Final Report of the Commission for the Study of Alternatives to the Panama Canal

Volume XIX

Analysis of Impact Upon Panama

1993

A COMPONENT STUDY FOR THE STUDY OF THE ALTERNATIVES TO THE PANAMA CANAL

Comisión de Estudio
de las Alternativas
al Canal de Panamá
CENTRO DE INFORMACION

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FINAL REPORT

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COMPONENT STUDY

ANALYSIS OF IMPACTS UPON PANAMA

COMISION DE ESTUDIO
DE LAS ALTERNATIVAS
AL CANAL DE PANAMA
16 JUL. 1993

VOLUME II

SUBMITTED TO:

Commission for the Study of Alternatives to the Panama Canal

16 July 1993

SUBMITTED BY:

Booz•Allen & Hamilton, Inc.

COMPONENT STUDY IMPACT UPON PANAMA

FINAL REPORT

TABLE OF CONTENTS FOR VOLUME II

IV. POLITICAL IMPACT

4.0	Introduction	IV-1
4.1	Assumptions	IV-2
4.2	Methodology	IV-3
4.3	Identification of Impacts	IV-5
4.4	Current Situation	IV-7
4.5	Analysis of Political Impacts	IV-11

V. ENVIRONMENTAL IMPACT AND AND IMPACT ON THE GEOGRAPHY

5.0	Introduction	V-1
5.1	Assumptions	V-2
5.2	Methodology	V-3
5.3	Identification and Analysis of Environmental and Geographic Impacts	V-6
5.4	Findings	V-10
5.5	Conclusions	V-34

COMPONENT STUDY IMPACT UPON PANAMA

FINAL REPORT

TABLE OF CONTENTS CONTINUED

VI. INFRASTRUCTURE IMPACT

6.0	Introduction	VI-1
6.1	Assumptions	VI-2
6.2	Methodology	VI-5
6.3	Identification and Analysis of Impacts on Infrastructure	VI-6
6.4	Categories of Impacts	VI-27
6.5	Cost Estimates	VI-30
6.6	Conclusions	VI-42
6.7	Significant Findings and Conclusions	VI-45

VII. FINANCIAL IMPACT AND IMPACT OF THE EFFECTS ON USERS ON PANAMA

7.0	Introduction	VII-1
7.1	Methodology and Key Assumptions	VII-2
7.2	Financial Impacts on Panama	VII-4
7.3	Impacts on Panama of Impacts on Users	VII-11
7.4	Conclusions and Findings	VII-17

COMPONENT STUDY IMPACT UPON PANAMA

FINAL REPORT

TABLE OF CONTENTS CONTINUED

VIII. SYSTEM DYNAMICS MODEL RESULTS

8.0	Introduction	VIII-1
8.1	System Dynamics Methodology	VIII-1
8.2	Analysis of Panama and the Canal Alternatives	VIII-6
8.3	Findings	VIII-14
8.4	Conclusions	VIII- 28

IX. SUMMARY OF ASSUMPTIONS, CONCLUSIONS AND RECOMENDATIONS

9.0	Purpose	IX-1
9.1	Background	IX-1
9.2	Assumptions	IX-1
9.3	General Findings and Conclusions	IX-7
9.4	Conclusions and Recommendations	IX-24

COMPONENT STUDY IMPACT UPON PANAMA

FINAL REPORT

TABLE OF CONTENTS CONTINUED

APPENDIX A - BIBLIOGRAPHY

Bibliography - Economic Impact	Appendix A-1
Bibliography - Socio-Cultural Impact and Impact on Population	Appendix A-2
Bibliography - Political Impact	Appendix A-10
Bibliography - Environmental Impact and Impact on the Geography	Appendix A-14
Bibliography - Impacts Concerning Infrastructures	Appendix A-24
Bibliography - Financial Impact and Impact of the Effects on Users	Appendix A-26

APPENDIX B - BACKGROUND OF THE SYSTEM DYNAMICS MODEL APPLIED TO PANAMA

IV. POLITICAL IMPACT

4.0 INTRODUCTION

The history of Panama, as a colony of Spain, as a state of Colombia, and as an independent nation, is bound to the geography and location which made it first a land bridge and subsequently a waterway between the major oceans. In many ways it can be said that the common purpose of Panama is to provide for the world's interoceanic movement of goods. Built into its culture, built into the traditions of its population, is the idea that Panama is a conduit of world trade. Therefore, its political views and actions are in many ways subject to this position in the international scenario.

The independence of Panama from Colombia was at the roots of the project of building the Canal. The very identity of Panama as an independent nation, and as an important member of the world's nations, is tied to the Panama Canal. This identification with the Canal, coupled with centuries of tradition as an interoceanic conduit, creates a particular national identity relating to the Canal which is difficult to understand in terms of technical works. The Canal is not a shrine, but in the minds of the people it is a source of pride considered more as a national treasure than as a major work of infrastructure. Certain aspects of the Panama Canal concerning sovereignty may have been sources of internal and international disagreements in the past, but the safety of the Canal has never been threatened by the people of Panama.

The building of the Canal was a concern of the United States and later it was to manage, maintain and defend it. For Panamanians it was the building of a nation, under very hard conditions from many points of view: fiscal, economic, social, cultural, population, and others. At the same time, Panamanians had to face the very rapid growth of the capital city, from the small town of 30,000 people at the beginning of the century, to the Metropolitan area- 85% urban- of over 1,400,000 inhabitants. This Metro-city concentrates most of all the activities of the nation, industry, commerce, education and health facilities, etc., and has always been the seat of national government. It is the political scenario where the important decisions are taken. It's problem is essentially an urban phenomenon: high population growth due to migration, rapid urbanization and expansion, high density, contiguity of development, large groups of poor people in squatter areas, and many other situations not too different from those presented in other major cities of Latin America.

As Panama approaches the year 2000, and the time beyond to the building of one or the other of the alternatives for the Canal, the Canal alternative project will become a main concern for Panamanians, but *the Nation* and the *City* (take into account that 75% or more of total population in the country will be urban) will continue to be first priority too. It is interesting to add, that the administration of the present Canal has never had to concern itself with the problem of the Nation or the city, as the previous one never had problems of growth within the "Zone." Most of this situation should be attended by the proper use of the reverted areas. Nevertheless, there may exaggerated expectations regarding the millions that the present Canal and the new investments should provide to solve problems of economic development and social justice. *Nation, Canal, City,* are key words containing myriad situations that wait to be decided upon, about the political policies and other factors that may contribute to solve them.

In assessing the political impacts of the Canal alternatives, the idea that the enhancement of the current Canal is more than an economic or financial consideration must always be kept in mind. In this light, the enhancement of the current Canal through development of additional high rise locks within the traditional Canal area will be perceived and assessed by the Panamanian people as part of an on-going tradition and a continuity of the purpose and identity of the nation. On the other hand, enhancement of the current Canal's capabilities by digging a separate canal in a new area will most likely be considered in a more pragmatic view as another major infrastructure enterprise, and such an attitude would not necessarily ensure the same support in terms of national identity and common purpose of the population.

4.1 ASSUMPTIONS

In developing the political impacts of the Canal alternatives five assumptions were used. These assumptions are important for fully grasping the political impacts envisaged at the time of the mobilization for and the construction of either alternative.

4.1.1 Foreign administration and control over the current Canal is to terminate in the decade preceding the construction of either alternative. This will strengthen Panama's internal and external political structures and policies.

4.1.2 In twenty years after the restoration of democratic institutions in the country, the political system will be strengthened and so will Panama's position in any international negotiations.

4.1.3 The Government of Panama will take both legislative and administrative actions to ensure that procurement for project execution be open, not discriminatory. This implies that construction and financing costs will be the lowest possible.

4.1.4 Political decisions and arrangements for indemnification will be made by the Government of Panama prior to required relocation.

4.2 METHODOLOGY

The methodology used to determine the impacts of either Canal alternative, on the Panamanian political system included defining the scope of the analysis in terms of the political system, and developing the analysis in such manner that it would encompass the literature on every aspect of the project and the current situation concerning the Panamanian political system.

4.2.1 Scope

4.2.1.1 *Political System.* An analysis of the impacts on a political system requires an analysis of its institutions: the legal framework (the Constitution and the Laws); the administrative forms and structures (the governmental institutions that regulate the life of the people, that is: the Executive, the Legislative and the Judicial bodies); and the study of formal and informal channels of popular expression (political parties, syndicates, associations, popular movements, and other means).

4.2.1.2 *Political Stability.* The political stability of the State is important to the ability of a political regime's to manage its internal and external affairs. This stability is the most important internal and external indicator of the government's political legitimacy. Political legitimacy is defined here as an internal dynamic referring to the support given to a regime by the populace and the social institutions within a country, on the basis of traditions and idiosyncrasies as can be measured in terms of the political philosophy and consent, acceptance, opposition or revolt by the population perception of individual or collective convenience in the light of the degree to which a government is able to meet the social and economic needs of the country.[1]

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[1] Courtney E. Prisk, "The Umbrella of Legitimacy," Uncomfortable Wars, p.71.

individual or collective convenience in the light of the degree to which a government is able to meet the social and economic needs of the country.[1]

Using this definition, political stability is in direct relation with the capability of the administration of the State to meet social and economic needs and with the expectations of the population.

4.2.1.3 *Political Regime.* Another element to be taken into consideration is the political regime, which we define as the total sum of values (principles and collective goals on which there usually exists a workable degree of agreement within the community):

- The norms (the regulations that discipline the participation in political life),
- The structures of authority (the functions performed by legitimate rulers) typical of all political systems, and
- The values, among which the conscience of a common pursuit or national identity stands out, understood as the elements comprised in the sentiment of belonging to a socio-cultural entity.

4.2.2 Methodological Steps

Methodological steps which were taken to identify and to analyze the impacts of the two Canal alternative included the following:

4.2.2.1 Collection of data and available information, as well as discussions about available results obtained from other studies on the projected trends of growth of the population, and socio-cultural and political aspects.

4.2.2.2 Calculation of projections of population for the country, the Metropolitan Region and the project's region.

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[1] Courtney E. Prisk, "The Umbrella of Legitimacy," Uncomfortable Wars, p.71.

4.2.2.3 Determination of impacts according to the two alternatives for the new Canal, on the basis of historical trends, existing data and projections for the future.

4.2.2.4 A comparison with previous large interoceanic projects in Panama, with emphasis on the internal and international characteristics. These characteristics were analyzed for existing conditions as compared to the success or failure of negotiations surrounding the construction or the operation of the facilities.

4.3 IDENTIFICATION OF IMPACTS

4.3.1 Historical Political Trends

Panama's economy is not based on the agricultural sector or on the country's raw material resources; it is not similar to other Latin American Countries. Its main economic activity is connected with the tertiary sector of the economy. This characteristic dates from the Sixteenth century when the interests of the Spanish Crown imposed isthmian functions on Panama. During this period, the Isthmus served as a transit site and an exchange market for European merchandise shipped to the New World and for precious metals and raw materials sent to Europe. At the beginning of the Twentieth Century, this modality gave place to a second condition, represented by the Panama Canal and the economic activities linked to it. During the 1970s, under new constitutional and legal provisions, a third type of major economic activity was instituted in the form of an International Banking Center.

Throughout Panama's history, this service economy has been strongly dependent on the world's economy and world politics. The Metropolitan Region (or the Interoceanic Region) and the national identity have been determined by this dependency, giving origin to deep differences between two areas in the national territory: one that is the point of insertion of the country in the world's economy, the Metropolitan Region (22% of the country), and the rest of the country.

The political history of the Isthmus of Panama shows alternate periods of stability and instability which have affected the social structure. Periods of economic growth are always visible in Panama when any modernization of the Interoceanic pathway has been undertaken, particularly during construction. Post-construction periods have been related to instability and a decrease in economic growth with eventual slow recovery.

The political systems in force during the periods of construction and operation of each interoceanic modernization project over Panama's history provide a political context of similar or different characteristics, depending on the success or failure of the works. Since 1850, and up to the present, there have been three major construction efforts: the building of the railroad; the French Canal; and, the US.. Canal. Each has taken place within the context of bi-national negotiations. During the course of the study, the internal and international situation and the economy under which the negotiations were analyzed. We have also considered the actions taken by the respective governments for the construction agreements and the negotiations, the type of enterprise to execute the works, and the guarantees requested by the enterprise including the responses to their requests.

During the study, ten cases of international negotiations concerning interoceanic transit of goods through Panamanian sovereign territory were reviewed for commonalities.[2]

4.3.2 Of the ten cases analyzed, five had favorable results and five did not. Those cases which had favorable results appear to have coincided with the existence of national consensus on the terms of the negotiations; and with considerable international and internal economic and political stability. Those that did not produce positive results appear to have been subject to an instability either internal or international, lack of the national consensus or were perceived as charged with disfavorable economic and political consequences.

4.3.2.1 In the five positive cases, three conditions were consistently present in the successful negotiations and construction of the interoceanic transit facility. These characteristics were:

- National agreement and consensus support for the national government on the issue;
- National economic growth; and
- Either national or foreign supervision of the facility.

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[2] The ten cases were: (1) 1855, Colombia-United States,The Construction of the Railroad; (2) 1885, the digging of the French Canal; (3) 1902, Herran-Hay Treaty; (4) 1903 Treaty, the digging of the U.S. Canal; (5) 1926, Kellogg-Alfaro Treaty; (6) 1936, Arias-Roosevelt Treaty; (7) 1947, Filos-Hines Treaty; (8) 1955, Remon-Eisenhower Treaty; (9) 1964-67, Robles-Johnson Treaty; (10) 1977, Torrijos-Carter Treaty.

4.3.2.2 The five cases of failure which were considered have the common characteristics of:

- Lack of national acceptance or consensus,
- Worldwide economic instability, and
- National and international instability.

4.4 CURRENT SITUATION

Panama has undergone an intense period of transition to democratic rule after 20 years of military dictatorship. During those two decades, Panama's public debt rose to the extent that Panama now has one of the highest per capita debts in the world. This situation, coupled with the economic boycott that began in 1986, caused the economy to plunge to such an extent that it is still below real growth in the first months of 1986. With this as a background, the new democratic Government of Panama is currently faced with formidable challenges such as international pressures to restructure an enormous public debt, a Constitution developed to support the military dictatorship, labor laws which are complex and burdensome to private business thus inhibiting investment, and reduced government financial capabilities for needed infrastructure maintenance and enhancement.

The Panamanian government has also been challenged with reconstructing the civil functions of government and the political system in a period of extensive changes such as the reversion of U.S. military bases and the Panama Canal which require decision and action on delicate issues. The capacity to accommodate these changes, while instituting structural reforms and overcoming the economic legacy of the military regime, is one of the elements which were taken into consideration in the process of identifying and analyzing the political impacts of either Canal alternative.

4.4.1 The Legal Framework (the Constitution and the Laws)

It is understood that there will be changes in current laws and amendments to the Constitution prior to the start of final design and construction of a Canal alternative. The number of legal areas which could be affected by the Canal alternatives are numerous. There are five legal areas identified during this study which will require political attention and changes, once the decision has been made, and prior to the mobilization for construction.

4.4.1.1 *Migratory Laws and Labor Codes.* Both alternatives require the importation of foreign labor to complete the construction phase. The numbers of workers required means that there will be an obvious influx and the Panamanian work force, at the very least, will perceive it as a threat. Contracting foreigners for the construction will require changes in immigration laws (policies of repatriation), in the labor code, in aspects of the social security system, and also in legislation passed in order to implement international agreements over penal and judicial issues.

4.4.1.2 *Protective Tariffs.* Panama has enacted very strong protective tariffs in regulating the importation of goods and materials. In order to construct either alternative, it will be necessary for the Government of Panama to take both legislative and administrative actions in order to allow for material related to the construction and operation of the Canal to be purchased through a procurement system that is open and not discriminatory. This implies that construction and financing costs will be the lowest possible, due to project requirements.

4.4.1.3 *Relocation of People.* Legal considerations and means for indemnification and payment will have to be put in place prior to the start of construction for either alternative. This problem would be significant with the selection of the Sea Level Canal. With the selection of the High-Rise Lock Canal alternative, relocation will be minimal; but, even if only a small concentration of population is to be relocated, political decisions and legal procedures will have to be made concerning the ways to proceed with the relocation of the people and their livelihood.

4.4.1.4 *Guarantees.* The financing of either of the Canal alternatives will require some type of Government guarantee. The significance and the magnitude of the guarantee would be greater with the Sea Level Canal. Guarantees of the magnitude envisioned will require political decisions, negotiations and possible changes to legislation in order to be possible.

4.4.1.5 *Treaties.* The Neutrality Treaty (including the De Concini Amendment) and the Treaty of Monteria directly affect considerations of the Canal alternatives.

Under the Neutrality Treaty it is Panama responsibility to protect and defend the Canal. This treaty ratified on July 15, 1978, places Panama in the obligation of providing for the defense and the protection of the Canal with its own forces, and it expressly rules out any military installations of any foreign power. This requirement may be significant in the case of the Sea Level Canal, which would

require more forces and sophisticated and expensive equipment to protect, being in a more remote area. That with the concurrent requirement of defense and protection for the current Canal with greater distances for movement and surveillance, make the problem rather abstruse since the area to be protected and controlled is doubled or tripled.

The Treaty of Monteria, signed by the Foreign Ministers of Panama and Colombia (Carlos Ozores Typaldos and Diego Uribe Vargas, respectively), on August 22, 1979 and ratified by the National Assembly on November 25, 1980, has a direct bearing on financial projections for the current Canal and on either of the alternatives selected. Panama's credit situation and the capacity to repay its financial obligations in general after the end of the joint administration can be substantially affected by the Treaty of Monteria insofar as projected figures of Canal revenues are concerned.

Even if the import of the pertinent parts in the text had not been fully understood at the time, it is obvious that the following extracts must be considered by the Government of Panama.

"...as long as the United States of America has the responsibility for the functioning of the Canal, it may grant to the Republic of Colombia transit through the Canal free of tolls for (Colombia's) its troops, vessels and materiel of war. Afterwards the Republic of Panama may grant to the Republics of Colombia and Costa Rica the right to transit free of tolls."

The above extract of Article I of the Treaty is subsequently qualified by the following recitals:

"As of midday, Panama time, of the 31st of December 1999, the Republic of Panama shall grant to the Republic of Colombia the following benefits:

1. Transit through the Canal for Colombia's natural and industrial products, free of any charge or dues with the exception of those which, on equal terms, are applied or may be applied to products and mail of the Republic of Panama.

2. Colombian nationals transiting through Panama's interoceanic waterway will do so free of tolls or taxes or contributions which are not applicable to Panamanian nationals, provided that they produce full proof of their nationality.

3. The Government of the Republic of Colombia may at all times transport through the Panama Canal its troops, its vessels and war matériel, without paying any tolls."

Taken to its extreme, Colombia can under this treaty create the largest merchant navy in the world and then through charter or direct use begin to move the bulk of current world shipping through the Canal without paying tolls.

4.4.2 The administrative structures of the government and how they are able to handle the projected population, how they are able to handle the forecasted economic situation, and how they are able to demonstrate their ability to manage the Canal will be extremely important to the management of the Canal, and provide an important element for consideration in selecting an alternative and encouraging international agencies to support the financing of the construction of either alternative.

4.4.2.1 *The Panama Canal Authority.* Panama has recently passed legislation to establish the Interoceanic Regional Authority. This Authority has been given the mandate and responsibility to develop the "Regional Plan for the Development of the Interoceanic Region" and to develop a "General Plan For The Use, Conservation And Development Of Canal Areas." The importance of this mandate is significant. The potential loss of over $400 Million a year in direct and indirect revenues of the Government of Panama (1993 figures) will be significant and will impact any future Panamanian capability to finance and guarantee major projects including either of the Canal alternatives. Similarly, the Government of Panama has recently contracted a study on the future management mode for the Panama Canal. Whether Panama selects the recommended management structure as proposed in the Nathan and Associates' "Financing Scheme, Financial Analysis and Management Arrangements" Component Study or the recommendations of their current study, is less of a concern than the ability of the Government to demonstrate serious and consistent development of capabilities to manage the Panama Canal as efficiently or in a more efficient manner than the current administration.

4.4.2.2 *Development of Social and Technical Infrastructure.* Given the projections of population growth, the current shortfalls in maintenance and development of technical infrastructure, the current needs and projected needs in social infrastructure, and the Government's currently forecasted abilities to meet the financial requirements of improvements, the Government of Panama faces serious challenges before consideration or selection of an alternative to expand the capacity of Panama

Canal. It is necessary for the purpose of the study to assume that Panama will be able to solve the social and technical infrastructure problems. It is also necessary to draw attention to the fact that politically, Panama will have to face and solve these problems, while at the same time taking actions to overcome a major loss of income from the US. military's departure and to develop sufficient monetary credentials to warrant international support for the Canal alternative selected.

4.4.3 The Formal and Informal Channels of Popular Expression

Historically, the Panama Canal has been, on one hand, an element of national cohesion and, on the other hand, both a source of confrontation and co-operation between Panama and the United States. Popular movements, more than political movements have been the social forces to lead both the cohesion and the confrontation. It should be noted that the Panamanian political parties and movements suffer from the structural weakness observed in other Central American countries. This weakness is the result of their scarce practice as channels of popular expression and legitimate representatives of the people's will.

When considering how the Government of Panama is to build a consensus for the selection and promotion of a Canal alternative, it must be understood that the current Canal is and will remain an important element of reference in terms of national identity . The ability of the Government to promote and gain consensus for improvement of "The Canal" will be one case. The ability of the Government to promote and gain consensus for what is perceived as "another canal" will be a totally different and separate case.

4.5 ANALYSIS OF POLITICAL IMPACTS

4.5.1 Direct Impacts

The announcement of activities for the construction of the canal will promote strong internal and external migration. This will cause a higher increase of the population than has been projected. In the same manner, more pressure will be placed on housing, public services, social security, and ordinary as well as administrative justice administration, all of which must be provided or

guaranteed by the Panamanian government. On the other hand, the urban labor market and the economic system will be stressed.

4.5.1.1 Panama's selection of a Canal alternative will have international political dimensions. The international momentum behind the Rio Conference on Environment and Development, the "Earth Summit," should be a factor in either decision. The possibility that the High Rise Lock Canal alternative disturbs some areas of rain forest will become an issue with such resonance that it will be the subject of debate. This debate will cause the Government of Panama to provide justification and scientific proof that it has weighed the consequence and can take measures to safeguard the environment.

Strictly from an environmental standpoint, if the Sea Level Canal alternative were selected, the potential negative political impact on Panama is much greater than that of the High-Rise Lock alternative. The Sea Level Canal may cause interoceanic transmigration of species, with unknown and incalculable change and possibly considerable damage to marine life in the Caribbean and the Pacific; it will disturb and reduce endemic habitat for endangered species; and it will create an additional barrier to rare species migration. Just the possibility that these situations can occur will capture the concern of almost every one of the more than 800 international non-governmental agencies concerned with environmental problems. The political pressure on the Government of Panama, from all of the Caribbean nations, worried about their coral reefs, is one anticipated reaction, which, ironically, may be of less consequence than the other anticipated reactions. International new coverage concerning the potential dangers (almost assured to be negative), coupled with anticipated activities from some groups such as Greenpeace, will place tremendous political pressure upon the Government of Panama. The potential for Panama being labeled as an enemy of the environment is very real.

The ability of Panama to justify its selection of the Sea Level Canal alternative, based on economic and financial criteria, may even be used to denounce it as evidence of the Government's indifference in the face of so many adverse effects, and made mock of in the negative reaction of the international environmental community. The ability to support the selection of the Sea Level Canal alternative in terms other than economic and financial will require extensive and costly studies at the end of which the perceptions of the dangers will most likely continue to exist.

4.5.1.2 *National Consensus.* The Government of Panama will be required to establish clearly define policies and build a national consensus among the social institutions and the people in support of Canal alternative construction issues prior to the final design phase or the start of construction. These include politically sensitive issues such as the public debt, foreign influence, foreign rights and responsibilities, and the import of a large number of foreign workers. Given the projection of increases in population and in the demand for social and technical infrastructure made without taking any canal alternative into consideration, the development of policies and the building of consensus could become a political problem and an impact stemming out of either alternative. It would be much more significant impact in the case of the Sea Level Canal on account of the expanded territory being assigned for the waterway and associated issues.

Contracting foreigners for the construction will require changes in immigration legislation (policies of repatriation), in the labor code, and in the social security system as well as legislation enacted in order to implement international agreements over penal matters and the administration of justice. This could be a very negative political impact if the government has not successfully prepared for such a requirement prior to the announcement of the decision, concerning the Canal alternative.

4.5.1.3 The extent of investments in the Canal project, and especially in the Sea Level Canal during almost two decades, will have a direct positive impact, if, at the same time, the rate of unemployment and underemployment is decreased by those investments.

4.5.1.4 *Sovereignty and Management of the Canal.* Given the fact that over 85% of current Canal employees are Panamanian, and given the positive actions which the Government of Panama is taking to structure the management of the current canal under a new authority established by the constitution, the impact of either alternative on the political structure's capability to manage the expanded canal will be the same. With the experience of twenty years of sovereign management of the current Canal, Panama will have demonstrated its ability to manage the international waterway. The international community will have a measure against which to calculate independent sovereign capabilities to manage the construction and operation of either alternative. However, internally, the degree of independent Panamanian control of the Canal alternative project, as it is perceived and understood by the populace, will have an impact on the stability of the political system and on the strength of national institutions. If it is perceived and understood that Panama has sovereign control

of the facility, a positive impact occurs. If it is perceived or understood that Panama does not have sovereign control of the Canal facilities, a significant negative impact occurs.

4.5.1.5 *Security and Security Forces.* There will be direct political impacts regarding expansion of the area in which the political system will be required to provide security and control. This will have a greater impact during the operations. The provision of security under the Neutrality Treaty, and the development of security forces required to provide security and control over the extended area encompassed by the current canal and either alternative could have a major negative political impact. This impact will be much greater in the case of the Sea Level Canal alternative. The additional security forces required to provide day-to-day security and protection services for the High-Rise Lock Canal alternative are minimal. The location of the new locks within the current Canal area means that additional personnel and facilities will be perceived as an addition to the current force of 900 persons. The Sea Level Canal alternative requirement of an additional 900 to 1000 persons is significant. Given Panama's experience with the 1968 coup and the two decades of military dictatorship, developing and training the larger number of armed personnel along with the sophisticated equipment needed to provide surveillance and to secure the separate Canal facility could create a destabilizing influence on the political system. The problem created by such additional security forces requires additional study.

4.5.1.6 There will be a direct political impact in terms of labor relations, if imported labor or Panamanian labor used during construction are not under the Panamanian labor code as it exists at the time of mobilization for construction.

4.5.2 Indirect Impacts

4.5.2.1 Relocation caused by either Canal alternative will cause an indirect political impact. The government will be required to create through legislation a means of indemnification and compensation, prior to the start of either alternative or this will be a major negative impact. The Sea Level Canal alternative will cause a significantly larger displacement of the population. From the socio-cultural and political viewpoint, it may be necessary and more feasible that some communities remain where they are.

4.5.2.2 In order to succeed in a major project such as the Canal alternative, the Government and the major political parties will need to form and continually support an independent authority vested, with sufficient power to manage the project without undue political influence. Given the history of Panamanian politics, this will be a major undertaking and will be definite indirect political impact of either canal alternative.

4.5.2.3 Beginning with the announcement of construction work for either Canal alternative, the Government will be required to plan and fund sufficient social and technical infrastructure expansion to decrease the level of perceived relative deprivation. While for purposes of the identification of infrastructure impacts, this study assumed that the Government would develop the required and planned infrastructure to meet the needs of an increase in population, without such planning and funding actions the Canal expansion will highlight and increase the associated problems, and therefore will have a negative impact on the political stability of the Government. This impact may be greater with the Sea Level Canal on account of the magnitude of the disruption.

4.5.2.4 Demographic indicators show that the increase in population in the Metropolitan Region will most likely produce an increased poverty, informal markets, and social pathologies. This will affect the public security system and the administration of justice. This impact may be more severe as pressures to expand the urban areas increase with the opening of significantly larger areas of the country should the Sea Level Canal be selected.

4.5.2.5 An important impact deals with the way the project, and how it is perceived by the population concerns the facilities and public services contained in the Engineering Report, such as schools, churches, health clinics and post offices. Each additional service must be addressed appropriately in the form of legislation, in terms of priorities and existing needs.

V. ENVIRONMENTAL IMPACT AND IMPACT ON THE GEOGRAPHY

5.0 INTRODUCTION

The opening of the Canal in 1914 turned Panama into an important crossroads for world maritime routes -- an event that has consolidated an economic structure where services, warehousing, and finances provided to the international economy are significant.

At present, the route connecting the eastern coast of North America (United States and Canada) with Asia, especially Japan -- and to a lesser degree with China, South Korea and Taiwan -- is most commonly used. This route accounts for 35.8% of the cargo passing through the Canal, which consists mainly of grain (corn, wheat, soy, etc.) and fertilizers.

The second route of importance is the return from the Far East to the eastern coast of the United States and Canada, where 9.7% of the cargo consists mostly of petroleum and petroleum products, containerized goods and machinery from Japan, China, Taiwan, South Korea and Indonesia, in that order.

The third important route is that connecting ports on the North American Pacific coast -- especially Canada -- with Europe, including The Netherlands, the United Kingdom and Belgium, in that order. This route is mainly used for petroleum and coal.

In sum, the cargo flow from the Caribbean to the Pacific through the Canal is the most important, amounting to 58.2% of the total. In order of importance, the merchandise consists of grain (19.7%), petroleum and petroleum products (9.4%) , ores and metals (6.9%), and lumber and wood products (6.2%). The total cargo transiting annually amounts to 160,000,000 long tons.

Immediate future predictions show relatively few changes[1]. Cargo tonnage could increase to 220,000,000 by the year 2010, a 31.2% increase in 18 years with little change in its composition, except for some increase in

[1]Wainio, Richard A. "Perspectivas del Canal ante el comercio internacional", Executive Planning Office, Panama Canal Commission, Panama, April 5, 1993 .

petroleum. These figures were provided by the Panama Canal Commission and are considered to be more realistic as to transit projections.

Slight changes in volume and composition will increase the number of user ships and their average capacity. The number of Panamax ships, the largest that the Canal can accommodate, will increase and will represent one-third of the transits by the year 2010, up from the current one-fourth.

The construction period for a new Canal will not bring about considerable changes in user patterns. Nevertheless, there will be a temporary increase in the international flow of materials and machinery, equipment and manufactured products to Panama for use in construction and in direct proportion to the investments during a period of 10.5 years.

5.1 ASSUMPTIONS

5.1.1 General Assumptions

5.1.1.1 The scope of the Environmental and Geographic Impacts section in this analysis includes ecology and related geography only. Therefore, infrastructure and population elements are to be dealt with as transforming agents.

5.1.1.2 Both of the proposed alternatives, the Sea Level Canal or the High-Rise Lock Canal, will generate major impacts on Panama due to the extent and costs of environmental projects and studies required.

5.1.1.3 The ecology of the Metropolitan Area shows a delicate balance and a concentrated development process as well. Due to the close relationship between a strong climactic activity, net hydrographic density, and soils that are very vulnerable to erosion, a considerable disturbance of the environment could endanger the biodiversity and natural resources.

5.1.2 Specific Assumptions

5.1.2.1 An acceleration of the growth rate of the Metropolitan Region has been anticipated if a Canal

alternative project is not selected. This will add stress to Canal excavation work and security requirements during Canal operation, and may strongly affect the geographic environment and the ecosystem.

5.1.2.2 An environment thus disturbed by economic polarization and the construction of the Canal could affect the existing waterway. The Sea Level Canal could be a source of oceanographic, geomorphologic and especially hydrological problems. These impacts could threaten the entire system of the current Canal.

5.1.2.3 The problem of marine life transmigration between the Pacific Ocean and the Caribbean Sea caused by a Sea Level Canal would bring about serious consequences for Panama and the world in general, in terms of a major alteration of the oceanic and coastal marine environment.

5.1.2.4 A variation in the tropical environment and larger demographic concentrations could maintain or reactivate known epidemics, such as cholera, dengue, yellow fever, malaria, Chagas disease, leishmaniasis, rabies, meningitis and other contagious diseases.

5.2 METHODOLOGY

The study of the various components of the selected Canal alternatives was the departure point for the Geographic and Environmental Impacts upon Panama. This was followed by collection and interpretation of existing documents, the discussion of the effects of such projects, and final identification and evaluation of construction and operation impacts of a Sea Level Canal (Route 10) and a High-Rise Lock Canal. The methodological steps were as follows:

5.2.1 Identification of the geographic, environmental and technical aspects of the selected alternatives through the analysis of recent engineering reports (February 1993 and April 1993), taking into consideration the maps available at 1:100,000 scale.

5.2.2 Estimate of the scale on which geographic and environmental impacts could occur as a result of project implementation and operation of facilitiesz:

5.2.2.1 *International Scale.* Impacts on environment (land and sea) in connection with Panama's geographic position.
5.2.2.2 *National Scale.* Impact within the Republic of Panama, including land, freshwater sources and marine spaces.
5.2.2.3 *Regional Scale.* Impacts within the Metropolitan Region of Panama and Colon, which has been officially defined by the Ministry of Planning and Economy Policy (MIPPE) and adopted by the Bureau of Statistics.
5.2.2.4 *Local Scale.* Impacts on adjacent areas

5.2.3 Infrastructure representations of both projects, proposed by Yachiyo Engineering Co., as well as the possible geographic transformation, were overlayed on 1:50,000-scale maps edited by the "Tommy Guardia" National Geographic Institute. The biological collection sites determined by other component studies were added on these maps to indicate the areas of investigation.

5.2.4 Collection of ecological and geographic documentation related to the current Canal area and to affected areas, books, articles, thesis, statistics, newspapers and maps, so as to include it in the analysis.

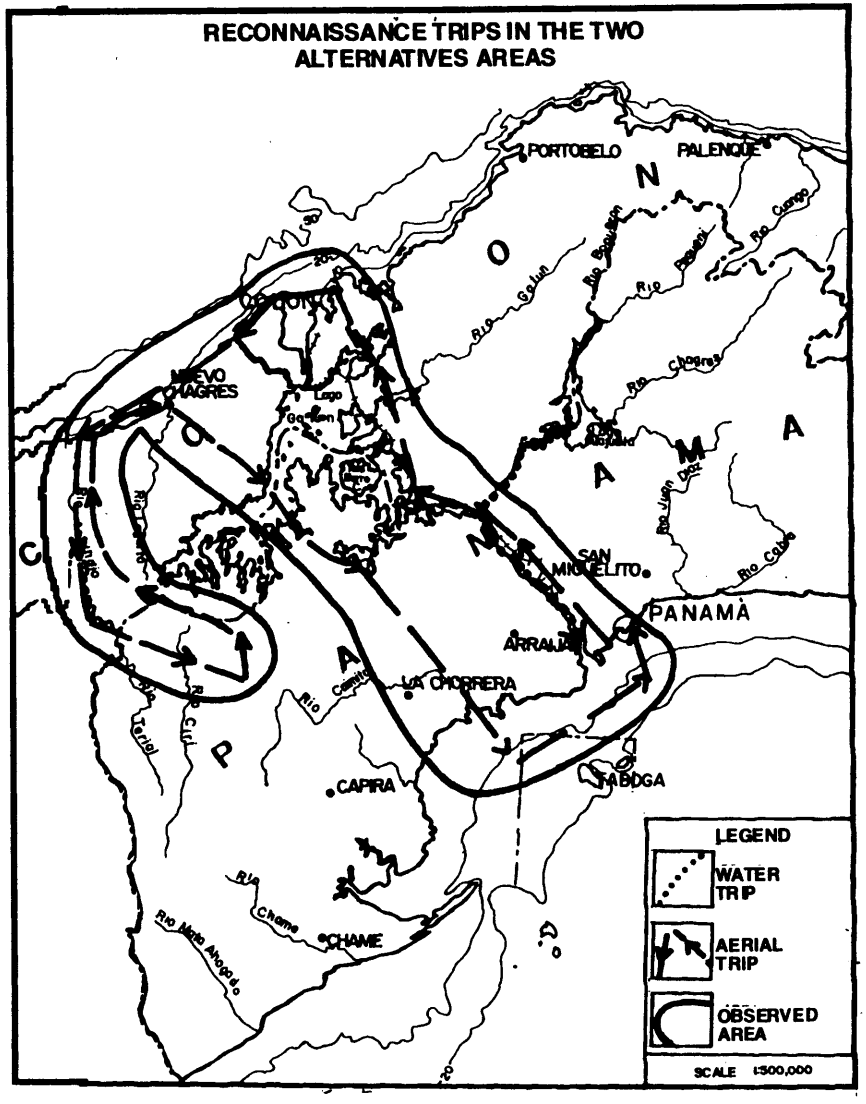
5.2.5 Preparation of the geographic and ecological material required for construction of a system dynamics model for the Republic of Panama.

5.2.6 Review of work previously done in different areas of the Canal waterway. However, the following trips were undertaken for this investigation:

5.2.6.1 A boat trip through the Canal from Gamboa to Diablo.
5.2.6.2 Land trips to the Gaillard (Culebra) Cut areas currently undergoing widening.
5.2.6.3 Helicopter trip over the proposed routes and watersheds of the Indio, Trinidad and Ciri Grande rivers (see Map V-1)

5.2.7 Interviews were conducted with local experts, including ecology specialists from Dames & Moore, the Smithsonian Tropical Research Institute, and the Panama Canal Commission technicians, as well as other area consultants.

MAP V-1


RECONNAISSANCE TRIPS IN THE TWO ALTERNATIVES AREAS
PORTOBELO
PALENQUE
COLON
NUEVO HAGRES
SAN MIGUELITO
PANAMA
ARRAIJAN
LA CHORRERA
CAPIRA
TABOGA
CHAME
Rio Galun
Rio Chagres
Rio Cabra
Rio Cirí
Rio Terial
Rio Chame
Rio Mata Ahogado
LEGEND
WATER TRIP
AERIAL TRIP
OBSERVED AREA
SCALE 1:500,000

5.3 IDENTIFICATION AND ANALYSIS OF ENVIRONMENTAL AND GEOGRAPHIC IMPACTS

5.3.1 Impacts on the Country

Investment and the creation of jobs will benefit the Metropolitan Region, but will also impact the entire country through the speculative and actual increase in the value of Panama's geographic position, and due to regional imbalance.

