DB. V

ENVIRONMENTAL IMPACT STATEMENT

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EXECUTIVE SUMMARY

This report on the Environmental Impact Assessment (EIA) Study of the Phase I Priority Projects on the proposed flood control system in the Laoag River Basin is presented in the form of an Environmental Impact Statement (EIS) in accordance with the requirement of the revised rules and regulations for the EIS System embodied in DENR's DAO No.37 series of 1996. Objectives of the report are to: (1) establish and analyze the relationship between the proposed project and its surrounding environment, (2) recommend mitigating measures for the adverse environmental impacts, (3) provide information for an informed decision-making process, and (4) help the project proponent (DPWH) comply with existing government regulations. This document shall therefore help ensure that the overall project benefits will be optimized by including the environmental considerations in project implementation.

This EIS contains a large amount of data and the environmental analysis of the proposed project. This includes the engineering aspects, baseline studies, water quality study, socioeconomic study, and perception surveys. Results of these sub-studies are placed in the appendix. A process documentation report is also presented in the appendix. It contains the scoping and public consultation documentation. A general public consultation meeting was held at the Laoag ampitheater last 30 May 1997. It was attended by representatives of the stakeholders. Representatives of the Ilocos Norte PENRO Office and the DENR's Region I Office also attended the meeting. The positive response of the people resulted to the various project endorsements presented in Appendix H.

The proposed project on sabo and flood control in the Laoag River Basin is an outcome of the request for technical assistance by the Government of the Philippines (GOP) from the Government of Japan (GOJ) in 1992. The JICA Study Team was dispatched to the Philippines on 24 March 1996 for carrying out the study. Results of the study pointed to the necessity of constructing sabo dams and river improvement works to provide protection to the inundation areas, while the urgent drainage works are intended to reduce the flood damages in selected urbanized areas of Laoag City. The Laoag River Basin suffers from annual flood and sediment damages caused by typhoons. Damages from a small flood alone with a return period of five years can reach to some 361 million pesos at 1996 prices. Recent typhoons caused serious damages to the basin. Typhoon Maring in 1992 affected an estimated 71,000 people and inundated Laoag City with a water depth of 1.0 to 1.5 meters.

Construction of dikes is the principal measure for flood control, while sabo dams are selected to control the excessive sediment runoff in the downstream reaches of the various rivers. Sabo dams are selected for the effective mitigation of the annual excessive sediment runoff in the rivers since it is the most practical structural measure with high reliability to prevent the catastrophic disasters during a large flood time. Although the master plan will protect a wide inundation area, the Phase I Priority Projects will only cover an inundation area of 13,220 hectares and a corresponding existing population of 46,900.

The overall master plan will be implemented in three phases. However, only the Phase I Priority Projects are the subject of the ECC application. This include five sabo dams, seven river improvement works, and the urgent improvement works for the Laoag Urban Drainage System. This project is still in the planning phase with the conclusion of the master plan preparation. Hence, any land acquisition will be done during the pre-construction phase. Only three houses will be relocated for the implementation of the Phase I Priority Projects.

Potential environmental impacts of this project were comprehensively evaluated for the construction, operation, and abandonment phases. Impact analysis of a Sabo dam considered the fact that this type of dam is designed as a sediment trap and not intended as water impounding structure. Its volume of impounded water will be quite small and will eventually represent only the void spaces of the sediments which is around 8% of the sedimentation volume. Unlike the large water impounding dams, a Sabo dam has small potential energy due to a very low effective height. Hence, most of the adverse impacts associated with dam projects are absent in this particular proposed project.

The adverse impacts during the construction phase are not significant. These occasional impacts, however, are all short-term in nature and manageable. There is therefore no cause for alarm. Based on the impact analysis of the operation phase for nine general impact areas covering 33 impact items, the proposed project has only five negative impacts as shown below. Of this, only the increase in river bank erosion at critical sites has a relatively moderate magnitude, while the other four impacts have relatively minimal magnitudes. River bank erosion at critical sites can easily be mitigated by careful design with due consideration to the expected hydraulic force. The design will therefore ensure adequate river bank protection.

IMPACT	NATURE	MAGNITUDE
Increase river bank erosion at critical sites	negative	moderate
Reduction of groundwater recharge	negative	minimal
Decrease supply of sand to the coastal area	negative	minimal
Reduce aesthetic appeal of the dam site landscape	negative	minimal
Land acquisition and house relocation	negative	minimal

Negotiations for land acquisition and house relocation will be made during the pre-construction phase since the proposed project is still in the planning phase with the recent completion of the master plan preparation. However, future negotiations are expected to move smoothly since the required areas are quite small and only three houses will be relocated.

