact downstream from the dam site depends on the amount of water being released.

WATER QUALITY

Project impacts on water quality are not known. Damming the Lower Rio Trinidad could increase the amounts of nutrients and debris in this portion of Gatun Lake. A pilot plant tilapia farm is in the project area and may affect water quality. The rate nutrients and debris enter the lake will determine the severity of the impact on water quality. Project implementation could cause an increase in turbidity, which would interfere with photosynthesis and deprive plants and other aquatic species from sunlight. Aquatic plants and organisms serve to maintain water quality. The dam would interfere with the circulation of freshwater throughout the Gatun Lake environment. Species inhabiting specific depths could be impacted when lake depth increases to 33.5 m and/or decreases to 22.9 m.

The impacts of the Rio Indio project on water quality could be positive. The people living downstream from the dam and around the impoundment would have access to a water supply of higher quality. Water quality in the impoundment area would differ from water released downstream from the dam. If the water in the impoundment area does not circulate or turn over periodically, it could become anoxic. A change in temperature, dissolved oxygen, turbidity, or pH could change water quality.

DOWNSTREAM AQUATIC FAUNAL HABITAT

The impacts of the project on aquatic faunal habitat could be substantial. The project may affect the breeding and the nursery habitat of many aquatic species. Impacts to fish spawning areas may be detrimental when turbidity, nutrient content, and depth of the water suddenly increase or decrease, by altering the conditions needed for a successful hatching of the fishfish hatch. Plant populations may decrease as a result of fluctuating water depths, clarity, and quality. the increase in water depth and decrease in sunlight; therefore, iInvertebrate populations may decline, which could reduce the food supply for fish and other aquatic species.

Impacts to downstream aquatic faunal communities in the Upper Rio Indio project area could be substantial, because the dam structure will prevent their migration throughout the riverine habitat. The dam structure would be designed for multi-level releases to maintain a water level downstream from the dam site. The dam would act as a large sediment trap; the released water would have low turbidity, which could

result in better visibility and increased predation on the fish species. Aquatic faunal habitats downstream would be deprived of the beneficial nutrients and silts that were transported in the sediment. Native riverine fish species may be negatively impacted as a result of the project. The extent of the impact is not known.

FUTURE LAKE AQUATIC PLANT COMMUNITY

The impacts of the project on future aquatic plant communities depend on water quality and stability of water levels. Plant species in the Lower Rio Trinidad portion of Gatun Lake could be impacted by fluctuating water levels. the increase in water depth. Aquatic plant communities could be impacted during project implementation; however, they could re-establish after conditions stabilize.

The severity of impacts from the Upper Rio Indio project will depend on water level fluctuations. Since water levels are anticipated to fluctuate widely, large portions of the shores would be covered with mud, allowing neither aquatic nor terrestrial plants could thrive.

AQUATIC FAUNA INHABITING AFFECTED AREAS

The proposed project impacts could have some unavoidable, adverse environmental impacts on aquatic fauna in the Lower Rio Trinidad and associated rivers and tributaries. These impacts should be identified and minimized with appropriate mitigation measures (to be discussed in a feasibility level study). The impacts of the project on aquatic fauna inhabiting the Lower Rio Trinidad and the affected areas could be important. If aquatic faunas were able to thrive in the newly created reservoir, they would be beneficially affected by having their habitat enlarged. Some unavoidable, adverse environmental impacts could occur, these impacts should be identified, and appropriate mitigation measures addressed in feasibility level studies, should the alternative be recommended for further consideration. Gatun Lake has populations of peacock bass and tilapia, both introduced species that have adapted well. However, several native riverine species, which formerly occupied the impoundment, have disappeared.
The Lower Rio Trinidad project would also take part of Gatun Lake; therefore, the peacock bass and tilapia would already be present.

The impacts of the Upper Rio Indio project on aquatic fauna in the Rio Indio and its upstream tributaries could be substantial, since the habitat area would change from riverine to lacustrine. Some aquatic species would continue to inhabit the area; non-native fish species could become dominant in the impoundment area and native riverine species could be pushed upstream or extirpated. Other manmade lakes in the Republic of Panama have been stocked with peacock bass and tilapia. The impoundment area would probably be stocked with these species to promote sport fishing and to provide the local communities with fish for food.

WETLANDS

The impacts to wetlands could be significant. Inundation of wetlands could cause them to become aquatic habitat. The changes in water depth caused by the project may lead to increased or decreased sedimentation and turbidity, which could hamper the biological processes in the wetlands and decrease their productivity. Such impacts could be detrimental to the health and sustainability of the Lower Rio Trinidad area portion of Gatun Lake. Fish and other aquatic species use shallow water areas as spawning grounds, as well as habitat for juvenile aquatic species who survive in the shallow waters until large enough to venture into deeper water. These wetlands are vital to the sustainability of this portion of Gatun Lake, including the Lower Rio Trinidad area..

The impacts to wetlands both upstream and downstream from the Upper Rio Indio project area could be significant. Owing to the topography of the project area, a number of wetlands could be impacted. It is possible that although the reservoir level will fluctuate, new wetlands could develop in the littoral zones. Downstream from the dam site, wetlands along the minimal flow zone would survive; wetlands that depend on seasonal flooding for survival may be adversely affected.

AIR QUALITY

During project implementation, emissions from construction equipment, as well as from slash and burn activities, could cause deterioration of air quality. After project implementation, the air quality may be impacted by the operation of the power generation facility and the pumping stations.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

The potential impacts on cultural resources and historic properties from the Upper Rio Indio project can be defined and mitigated. In the La Boca de Uracillo area in particular, there are previously identified archaeological sites. The project area is relatively large and is known to contain pre-Columbian sites; therefore, the presence of cultural resources and historic properties is highly probable. Prior to construction, surveys to locate cultural resources and historic artifacts would be conducted, and the important sites would be preserved or salvaged as appropriate.

SOCIO-ECONOMIC IMPACTS

The socio-economic impacts of the project could be substantial. The relocation of the towns and other small communities along the lakeshore would be an important issue. The average monthly income of families in the project area ranges from less than $100 to $200 per month. No indigenous groups are known to reside in the impact area. Land use would be greatly impacted by the inundation of pastures and agricultural lands to expand the impoundment. The relocation of agricultural and ranching activities would be critical, because approximately 10 percent of the land in the impoundment area is used for farming and ranching. After the water level is raised, additional agricultural land could be lost as islands are created from isthmuses. The incremental surface area of the proposed lake is 7,712 ha; another 1,318 ha from the Lower Trinidad project and 634 ha from the Upper Rio Indio project will be occupied by the dam and construction areas including permanent disposal areas.

During construction, the influx of workers could create a temporary demand for additional housing, resulting in an increase in housing values near the dam site. However, after completion of the project, the workers could leave, the housing demands could drop, and the housing values could return to pre-construction levels. Currently, all residents have access to public schools and health centers. During construction, these services should continue to be available, and additional public and community services may be offered. After construction, these services would return to the normal level.

To construct the dam, some existing roads must be improved and some new roads must be built. However, some paved and unpaved roads within the impoundment area would be eliminated, which could change traffic patterns and could cause some communities to lose overland transportation, communication, cohesion, and commerce with other communities. During construction, the traffic volumes over both new and existing roads systems would increase; however, following completion of construction, the traffic volumes could decline. Noise levels would temporarily increase during construction and could negatively impact noise-sensitive receptors; after construction noise levels may remain elevated as a result of the power generation facility and pump stations.

Communities receiving people displaced by the project could be negatively impacted by overcrowding and by competition for jobs, land, and working areas. Construction of the dams would permanently displace some people and disrupt lives through the division of communities, separation of families, and loss of livelihood. Following completion of the impoundment, the tourism trade in the affected region, including sport fishing and ecotourism, could increase.

Additional Environmental Information Required

This section identifies the subject areas for which additional data are required to evaluate in further detail, the scope and magnitude of the potential effects of the Lower Rio Trinidad and Upper Rio Indio alternative. The subject areas are discussed by impact category.