5.3.1.1 *Direct Impacts*

Whatever the alternative, the direct and indirect impacts will combine to exert an influence on Panama's geographic position and on regional development. These, however, are foreseeable and identifiable. In this light, there should be an increase in the value of Panama's geographical position.

Because of an increase in the value of Panama's geographic position as a result of planned financial influx, increased flow of adequate information, workers and tourism, Panama's economic activities, combined with the international economy, will be strengthened. This will include a reinforcement of the banking system, the insurance business, ports, airports and communications activities.

The Central Provinces are noted for having the highest agricultural production, cultivated areas, dense road network (5,242 sq. Km) and the widest range of agro-industrial equipment in the country. The Port of Aguadulce has an international cargo movement of more than 110,000 metric tons. The region has ready access to the Metropolitan Region, especially the Province of Cocle which is the most industrialized.

Benefits would also accrue to the western region (Chiriqui and Bocas del Toro). This region is second in agricultural and agro-industrial production in the country, has a 2,251-sq. km. road network, and important international ports, such as Puerto Armuelles and Almirante, with an annual cargo movement of 500,000 metric tons each. This region, especially the Caribbean slope, does not have ready access to the Metropolitan market, but accounts for considerable exports of bananas, coffee, sugar and orange concentrate. The transisthmian oil pipeline also runs through the region and competes with the Panama Canal internationally.

5.3.1.2 *Indirect Impacts*

The indirect impacts of the construction of the High-Rise Lock Canal will be the result of the multiplying effects of an increase in the value of the geographic position and of the investment involved. Its main effect will be the alteration of the regional system with destabilizing effects, particularly in the Metropolitan area, but within a consolidated regional development process.

5.3.1.2.1 *Increase of Agrochemical Pollution*

Following the peculiar Central American tendency, Panama is affected by a growing agrochemical pollution. During the past twenty years, an annual increase in the importation and use of agrochemicals has been noted[2].

The dispersion of chemical substances from fertilizers, fungicides, nematicides and fumigants that affect the environment has taken its toll. Fertilizers unleash eutrophication processes that decrease oxygen content in swamps, estuaries, lakes and rivers. This process simplifies marine, river and lake biodiversity and also generates nitrification and decay processes affecting the ichtyofauna and reducing water quality. A wide range of pesticides pollute surface and ground waters.

The increasing demand for food and agricultural raw materials required by the construction of a new Canal could trigger an increase in agricultural production activities and higher chemical input. The agro-industrial sector has thus far been a major source of pollution in the Central and Western Provinces.

[2]Pinzón, Ambar M.D. Inaugural lecture in the "Foro sobre el desarrollo del saneamiento ambiental y de la protección del ambiente". W.H.O.

5.3.2 Impacts on the Project Region

5.3.2.1 *Direct Impacts*

The Canal excavation and the construction of ancillary projects, be it the High-Rise Lock or the Sea Level alternative, entail major changes on both a physical and socioeconomic scale. The impacts on the region are as follows:

5.3.2.1.1 *Oceanographic Alterations in the Bay of Panama and the Colon Coast*

The High-Rise Lock Canal will have underwater access channels. The Caribbean Channel will have a length of 14.1 to 14.4 kms and depth of 21 meters , while the Pacific Channel will be 14.3 to 17.5 kms long and 21 meters deep. The Caribbean Channel of Route 10 will be 3.3 kms long and 24 meters deep, and its Pacific Channel, 22.7 to 25.1 kms long and 24 meters deep.

Unlike the Sea Level Canal, the High-Rise Lock Canal will not need new breakwaters. In the Caribbean, their length will be 3,000 meters in the east and 3,400 meters in the west. In the Pacific, their length will be 8,000 meters and 10,500 meters in the West. In addition to the breakwaters for the underwater channels, plans include earth and rock excavation deposits toward the western end of the exits in both projects. There will be a deposit in the lock Canal for excavated material on the Caribbean side, covering an area of 5.2 sq. km. and a capacity for 53.8 million cubic meters. In the case of the Sea Level Canal, the Caribbean deposit will be parallel to the breakwater, measuring 8.8 sq. km. and containing 101.2 million cubic meters of material. The Pacific deposit will contain 17.6 sq. km. of excavated material, and will be parallel to the marine channel, the southern end reaching Taboga Island (see Maps V-2 and V-3).

In the entire Panamanian Caribbean, because of the low tides, the high temperature of the waters, its transparency and other physical factors, there is great abundance of corals reefs and associated marine life. In this sense, it is one of the richest areas in the Caribbean.[3] Water transparency allows solar light penetration and promotes underwater flora growth that is richer and denser than that of the Pacific shore. There are great expanses of sea grass, among them, Thalassia testodinum. The coral

[3] Porter, James W., Ecology and species diversity of coral reefs on opposite sides of the Isthmus of Panama, Bulletin of the Biological Society of Washington No. 2, 1972, p.106.

environment and associated algae foster animal life. Lobsters develop in the corals, Panilurus argus and Panilurus laevicauda, while the Thalassias fields are breeding grounds for anchovy, red snapper and certain shrimp species. Any marine operation that would move sediment on the Caribbean shelf will have an effect on the transparency of the waters and, consequently, on the coralligenous ecosystems and the algae fields (see Map V-3).

The fauna and flora of the Gulf of Panama readily adapt to changes in salinity and temperature, and the impact of sediments could be minimal. However, there are changes in coral formation subject to adverse factors south of Taboga and in the Pearl Islands. The former may be affected by the sediments from the Sea Level Canal construction on the Pacific side (see Map V-3).

In the Gulf of Panama there is a marine current flowing from Darien to Los Santos and passing through the Bay of Panama. The Flamenco Causeway, constructed at the beginning of the century from excavated material, has already increased sedimentation in the waters facing Panama City. This could be a serious problem on the Pacific side of the Sea Level Canal due to the breakwaters and the excavation material deposited, and would affect the Port of Vacamonte in view of the deposit areas envisaged in Caimito River (see Map V-3)

In the province of Los Santos, an abandoned dock constructed of excavated rock and dirt intercepts the coastal current in the Gulf of Panama and has transformed the neighboring coast (see Map V-3).

5.3.2.1.2 *Usable Area Reduction*

Due to the various projects, including the current Canal and the Bayano hydroelectric dam, the Metropolitan Region has less usable space because of excavation and artificial lakes. At present, 665.58 sq. km. are covered by water (see Table V-1), an area almost as large as the district of La Chorrera. With the creation of the Ciri Grande, Trinidad and Indio reservoirs, which are necessary for a High-Rise Lock Canal, the freshwater lake area will cover 717.58 sq. k.m, that is, 4.2% of the entire Metropolitan area.

TABLE V-1

LAKE	AREA IN SQ. KM.	TOTAL (SQ. KM.)
1993 TOTAL		665.58
ALAJUELA	57	
BAYANO	185.43	
GATUN	423.15	
2060 TOTAL		728.58
ALTO GATUN	11	
CIRI GRANDE	13	
INDIO	17	
TRINIDAD	22	

In this regard, the Sea Level Canal will require only one on the Gatun River as an auxiliary reservoir with a span of 11 sq. km·

In addition to lakes, useful lands will be lost due to landfills caused by materials excavated along the Canal route. For the High-Rise Lock Canal, this will amount to 20.2 sq. km., and where the Sea Level Canal is concerned, the area formed by hillocks of excavated material will span 51.0 sq. km.

5.4 FINDINGS

5.4.1 Species migration between the Pacific Ocean and the Caribbean Sea, as a result of the Sea Level Canal alternative and, hence, the altering of oceanic and coastal marine life, will prove to be hazardous to Panama and the world in general. In view of their significance and inasmuch as their exact implications are not known, they are defined as a significant negative impact.

5.4.2 Under the assumption that an accelerated growth rate in the Metropolitan Region will add to the stress of Canal excavation work and to the ensuing Canal operation, which will in turn change the geographic environment and upset the ecosystem, it is clear that such an economic polarization during Canal construction may affect the current Canal. The Sea Level Canal will be a source of oceanographic,

geomorphologic and, particularly, hydrological problems, posing threats to the entire system of the current lock Canal.

5.4.3 Water is one of the natural resources that are most vital to the Metropolitan Area and most seriously affected by the construction of a Canal alternative. New Canal requirements would be added to those arising from the concurrent aggravation of a concentrated economy and would increase considerable new demands on the existing water supply potential, given the available catchment areas.

5.4.4 The excavation of a Sea Level Canal has the potential to lower the freshwater tables presently located at an average depth of 5 meters in the Continental Divide and in the Pacific watershed, thus endangering groundwater resources. There will be other associated problems, such as sedimentation, salinization and other physio-chemical alterations of water quality. The availability of water and its quality are issues that must be studied in greater depth prior to selecting a Canal alternative.

5.4.5 A Sea Level Canal alternative would generate large volumes of earth and rock which are difficult to dispose of, and relocation of such materials would cause significant hydrological and geomorphic problems, aside from the consequences of using land for dumping and destroying mature forests unprotected by law in areas W-4, W-5, W-6 and W-7, as described in the Yachiyo report.

5.4.6 Increase in Agrochemical Pollution. Increase in the demand for food and agricultural raw materials due to an increase in population triggered by the new Canal construction will give rise to agricultural intensification and higher chemical input. The agro-industrial sector is currently a major source of pollution in the Central and Western Provinces. Excavation deposits and the creation of more artificial lakes reducing usable land area for dwellings and other activities, will severely influence the environment and negatively affect the biodiversity and water quality of lands and streams due to physiochemical changes. This impact will be greater in the case of the Sea Level Canal.

5.4.7 Oceanographic Alterations in the Bay of Panama and the Atlantic Coast. It is a known fact that the fauna and flora of the Gulf of Panama adapt to changes in salinity and temperature and, therefore, dumping of sediments herein could have a lesser impact than in the Caribbean. However, there may be changes in coral formations subject to adverse factors south of Taboga and in the Pearl Islands. The former may be affected by coastal transformations and changes in the seabed of the continental shelf if construction of the Sea Level Canal in the Pacific were to begin. The huge breakwaters and excavated material deposits (dumps) from land and coast will increase sea water turbidity. The coastal ecosystems will be greatly disturbed, especially in the Caribbean, where the entire system has adapted to transparent water. This situation could endanger existing fisheries and bring about socioeconomic impacts over a long period of time, especially because of sedimentation over coral reefs transported by coastal currents.

5.4.8 A significant negative impact of the Sea Level Canal alternative is the alteration of various streams in the area that activates erosion processes caused by deforestation and changes in riverbed levels. This increases the transportation of sediments to Gatun Lake and the current Canal. Additionally, this excavated material will be unstable, and heavy tropical rains will cause landslides and block valley streams, especially during high runoff periods after the rainy season (map 5.6).

5.4.9 The Sea Level Canal area is known for endemic diseases such as trypanosomiasis, leishmaniasis, toxoplasmosis, with frequent outbreaks of Hepatitis "B" and enteric diseases. The current dangerous levels of the once-eradicated Aedes aegypti (the yellow fever and dengue vector) increase the possibility of new outbreaks of contagious diseases in the area and subsequently in the country as a result of habitat destruction and displacement of rodents, mosquitoes, fleas and others from these areas. A less stable population spreads these diseases easily.

5.4.10 Impacts During the Operation of the Canal

Canal operation impacts are more difficult to predict in either alternative, especially when impacts on the country or on the Metropolitan Region arise from economic or political situations. Some long-term impacts affect the environment and thus require more precise research and data in order to arrive at accurate predictions.

5.4.10.1 *Impacts on Panama*

In the process of evaluating the geographic position, regional imbalances that become more acute during the construction period will tend to be permanent. Only exceptional circumstances will weaken the migratory flow toward Panama and foster any significant development outside the Metropolitan Region.

5.4.10.1.1 *Direct Impacts Specifically Affecting the Natural Environment*

5.4.10.1.1.1 *New barriers against Cross-migration of Species*

Even with the Gaillard widening, the High-Rise Lock Canal will still offer ample possibilities and barriers to the migration of like animals, which would not be the case with the Sea Level Canal since it is conceived to be 380 meters wide and 24 meters deep, with one channel of brackish water and bare banks. This would be a formidable obstacle to many animals. The effects of the new land barrier will be long term. At present, Panama and Central America, as far as the Isthmus of Tehuantepec, are the only land bridge of biological significance. Various studies show that continental species in Panama are common to North and South America. At the same time, Panama is a biological frontier that has not been crossed by many species on their north-south exchange. According to Davidse, 57% of the gramineous species in Panama also exist in Central and South America, yet only 11% are from the north and 5% from the south. Among the arboreal species studied by Holdridge, many, such as Cavallenesia platanifolia (Cuipo), Iriartea corneto and Cassia moschata, are found only in South America and Panama. Others, such as Dalbergia retusa (cocobolo), Myroxilon balsamum (balsam), Plumeria rubra (caracucha) and Manilkara achras (medlar or loquat), are found from Mexico down to Panama. Of the 84 families of birds in Panama 42% are originally from the southern part of the hemisphere and 11% from North America. On the other hand, mammals such as Microsciurus, Reithrodontomys, Cabassous, Sygmodon and Procyon lotor are found only in the western half or end of Panama. An example is the Cannis latrans, found from Alaska to Costa Rica, that is migrating and can already be sighted in the province of Veraguas.

A barrier against vectors and disease carriers might help to control epidemics. Nevertheless, this does not rule out the possibility of changes in habitat due to deforestation and the migration of infected persons carrying previously eradicated diseases or those diseases with low contagion levels to

other locations. If the vectors exist, they can revive. Such is the case of the Aedes aegypti now reaching hazardous levels in Panama, even though the howler monkey, Alouatta palliata -- a disease carrier -- is an endangered species due to deforestation. The threat of yellow fever and dengue is latent, as is the Anopheles albimanus carrier of malaria; the simulid, transmitters of filariasis; and the culex mosquitoes that transmit arbovirus.

The Sea Level Canal has a significant impact in epidemiology since it crosses an area of endemic trypanosomiasis (Chagas disease) which is transmitted by the Triatoma dimidiata and Rhodnius pallescens, and villages to the east of Mendoza, such as La Laguna, La Arenosa, Alto del Jobo, located within the security kilometer of the Sea Level Canal. This is an area plagued by leishmaniasis (Leishmania panamensis)[4], the carrier of which is the Lutzomyia spp.

The rural community, as well as members of the U.S. Armed Forces in charge of Canal security, are afflicted by toxoplasmosis. There are frequent outbreaks of Hepatitis B and endemic diseases causing a high incidence of diarrhea. All this could be further aggravated by population flow toward the new construction area.

5.4.10.1.1.2 *Merging of the Pacific Ocean with the Caribbean*

This fact was proven in Panama by Meek, Seth and Hildebrand in 1923, who studied 450 species of Pacific marine fish and 380 in the Caribbean. They found 72 species common to both seas,[5] which was corroborated in more recent studies. However, the two seas are very different in many other aspects, especially the Gulf of Panama with its very special oceanographic characteristics.

The continental shelf of the Caribbean covers just 11,447.6 sq. k.m and is parallel to the coast. The Pacific continental shelf is 40,883.7 sq. km. wide in the Gulfs of Chiriquí, Montijo and Panama, but very narrow in Burica and south of the Azuero Peninsula. The numerous Caribbean islands are mostly small, while the fewer Pacific islands are larger with more river runoff creating a lower salinity.

[4]Mendez, E. Sousa, O. E. Identificación y Distribución de los Treatominos de Panamá. Revista Médica de Panamá 4: 258-80, 1968.
[5] Meek, Seth & Hildebrand, Samuel. The marine fishes of Panama, Field of Natural History, Chicago, 1923. Vol. 1. pp 11.

The salinity of the Caribbean varies little throughout the year, while in the Pacific, salinity increases in the dry season. The Caribbean tends to be warmer in the dry season. The Gulf of Panama has temperatures nearing 28°C in the rainy season, but temperatures fall in the dry season when trade winds blow. As the wind displaces the warm layers, cooler water rises from the depths and surface temperatures in certain areas can vary within 24 hours from 27°C to nearly 15°C[6]. Among other such differences, a very important one consists of tides, which are very changeable and difficult to predict when trade winds hit the coast and can be exceptionally high. In the Pacific, the maximum tide per day can reach 6 meters, uncovering very wide beaches when low, especially in shallow areas. Here the different currents play important roles (see Map V-4). During the rainy season, the Nicaraguan current flows at 30-40 cm/second along the Caribbean towards Colon where it branches to the north and slowly to the east to San Blas and Colombia. In the dry season, this current is slower and does not branch out. A "Colombian" current enters the Pacific during the rainy season, with moderate speed from the eastern part of the Gulf of Panama, and branches out in two directions. One branch follows the coastline toward deep waters off Punta Mala, while the other continues south through the Pearl Islands. In the dry season, these currents are faster, especially where they exit to deeper waters off the province of Los Santos. In the Gulf of Chiriqui, a current flowing eastward passes in front of the coast year-round, continuing south away from the Gulf of Montijo (see Map V-4).

All these oceanographic differences would not make a mass migration of species any easier through a Sea Level Canal, but there would always be migratory possibilities. Through active or passive dispersion in ship hulls, some species could cross the channel[7]. There is the danger that the Pelamis platurus (Rubinoff et al 1988), a very dangerous and poisonous serpent in the Pacific, aside from the fact that it is a predator of other species, could cross the channel. Other repercussions would take place since this serpent can poise a threat to human life. Another species of coral eaters, such as the Acanthaster starfish that could devour 18-47% of a 20-hectare reef in 4 months, is only found in the Pacific[8], but could migrate to the Atlantic with serious consequences for the ecosystem where there are extensive and numerous corals.

[6] Glynn, Peter. "Observation on the ecology of the Caribbean and Pacific Oceans of Panama. In The Panama Biotic, Op. Cit., P.14.
[7] Rubinoff, I. et al. "Divergence of the Sea Snake (Pelamis platurus) in the Gulf of Panama, Marine Biology" Vol. 97; 157-63, 1988.
[8] Glynn, et al and others, "The coral Reef Annual Report Smithsonian Institute, 1985.

The Gulf of Panama is highly populated and numerous rivers running through densely populated areas flow into it, causing pollution by microorganisms, such as E. coli. If found in large numbers, as shown in the study on water quality[9], due to the reflux of the waters of the Pacific, these could pass freely and very rapidly to the Caribbean if a barrier such as the current Canal did not exist.

Studies have shown that pollution of species of the Caribbean by water pollution from the Pacific would produce short-term impacts. The destruction of Caribbean species, such as the Mitrax Spinosissimus[10], is an example.

5.4.10.1.1.3 *Increase in Canal Transit and Cargo and Geographic Position*

According to predictions, Canal traffic patterns in the near future will undergo relatively few changes[11]. At present, it is estimated that 5% of the world's merchant marine fleet transits the Canal and a decrease is anticipated. On the other hand, YEC projections foresee a slight increase, as indicated by the figures on Table V-2:

TABLE V-2
TRAFFIC PROJECTIONS

WORK	YEAR 2020	YEAR 2060
Current Canal	16,200	20,000
High-Rise Lock Canal	18,200	24,600
Sea Level Canal	16,200	19,400

5.4.11 Direct Impacts

Direct impacts derived from the operation of Canal projects affecting the geography and on the environment in Panama will have a geopolitical base.

[9]CONAMA, 1988.
[10] Sousa, Francisca et al, 1988; "Efectos de la Contaminación de las Aguas del Pacífico sobre el Mitrax Spinosissimus (Cangrejo Rey, Centollo, etc.), Decapoda Mojidae; Revista Médica Vol. 3, 1988 pg. 183-191.
[11]Wainio, Richard. "Canal Perspective vis-a-vis International Trade". Office of Executive Planning, Panama Canal Commission, Panama, April 5, 1993, page 2.

5.4.11.1 *Adaptation of Regional Planning*

The regional imbalance will worsen during Canal construction, and mechanisms will be developed to maintain or intensify these disparities. Consequently, the urbanization process will continue.

Future regional problems will be acute and will create tension. As a crisis looms, it will be necessary to reinforce regional planning to promote regional development with a view to achieving some harmony and balance within the country. Decentralization, which has been successful in countries such as France, Spain and Peru, as well as other Latin American countries, could be a medium for alleviating imbalances. Other resources are the regionalization of investments and the reorganization of the urban system with the selection of regional centers.

5.4.11.2 *Energy Demand Increase*

The Sea Level Canal would require considerable electricity, but the High-Rise Lock Canal would require much more because of the need to pump and recycle water. At present, the Canal area consumes about 525 millions kw, half of which is produced by Gatun and Alajuela lakes and the rest by the Panama Canal Commission's thermoelectric plants, with few interfaces with the national electric network (IRHE).

Most of the 2,790 million kw for the country were generated by hydroelectric plants in 1991. Currently, there is no national consumption increase, but future growth prompted by new Canal work will increase demand.

As a matter of policy, Panama has been investing in hydroelectric projects so as not to depend on imported petroleum for this purpose, and to exploit the natural resources which the country has at hand. The Metropolitan Region has only a reduced capability to generate more hydroelectric energy, even with the projects envisaged in Alto Gatun, Ciri, Trinidad and Indio Rivers. Therefore, the sources in the western part of the country, especially those of Bocas del Toro, must be developed to avoid an energy deficit. This would mean large investments made necessary by the development of the Metropolitan Region, and under the influence of implementation of Canal projects. New plans for land use will have to be adopted (Source: IRHE Energy Report, 1980).

5.4.12 Impacts on the Metropolitan Region

The long-term impacts on the Metropolitan Region will include the environment, local geography and new structures.

5.4.12.1 *Direct Impacts*

Future Canal operations will affect the environment and natural resources in the Metropolitan Region, and all other resources, especially water, because of the greater demand.

5.4.12.1.1 *Increased Pollution.*[12]

After grain, the most frequent cargoes in the Canal are petroleum and petroleum products. Spills are always a danger, and there are also many explosives, gases, flammable liquids, oxidants, organic peroxides and poisonous substances, as well as ethiological, corrosive and radioactive materials. Aside from a possible disaster caused by other substances, current pollution has been mainly due to petroleum. Concentrations of up to 87 micrograms per liter have been found in the Pacific port of Balboa where fuel is distributed to ships.[13]

The hazard of hydrocarbon spills and dangerous substances will increase proportionately to the number of ship transits in an enlarged Canal system, the High-Rise Lock or Sea Level Canal.

[12]COMANA 1984/1992 Plan de Acción Ambiental del Pacífico.
[13]Ibidem.

5.4.12.1.2 *Water Management*

The environmental and geographic field of study has determined that impacts on the water supply in the region will be the most important. As of some years ago, an alarming deterioration of the waterway's delicate ecosystem has become noticeable. Therefore, any alternative -- be it the High-Rise Lock Canal or the Sea Level Canal -- will require new water sources; first from the very waterway, and, secondly, from small neighboring watersheds, such as the Indio, Lagarto and the North Cocle Rivers. At the same time, the 16-km distance separating the Sea Level Canal alternative (Route 10) from the present Canal route is too short. This means that water resources should be contemplated in an integral form, with respect to the alternatives proposed. Currently, either alternative could bring about serious problems in the water supply, affecting operations and the demands of a constantly increasing population, inasmuch as the terms of reference indicate that the Sea Level Canal will function alongside the present waterway, thus reducing water availability .

This possibility requires that problems of this nature affecting the waterway be addressed in terms of constant human pressure. The waterway is small and covers only 333,000 hectares comprising Gatun and Alajuela Lakes. The latter covers an area of only 97,533 hectares (29%), supplies 40% of the water, and the flooded area of the two lakes represents 10% of the total area.

There is an annual rainfall of 2,800 to 3,900 mm., averaging 2,845 mm. in recorded years, and rainstorms are heavy. For example, 33% of all annual rainstorms in Alajuela Lake were dense -- more than 100 mm/hour and even 187.5 mm/hour[14].

According to the YEC Engineering Report and other consulting work, total annual average evaporation is approximately 1,370 mm., which means that 48% of the total precipitation is lost and the remaining 52% falls into rivers and lakes. Based on studies at 18 meteorological stations and 40 years of records for the area, rains decrease an average of 5 mm/year, varying from 1 to 11 mm per year[15]. The topography is comprised of irregularly sloped lowlands, more than 40% steep at times (see following figure).

[14]Alvarado, Luis. El Agua y el Canal de Panamá La Cuenca del Canal, 1986.

[15]Windsor, Donald y Rand, Stanley. Cambios climáticos en los registros de lluvia en Panamá y Costa Rica. Agonía de la Naturaleza, pag. 147-164.

TABLE V-3
AVERAGE SLOPES IN THE BASINS OF THE MOST IMPORTANT RIVERS OF THE CANAL

Sub-Basin	Average Slope %	Drainage Area sq. km.
Chagres River	55	434.70
Pequeni River	47.3	149.24
Boqueron River	37.9	113.04
Salamanca Stream	25.2	10.48
La Puente River	20	37.97
Indio River	45.6	96.7
Gatun River	37.2	141.77
Ciri River	25.9	203.33
Trinidad River	23.5	233.33
Zaino River	15	20.00

Source: Isaza, César. La Cuenca del Canal (1986).

The land is susceptible to high erosion, and low-fertility soils limit possible uses. The soil erosion index (K) in Rio Indio (Alajuela watershed) is K=17, and in the Gatun area the rate is K=43, indicating that the structural stability of soils ranges from medium to low[16] (see Map V-5).

Because of their low fertility and low agricultural capacity, only 3% of the land is really suitable for intensive cultivation and only 12% is suitable for small crops and animals. Most of the area is therefore fit for forestation[17].

According to the Yachiyo Engineering Report (1993), the average annual water capture of the waterways for 51 years (1932-1983) was 5,923 million cubic meters. Canal reservoirs could store 1,198 million cubic meters (659 million cubic meters in Gatun and 593 million cubic meters in Alajuela).

[16] Isaza, César(1986).
[17] Jonás, Jorge and Ponce, Victor; "Types of Soil and their Limitations".

The locks consume 355 million cubic meters (45%), the urban sectors of Panama and Colon, 274 million cubic meters (4%), while the loss from energy generation and spillway is 41%. In 1990, drinking water consumed in the Metropolitan Region was determined as follows: 72.7% residential, 9.2% commercial, 2.4% industrial and 15.7% for the public sector (schools, hospitals, landscape, swimming pools, fire-fighting, etc.). Consumption increased 14% from 1986 to 1990.

The High-Rise Lock Canal for 150,000 DWT vessels would require 3,861 million cubic meters in the year 2020 and 5,871 million cubic meters for the year 2060. Its design for 200,000 DWT would require 4,068 million cubic meters by 2020 and 6,303 million cubic meters by the year 2060. This means that there is enough water at present, but by the year 2060 it will be very limited and the reserves of Rio Indio, Ciri Grande and the Trinidad rivers will be required.

In the last two decades, migration to the watershed increased notably, bringing about a disorganized use of the land and competition for water and raising serious disequilibrium problems in the general ecosystem. The causes are summarized as follows:

- *Migration to the watershed area.*

In 1950, the population was 20,000; by 1985, it was 110,000, and projections for the year 2000 are 200,000, while the population for the Metropolitan Region[18] will be 1,600,000 by the year 2000 and 2,000,000 by the year 2010.

- *Deforestation*

Production systems used by peasants settling in the area will devastate it inexorably (see Table V-4). The deforestation rate is 810 hectares per year[19] , thereby causing 50 cubic meters of erosion per year.

[18] Riba, Jorge (1990). "Urban Development and Environment: the Case for the Metropolitan Area of Panama, and other Growth Centers in the country, National Tables No. 4, Environment and Development in Panama. IDEV.
[19] Alvarado, Luis A. (1986). "Water of the Panama Canal". Book of the Canal Waterway.

TABLE V-4

Year	Forest (hectares)	Percentages %
1940	245,250	75
1987	120,393	37
1990	105,795	32

Source: INRENARE G.T.C.C.

- *Road construction*

There is a direct relationship between population and roads, causing innumerable indiscriminate road extensions for vehicles and animals that are poorly built on compacted soil, with steep grades and no maintenance and are subject to erosion.

- *Industrialization*

Considerable lumbering activities moving into the area in the last three decades have brought waste and affected the water quality of rivers, and probably that of groundwater[20].

- *Urbanization*

Urbanization in the watershed area of the Canal not only consumes water to meet the demands of an increasing population, but also occupies natural areas through expansion. The urban nucleus of Panama, as well as the agglomerations of Arraijan and Chorrera and other settlements, are constantly changing the environment with the usual concurrent problems of waste and sewage management, both highly polluted.

All of these factors inevitably cause two types of problems:

- Erosion and soil deposits in dams, especially in Lake Alajuela. Reliable projections for loss of water storage capacity: from 1934 to 1983, placed them around 4.7%, and increasing thus:

[20] Rubinoff, Ira (1982). "Environmental Problems confronting Panama". In the book Colonization and Destruction in Panama's Woods.

1983-1990	6.5%
1990-2000	9.7%
2000-2010	13.7%
2010-2020	18.4%

- Water storage, use and pollution. Since the availability of water is limited, a future water shortage is highly possible in the Canal watershed. It is important to understand that the use of water in the project should be carefully planned to avoid water availability problems in the future.

5.4.12.2 *Indirect Impacts*

Either alternative will exert great pressure on the area and its resources. Add to this the expected development of the Metropolitan Region due to work on the Canal and new uses for land that will have to be determined.

5.4.12.2.1 *Changes in Plans for Land Use*

On December 31, 1999 the United States is committed to turn over the Canal and an additional 52,000 hectares of land and waters to Panama.

For years, Panama has been designing plans for land use in the Canal Region. Decree No. 232 of September 27, 1979 approved the General Plan for Land Use in the Panama Canal area; Decree No. 14 of February 3, 1993 established the use of lands therein for the Atlantic and Pacific sides. The law should be revised to adapt to XXI Century realities and to Law No. 5 of February 25, 1993, which creates the Interoceanic Region Authority and adopts measures governing reverted properties and land. It should be noted that the studies and reports available do not take this last development into consideration, despite the fact that its financial repercussions may be enormous and may create even greater needs for drinking water than either alternative, and even though overlapping is inevitable.

As with the present Canal, plans will contribute to the integral preservation of the Chagres river watershed as a priority in order to guarantee the demand for water. Since the '80s, there are more protected areas in the Canal watershed. This policy should continue and be extended to incorporate the area of the Indio River as well (see Map V-3 and Table V-5).

TABLE V-5

PROTECTED WILDLIFE AREAS	AREA (IN HECTARES)	LEGAL BASIS
TOTAL	223,011	
Gatun Lake recreational area	348	Decree N° 88, July, 1985
Barro Colorado	5,400	Exchange of Notes. Canal Treaty, 1977
Las Cruces National Park	4,000	Law N°30, December 30, 1992
Chagres National Park	129,000	Decree N°73, October 2, 1984
Interoceanic National Park of the Americas	62,159	Resolution N° 028 from the Board of Directors of INRENARE, May 25, 1993
Sovereignty National Park	22,104	Decree N°13, May 27, 1980

Source: INRENARE, ANCON

5.4.13 Impact on the Project Area

5.4.13.1 *Sea Level Canal*

The excavation of a ditch that is 24.3 meter deep along the 63.3 kilometers from the Caribbean Coast to the tide gates or locks of the Pacific slope, and 27.40 meters of the remaining 20.1 kilometers (Zone V) would cause the following impacts:

5.4.13.1.1 *Abrupt Decrease in the Water (Phreatic) Table*

This is likely to happen in Zone IV (Continental Divide) and Zone V (approach area to the Pacific Ocean). The geologic base in these zones includes intrusive and extrusive igneous, basaltic rock with very complex patterns. From the interpretation of topographic maps on a 1:50,000 scale, it can be noted that the hydrographic network has a rectangular pattern and wetland depressions are abundant[21], indicating secondary sources of permeability and porosity (high tectolineal density). The above accounts for the location of the water table below depths of 4 to 8 meters.[22] The population in Zones IV and V obtains its freshwater supply from this groundwater. More than 50% use wells that provide between 20 and 100 gallons per minute (estimated). The level of these wells drop and, in some cases, dry up during long dry seasons.

The Sea Level Canal will lower the level of the water table below current figures (to more than 25 meters), and therefore lead to significant social and political problems for the Government. The Government will eventually have to invest large amounts of money to drill deeper wells. 75% of the Arraijan-La Chorrera inhabitants rely on groundwater for their water supply.

5.4.13.1.2 *Pollution of Groundwater due to Salinization Processes*

An abrupt decrease in the groundwater level can cause an increase in its salinization, thus:

- Washing mineral salt from rains will increase groundwater salinization. 1384 mm and 1354 mm, respectively, of water evaporates from Gatun and Alajuela Lakes per year[23]. This is a significant evaporation that, linked to the washing of mineral salt, increases salinization of groundwater.

- The sites where fresh and saltwater layers come together close to the shore will be affected by large excavations. This can cause the same effect as rainwater, washing mineral salt into groundwater.

[21]Observed during a helicopter trip over the area.
[22]Tecnipan S.A., Hazen and Sawyer (1975). Feasibility Studies for a New Water Supply System in Arraijan and La Chorrera.
[23]Yachiyo Engineering Report.

5.4.13.1.3 *Changes in River Beds, Streams and River Dynamics*

The disappearance of several small rivers and the transformation of larger rivers into seasonal rivers is expected as a result of changes in underground aquiferous mantles.

5.4.13.1.4 *Changes in Certain Riverbeds.*

Changes in certain riverbeds, as in the lower reaches of the Caimito River and the tributaries of the Pescado River (Santa Cruz, El Asado, etc.), as well as the total diversion of the Congo River, since the direction of the flow divides it in two. There are various examples in the Province of Colon.

The volume of earth movement to build the Sea Level Canal (1,252 million cubic meters, case A and 1,385 million cubic meters, case B) will cause other short-term impacts, such as:

- Movements and resettling of population currently living at sites to be used as landfill deposit areas for excavated materials, such as Paulino, La Marañona, Caño Quebrado, La Chinga Alta, Frijolito, Los Pavos, Cerro Cañito, La Celestina, Moscu and El Limon.

- Deforestation and dumping in the excavation sites, be it depressions caused by streams or hilltops, in an area which alone represents 50% of the wooded area on the Caribbean slope and 5 to 10% on the Pacific. Moreover, the disposed sediment could dissolve and pollute Gatun Lake, until it regenerates.

- Destruction of Mangroves. Since the mouth of the Caimito River will be located as the Pacific entrance of the Sea Level Canal, excavation and dumping will destroy approximately 5 sq. km of mangroves in the Caimito River estuary.

- Diversion of rivers and creation of dangerous damming in river valleys.

- These phenomena will occur in the river valley of the Caimito and Bernardino rivers (Pacific Slope): Los Hules, Pescado and Tinajones (Central Section) and the Lagarto and Quebrada rivers (Caribbean Slope). These riverbeds will be diverted mechanically, triggering a significant transformation in the ecology including:

- Loss of alluvial soils suitable for cultivation.

- Loss of flora and fauna in rivers and of colluvial and alluvial depressions (see Map V-5).

5.4.13.1.5 *Reactivation of Regressive Erosion in Rivers*

According to data received, the Sea Level Canal would require the removal of 1,385 million cubic meters of earth and rock, causing instability in the hydrographic system. It must be noted that Panama's rivers are torrential in their upper reaches, and the work hardly adapts itself to the existing drainage layout. It is also different from the existing Canal which uses the Chagres drainage basin. Consequently, rivers seeking a new level would destroy their banks and reactivate erosion in the upper reaches, causing additional sediment to reach Lake Gatun and dams to be built. Substantial increase in current force would surpass the river capacity to wash and cleanse.

In the Caimito River this phenomena will affect the water purification plant of La Chorrera, causing an increase in water treatment costs.

- *Changes in the topography with various hydrologic effects*

Accumulation of landfill over depressions, slopes and hills will seriously transform the present topography in the project area. These dump sites will be sources of sedimentation affecting rivers and actual flow, due to the petrographic and topographic characteristics of the area. On the other hand, hills and slopes no more than 150 meters high present convex slopes of more than 45%, especially in Zone IV. Moreover, the thick clay cap produced by chemical weathering, according to petrographic analysis[24], contains a predominance of montmorillonites of value varying between 40 and 95% (especially the basaltic tuffs of Zone IV).

The Plasticity Values are high, more than 40 and sometimes over 100. The predominance of montmorillonite in these soils indicates a high susceptibility to erosion caused by rain[25] as well as by

[24] Rock and Clay Mineral analysis based on the OICS JAX 92, 1969.
[25] César Díaz, 1965. Analysis of Factors Influencing Valley Erosion.

landslides. This is especially true with such an aggressive climate, the "R" factor of which fluctuates between 506 and 2093 in the Canal basin[26]. In this respect, the sediments would have the following effects (Map V-2):

- Significantly reduce the Lake Gatun catchment capacity and that of other dams to be built. Landfill sites W-2, D-8, D-10 and D-11, located in Lake Gatun, would have an adverse effect.

- Substantially increase the torrential capacity of rivers, increasing erosion and the danger of floods.

- Pollute surface waters, rivers and lakes.

5.4.13.1.6 *Noise During Excavations, Transportation and Accumulation of Materials.*

Although there is no comparison with the scale of the impact on the High-Rise Lock Canal area, anticipated noise (explosions, heavy equipment and trucks) will have negative effects on human beings, their activities and on animal life).

- *Effects of Sedimentation*

Dredging and material sedimentation (see Table V-5.) have a direct effect on the turbidity of the water, both in marine and lacustrine environments, and directly affect sports and commercial fishing and the salt marshes as well. The latter will have a negative effect on crustacean hatching, and is of socioeconomic and sociocultural significance.