Proper coordination between the project proponent, Local Government Units, and the DENR is very important for a smooth implementation of the project. This will ensure the expeditious action on any environmental issues or problems that will arise during the construction and operation stages of the project. The proponent shall therefore designate an Environmental Coordinator who shall be responsible for all environmental matters regarding the project. Budget for the monitoring activities are shown below:

MONITORING ACTIVITIES	ANNUAL BUDGET (Pesos)
Water quality surveys	100,000
Riverbed surveys	70,000
River flow survey	100,000

Finally, this assessment report concludes that the proposed project can be implemented in an environmentally acceptable manner. ***Environmentally, the proposed project is beneficial since it is actually a mammoth mitigating measure against the annual adverse impacts of a natural hazard*** (which is flooding) that is causing havoc to the people and economy of the Laoag River Basin.

1.0 PROJECT PROPONENT

The Department of Public Works and Highways (DPWH) is the proponent of the proposed Phase I Priority Projects of the sabo and flood control project in the Laoag River Basin. Communications shall be addressed to:

Engr. Nonito F. Fano
OIC - Project Director
PMO - Major Flood Control Projects
DPWH, Port Area
Manila
Tel./Fax. No. 527-27-22

2.0 PROJECT TYPE

The proposed sabo and flood control project belong to the infrastructure category. Its implementation is therefore covered by Presidential Proclamation No.2146 and Presidential Decree No.1586.

3.0 OVERVIEW SUMMARY

An environmental impact assessment was prepared with the aim of making project implementation an environmentally acceptable activity. This Environmental Impact Statement (EIS) will help ensure that overall project benefits will be optimized by including the environmental considerations during the planning, design, and operation phases of the project.

The proposed project on sabo and flood control in the Laoag River Basin is an outcome of the request for technical assistance by the Government of the Philippines (GOP) from the Government of Japan (GOJ) in 1992. The JICA Study Team was dispatched to the Philippines on 24 March 1996 for carrying out the study. Results of the study pointed to the necessity of constructing sabo dams and river improvement works to provide protection to the inundation areas, while the urgent drainage works are intended to reduce the flood damages in selected urbanized areas of Laoag City. The Laoag River Basin suffers from annual flood and sediment damages caused by typhoons. Damages from a small flood alone with a return period of five years can reach to some 361 million pesos at 1996 prices. Recent typhoons caused serious damages to the basin. Typhoon Maring in 1992 affected an estimated 71,000 people and inundated Laoag City with a water depth of 1.0 to 1.5 meters.

The proposed project is the Phase I of a master plan intended to provide adequate flood protection for a significant portion of the Laoag River Basin against a 25-year flood. Although the master plan will protect a wide inundation area, the Phase I Priority Projects will only cover an inundation area of 13,220 hectares and a corresponding existing population of 46,900.

Project components include five sabo dams, seven river improvement works, and the urgent drainage improvement works for Laoag City. Construction of dikes is the principal measure for flood control of the Laoag River including the tributaries, while sabo dams are selected to control the annual sediment desposition on the riverbeds and the excessive sediment deposition at the fan apexes during flood time. In addition, the sabo dams are also considered for supplementing the irrigation water requirements in the INIP I area.

The San Isidro Creek Basin is the target area for the urgent drainage improvement works for Laoag City. The drainage improvement works will reduce the inundation volume by approximately 70% (please see Figure A.16 of Appendix A) and the inundation area to 265 hectares from the present 676 hectares. The present flooding problem of this area is due to the lack of flood carrying capacity of the Daoarao Creek. The northeastern area of 0.83 km^2 (please see Figure A.15 of Appendix A) adjacent to the San Isidro Creek intended for residential use will benefit from these drainage works.

The project is expected to prevent a significant flood damage annually. Damages from a 5-year flood are estimated to reach some 361 million pesos (at 1996 prices). Although a 25-year flood will only inundate an additional 17% of the area covered by a 5-year flood, the damages will be twice that of the 5-year flood. It is therefore important that the area will be protected against a 25-year flood.