SOCIO-ECONOMIC IMPACTS

Conduct a SIA. The SIA would consist of three tasks: scoping, assessment, and mitigation and monitoring. The following information should be developed:

- Business, Industrial, and Agricultural Activities;
- Employment;
- Land Use;
- Property Values;
- Public and Community Facilities and Services (including utilities and schools);
- Transportation;
- Housing;
- Health (vector routes);
- Population;
- Community Cohesion; and,
- Recreational Resources.

TERRESTRIAL AND AQUATIC HABITAT

- Prepare site-specific habitat maps to ensure that the major types of aquatic habitat are identified and quantified.
- Conduct field studies to locate rare and unique habitats, such as wetlands, primary forests, roosting sites, foraging areas, old growth, and migration flyways.
- Determine the present quality and ecosystem value of existing habitats within the Gatun Lake project area.
- Coordinate with local experts to identify and evaluate aquatic and terrestrial habitat areas.
- Prepare species inventory lists for each site area, identifying their status as native or exotic and whether they are threatened and or endangered species.
- Conduct additional research into water currents and estimated turbidity levels to evaluate impacts to the shallow areas along Barro Colorado Island.
- Address cumulative effects caused by natural flow diversions.

ANIMALS ON THE ENDANGERED LIST

- Compile habitat maps to assess the availability and quality of suitable habitats for the animals on the endangered and/or threatened species list.
- Establish field methodology to assess wildlife habitat values.
- Conduct site surveys to determine the presence of selected species or their habitats.
- Develop candidate mitigation measures for the appropriate project alternatives to be considered in the Conceptual Phase.
- Coordinate with local experts on the presence of endangered species.

WATER QUALITY

- Since limited water quality data are available for the Gatun Lake area, compile information on TSS, conductivity, TDS, dissolved oxygen, nutrients, pH, and coliform bacteria.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

- Information regarding cultural resources and historic properties in the project area is incomplete. Additional evaluation studies should be completed to identify any such resources and/or properties.

Evaluation Matrices

Table 43 - 1 Environmental Effects

Item	Measure [1]	Importance [2]	Composite [3]
Terrestrial Habitat	3	8	24
Animals on Extinction List	2	10	20
Water Quantity Impacts – Lake	8	10	80
Water Quantity Impacts -- Downstream	4	7	28
Water Quality	5	10	50
Downstream Aquatic Fauna Habitat	3	8	24
Future Lake Aquatic Plant Community	6	8	48
Aquatic Faunal Inhabiting Affected Area and Upstream Tributaries	4	5	20
Potential for Fishing on Lake	6	6	36
Wetlands	4	4	16
Air Quality	5	3	15
Cultural Resources and Historic Properties	3	10	30
Total			391

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

Table 43 - 2 Socio-Economic Effects

Item	Measure [1]	Importance [2]	Composite [3]
Land Use	1	7	7
Relocation of People	2	10	20
Relocation of Agricultural/Ranching Activities	2	6	12
Post-Construction Business	6	5	30
Post-Construction on Existing Employment	6	5	30
Property Values During Construction	7	4	28
Property Values Post-Construction	5	5	25
Public/Community Services During Construction	6	4	24
Public/Community Services Post-Construction	5	8	40
Traffic Volumes over Existing Roadway System During Construction	3	5	15
Traffic Volumes over New Roadway System Post-Construction	5	5	25
Noise-Sensitive Resources or Activities	4	4	16
Communities Receiving Displaced People	1	8	8
Community Cohesion	1	8	8
Tourism	6	5	30
Total			318

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

SECTION 44 – LOWER RIO TRINIDAD 22.9m to 33.5m, RIO CAN QUEBRADO 22.9m to 33.5m, RIO INDIO 50m to 80m

Socio-Economic Impacts

The description of the environmental setting is based on field observations made while conducting field reconnaissance throughout Gatun Lake, specifically the Lower Rio Trinidad and Rio Indio areas with ACP personnel. Autoridad Nacional del Ambiente (ANAM), ACP, Asociacion Nacional para la Conservacion de la Naturaleza (ANCON), Electrical Transmission Agency, Smithsonian Tropical Research Institute (STRI), and Directorate of Mineral Resources personnel were interviewed to gain information on site characteristics and potential activities that could affect the project. In addition, extrapolations of the 2000 census data were used, and a review of the Informe de Cobertura Boscosa 1992 were used to determine the extent of forest cover.

Environmental Setting

This alternative combines three projects, the Lower Rio Trinidad (lake level (22.9 - 33.5 m) with Rio Caño Quebrado (lake level 22.9 - 33.5 m), and Rio Indio (lake level 50 - 80 m). This project will provide additional storage of water for Gatun Lake and 24.41 additional lockages per day on a continual basis. The project area consists of 27,259 ha within Gatun Lake and 5,600 ha within the Rio Indio watershed. The area near Gatun Lake is sparsely populated and has topography of rolling hills, and low regions near Gatun Lake. Near Rio Indio, the area is sparsely populated with terrains consisting of steep hills, as well as coastal regions. The Lower Rio Trinidad, Rio Caño Quebrado, and Rio Indio are west of the Panama Canal and flow northward from the Continental Divide into Gatun Lake. The watershed above the Lower Rio Trinidad with Rio Caño Quebrado and the Rio Indio dam project covers approximately 1052 km^2 and 381 km^2 respectively. The incremental impoundment area, which covers approximately 23,355 ha, consists of approximately 50 percent of forested land, 30 percent of pasture land (used by ranchers), 10 percent of cropland, and 10 percent of newly slashed and burned land. Gatun Lake's normal pool level is 26.7 m. The lake level during field observations (August 2001) was approximately 25.4 m.

LAND USE

The Lower Rio Trinidad project area encompasses the southwestern portion of Gatun Lake and areas along its shores. The areas to be flooded or partially flooded include the town of Escobal (population – 1,653), Nuevo Provenir (population – 121), Cuipo (population – 249), Ciricito (population – 72), La Arenosa (population – 242), La Garterita (population – 138), La Gartera (population – 348), and a few small isolated establishments.

The Rio Caño Quebrado project proposes to maintain the impoundment at pool levels between 22.9 and 33.5 m. The normal pool level is 26.67 m. La Laguna (population 246) and Pueblo Nuevo (population 47) are the only towns on the Rio Caño Quebrado arm. The lake is also used for fishing, bathing, and transportation. Houses in La Laguna and Pueblo Nuevo are constructed of forest products and/or of concrete.

Some areas along the shores of the Lower Rio Trinidad and Rio Caño Quebrado have been deforested. Approximately 65 percent of the lakeshore areas are forested, mostly with secondary growth. Farms and ranches of various sizes, as well as teak and African mahogany plantations, occupy the remaining land.

Farm crops include maize, rice, beans, sugar, coffee, mangos, pineapples, and tobacco. Ranchers raise cows, horses, chickens, hogs, and tilapia. Some of the farmers and ranchers operate commercial enterprises, while others rely on cash crops and subsistence farming. No significant ore deposits or mineral resources are located along the Rio Caño Quebrado arm of Gatun Lake.

The Rio Indio project area is inhabited by about 2,300 people, residing in the towns of: Tres Hermanas (population – 200), Los Cedros (population – 80), El Coquillo (popoulation – 150), El Limon (population – 140), Los Uveros (population – 140), and La Boca de Uracillo (population – 110), and in approximately 30 smaller settlements. Downstream from the site, at El Limon, are 14 communities with a combined population of approximately 600. The largest of these is La Boca del Rio Indio, which has a population of more than 150.

Approximately 60 percent of the land in the project area is occupied by farms and ranches of various sizes as well as some teak plantations. Farm crops include maize, rice, beans, sugar, coffee, and tobacco. Ranches raise horses, cows, chickens, and hogs. Some of the farmers and ranchers run small commercial enterprises, or rely on cash crop and subsistence farming.