Currents that flow year-round in the Caribbean from west to east will deposit a large amount of sediments on coral reefs in the long run. The ecological systems of the reefs and mangroves are considered to be rich in biodiversity and the habitats are estimated to be the most productive in the world. Suspension of anthropogenic pollutants will also cause chemical changes in the water that will generate heat and affect the benthonic flora and fauna.

[26] Minor tremor dynamics are more probable in these sites.

TABLE V-6
DETAILS OF EXCAVATION AMOUNTS IN MILLIONS OF CUBIC METERS

Alternatives	Excavation Zone	150,000 Ton alternative	200,000 Ton alternative	Cases A and C 250,000 Ton	Case B 250,000 Ton
High-Rise Lock Canal	Caribbean Entrance	45.9	54.2		
	Gatun Lake	134.9	160.3		
	Gaillard Cut	125.2	142.6		
	Miraflores	138.3	153.2		
	Pacific Entrance	66.9	89.2		
	Total Amount	512.1	599.5		
Sea Level Canal	Caribbean Entrance			16.3	17.5
	Quebrado			234.5	398.4
	Gatun Lake			234.2	234.2
	Continental Zone			646.6	637.2
	Pacific Entrance			121.0	97.8
	Total Amount			1,256.6	1,385.1

5.4.13.1.7 *Freshwater Barrier in the Sea Level Canal*

In its report, the YEC submits the possibility of introducing a freshwater barrier in the Sea Level Canal to prevent migration of species from one ocean to the other.

Since other bodies of water, in addition to Gatun Lake, would be required for the High-Rise Lock alternative, the amount of water for the Sea Level Canal alternative would have to be greater because the engineering reports show the need for deeper dredging in the barrier area.

Feasibility studies should be carried out for this proposal. None of the reports offers convincing explanations or solutions to this aspect of the project.

5.4.13.1.8 *Division of Gatun Lake*

The division of Gatun Lake into two bodies of water (the new Gatun Lake and reservoir) by Three Barrier Dams (E, F and G), as well as the diversion channel connecting the western sector of the Lagarto River, would cause different negative impacts:

- *On the aquatic species in the lake.*
- A reduction of the water volume capacity in the lake, seriously affecting Canal operation.
- On the humid soils of the Los Hules and Pescado rivers.

5.4.13.2 *High-Rise Lock Canal*

5.4.13.2.1 *Deposition sites would affect water and land ecosystems.*

Landfill deposits would affect aquatic and land ecosystems.

Disposal sites for Canal excavation W-1, D-4, D-5, D-6, D-7, D-8 and D-9 would have a catastrophic effect on unprotected woodlands, with direct impacts on:

- The ecosystems of these areas.
- A decrease of wooded areas in the Canal watershed, presently comprising only 105,795 hectares of a total 330,000, which is only 32%.
- Canal operations, since the dumps would be great sources of sedimentation (surface runoff or landslides) towards Lake Gatun, and mainly towards the Canal and Zones IV and V.
- Increase of dredging costs for the Gaillard Cut at the Pacific exit.

Accumulation of sedimentation due to disposal areas W-1 through W-8 at the Canal entrance, in Gatun Lake and on shores would have the following impacts:

- On the lacustrine ecosystems due to sedimentation (chemical and physical alteration of water).
- Reduction of water storage capacity of Gatun Lake.

5.4.13.2.2 *Creation of New Lakes*

From the year 2020 through 2060, the amount of water in the locks will have to be increased for vessels of either 150,000 or 200,000 DWT, so that these vessels may transit without problem. The construction of dams in the Indio River and the deviation of the river from the Canal watershed is therefore proposed. It is anticipated that other minor dams will be constructed in the Trinidad and Ciri Grande rivers -- approximately 3 to 9 km upstream from the Gatun lake.

The formation of these new bodies of water would have an impact on the environment. The following are some concerns arising from these effects:

- A loss of agriculture lands.
- A reduced flow of water once the dam is built on the Indio River. This will have a negative impact on towns like Santa Rosa, El Marañon, El Charcon and the mouth of the Indio River.
- A diminishing flow from the Indio River will bring changes in river affluents and create conditions for marine erosion.
- Small dams 50 meters deep, like Ciri Grande and Sona, could lose large quantities of water due to evaporation. According to the Yachiyo report, the loss of water of Gatun and Alajuela lakes due to evaporation is between 1,384 mm and 1,354 mm per year. The latter figures can be translated into an average loss of 2.5% of the lakes' storage capacity. This must be added to the effects of sedimentation and erosion resulting from construction on these new lacustrine bodies.

5.4.13.2.3 *Pumping of Recycled Water for the High-Rise Lock Canal Operation.*

If the High-Rise Lock alternative is determined to be the most feasible, by the year 2060 it will be necessary to create reservoirs by damming the Indio, Ciri and Trinidad rivers. The recycling mentioned

as one of the alternatives for pumping water and increasing the level of Gatun Lake would be a counterproductive measure since, although the increase of salinity in the lake might not be significant, there are freshwater biota species that would not withstand the change, such as the macrophytes that comprise approximately 28 species, including the Hydrilla verticillata. These macrophytes cannot tolerate salinization rates of more than 0.666%, and aside from sports fishing in the area, they are of socioeconomic significance to the country.

Another species of the biota of the current Canal area that would be affected is the Trichechus manatus (manatee), which is included in the red list of the International Union for the Conservation of Nature (UICN) as being in danger of extinction. It is a very important mammal that was brought into the country to keep Canal vegetation under control.

However, an increase in salinity would facilitate the migration of species, mainly from the Pacific to the Caribbean, causing specific impacts due to bacterial, parasitologic, and other types of pollution mentioned in other sections of this paper. There would be a considerable impact on the marine and land environment on both sides of the Sea Level Canal.

TABLE V-7

Envions	Alternatives			
	High-Rise Lock Canal		Sea Level Canal	
	During Construction	During Operation	During Construction	During Operation
Soils	- Landfills will destroy unprotected sectors of the forest. - Deposition sites: • loss of usable soils because of new dams.	- Landslides	- Areas of deposition will modify the topography. - Landfills will cause sediments. • Laminar erosion. • Ditches. - Destruction of humid soil areas.	- Landslides
Hydrography	- Landfills will affect storage capacity of the Gatun Lake.	- Landfills within the Gatun Lake area will affect: • storage capacity of the lake. • Benthonic fauna. • Freshwater adequacy.	- Division of the Gatun Lake. - Pollution of surface water (by sediments from rivers and dams). - Changes in certain riverbeds. Disarrangement of natural drainage network. - Reactivation of regressive river erosion. - Deeper erosion of riverbeds. - Intense lateral erosion.	- Decrease in the water table. - Pollution of aquiferous subsurface layers due to salinization. - Disappearance of small rivers. - Large rivers become stationary. - Increase of competence and torrentiality of the rivers. - Greater risk of floods. - Freshwater inadequacy.

5.5 CONCLUSIONS

This Environmental and Geographical analysis has covered the possible impacts of Canal alternatives on Panama and has arrived at the following conclusions:

5.5.1 Both Canal alternatives will have a negative ecological impact by placing a greater barrier to migration of land species between the Americas. In this respect, the Sea Level Canal would become a greater obstacle to land migration, but, nevertheless, would open the way for species migration from one ocean to another.

5.5.2 During construction and operation, the Sea Level Canal alternative will have a direct impact on the habitat of some of Panama's endangered species. In 1980, the Smithsonian Tropical Research Institute (STRI) reported 82 species of wildlife in danger of extinction, some of which are endemic to Panama's habitat, such as the Tapir Tapirus bairdii, the titi monkey Sagüinus geoffroyi, the porcupine Coendou rothschildi, and the white tail deer Odocoileus virginianus. The findings of the Smithsonian Tropical Research Institute were subsequently supported in 1985 by the Convention on International Trade in Endangered Species of Wild Fauna and Flora and in 1990 by the International Union for the Conservation of Nature and in ANCON and the University of Panama's Background of Biological Data and Biological Inventory, in 1993. The geographic zone cited for Panama's endemic habitat includes most of the area planned for the Sea Level Canal alternative. Given today's world sensibility to ecological problems, studies into possible repercussions should be conducted.

5.5.3 Although ocean environments are dissimilar (salinity, temperature, currents and tides), the potential exchange of species between the Pacific Ocean and the Caribbean Sea and the alteration of the sea and coastal marine life caused by the Sea Level Canal alternative will pose grave consequences for Panama and the world in general. These consequences are significant and, since their implications are unknown, they entail a negative impact requiring further detailed study.

5.5.4 Assuming that an accelerated growth rate in the Metropolitan Region will add to the stress associated with Canal excavation work and the ensuing Canal operations, and based on the premise that it will transform the geographic environment and the ecosystem, the economic polarization triggered by Canal construction work will affect the current Canal. This negative impact applies to both alternatives, but

is much greater in the case of the Sea Level Canal which will be a source of oceanographic, geomorphological and, above all, hydrological problems, threatening the entire system of the current locks Canal. This must be considered as a significant negative impact.

5.5.5 The excavation of a Sea Level Canal will lower the freshwater tables presently located at an average depth of 5 meters in the Continental Divide and in the Pacific watershed, thus endangering groundwater resources. Other associated problems are likely to arise, such as sedimentation, salinization and other physiochemical alterations of water quality. Availability of water and water quality are issues that must be studied in greater depth prior to selecting a Canal alternative.

5.5.6 The Sea Level Canal alternative would generate large volumes of earth and rocks, which are hard to dispose of and difficult to relocate. This would cause significant hydrological and geomorphical problems. The use of land for dumping involves a negative impact on available natural resources in placing areas W-1, D-4, D-5, D-6, D-7, D-8 and D-9. Likewise, the disposal of material deposits offshore and the creation of large breakwaters would increase water turbidity. The coastal ecosystem will be greatly disturbed, especially in the Caribbean, since its system is adapts to transparent water. The impact of this planned engineering solution for disposal of the discharged materials will be negative, and will be significantly greater with the Sea Level Canal.

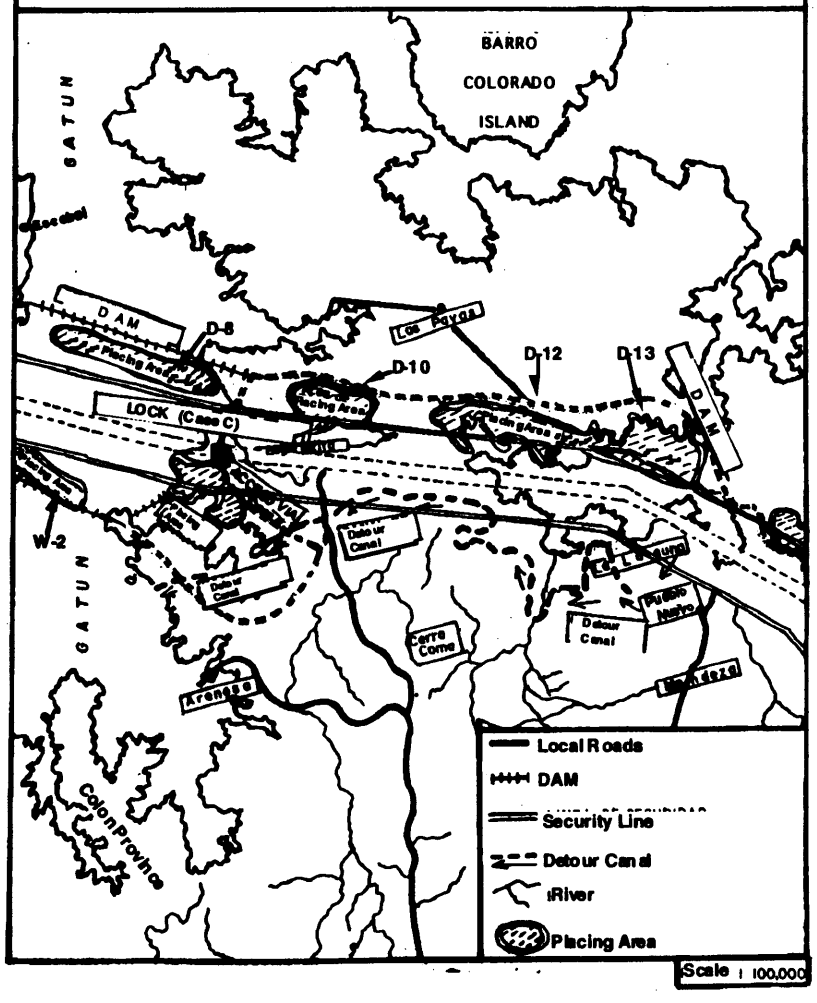
5.5.7 An increase in demand for food and agricultural raw materials, created by the excavation of a new Canal, could give rise to agricultural intensification and a higher input of chemicals with subsequent increases in agrochemical pollution. The agro-industrial sector is currently a primary pollution source in the Central and Western Provinces. While actions can be taken to reduce and control the use of chemicals, it is more likely that such use would increase significantly. This impact would only be marginally greater in the case of the Sea Level Canal.

5.5.8 Oceanographic Alterations in the Bay of Panama. The fauna and flora of the Gulf of Panama readily adapts to changes in salinity and temperature and, therefore, the impact of dumping sediments is less than on that of the Atlantic. However, there are changes in coral formation subject to adverse factors south of Taboga and in the Pearl Islands. The coral formation near Taboga may be affected by coastal transformation and transmigration of species due to construction work in the Pacific for the Sea Level Canal.

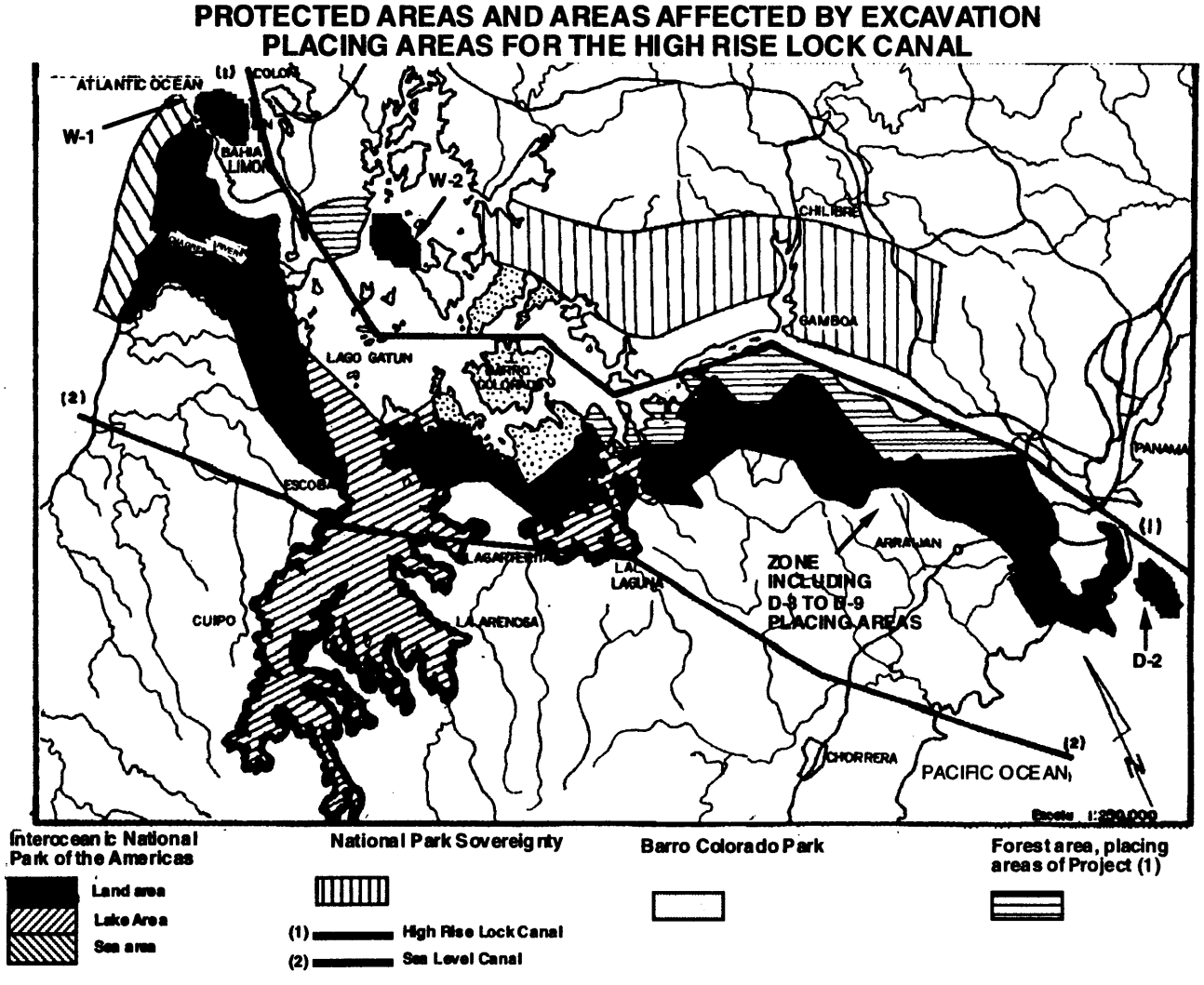
5.5.9 An important negative impact of the Sea Level Canal alternative is the alteration of various streams in the area, activating erosion processes caused by deforestation, and changes in riverbeds and levels. This would increase the transportation of sediment to Gatun Lake and to the current Canal. Excavated material would also be unstable, creating a potential for landslides and blocking of valley streams, especially during the high runoff periods after the rains.

MAP V-2

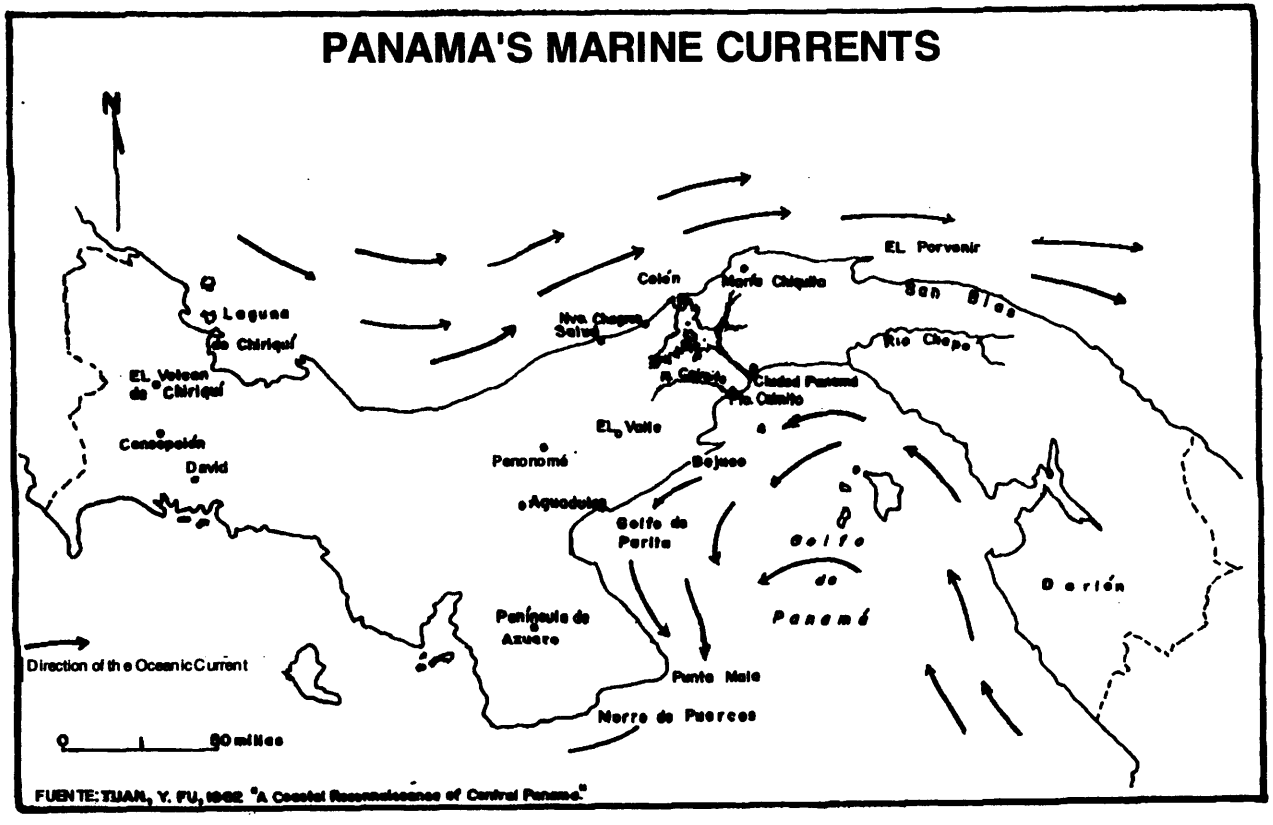
DETAIL OF THE SEA LEVEL CANAL IN THE INLET OF THE GATUN LAKE BETWEEN LA LAGUNA AND CAÑO GIGANTE, INCLUDING PLACING AREAS



MAP V-3

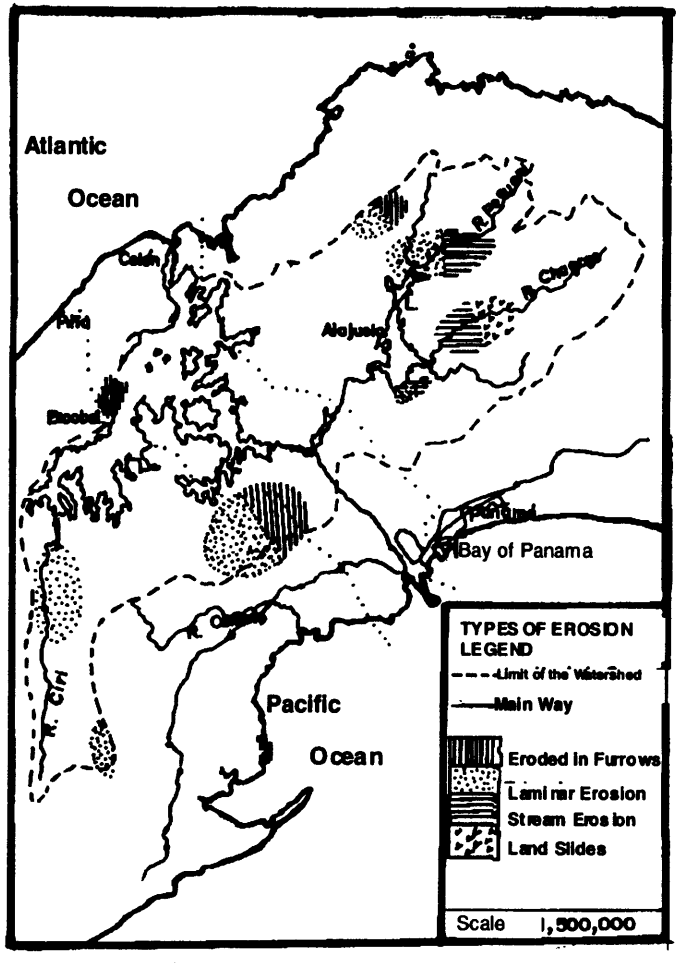

PROTECTED AREAS AND AREAS AFFECTED BY EXCAVATION
PLACING AREAS FOR THE HIGH RISE LOCK CANAL
ATLANTIC OCEAN
(1)
W-1
BAHIA LIMON
W-2
CHILIBRE
GAMBOA
LAGO GATUN
BARRO COLORADO
(2)
PANAMA
ESCOBAL
(1)
ARRAIJAN
LAGARTERITA
LA LAGUNA
ZONE INCLUDING D-3 TO D-9 PLACING AREAS
CUIPO
LA ARENOSA
D-2
(2)
CHORRERA
PACIFIC OCEAN
Scale 1:250,000
Interocean ic National Park of the Americas
Land area
Lake Area
Sea area
National Park Sovereignty
(1) High Rise Lock Canal
(2) Sea Level Canal
Barro Colorado Park
Forest area, placing areas of Project (1)

MAP V-4


PANAMA'S MARINE CURRENTS
N
Laguna de Chiriquí
EL Volcan de Chiriquí
Concepción
David
Colón
Nva. Chagres
Salud
María Chiquita
EL Porvenir
San Blas
Río Chepo
Ciudad Panamá
Pto. Caimito
EL Valle
Panonomé
Bejuco
Aguadulce
Golfo de Parita
Golfo de Panamá
Darién
Península de Azuero
Punta Mala
Morro de Puercos
Direction of the Oceanic Current
0
80 miles
FUENTE: TUAN, Y. FU, 1962 "A Coastal Reconnaissance of Central Panama."

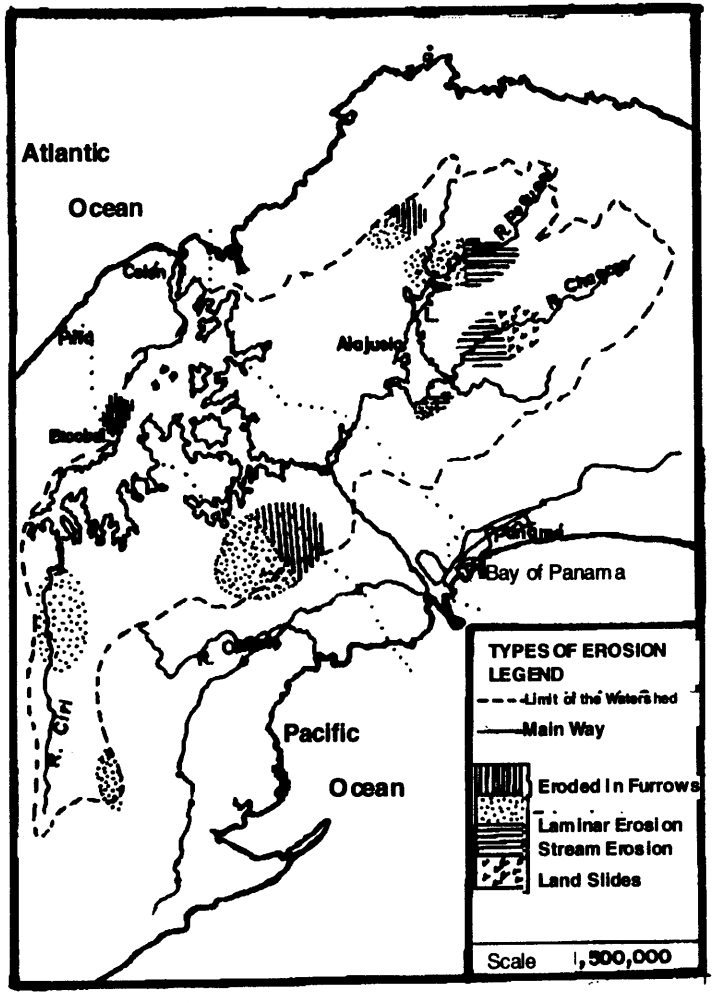
MAP V-5

TYPES OF EROSION



Source ISAZA, César
Factores que influyen en la erosión de la Cuenca. 1986.

TYPES OF EROSION



Source ISAZA, César
Factores que influyen en la erosión de la Cuenca. 1986.

VI. INFRASTRUCTURE IMPACT

6.0 INTRODUCTION

6.0.1 Both, the infrastructure of the project area and the Metropolitan Area will be affected by the impacts of either canal alternative. Most major impacts concerning infrastructure will occur during the construction stage. Infrastructure required for the construction of the alternatives, left as permanent infrastructure after project completion, will serve both the community in the areas outside the jurisdiction of the Panama Canal Authority, or and the communities within the project areas under the control of such Authority.

6.0.2 Indirect impacts are those produced from the growth of the population in the Metropolitan area and the project area due to construction of the alternative. Additional infrastructure would be required to serve the population growth. Information gathered provided in the Socio-Cultural and Population Chapter of this report indicates that the population in the area (La Chorrera to Pacora) will double in the next 15 to 20 years regardless of any announcement of a canal alternative or even the beginning of any such construction works.

6.0.3 The infrastructure demands of this population increase will be great and is being considered by all the infrastructure authorities in their plans for the future. Additional population growth due to construction of either canal alternative will be minimal compared to overall growth envisaged for the area. The Panamanian Government will have to program its investment in infrastructure according to the population growth projections in the area. All available information on this subject shows that each of the institutions concerned with infrastructure is properly preparing for future demands; regardless of whether these plans are executed or not. For the purpose of this report, it is assumed that Panama will be able to invest in its primary infrastructure requirements as they are now discussed in blueprints and/or planning, and no additional planning for infrastructure will be required because of the announcement or construction of either canal alternative. Since the projected population growth in the area is about one million people, if either alternative attracts anywhere from 10,000 to 50,000 additional people, it is an insignificant number when compared to the overall growth. If this growth is related to infrastructure, neither alternative requires the government of Panama to invest a significant additional amount in infrastructure other than already planned.

6.1 ASSUMPTIONS:

6.1.1 PORTS

The port at Rodman will be eliminated by the High-Rise Lock Canal alternative. It is assumed based on current plans that a similar facility will be rebuilt adjacent to the current facility.

The installations of Port Caimito, as well as its present activity will be affected by the excavation and dredging operations. It is assumed that there will be indemnification.

Furthermore, the Panamanian government will have to undertake reconstruction and repairs in the ports of Balboa and Cristobal before the year 2000, and should be able to avoid major damage during construction of the High-Rise Lock Canal.

The basin areas of the ports of Cristobal and Balboa will be affected by the works to widen the waterway, and there will be more sediment due to landslides and dragging operations.

It is further assumed that the Port of Vacamonte will be positively impacted, benefiting from the new structure and other infrastructure, although, from a commercial standpoint, it remains to be seen whether the companies working there share this opinion in view of the type of activities currently being carried out.

6.1.2 ELECTRICITY

Additional electricity requirements due to canal construction will be met by the construction contractor thus not impacting the existing network.

6.1.3 TELECOM-MUNICATIONS

Technology will solve most telecommunications requirements through cellular and other new applicable breakthroughs.

6.1.4 WATER WORKS

At present, the supply of drinking water which is obtained from wells is scarce in the area of Arraijan; therefore it is assumed that the well drilling method may possibly disappear as a consequence of the Sea Level Canal excavations; wells will probably have to be drilled deeper than the present depth of 5 meters approximately.

The High-Rise Lock Canal will have some impact on water because of dredging and sedimentation which will affect the actual volumes of fresh water and treated water.

Pipelines interrupted by the High-Rise Lock Canal in the Atlantic and Pacific sides will be laid anew under the new canal.

The pipeline interrupted by the Sea Level Canal would be reinstalled by means of elevated bridges, since it would be extremely costly to do it otherwise.

Water requirements for human consumption will increase. The Yachiyo ECE Report indicates 4% for municipal use. If the population increases 100% by the year 2010, it is assumed that calculation performed by the Yachiyo group for water needs could be incorrect and alternate water supplies would have to be found.

Alternate water supply for municipal use will probably be required for both alternatives. The present water supply will be contaminated, depleted, or impacted by construction in both cases.

6.1.5 ROAD NETWORK

Wear and tear of the existing road system will be approximately the same in both alternatives.

New road networks will have to be built in the reverted areas of Panama City around planned expressways such as the Corredor Norte and the Corredor Sur.

6.1.6 STRUCTURES For the Sea Level Canal the assumption is that the Yachiyo ECE Report is not rigorous in its estimate of affected structures.

The one kilometer Canal area will permit residents to continue living in the area under the supervision of the Panama Canal Authority.

Some small towns will have to be included in the number of those to be affected along the Sea Level Canal route itself and in the vicinity of the project working area. These, however, have not been taken into consideration by the Yachiyo ECE Report. It is assumed that the Yachiyo ECE Report cost estimates takes into consideration the equipment in the structures of these small towns.

Some structures in the Cocoli and Gatun Housing areas will probably be damaged during the work period.

6.1.7 BRIDGES The Van Dam bridge will be built before the end of the century.

The bridge at Gatun locks can not withstand heavy machinery. For the Sea Level Canal a new bridge across the Gatun route will be built in the year 2060 (only bridges across the Sea Level Canal route, Escobal, and the bridge in the Pacific side). Excavation materials and equipment used in the construction site on the west bank of the existing Canal in the Atlantic side, will have to be transported either by sea or across Panama through the Transisthmian Highway, the Pan-American Highway, and the new access roads built for the project. Therefore, it is assumed that the roads between Colon and the town of Nuevo Chagres will not be impacted by the construction of the Sea Level Canal.

6.1.8 RAILROADS The Panama Railroad will be functioning in excellent conditions by the end of the century.

6.2 METHODOLOGY

6.2.1 All documentation, studies, master plans, maps, and drawings related to the project and Panama were identified. All impacts identified in the bibliography related to the infrastructure of the area were analyzed, ranging from those which are specific and directly relate to the project area, to those that indirectly affect infrastructure on the national level, if so. This Analysis was based mainly on maps indicating existing infrastructure and master plan drawings of future installations plus aerial viewing of the project areas. Figures concerning costs have been obtained from the principal infrastructure agencies in respect of: 1) maintenance of existing infrastructure, 2) relocation, or 3) new required infrastructure. The objective was to determine and specify the impact and its location, quantify it where possible, and then proceed to its evaluation.

6.2.2 This chapter includes an inventory of impacts derived from the Yachiyo ECE Report. From the review of available maps and bibliographies, other impacts were identified specially in the sewage system infrastructure and other categories such as Oil Pipelines and Tank Farms, and Waste Management.

6.2.3 This report also investigated the cost of installing new infrastructure; this information was retrieved from the pertinent agencies such as Instituto Nacional de Telecomunicaciones (INTEL), Instituto de Recursos Hidráulicos y Electrificación (IRHE), Ministerio de Obras Publicas (MOP), Ministerio de Planificación (MIPPE), Ministerio de Vivienda (MIVI) and the Autoridad Portuaria Nacional. Other information was obtained from the Ministerio de Educación and the Dirección Nacional de Estadística y Censo at the Contraloría General de la Republica. A review of present and future plans was performed in order to determine the outlook for infrastructure in the year 2020.

6.2.4 Close relationship was kept with the computer model group to ensure that all infrastructure impacts were made available for analysis of related impacts.

This report illustrates the impacts on the following infrastructure:

1	Water tap and purification plants	9.	Canal
2.	Water distribution	10.	Dams
3.	Sewage treatment and distribution	11.	Construction of access roads
4.	Rain water drainage system	12.	Electrical distribution
5.	Road networks	13.	Telecommunications network
6.	Bridges and access roads	14.	Anchorage sites
7.	Railroads	15.	Waste management
8.	Ports, jetties and facility sites	16.	Oil infrastructure

6.3 IDENTIFICATION AND ANALYSIS OF IMPACTS ON INFRASTRUCTURE

Both alternatives, the Sea Level Canal and the High-Rise Lock Canal will generate impacts on existing and future infrastructure. The impacts of both cases are discussed below in different columns for each case. Whenever there is a more significant impact during construction than after completion, this will be clearly indicated.