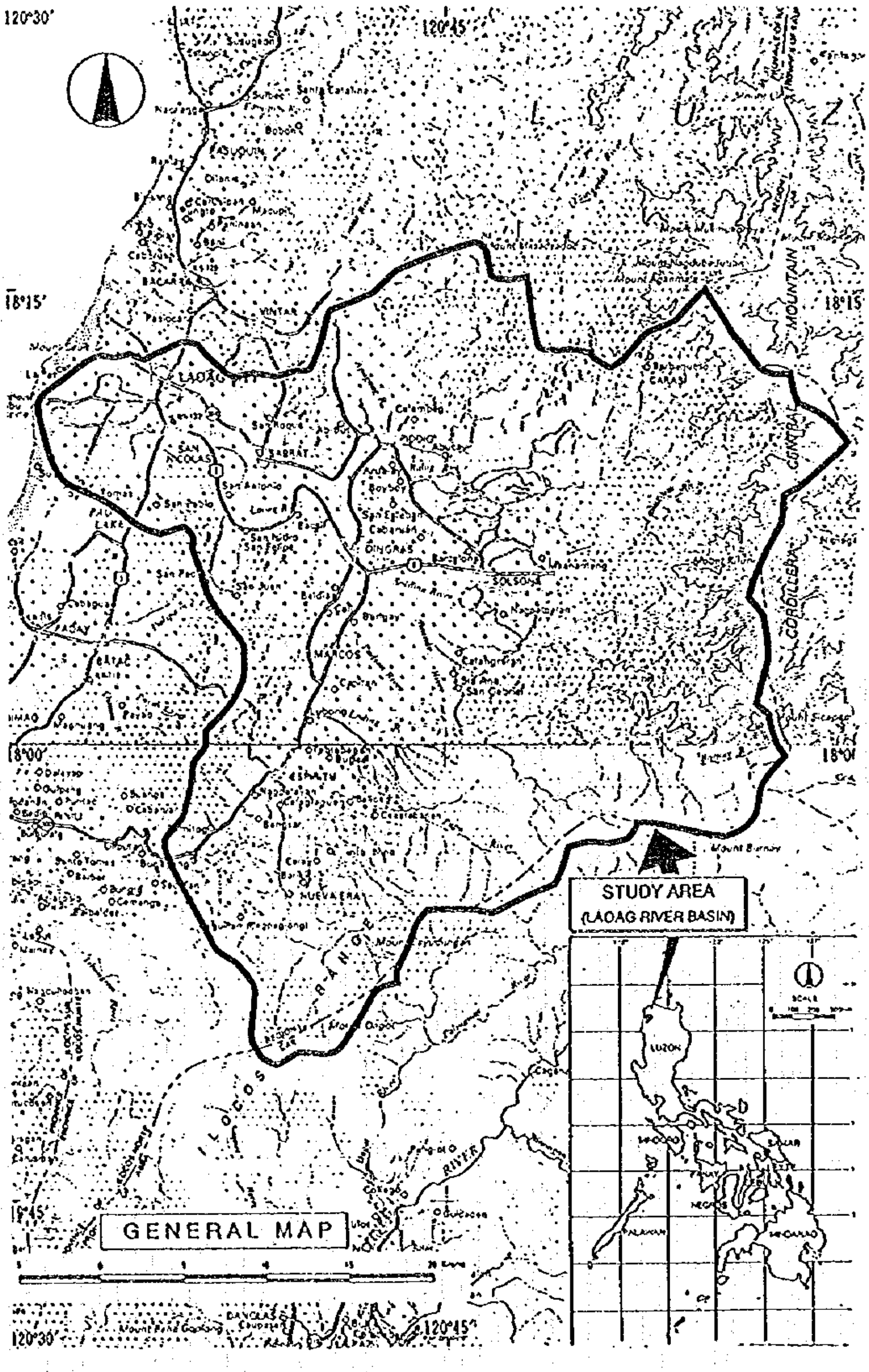
However, the people and the local government units should be aware that the degree of protection to be provided by this project ***is based on a calculated risk and not an attempt to provide absolute flood control.*** It should be understood therefore that floods greater than the design flood (25-year flood) may also occur.

Potential environmental impacts of this project were comprehensively evaluated for the construction, operation, and abandonment phases. **The adverse impacts during the construction phase are not significant.** These occasional impacts, however, are all short-term in nature and manageable. There is therefore no cause for alarm. **The major environmental concern during the operation phase is the presence of the sabo dam as a barrier in the streams.** Fortunately, a sabo dam is merely a sediment trap and not a water impounding structure. Hence, most of the adverse impacts associated with dam projects due to the large dam structures with the associated large water impoundment are absent in this case.

Based on the impact analysis of the operation phase for nine general impact areas covering 33 impact items, the proposed project has only five negative impacts. River bank erosion at critical sites can easily be mitigated by be careful design with due consideration to the expected hydraulic force. The design will therefore ensure adequate river bank protection.

The proposed project is still in the planning phase with the recent completion of the master plan preparation. Negotiations for land acquisition and house relocation will therefore be made during the pre-construction phase. However, future negotiations are expected to move smoothly since the required areas are quite small and only three houses will be relocated. In addition, the proponent will designate an Environmental Coordinator who shall be responsible for all environmental matters regarding the project. These will ensure the expeditious action on any environmental issues or problems that will arise during the construction and operation stages of the project.

Finally, this EIS report concludes that the total benefits to be derived from the proposed project will overwhelmingly outweigh the effects of the adverse impacts. Effective project management will help ensure that overall project benefits will be optimized and the proposed project can be implemented in line with the government's policy of promoting environmentally sustainable economic development.