INFRASTRUCTURE

During site investigations in the Lower Rio Trinidad area, the town of Escobal was the largest settlement visited. Escobal has businesses, schools, churches, cemeteries, medical centers, residences, and paved roadways of good condition. A new and improved roadway (Highway 35) is adjacent to the project area near Escobal. Other establishments in the project area Nuevo Provenir; Cuipo; Ciricito; La Arenosa; La Garterita; La Gartera; and a few small isolated establishments have elementary schools, small cemeteries, churches and meeting centers, medical clinics, and a few small businesses (i.e. general stores). The towns and villages depend on Gatun Lake or groundwater wells for their potable water supply. Each community also had docks, small ports, and other boat access facilities. Goods are transported from one town to another by boat. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach the Lower Rio Trinidad portion of Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners; some homes have septic tanks, while others have an outdoor latrine (a hole in the ground). There are some health problems, such as hepatitis, dysentery, dermatitis, intestinal parasites, and respiratory illnesses, which are attributable to the present waste disposal methods. No major industries or meat processing plants are located in the project area. The project area is traversed by unpaved horseback riding trails that link the various communities and by unpaved roads used by the ACP for maintenance. These roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities because of the relatively isolated location of the project area.

In the Rio Caño Quebrado project area, La Laguna and Pueblo Nuevo have access to cemeteries, churches, and medical centers, and rely on Gatun Lake or groundwater wells for their drinking water supply. Most homes have electricity and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may reach Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners; some homes have a septic system or an outdoor latrine. There are some health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses that are attributed to the present waste disposal methods. No known major industries or meat processing plants are located in the project area. La Laguna is accessible by a poorly maintained unpaved road that is usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Pueblo Nuevo is accessible only by an unpaved trail. These roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities because of the relatively isolated location of the project area.

In the Rio Indio project area, the towns of El Limon, El Silencio, San Cristobal, and Piedra Amarilla have elementary schools. Several towns have cemeteries, churches, and medical centers. All these towns obtain water from rivers or groundwater wells. Some have electricity (from small generators) and limited

telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it might eventually reach Rio Indio and its tributaries. Disposal of domestic waste is the responsibility of individual homeowners; each home has an outdoor latrine. There are some known health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses which are attributed to the present waste disposal methods. No known major industries or meat processing plants are located in the project area. The only roads in the project area are unpaved and poorly maintained, and are usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. These roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities because of the relatively isolated location of the project area.

TERRESTRIAL HABITAT

The terrestrial habitat in the Lower Rio Trinidad and Rio Caño Quebrado project areas of Gatun Lake consists of tropical forest ecosystems, mostly secondary growth forests with patches of primary forest. About 65 percent of the lands along the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake are forested and supports diverse wildlife populations. This area of Gatun Lake also contains islands inhabited by wildlife. Some of the wildlife species do not interact with species on the mainland; others migrate between the island and the mainland. The species interrelationships are of great interest to scientists studying tropical ecosystems. Slash and burn activities have opened tracts of land for farming and cattle grazing. The majority of the lakeshore is forested to the edge of the water. Terrestrial areas are used by migratory species as wintering, breeding, and feeding grounds. The complex and diverse tropical ecosystems offer habitat to connect a variety of wildlife communities and may provide critical wildlife habitat to many native species.

In Rio Indio, ests along the river that could support diverse wildlife populations cover about 90 percent of the areas along the Rio Indio and its tributaries. The forests also extend to the mountainous areas above the Rio Indio impoundment. As a result of slash and burn activities, there are no large contiguous tracts of forests at lower elevations in the impoundment.

ANIMALS ON ENDANGERED LIST

ANAM, Resolution 002-80 enacted on June 7, 1995, declared 33 mammals, 39 birds, and 11 reptiles and amphibians are in danger of becoming extinct in Panama. Although their presence has not been confirmed to date, some of the listed species of interest on the threatened list might be found in the project area. The manatee is an aquatic mammal known to inhabit Gatun Lake around the Barro Colorado Island; however, it has not been sighted in the project area.

AQUATIC HABITAT

Gatun Lake, one of the world's largest manmade lakes, was created during the construction of the Panama Canal. The lake's water depth and quality vary widely. Aquatic habitat ranges from inundated forests to clear water in areas distant from shipping lanes. The Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake provide habitat for a variety of wildlife species, both resident and migratory, as well as for native or introduced fish, and other aquatic species.

Rio Indio in the project area has characteristics typical of streams in mountainous regions. Its water is clean and cool, and its bottom ranges from sand to boulders, with numerous riffles, runs, and pools. Tributaries to Rio Indio include four major streams: Rio El Torno, Rio Uracillo, Rio Teria, and Rio Riacito, and 20 smaller streams. The river is approximately 16 km long, its width ranges from 3 m (in the dry season) to 10 m. The tributaries appear to support some fish communities; however, information about these communities is limited.

WETLANDS

Areas that contain hydric soils and hydrophytic plant communities, and that are subject to hydric conditions are termed wetlands. Wetlands occur in topographic areas where water remains pooled long enough to produce hydric soil conditions and wetland plant communities. Wetlands in the Lower Rio Trinidad and Rio Caño Quebrado project areas consist of shallow water habitats and lands subject to frequent flooding. Shallow water areas along the banks of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake receive sunlight to a depth of approximately 1 m. Sunlight stimulates growth of submergent, emergent, or floating mats of aquatic vegetation. Wetlands in the project area are stressed due to excessive sediments, municipal waste, agricultural runoff, and other debris carried in the runoff.

Wetlands in the Rio Indio project area consist of forested riparian habitat and are limited by their relatively steep topography. The width of the riparian habitat within the impoundment area varies from approximately 5 - 50 m. Approximately 90 percent of the streams both above and below the dam site along the Rio Indio and its tributaries are bordered by forested riparian habitat.

AIR QUALITY

Air quality in the project area is generally good, except during the slash and burn activities. At the end of the dry season (in March or early April), areas of forest and secondary growth are burned and cleared for agricultural use. During this period, the air is filled with smoke and ash, which may be transported by winds to the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Based on observations in the Rio Indio project area, approximately 10 percent (or 400 hectares) of forested land is burned annually. Air quality monitoring has not been implemented within the project area.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

Barro Colorado Island is an international center for tropical research and one of the first biological reserves established in the Neotropics. From 1923 through 1940, a scientific committee of the U.S. National Academy of Sciences administered the biological reserve/laboratory. In 1940, by an Act of the United States Congress, the facility was renamed the Panama Canal Zone Biological Area, and in 1946, the responsibility for its maintenance was assigned to the Smithsonian Institution. With the Panama Canal Treaty Implementation in 1977, the island was granted the category of National Monument and to date it continues to be managed by the Smithsonian Institute. It should also be noted that most of the Atlantic region of Panama is within the interest and objectives of the Mesoamerican Biological Corridor, an international project to conserve biodiversity.

In the pre-Columbian period, Rio Indio was a language frontier; the inhabitants on each side of the river spoke a different native language. During the Spanish colonial period, the river served as a political boundary. The project area has a high potential to be rich in archaeological and historical remains.

Environmental Impacts

TERRESTRIAL HABITAT

The impacts of the project on terrestrial habitat in the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake could be substantial. The boundary between two types of habitats, in this case between a forest and a lake, is called an ecotone. Ecotones are inhabited by a variety of species from neighboring habitats, and are unique, with high species diversity. Considering the proposed operating levels for both impoundments, between 22.9 - 33.5 m as the normal zone of operation there may be substantial erosion of the shoreline as pool levels rise and fall. Terrestrial habitat that would be inundated above the 26.7 m (existing level) to the 30.5 m proposed normal pool level consists of 21,912 ha for the Lower Rio Trinidad

project. The permanent raising of the water level in Rio Caño Quebrado Lake will impact wildlife habitat as approximately 3,443 ha of additional land will be inundated. The placement of a dam structure, access roads and pump stations would permanently impact terrestrial habitat. Wildlife species that are able to relocate to suitable areas will compete with similar species for resources; species that are not able to relocate will not survive. As a result, competition for natural resources in surrounding habitat areas will increase. This is considered a secondary impact to terrestrial habitat outside the proposed zone of inundation and construction.