On the left column are all impacts related to the High-Rise Lock Canal and on the right column are those related to the Sea Level Canal. Impacts are different on both ends of the Canal (Pacific and Atlantic Sides), and on both sides, the western and eastern sides of the existing and future canals.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.3.1 Water Tap and Treatment Plants Interest lies in quantity and quality of the water supply taken from Madden Lake. The Yachiyo ECE Report discusses the water supply issue in great length. For long-term increase in traffic they recommend storing water outside the Gatun watershed and recycling fresh water. Much emphasis is placed on the need for further studies to ensure that the existing water supply is not polluted by sea water during recycling. Water supply available for the existing operation of the canal is more than sufficient, but in the year 2060 water available for the operation of both canals will barely cover their water requirements. This could seriously impact canal operation and also affect the availability of municipal water.	**Water Tap and Treatment plants** There is more risk of mixing sea water with freshwater with the Sea Level Canal alternative. The Yachiyo ECE Report seriously recommends further studies to ensure sea water does not contaminate existing sources . A freshwater barrier system is proposed but this solution has not been presented clearly and distinctly. By using freshwater as a barrier against linkage of sea water from both oceans, the water needed for the operation of the canal and drinking water supply for municipal use could be affected. Until this issue is resolved, it can not be known how much water will be required to maintain a satisfactory barrier level. These two aspects of water management must be guaranteed:
At the same time, the Miraflores water intake could be affected during Canal construction. This installation will need additional maintenance at the time of flooding, due to possible impacts on the water supply.	1) water quality as it exists today from the tap at Gatun lake, and 2) the availability of water for municipal use.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL

	The impact of the water supply for the Arraijan and La Chorrera towns has not been considered. A plan calls for a water intake and purification facilities utilizing the Caimito River. The Caimito River may be dammed as the means of having an ample supply of drinking water for La Chorrera, but the impact of such an action has not yet been considered in the construction of the Sea Level Canal nor its effects on the freshwater barrier system. There is an interrelationship between the Caimito River's water supply for use in La Chorrera and Arraijan, and the need to maintain a freshwater barrier for the Sea Level Canal. Most of the water supply from the region bordering the Canal route comes from wells. The relationship between the effects of excavation, dredging and additional sedimentation on the river and lakes of the area and well depth could be of impact, even on the existing forest in the region and warrant further studies. Excavation works make surface water tend to seek another level and their current velocities increase, causing bed erosion and sedimentation in deeper areas; therefore, diminishing water volume available on the surface.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.3.2 Water Distribution	**Water Distribution**
Pacific Side:	Pacific Side:
The distribution of water in both the Pacific Side of the Canal originates at Lake Miraflores. The Miraflores pipelines travel to all areas west of the former Canal Zone and to Panama, and they supply water to the old section of Panama City. These pipelines cross the Panama Canal and supply water to the Horoco complex (Howard, Rodman, Cocoli) and Arraijan. These conduits will be affected by the construction of the High-Rise Lock Canal.	Water distribution exists both in Arraijan and La Chorrera. There is a feasibility study for the construction of a water supply system in the Arraijan-La Chorrera. May 1993, plans were completed specifying 16" water main from San Jose (Arraijan) to La Chorrera; construction is planned in 1994. This plan will be affected by the canal excavation.
Atlantic Side:	Atlantic Side:
The water treatment plant in Colon is in Mount Hope. Water is distributed to the City of Colon and to all the former Canal Zone areas including Ft. Davis, Ft. Gulick, and the town of Gatun. The construction of the new set of locks at Gatun will affect this pipeline.	The Sea Level Canal outlet is on the Atlantic side, near the town of Nuevo Chagres. Minor impacts on the distribution system could be caused by the Sea Level Canal alternative.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.3.3 Sewage Treatment and Distribution	**Sewage Treatment and Distribution**
Pacific Side:	Pacific Side:
On the east/north side of the canal, sewage is routed and treated before it is dumped into the ocean. Sewage control and distribution on the west/south side of the Canal is done independently of the east side. Because both sides treat their sewage independently, the construction of the new High-Rise Lock Canal does not have an impact on the sewage infrastructure.	At present, neither La Chorrera nor Arraijan have waste-water sewage systems. Houses rely on individual septic tank systems. These will not be affected. IDAAN is considering building a system for La Chorrera, which would be affected, since its discharge would be in the Matias Hernández river run-off to the west.
Atlantic Side:	Atlantic Side:
On the east side of the canal, the town of Gatun will be separated from Colon by the new High-Rise Lock Canal. Sewage treatment at Gatun is in the town and it will not be affected in any major way by the new construction.	The town of Nuevo Chagres has a small septic tank system and only minor impacts are probable if the route for the new Canal is chosen to pass by this site.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.3.4 Water Diversion System (Rain Water Drainage)	**Water Diversion System (Rain Water Drainage)**
Pacific Side:	Pacific Side:
There is an extensive water diversion infrastructure on the east side of the Canal. Because most of the construction of the new High-Rise Lock Canal will occur on the west bank, these structures will not be affected. The existing water drainage system in the west bank will be impacted by the new construction and the infrastructure will have to be modified in order to reroute the waters toward the ocean.	No existing water diversion infrastructure exist along the alignment of the Sea Level Canal. The construction of the new Canal should not affect the drainage systems of either La Chorrera or Arraijan.
Atlantic Side:	Atlantic Side:
The new High-Rise Lock Canal disrupts the existing drainage system in the towns of Gatun, Ft. Davis, and Ft. Gulick. The infrastructure will have to be modified according to the new location of towns in respect of the new locks.	The diversion system on the Atlantic side would not be affected by the new Sea Level Canal.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.3.5 Road Network Pacific Side: The construction of the new High-Rise Level Canal will not directly affect the roads on the east bank of the Canal, i.e., the new route does not intersect any roads in the Pacific east side. All roads would feel the impacts of additional traffic caused by the new construction. The Ministry of Public Works (MOP) would have to budget large sums of money for maintenance of the Boyd-Roosevelt Highway (Colon-Panama Transisthmian Highway), the Gaillard Highway and other small roads in and around Colon and Panama City. The Yachiyo ECE Report indicates that they were not able to study traffic requirements, but did mention that most roads around Panama City and Colon are already saturated.	**Road Network** Pacific Side: All roads affected by the building of a new Sea Level Canal are indicated in the Yachiyo ECE Report. Considering the amount of additional traffic that will be traveling on the existing secondary and primary roads, due to increase in traffic directly and indirectly related to the construction of the new canal, existing roads will require intensive additional maintenance in order to withstand the additional wear and tear.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
On the west bank, the Yachiyo ECE Report clearly indicates all the roads that will be impacted by the construction of the new set of locks. The most affected roads will be the Borinquen Highway and Bruja Road. Maintenance needs were not calculated in the existing Borinquen Highway nor in the new construction access roads connected to it once excavations on this side of the Canal are started. This could impact the operation of the existing Canal if it is not taken into consideration. Atlantic Side: On the east bank (Gatun township) the main road traveling from Colon to Gatun will be interrupted. The Yachiyo ECE Report clearly states the roads which will be affected, and the new access roads which must be built to join the new bridge and other sites cut off by the new canal locks. Roads will not be affected in the west bank because the major part of the works cross the existing Canal on the Gatun side of the locks.	Atlantic Side: The Yachiyo ECE Report proposes alternative routes for all minor roads that are affected in the Atlantic side of the Canal.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL

Transisthmian: The existing road network between Panama and Colon will be impacted to about the same degree by either alternative.	Transisthmian: The existing road network between Panama and Colon will be impacted to about the same degree by either alternative. A new transisthmian highway will be built.
6.3.6 Bridges and Access Roads Pacific Side: The major impact on the Pacific side is the removal of the existing bridge because the entrance of the Canal has to be widened for vessels of up to 150,000DWT and 200,000DWT. A new bridge will have to be built, including access roads. The new bridge and access roads have all been properly included in the cost estimates. Atlantic Side: Because of the construction of the new canal on the east bank of the existing Canal, a new bridge will have to be built. Gatun will be totally cut off from the mainland except for the new bridge to be constructed. For the existing Canal to be able to continue to operate this new bridge would have to be constructed before excavation.	**Bridges and Access Roads** The Yachiyo ECE Report recommends that 3 bridges be built during the initial construction phase in the year 2020. The three bridges recommended are a bridge to be used by the highway and the Pan American Highway, a bridge at the Atlantic end of the Canal near the town of Nuevo Chagres, and a bridge over the Canal near the town of Escobal. The cost estimates include the construction of these bridges and their access roads. The report also recommends no additional bridges to be constructed over the existing Canal until the year 2060. This contradicts local expectations which indicate that the Van Dam bridge will be built earlier. If the Van Dam Bridge is built before the start of the new Sea Level Canal, the impact on the construction of the canal will be positive because the transportation of materials to and from the construction sites will be facilitated by the new infrastructure.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.3.7 Railroads Pacific Side: The High-Rise Lock Canal may require the use of the railroad as a means of transportation of materials along the Canal. However, it will require rehabilitation of the railway tracks. Atlantic Side: The existing railroad will be impacted by the High-Rise Lock Canal in several locations at Gatun; however, the National Transportation Study proposed to relocate the Gatun Station on the East side of what would be the new set of locks. Should this be the case, the High-Rise Lock Canal would not intersect the railway.	**Railroads** Pacific Side: The Sea Level Canal will have no direct impact on the existing railroad. Atlantic Side: A railway will be built to provide access to the Atlantic side of the Canal from the Pacific side, passing over Gatun Lake. This infrastructure could continue to be used after completion of the project. For operational purposes, it does not interfere with the National Railroad, however, there will be additional cost to maintain and operate. It is a duplicate of the existing operation that has yet to become productive.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
HIGH RISE LOCK CANAL	**SEA LEVEL CANAL**
6.3.8 Ports, Jetties and Facility Sites	**Ports, Jetties and Facility Sites**
<u>Ports</u>	<u>Ports</u>
Pacific Side:	Pacific Side:
The new canal alignment at the entrance of the Canal passes over the piers at Rodman. If this occurs, the Rodman port will no longer be functional. Preliminary studies by various private groups in Panama are promoting the development of a major port area on the Rodman site. The new route impacts this concept.	The investment around the Port of Vacamonte will be an improvement, and could become an active port area. The port of Caimito exists on the western side of the new Canal. This small port is used by a private group under concession from the Autoridad Portuaria Nacional. It is assumed that this minor port facility will be affected by the construction of the new Canal; it is also assumed that this entire area will become a maritime center; thus a new port will have to be rebuilt in Caimito, and the area with the area benefiting from this investment. Existing port facilities are useless for a major port.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
Atlantic Side: The widening of the access to the locks at Gatun will seriously affect the existing ports in Colon. Maintenance and major overhaul in these ports has not been adequate and major overhauls would be necessary to ensure that they will not be affected by new dredging. Puerto Pilon will receive a positive impact due to the new structures and infrastructure. Jetties New jetties or small wharfs will be constructed at the entrance of the Canal and on the route. These are new installations that do not impact present infrastructure. But, the impact would be positive if these wharfs were made available to the tourism industry for tourism-related marine traffic. **Logistic Base Facilities** Logistic Base Facilities will be required to assist the construction of the new High-Rise Lock Canal. The project calls for massive investment in port facilities, warehousing, access roads and port infrastructure. These facilities will be a positive addition to the existing infrastructure in the area and will enhance the facilities of the pier.	Atlantic Side: No major ports exist in the Atlantic side of the Sea Level Canal. Puerto Pilon will receive a positive impact due to the new structures and infrastructure. Jetties Small piers will be constructed at the entrance of the Sea Level Canal and along the route. This new infrastructure could be useful if there is a growth in the tourism industry. **Logistic Base Facilities** Logistic Base Facilities will be required to assist the construction of the new Sea Level Canal. The project calls for massive investment in port facilities, warehousing, access roads and port infrastructure. These facilities will be a positive addition to the existing infrastructure in the area and will be a duplication of the existing facilities of the Panama Canal Commission.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
7.3.9 Dams Additional dams are needed to compensate for water loss during the operation of the Canal. These new infrastructures will flood existing rain forest areas. Although no infrastructure exists in these site, the possibility of using the locked water for municipal needs could be a positive impact. Also, they can be used for electrical power source.	**Dams** One dam is needed by the year 2020 to cover the additional water required by the existing Canal's additional traffic volume. This new infrastructure will flood existing rainforest areas, but could be useful as a source of drinking water to be used by the municipality and/or for power generation.
7.3.10 Construction Access Roads Construction access roads will be built in the Pacific side to the west of the excavation. Access roads will also be built in order to reach quarry sites, facility sites, and dam sites.	**Construction Access Roads** An inter-isthmian road will be constructed to assist in the construction of the new canal. This road will remain permanently and can be used for maintenance and future development of the area.
7.3.11 The Panama Canal Beyond schedule adjustments, the existing Canal will not be impacted during construction.	**The Panama Canal** The barrier dams in Lake Gatun will restrict water from the available pool for the current Canal.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
7.3.12 Electrical Distribution Pacific Side: Two electrical distribution systems operate simultaneously in Panama. The Panama Canal Commission's system provides energy for the operation of the Canal and for the US military bases through an agreement with the Government of Panama. Panama provides energy to the bases utilizing the infrastructure provided by the US prior to the Canal Treaties. The electrical distribution system that crosses the existing Canal will be impacted by the construction of the new canal. Panama could supply energy to the Horoco complex from the west bank, but this would require additional investment in infrastructure. The conduit crossing the canal at Miraflores and connects to the Horoco complex will be intersected by the new High-Rise Lock Canal.	**Electrical Distribution** Pacific Side: The main power line to Panama City that comes from Chiriqui, crosses the new Sea Level Canal alignment and will be impacted by the new construction. Presently this power line crosses high above the existing Canal and will probably cross the new canal at similar height. Realignment of towers will be necessary. Electrical distribution between La Chorrera and Arraijan will be impacted by the new construction. Power distribution network among small towns at the present time in the La Chorrera-Arraijan area are interconnected to the La Chorrera-Arraijan Substation will be affected during construction of the new Sea Level Canal.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
IRHE's high-voltage power lines coming from the hydroelectric plants in Chiriqui cross above the existing canal at a point north of the Miraflores locks. These lines will be impacted by the construction of the new set of locks. Realignment of towers will be necessary. A planned 500KW line connecting power generation from Chiriqui to Panama will be impacted by the new construction. Atlantic Side: Because the new High-Rise Lock Canal alignment crosses between the existing locks and the town of Gatun, the main electrical distribution system will be affected.	By the year 2020 a new 500KW line programmed to cross the isthmus from Chiriqui to Panama, will be impacted by the new construction. Some electrical systems along the route will be interrupted. Atlantic Side: The electrical infrastructure on the Atlantic side will be affected mainly at the canal crossing.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.3.13 Telecommunications Network The Panama Canal Commission has a telephone cable crossing the Canal through the Bridge of the Americas. Panama uses this cable and has plans to install a nationwide fiber optics cable in a few years. Both the cable and the plans for the new cable would be affected by the new construction. By the year 2000 much of the existing long- distance and intercity calls will be made using high technology microwave and cellular connections using satellite interconnections. The new construction should not impact these types of communications.	**Telecommunications Network** INTEL has rural telephone systems installed throughout the Republic of Panama. INTEL plans to install a public telephone exchange in the town of Nuevo Chagres in the near future. The connection from the exchange in Colon or Panama to Nuevo Chagres will be using air waves and will not be affected by the new construction except in cases of blasting. By the year 2000/2020 technology will have advanced to a point that telecommunications will be available to this remote area at a low cost.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
There are a number of radio-controlled stations installed along the Canal route. Many of these stations could be affected by the blasting that is going to take place during construction. Care should be taken to safeguard these installations during the construction stage.	Telecommunications will be needed during the construction phase and post-construction operations.
HIGH-RISE LOCK CANAL	**SEA LEVEL CANAL**
6.3.14 Structures (housing, industry and others)	**Structures (housing, industry and others)**
Pacific Side: Some structures at the Cocoli housing complex will be affected. The Yachiyo ECE Report mentions problems that could arise from the blasting, but they emphasize that existing technology can be applied to absorb the shocks of the blasting so that other housing areas are not affected.	The Yachiyo ECE Report has not identified all the housing to be affected by the new canal construction which must be taken into consideration before damming the river by year 2020. There are small population centers such as Cerro Azul and some sparse houses along the rivers, as well as 20 other sites along the route or in areas, which will be affected as well. This data could change drastically and the cost of buying land along the route could be expensive.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
Atlantic Side: Some housing and buildings will be affected in the township of Gatun by the Gatun crossing of the new High-Rise Lock Canal. Dam areas are envisaged for the Rivers Ciri, Trinidad and Indio, though the Yachiyo ECE Report specifies no flooded areas. Part of them appear on the maps provided with the report. In these areas there are small towns of up to 250 inhabitants which will have to be relocated before the year 2020.	If the government of Panama was to announce any intention to build a Sea Level Canal 10 years before construction, land speculation along the route might be a major influence to assignment of costs for the lands needed for the construction. Simultaneously, present owners would raise land prices immediately. Once the route and alternative have been decided, more extensive censing will be required. To be able to arrive to more realistic cost figures, field studies would be required covering the economic and physical situation of the live-in structures, their schools, health centers, churches, and community centers. The government will have to draft urban development plans for relocated areas, to avoid problems such as those experienced in Alto Bayano.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.3.15 Anchorage Sites	**Anchorage Sites**
Crossing average 9 hours, the wait as an average is from several hours to two days for small ships to be added to the additional larger ships, which will have to wait an average of 11 hours before crossing the Canal. This will create a waste problem and pollution of beaches and ocean water which the municipality of Panama is not prepared to address.	Anchorage sites are mentioned as infrastructure because there are moorage buoys in place, both permanently placed and temporary. The number of existing smaller ships crossing the canal can wait several hours to two days. There are larger ships which will have to wait an average of 11 hours before crossing the Canal. This will create a waste problem and pollution of beaches and ocean water which the municipality of Panama is not prepared to address.
6.3.16 Waste Management	**Waste Management**
Waste management is viewed as function of the infrastructure management of the municipality. Waste will be generated by the additional work force, the additional migrant community, and by the additional ships using the canal.	Waste management is viewed as function of the infrastructure management of the municipality. Waste will be generated by the additional work force, the additional migrant community, and by the additional ships using the canal.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.3.17 Oil Pipelines and Tank Farms	**Oil Pipelines and Tank Farms**
An existing pipeline crossing the isthmus alongside the existing Canal is not in use at present according to the Yachiyo ECE Report. It is the pipeline extending from the Arraijan Tank Farm to the existing Canal and it will be affected by the new construction.	Unless another pipeline is installed in the vicinity of the Route 10 alignment, the new construction should not affect any existing petroleum infrastructure in the area.

6.4 CATEGORIES OF IMPACTS

The impacts on present and future infrastructure are listed in diminishing order of importance:

IMPORTANT IMPACTS FOR EVALUATION AND DISCRIMINATION PURPOSES:

6.4.1 DRINKING WATER SUPPLY

Drinking Water Supply

6.4.1.1 The availability of water primarily related to Canal operations and use is first addressed in the Yachiyo (ECE) report. The possibilities of tapping fresh water that could be contaminated by sea water, or by the need to dig extremely deep wells cannot be determined without further studies by hydrogeological experts The Sea Level Canal alternative with its relative depth of excavation appears to be the most risky for the ground water supply especially, if the water lens is cut by excavation works.

6.4.1.2 Significant amounts of water for municipal use will be required for the La Chorrera-Arraijan area. The Sea Level Canal will have an impact on future, planned new infrastructure, and will deplete water supplies in the areas should the water barrier system be possible.

6.4.2. PORTS: The High-Rise Lock canal alternative eliminates the Port at Rodman. Current Government of Panama planning calls for the development of this facility as a commercial port as an extension of the Balboa port complex. The cost of replacing this facility is very high, and as an impact ought to be considered in the light of current planning.

6.4.3 STRUCTURES

6.4.3.1 Structures, housing and other minor facilities (no more than 100) will have to be replaced in Gamboa and Cocoli are affected by the High-Rise Level Canal alternative. Further planning should take this into account should this alternative be selected.

6.4.3.2 It is estimated that approximately 1000 structures will be affected by the Sea Level Canal alternative, including small towns along the river of the Sea Level Canal route and structures within the dammed water areas. The Yachiyo ECE Report identifies 2 town sites and 5 camps for the Sea Level Canal alternative versus one town site and 1 camp for the High-Rise Lock Canal alternative.

6.4.4. ROADS

6.4.4.1 The Sea Level Canal requires construction of a new transisthmian highway and new construction roads which will provide better access to the Panamerican Highway and the Arraijan-La Chorrera Freeway for some remote towns.

6.4.4.2 The construction of the Sea Level Canal alternative will require greater use of the existing road network and the Pan-American Highway resulting in increased maintenance costs, traffic congestion and longer travel time.

6.4.5 BRIDGES

6.4.5.1 The ECE report provides an allowance for the Van Dam (Simón Bolívar) bridge over the current canal and the new High-Rise Lock canal in the year 2060. As currently planned, the Van Dam (Simón Bolívar) bridge will be built by Panama before the year 2000; this bridge will not span over the future facilities of the High-Rise Lock canal. If the High-Rise Lock Canal is selected, planning for the construction of the Van Dam

(Simón Bolívar) bridge will be directly affected. If Panama does not allocate resources to accommodate the enlarged span prior to construction or final design of the High-Rise Lock Canal alternative, this will be a direct negative impact.

6.4.5.2 The current bridge at Gatun locks does not have the capacity for heavy machinery to cross. For the Sea Level Canal, a new bridge across the Gatun route is not to be built until the year 2020 (only the bridges across the Sea Level Canal route, Escobal, and the bridge on the Pacific side); All materials and equipment used in the construction site on the west bank of the existing canal (on the Atlantic side) will have to be transported either by sea or across Panama using the trans-isthmian highway, the Pan-American Highway, and new access roads built for the project. Therefore, the roads between Colon and the town of Nuevo Chagres will not be impacted by the construction of the Sea Level Canal.

6.4.6 OIL INFRASTRUCTURE

The High-Rise Lock Canal alternative affects small tank farms at Rodman Naval Base and on the town of Gatun.

IMPACTS THAT ARE THE SAME FOR BOTH ALTERNATIVES:

6.4.7 Water distribution network

Existing water distribution networks, will be affected both with the Sea Level Canal and the High-Rise Lock Canal alternatives. These costs are low and will have no significant bearing on other construction costs.

6.4.8 Sewage Treatment

Sewage treatment facilities and collection/distribution networks will have to be installed for the expected population growth regardless of the canal alternatives.

6.4.9 Road Network

The existing road network between Panama and Colon will be affected in about the same degree by the construction of either alternative.

6.4.10 ELECTRICAL

Electrical towers for high-voltage power lines and projected lines will be affected equally by both alternatives. The Sea Level Canal will affect distribution lines along the Canal alignment route, and in the case of the High-Rise Locks Canal distribution lines will be affected in the towns of Gatun and Cocoli.

6.4.11 TELECOMMUNICATIONS

Existing telecommunication lines will be affected equally in both alternatives. There will impacts on lines along the route of the High-Rise Lock Canal at both ends of the Canal, and lines to be affected by the Sea Level Canal are those along the route between La Chorrera and Arraijan. However, technology should alleviate the effect.

6.5 COST ESTIMATES

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.5.1 Tap water and treatment plants BEST CASE: Minor costs will be incurred because of alteration of tap water at Miraflores due to dredging works. It was not possible to determine the cost with available information. WORST CASE: New dams built for retention of water and the installation of a new water tap. COST: $ 30 Million.	**Tap water and purification** Wells: About 100 new individual wells will have to be dug: Aqueduct wells cost $30,000.00 each for a total of $300,000.00. Cost: $500,000. PANAMA CITY AND COLON: If the lakes are contaminated, a new water supply source will have to be built. Cost: $25 Million.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
	LA CHORRERA AND ARRAIJAN The use of fresh water for a barrier against sea water will deplete the water supply in the La Chorrera area. Water treatment plant and capacity of production will be impacted by excavation at La Chorrera. Cost of a new water supply source: $ 25Million.
6.5.2 Water Distribution	**Water Distribution**
Pacific Side: Cost of replacing water pipeline that will be affected between Miraflores and Howard: 3 pipelines (1993 prices): 2 of 16" I.D.=$520,000. 1- 24" I.D.= $400,000. Plus tunnel cost to be determined. Cocoli town site: Cost: $500,000.	Pacific Side: Replacement of water conduit cut by the Sea Level Canal route between La Chorrera and Arraijan. 1- 16" diameter. Cost $500,000.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
Atlantic Side: Cost of replacing pipelines from Mount Hope to Gatun cut by the new construction, includes two pipelines of 12" diameter at $160,000 each, plus other works. Total cost: $500,000.00.	Replacement of water distribution near La Chorrera and Puerto Caimito. Cost: $1Million. Atlantic Side: Cost of impact on water distribution near the town of Nuevo Chagres is minor.
HIGH RISE LOCK CANAL **6.5.3 Sewage Treatment and Distribution** Pacific Side: There will be some minor impacts in the Cocoli area. Cost $ 250,000. Atlantic Side: Minor impacts in the town of Gatun: Cost: $ 250,000.	**SEA LEVEL CANAL** **Sewage Treatment and Distribution** Pacific Side: No impact on infrastructure anticipated. Atlantic Side: No impact anticipated on infrastructure due to the canal construction.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.5.4 Rain Water Drainage Pacific Side: On the west side of the bank, the existing drainage system will be affected by the new construction and the infrastructure will have to be modified in order to reroute the waters to the ocean. Cost: Minor. Atlantic Side: The new High-Rise Lock Canal disrupts the existing drainage system of the town of Gatun, Ft. Davis and Ft. Gulick. The infrastructure will have to be modified to adapt it to the towns new position in respect of the new locks. Cost: Approximately $1Million.	**Rain Water Drainage** Pacific Side: The Sea Level Canal will affect the drainage systems of La Chorrera and Arraijan and there will be a need to provide increased drainage to prevent mosquito growth. Atlantic Side: The drainage system on the Atlantic side would not be affected by the new Sea Level Canal.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.5.5 Road Network Pacific Side: The trans-isthmian highway is going to be affected by the construction of the High Rise Lock Canal: Additional $2 Million per year, maintenance cost in 10 years: $20Million.	**Road Network** Pacific Side: Additional wear and tear on the Pan-American Highway, on the Transisthmian Highway and on the Highway due to the construction of the Sea Level Canal. Cost: $2Million per year, maintenance cost in 12 years: $24 Million.
Atlantic Side: No impact due to the construction of the Canal on the west bank of the Atlantic side. The east bank will be affected by the additional traffic between Colon and Gatun: Cost $500,000 per year. In 10 years: $5Million.	Atlantic Side: It is assumed that heavy machinery cannot cross the bridge at the Gatun locks. Therefore the road between Colon and the construction site will not be affected by additional traffic.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.5.6 Bridges and Access Roads Pacific Side: The new bridge will positively impact the flow of traffic between the east and west banks of the existing Canal. There is a positive economic impact. Atlantic Side: No impact on existing or future infrastructure caused by the building of the new bridge.	**Bridges and Access Roads** The new infrastructure left behind as permanent will have positive effects on the area near the town of Nuevo Chagres in the Atlantic side.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.5.7 Ports, Jetties and Facility Sites Ports Pacific Side: Replacement of the port of Rodman: The impact is to planning: Cost $100,000. Balboa Port enhancement required because of new dredging: Cost $7Million. Atlantic Side: Reinforcing existing ports due to widening of existing approach channel. Cost $7Million.	**Ports, Jetties and Facility Sites** Ports Pacific Side: The enhancement of the Port of Vacamonte will have positive effects on the area. The Port of Caimito may be impacted by competition. Atlantic Side: No major ports exist on the Atlantic side of the Sea Level Canal.
Jetties New jetties or small wharfs will be constructed at the entrance of the Canal and on the route. These are new installations that do not affect the present operation of the Canal infrastructure. But, the impact would be positive if these wharfs were made available to the tourism industry for tourism -related marine traffic.	Jetties Small piers will be constructed at the entrance of the Sea Level Canal and along the route. This new infrastructure could be useful to the tourism industry, if developed, on the Atlantic side.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
Logistic Base Facilities Logistic Base Facilities will be required to assist the construction of the new High-Rise Lock Canal. The project calls for massive investment in port facilities, warehousing, access roads and port infrastructure. These facilities will enhance the existing infrastructure in the area. **6.5.8 Dams** Additional dams are needed to compensate for water loss during the operation of the Canal. These new infrastructures will flood existing rain forest areas. Although no infrastructure exists in these sites, the possibility of using locked water for municipal consumption could be a positive impact. Cost of relocating displaced families: 571 units at $50,000 per unit: Cost $25 Million.	Logistic Base Facilities Logistic Base Facilities will be required to assist the construction of the new Sea Level Canal. The project calls for massive investment access roads and port infrastructure. These facilities will duplicate existing facilities while enhancing the existing infrastructure in the area. **Dams** One dam is needed by the year 2020 to provide additional water required by the existing Canal's greater traffic volume. This does not impact other infrastructure in the area, but could be useful as an intake for water to be used by the municipality. Cost of relocating displaced families: 50 units at $50,000 per unit = $2.5 Million.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.5.9 Construction Access Roads Construction access roads will be built on the Pacific side to the west of the excavation. Access roads will also be built in order to reach quarry sites, facility sites, and dam sites.	**Construction Access Roads** An inter isthmian road will be constructed to assist in the construction of the new Canal. This road will be left as a permanent road to be used for maintenance and future development of the area.
6.5.10 Electrical Distribution Pacific Side: A power station on the west side of the existing canal will be affected: Cost: $1 Million. A new line and its respective towers will have to be installed over the new ditch: Cost: $1 Million. Should they be required, the underground lines from Miraflores to the Cocoli area along the path of the new route will have to be temporarily installed overhead: Cost: $2 Million	**Electrical Distribution** Pacific Side: The main electrical power line coming from Chiriqui will cross the new Sea Level Canal alignment will be affected by the new construction. Cost: $1 Million. Electrical distribution between La Chorrera and Arraijan will be affected by the new construction. Cost: $2 Million. Power distribution for small towns in the La Chorrera area are connected to the La Chorrera-Arraijan sub-station. This distribution network will be impacted. Cost $2 Million.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
Electrical distribution in Cocoli will be affected: Cost: $2 Million.	A new 500 KW line programmed to cross the isthmus will also be affected by the new Sea Level Canal. Cost: $1 Million.
Atlantic Side:	Atlantic Side:
The new High-Rise Lock Canal alignment crosses between the existing locks. Due to this, the electrical distribution system in the town of Gatun will be affected.	The Sea Level Canal electrical infrastructure in the Atlantic Side will only be affected at the Canal crossing. Cost: $1Million
Impact on existing sub-station: Cost: $2 Million.	Distribution network in the Nuevo Chagres town area will be affected: Cost: $1 Million.
6.5.11 Telecommunications Network	**Telecommunications Network**
The Panama Canal Commission and the US Army have telephone cables that cross the Canal through the Bridge of the Americas. Panama uses this cable and has plans to install a nationwide fiber optics cable in a few years. Both the cable and the plans for the new cable would be impacted by the new construction. Replacement of existing network, tied to new bridge: Cost $3 Million.	INTEL has rural telephone systems installed throughout the republic. This will be the case of the town of Nuevo Chagres on the Atlantic end of the new Sea Level Canal. By year 2000/2020 technology will have advanced to a point that telecommunications will be available to this remote area at a low cost. Telecommunications will be needed during the construction phase and the post construction operations. Relocation of lines under the Canal crossing at La Chorrera. Cost: $500,000.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.5.12 Structures (housing, industry and others) Pacific Side: Some structures in the Cocoli housing area should be impacted. The Yachiyo ECE Report mentions problems that could arise from the blasting, but they emphasize that there exists technology capable of absorbing the shocks of blasting. Yachiyo does not specify further. Atlantic Side: Some housing and buildings will be affected at the Gatun crossing and in Ft. Davis. Yachiyo considered the cost of this replacement to be $105Million. This report estimates this cost to much less: 200 units at Cocoli, Gatun, and Ft. Davis at $200,000 per unit involve a cost of $40Million.	**Structures (housing, industry and others)** The Yachiyo ECE Report has not identified all the housing to be affected by the new Canal construction. The Yachiyo ECE Report has calculated the unit cost per housing at $50,400 each; $38,400 in relocation and $12,000 in compensation. This reports estimates the land cost at $7,550,380 and a compensation is provided for 269 dwellings for a total sum of $13,357,600. Out of the entire sum of $13,357.600 for 269 dwellings, Yachiyo estimates $7,560,300 for 150 houses. Additional structures not identified by the Yachiyo ECE Report add up to: 1200 units at $54,000 per unit for a total cost of $65Million. Yachiyo ECE Report says $40Million, a difference of $25Million.
6.5.13 Anchorage Sites Impact of recovering waste material from ships anchored in these sites: Cost: not possible to determine from available information.	**Anchorage Sites** Impact of recovering waste material from ships anchored in these sites: Cost was not determined.

HIGH-RISE LOCK CANAL	SEA LEVEL CANAL
6.5.14 Waste Management Waste management is a function of the infrastructure management of the municipality. Waste will be generated by the additional work force, the additional migrant community, and by the additional ships using the canal. It was not possible to determine cost.	**Waste Management** Waste management is mentioned as a function of the infrastructure management of the municipality. Waste will be generated by the additional work force, the additional migrant community, and by the additional ships using the Canal. It was not possible to determine cost.
6.5.15 Oil Pipelines and Tank Farms Pacific: An existing pipeline that crosses the isthmus is not in use according to the Yachiyo ECE Report. The pipeline that extends from the Arraijan Tank Farm to the existing Canal will be affected by the new construction. Cost: $1 Million. If required, the small tank farm has to be relocated near Cocoli/Rodman Naval Base. Cost: $3 Million. Atlantic: A small tank farm is affected by the route of the High Rise Lock Canal: Cost $3 Million.	**Oil Pipelines and Tank Farms** Unless another pipeline is installed in the vicinity of the Route 10 alignment, the new construction should not affect any existing oil infrastructure in the area.

6.6 CONCLUSIONS

The conclusions are based on the summary of impact cost on the infrastructure. For the purpose of defining positive infrastructure balance due to infrastructure that is left behind by the construction of the canal can only be quantified positively by the cost of the investment.

Figure VI-1
Table of Final Cost of Impacts

INFRASTRUCTURE	HIGH-RISE LOCK CANAL		SEA LEVEL CANAL	
	DESCRIPTION (Impacts)	COST	DESCRIPTION (Impacts)	COST
WATER TAP AND PURIFICATION PLANTS	New dam for retention of water and new water tap:	30M	New wells	.5M
			PANAMA CITY AND COLON -New dam for drinking water supply	25M
			LA CHORRERA AND ARRAIJAN	
			La Chorrera-Arraijan pipeline replacement	.5M
			La Chorrera water supply infrastructure	35M
WATER DISTRIBUTION	Water pipeline on the Miraflores-Howard route.	.5M	Water distribution system near La Chorrera and Puerto Caimito	1M
	Water pipeline on the Mount Hope-Ft. Davis route.	.5M		
	Cocoli water distribution system.			

Figure VI-1
Table of Final Cost of Impacts Continued

INFRASTRUCTURE	HIGH-RISE LOCK CANAL		SEA LEVEL CANAL	
	DESCRIPTION (Impacts)	COST	DESCRIPTION (Impacts)	COST
SEWAGE TREATMENT & DISTRIBUTION NETWORK	Minor impacts in the town of Gatun. Cocoli sewage distribution system	.25M	No major cost(impact on major or small town sites)	
RAIN WATER DRAINAGE SYSTEM	Construction of new water drainage in Rodman. Construction of new water drainage in Gatun.	.25M 1M	No major cost(impact on major or small town sites) New infrastructure (Spillways)	
ROAD NETWORKS	Additional maintenance of the trans-isthmian highway. Additional maintenance of the Colon-Gatun highway.	5M 1M	Additional maintenance of the trans-isthmian highway.	5M
BRIDGES & ACCESS ROADS	New infrastructure		New infrastructure, specially crossing Gatun and access to Nuevo Chagres.	
RAILROADS	New routing of railroad on the Atlantic Side.		No cost.	
PORTS, JETTIES AND FACILITY SITES	New infrastructure		Enhancement of the Port of Vacamonte	
CANAL	30 day canal closing	UA	No cost.	
DAMS	New infrastructure Impact on existing housing to be flooded.	$25M	New infrastructure for the year 2060. Impacts of floods	$2.5M
CONSTRUCTION ACCESS ROADS	New infrastructure		New trans-isthmian highway and other smaller roads.	

Figure VI-1
Table of Final Cost of Impacts Continued

INFRASTRUCTURE	HIGH-RISE LOCK CANAL		SEA LEVEL CANAL	
	DESCRIPTION (Impacts)	COST	DESCRIPTION (Impacts)	COST
ELECTRICAL DISTRIBUTION	Replacement of power station. Realignment of towers. Subterranean lines crossing between Miraflores and Howard. Electrical distribution in Cocoli. Electrical distribution Atlantic	2M 1M 2M 2M 2M	Realignment of high power line crossing canal. Electrical line between La Chorrera and Arraijan. Electrical distribution in towns near La Chorrera. Realignment of 500kw line to be installed before year 2020. Electrical distribution and canal crossing at the town of Nuevo Chagres.	1M .5M 1.5M 1M 2M
TELECOMMUNICATIONS NETWORK	Replacement of telephone lines running under the existing bridge. Telecommunication distribution in Cocoli. Telecommunication distribution in Gatun.	3M 1M 1M	Replacement of telephone lines between La Chorrera and Arraijan.	.5M
STRUCTURES	Housing in Gatun and Cocoli	105M Yachiyo ECE Report 40 M IOP Report	Housing along the Sea Level Canal route (three small towns and dispersed housing along the route not necessarily identified in the Yachiyo ECE Report.	25M Additional Total = 65M
ANCHORAGE SITES	Waste Recovery	2M	Waste recovery	N/A

Figure VI-1
Table of Final Cost of Impacts Continued

INFRASTRUCTURE	HIGH-RISE LOCK CANAL		SEA LEVEL CANAL	
	DESCRIPTION (Impacts)	COST	DESCRIPTION (Impacts)	COST
WASTE MANAGEMENT	Waste Recovery in the area.	2M	Waste recovery in the project area.	N/A
OIL INFRASTRUCTURE	Replacement of pipeline at the Rodman crossing. Replacement of the pipeline at the Gatun Crossing. Small tank farm at Rodman. Small tank farm at Gatun.	1M 1M 3M 3M	No oil infrastructure in the area.	
TOTAL COST				

6.7 SIGNIFICANT FINDINGS AND CONCLUSIONS

6.7.1 Drinking Water Supply

The availability of water for municipal and Canal use is first addressed in the Engineering Cost Estimates in the Yachiyo (ECE) report. The possibilities of tapping fresh water that could be contaminated by sea water, or by the need to dig extremely deep wells cannot be determined without further studies by hydrogeological experts The Sea Level Canal alternative appears to be the most risky, particularly if the water lens is cut by excavation works. Likewise, significant amounts of water for municipal use will be required for the La Chorrera-Arraijan area. The Sea Level Canal will have an impact on future, planned new infrastructure, and deplete water supplies for the water barrier system in the area.

6.7.2 Ports: The High-Rise Lock Canal alternative eliminates the Port at Rodman. Current Government of Panama planning calls for the development of this facility as a commercial port as an extension of the Balboa port complex. The cost of replacing this facility is very high, and as an impact ought to be considered in the light of current planning.

6.7.3 Structures: It is estimated that approximately 1000 structures will be affected by the Sea Level Canal alternative, including small towns along the river of the Sea Level Canal route and structures within the dammed water areas.

6.7.4 Roads: The Sea Level Canal alternative will have favorable effects due to a new trans-isthmian highway and new construction roads that will enable some remote towns to have better access to the Pan-American Highway and the Arraijan-La Chorrera Freeway. Likewise, to a lesser extent, the High-Rise Lock alternative provides a positive impact by the upgrading roads and bridges.

6.7.5 Bridges

The ECE report provides an allowance for the Van Dam (Simón Bolívar) bridge over the current canal and the new High-Rise Lock Canal in the year 2060. As currently planned, the Van Dam (Simón Bolívar) bridge will be built by Panama before the year 2000; this bridge will not span over the future facilities of the High-Rise Lock canal. If the High-Rise Lock Canal is selected, planning for the construction of the Van Dam (Simón Bolívar) bridge will be directly affected. If Panama does not allocate resources to accommodate the enlarged span prior to construction or final design of the High-Rise Lock Canal alternative, this will be a direct negative impact.

The current bridge at Gatun locks does not have the capacity for heavy machinery to cross. For the Sea Level Canal, a new bridge across the Gatun route is not to be built until the year 2020 (only the bridges across the Sea Level Canal route, Escobal, and the bridge on the Pacific side); All materials and equipment used in the construction site on the west bank of the existing Canal (on the Atlantic side) will have to be transported either by sea or across Panama using the Trans-isthmian highway, the Pan-American Highway, and new access roads built for the project. Therefore, the roads between Colon and the town of Nuevo Chagres will not be impacted by the construction of the Sea Level Canal.