Source: JICA, 1997

ENVIRONMENTAL IMPACT STATEMENT OF THE SABO AND FLOOD CONTROL PROJECT OF THE LAOAG RIVER BASIN	Figure 3.1 GENERAL MAP OF THE LAOAG RIVER BASIN

4.0 PROJECT SETTING

4.1 Declaration and Objective

The main objective of the proposed project is to provide adequate flood protection for a significant portion of the Laoag River Basin and some built-up areas of Laoag City. Aside from the annual flooding, the proposed project should also provide protection against a flood with a return period of 25 years (cited as "25-year" flood).

The project has far-reaching benefits beyond the direct benefit of providing flood protection. The reduce risk of flooding will encourage economic development and improve the quality of life in the Laoag River Basin.

Flood Protection Areas

Although the master plan will protect a wide inundation area, the Phase I Priority Projects will only cover an inundation area of 13,220 hectares and a corresponding existing population of 46,900. These areas, as reflected in Table 4.1, while the locations of the overall target flood protection districts are indicated in Figure A.1 of the appendix. The San Isidro Creek Basin is the target area for the urgent drainage improvement works for Laoag City. This will reduce the inundation to 265 hectares from the present 676 hectares. The northeastern area of 0.83 km² (please see Figure A.15 of Appendix A) adjacent to the San Isidro Creek intended for residential use will benefit from these drainage works.

Table 4.1

TARGET FLOOD PROTECTION AREAS

AREA TO BE PROTECTED	AREA (ha)	POPULATION TO BE PROTECTED
Poblacion of Laoag City	130	5,150
Poblacion of San Nicolas	230	5,840
Poblacion of Dingras	550	4,230
Cura/Labugaon River Area	3,900	11,120
Solsona River Area	2,280	7,150
Madongan River Area	4,180	8,760
Papa River Area	1,950	4,650
Total	13,220	46,900

4.2 The Need

Eversince, man has always lived in fear of natural forces beyond his control. Although his existence has been nourished by the natural evironment, it is also frequently threatened by the natural hazards. In areas where hazards in the environment have frequently occured, humans have naturally sought to reduce the extent of the threat to their settlements.

The need to reduce the extent of the threat from natural hazards has caused the implementation of various man-made solutions. In the case of the Laoag River Basin, it is frequently flooded due to its small flood carrying capacity. In fact, some of the rivers have floods with a return period of less than six years.

A 25-year flood will bring great damage to the area since it will not only bring flood waters but also large amount of sediments. The estimated total sediment inflow to the river system will be 1.5 times the average annual sediment runoff and 35.5 percent of this is expected to be deposited at the apexes of the six major tributaries.

<u>Flood Damage</u>

A 5-year flood in the Laoag River Basin can inundate some 14,800 ha and affect a population of 46,400 with damages estimated to reach some 361 million pesos (at 1996 prices). Although a 25-year flood will only inundate an additional 17% of the area covered by a 5-year flood, the damages will be twice that of the 5-year flood. This points out the necessity of protecting the area against a 25-year flood. The potential flood areas are indicated in Figure A.2 of the appendix, while Figure A.3 presents the inundation area of a 25-year flood.

<u>Trade-offs/Benefits</u>

Overall, the beneficial impacts will easily outweigh the adverse environmental consequences. The benefits to be derived from this project cannot be over emphasized for an area that is annually flooded and constantly under the threat of large floods that could cause tremendous damages. The northeastern area of 0.83 km^2 (please see Figure A.15 of Appendix A) adjacent to the San Isidro Creek intended for residential use will benefit from these drainage works.

The adverse effects have minimal magnitudes and are all manageable. The project will not damage any resources nor will it destroy any irreplaceable resources. Environmentally, it is an acceptable scheme.

It will actually produce the following socio-economic benefits:

(a) Approximately 46,900 people will be relieved from the menace of floods. A significant area of Laoag City will be protected from floods;

(b) Prevent the annual loss of farmland by 56 hectares and convert the existing devastated farmlands of some 1,800 hectares to arable lands.

(c) Improve the economic situation in the upper alluvial fan areas which are economically depressed by the recurrent flood disasters.

(d) Creation of job opportunities

In addition, the void spaces of the sediments of the proposed five sabo dams for the Phase I development can hold enough water which can extend the irrigable area by 665 hectares in the wet season and 54 hectares in the dry season for a 5-year design drought.

4.3 Alternatives

Alternatives were studied for a structural measure to control the sediment runoff during a large flood. Sand pockets are usually considered as alternatives to the construction of a Sabo dam. Unfortunately, there are no feasible sites in the basin.

River dredging was also considered since it is one of the most preferable measures to attain flood control with high safety values. However, this approach is not economically feasible since only the sea or sand dune seacoast are the available area for the dredge spoils. Large volume of materials has to be transported to these areas. In addition, periodic dredging is necessary since partial or local dredging will not be effective.