The terrestrial impacts of the Rio Indio project, which is located in area of relatively high quality forest habitat, would be substantial. With the creation of the lake, the migratory routes of some species could be adversely affected. Forested areas along lower elevations would be lost as a result of the impoundment. The only forests that would remain near the Rio Indio reservoir and its drainage basin would be confined to the higher elevations, where the vegetation and species may be completely different from those found at lower elevations. Natural communities are linked together by complex interactions and relationships among various species, therefore impacts to upper forested areas may occur resulting from the inundation of the lower forests.

ANIMALS ON ENDANGERED LIST

The severity of impacts on endangered species cannot be determined at this time, because although it is expected that some of the listed species are found in the region, it is not known which of the listed species inhabit the proposed project area. Some endangered and/or threatened species may use the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake during some or all parts of their life cycle.

WATER QUANTITY

The impacts of the Lower Rio Trinidad and Rio Caño Quebrado projects on water quantity would be substantial. The increase in the volume of water could have negative impacts to lakeshore communities as well as on existing ecosystems. The same is true if the lake level is lowered and maintained at 22.9 m.

The impacts of the Rio Indio project area on water quality would also be substantial. The volume of water will increase, making fresh water available during the dry season. The impacts downstream from the dam would be significant. Sediment loads would be deposited upstream from the dam as water velocity slows. Downstream from the dam the water will be released at an increased velocity, causing erosion of banks and river bottoms. Seasonal flooding could be significantly reduced. It would also be possible to periodically release water in appropriate amounts to avoid problems with water quality and temperature downstream. The cumulative impacts downstream from the dam site depend on the amount of water being released.

WATER QUALITY

Project impacts on water quality are not known. Damming the Lower Rio Trinidad and Rio Caño Quebrado could increase the amounts of nutrients and debris in this portion of Gatun Lake. A pilot plant tilapia farm is in the project area and may affect water quality. The rate nutrients and debris enter the lake will determine the severity of their impact on water quality. Project implementation could cause an increase in turbidity, which would interfere with photosynthesis and deprive plants and other aquatic species from sunlight. Aquatic plants and organisms serve to maintain water quality. The dam would interfere with the circulation of freshwater throughout the Gatun Lake environment. Species inhabiting specific depths could be impacted when the lake depth increases to 33.5 m and/or decreases to 22.9 m.

The impacts of the Rio Indio project on water quality could be positive. The people living downstream from the dam and around the impoundment would have access to a higher quality water supply. Water quality in the impoundment area would differ from water released downstream from the dam. If the water in the impoundment area does not circulate or turn over periodically, it could become anoxic. A change in temperature, dissolved oxygen, turbidity, or pH could change water quality.

DOWNSTREAM AQUATIC FAUNAL HABITAT

The impacts of the project on aquatic faunal habitat could be substantial. The project may affect the breeding and nursery habitat of many aquatic species. Impacts to fish spawning areas may be detrimental when turbidity, nutrient content, and depth of the water suddenly increase or decrease, by altering the conditions needed for successful fish hatching. Plant populations may decrease due to fluctuating water depths, clarity, and quality. Invertebrate populations may decline, which could reduce the food supply for fish and other aquatic species.

Impacts to downstream aquatic faunal communities in the Rio Indio project area could be substantial, because the dam structure will prevent migration throughout the riverine habitat. The dam structure would be designed for multi-level releases to maintain a water level downstream from the dam site. The dam would act as a large sediment trap; thus, the released water could have low turbidity, which could result in better visibility and increase predation on the fish species. Aquatic faunal habitats downstream would be deprived of the beneficial nutrients and silts that were transported in the sediment. Native riverine fish species may be negatively impacted as a result of the project; the extent of the impact is not known.

FUTURE LAKE AQUATIC PLANT COMMUNITY

The impact of the project on future aquatic plant communities depends on water quality and stability of water levels. Plant species in the Lower Rio Trinidad and Rio Caño Quebrado portions of Gatun Lake could be impacted by fluctuating water levels. Aquatic plant communities could be impacted during project implementation; however, they could re-establish after conditions stabilize.

The severity of impacts from the Rio Indio project will depend on water level fluctuations. Since water levels are anticipated to fluctuate widely, large portions of the shores would be covered with mud, allowing neither aquatic nor terrestrial plants could thrive.

AQUATIC FAUNA INHABITING AFFECTED AREAS

The proposed project could have some unavoidable, adverse environmental impacts on aquatic fauna in the Lower Rio Trinidad, Rio Caño Quebrado, and associated rivers and tributaries. These impacts should be identified and minimized with appropriate mitigation measures (to be discussed in a feasibility level study). Gatun Lake has populations of peacock bass and tilapia, both introduced species that have adapted well. However, several native riverine species that formerly occupied the impoundment have disappeared.

The impacts of the Rio Indio project on aquatic fauna could be substantial, since the habitat area would change from riverine to lacustrine. Some aquatic species would continue to inhabit the area; however, non-native fish species would become dominant in the impoundment area and native riverine species would be pushed upstream or extirpated. Other manmade lakes in the Republic of Panama have been stocked with peacock bass and tilapia, both of which have adapted well. The impoundment area would probably be stocked with these species to promote sport fishing and to provide the local communities with fish for food.

WETLANDS

The impacts to wetlands could be significant. Inundation of wetlands could cause them to become aquatic habitat. The changes in water depth caused by the project may lead to increased or decreased sedimentation and turbidity, which could hamper the biological processes in the wetlands and decrease their productivity. Such impacts could be detrimental to the health and sustainability of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Fish and other aquatic species use shallow water areas as spawning grounds, as well as habitat for juvenile aquatic species who survive in the shallows until large enough to venture into deeper water. These wetlands are vital to the sustainability of this portion of Gatun Lake, including the Lower Rio Trinidad and Rio Caño Quebrado areas.

The impacts to wetlands both upstream and downstream from the Rio Indio project area could be significant. Owing to the topography of the project area, a number of wetlands could be impacted. It is possible that although the reservoir level will fluctuate, new wetlands could develop in the littoral zones. Downstream from the dam site, wetlands along the minimal flow zone would survive; wetlands that depend on seasonal flooding for survival may be adversely affected.

AIR QUALITY

During project implementation, emissions from construction equipment, as well as from slash and burn activities, could cause deterioration of air quality. After project implementation, the air quality may be impacted by the operation of the power generation facility and the pumping stations.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

The potential impacts on cultural resources and historic properties from the Rio Indio project can be defined and mitigated. In the La Boca de Uracillo area in particular, there are previously identified archaeological sites. The project area is relatively large and is known to contain pre-Columbian sites; therefore, the presence of cultural resources and historic properties is highly probable. Prior to construction, surveys to locate cultural resources and historic artifacts would be conducted, and the important sites would be preserved or salvaged as appropriate.

SOCIO-ECONOMIC IMPACTS

The socio-economic impacts of the project could be substantial. The relocation of the towns and other small communities along the lakeshore would be an important issue. The average monthly income of families in the project area ranges from less than $100 to $200 per month. No indigenous groups are known to reside in the impact area. Land use would be greatly impacted by the inundation of pastures and agricultural lands to expand the impoundment. The relocation of agricultural and ranching activities would be critical, because approximately 10 percent of the land in the impoundment area is used for farming and ranching. After the water level is raised, additional agricultural land could be lost as islands are created from isthmuses. The incremental surface area of the proposed lake is 11,155 ha; another 1,504 ha from the Lower Trinidad Rio Caño Quebrado project and 760 ha from the Rio Indio project will be occupied by the dam and construction areas, including permanent disposal areas.