6.7.6 Electrical: Electrical towers for high-voltage power lines, and other projected lines will be impacted equally by both alternatives. The Sea Level Canal will impact distribution lines along the Canal alignment route. In the case of the High-Rise Lock Canal distribution lines will be impacted in the towns of Gatun and Cocoli.

6.7.7 The data related to infrastructure impacts does not strongly favor either of the two alternatives; however, the High-Rise Lock alternative appears to offer greater benefits to Panama, in light of current planning and capabilities to support.

Figure VI-2

Population Areas With Structures Affected By The Sea Level Canal And Flooded Areas

No	Name of Town	Ward	No. of houses	Habitant	Churches	Schools	Health Centers	Comm erce	Indus- try	Cemetery	Commun . Centers	Others	Characteristic of the Housing Unit					Impact Reason
													Dirt floor	No water	No Sanitat	No light	No Teleph	
1	Punta Grande	Chagres	14	55	1			1			1	Ofic. MOP	2	1	2	6	14	Temp. Jetty
2	Nuevo Chagres	Chagres	164	599		2							10	3	22	44	162	Route
3	Pueblo Nuevo	Palmas Bellas	83	348									10	2	9	28	63	Divers. Channel
4	Mateo	Palmas Bellas	16	66									5	10	4	12	12	Divers. Channel
5	La Loma	Palmas Bellas	8	35									0	2	2	3	7	Divers. Channel
6	Paulino	Achiote	15	18									0	2	1	3	3	Route
7	Llano Bonito	Achiote	7	36									2	6	3	6	6	Route
8	Vino Tinto	Achiote	1	7									1	1	0	1	1	Route
9	Caño Quebrado	Achiote &Escobal	14 19	39 80		1							18	28	11	9	28	Route
10	La Chunga	Achiote	2	10		1							2	2	2	2	2	Route
11	Frijolito	Achiote	5	17									4	5	4	5	5	Yachiyo ECE Repor
12	La Tagua	Achiote	14	67		1							8	13	1	13	13	Route
13	La Escoba	Escobal	17	66		1							12	15	3	15	15	Fill area
14	Portachuelo	Escobal	6	14									1	2	0	2	2	Route
15	Quebraon	Escobal	14	60		1							11	14	3	14	14	Route
16	Brazito	Escobal	5	31									3	5	4	5	5	Route
17	Los Negros	Escobal	3	12									1	0	0	3	3	Route
18	Lagarterita	Amador	40	134		1		1	1	1			7	11	3	7	36	Route & Fi area
19	Las Pavas	Amador	63	247	2	2		1					42	42	11	52	52	Yachiyo ECE Repor
20	Gigante	Amador	5	25									3	5	0	5	5	Fill area
21	La Laguna	La Represa	47	187	1	2	1	5			2	2 Muell	21	1	1	13	47	Route
22	Cañito	La Represa	4	13									1	4	0	4	4	Route
23	Cerro Cañito	La Represa	22	56									16	15	3	16	22	Fill area
24	Calabacito	La Represa	7	25									5	7	2	6	7	Route

Figure VI-2 CONT.
Population Areas With Structures Affected By The Sea Level Canal And Flooded Areas, Continued

No	Name of Town	Ward	No. of houses	Habitant	Churches	Schools	Health Centers	Commerce	Industry	Cemetery	Commun Centers	Others	Characteristic of the Housing Unit					Impact Reason
													Dirt floor	No water	No Sanitat	No light	No Teleph	
25	Rio Pescado	Represa /El Arado	2/ 5	0/ 16									2/ 7	5/ 7	4/ 1	5/ 7	5/ 7	Route & Fi Area
28	Celestina	El Arado	17	61									4	2	0	17	17	Route & Fi Aea
29	Moscú	El Arado	13	34									4	3	3	6	13	Fill Area
30	El Limón	El Arado	15	51									10	15	0	15	15	Fill Area
31	Los Monteros	El Arado	9	36	2			1					6	9	0	9	9	Fill Area
32	Loma Alta	El Arado	71	242				1	1	1		Finca	20	28	2	38	55	Route & Fi Area
33	Rio Congo	El Arado	140	599									22	10	2	37	136	Fill Area
34	El Limón	Barrio Colón	213	867	2	1		1	3			LaHer ra- dura						Bridge 206 Route
35	Rio Caimito	JD Arosemena																Bridge 206
36	Hato Montaña	JD Arosemena	25	109									0	6	1	5	109	Fill Area
37	Puerto Caimito	Puerto Caimito	367	1449	2	1		18	5	1			8	2	82	58	319	Route
38	Los Chorros del Ari	Ciri de los Sotos	36	244	1			2		1			20	25	0	36	36	Flooded area
39	Nuevo Paraiso	Ciri de los Sotos	25	120	1	1				1			10	4	0	25	25	Flooded area
40	Los Uveros	Ciri	38	135	1	2		4				club	15	13	5	38	38	Flooded area
41	Baca de Uracillo	Rio Indio	8	45	1	1	1	1		1	1	SNEM, C. Catolico	1					Flooded area
42	El Limón	La Encantada	34	137	1	1	1	1	1	1	1		15	22	6	25	25	Flooded area
43	Quebrada Conga	Ciri de los Sotos	22	118									16	20	4	22	22	Flooded area
44	Gatún	Puerto Pilón	8	31									1	8	3	8	8	Flooded area
45	Cerro Azul	Limón	13	79									11	11	6	13	13	Flooded area
46	Nuevo Limón	Mendoza	20	84									15	19	5	19	84	Divers. Channel
47	Casas a lo largo del Rio Gatún		10															
TOTAL			1792	7134	15	18	3	37	11	7	6	12	452	462	742	763	1569	

VII. FINANCIAL IMPACT AND IMPACT OF THE EFFECTS ON USERS ON PANAMA

7.0 INTRODUCTION

7.0.1 Financial impacts and impacts on users of the two Panama Canal alternatives were the subjects of separate component studies for the Study of Alternatives to the Panama Canal. The component study entitled "Economic Analysis and Impact on Users" addresses economic impacts and impacts on users of the two Canal alternatives. The component study entitled " Financing Scheme, Financial Analysis, and Management Arrangements" addresses the financial impacts.

7.0.2 So as not to have redundant efforts, this component study of the "Impacts Upon Panama", used the prior two cited studies as the basis for, and input into, the analysis of all three areas: economic impacts, financial impacts and the impacts on users as they impact upon Panama. The economic impacts of the two Canal alternatives were addressed earlier in Appendix of Section II of this report. This section of the report will address the financial impacts and the impacts on Panama of the impacts on users.

7.0.3 This section of the report is organized as follows:

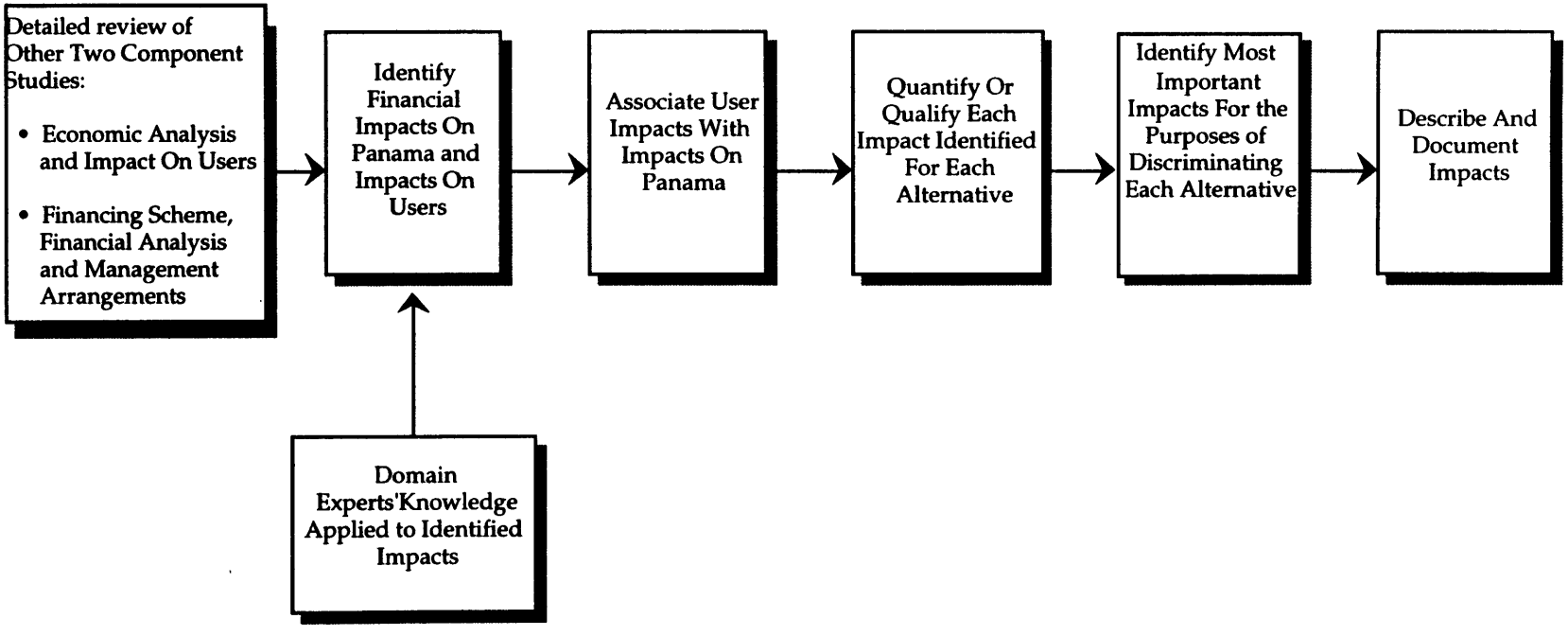
- Methodology used to identify the impacts, including key assumptions used.
- General findings regarding financial impacts on Panama.
- General findings regarding the impacts on users as they impact upon Panama.
- Brief recapitulation of major findings and conclusions.

Each of these items is addressed in the balance of this section.

7.1. METHODOLOGY AND KEY ASSUMPTIONS

7.1.1 The methodology used to identify the financial impacts and impacts associated with impacts on users was basically to take the impacts identified in the two "source" component studies, and apply the knowledge of the experts in those fields in order to arrive at a clearer analysis of impacts, and then proceed to point out those which could best serve as reference in evaluating advantages and disadvantages of each alternative. The methodology used is outlined generally in VII-1.

FIGURE VII-1
FINANCIAL AND USER IMPACTS
METHODOLOGY FOR IDENTIFICATION AND ANALYSIS



7.1.2 The first step was to review, and gain a thorough understanding of, the two component source studies. The Economic Analysis and Impact on Users Study was reviewed in detail, and meetings were held with Mitsubishi Research Institute personnel to obtain clarification of a number of questions. Likewise, the Financing Scheme, Financial Analysis and Management Arrangements Study was reviewed in detail, and a meeting held with Nathan Associates, Inc. personnel to clarify a number of questions. All impacts identified in the two studies were delineated in the Report on Review of Literature forms used by our team for this effort.

7.1.3 Likewise, subject matter experts in the user industry and in finance independently, and through discussions with CAS personnel, identified what financial impacts and results from user impacts were likely to arise. For user impacts which were identified, the associated impact on Panama was then determined. This was accomplished through internal team discussions, the discussions with the EAIU and the FSFA/MA Component Contractors.

7.1.4 All impacts identified were then either quantified or qualified as to their effects on Panama. Differences in the impacts between the final Canal Alternatives were identified, when appropriate. The most important impacts for the purposes of evaluation and selection of an alternative were then highlighted. Finally, the total anticipated impacts were described and documented.

7.1.5 A few key assumptions were used in this identification and discussion of the financial impacts, and the effects which the impacts on users would have on Panama. Those key assumptions are delineated below:

- Any toll revenue increases projected for the current Canal and from the selected Canal alternative will be used to service the debt of the new Canal, and provide some return on equity to the Panamanian equity portion of the financing. This means that there will be no further spending of any portion of the toll revenue increase in the local economy, or, if any, it will be minimal. This assumption is consistent with the Financing Scheme, Financial Analysis, and Management Arrangements Study.

- The final two Canal alternatives out of the five finalists (two variations on the High-Rise Lock Canal and three variations on the Single-Lane Sea Level Canal) will be the two showing the best

results in the analyses in both the economic and the financial component studies. The two best final Canal alternatives on the basis of these two studies are:

- The High-Rise Lock Canal with a capacity for up to 150,000 DWT vessels.

- The Sea Level Canal, Case C, which includes tidal locks in Pacific and in the Atlantic.

  This assumption is important as discrete, quantified impacts are obtained from the two source studies, and also developed herein. In addressing, comprehending and comparing quantified impacts, it is much easier to focus on one point, i.e. one dollar figure, than to focus on a range of two or three points, i.e. a range of two to three dollar figures, which would be required if the variations on the two main alternatives were carried throughout the discussion.

- Only impacts with an estimated order-of-magnitude difference of 10 percent are significant reference in evaluating and discriminating between Canal alternatives. Given the highly qualitative nature of this analysis, smaller differences in quantified impacts may not be significant.

- There will be no impacts on users during the construction period of the new Canal alternative, or, if any, they will be negligible. This is consistent with the assumption of the Economic Analysis and Impact on Users Component Study.

- The "other Canal excavation" costs which are part of the costs of the Sea Level Canal will not be expended in Panama.

- As in the Economic Analysis and Impact on Users, as well as in the Financing Scheme, Financial Analysis and Management Structures sources, all dollars cited in this section are 1990 constant dollars.

- The optimal toll structure, as delineated in the Financial Component Study, will be adopted.

7.2 FINANCIAL IMPACTS ON PANAMA

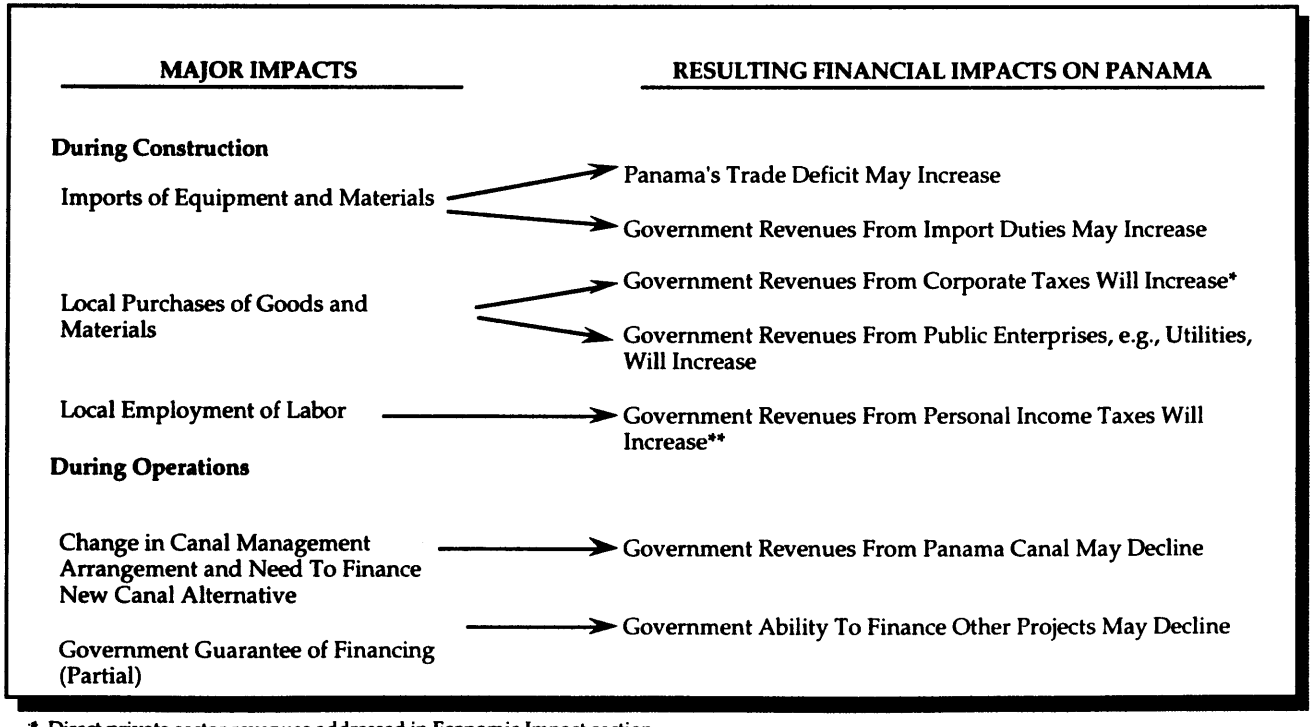
Financial impacts on Panama of the two Canal alternatives will be felt both during construction and operations. Anticipated financial impacts on Panama are addressed below.

7.2.1 Nature of the Financial Impacts on Panama

A number of financial impacts will be felt by Panama during both the construction and operations of either Canal alternative. Several major direct impacts or events during both construction and operations will result in financial impacts on Panama. These are major effects and the ensuing financial impacts are illustrated in VII-2.

FIGURE VII-2

MAJOR FINANCIAL IMPACTS ON PANAMA



* Direct private sector revenues addressed in Economic Impact section.
** Direct wages impact addressed in Economic Impact section.

7.2.1.1 The major events or actions envisaged to occur during construction, giving rise to financial impacts will be the importation of equipment and materials, procurement of goods and materials from the local economy, and recruitment of local labor. Each of these three will have financial impacts on Panama.

7.2.1.2 The importation of equipment and materials will be necessary for the construction of either Canal alternative. This importation of goods may result in increased revenues to the government of Panama from import duties. The increased imports may, however, also increase the country's trade deficit. Procurement of goods and materials from the Panamanian economy will increase the government's revenues from corporate/business taxes. Likewise, this local procurement of goods and materials will entail an increase in purchases from public enterprises, such as utilities, also increasing revenues to the Panamanian government.

7.2.1.3 Local recruitment of labor will have financial impacts in that the government's revenue from personal income tax will increase. To the extent that local recruitment will reduce the country's unemployment.

7.2.1.4 During operations, two main causes of financial impacts on Panama are manifest from any perspective. The anticipated and planned change in Canal management coupled with the need to finance the new Canal alternative will result in less direct revenues from the Panama Canal for the Government of Panama. The potential for the Panamanian Government to guarantee part of the financing may also impact the government's ability to finance other projects, such as other infrastructure projects.

Many of these financial impacts on Panama are quantified below with an identification of which ones are most helpful in evaluating the two alternatives.

7.2.2 Differences in the Import of Financial Impacts Between the Two Alternatives

The financial impacts on Panama which the two Canal alternatives involve will be the same or similar as to the type, or nature of discrete impacts. However, the relative magnitude of at least some of the discrete financial impacts can and will vary. Those discrete financial impacts which can be quantified from available information and reports are shown in Figure VII- 3.

FIGURE VII-3

SUMMARY OF MAJOR FINANCIAL IMPACTS OF TWO CANAL ALTERNATIVES

	High–Rise Locks Canal	Sea Level Canal	Difference
During Construction			
Imports into Panama* (millions of dollars)	$7,818	$10,180	30%
Purchases in Panama* (millions of dollars)			
– Goods and Materials	$349	$352	< 1%
– Labor	$569	$696	22%
During Operations — In Year 2000			
Direct Government Revenues from the Canal** (millions of dollars)	$123.7	$127.5	3%
Government Guarantee of Financing – partial**	to be determined		minimal

*Source: Component Study: Economic Analysis And Impact On Users By Mistubishi Research Institute

* *Source: Component Study: Financing Scheme, Financial Analysis, And Management Arrangements By Nathan Associates

7.2.2.1 Imports of equipment and materials into Panama during construction of the High-Rise Lock Canal alternatives are estimated at $7.818 billion. Imports required for the Sea Level Canal alternative are estimated at $10.18 billion. The anticipated difference of 30 percent of importance in the evaluation of the alternatives.

7.2.2.2 From the increase in imports during construction, the Panamanian Government may receive revenues from import duties in the case of either of the alternatives. Using general indicators only, any import duty revenues are estimated at approximately ten percent of the value of the imports.[1] Thus, the High-Rise Lock Canal would generate an estimated $782 million in increased import duty revenues to the Government while the Sea-Level Canal would generate an estimated $1.018 billion. The difference in the import duty revenues under the two alternatives is 30 percent, and is again a discriminator between the two alternatives.

7.2.2.3 During construction of either alternative, there will purchases of goods and materials in the Panamanian economy and the employment of local labor. For the High-Rise Lock Canal alternative, the purchases of goods and materials are estimated at $349 million and recruitment of local labor is estimated at $569 million. In the case of the Sea Level Canal, an estimated $352 million of local goods and materials will be purchased and local employment equaling $696 million will be utilized. Thus, between the two Canal alternatives, there is no meaningful difference in the value of goods and materials to be purchased locally. However, in terms of the level of employment of local labor, there is a significant difference between the two alternatives. The Sea-Level Canal will employ significantly more local labor, with the difference, in terms of total wages, estimated at 22 percent.

7.2.2.4 From the increased employment in Panama resulting from the Canal construction, the Government will derive increased revenues in personal income tax. The increase in personal income tax revenue was estimated on the basis of the salary for the average construction tradesman. Under the High-Rise Lock alternative, the increased personal income tax revenues for the Government are estimated at $20 million while, in the case of the Sea Level alternative, increase is estimated at $25

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1 The import duty revenues to the Government are very general, and ought to be seen as order-of-magnitude estimates only. The estimate was developed based on the information that, in 1990, the value of imports into Panama was $1.489.1 million(CIF) while the revenues to the Panamanian Government from import duties was $148.5 million. This provides an indication that $1 in import duties is generated for every $10 in imports.

million.[2] Thus, both the sums to be paid in wages and Government revenues in personal income tax thereon are helpful reference in evaluating the alternatives.

7.2.2.5 Another financial impact of the alternatives will be that the level of revenues which the Panamanian Government receives from the Canal may decline. This financial impact will occur both during construction of the new Canal alternative and during its operation. In FY 1991, the Government of Panama received payments of $ 87.6 million from the Panama Canal Commission. These payments are broken down into as follows: $10 million for public services provided by the Government, $10 million in a fixed annuity, and $67.6 million on the basis of total tonnage. It is anticipated that this annual payment, under both alternatives, will decline to $53.6 million per annum in the year 2000. By the year 2020, there will be a slight difference in the level of annual payments to the Government in the case of either alternative. In 2020, annual payments to the Panamanian Government with the High-Rise Lock alternative will be $123.7 million, and in 2060, the payment will be $179 million. In the case of the Sea Level Canal alternative, payments to the Government in 2020 are estimated at $127.5 million and, in 2060, 184.9 million. Thus, over time, the Sea Level Canal entails annual payments to the Panamanian Government only about 3 percent higher, and can be considered a negligible difference.[3]

7.2.2.6 Another financial impact to be felt primarily during operation of the new Canal alternative is derived from the requirement for a Panamanian Government guarantee of part of the financing. It is anticipated that a Panamanian Government guarantee will be required for financing by various development banks, U.S. source, from the Japanese Overseas Economic Cooperation Fund (OECF) and from Japan-EXIM Overseas Investment. The financial impact of any government guarantees has not been quantified.

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2 Estimates of increased personal income tax are very general, and ought to be seen as order-of-magnitude estimates only. Estimates are based on the average minimum wage for construction tradesmen in Panama City and Colon, an assumed 40 hours per week and 52 weeks plus a 13th month mandatory bonus. The personal income tax level table was used to identify annual tax per job. The estimates of 68,000 jobs for the High-Rise Locks Canal and 87,000 jobs for the Sea Level Canal were used.

3 The decline in the annual payments to the Panamanian Government from the Canal is a function of the new management structure to be put in place and Panama's contribution to financing the alternative. Thus, the decline in revenues to the Government should bear no importance in selecting between the two Canal alternatives.

7.2.2.7 The implications of this impact on Panama will likely be different in either alternative, due to the difference in cost and, consequently, in the amount of financing required. As the Sea Level Canal alternative is the more expensive of the two alternatives, the level of financing required it can be financed, for it is greater and thus the government guarantee required would be larger. However, the financial impact on the Panamanian Government's international credit standing and on ensuing limitations in its investment budget has not been quantified. Overall, however, the difference in the government guarantees of the two alternatives, in terms of the financial impact on Panama, is anticipated to be more for the Sea Level Canal alternative.

7.2.2.8 Thus, in terms of financial impacts on Panama, the level of imports, the level of local employment generated and the level of local goods purchased appear as important impacts for evaluation purposes in a restricted sense, not considering overall repercussions. These financial impacts serve thus to discriminate between the High-Rise Lock Canal alternative and the Sea Level Canal alternative, and they are a direct function of the relative costs of the two alternatives. In other words, the more costly alternative generates the most financial and economic impacts on Panama.

7.2.3 Results of the Financial Impacts on Other Impact Areas

7.2.3.1 The financial impacts on Panama will also influence the politics and infrastructure of Panama. Political institutions in Panama involved in labor and economic issues will have to address the issues surrounding the impacts arising from such a significant undertaking as the construction of either alternative. These institutions may have to become involved with local labor in organizing and structuring processes to assist in smoothing out recruitment requirements and ensuring that appropriate processes are in place for the safety and protection of workers. Government institutions may have to become involved in that process of worker relocation.

7.2.3.2 National cohesion and support for the project and for the Government could be impacted by a perceived reallocation of resources, and a shift in official attention, toward the new Canal project and away from other pressing issues. Panama's ability to fund its own infrastructure projects could be negatively affected by the requirement of a government guarantee of part of the financing.

7.2.3.3 Again, these other impacts are not likely to differ significantly between the two alternatives, except for a potential major impact regarding the guarantee of funding for the Sea Level

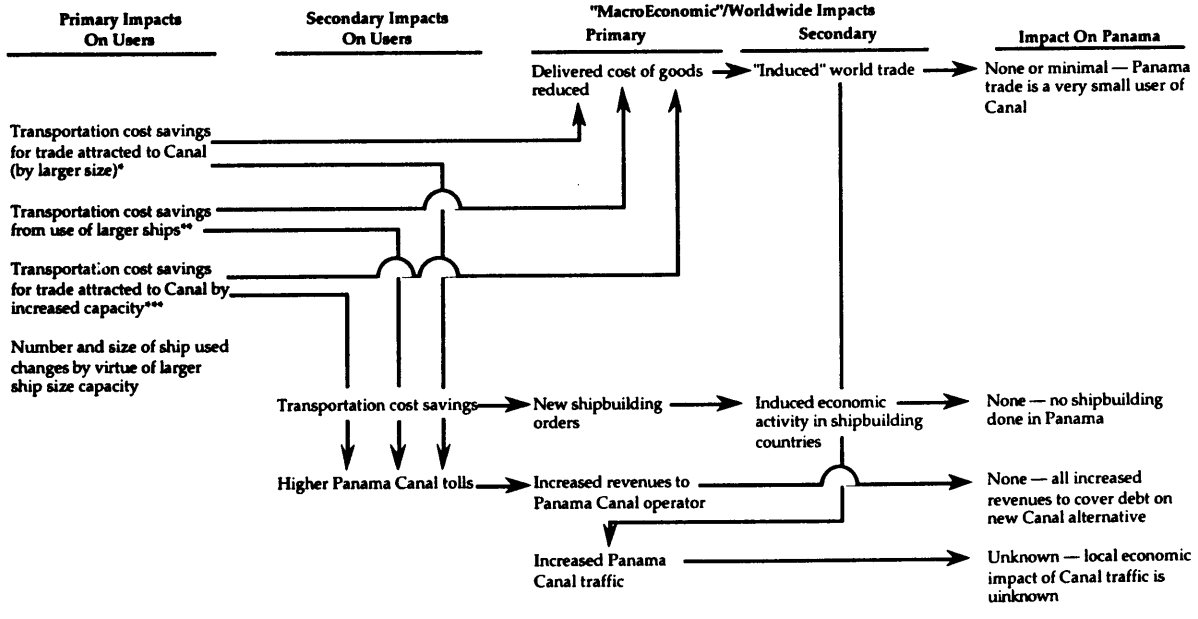
Canal, and will not be of great assistance in selecting one of the alternatives, unless further studies are conducted in a more encompassing context of foreseeable overall consequences.

7.3 IMPACTS ON PANAMA OF THE IMPACTS ON USERS

The new Canal alternatives will have a number of both primary and secondary impacts on users. These impacts on users are shown in Figure VII-4. The exhibit also identifies further indirect, "macroeconomic" or worldwide impacts which the user impacts on users may cause. Lastly, the far right hand column of Figure VII-4 identifies the impacts on Panama which impacts on users will give rise to.

FIGURE VII-4

IMPACTS ON PANAMA OF THE IMPACTS ON USERS



** Called "Shift To" Benefits In Mitsubishi Report*
*** Called "Size Up" Benefits In Mitsubishi Report*
**** Called "Capacity Up" Benefits In Mitsubishi Report*

The term "macroeconomic" or worldwide impact, as used herein, is intended to denote the nations and international concerns that are major beneficiaries of the Panama Canal, and that will feel the indirect impacts resulting from the direct impacts on users.[4] For example, the nations trading goods transported on the ships that use the Canal. In the interest of clarity, the term users refers to actual ships using the Canal and paying tolls, as well as the companies that own and operate them. Beneficiaries and beneficiary countries refer to the nations and/or companies whose trade moves through the Canal, or who may otherwise benefit from the business through the Canal.

While this report is not intended to address the impacts on users of the two final Canal alternatives, these impacts will be addressed briefly to assist the reader in understanding their indirect effects, including their ultimate impact on Panama. In the following discussion, impacts on users are first addressed briefly, and then follows a discussion of their indirect effects, both worldwide and on Panama.

7.3.1 Primary and Secondary Impacts on Users

7.3.1.1 The direct benefit is defined as transportation cost savings, in this context, are defined as the reductions in operating costs of the vessels that transit through the Canal, either in absolute terms or per unit of cargo. Transportation cost savings will benefit users as a result of a new Canal, due to three reasons: the use of larger ships by current users, a shift to a Canal route from another or from a different transportation system by virtue of the capacity for larger vessels, and/or the increased capacity of the new Canal which means that a larger volume of traffic can be handled.[5]

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4 Macroeconomic as used here refers to the world economy.

5 These are the same three transportation cost savings benefits addressed, and estimated, in the Economic Analysis and Impact on Users Component Study. In that study, the three types of transportation cost savings are referred to as ship switching, route-switching, and capacity benefits.

7.3.1.2 Another primary or direct impact on users of the new Canal alternative will be a change in the number and size of ships used in maritime trade involving the Canal. This impact on users will be a consequence of the new Canal alternative's capacity to accommodate larger ships. Many of the world's larger ships cannot transit the existing Canal, but would be able to transit through either of the new Canal alternatives.

7.3.1.3 The primary or direct impacts on users will have a number of secondary impacts on users, as shown in Figure VII-4. The use of larger ships may lead to economies on account of reductions in the number of ports of call, and further transportation cost savings. It is also anticipated that transportation cost savings to be made by Canal users may warrant a toll increase.[6] This is the first negative impact on users to be identified. All user impacts addressed above have been positive.

7.3.1.4 When considered on a net basis, the anticipated Canal toll increase will still be positive. In conjunction with transportation cost savings, on a net basis per unit of cargo, the overall impact on users should still be positive. Thus, all of the user impacts, both direct and indirect, are ultimately translated into transportation cost savings.

7.3.1.5 The Economic Analysis and Impact on Users Component Study has estimated transportation cost savings to users of the High-Rise Lock Canal and the Sea Level Canal alternatives. The transportation cost savings estimates from that study are shown in Figure VII-5, for the years 2020 and 2060.[7]

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6 This does not imply that all of the realized transportation cost savings will be offset by increases in the Panama Canal tolls or the tolls of the new alternative. Rather, it is anticipated that some portion of the savings will be taken up in new tolls so that the savings do benefit the trading nations through lower freight rates, and lower prices of delivered goods.

7 At stated in the assumptions at the beginning of this section, only those variations of each alternative which show in the economic and financial analysis to be best are used for the discussion herein. As such, the High-Rise Lock Canal refers to the 150,000 DWT variation and the Sea-Level Canal refers to Case C.

FIGURE VII-5

SUMMARY OF BENEFITS TO USERS
TRANSPORTATION COST SAVINGS IN MILLIONS (U.S.$)

ALTERNATIVE	In 2020	In 2060
High–Rise Locks Canal	$ 489	$1,040
Sea Level Canal	$ 532	$1,095
Difference	9%	5%

Source: Component Study: Economic Analysis And Impact On Users By Mitsubishi Research Institute, Inc.

7.3.1.6 As shown above, in the year 2020, transportation cost savings to users of the High-Rise Lock Canal are estimated at $489 million while the savings from the Sea Level Canal alternative are estimated at $532 million. This is a difference of 9 percent. In the year 2060, transportation cost savings are estimated at $1.04 billion for the High-Rise Lock Canal and $1.095 billion for the Sea Level Canal. In the year 2060, the difference between the two alternatives in user benefits is estimated to be only 5 percent. Also it should be noted that the majority of the increase is accrued to the High-Rise Lock Canal 150,000 DWT alternative.

7.3.2 Indirect Worldwide or "Macroeconomic" Impacts of the Impacts on Users

7.3.2.1 Transportation cost savings benefits for the users of either Canal alternative will result in a number of indirect impacts on a worldwide and on a beneficiary country level. Referring back to earlier Figure VII-4, the indirect worldwide impacts of the discrete user impacts are illustrated. It is important to understand these indirect worldwide impacts to understand how the direct user impacts do, or do not, result in impacts on Panama.

7.3.2.2 Transportation cost savings for users of the new Canal alternative will result in reductions in the prices of goods delivered to world markets.[8] These reductions in prices of goods will induce new and increased world trade.[9] As world trade increases, the traffic through the Panama Canal will likewise increase.

7.3.2.3 Transportation cost savings due to the ability to use larger ships in the new Canal may induce users to increase their fleet of larger ships. The result will be potential new shipbuilding orders for the world's shipyards, and the new shipbuilding orders will result in increased economic activity in shipbuilding countries.

7.3.2.4 Lastly, the transportation cost savings will allow an increase in the tolls of Canal. While the increase in tolls beyond inflation plus 25 per cent will require enhanced services from the Canal, the future Canal operator will benefit from an increase in revenues from the Canal alternative, both on a per cargo unit basis and in absolute terms.

7.3.3 Impacts on Panama of the Impacts on Users

7.3.3.1 The direct impacts on users give rise to indirect worldwide macroeconomic impacts, as indicated above. This chain of impacts results, however, in few if any, impacts on Panama. The

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[8] Another indirect impact of the transportation cost savings is the income to worldwide importers and exporters, and the further spending, or multiplier, thereof.

[9] The increased world trade likewise cascades to another whole set of indirect benefits, including the economic impacts at ports worldwide of the increased trade.

anticipated impacts on Panama were illustrated in earlier Figure VII-4, and those effects are none to minimal, or are unknown at this time.

7.3.3.2 However, additional world trade induced by transportation cost savings and lower prices of delivered goods will have any impact on Panama since it is a very minor user of the Canal. The new shipbuilding orders and economic activity induced by shipbuilding will not have any effects on Panama either since it has no shipbuilding industry.

7.3.3.3 Higher toll revenues for the future Canal operator will not likely have an impact on Panama as it is anticipated that any increase in toll revenues will go toward covering the debt for the new Canal.[10]

7.3.3.4 Lastly, there will be an increase in maritime trade through the new Canal, caused by traffic diverted to the Canal route on account of the increased capacity of the new Canal, and overall induced world trade. However, it is not known what local economic impact is to be generated by either the current Canal traffic, or by the projected increased traffic through the selected Canal alternative. In other words, while some vessels may purchase bunker fuel from local oil companies, and thus generate local economic impact, the extent of this is not known.[11] Likewise, the volume of local purchases by vessels transiting through the Canal, such as ship's stores or supplies or other services, is not known. These purchases of bunker, other supplies, etc. generate economic impacts in that local employment is created and revenues for local businesses generated. According to the Panama Canal Commission, the local economic impact of the Canal traffic has never been studied or quantified. It is possible that current traffic through the Canal has no impact on the local economy or only a negligible one, apart from Canal tolls and other direct services acquired from the Panama Canal Commission. In other words, this traffic simply transits the Canal and expends few dollars for, and makes little use of, other local services in Panama. If such is the case now, it would likely be the case in the future. While it is generally believed that the economic impact is minimal, this is one area of impact on Panama which should be studied further, as is suggested in Section IV of this report. Upheavals and economic

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10 See assumptions.

11 In the case of bunker fuel, specifically, local purchases by vessels transiting the Canal, would vary according to fluctuations in fuel prices in different parts of the world. It is believed that a large portion of the Canal traffic bunkers on the North American West Coast rather than Panama, but more ships might bunker in Panama if fuel prices in the West Coast were high.

shocks sustained by Panama in recent times would make the economy more sensitive even to effects on livelihoods depending on activities that would appear only under closer scrutiny.

7.3.3.5 This finding of no indirect impacts on Panama or only minimal ones, as a result of impacts on users, does not vary in the case of either of the Canal alternatives under consideration. Both the High-Rise Lock Canal or the Sea Level Canal will have negligible impacts on Panama as a result of impacts on users.

7.3.3.6 As the above discussion highlights, the major indirect impacts of the direct impacts on users are macroeconomic in nature, that is, on those nations that are the major beneficiaries of the Panama Canal and/or its successor. The major indirect benefits of the impacts on users have no effect on Panama.

7.3.4 Potential Future Impacts on Panama

7.3.4.1 In the future, as transportation systems and modes of handling international trade evolve and change, and as the new Panama Canal route becomes an increasingly attractive transportation option due to its new capacity for larger vessels, it is possible that the new Canal may generate more direct impacts on Panama. Such new impacts are not known at this time, and their potential should be studied further.