4.4 Associated Projects

Projects closely associated with this proposed Phase I Priority Projects are the non-structural measures for flood mitigation which should be implemented by various government agencies. These associated projects include the following: (1) watershed management (reforestation), (2) flood forecasting and warning, (3) flood fighting, and (4) floodplain management (land use control). Implementation of these associated projects require the strong involvement of the local government units and the assistance/support from the concerned government agencies.

5.0 THE PROPOSAL

The proposed project is the **Phase I Priority Projects** of the proposed plan on sabo and flood control in the Laoag River Basin. Project components include five sabo dams, seven river improvement works, and the urgent urban drainage improvement of Laoag City which are described in Section 5.2. Although the proposed overall master plan will be implemented in three phases, ***this project, which is the subject of the ECC application, covers only the Phase I.***

5.1 Planning and Design Considerations

Important considerations in the planning and design of this project are the selection of the: (1) design flood discharge and (2) possible structural measures. In addition, the irrigation function of the sabo dams is also considered.

Design Flood Discharge

The selected design flood discharge probability for the Master Plan of the Laoag River Basin is 25 years based on the following considerations: (1) Around 90% of the flood damage in the basin, on an annual average, is caused by floods below the 25-year return period, (2) the largest flood in the basin during the 1967 typhoon Gening has a recorded peak discharge with a return period of 25 years, and (3) the flood prone areas and affected population are less than those of the other major river basins in the country.

Flood and Sediment Control

Construction of dikes is the principal measure for flood control of the Laoag River including the tributaries, while sabo dams are selected to control the excessive sediment runoff in the downstream reaches of the various rivers. Reforestation is also considered for the effective mitigation of the annual excessive sediment runoff. However, only sabo dams are considered as the practical structural measure with high reliability to prevent the catastrophic disasters during a large flood time.

Description and ideas regarding the use of the sabo dams are presented in the Appendix A.

Sabo Dam Irrigation Function

Usually, a sabo dam is provided with drain holes and will not store water. In this project, however, the sabo dams are considered for supplementing the irrigation water requirements in the INIP I area during the dry periods. These dams will be provided therefore with cutoff walls on the foundations and control gates for the drain holes.

The proposed five sabo dams for the Phase I development can hold around 365,000 m^3 of water in the void spaces of the sediments. The water volume can extend the irrigable area by 665 hectares in the wet season and 54 hectares in the dry season for a design drought with a 5 year return period.

Urgent Urban Drainage Improvement

The drainage improvement works for Laoag City will reduce the inundation volume by approximately 70% (please see Figure A.16 of Appendix A) and the inundation area to 265 hectares from the present 676 hectares. The present flooding problem of this area is due to the lack of flood carrying capacity of the Daoarao Creek. The design flood frequency of 5-year is applied for the drainage improvement.

5.2 General Layout/ Project Components

Implementation of the Phase I development will include the following:

(a) Sabo dams for Cura No.1, Labugaon No.1, Solsona No.1, Madongan, and Papa;

(b) Dike protection works for the upper half river sections of Solsona, Madongan, and Papa rivers and related works;

(c) Dike construction for the entire reaches and dike protection works for the upper half reaches of Cura/Labugaon River and related works;

(d) Dike construction and related works for Poblacion, Laoag; Poblacion, San Nicolas; and Poblacion, Dingras.

(e) Urgent urban drainage improvement of Laoag City covering Daorao Creek, San Isidro Creek, drainage mains DM1 and DM2.

These improvement works include channel improvements, small bridge and cuvert works, revetments, creek mouth opening, and an interceptor channel. The details are presented in Appendix A.

The listed project components (a) to (d) are indicated in Figure 5.1, while the details are presented in the tables and figures of Appendix A. Component (e) is indicated in Figures A.15, A.16, and A.17 of Appendix A. Detailed design is scheduled in 1999. Total project cost is estimated to be P1,875 millions at 1997 prices for items (a) to (d), while that of item (e) is P117.9 millions.

5.3 Construction Details

Construction activities for the Sabo dams and river improvement works are expected to last for four years (2000 to 2003), while that of the urgent urban drainage works for Laoag City will last for two years. Required activities during construction are the usual activities associated with earthworks and horizontal concreting projects. These activities include the following:

- site clearing
- excavation
- temporary access road construction
- concreting

Specific timing and duration of each activity will be determined during the detailed design phase.

Construction Methods/ Materials

Construction activities will be executed with care to avoid unnecessary destruction, scarring, or defacing of the natural surroundings in the vicinity of work. Trees and vegetation will be preserved and protected from damage unless required by the clearing activities for permanent structures.

Except for cement, construction materials for the concrete structures are readily available in the site. Concrete volume requirement for the sabo dams ranges from 9,600 m^3 to 18,500 m^3. Thickness of the dam aprons ranges from 0.9 m to 2.0 m. Dimensions of the sabo dams are presented in appendix A.