During construction, the influx of workers could create a temporary demand for additional housing, resulting in an increase in housing values near the dam site. However, after completion of the project, the workers could leave, the housing demands could drop, and the housing values could return to pre-construction levels. Currently, all residents have access to public schools and health centers. During construction, these services should continue to be available, and additional public and community services may be offered. After construction, these services would return to the normal level.

To construct the dam, some existing roads must be improved and some new roads must be built. However, some paved and unpaved roads within the impoundment area would be eliminated, which could change traffic patterns and could cause some communities to lose overland transportation, communication, cohesion, and commerce with other communities. During construction, the traffic volumes over both new and existing roads systems would increase; however, following completion of construction, the traffic volumes could decline. Noise levels would temporarily increase during construction and could negatively impact noise-sensitive receptors; after construction noise levels may remain elevated as a result of the power generation facility and pump stations.

Communities receiving people displaced by the project could be negatively impacted by overcrowding and by competition for jobs, land, and working areas. Construction of the dams would permanently displace some people and disrupt lives through the division of communities, separation of families, and loss of livelihood. Following completion of the impoundment, the tourism trade in the affected region, including sport fishing and ecotourism, could increase.

Additional Environmental Information Required

This section identifies the subject areas for which additional data are required to evaluate in further detail, the scope and magnitude of the potential effects of the Lower Rio Trinidad and Rio Indio alternative. The subject areas are discussed by impact category.

SOCIO-ECONOMIC IMPACTS

Conduct a SIA. The SIA would consist of three tasks: scoping, assessment, and mitigation and monitoring. The following information should be developed:

- Business, Industrial, and Agricultural Activities;
- Employment;
- Land Use;
- Property Values;
- Public and Community Facilities and Services (including utilities and schools);
- Transportation;
- Housing;
- Health (vector routes);
- Population;
- Community Cohesion; and,
- Recreational Resources.

TERRESTRIAL AND AQUATIC HABITAT

- Prepare site-specific habitat maps to ensure that the major types of aquatic habitat are identified and quantified.
- Conduct field studies to locate rare and unique habitats, such as wetlands, primary forests, roosting sites, foraging areas, old growth, and migration flyways.
- Determine the present quality and ecosystem value of existing habitats within the Gatun Lake project area.
- Coordinate with local experts to identify and evaluate aquatic and terrestrial habitat areas.
- Prepare species inventory lists for each site area, identifying their status as native or exotic and whether they are threatened and or endangered species.
- Conduct additional research into water currents and estimated turbidity levels to evaluate impacts to the shallow areas along Barro Colorado Island.
- Address cumulative effects caused by natural flow diversions.

ANIMALS ON THE ENDANGERED LIST

- Compile habitat maps to assess the availability and quality of suitable habitats for the animals on the endangered and/or threatened species list.
- Establish field methodology to assess wildlife habitat values.
- Conduct site surveys to determine the presence of selected species or their habitats.
- Develop candidate mitigation measures for the appropriate project alternatives to be considered in the Conceptual Phase.
- Coordinate with local experts on the presence of endangered species.

WATER QUALITY

- Since limited water quality data are available for the Gatun Lake area, compile information on total suspended solids, conductivity, total dissolved solids, dissolved oxygen, nutrients, pH, and coliform bacteria.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

- Information regarding cultural resources and historic properties in the project area is incomplete. Additional evaluation studies should be completed to identify any such resources and/or properties.

Evaluation Matrices

Table 44 - 1 Environmental Effects

Item	Measure [1]	Importance [2]	Composite [3]
Terrestrial Habitat	2	8	16
Animals on Extinction List	2	10	20
Water Quantity Impacts – Lake	8	10	80
Water Quantity Impacts -- Downstream	4	7	28
Water Quality	5	10	50
Downstream Aquatic Fauna Habitat	3	8	24
Future Lake Aquatic Plant Community	6	8	48
Aquatic Faunal Inhabiting Affected Area and Upstream Tributaries	4	5	20
Potential for Fishing on Lake	6	6	36
Wetlands	2	4	8
Air Quality	5	3	15
Cultural Resources and Historic Properties	3	10	30
Total			375

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

Table 44 - 2 Socio-Economic Effects

Item	Measure [1]	Importance [2]	Composite [3]
Land Use	2	7	14
Relocation of People	1	10	10
Relocation of Agricultural/Ranching Activities	1	6	6
Post-Construction Business	6	5	30
Post-Construction on Existing Employment	6	5	30
Property Values During Construction	7	4	28
Property Values Post-Construction	5	5	25
Public/Community Services During Construction	6	4	24
Public/Community Services Post-Construction	5	8	40
Traffic Volumes over Existing Roadway System During Construction	3	5	15
Traffic Volumes over New Roadway System Post-Construction	5	5	25
Noise-Sensitive Resources or Activities	4	4	16
Communities Receiving Displaced People	1	8	8
Community Cohesion	1	8	8
Tourism	6	5	30
Total			309

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

SECTION 45 – LOWER RIO TRINIDAD 22.9m to 33.5m, RIO CANO QUEBRADO 22.9m to 33.5m, UPPER RIO INDIO 50m

Socio-Economic Impacts

The description of the environmental setting is based on field observations made while conducting field reconnaissance throughout Gatun Lake, specifically the Lower Rio Trinidad, Rio Caño Quebrado, and Rio Indio areas in company with ACP personnel. Autoridad Nacional del Ambiente (ANAM), ACP, Asociacion Nacional para la Conservacion de la Naturaleza (ANCON), Electrical Transmission Agency, Smithsonian Tropical Research Institute (STRI), and Directorate of Mineral Resources personnel were interviewed to gain information on site characteristics and potential activities that could affect the project. In addition, extrapolations of the 2000 census data were used, and a review of the Informe de Cobertura Boscosa 1992 were used to determine the extent of forest cover.

Environmental Setting

This alternative combines three projects, the Lower Rio Trinidad (lake level 22.9 - 33.5 m) with Rio Caño Quebrado (lake level 22.9 - 33.5 m), and Upper Rio Indio (lake level 50 m). This project will provide additional storage of water for Gatun Lake and 15.44 additional lockages per day on a continual basis. The project area consists of 27,259 ha within Gatun Lake and 1,898 ha within the Rio Indio watershed. The area near Gatun Lake is sparsely populated and has a topography of rolling hills, and low regions near Gatun Lake. Near Rio Indio, the area is sparsely populated with a topography consisting of steep hills, as well as coastal regions. The Lower Rio Trinidad, Rio Caño Quebrado, and Upper Rio Indio are west of the Panama Canal and flow northward from the Continental Divide into Gatun Lake. The watershed above the Lower Rio Trinidad with Rio Caño Quebrado and the Upper Rio Indio the dam project covers approximately 1,052 km^2 and 256 km^2 respectively. The incremental impoundment area which covers approximately 11,155 ha consists of approximately 50 percent of forested land, 30 percent of pasture land (used by ranchers), 10 percent of cropland, and 10 percent of newly slashed and burned land. Gatun Lake's normal pool level is 26.7 m. The lake level during field observations (August 2001) was approximately 25.4 m.

LAND USE

The Lower Rio Trinidad project area encompasses the southwestern portion of Gatun Lake and areas along its shores. The areas to be flooded or partially flooded include the town of Escobal (population – 1,653), Nuevo Provenir (population – 121), Cuipo (population – 249), Ciricito (population – 72), La Arenosa (population – 242), La Garterita (population – 138), La Gartera (population – 348), and a few small isolated establishments.

The Rio Caño Quebrado project proposes to maintain the impoundment at pool levels between 22.9 and 33.5 m. The normal pool level is 26.67 m. La Laguna (population 246) and Pueblo Nuevo (population 47) are the only towns on the Rio Caño Quebrado arm. The lake is also used for fishing, bathing, and transportation. Houses in La Laguna and Pueblo Nuevo are constructed of forest products and/or of concrete.