7.3.4.2 Likewise, the new Canal could directly result in more business for the Colon Free Trade Zone. The probable impact on the Colon Free Trade Zone is not known and is another area recommended for further study.

7.3.4.3 While there are potential future impacts on Panama concerning which no information has been made available, it is considered unlikely that these future impacts would differ in the long run, although immediate negative effects could be aggravated by a protracted process in the ongoing economic recovery. In other words, only upon further studies conducted in the light of this sensitivity, would these potential impacts serve as concrete reference in evaluating the alternatives.

7.4 CONCLUSIONS AND FINDINGS

The major findings and conclusions regarding the financial impacts, and the impacts on Panama of the impacts on users are highlighted below.

7.4.1 The primary beneficial financial impacts on Panama will be as a result of the construction of the new Canal. These primary impacts include:

7.4.1.1 Potential increased import duties as a result of the importation of equipment and materials for construction.

7.4.1.2 Increased Government revenues from personal income tax resulting from the increase in local employment, and business taxes resulting from local procurement of goods and services.

7.4.2 Based on this consideration only, the preferred alternative would appear to be the Sea Level Canal, since it costs more to construct and, therefore, means more imports and local purchases of goods and services. However, the heavier burden in terms of debt servicing and the more encompassing overall repercussions cannot be ignored.

7.4.3 Potential negative financial impacts on Panama generated by the new Canal alternative consist of possible decline in payments to the Panamanian Government from the Canal, as a function of the new management structure to be put in place, and that a government guarantee of part of the financing be required. Such a guarantee may hinder the Government's ability to obtain financing for other domestic projects, such as new infrastructure and infrastructure maintenance. In this case, the Sea Level Canal alternative, with the higher cost, would present the greatest negative impact. The financial impacts must also be weighed in this sense, in the context of present economic situation and limitations, and in terms of the real ability of Panama to maintain financial and economic flexibility in the future.

7.4.4 There will be negligible indirect impacts on Panama as a result of the impacts on users.

7.4.4.1 While users of the Canal alternative will receive a number of benefits, all of which are, in essence, translated into transportation cost savings, little if any of this will have effects on Panama, beyond the direct impacts of the Canal itself.

7.4.4.2 The indirect impacts of the direct user impacts are primarily macroeconomic or worldwide in nature, and will benefit the major nations that are the primary users of both the existing and future Canal(s). Thus, the major beneficiaries of the impacts on users do not include Panama in their numbers, and this should also be borne in mind when evaluating the extent of the repercussions and the new economic obligations which either alternative will impose on Panama and on its Government.

VIII. SYSTEM DYNAMICS MODEL RESULTS

8.0 INTRODUCTION

The System Dynamics Section of this report presents the results of the system dynamics modeling effort which was conducted in conjunction with the qualitative analyses of Sections III through VIII of this report. The section includes a discussion of the methodology used to integrate qualitative and quantitative analysis efforts, it describes the model structure and its information requirements, and then presents findings concerning those impacts that are both useful in making comparative evaluations and cross study area domain boundaries.

In order to be considered for examination by the system dynamics model, potential impacts were required to meet all three of the following criteria:

- Multiple study areas (domains) are involved, e.g., an impact identified by one of the domain teams would have significant consequences in another domain.

- It is a sensitive impact, meaning that the anticipated effect could result in serious social, economic, or political consequences for Panama.

- It is an impact of substantial use in comparative evaluation, meaning that Commission decision making is facilitated in view of significant differences between the effects of the two alternatives.

8.1 SYSTEM DYNAMICS METHODOLOGY

This methodology overview provides a brief description of system dynamics; discusses the rationale for choosing system dynamics as the vehicle for examining overarching impacts; and outlines the system dynamics modeling methodology used for the study.

8.1.1 System Dynamics Overview

System dynamics is a computer simulation methodology for representing complex, dynamic systems and the processes which occur within. The methodology focuses on the interactions between entities within the system and the resultant feedback. System dynamics promotes a systemic view of processes, focusing on the collective, emergent properties of a system; addressing questions about the dynamic behavior of complex systems over time.

8.1.2 Providing an Integrating Function

System dynamics modeling was chosen as a means of linking the findings of the separate domains and analyzing those factors that cross domain boundaries. An approach such as system dynamics was needed in order to represent the multitude of dynamic links between domains which interact simultaneously. While system dynamics may be useful for examining direct effects within one domain, as a methodology it is much better suited to focusing on interactions between domains. Since it focuses on cause and effect relationships, it allows the analyst to dissect a complex system into simple elements. Using this approach, an analyst can trace the effect of change through the entire system by following chains of cause and effect relationships. The task of simultaneously tracking a multitude of interrelationships, indirect effects, time delays, interventions, and feedback loops is beyond the capacity of the human mind. This challenge may only be met with the aid of a computer simulation model.

8.1.3 System Dynamics Methodology

The initial steps of the development methodology of the system dynamics model parallel the research methodology employed in the domain studies. Consequently, the efforts that produced the domain research findings satisfied the initial model development requirements as well. The following outlines the methodology employed to reach the findings described in this section of the final report.

8.1.3.1 Development of Basic Conceptual Model and Background Information. At the outset of the project, information on Panama was assembled to form the basic setting within which the historical

research and modeling would be conducted. Information was gathered within the context of a basic conceptual framework and accompanying system dynamics model structure that focuses on the dynamic processes that are common to countries dealing with developmental issues.

8.1.3.2 *Literature Review.* Then general areas were identified on which to focus efforts. Responsibility for each of the separate functional areas was determined and an extensive literature review in that area was conducted. Significant articles were documented with the purpose of highlighting the hypotheses presented and capturing the cause and effect relationships which linked key factors within each domain. As the literature review continued, many hypotheses were collected, both conflicting and complementary ones, and chains of cause and effect relationships came to the surface.

8.1.3.3 *Causal Diagramming.* Once a sufficient number of hypotheses was collected, the findings were supplied to process. Diagrams of the cause and effect relationships were developed, linking factors within and between domains. Diagrams documented the cause and effect relationships captured in the research findings. This resulted in a network of cause and effect relationships which captured the dynamics of the entire system and formed the theoretical basis for model development.

It is important to note that, except as a result of synthesis, the causal diagramming session did not create new theory. All relationships included in the final causal diagrams are products of the literature review subsequent analysis sessions of joint discussion. Causal diagrams merely display existing knowledge, explicitly displaying the causal relationships which the model has accepted and assimilated. Any need for additional theory development which may have surfaced during the causal diagramming session triggered additional research and analysis.

8.1.3.4 *Review and Revision.* Modeling was then begun on the basis of additional findings. The process of model development was iterative. At each step efforts were enhanced by improved theory provided for the process. The result was an evolved causal diagram and an improved system dynamics model. Notwithstanding, it was obvious that sources of information skimmed over the fact that problems and situations in a country like Panama involve deeply complex human aspects, and

sufficient study space was not allowed to let local idiosyncrasies provide the necessary seasoning to the purely scientific approach.

8.1.3.5 *Computer Model Development.* Once the first causal diagram was obtained, the modeling team the process of translating causal diagrams into the logic and structure of a system dynamics model began. This step began the actual computer modeling process. Each factor that appears in the causal diagrams was included in the system dynamics model, with the surrounding model structure representing the links between factors in the causal diagrams.

The translation of the causal diagrams into terms of the model structure was completed. Worked proceeded with research and analysis to define the links between factors. Each link between two factors was defined by a mathematical equation reflecting the nature of the cause and effect relationship. Proper equations were determined conducting detailed analysis of each pair of linked factors. This process required the use of statistical analysis and basic historical research techniques.

In the final step of the model development process, initial numerical values were assigned to each factor in the model. Assigning initial values to factors in the model is more than a data collection effort. Because of the difficulty of quantifying social factors, quantitative indicators or scaling techniques for the qualitative factors had to be found.

8.1.3.6 *Model Analysis.* After the model had been constructed and loaded with initial data, the simulation began. The model's reaction to change was tested by altering values for the input variables. These input variable changes simulated actions taken in or associated with the construction or operation of each canal alternative. Results were analyzed on the basis of their impact on Panama. As change was introduced into the model, model behavior was observed and analyzed for the purpose of assessing the likely effect of that change on Panama. Effects were examined on both short term and long term perspectives.

8.1.3.7 *Model Output.* System dynamics model output reflected the behavior of factors within Panama over time. The long term, system-wide effects of the actions associated with the construction

and operation of each Canal alternative were displayed to reflect trends likely to emerge. With model output, the impact of individual actions associated with each alternative, combinations of actions, and alternative timing of sequenced actions was assessed.

Model output was valuable not only for application to the analysis of a specific action or a Canal alternative in general, but also for the general insight it provides into the internal dynamics of Panama. Upon assessment of each action or set of actions, expectations for the impact of the initiatives were formulated. Model results that differed from expectations led the analysis onto an investigation of the cause and effect relationships and the assumptions on which the model was based. *This usually brings out interactions which have been overlooked, as well as previously unknown relationships, or inconsistencies in the model assumptions.* In all cases, understanding of the internal dynamics of Panama and the effects of construction and operation of a Canal alternative was enhanced.

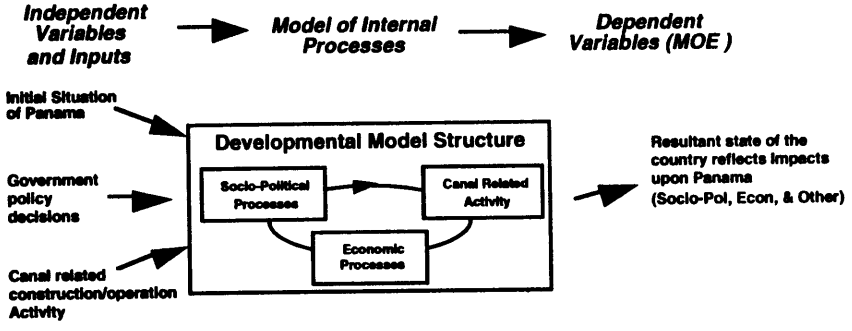
Graphical viewing is often more useful since system dynamics output is valued for the trends it displays as opposed to specific numerical values it returns. Numerical precision is neither desired nor readily attainable with system dynamics modeling. During model construction, it is difficult to determine which factors are qualitatively important and how those elements with mathematical equations may be defined. Consequently, it is extremely important to recognize that although model output is valuable and provides a wealth of insight, model results are by no means predictive. Model results should be viewed for the trends they project, and not for the exact numbers they yield.

8.2 ANALYSIS OF PANAMA AND THE CANAL ALTERNATIVES

8.2.1 Basic Model Structure

FIGURE VIII-1

System Dynamics Developmental Model



The model used for this project focuses on the dynamic processes that define countries dealing with developmental issues. Providing the basis for a dynamic simulation of the socio-political and economic processes in a nation, the structure is intended to provide assistance in an examination of the long range effects of developmental actions. Because the conceptual framework focuses on the interactions between the various dimensions of a system, rather than on the details of any one dimension, research had to begin by assimilating general information on Panama and the Canal alternatives.

8.2.2 Background

The conceptual background for this work recognized both traditional socio-political divisions of power and the effects of events that are relatively close in time, such as the transfer of the Canal. For the purposes of the study, society was divided into five broad socio-political groups -- (1) the elites, (2)

the middle classes, (3) the predominantly urban lower classes, (4) the Roman Catholic Church, and (5) a general combination of other groups such as rural labor, Indigenous minorities, security forces, and the immigrants. The socio-political strength of the elite and the church was recognized.

Basic information on the Canal alternatives was extracted from the Canal alternatives engineering report[1] and from the functional domain sections of this report. A general discussion of the basic conceptual model used for this simulation, significant extracts of the socio-political background information on Panama, and key data elements from the engineering report are included as Appendix B. Other basic, non-controversial data used to load the model came from the engineering study, the domain reports, and standard data sources such as the *Statistical Abstract of Latin America* and the *World Fact Book.*

8.2.3 System Relationships

The research process yielded diagrams of cause and effect relationships which link factors within and between domains. Consequently, each factor and every relationship between two factors is documented. (Relationships described in these diagrams are supported by specific findings in the study area sections and the annotated bibliographic entries appended to this report). These diagrams are significant not only for their contribution to the simulation itself, but as heuristic devices for gaining and overaching understanding of the cause and effect relationships associated with those actions that appear to have the greatest impact on the social, political, and economic structure of Panama.

In the following diagrams a cause and effect relationship between two factors is indicated by an associated plus (+) or minus (-) symbol. The arrow points from the independent to the dependent variable while the plus or minus symbol indicates positive or negative causality respectively. Positive causality (indicated by "+") exists when a change in the independent variable causes the dependent variable to change in the same direction. Negative causality (indicated by "-") exists when a change in the independent variable causes the dependent variable to change in the opposite direction (an increase in the independent variable causes a decrease in the dependent variable.) When following a string of

[1]Yachiyo Engineering Co., Ltd. The Study of Alternatives to the Panama Canal (Component Study: Engineering and Cost estimates), Phase 2: Preliminary Engineering and Cost Estimates. Draft Final Report, February 1993.

cause and effect relationships it is important to note that when the independent variable which is the dependent variable in one relationship becomes the independent variable in the next relationship, the variable's direction of change should be maintained. For example: in Figure VIII-2, increased deforestation will cause a *decrease in rainfall* (negative causality) while a *decrease in rainfall* will cause a decrease in fresh water supply (positive causality).

The diagrams, figures VIII-2 through VIII-6, are divided into 5 general areas: (1) Environmental and Geographic (Socio-Cultural and Population, (3) Infrastructure, (4) Economic, and (5) Political. These six diagrams display the causal relationships from individual domains or combinations of domains. Though each diagram is presented separately they overlap. Effort has been expended to note overlaps by including some factors in more than one diagram. Relationships described in these diagrams are supported by specific findings in the domain sections and the annotated bibliographic entries appended to this report.

FIGURE VIII-2

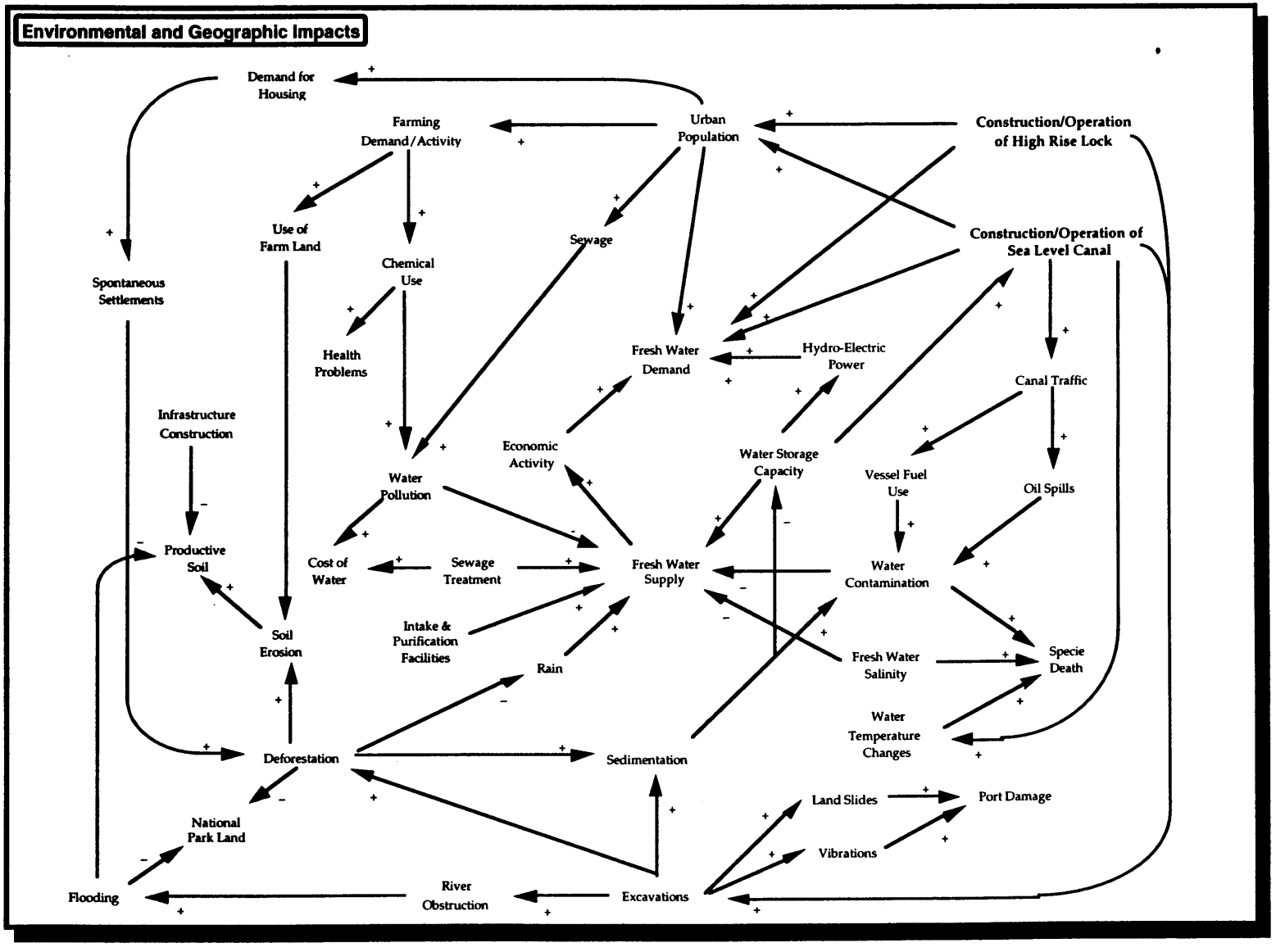


FIGURE VIII-3

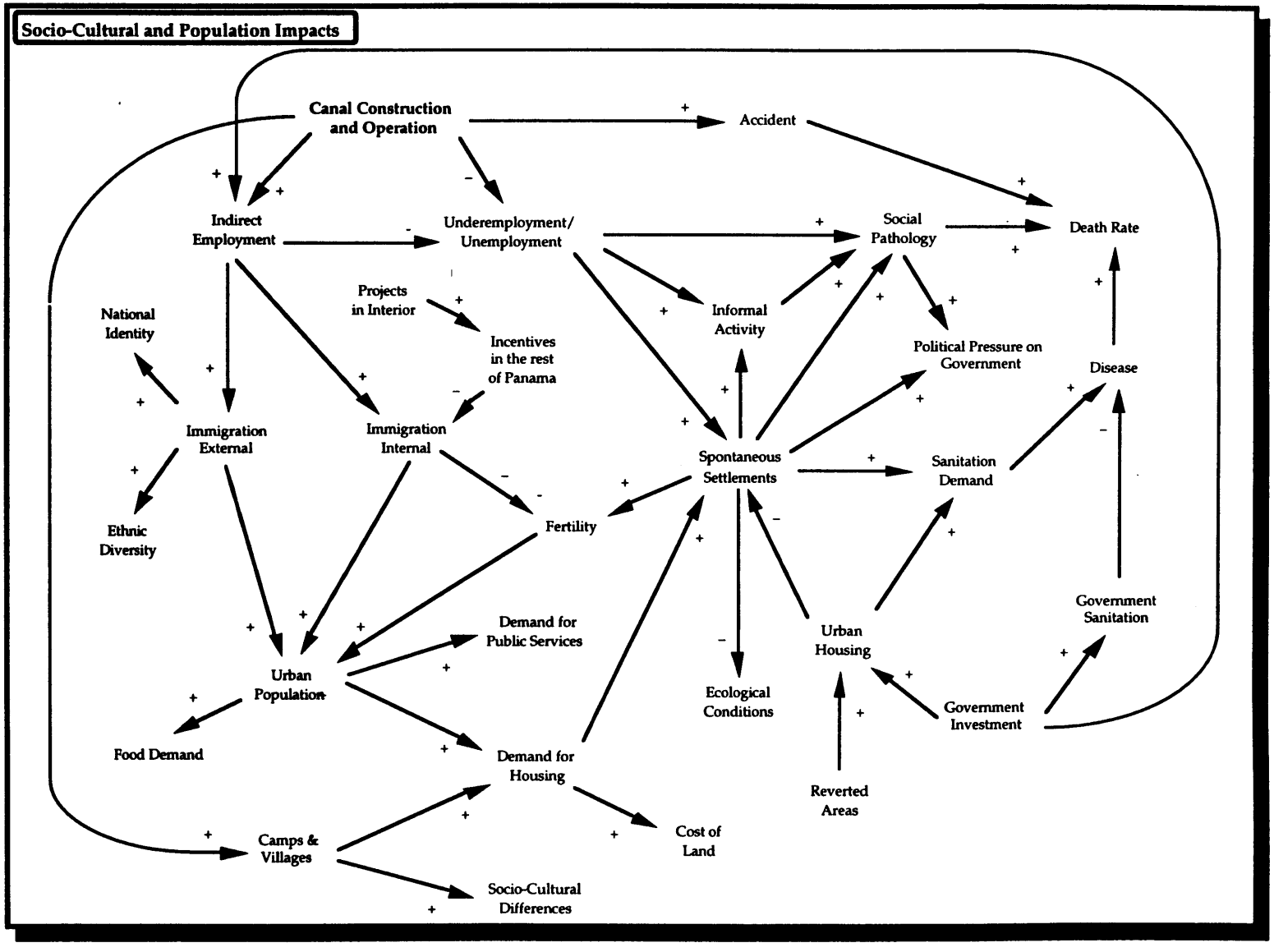


FIGURE VIII-4

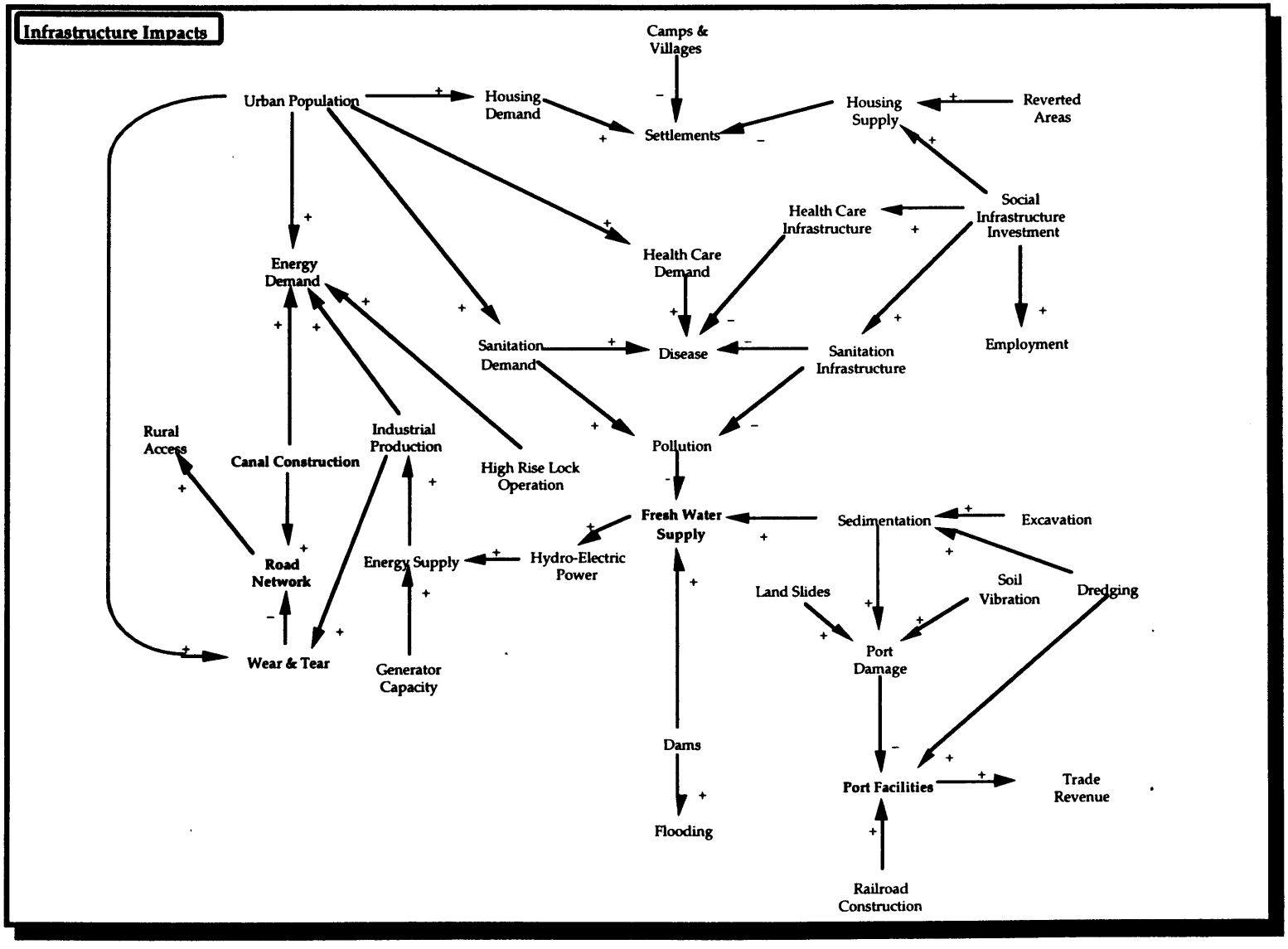


FIGURE VIII-5

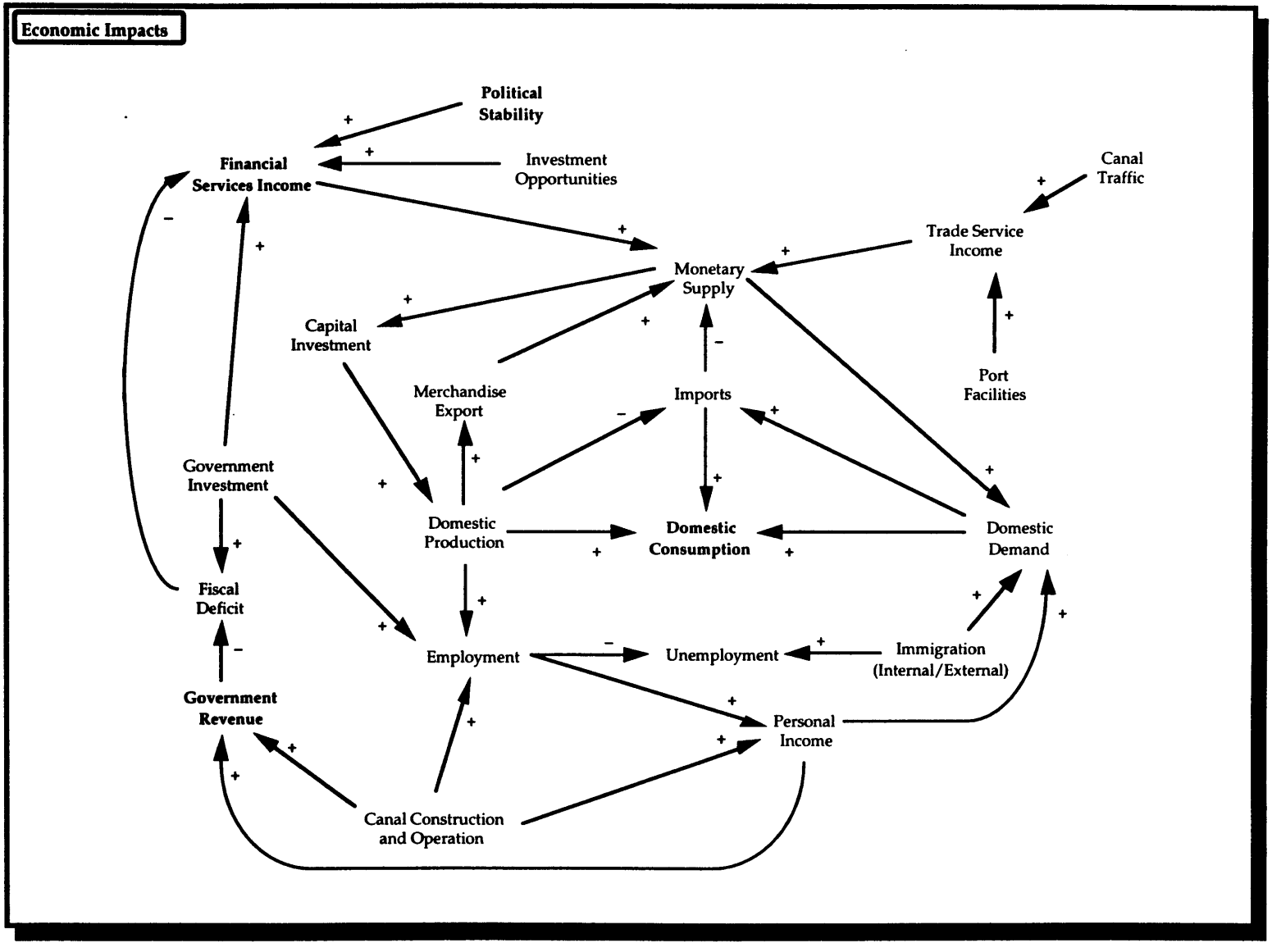
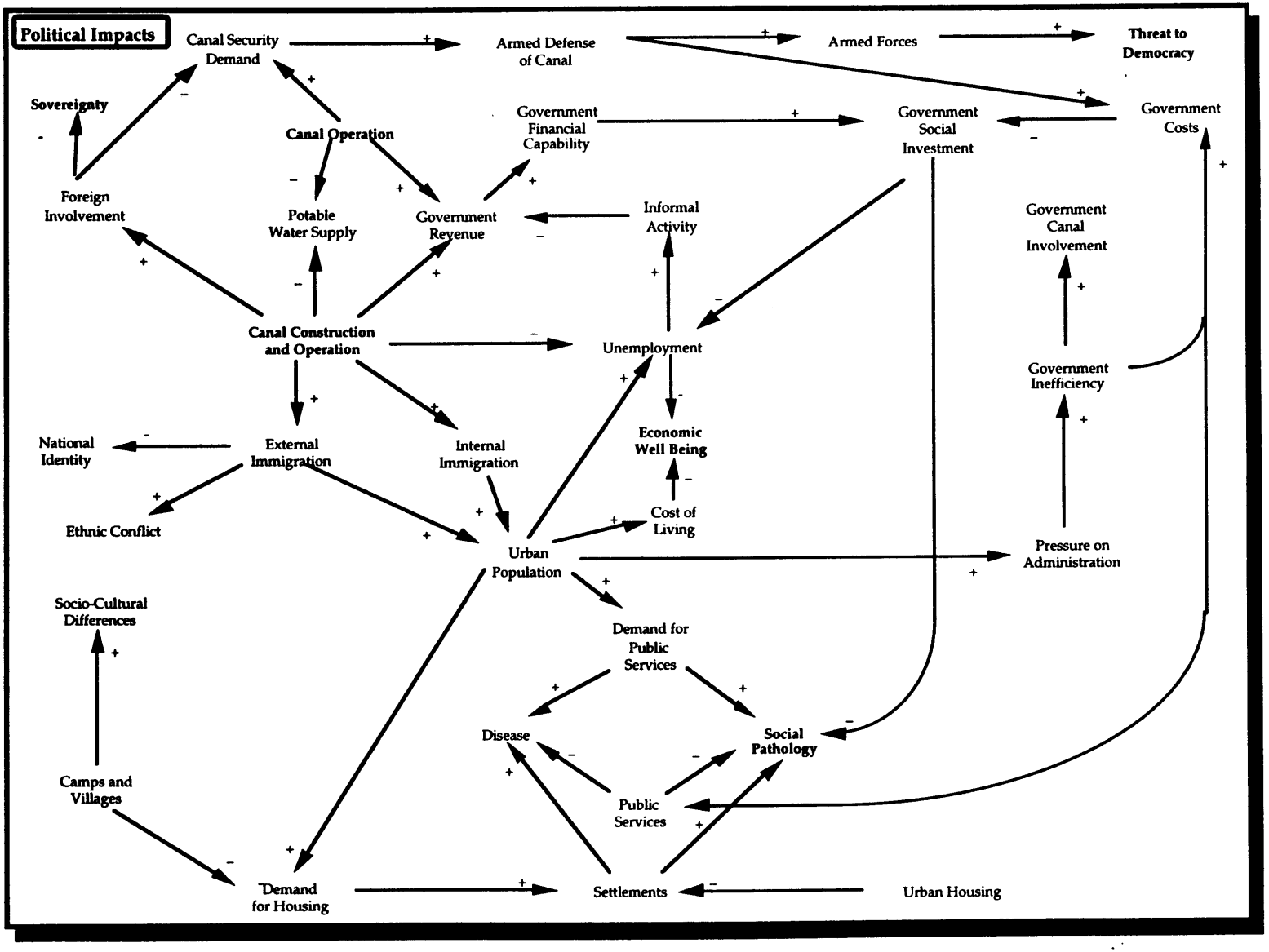


FIGURE VIII-6

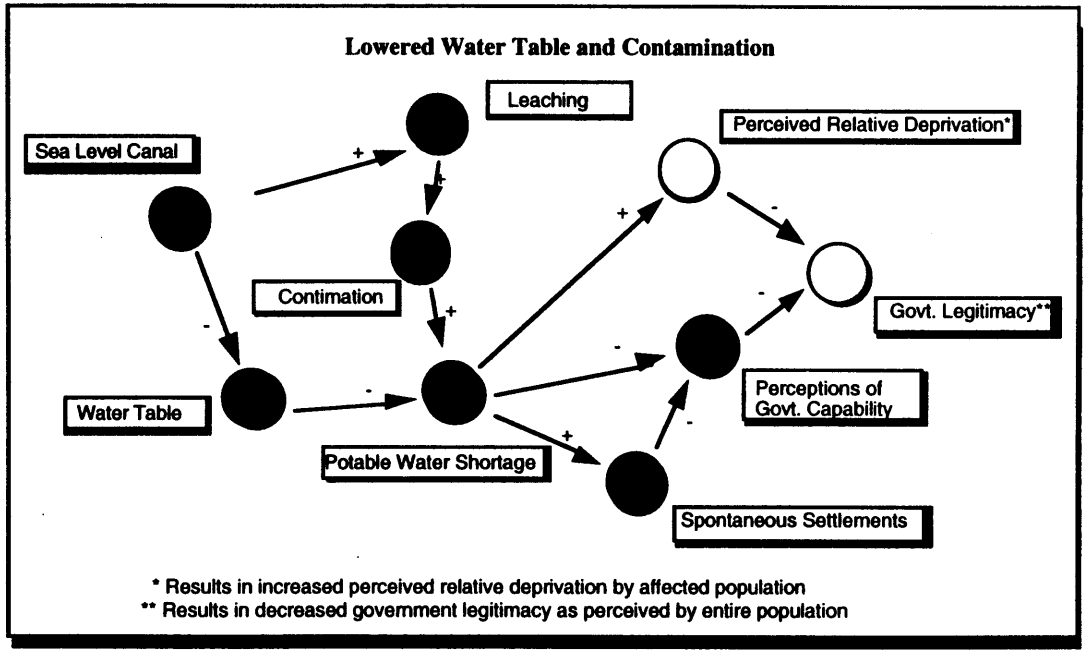


8.3 FINDINGS

8.3.1. Lower Water Table and Contamination

8.3.1.1 *Causal Relationships*

FIGURE VIII-7

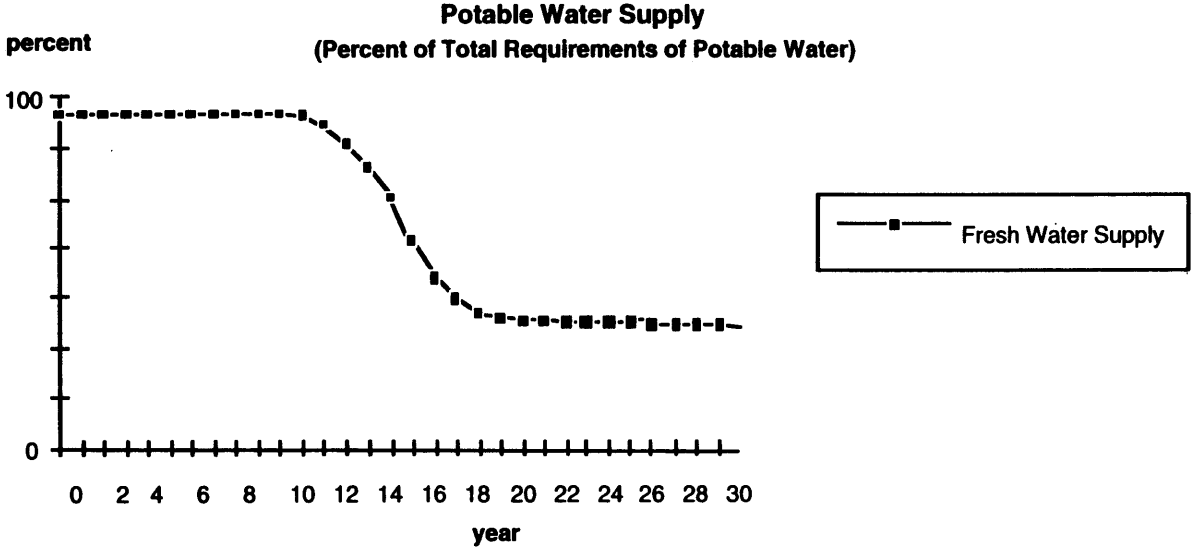


8.3.1.2 *Impact.* Geologists indicate that excavation works for a Sea Level Canal may lower the water table in the area of Continental Divide from its present level of approximately 5 meters to as low as 50 meters. Likewise there is concern at the possibility of that, seepage of polluted water from the Sea Level Canal entering the underground water supply because the canal trench will go below the current level of the water table. Underground water is the source of potable water for most individual homes and communities in that region. The Government of Panama must deal with the short-term problem of

replacing wells for area residents. Because much of the surface water in this region is to be used to support the fresh water barrier of the Sea Level Canal alternative, there may not be viable substitutes for underground water. The shortage of water, when combined with other social issues discussed in this report, may lead to significant discontent in the region. Likewise, the government's inability to come to grips with the problem could have a significant impact on the government's political strength.