5.4 Operation and Maintenance

The proposed project does not involve any manufacturing processes. Hence, it will not process any raw material nor produce any manufacturing wastes. Operation and maintenance will not be a problem since the project components are all passive structures.

Periodic inspection of all structures will be made to insure the early detection of any problems. The frequency, nature, and extent of inspections will be described in an inspection manual to be prepared by the proponent.

Structural integrity of the concrete structures, particularly the dam, will be examined annually. The inspections will not be limited to the following items (UDSI, 1974):

- Abnormal settlements, heaving, deflections, or lateral movement of concrete structures

- Cracking or spalling of concrete and opening of contraction joints
- Deterioration, erosion, or cavitation of concrete joints
- Abnormal leakage through foundation or concrete surfaces, construction joints, or contraction joints
- Possible undermining of the downstream toe or other foundation damage
- Unusual of inadequate operational behavior.

Responsible Office

The constructed structures will be maintained by the DPWH District Engineer's Office.

Jobs Availability

There will be very few jobs directly associated with this type of project during operation. The necessary personnel will be provided by the proponent.

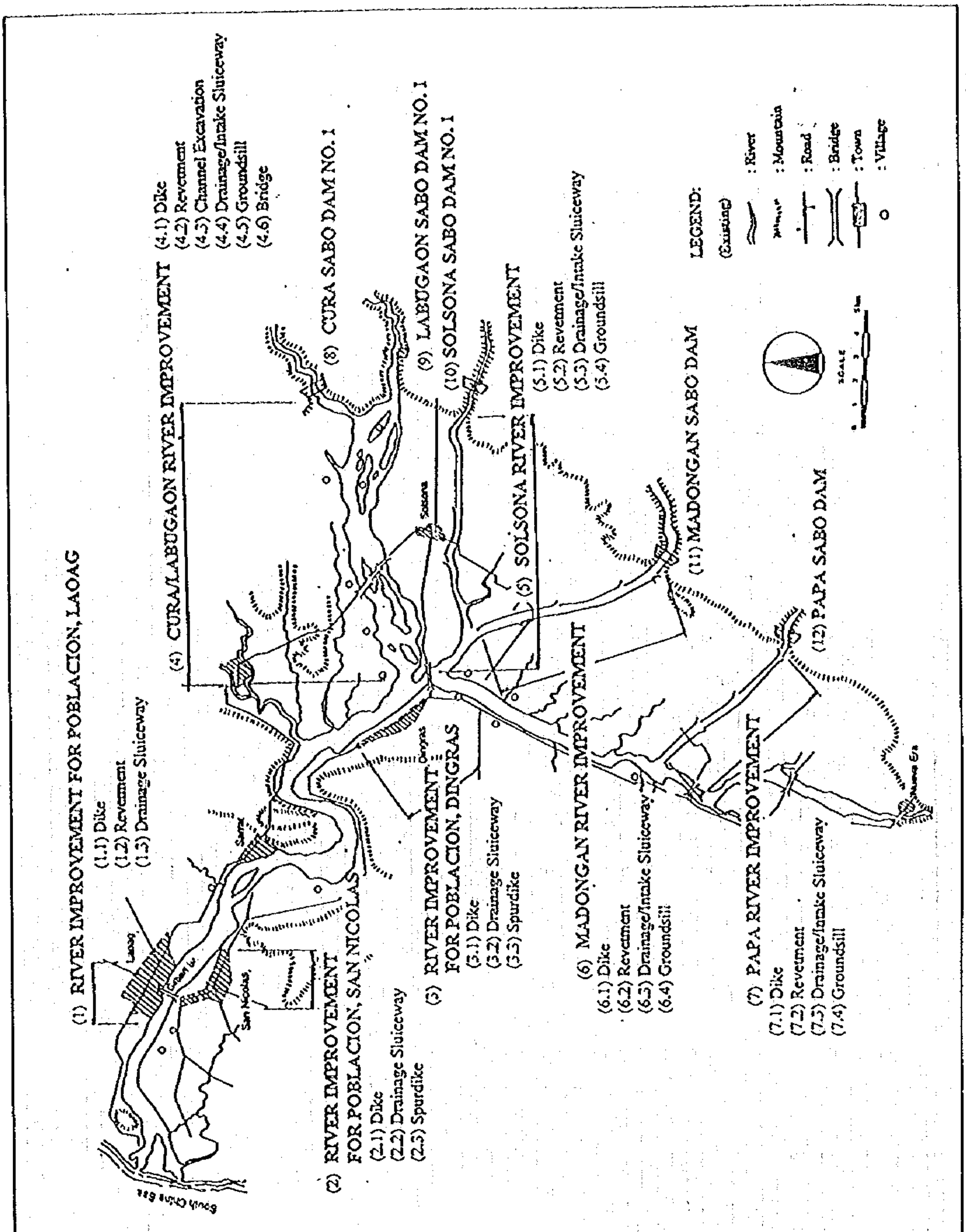
5.5 Contingency

The construction and operation of the project will not create or lead to significant environmental hazards. However, it will be explained clearly to the people and the local government units in the flood-prone areas to be protected by dikes that the degree of protection to be provided by this project ***is based on a calculated risk and not an attempt to provide absolute flood control.*** They will be made to understand that floods greater than the design flood may also occur. They should be aware on the limits of the project in solving the problems confronting them regarding the annual floods. The local government units shall therefore prepare their contingency plans on the basis of this information.