Some areas along the shores of the Lower Rio Trinidad and Rio Caño Quebrado have been deforested. Approximately 65 percent of the lakeshore areas are forested, mostly with secondary growth. Farms and ranches of various sizes, as well as teak and African mahogany plantations, occupy the remaining land.

Farm crops include maize, rice, beans, sugar, coffee, mangos, pineapples, and tobacco. Ranchers raise cows, horses, chickens, hogs, and tilapia. Some of the farmers and ranchers operate commercial enterprises, others rely on cash crops and subsistence farming. No significant ore deposits or mineral resources are located along the Rio Caño Quebrado arm of Gatun Lake.

The Rio Indio project area is inhabited by about 2,300 people, residing in the towns of Tres Hermanas (population – 200), Los Cedros (population – 80), El Coquillo (popoulation – 150), El Limon (population – 140), Los Uveros (population – 140), and La Boca de Uracillo (population – 110), and in approximately 30 smaller settlements. Downstream from the dam site, at El Limon, are 14 communities with a combined population of approximately 600. The largest of these is La Boca del Rio Indio with a population of more than 150.

Approximately 60 percent of the land in the project area is occupied by farms and ranches of various sizes as well as some teak plantations. Farm crops include maize, rice, beans, sugar, coffee, and tobacco. Ranches raise horses, cows, chickens, and hogs. Some of the farmers and ranchers run small commercial enterprises, or rely on cash crop and subsistence farming.

INFRASTRUCTURE

During site investigations in the Lower Rio Trinidad area, the town of Escobal was the largest settlement visited. Escobal has businesses, schools, churches, cemeteries, medical centers, residences, and paved roadways of good condition. A new and improved roadway (Highway 35) is adjacent to the project area near Escobal. Other establishments in the project area Nuevo Provenir; Cuipo; Ciricito; La Arenosa; La Garterita; La Gartera; and a few small isolated establishments have elementary schools, small cemeteries, churches and meeting centers, medical clinics, and a few small businesses (i.e. general stores). The towns and villages depend on Gatun Lake or groundwater wells for their potable water supply. Each community also had docks, small ports, and other boat access facilities. Goods are transported from one town to another by boat. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may eventually reach the Lower Rio Trinidad portion of Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners; some homes have septic tanks, while others have an outdoor latrine (a hole in the ground). There are some health problems, such as hepatitis, dysentery, dermatitis, intestinal parasites, and respiratory illnesses, which are attributable to the present waste disposal methods. No major industries or meat processing plants are located in the project area. The project area is traversed by unpaved horseback riding trails that link the various communities and by unpaved roads used by the ACP for maintenance. These roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities because of the relatively isolated location of the project area.

In the Rio Caño Quebrado project area, La Laguna and Pueblo Nuevo have access to cemeteries, churches, and medical centers, and rely on Gatun Lake or groundwater wells for their drinking water supply. Most homes have electricity and limited telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it may reach Gatun Lake. Disposal of domestic waste is the responsibility of individual homeowners; some homes have a septic system or an outdoor latrine. There are some health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses that are attributed to the present waste disposal methods. No known major industries or meat processing plants are located in the project area. La Laguna is accessible by a poorly maintained unpaved road that is usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. Pueblo Nuevo is accessible only by an unpaved trail. These roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities because of the relatively isolated location of the project area.

In the Upper Rio Indio project area, the towns of El Limon, El Silencio, San Cristobal, and Piedra Amarilla have elementary schools. Several towns have cemeteries, churches, and medical centers. All these towns obtain water from rivers or groundwater wells. Some have electricity (from small generators) and limited

telephone service. No treatment of community waste is provided. Wastewater from showers and washing is discharged into the environment; some of it might eventually reach Rio Indio and its tributaries. Disposal of domestic waste is the responsibility of individual homeowners; each home has an outdoor latrine. There are some known health problems, such as hepatitis, diarrhea, dermatitis, intestinal parasites, and respiratory illnesses which are attributed to the present waste disposal methods. No known major industries or meat processing plants are located in the project area. The only roads in the project area are unpaved and poorly maintained, and are usable only in the dry season (mid-December through March). The roads are rarely graded and receive little attention from either the Ministry of Public Works or the local government. These roads are extremely important to the residents for transportation, community cohesion, commerce, and communication with neighboring communities because of the relatively isolated location of the project area.

TERRESTRIAL HABITAT

The terrestrial habitat in the Lower Rio Trinidad and Rio Caño Quebrado project areas of Gatun Lake consists of tropical forest ecosystems, mostly secondary growth forests with patches of primary forest. About 65 percent of the lands along the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake are forested and supports diverse wildlife populations. This area of Gatun Lake also contains islands inhabited by wildlife. Some of the wildlife species do not interact with species on the mainland; others migrate between the island and the mainland. The species interrelationships are of great interest to scientists studying tropical ecosystems. Slash and burn activities have opened tracts of land for farming and cattle grazing. The majority of the lakeshore is forested to the edge of the water. Terrestrial areas are used by migratory species as wintering, breeding, and feeding grounds. The complex and diverse tropical ecosystems offer habitat to connect a variety of wildlife communities and may provide critical wildlife habitat to many native species.

In Upper Rio Indio, forests along the river that could support diverse wildlife populations cover about 90 percent of the areas along the Rio Indio and its tributaries. The forests also extend to the mountainous areas above the Rio Indio impoundment. As a result of slash and burn activities, there are no large contiguous tracts of forests at lower elevations in the impoundment.

ANIMALS ON ENDANGERED LIST

ANAM, Resolution 002-80 enacted on June 7, 1995, declared 33 mammals, 39 birds, and 11 reptiles and amphibians are in danger of becoming extinct in Panama. Although their presence has not been confirmed to date, some of the listed species of interest on the threatened list might be found in the project area. The manatee is an aquatic mammal known to inhabit Gatun Lake around the Barro Colorado Island; however, it has not been sighted in the project area.

AQUATIC HABITAT

Gatun Lake, one of the world's largest manmade lakes, was created during the construction of the Panama Canal. The lake's water depth and quality vary widely. Aquatic habitat ranges from inundated forests to clear water in areas distant from shipping lanes. The Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake provide habitat for a variety of wildlife species, both resident and migratory, as well as for native or introduced fish, and other aquatic species.

Rio Indio in the project area has characteristics typical of streams in mountainous regions. Its water is clean and cool, and its bottom ranges from sand to boulders, with numerous riffles, runs, and pools. Tributaries to Rio Indio include four major streams: Rio El Torno, Rio Uracillo, Rio Teria, and Rio Riacito, and 20 smaller streams. The river is approximately 16 km long, its width ranges from 3 m (in the dry season) to 10 m. The tributaries appear to support some fish communities; however, information about these communities is limited.

WETLANDS

Areas that contain hydric soils and hydrophytic plant communities, and that are subject to hydric conditions are termed wetlands. Wetlands occur in topographic areas where water remains pooled long enough to produce hydric soil conditions and wetland plant communities. Wetlands in the Lower Rio Trinidad and Rio Caño Quebrado project areas consist of shallow water habitats and lands subject to frequent flooding. Shallow water areas along the banks of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake receive sunlight to a depth of approximately 1 m. Sunlight stimulates growth of submergent, emergent, or floating mats of aquatic vegetation. Wetlands in the project area are stressed due to excessive sediments, municipal waste, agricultural runoff, and other debris carried in the runoff.

Wetlands in the Upper Rio Indio project area consist of forested riparian habitat and are limited by their relatively steep topography. The width of the riparian habitat within the impoundment area varies from approximately 5 - 50 m. Approximately 90 percent of the streams both above and below the dam site along the Rio Indio and its tributaries are bordered by forested riparian habitat.