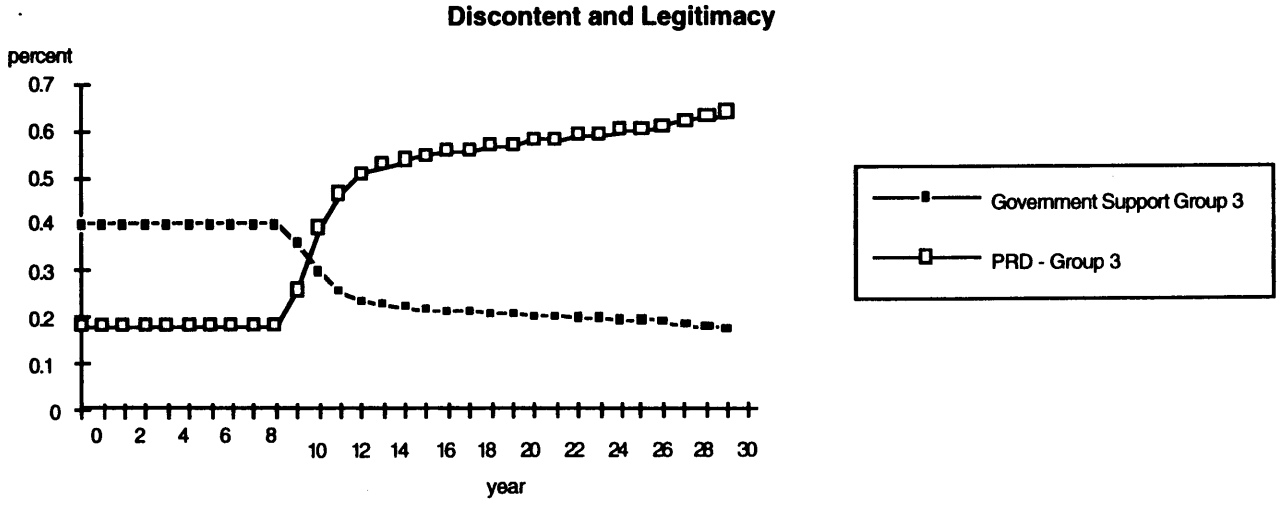
8.3.1.3 *Discussion.*

GRAPH VIII 4-1-1



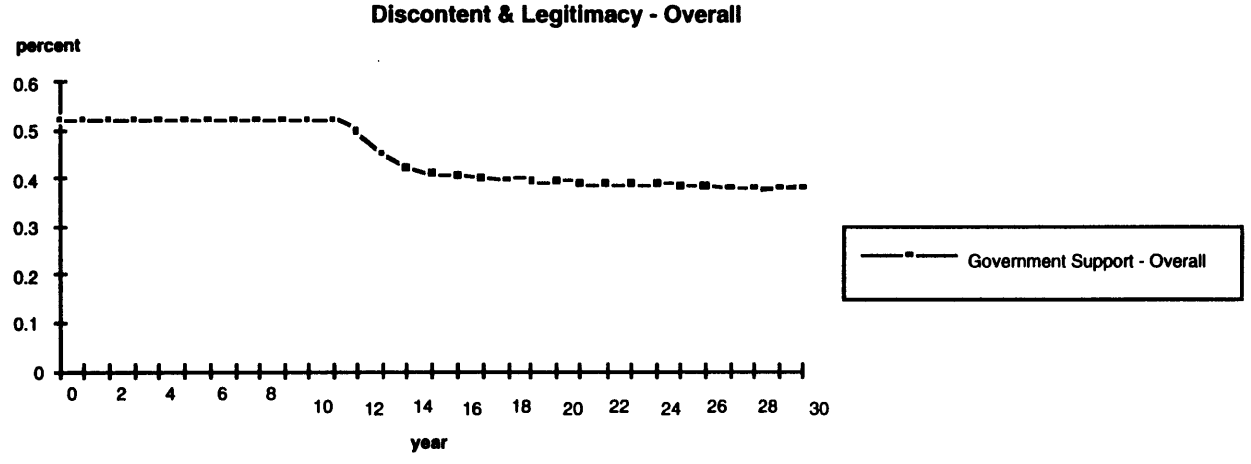
Environmental and infrastructure findings indicate that potable water supplies in the area of the proposed Sea-Level Canal are heavily dependent on sub-surface water. They further note that the present supply sometimes falls short of meeting 100% of the minimum requirements. The environmental analysis indicates that strong evidence exists to suggest that digging a Sea Level Canal will lower the water table well below the depth of most wells in the area. The developmental model was used to examine the consequences of a reduction of potable water supply in the area from a 100 percent of minimum needs to approximately 20 percent of needs, as indicated in Graph VIII 4-1-1. The possible extent of this reduction and its indirect effects on forest conservation in the present Canal's hydrographic basin may have enough long-range interest to warrant a separate study.

GRAPH VIII 4-1-2
Attitude Changes Among Affected Population



Model analysis indicated, as would be expected, that this failure to meet minimum needs would raise the general level of dissatisfaction and significantly increase the degree to which the affected population would feel that it was being unjustly affected. Thus, as indicated by Graph VIII 4-1-2, the population would feel that there was a significant increase in the extent of differential between the services they deserved and what they would get (Perceived Relative Deprivation). See Appendix B for an expanded discussion of Perceived Relative Deprivation.

GRAPH VIII 4-1-3
Attitude Changes Among General Population



Less intuitively apparent are model results that indicate adverse political consequences among the population outside of the affected area. Because the government is also judged on its capability to perform, the general population would likely withdraw some support on account of a perceived decrease in government legitimacy. (See Graph VIII 4-1-3).

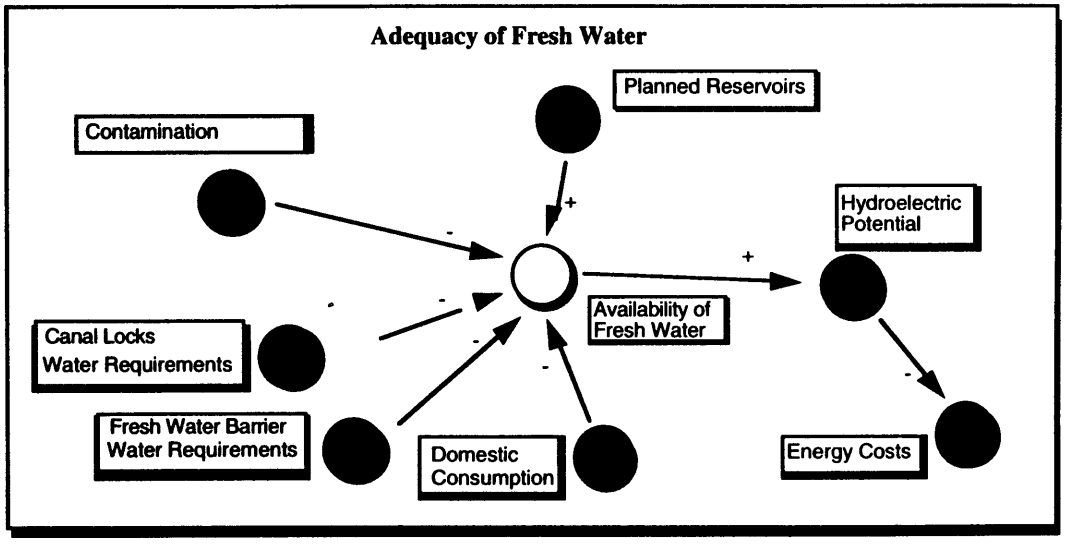
8.3.1 Unlike impact 8.4.1 (Lowered Water Table and Contamination), a well defined, specific impact that would affect a specific population, this impact is less well-defined but could affect the entire population. It is not at all certain that construction of either of the alternatives would result in a general shortage of fresh water. Likewise, it is unknown whether the Sea-Level Canal would result in contamination of Panama's fresh water supply. It is this uncertainty that makes fresh water a cross-domain phenomenon. As rumors spread concerning the possibility of a fresh water shortages and the contamination of the fresh water supply, support for canal expansion will likely waiver. Unless the government is able to convince the population that these

rumors are unfounded, demonstrations or violence may erupt. While the problem is very different from Graphs associated with Impact 8.4.1 also apply to Impact 8.4.2 (Adequacy of Fresh Water) because the results are much the same, in terms of less support for the Government of Panama.

8.3.2 Adequacy of Fresh Water

8.3.2.1 *Causal Relationships.*

FIGURE VIII-8



8.3.2.2 *Impact.* Existing fresh water supplies are barely adequate to meet current needs (to include requirement for operation of the existing canal) and popular sentiment against any worsening of present limitations and supply interruptions should be expected in terms of a general reaction. Likewise, while the present canal operation results in some contamination of the water, such contamination is generally understood and under control. While both alternatives include provision of additional water supplies, there is concern at the possibility that studies conducted are not sufficient to determine the adequacy of the new supply to meet the greater requirements of either of the two alternatives. Likewise, because there are so many unknowns associated with the Sea Level Canal, there

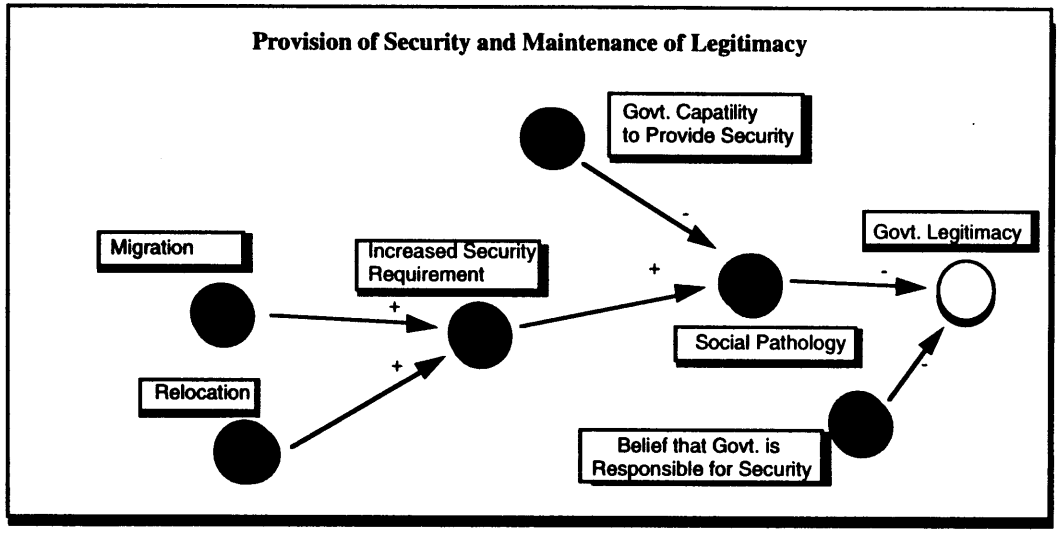
is significant concern about its effects on the water table and possible ensuing contamination of important fresh water supply sources.

8.3.2.3 *Discussion*. Unlike impact 8.3.1 which is a well-defined, specific impact with effects on a specific population, this impact is less well-defined but could affect the entire population. It is not at all certain that construction of either of the alternatives would result in a general shortage of fresh water. There is already considerable discontent over the administration of the public utility agency involved. Likewise, it is unknown whether the Sea Level Canal would result in contamination of Panama's fresh water supply. It is this uncertainty that makes fresh water a cross-domain phenomenon. As rumors spread concerning the possibility of fresh water shortages and the contamination of the fresh water supply, support for canal expansion is likely to peter out. Unless the government is able to convince the population that these rumors are unfounded, demonstrations or violence may erupt. While the problem is very different from Graphs associated with Impact 8.3.1 also apply to this Impact because the results are much the same: a loss of support to and popular reaction against the Government of Panama.

8.3.3 Provision of Security and Maintenance of Legitimacy

8.3.3.1 *Causal Relationships.*

FIGURE VIII-9



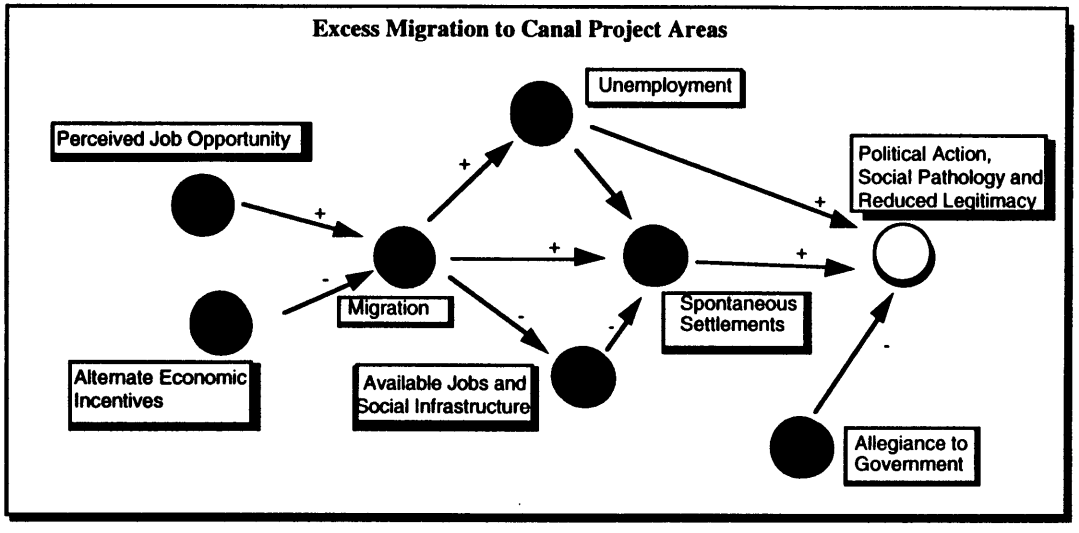
8.3.3.2 *Impact.* The opening of a predominately rural/remote area to significant job opportunities and the relocation of large numbers of people, associated with construction of the Sea Level Canal, will result in new requirements for the provision of security. Although much in the way of security and services associated with the Canal alternatives will be furnished by Canal authorities, the ultimate responsibility for both rests with the government of Panama, and there is concern at the fact that the maintenance of full control over the area may offer a significant challenge to the Government of Panama. The inability to provide adequate security in the area is significant in its own right, however, the inability to provide such security has significant implications concerning the legitimacy of the government. Furthermore, turmoil and hostilities in the Colombian side of a not too distant border, and the nature of the terrain in between, (jungle, tropical forests and scarcely populated regions), may combine in a perception of the area as a new vulnerable arena, endowed with unusual international resonance, for political vendettas and otherwise.

8.3.3.3 *Discussion.* If the government is unable to provide the necessary security to the newly developed areas along the sea level canal, there would be the expected increase in social pathology. As indicated in the graph below, that rise in crime would be followed by a general loss of perceived legitimacy and a reduction of popular support for the government. Model results indicate the eventual recovery of support, however such a rapid decrease in support as indicated at years 8-10 could have significant consequences. It may also be expected that many of the issues concerned in the choice of an alternative, and in project execution shall become a part both of serious in-depth discussion and political tactics by the end of 1993 and the beginning of a highly controversial and complicated political campaign for the general elections to be held in May 1994. This probability has unfortunately been treated lightly when not ignored completely in source studies and information. This election campaign may prematurely trigger many important direct and indirect impacts both those with immediate effects and those with long-range consequences.

8.3.4 Excess Migration to Canal Project Areas

8.3.4.1 *Causal Relationships.*

FIGURE VIII-10



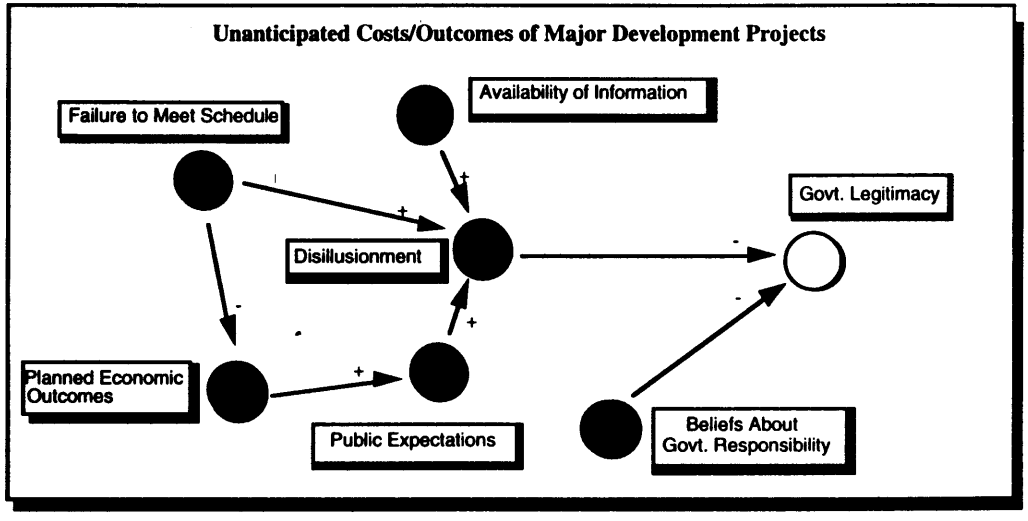
8.3.4.2 *Impact.* Given existing levels of poverty and existing employment conditions throughout Central America, it is highly likely that pressure of prospective migrants and even migration to the project areas may greatly exceed project requirements and become a burden to society if left uncontrolled. Although this is likely to be significant in the case of either alternative, the remote areas surrounding the Sea Level alternative present greater potential problems. In addition to excess migration, there is the associated problem of the relatively sudden loss of approximately 10,000 jobs once either project is complete.

8.3.4.3 *Discussion.* Model results associated with excess migration were essentially the same as those obtained in respect of security provisions. In both cases, local dissatisfaction led to social pathology, which resulted in an eventual loss of support for the government.

8.3.5 Unanticipated Costs/Outcomes of Major Development Projects

8.3.5.1 *Causal Relationships.*

FIGURE VIII-11



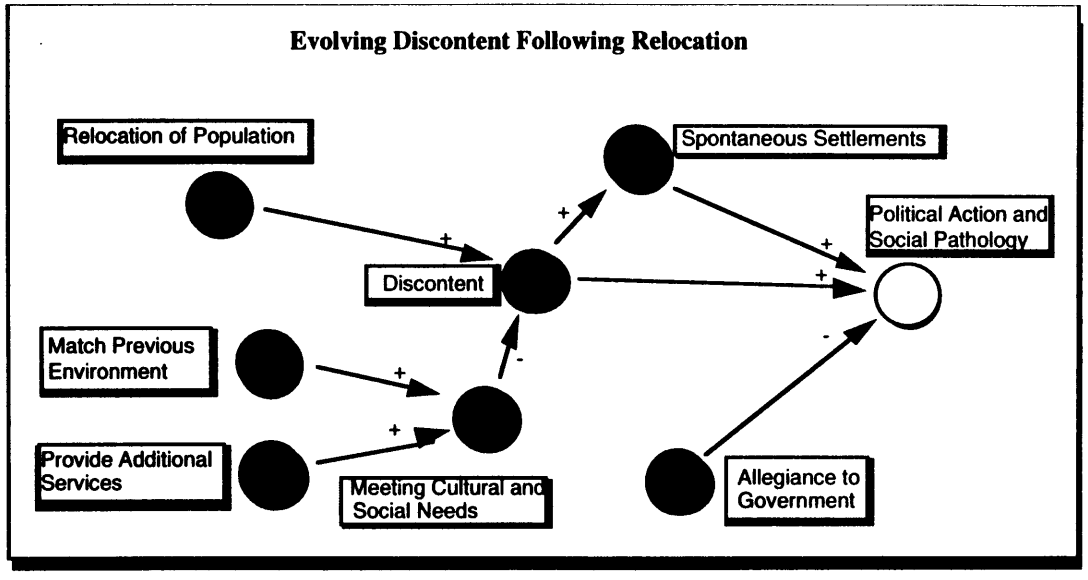
8.3.5.2 *Impact.* Development projects are often prone to harboring unrealistic expectations over ambitious project completion dates. Both Canal alternatives include 24-hour, 7-day-week work schedules which may mean excessive stress to both men and machine. Review of other development projects indicates that failure to meet an overly ambitious schedule may result in disillusionment and thus have significant consequences on perceptions of government legitimacy. While such disillusionment would be a factor in both alternatives, it may be of greater consequence with the High-Level Locks Canal alternative where results are expected on a relatively short term basis, and with a great portion of the population in close proximity to ongoing work and all effects as the impact area "par excellence".

8.3.5.3 *Discussion.* Model runs associated with this impact indicated a gradual increase in discontent and an associated perception of relative deprivation with the resultant loss in long term support.

8.3.6 Evolving Discontent Following Relocation.

8.3.6.1 *Causal Relationships.*

FIGURE VIII-12

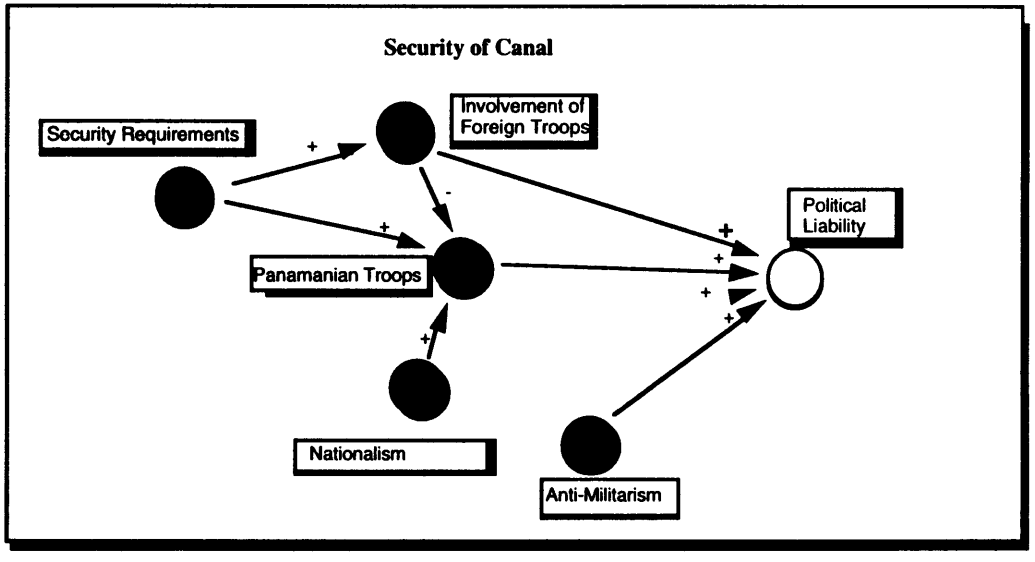


8.3.6.2 *Impact.* Although Canal Engineering studies address the requirement to relocate significant portions of the population, they do not detail any plans for such relocation. Study of relocations associated with other development projects show that, even with detailed planning, there are numerous unanticipated consequences to relocation capable of raising levels of dissatisfaction. Even in relatively successful relocations, favorable attitudes often wane with time. Although relocation is associated with both alternatives, the Sea Level alternative requires greater numbers to be relocated and will probably require a greater change in environment for relocation subjects.

8.3.7 Security of Canal

8.3.7.1 *Causal Relationships.*

FIGURE VIII-13



8.3.7.2 *Impact.* The construction of a Sea Level Canal will require a doubling of the security force required for the protection of the Canal itself. The High Level Locks Canal alternative will require a slight expansion of security forces. The types of surveillance aircrafts and an increase in number and types of weapons would be less noticeable than in the Sea Level Canal option.

8.3.7.3 *Discussion.* There are political risks associated with the introduction of additional security forces and especially any introduction of foreign security forces. Such action has the potential to support for the Government and the system diminish, and both could very well have a difficult time recovering from such a drop.

8.4 CONCLUSIONS

A system dynamics modeling approach was used to investigate outcomes with implications for more than one domain, and also to assist in the process of identifying sensitive impacts useful in an evaluation effort, in order to facilitate decision making by the Commission. As is readily apparent from the study of the causal diagrams in Figures 2-6, numerous impacts crossed study domain boundaries. The system dynamics modeling process described above was of valuable assistance in coordinating the results of this Analysis, and its feedback accounts for numerous cross domain effects within the domain sections. Thus it was possible to concentrate on those cross-domain impacts that were likely to be the most significant and useful for evaluation and comparison purposes.

TABLE VIII-1

High-Level Alternative

Independent Variables	*Intervening Variables*	*Primary Dependent Variable*
Failure to Meet Schedule		
Raised Public Expectations	Disillutionment/ Discontent	
Failure to Meet Relocation Expectations	Social Pathology	Government Stability and Legitimacy
	Lack of Potable Water	
Insufficient Dams		
Polution of Water	Shortage of Fresh Water	
Excess Migration	Unemployment	
Increased Security Requirements	Spontaneous Settlements	

Sea-Level Alternative

Independent Variables	*Intervening Variables*	*Primary Dependent Variable*
Failure to Meet Schedule		
Raised Public Expectations	Disillutionment/ Discontent	
Failure to Meet Relocation Expectations	Social Pathology	
Lowering of Water Table	**Lack of Potable Water**	**Government Stability and Legitimacy**
Insufficient Dams		
Polution of Water	Shortage of Fresh Water	
Excess Migration	Unemployment	
Increased Security Requirements	**Spontaneous Settlements**	

After thoroughly examining results from each of the study areas and analyzing the results of model runs, it became clear that the emergent theme is the significant effect of the major impacts on questions of

perception of government legitimacy and its contiguous elements of stability and public order. Not only did impacts from each of the study areas result in public discontent, affect legitimacy, and/or reduction of support for the government, but their effects were generally cumulative. It is anticipated that efforts will be made to deal with the impacts discussed in this study. However, if action is not taken to resolve these issues, it is probable that a government, and perhaps the democratic system of government, would face serious challenges in withstanding the pressures of their cumulative effects. This all-too-human side of the effects must be considered.

IX. SUMMARY OF ASSUMPTIONS, CONCLUSIONS AND RECOMMENDATIONS

9.0 PURPOSE

The purpose of this summary is to highlight the assumptions, the important impacts and the discriminatory findings of this component study.

9.1 BACKGROUND

The main objectives of the Analysis of Impact Upon Panama were to qualify and quantify, to the utmost extent possible, probable effects and impacts of two pre-screened Canal alternative projects (the High-Rise Lock Canal with a maximum capacity for 150,000-200,000 DWT vessels and the Single-Lane Sea Level Canal following Route 10 with a maximum capacity for 250,000 DWT vessels) on Panama and the project region, as well as to complement appropriate data and information for the Economic Analysis.

9.2 ASSUMPTIONS

A summary of the key assumptions used during the study are as follows:

9.2.1 *Economic and Financial:*

9.2.1.1 The globalization process of the world economy will continue during the first half of the next century. This assumption is implicit in the estimates of demand for Canal services, but also in prices and costs structures presented in other studies. In this component study, the assumption is important because it confirms the need to insert the Panamanian economy in an integrated world economy as a way of promoting domestic welfare.

9.2.1.2 Technology for the construction of either alternative will not change on account of changes in factors and inputs relative prices. The alternatives would be carried out with the mixture of resources and with the relative prices suggested in the Yachiyo Engineering project.

9.2.1.3 The financial surplus of the Panama Canal Authority will not be taxed by the Central Government.

9.2.1.4 The Panamanian economic structure will not suffer positive external shocks (discovery of resources or spontaneous capital inflows) nor negative external shocks (important natural disasters or a sudden decline in demand for major export goods involved in maritime trade using the Canal).

9.2.1.5 Any increase in toll revenues projected for the current Canal and new Canal alternative will be used to cover the debt of the new Canal, and to provide some return on equity to the Panamanian equity portion of the financing. This means that toll revenue increases will have no effects or only negligible ones on the local economy.

9.2.1.6 The final two Canal alternatives out of the five finalists (two variations on the High-Rise Lock Canal and three variations on the Single-Lane Sea Level Canal) will be those two with the best results in the analyses in both the Economic and Financial Component Studies. The two best final Canal alternatives in those two studies are:

- The High-Rise Lock Canal with a capacity for 150,000 DWT vessels.
- The Sea Level Canal, Case C, including Pacific tidal locks and Atlantic tidal locks.

9.2.1.7 There will be no impacts on users or very negligible ones during the construction period of the new Canal alternative. This is consistent with the assumption of the Economic Analysis and Impact on Users Component Study.

9.2.1.8 The "other Canal excavation" costs which are part of the costs of the Sea Level Canal will not be spent in Panama.

9.2.1.9 The optimal toll structure, as delineated in the Financial Component Study, will be adopted.

9.2.1.10 "The Panama Canal Authority" will be the administering agency in charge of Canal Management.

9.2.2 *Political, Socio Cultural and Population:*

9.2.2.1 Foreign administration and control of the current canal will end during the decade preceding the construction of either alternative. This will strengthen Panama's domestic and international political structures, as well as the country's domestic and international policies. (

9.2.2.2 During the two decades following the return to democratic institutions in the country, the political system will be strengthened, as well as Panama's position in any international negotiations.

9.2.2.3 The Government of Panama will take both legislative and administrative actions to ensure that the procurement system will be open, not discriminatory. This implies that construction and financing costs will be the lowest possible, due to project requirements.

9.2.2.4 Political decisions and arrangements for indemnification will be made by the Government of Panama as part of the planning for relocating people from the canal alternative project area.

9.2.3 *Environmental and Geographic Impacts:*

9.2.3.1 Both of the proposed alternatives, the Sea Level Canal or the High-Rise Lock Canal, will generate major impacts on Panama due to the magnitude and costs of environmental works and the costs of required environmental studies.

9.2.3.2 An acceleration of the growth rate of the Metropolitan Region has been anticipated without the introduction of any Canal alternative project. This will add stress to canal excavation work and to the ensuring canal operations.

9.2.3.3 The problem of marine life transmigration between the Pacific Ocean and the Caribbean Sea caused by a sea level canal would be of great consequences for Panama and for the world in terms of a major alteration in the sea and coastal marine environment.

9.2.3.4 A variation in the tropical environment and larger demographic concentrations, could maintain or reactivate known epidemics, such as cholera, dengue, yellow fever, malaria, Chagas disease, leishmaniasis, rabies, meningitis and others, in the project areas.

9.2.4 *Infrastructure General:*

9.2.4.1 In terms of the impact on infrastructure costs, the percentage of increase in population due to the construction of either Canal alternative will be insignificant when compared with projections for total growth.

9.2.4.2 The Panamanian Government will program its investments in infrastructure according to the current projections of population growth in the project areas.

9.2.4.3 Panama will be able to invest in its primary infrastructure requirements, and no significant additional infrastructure will be required upon the announcement of construction works for either canal alternative or the beginning of construction proper.

9.2.5 *Ports:*

9.2.5.1 The port facilities at Rodman will be eliminated in the case of the High-Rise Lock Canal alternative.

9.2.5.2 The Panamanian Government will provide indemnification for the installations at Port Caimito, which will be affected by excavation and dredging operations.

9.2.5.3 The Panamanian Government will undertake reconstruction activities in the ports of Balboa and Cristobal before the year 2000, thereby avoiding major damage during construction of the High-Rise Lock Canal.

9.2.5.4 The basin areas of the ports of Cristobal and Balboa will be affected by the widened waterway, and more sediment will be produced because of landslides and dredging operations.

9.2.6 *Electrical:* Additional electrical requirements due to canal construction will be met by the construction contractor, and will not impact the existing network.

9.2.7 *Telecommunications:* Technology will solve most telecommunications requirements through cellular and other new communications.

9.2.8 *Water Works:*

9.2.8.1 The supply of drinking water from wells in the area of Arraijan will be greatly diminished or disappear as a consequence of the Sea Level Canal excavations.

9.2.8.2 The High-Rise Lock Canal will have some impact on water supply because of dredging and sedimentation affecting the actual volumes of fresh water taken from the Miraflores facility.

9.2.8.3 The pipelines interrupted by the High-Rise Lock Canal in the Atlantic side and in the Pacific side will be relocated under the new Canal.

9.2.8.4 The pipeline interrupted by the Sea Level Canal would be reinstalled using protected bridges.

9.2.8.5 Other sources of water supply for municipal use will be required in both alternatives.

9.2.9 *Road Network:*

9.2.9.1 Wear and tear in the existing road system will be approximately the same in both alternatives.

9.2.9.2 New road networks, such as the Corredor Norte and the Corredor Sur, will be built prior to the year 2000, and would include modifications to adapt them to the selected alternative, if required.

9.2.10 *Structures:*

9.2.10.1 For the Sea Level Canal alternative, the one-kilometer Canal control area will permit residents to continue to live in the area under the supervision of the Canal Authority.

9.2.10.2 It is assumed that the Yachiyo cost estimates for relocating of structures take into consideration equipment within the structures.

9.2.11 *Bridges:* The Van Dam (Simon Bolivar) bridge, together with the corresponding parts of the major highways, will be built before the end of the century.

9.2.12 Railroads: The Panama Railroad will be functioning in excellent condition by the end of the century.

9.3 GENERAL FINDINGS AND CONCLUSIONS

The successful construction and subsequent operation of either alternative will have long-term positive benefits in terms of providing Panama with a sustainable income source throughout the next century.

Major direct impacts on Panama occur during the mobilization for construction and during construction itself, in the case of either alternative. Major indirect impacts on Panama occur during the Operation Phase of either alternative.

9.3.1 *Discriminator Impacts Developed By System Dynamics Model*

While each of these impacts is discussed in the individual fields of study in the report, the following impacts were highlighted by the model as the most significant, when it considered impacts overlapping study fields or domains.

9.3.1.1 *Lower Water Table and Contamination.* Digging a sea level canal may lower the water table in the area of the Continental Divide and in the Pacific watershed from its present level of approximately 30 feet to as low as 150 feet. There is significant concern of the fact that the canal trench will go below the current level of the water table, and seepage of polluted water from the Sea Level Canal may enter the underground water supply. Underground water is the source of potable water for most homes and communities in that region. The Government of Panama must deal with the short-term problem of replacing wells for area residents. Because much of the surface water in this region will be used to support the Sea Level fresh water barrier, there may not be viable alternatives to underground water. A shortage of water combined with other social issues discussed in this report may lead to significant discontent in the region. The Government of Panama must take significant action in this area, as failure in coming to grips with the problem and solving it could have a significant impact on its political strength.

9.3.1.2 *Adequacy of Fresh Water Supplies.* Existing fresh water supplies are barely sufficient to meet current needs (including requirements for operation of the existing Canal). Likewise, while the operation of the present Canal results in some contamination of the water, such degrees of contamination are generally understood and under control. During construction, the High-Rise Lock alternative will have an impact on the water intake from the Miraflores

plant. While both alternatives include provision of additional water supplies, further studies, are required until the adequacy of the new supply in light of the greater requirements of either of the two alternatives is determined. Likewise, because there are so many unknowns associated with the Sea Level Canal, there is a significant possibility of contamination of the fresh water supply.

9.3.1.3 *Provision of Security and Maintenance of Legitimacy.* The opening of a predominately rural/remote area with significant job opportunities and the relocation of large numbers of people associated with the construction of the Sea Level Canal alternative will result in new security requirements. Although in the way of security and services associated with the canal alternatives much will be furnished by the Panama Canal Authority, the ultimate responsibility rests with the Government of Panama. Maintenance of full control over the area may offer a significant challenge to Panamanian authorities.

9.3.1.4 *Excess Migration to Canal Project Areas.* Given existing levels of poverty and existing employment conditions throughout Central America, it is most likely that migration to project areas will greatly exceed project requirements, thus increasing unemployment and underemployment. Although this may be significant in either alternative, the remote areas surrounding the Sea Level Canal alternative represent greater challenges. In addition to excess migration, there is the related indirect impact of the relatively sudden loss of approximately 10,000 direct construction and related service support jobs upon completion of either project.

9.3.1.5 *Unanticipated Costs/Outcomes of Major Development Projects.* Development projects often tend to establish unrealistic expectations and overly ambitious project completion dates. Both Canal alternatives include 24-hour, 7-day-week work schedules that may put both man and machine under excessive stress. A review of other development projects, such as dams and other large utility projects, indicates that failure to keep overly ambitious schedules may result in disillusionment, and thus have significant consequences on government credibility, and subsequently, on its ability to maintain popular support. While such disillusionment would be a factor in both alternatives, it may be of greater consequence in the High-Rise Lock Canal alternative where relatively short-term results are expected and a greater portion of the population is in close proximity to ongoing work. The phased construction approach for the High-Rise Lock Canal would tend to mitigate this impact.

9.3.1.6 *Evolving Discontent Following Relocation.* Although Canal engineering studies address the requirement to relocate significant portions of the population, they do not detail plans for such relocation. Study of relocations associated with other development projects show that, even with detailed planning, there may be numerous unanticipated consequences to relocation raising the levels of dissatisfaction. Even with relatively successful relocations, favorable attitudes often wane with time. Although relocations are associated with both alternatives, the Sea Level Canal alternative requires greater numbers to be relocated and will probably entail greater changes in environment.

9.3.1.7 *Security of Canal.* The construction of a Sea Level Canal alternative will require a doubling of the security force required to protect the Canal itself, a requirement that would impose a significant political consideration to the Government of Panama. While the High-Rise Lock Canal alternative will require a slight increase in the number of security forces, the associated political concern is relatively small.

9.3.2 *Other Significant Impacts*

The following impacts were identified as important or very important discriminating impacts within the specific field of study.

9.3.2.1 *Economic Impacts*

9.3.2.1.1 The expansion of the Panama Canal -- either by means of a High-Rise Lock or a Sea Level Canal -- will represent the single most important investment Panama has ever witnessed. The largest direct impact occurs in the Sea Level Canal option, which represents 28.6% more total expenditures than the High-Rise Lock with a capacity of up to 150,000 DWT vessels and 14.8% more than the High-Rise Lock with a capacity of up to 200,000 DWT vessels. Direct impacts are proportional to construction expenditures. The largest total direct impact during operation occurs also in the Sea level Canal option.