5.6 Abandonment

Future abandonment of the project is a remote possibility. The project will have a significant influence on the economic and social activities of the Laoag River Basin. Its operation is expected to progressively increase the economic activities in the future. Considering the magnitude of these future economic activities, the huge project investment, and the need for which the project was proposed, it is unlikely that the project will be abandoned in the future. The proponent's long-term aim is therefore to sustain the operation of the system

However, any abandonment decision in the future can easily be carried out since the project's construction materials are only concrete, steel, and boulders. There will be no decontamination activities since toxic and hazardous wastes will not be present.



Source: JICA, 1997

ENVIRONMENTAL IMPACT STUDY OF THE SABO AND FLOOD CONTROL PROJECT OF THE LAOAG RIVER BASIN	Figure 5.1 LOCATION OF PROPOSED PHASE I PROJECT COMPONENTS

6.0 PAST AND EXISTING ENVIRONMENTAL CONDITIONS

This chapter presents a description of the present and historical trends of the environment at the project site. Its objective is to provide the necessary baseline information regarding the natural environment and the socio-economic setting of the project area.

6.1 Climate

Climate of the Laoag River Basin has two distinct seasons. May to October is the wet season, while the dry season is between November to April. The estimated average annual rainfall is 2,135 mm at Laoag City during the period 1961 to 1995. Ninety seven percent of the rainfall events occured during the wet season. Average monthly rainfall varies from 1 mm in February to 580 mm in August. Recorded temperature in Laoag City showed an annual average of 27.0°C with a lowest value of 24.5°C (January) and a highest value of 29.1°C (May).

Every year, tropical cyclones affect the area with heavy rainfall. During the past 48 years, 250 cyclones hit or came close to the area. Big cyclones affect the area on an average of three times a year with a rainfall of more than 50 mm. About 75% of such big cyclones occurred between July to September.

6.1.1 Records of Typhoon Gloring (1996)

Typhoon Gloring was the most recent typhoon which provided a good opportunity for rainfall observation. It brought a heavy storm rainfall in the area between 23 to 27 of July 1996. This typhoon caused a large flood in the entire stretches of the Laoag River. Its 3-day rainfall varied from 594 mm to 795 mm with a maximum hourly range of 30 mm to 69 mm. The recorded rainfall depths at four stations are presented in Table B.1 of the appendix.

6.2 Geology and Terrain

Materials for this section were provided by the JICA Study Team who prepared an extensive study of the subject.

6.2.1 Geology

The Laoag River Basin has eleven stratigraphic sequence: (1) Recent Sand Dunes, (2) Recent Alluvium, (3) Recent Alluvial Fan Deposits, (4) Plio-Pleistocene Sediments, (5) Middle to Upper Miocene Limestone, (6) Middle to Upper Miocene Sediments, (7) Plio-Pleistocene Volcanic, (8) Neogene Intrusive, (9) Lower Miocene Volcanic, (10) Cretaceous-Paleogene Volcanic, and (11) Cretaceous-Paleogene Intrusive.

Geologically, the eastern part of the basin is mainly Neogene Intrusive and Cretaceous-Paleogene Volcanic. The rocks in the middle to lower portions of the Cura, Labugaon, Solsona, and Madongan watersheds are of the weathered Neogene Intrusive materials which have disintegrated into some thick loose granular material. Extending over the eastern watersheds are materials of Cretaceous-Paleogene Volcanic materials which are highly faulted and jointed with fracture zone in some places.

The geological map of the basin is presented in Figure B.1 of the appendix.

6.2.2 Floodplain Topography

The Laoag River Basin has various topographic features that could be classified into eight micro-topographic components which are described below and in Figure B.2 of the appendix.

Alluvial Fan

Sediment deposits of the Cura, Labugaon, Solsona, Madongan, Papa, and Bongo Rivers formed the major alluvial fans which are rugged due to the existence of old channels, gully erosion, and natural levees. Sediments are still deposited in the old channels by the overflowing flood waters.

The alluvial fans of the Solsona, Madongan, and Papa Rivers are widespread. Those of the Cura, Labugaon, and Bongo Rivers are confined within a long and narrow area of the surrounding terraces and hills.