AIR QUALITY

Air quality in the project area is generally good, except during the slash and burn activities. At the end of the dry season (in March or early April), areas of forest and secondary growth are burned and cleared for agricultural use. During this period, the air is filled with smoke and ash, which may be transported by winds to the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Based on observations in the Rio Indio project area, approximately 10 percent (or 400 ha) of forested land is burned annually. Air quality monitoring has not been implemented within the project area.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

Barro Colorado Island is an international center for tropical research and one of the first biological reserves established in the Neotropics. From 1923 through 1940, a scientific committee of the U.S. National Academy of Sciences administered the biological reserve/laboratory. In 1940, by an Act of the United States Congress, the facility was renamed the Panama Canal Zone Biological Area, and in 1946, the responsibility for its maintenance was assigned to the Smithsonian Institution. With the Panama Canal Treaty Implementation in 1977, the island was granted the category of National Monument and to date it continues to be managed by the Smithsonian Institute. It should also be noted that most of the Atlantic region of Panama is within the interest and objectives of the Mesoamerican Biological Corridor, an international project to conserve biodiversity.

In the pre-Columbian period, the Upper Rio Indio was a language frontier; the inhabitants on each side of the river spoke a different native language. During the Spanish colonial period, the river served as a political boundary. The project area has a high potential to be rich in archaeological and historical remains.

Environmental Impacts

TERRESTRIAL HABITAT

The impacts of the project on terrestrial habitat in the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake could be substantial. The boundary between two types of habitats, in this case between a forest and a lake, is called an ecotone. Ecotones are inhabited by a variety of species from neighboring habitats, and are unique, with high species diversity. Considering the proposed operating levels for both impoundments, between 22.9 - 33.5 m, as the normal zone of operation, erosion of the shoreline may be substantial as pool levels rise and fall. Terrestrial habitat that would be inundated above the 26.7 m (existing level) to the 30.5 m proposed normal pool level consists of 21,912 ha for the Lower Rio Trinidad project. The permanent raising of the water level in Rio Caño Quebrado Lake will impact wildlife habitat

as approximately 3,443 ha of additional land will be inundated. The placement of a dam structure, access roads and pump stations would permanently impact terrestrial habitat. Wildlife species that are able to relocate to suitable areas will compete with similar species for resources; species that are not able to relocate will not survive. As a result, competition for natural resources in surrounding habitat areas will increase. This is considered a secondary impact to terrestrial habitat outside the proposed zone of inundation and construction.

The terrestrial impacts of the Rio Indio project, which is located in area of relatively high quality forest habitat, would be substantial. With the creation of the lake, the migratory routes of some species could be adversely affected. Forested areas along lower elevations would be lost as a result of the impoundment. The only forests that would remain near the Upper Rio Indio reservoir and its drainage basin would be confined to the higher elevations, where the vegetation and species may be completely different from those found at lower elevations. Natural communities are linked together by complex interactions and relationships among various species, therefore impacts to upper forested areas may occur resulting from the inundation of the lower forests.

ANIMALS ON ENDANGERED LIST

The severity of impacts on endangered species cannot be determined at this time, because although it is expected that some of the listed species are found in the region, it is not known which of the listed species inhabit the proposed project area. Some endangered and/or threatened species may use the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake during some or all parts of their life cycle.

WATER QUANTITY

The impacts of the Lower Rio Trinidad and Rio Caño Quebrado projects on water quantity would be substantial. The increase in the volume of water could have negative impacts to lakeshore communities, as well as on existing ecosystems. The same is true if the lake level is lowered and maintained at 22.9 m.

The impacts of the Rio Indio project area on water quality would also be substantial. The volume of water will increase, making fresh water available during the dry season. The impacts downstream from the dam would be significant. Sediment loads would be deposited upstream from the dam as water velocity slows. Downstream from the dam the water will be released at an increased velocity, causing erosion of banks and river bottoms. Seasonal flooding could be significantly reduced. It would also be possible to periodically release water in appropriate amounts to avoid problems with water quality and temperature downstream. The cumulative impacts downstream from the dam site depend on the amount of water being released.

WATER QUALITY

Project impacts on water quality are not known. Damming the Lower Rio Trinidad and Rio Caño Quebrado could increase the amounts of nutrients and debris in this portion of Gatun Lake. A pilot plant tilapia farm is in the project area and may affect water quality. The rate nutrients and debris enter the lake will determine the severity of their impact on water quality. Project implementation could cause an increase in turbidity, which would interfere with photosynthesis and deprive plants and other aquatic species from sunlight. Aquatic plants and organisms serve to maintain water quality. The dam would interfere with the circulation of freshwater throughout the Gatun Lake environment. Species inhabiting specific depths could be impacted when lake depth increases to 33.5 m and/or decreases to 22.9 m.

The impacts of the Upper Rio Indio project on water quality could be positive. The people living downstream from the dam and around the impoundment would have access to a higher quality water supply. Water quality in the impoundment area would differ from water released downstream from the dam. If the water in the impoundment area does not circulate, it could become anoxic. A change in temperature, dissolved oxygen, turbidity, or pH could change water quality.

DOWNSTREAM AQUATIC FAUNAL HABITAT

The impacts of the project on aquatic faunal habitat could be substantial. The project may affect the breeding and nursery habitat of many aquatic species. Impacts to fish spawning areas may be detrimental when turbidity, nutrient content, and depth of the water suddenly increase or decrease, altering the conditions needed for successful fish hatching. Plant populations may decrease due to fluctuating water depths, clarity, and quality. Invertebrate populations may decline, which could reduce the food supply for fish and other aquatic species.

Impacts to downstream aquatic faunal communities in the Upper Rio Indio project area could be substantial, because the dam structure will prevent migration throughout the riverine habitat. The dam structure would be designed for multi-level releases to maintain a water level downstream from the dam site. The dam would act as a large sediment trap; thus, the released water would have low turbidity, which would result in better visibility and increase predation on the fish species. Aquatic faunal habitats downstream would be deprived of the beneficial nutrients and silts that were transported in the sediment. Native riverine fish species may be negatively impacted as a result of the project; the extent of the impact is not known.

FUTURE LAKE AQUATIC PLANT COMMUNITY

The impacts of the project on future aquatic plant communities depend on water quality and stability of water levels. Plant species in the Lower Rio Trinidad and Rio Caño Quebrado portions of Gatun Lake could be impacted by fluctuating water levels. Aquatic plant communities could be impacted during project implementation; however, they could re-establish themselves after conditions stabilize.

The severity of impacts from the Upper Rio Indio project will depend on water level fluctuations. Since water levels are anticipated to fluctuate widely, large portions of the shores would be covered with mud, where neither aquatic nor terrestrial plants could thrive.

AQUATIC FAUNA INHABITING AFFECTED AREAS

The proposed project impacts could have some unavoidable, adverse environmental impacts on aquatic fauna in the Lower Rio Trinidad, Rio Caño Quebrado, and associated rivers and tributaries. These impacts should be identified and minimized with appropriate mitigation measures to be discussed in a feasibility level study. Gatun Lake has populations of peacock bass and tilapia, both introduced species that have adapted well. However, several native riverine species that formerly occupied the impoundment have disappeared.

The impacts of the Upper Rio Indio project on aquatic fauna in the Rio Indio and its upstream tributaries could be substantial, since the habitat area would change from riverine to lacustrine. Some aquatic species would continue to inhabit the area; non-native fish species could become dominant in the impoundment area and native riverine species could be pushed upstream or extirpated. Other manmade lakes in the Republic of Panama have been stocked with peacock bass and tilapia, both of which have adapted well. The impoundment area would probably be stocked with these species to promote sport fishing and to provide the local communities with fish for food.

WETLANDS

The impacts to wetlands could be significant. Inundation of wetlands could cause them to become aquatic habitat. The changes in water depth caused by the project may lead to increased or decreased sedimentation and turbidity, which could hamper the biological processes in the wetlands and decrease their productivity. Such impacts could be detrimental to the health and sustainability of the Lower Rio Trinidad and Rio Caño Quebrado areas of Gatun Lake. Fish and other aquatic species use shallow water areas as spawning grounds, as well as habitat for juvenile aquatic species who survive in the shallows until

large enough to venture into deeper water. These wetlands are vital to the sustainability of this portion of Gatun Lake, including the Lower Rio Trinidad and Rio Caño Quebrado areas.