9.3.2.1.2 Annual impacts on GDP are very similar for all alternatives: close to 1% per year during construction and close to 1.2% per year during operation. Employment creation is higher for the Sea Level Canal option.

9.3.2.1.3 Neither alternative is expected to change the economic structure of the country during construction or during operation. During construction, most of the inputs will be imported by the contractors. Local industries will provide some materials, but there will not likely be expansions of existing capacity or investments in new ventures.

9.3.2.1.4 During the operation of the alternatives, the increase in GDP calculated in the study will come from the already dynamic service sector, not by new developed sectors. Income distribution, therefore, is expected to remain skewed as it is today.

Total impacts on the economy during construction (in 1990 millions) are shown in Figure IX-1 below.

Figure IX-1: Total Impacts Upon the Economy During Construction

	High-Rise Lock (150,000DWT)	High-Rise Lock (200,000DWT)	Sea Level Canal
Value Added	708.1	792.9	911.1
Intermediate Purchases	809.3	906.3	1,041.3
Impact upon Total Employment	95,760	107,236	140,828
Impact upon GDP (annual average increase)	0.95%	1.06%	0.81%

Total impacts (in 1990 millions) during operation (at 6% discount rate) are shown in Figure IX-2 below.

Figure IX-2: Total Impacts Upon the Economy During Operation

	High-Rise Lock (150,000DWT)	High-Rise Lock (200,000DWT)	Sea Level Canal
Value Added	3819.8	3,635.6	4174.6
Intermediate Purchases	2,030.7	1,932.4	2,219.3
Impact upon Total Employment	12,853	12,233	14,046
Impact upon GDP (annual average increase)	1.3%	1.2%	1.4%

Sea Level Canal alternatives show the largest direct impact, 15.3% larger than the High-Rise Lock (200,000 DWT).

9.3.2.2 *Financial Impacts On Panama*

9.3.2.2.1 The primary beneficial financial impacts on Panama will be a result of the construction of the new Canal. Primary impacts include:

- The potential for increased import duties as a result of the importation of equipment and materials for construction.

- Increased government revenues from personal income tax resulting from the increased local employment and business taxes resulting from the local purchase of goods and services.

Based on the above consideration of beneficial financial impacts only, the preferred alternative would be the Sea Level Canal, because it costs more to construct and therefore, requires more imports and local purchases of goods and services. However the heavier burden in terms of devt servicing and the more encompassing overall repercussions cannot be ignored.

9.3.2.2.2 A potential negative financial impacts on Panama generated by the new Canal alternative consists of a possible decline in the payments to the Panamanian Government from the Canal, as a function of the new management structure to be put in place, and that a Government guarantee of part of the financing may be required. Such a guarantee may hinder the Government's ability to obtain financing for other domestic projects, such as new infrastructure and infrastructure maintenance. In this case, the Sea level Canal alternative,with the higher cost, would present the greatest negative impact. The financial impact must be weighed in this sense, in the context of present economic situation and limitations, and in terms of the real ability of panama to maintain financial and economic flexibility in the future.

9.3.2.3 *Political Impacts*

Direct Impacts

9.3.2.3.1 Panama's selection of a Canal alternative will have international political dimensions. The international momentum behind the Rio Conference on Environment and Development, the "Earth Summit," should be a factor in either decision. The possibility that the High Rise Lock Canal alternative disturbs some areas of rain forest will become an issue with such resonance that it will be the subject of debate. This debate will cause the Government of Panama to provide justification and scientific proof that it has weighed the consequence and can take measures to safeguard the environment.

Strictly from an environmental standpoint, if the Sea Level Canal alternative were selected, the potential negative political impact on Panama is much greater than that of the High-Rise Lock alternative. The Sea Level Canal may cause interoceanic transmigration of species, with unknown and incalculable change and possibly considerable damage to

marine life in the Carribbean and the Pacific; it will disturb and reduce endemic habitat for endangered species; and it will create an additional barrier to rare species migration. Just the possibility that these situations can occur will capture the concern of almost every one of the more than 800 international non-governmental agencies concerned with environmental problems. The political pressure on the Government of Panama, from all of the Caribbean nations, worried about their coral reefs, is one anticipated reaction, which, ironically, may be of less consequence than the other anticipated reactions. International new coverage concerning the potential dangers (almost assured to be negative), coupled with anticipated activities from some groups such as Greenpeace, will place tremendous poltical pressure upon the Government of Panama. The potential for Panama being labeled as an enemy of the environment is very real.

9.3.2.3.2 *National Consensus.* The Government of Panama will be required to establish clearly define policies and build a national consensus among the social institutions and the people in support of Canal alternative construction issues prior to the final design phase or the start of construction. These include politically sensitive issues such as the public debt, foreign influence, foreign rights and responsibilities, and the import of a large number of foreign workers. Given the projection of increases in population and in the demand for social and technical infrastructure made without taking any canal alternative into consideration, the development of policies and the building of consensus could become a political problem and an impact stemming out of either alternative. It would be much more significant impact in the case of the Sea Level Canal on account of the expanded territory being assigned for the waterway and associated issues.

9.3.2.3.3 *Sovereignty and Management of the Canal.* Given the fact that over 85% of current Canal employees are Panamanian, and given the positive actions which the Government of Panama is taking to structure the management of the current canal under a new authority established by the constitution, the impact of either alternative on the political structure's capability to manage the expanded canal will be the same. With the experience of twenty years of sovereign management of the current Canal, Panama will have demonstrated its ability to manage the international waterway. The international community will have a measure against which to calculate independent sovereign capabilities to manage the construction and operation of either alternative. However,

internally, the degree of independent Panamanian control of the Canal alternative project, as it is perceived and understood by the populace, will have an impact on the stability of the political system and on the strength of national institutions. If it is perceived and understood that Panama has sovereign control of the facility, a positive impact occurs. If it is perceived or understood that Panama does not have sovereign control of the Canal facilities, a significant negative impact occurs.

9.3.2.3.4 *Security and Security Forces.* There will be direct political impacts regarding expansion of the area in which the political system will be required to provide security and control. This will have a greater impact during the operations. The provision of security under the Neutrality Treaty, and the development of security forces required to provide security and control over the extended area encompassed by the current canal and either alternative could have a major negative political impact. This impact will be much greater in the case of the Sea Level Canal alternative. The additional security forces required to provide day-to-day security and protection services for the High-Rise Lock Canal alternative are minimal. The location of the new locks within the current Canal area means that additional personnel and facilities will be perceived as an addition to the current force of 900 persons. The Sea Level Canal alternative requirement of an additional 900 to 1000 persons is significant. Given Panama's experience with the 1968 coup and the two decades of military dictatorship, developing and training the larger number of armed personnel along with the sophisticated equipment needed to provide surviellence and to secure the separate Canal facility could create a distabilizing influence on the political system. The problem created by such additional security forces requires additional study.

Indirect Impacts:

9.3.2.3.5 Relocation caused by either Canal alternative will cause an indirect political impact. The Government will be required to create means of indemnification and compensation through legislation, prior to the start of construction for either alternative or this will be a major negative impact. The Sea Level Canal alternative will cause a significantly larger displacement of the population. From the socio-cultural and political viewpoints, it may be necessary and more feasible that some communities remain where

they are, requiring some realignment of the project control area or other engineering adjustments in the Sea Level Canal alternative.

9.3.2.3.6 Beginning with the announcement of construction work for either Canal alternative, the Government will be required to plan and fund sufficient social and technical infrastructure expansion to decrease the level of perceived relative deprivation. While for purposes of the identification of infrastructure impacts, this study assumed that the Government would develop the required and planned infrastructure to meet the needs of an increase in population, without such planning and funding actions the Canal expansion will highlight and increase the associated problems, and therefore will have a negative impact on the political stability of the Government. This impact may be greater with the Sea Level Canal on account of the magnitude of the disruption.

9.3.2.3.7 Demographic indicators show that the increase in population in the Metropolitan Region will most likely produce an increased poverty, informal markets, and social pathologies. This will affect the public security system and the administration of justice. This impact may be more severe as pressures to expand the urban areas increase with the opening of significantly larger areas of the country should the Sea Level Canal be selected.

9.3.2.4 *Socio-Cultural And Population Impacts*

Direct Socio Cultural and Population Impacts

9.3.2.4.1 Anticipation and actualization of large investments in either alternative will create an accelerated flow of domestic and foreign migrants from. The growth of the Metropolitan Region will exceed present forecasts. Anticipation of development in or near the project areas of the Sea Level Canal alternative will directly impact the migration flows to that area which is less capable of providing for such an increase. It will also create an increase in local needs for imported foods. Impacts stemming from the High-Rise Lock alternative will be of a smaller magnitude.

9.3.2.4.2 An increase in spontaneous settlements and/or population growth are expected impacts both during the mobilization for, and the construction of, either alternative. In both cases, the supply of labor will be higher than the demand estimated for either canal alternative. The need for selective qualified labor will not necessarily coincide with the oversupply created by migratory flows, or collateral formal activities generated by construction works.

Indirect Socio-Cultural and Population Impacts

9.3.2.4.3 Announcement of canal construction for either of the two canal alternatives will further increase the tendency of Panama's population to concentrate in the Metropolitan Region. This will have the indirect impact of increasing unemployment and underemployment especially in the unskilled labor categories.

9.3.2.4.4 During the construction period the provision for and the use of the workers camps and the housing areas for the staff could create negative indirect impacts. Conscious efforts by the Government will be required to organize and to manage these housing camps and villages in order to avoid the negative impacts experienced during and after the original Canal work. The larger number of workers for a longer period of time in the Sea Level Canal alternative, and the increased number of villages and camps to accommodate these workers, portends a more significant negaative impact from this alternative.

9.3.2.4.5 The incursion on government or private lands by domestic or foreign migrants, while at the same time anticipation and speculation in land potentially will inflate values, could also be an indirect negative socio-cultural impact. These situations may arise in the case of either of the alternatives, but can be predicted to be greater in the case of Sea Level Canal.

9.3.2.2.6 Social infrastructure and public services in the Metropolitan Region absorb a large part of Panama's financial, technical and professional resources. Both alternatives will require additional resources, which, if priority is given to those services, will be detrimental to the rest of the country. This impact is anticipated to be more significant with the Sea Level Canal.

9.3.2.2.7 The permanence of the villages after the construction period, unless they are constructed with a view to facilitating post construction utilization by the Canal Authority as maintenance or as industrial areas, will be a reminder of the Canal Zone days, which in turn, will entail a negative impact on the national conscience. This is much more significant in the case of the Sea Level Canal, because there is no history of such separation in the areas, and because existing accommodations in the Metropolitan Region could be used during construction of the High-Rise Lock Canal alternative, especially if the phased construction concept is utilized.

9.3.2.5 *Geographic And Environmental Impacts On Panama*

9.3.2.5.1 Both canal alternatives will have a negative ecological impact by placing a greater barrier to species migration between the two Americas. In this respect, the Sea Level Canal will present a greater obstacle to land migration, while at the same time permitting species migration from one ocean to another.

9.3.2.5.2 During construction and operation, the Sea Level Canal alternative will have a direct impact on the habitat of some of Panama's endangered species. In 1980, the Smithsonian Tropical Research Institute (STRI) reported 82 species of wildlife in danger of extinction, some of which are endemic to Panama's habitat, such as the Tapir Tapirus bairdii, the titi monkey Sagüinus geoffroyi, the porcupine Coendou rothschildi, the white tail deer Odocoileus virginianus, etc. The findings of the Smithsonian Tropical Research Institute were subsequently supported in 1985 by the Convention on International Trade in Endangered Species of Wild Fauna and Flora, in 1990 by the International Union for the Conservation of Nature, and by the CAS Component Study, Background of Biological Data and Biological Inventory, in 1993. The geographic zone cited for Panama's endemic habitat includes most of the area planned for the Sea Level Canal alternative. Given today's world sensibility to ecological problems, studies into possible repercussions should be conducted.

9.3.2.5.3 Although ocean environments are dissimilar (salinity, temperature, currents and tides) the potential exchange of species between the Pacific Ocean and the Caribbean

Sea and the alteration of the sea and coastal marine life caused by the Sea Level Canal alternative will be of great consequences for Panama and the world. These consequences are significant and, since their magnitude is not known, they present a significant negative impact requiring further detailed study.

9.3.2.5.4 Assuming that an accelerated Metropolitan Region growth rate will add to the stress associated with the canal excavation work and with the ensuing canal operations, and that in turn, it will transform the geographic environment and the ecosystem, the economic polarization of Canal construction will affect the current Canal. This negative impact applies to both alternatives, but is much greater in the case of the Sea Level Canal which will be a source of oceanographical, geomorphological and, above all, hydrological problems, threatening the entire system of the current locks Canal and is considered a significant negative impact.

9.3.2.5.5 Digging a Sea Level Canal will lower the fresh water tables presently located at an average depth of 5 meters in the Continental Divide and in the Pacific watershed, thus endangering underground water resources. Other associated problems are likely to arise, such as sedimentation, salination and other physio-chemical alterations of the water quality. The availability of water and the water quality are a matters which must be studied in greater depth prior to choosing a Canal alternative.

9.3.2.5.6 The Sea Level Canal alternative would generate large volumes of earth and rocks, which are hard to dispose of and hard to relocate. This would cause significant hydrological and geomorphical problems. The use of land for dumping involves a negative impact on available natural resources. Likewise, the dumping of material deposits off shore and the creation of large breakwaters will increase water turbidity. The coastal ecosystems will be greatly disturbed especially in the Caribbean, which system is adapted to transparent water. The impact of this planned engineering solution for disposal of the evacuated materials will be negative and the impact will be significantly greater with the Sea Level Canal.

9.3.2.5.7 An increase in demand for food and farm raw materials, created by the excavation of a new canal could give rise to agricultural intensification and more input of

chemicals, with subsequent increases in agro-chemical contamination. The agro-industrial sector is currently a primary contamination source in the Central Provinces and in the West; while actions can be taken to reduce and control the use of chemicals, it is more likely that such use would increase significantly. This impact would be marginally greater in the case of the Sea Level Canal.

9.3.2.5.8 Oceanographic Alterations in Panama Bay. The fauna and flora of the Gulf of Panama is more adapted to changes in salinity and temperature, and therefore, the impact of sediments dumping is less than that of the Atlantic. However, there are changes in coral formation subject to adverse factors south of Taboga, and in the Pearls Archipelago. The coral formation near Taboga may be affected by coastal transformation and transmigration of species due to the construction works in the Pacific for the Sea Level Canal.

9.3.2.5.9 An important negative impact of the Sea Level Canal alternative is the alteration of various watercourses in the area, activating erosion processes caused by deforestation, and the change of river beds and levels. This will increase the transportation of sediment to Gatun Lake and to the current Canal. Excavated material will also be unstable, creating the potential for landslides and blockages in stream valleys, especially during the high run-off periods after the rains.

9.3.2.6 *Impacts On Infrastructure*

9.3.2.6.1 *Drinking Water Supply*

The availability of water primarily relatedto Canal operations and use is first addressed in the Yachiyo (ECE) report. The possibilities of tapping fresh water that could be contaminated by sea water, or by the need to dig extremely deep wells cannot be determined without further studies by hydrogeological experts The Sea Level Canal alternative with its relative depth of excavation appears to be the most risky for the ground water supply especially, if the water lens is cut by excavation works.

Significant amounts of water for municipal use will be required for the La Chorrera-Arraijan area. The Sea Level Canal will have an impact on future, planned new infrastructure, and will deplete water supplies in the areas should the water barrier system be possible.

9.3.2.6.2 *Ports*

The High-Rise Lock canal alternative eliminates the Port at Rodman. Current Government of Panama planning calls for the development of this facility as a commercial port as an extension of the Balboa port complex. The cost of replacing this facility is very high, and as an impact ought to be considered in the light of current planning.

9.3.2.6.3 *Structures:* It is estimated that approximately 1000 structures will be affected by the Sea Level Canal alternative, including small towns along the river of the Sea Level Canal route and structures within the dammed water areas.

9.3.2.6.4 *Roads:* The Sea Level Canal alternative requires construction of a new trans-isthmian highway and new construction roads that will enable some remote towns to have better access to the Pan-American Highway and the Arraijan-La Chorrera Freeway. The construction of the Sea Level Canal alternative will require greater use of the existing road network and the Pan-American Highway resulting in increasedmaintenance costs, traffic congestion andlonger travel times.

9.3.2.6.5 *Bridges:*

The ECE report provides an allowance for the Van Dam (Simon Bolivar) bridge over the current canal and the new High-Rise Lock canal in the year 2060. As currently planned, the Van Dam (Simon Bolivar) bridge will be built by Panama before the year 2000; this bridge will not span over the future facilities of the High-Rise Lock canal. If the High-Rise Lock Canal is selected, planning for the construction of the Van Dam (Simon Bolivar) bridge will be directly affected. If Panama does not allocate resources to accommodate the enlarged span prior to construction or final design of the High-Rise Lock Canal alternative, this will be a direct negative impact.

The current bridge at Gatun locks does not have the capacity for heavy machinery to cross. For the Sea Level Canal, a new bridge across the Gatun route is not to be built until the year 2020 (only the bridges across the Sea Level Canal route, Escobal, and the bridge on the Pacific side); All materials and equipment used in the construction site on the west bank of the existing canal (on the Atlantic side) will have to be transported either by sea or across Panama using the trans-isthmian highway, the Pan-American Highway, and new access roads built for the project. Therefore, the roads between Colon and the town of Nuevo Chagres will not be impacted by the construction of the Sea Level Canal.

9.3.2.6.6 *Electrical:* Electrical towers for high-voltage power lines, and, other projected lines will be affected equally by both alternatives. The Sea Level Canal will affect distribution lines along the Canal alignment route. In the case of the High-Rise Lock, canal distribution lines will be affected in the towns of Gatun and Cocoli.

9.3.2.7 *User Impacts As They Impact Panama*

9.3.2.7.1 There will be no indirect impacts on Panama as a result of the impacts on users, or they will be negligible.

9.3.2.7.2 Induced world trade resulting from transportation cost savings and lowered delivery prices for goods will not have any impact on Panama since Panama is a very minor user of the Canal. Any potential new shipbuilding orders, and induced shipbuilding economic activity, will not impact Panama, as Panama does not have a shipbuilding industry.

9.3.2.7.3 The major indirect impacts of the direct impacts on users are worldwide or macroeconomic in nature, that is, on those nations that are the major beneficiaries of the Panama Canal and/or its successor. The major indirect benefits of effects on users are not for Panama.

9.3.3 MOST IMPORTANT IMPACTS FOR EVALUATION AND DISCRIMINATION

In Figure IX-3, on the following page, there is a summary of the most important discriminating impacts to consider at the time of evaluating and discriminating alternatives. Economically and financially, it appears that the Sea Level Canal alternative provides the greatest positive impacts at least during construction. In every other study field, the Sea Level Canal alternative has the most significant negative impacts upon Panama. On the basis of the Analysis Impact Upon Panama, Component Study effort, findings indicate that the High-Rise Lock Canal would be the best alternative for Panama.

In developing a means to compare impacts between the two alternatives, a scale was used with a view of presenting the relative significance. The scale is from -5 to +5 in significance as shown below.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Major	Very	Definite	Minor	Some	No	Some	Minor	Definite	Very	Major

Except for the economic and financial impacts that appear in projected numbers or dollars, the weights in Figure IX-3 are meant to be relative only in comparison with numbers used for the same impact.

Figure IX-3:

Most Important Impacts For Evaluation

Impact	Magnitude of Impact (1)	
	High-Rise Lock	Sea Level
Economic (Short Term)		
• Expenditures in Panama (in 1990 Millions)	$1,617.4 (150,000DWT)	$1,952.4 (+28.6%)
• Monetary Impact on Panama (in 1990 Millions)	$1,354.5 (200,000DWT)	$1,605.6 (+15.3%)
• Direct and indirect Employment During Construction	95,760 (150,000DWT) 107,236 (200,000DWT)	140,828
Imports into Panama (Short Term)		
• Imports into Panama (in 1990 Millions)	$7,818 (150,000DWT)	$10,180 (+30%)
Political-Economic		
• Unanticipated Costs/Delays	-2 (2)	-5
Political		
• Provision of Security and Maintenance of Legitimacy	-2	-5
• Political Dimension of Environmental Concerns	-1	-5
Socio-Cultural		
• Excess Migration to Project Areas	-2	-5
• Relocation	0	-3
Socio-Cultural/Infrastructure		
• Infrastructure Expansion	0	-3
Environmental and Geographic		
• Lower Water Table and Contamination	-3	-5
• Cross Ocean Migration of Species	0	-5
• Disruption of Endemic Habitat and Migration		
Geographic and Infrastructure	0	-5
• Adequacy of Fresh Water	-3	-5

(1) Except for Economic and Financial, the weights shown are meant to be relative only in comparison with the number in the same Impact area. The scale of impacts is from -5 to + 5.

(2) High-Rise Lock Canal has the capability of being phased and therefore anticipations and negative results of unanticipated costs and delays are mitigated.

9.4 CONCLUSIONS AND RECOMMENDATIONS

9.4.1 *Conclusion and Overall Recommendation:*

The Government of Panama is currently faced with formidable challenges, that need to be solved before entering into a final design stage for a given alternative. These challenges include international pressures to restructure an enormous public debt, a Constitution developed to support the Military Dictatorship, labor laws which are complexed, inhibiting to investment and a disincentive to private business, and improved government financial capabilities to support needed infrastructure maintenance and enhancement.

The Panamanian Government also has been challenged with reconstructing the civil functions of government and the political system in a period in which extensive changes such as the reversion of the US military bases and the Panama Canal must be planned and accomplished. The capacity to accommodate these changes, while instituting structural reforms and overcoming the economic legacy of the military regime, is one the key considerations in identifying and analyzing the political impacts of either Canal alternative.

Considering the numerous economic, socio-cultural, population, and infrastructure challenges facing the government in the next two decades, and given that both altenatives will provide the needed additional capacity to meet that projected growth in use of the Canal, the conclusion of the Analysis of Impact Upon Panama Study is that the Government should choose the least intrusive alternative.

This study concludes that the High Rise Lock Canal alternative will have less impact on environment and on the geography. It will impact less on the current or planned infrastructure and will require less additional infrastructure. It will impact less on the financial and economic flexibility of Government in terms of guarantees and revenue. It will have fewer negative impacts on the population and socio cultural infrastructure. It will have less potential political impacts in terms of relocation of people and in terms of Government areas of control and protection. In every sense, the High Rise Lock Canal alternative will be the least intrusive for Panama; and since the High Rise Lock Canal alternative will provide Panama with the required additional transit capacity, it is recommended that the Government of Panama select this alternative.

9.4.2 *Recommended Additional Studies:*

9.4.2.1 *Requirement for Security and Protective Forces:*

Scope:	Security Requirements for the Canal in the Future and the impact of the alternative.
Type of Study:	Analytical
Approximate Period:	Three to six months
Specialists Needed:	Political and Security Analysts
Estimate of Cost:	$100,000 to $200,000

9.4.2.2 *Population Relocation:*

-Population by ethnic group.
-Economical activities and employment of the affected population.
-Attitudes and expectations regarding relocation.
-Moving conditions and compensations (indemnification).
-Estimates on basic services for the relocated populations.
-Design on execution of an information program, and motivation for the directed re-colonization.
-Cadastral studies on the resettlement lands.

Scope:	Population Relocation Requirements and Policies
Type of Study:	Analytical and Statistical
Approximate Period:	Three to six months
Specialists Needed:	Socio-Cultural, Legal and Demographic Analysts
Estimate of Cost:	$150,000 to $200,000

9.4.2.3 Migrant and foreign immigrant workers laws and policies.
-Criterion manuals for the selection of workers, both national and foreign.
-Revision of contractual norms for foreign personnel.

Scope:	Legal and Structural Requirements and Recommendations
Type of Study:	Analytical
Approximate Period:	Three to six months
Specialists Needed:	Legal and Labor Relations Analysts
Estimate of Cost:	$100,000 to $150,000

9.4.2.4 Population increase projections in the townships of the Metropolitan Region.
-Revision of population projections using new data.
-Estimates of population and dwellings of involved areas for both alternatives.

Scope:	Population and Demographic Study of the Projects Areas
Type of Study:	Analytical and Statistical
Approximate Period:	Three to six months
Specialists Needed:	Socio-Cultural and Demographic Analysts
Estimate of Cost:	$50,000 to $100,000

9.4.2.5 *Concerning National Patrimony.* Archeological Sites studies in the proposed canal area to update the existing information.

Scope:	Survey of Sites, Development of Potential Sites, Sampling
Type of Study:	Analytical, Statistical, Field Survey and Computer Modeling
Approximate Period:	Four to six months
Specialists Needed:	Socio-Cultural and Archeological Analysts
Estimate of Cost:	$200,000 to $400,000

9.4.2.6 *Impact of Canal Alternatives on Colon Free Zone*

Scope:	Impact of Alternative on Use and Competitiveness of Free Zone
Type of Study:	Analytical
Approximate Period:	Three to six months
Specialists Needed:	Economic Analysts
Estimate of Cost:	$100,000 to $200,000

9.4.2.7 *Local Economic Impact of Canal Services*

Scope:	Future Private Enterprise Economic Development of Canal Services to Users
Type of Study:	Analytical
Approximate Period:	Two to four months
Specialists Needed:	Economic and Maritime Transportation Analysts
Estimate of Cost:	$100,000 to $250,000

9.4.2.8 *Adequacy of Fresh Water Supply and Impact of Canal Alternatives*

Scope:	Impact of Alternative on the availability of Fresh Water
Type of Study:	Analytical
Approximate Period:	Four to six months
Specialists Needed:	Geological and Hydralogical Analysts
Estimate of Cost:	$150,000 to $300,000

9.4.2.9 *Impact on the Tax Revenues of the Panamanian Government of the Construction of a New Canal*

Scope:	Increased tax revenues to the Government from both business and personal income taxes, to the full scope including such things as capital gains, social security, etc.
Type of Study:	Analytical
Approximate Period:	Three to six months

Specialists Needed: Economists, financial analysts
Estimate of Cost: $100,000 to $300,000

9.4.2.10 *How the Major Employment Generation of the Canal Project Translates into other Financial Costs and Benefits to the Government of Panama*

Scope: The significant employment generation of the new Canal will have other financial impacts on the Panamanian Government, such as less welfare payments, etc. The entirety of the financial impacts should be studied.
Type of Study: Analytical
Approximate Period: Six to nine months
Specialists Needed: Economists, financial analysts
Estimate of Cost: $500,000.

9.4.2.11 *Impact on the Economy of Panama of the Canal Traffic*

Scope: This study would look beyond the impact directly related to the Canal, such as tolls, use of tugs, Canal provided services, etc. of Canal traffic. The study would identify what economic impact Canal traffic has directly on the local economy such as the purchase of bunker fuel from local oil companies, the local purchase of ship stores, etc. The study should also analyze the direct impact on the local ports and the Colon Free Zone of the Canal traffic.
Type of Study: Survey and analytical
Approximate Period: Six months
Specialists Needed: Economists, maritime transportation experts
Estimate of Cost: $200,000 to $300,000

9.4.2.12 *Impact of the New Canal on Fleet Registry in Panama*

Scope: The study would determine what impact, if any, the new Canal will have on the Panamanian fleet registry.

Type of Study: Survey and analytical
Approximate Period: Four to six months
Specialists needed: Economists, maritime transportation specialists
Estimate of Cost: $250,000

9.4.2.13 *Geological Structure Characteristics of the Sea Level Canal Project Area.*

Scope: The study would include a complete layout out of the geological structure, geodynamics for rocks and soils, hydrogeology and the more relevant geomorphologic processes of the area. The following factors should be considered:

1. *Geological conditions*

   • *Lithology:* Lithographic characteristics; petrographic nature of rock (mineral composition, texture, structure, grade of alterability and geomechanical properties.
   • Tectonics, distensive and comprensive seismic activity.

2. *Geomorphologic conditions*

   • Morphologic factors: Slope geometry (form, slope, length, height)
   • Conditions of instability of hillside sequences and deposition interrelations.
   • Morphometrics of fluvial systems.
   • Evaluations of fluvial dynamics (flow, regime, evaluation of river erosion.
   • Relations between morphology and sedimentation.
   • Modifying man-made action (riverbed change, excavations, terracing, striping, soil impermeabilization.

3. A construction model showing natural disequilibrium level of area.

Type of Study: Survey, field work, sampling and analytical modeling

Approximate Period: 18 to 24 months
Specialists needed: Geologists, Hydrogeologists, geographiers
Estimate of Cost: $1,250,000 to $1,500,000

9.4.3 *Support For Other Recommended Studies*

In addition to the above recommended studies, the Analysis of Impact on Panama Component Study concurs with the other Component Study Reports that the following areas require additional studes:

- Environmental studies on the effect of sedimentation to be produced as a result of deposits of excavated materials for the building of a Sea Level Canal or a High Rise Locks Canal.

- A Complete the biological inventory of areas to be effected by the Route 10 alternative.

- Extensive studies on the use and effect of recycled waters, should their use be contemplated for raising the Lake Gatun level.

- A study concerning the form in which the currents influence long-term in the sedimentation of excavated material over corals east of Limon Bay on the Caribbean.

- A study on the effects of sedimentation of excavated material in the mangrove swamps of the outlets of Rio Caimito.

APPENDIX A

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APPENDIX B

BACKGROUND OF THE SYSTEM DYNAMICS MODEL APPLIED TO PANAMA

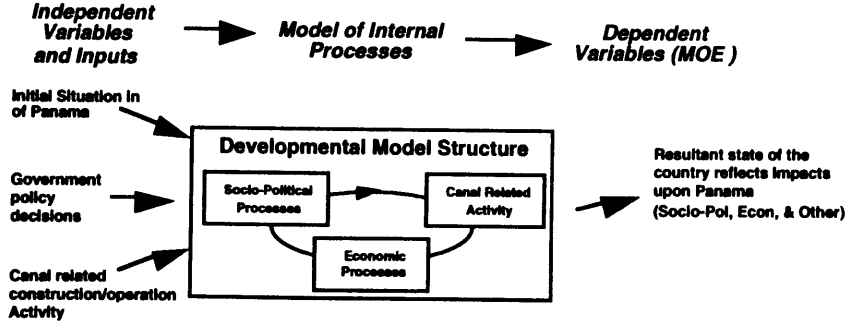
This appendix provides a general discussion of the basic conceptual model used for this simulation, significant extracts of the socio-political background information on Panama, and data elements from the engineering report which were considered indispensable for arriving at the cross-domain findings in this Analysis.

The Model and Its Conceptual Framework

The system dynamics model permits simulation of the socio-political, economic, and other processes in a developing nation. The general model structure is intended to provide assistance in any examination of long-range effects of the various courses of any developmental action being considered. While the model addresses all dimensions of development, its focus is on the interaction between the various dimensions of a system, rather than on the details of any one dimension.

In addition to providing assistance in identifying the effects of various alternatives, the model permits the identification of theoretical and modeling issues which require further research and analysis.

FIGURE VIII-A-1
System Dynamics Developmental Model



In simple terms, the model takes a number of independent variables as inputs, processes them through a simulation of the dynamics of a developing nation, and projects the future state of the country as impacted by these inputs. These independent variables or inputs include the initial conditions that describe the country, internal policy decisions that describe alternative courses of action for internal players in the country, and actions associated with the two canal alternatives. The independent variables are then processed by the model. As a result of that processing, changes in the dependent variables that define the new socio-political, cultural, and economic state of the country can be examined.

Applying the Model

There are significant analytical applications which the model is suited for. It can be used as an analytical tool for studying the impact of internal or external policies and programs in a wide variety of developmental situations. It can also be used to study the impact of internal decisions such as the one to be made concerning the selection of one of the canal alternatives. Likewise, it can assist in studying the impact of potential political or armed resistance to a government's programs and even to its continuation in power. Most importantly, because of the system dynamics approach, the model allows analysis of interactions between the dimensions of development. For example, the model can be used to look at the political implications of major economic restructuring or economic belt-tightening in a country. Because of the highly interdependent nature of social systems, system dynamics was chosen as the tool for modeling the various components of development and their interdependencies. The model can also be used as an education and training tool. It is well suited to this application because it permits experimental learning. It is also suited as a seminar game environment, prompting players with non-intuitive and easily overlooked options.

Regardless of the intended use, the developers of the model recognize that there are limitations to the use of this or any model. Models do not provide answers. Rather, they provide a tool for the organization of data and a framework for the analysis of that data. Models are only as good as the quality of the analysis which their users apply to the assumptions and theories upon which they are built. It is important that these limitations be taken into consideration when judging the results of its application in this Analysis.

Conceptual Framework

As implemented, the model is not designed to test hypotheses concerning developmental theory. Rather it operationalizes current theory. The model is based on political and developmental theory as described in classical and current literature. An effort has also been made to expand that theory so that it may include more generalized concepts of political stability and development. Specifically, the theory was expanded to handle political, economic, military, and social dimensions that are not implicit in classical developmental theory. As with all models, if the theory upon which the model is based is wrong then the model will be wrong. However, we have implemented the model in such a way that as our theory evolves and as our experience in model application grows, the model can be easily modified to represent new concepts as they emerge.

Work by Almond and Powell and their associates from the structural functionalist school of development, Ted Robert Gurr's *Why Men Rebel* and associated work on perceived relative depravation, and Jeffrey Race's *War Comes to Long An* heavily influenced both the development of doctrine and the structure of Regional Development Simulation System. More recent works such as *The Other Path* have influenced the development of the economic and other dimensions of the model which were not adequately covered by the more traditional theory. Research into insurgency and low intensity conflict has identified a number of foundations or key points in the theory which are captured in Regional Development Simulation System. The following tenets or principles of accepted low intensity conflict theory, as related to insurgency and counterinsurgency, have been expanded into a more generalized political stability model and have become the hallmarks of the theory as it is implemented in Regional Development Simulation System.

The concept of "perceived relative deprivation", as described by Gurr has heavily influenced developmental theory and is reflected in the model. According to Gurr, "perceived relative deprivation" is discontent based on the difference between what members of the society have (capabilities) and what they think they have a right to have (expectations).

Operationalizing the Theory

Whether popular support is given or withheld is viewed by the model as the key to the fortunes of stability, and it provides the environment for developmental actions. The movement of popular support can

actually be seen as a set of linked, interacting political, military, economic, and social pressures. The model treats the populace block as multiple, independent groups. These groups respond to the conditions in society (political, social and economic), and to the changes in those conditions, by giving support to policies and/or decisions, and/or making demands on society. As long as group demands are met and dissatisfaction does not grow beyond a certain threshold, and as long as the government takes actions to maintain group support, the system should remain within the realm of legal political processes. However, as group demands are rejected and group dissatisfaction grows, instability or even violence may result.

In implementing the model has focused on national level interactions between the political, economic, military, and social dimensions. Because it is of utmost importance to capture the interactions between the various dimensions at the macro level before focusing on the details of any one dimension, the model takes a top down approach. By focusing on top level interactions rather than the details of any dimension, model developers are less likely to miss important interactions and feedback mechanisms that drive development. Finally, the model takes a long term approach. In order to determine the impact of any set of actions, it is necessary to explore the ramifications of those actions, the interactions of the various dimensions, and the final effect of those interactions over the long term. Thus the model is designed to look at a five to ten years horizon with quarterly time steps and decision points.

Model Structure

As indicated in Figure VIII-A-1 above, three types of input are processed by the model as used in Canal Studies -- initial data and constants (initial conditions in the country), government policy decisions over time, and decisions associated with each of the canal alternatives. These inputs affect the various political, economic, and social processes that are represented by the model. Outputs are described and presented graphically in terms of changes in the nation's political, economic, and social status.

Each of the modules of Regional Development Simulation System deal with specific processes that govern changes in the state variables and that represent the internal dynamics of a developing nation. For example the socio-political module includes processes such as movements of popular support, social mobilization of the population, increases and decreases in perceived legitimacy. These processes operate in parallel and are constantly interacting with other process within the same module and with those processes in other modules. For instance, while hostile military activities destroy infrastructure, the economy is reacting

to the decreased infrastructure by producing less output. This reduced output affects government resources which affects how much the government can spend on security to block hostile destructive activities. The Regional Development Simulation System contains many examples of this type of causal chain with feedback. The connection of numerous such cause and effect relationships allows the Regional Development Simulation System to capture the many interactions and dependencies between these processes.

Model Output

Model output tracks the changes in the country's state over time. The same variables used to describe the initial state of the country are used as output indicators. Their change over time will define the development path of the country. Regional Development Simulation System can be used to determine the impact of a set of internal policies and programs, such as the Canal alternatives, on these variables. Because of the dynamic nature of the modeling approach taken, any variable in the model is potentially an output variable.

Although the economic module is extremely important in developmental projects, the socio-political module is the linchpin of the model. Using analyst inputs and all other modules, it tracks the perceptions and allegiances which are the key to long-term stability. It examines variables such as to which extent members of each socio-political group support the government; to which extent supporters are both motivated and organized to provide active support; the degree of discontent based on the difference between what members of each group believe they have and what they think they have a right to have ("perceived relative deprivation"); and the degree to which the members of each socio-political group support the government as the viable option.

Viewing society as a set of socio-political groups provides a fidelity that is not available when using the aggregate population as the level of analysis. One of the major difficulties in developmental modeling is the inability to come to grips with the complexity of socio-political situations. model is a major step in recognizing that goals are achieved by some combination of persuasion and coercion, and that popular support is generally, in the long run, the major source of power. The use of this model does come to grip with the fact that society is composed of a number of groups with differing degrees of influence and often countervailing goals and objectives. The division of society into five or fewer socio-political groups is a first step in recognizing the differing demands and degrees of support of the various elements of society. In its

present stage of development, the model has only limited capability for dealing with the fact that there are numerous such groups and that they are not necessarily cohesive. Accounting for these factors presently depends on the depth of the analysis and the rational receptivity which are applied to the results in the process of making final evaluations. Nevertheless, the division of society into a limited number of socio-political groups is a significant advancement in recognizing the differing needs and capabilities of its major elements without unnecessarily complicating the model and without increasing data requirements.