The impacts to wetlands both upstream and downstream from the Upper Rio Indio project area could be significant. Owing to the topography of the project area, a number of wetlands could be impacted. It is possible that although the reservoir level will fluctuate, new wetlands could develop in the littoral zones. Downstream from the dam site, wetlands along the minimal flow zone would survive; wetlands that depend on seasonal flooding for survival may be adversely affected.

AIR QUALITY

During project implementation, emissions from construction equipment, as well as from slash and burn activities could cause deterioration of air quality. After project implementation, the air quality may be impacted by the operation of the power generation facility and the pumping stations.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

The potential impacts on cultural resources and historic properties from the Upper Rio Indio project can be defined and mitigated. In the La Boca de Uracillo area in particular, there are previously identified archaeological sites. The project area is relatively large and is known to contain pre-Columbian sites; therefore, the presence of cultural resources and historic properties is highly probable. Prior to construction, surveys to locate cultural resources and historic artifacts would be conducted, and the important sites would be preserved or salvaged as appropriate.

SOCIO-ECONOMIC IMPACTS

The socio-economic impacts of the project could be substantial. The relocation of the towns and other small communities along the lakeshore would be an important issue. The average monthly income of families in the project area ranges from less than $100 to $200 per month. No indigenous groups are known to reside in the impact area. Land use would be greatly impacted by the inundation of pastures and agricultural lands to expand the impoundment. The relocation of agricultural and ranching activities would be critical, because approximately 10 percent of the land in the impoundment area is used for farming and ranching. After the water level is raised, additional agricultural land could be lost as islands are created from isthmuses. The incremental surface area of the proposed lake is 11,155 ha; another 1,504 ha from the Lower Trinidad and Rio Caño Quebrado project and 634 ha from the Upper Rio Indio project will be occupied by the dam and construction areas, including permanent disposal areas.

During construction, the influx of workers could create a temporary demand for additional housing, resulting in an increase in housing values near the dam site. However, after completion of the project, the workers could leave, the housing demands could drop, and the housing values could return to pre-construction levels. Currently, all residents have access to public schools and health centers. During construction, these services should continue to be available, and additional public and community services may be offered. After construction, these services would return to the normal level.

To construct the dam, some existing roads must be improved and some new roads must be built. However, some paved and unpaved roads within the impoundment area would be eliminated, which could change traffic patterns and could cause some communities to lose overland transportation, communication, cohesion, and commerce with other communities. During construction, the traffic volumes over both new and existing roads systems would increase; however, following completion of construction, the traffic volumes could decline. Noise levels would temporarily increase during construction and could negatively impact noise-sensitive receptors; after construction noise levels may remain elevated as a result of the power generation facility and pump stations.

Communities receiving people displaced by the project could be negatively impacted by overcrowding and by competition for jobs, land, and working areas. Construction of the dams would permanently displace some people and disrupt lives through the division of communities, separation of families, and loss of livelihood. Following completion of the impoundment, the tourism trade in the affected region, including sport fishing and ecotourism, could increase.

Additional Environmental Information Required

This section identifies the subject areas which require additional data to the scope and magnitude of the potential effects of the Lower Rio Trinidad, Rio Caño Quebrado, and Upper Rio Indio alternative. The subject areas are discussed by impact category.

SOCIO-ECONOMIC IMPACTS

Conduct a SIA. The SIA would consist of three tasks: scoping, assessment, mitigation and monitoring. The following information should be developed:

- Business, Industrial, and Agricultural Activities;
- Employment;
- Land Use;
- Property Values;
- Public and Community Facilities and Services (including utilities and schools);
- Transportation;
- Housing;
- Health (vector routes);
- Population;
- Community Cohesion; and,
- Recreational Resources.

TERRESTRIAL AND AQUATIC HABITAT

- Prepare site-specific habitat maps to ensure that the major types of aquatic habitat are identified and quantified.
- Conduct field studies to locate rare and unique habitats, such as wetlands, primary forests, roosting sites, foraging areas, old growth, and migration flyways.
- Determine the present quality and ecosystem value of existing habitats within the Gatun Lake project area.
- Coordinate with local experts to identify and evaluate aquatic and terrestrial habitat areas.
- Prepare species inventory lists for each site area, identifying their status as native or exotic and whether they are threatened and or endangered species.
- Conduct additional research into water currents and estimated turbidity levels to evaluate impacts to the shallow areas along Barro Colorado Island.
- Address cumulative effects caused by natural flow diversions.

ANIMALS ON THE ENDANGERED LIST

- Compile habitat maps to assess the availability and quality of suitable habitats for the animals on the endangered and/or threatened species list.
- Establish field methodology to assess wildlife habitat values.
- Conduct site surveys to determine the presence of selected species or their habitats.

- Develop candidate mitigation measures for the appropriate project alternatives to be considered in the Conceptual Phase.
- Coordinate with local experts on the presence of endangered species.

WATER QUALITY

- Since limited water quality data are available for the Gatun Lake area, compile information on total suspended solids, conductivity, total dissolved solids, dissolved oxygen, nutrients, pH, and coliform bacteria.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

- Information regarding cultural resources and historic properties in the project area is incomplete. Additional evaluation studies should be completed to identify any such resources and/or properties.

Evaluation Matrices

Table 45 - 1 Environmental Effects

Item	Measure [1]	Importance [2]	Composite [3]
Terrestrial Habitat	2	8	16
Animals on Extinction List	2	10	20
Water Quantity Impacts – Lake	8	10	80
Water Quantity Impacts -- Downstream	4	7	28
Water Quality	5	10	50
Downstream Aquatic Fauna Habitat	3	8	24
Future Lake Aquatic Plant Community	6	8	48
Aquatic Faunal Inhabiting Affected Area and Upstream Tributaries	4	5	20
Potential for Fishing on Lake	6	6	36
Wetlands	3	4	12
Air Quality	5	3	15
Cultural Resources and Historic Properties	3	10	30
Total			379

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

Table 45 - 2 Socio-Economic Effects

Item	Measure [1]	Importance [2]	Composite [3]
Land Use	2	7	14
Relocation of People	1	10	10
Relocation of Agricultural/Ranching Activities	1	6	6
Post-Construction Business	6	5	30
Post-Construction on Existing Employment	6	5	30
Property Values During Construction	7	4	28
Property Values Post-Construction	5	5	25
Public/Community Services During Construction	6	4	24
Public/Community Services Post-Construction	5	8	40
Traffic Volumes over Existing Roadway System During Construction	3	5	15
Traffic Volumes over New Roadway System Post-Construction	5	5	25
Noise-Sensitive Resources or Activities	4	4	16
Communities Receiving Displaced People	1	8	8
Community Cohesion	1	8	8
Tourism	6	5	30
Total			309

[1] Measure: 1 to 4 = negative impacts; 5 = neutral; 6 to 10 positive impacts.
[2] Importance - 1 to 10 increasing in importance.
[3] Composite - the product of the measure and importance.

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Black & Veatch Special Projects Corp.

September 17, 2002

Panama Canal Authority
Canal Capacity Projects Office
Building 714 Balboa, Panama

Attention: Ms. Hortensia Broce

Subject: Contract No. CC-3-544- FMCM (5)
Architectural and Engineering
Services for Environmental Services
and Related Responsibilities

Dear Hortensia:

We are pleased to submit our Final Report for the Environmental Evaluation of Selected Water Supply Projects for the Canal Capacity Study (Task Order 0002) under contract CC-3-544.

We look forward to continuing our relationship with the Panama Canal Authority on this project. Should you have questions or require additional information please call me at (913) 458-6665 or Ray Herzog at (913) 458-6600.

Very truly yours

Black & Veatch Special Projects

Todd Dudley

Todd Dudley, P.E.
Senior Chemical Engineer

CC: File