Valley Plain

This is formed in areas where hills and plateaus restrict the development of a fan-shaped topography such as along the Guisit River. During a large flood, water flows down the entire section of the valley plain.

Flood Plain

These are plain areas which are a few meters higher than the existing riverbeds and formed a terrace-like topography. Small scale flood will not submerge these plains. Flood plains are found on the left bank of the Laoag-Bongo River between the confluence with the Papa and Guisit Rivers. These are also found in both banks of the lower reaches of the Laoag River.

River Terrace

These are nearly level surfaces of a river bank bordering a steeper slope. The major river terraces are located along the right bank of the Cura River and the left bank of the Upper Bongo River. The poblacions of Banna and Nueva Era are located on the terrace along the Upper Bongo River which is single step type and located 20 to 30 meters above the existing riverbed.

San Dune

At both sides of the river mouth and along the coastal line extending over 1.5 kilometers is an unstable sand dune. A stable sand dune has developed at the hinterland of the unstable sand dune.

Natural Levee

These are broad and low embankments that built up along the banks of a river channel during floods. Natural levees are found in some parts of the banks along the Laoag River and the alluvial fan complex. Situated on these natural levees are the poblacions of San Nicolas, Sarrat, Solsona, and Laoag City.

Old River Channel

When the main river is flooded, flood water tend to flow along the old river channels. Many old river channels are found in the alluvial fans of the Solsona, Madongan, and Papa Rivers. The flood plain of the lower reaches of the Laoag River have old river channels also.

Riverbed and Sand Bar/ High Water Bank

Riverbed and sand bar/high water bank compose the present river channel. The high water bank, which is 2 to 5 higher than the riverbed, is easily flooded by a 2-year flood.

6.2.3 River System

The six principal rivers of the project area (Laoag River Basin) are the: Laoag, Bongo, Cura/Labugaon, Solsona, Madongan, and Papa. Laoag River and the lower part of Bongo River flow down through the alluvial plain. The other rivers (tributaries) and the upper part of Bongo River flow through the alluvial fan. Figure B.3 of the appendix shows the location of these rivers and the various sub-basins, while Table 6.1 presents the their geomorphologic characteristics. Information on the features of the existing sand bars are found in Table B.2 of the appendix.

Table 6.1

PHYSICAL CHARACTERISTICS OF RIVERS

RIVER	LEGNTH (km)	SLOPE (%)	WIDTH (m)	ALIGNMENT / NO. OF BENDS
Laoag	31.6	0.021 - 0.090	400 - 1,000	2
Lower Bongo	11.0	0.151 - 0.200	300 - 600	0, straight
Upper Bongo	12.0	0.311 - 0.943	300 - 400	1, much braided
Cura/Labugaon	17.0	0.331 - 1.08	100 - 1,000	many distributaries
Solsona	11.5	0.137 - 1.54	230 - 330	5
Madongan	9.5	0.452 - 1.35	300	1, almost straight
Papa	7.5	0.540 - 1.85	223	1, almost straight

Riverbed Materials

Riverbed materials are categorized as (1) large cobble/small boulder, (2) very coarse pebble/small cobble, (3) medium/coarse pebble, (4) very fine/fine pebble, and (5) sand. Large cobbles and small boulders are only found in the fan apexes up to the middle fan reaches. Riverbed materials of the Laoag River is 33% sand. Information on the grain size distribution of the riverbed materials are found in Table B.3 of the appendix.

Flood Carrying Capacity

The Laoag River Basin is frequently flooded due to its small flood carrying capacity as indicated in Table 6.2. Except for the Papa River, all the rivers are easily flooded by 25-year flood without any dikes. Laoag City, which can easily be flooded by a 2-year flood, is protected by a high riverbank at the central part.

Table 6.2

ESTIMATED FLOOD CARRYING CAPACITIES OF RIVERS

RIVER	DISCHARGE (m^3/s)	RETURN PERIOD (year)
Laoag	2,000 - 5,000	2 - 4
Bongo	500 - 2,000	5
Guisit	500 - 1,000	2 - 10
Cura/ Labugaon	500 - 2,000	1 - 10
Solsona	1,000 - 1,300	25
Madongan	2,000	25
Papa	1,000 - 1,500	100

Note: Return period is the average interval in years within which a given event will be equaled or exceeded.

Existing River Structures

Presently, structures can be found along and in the river channels. These include: (1) river control structures such as dikes, spur dikes, and revetment; (2) irrigation facilities such as diversion dams, pumping stations and brush dam; and (3) transportation related structures.

The largest river control structures in the basin are dikes constructed between 1991 to 1993 along the Solsona, Madongan, and Papa rivers as part of INIP I project. Information concerning these structures are found in Figure B.4 and Table B.4 of the appendix.

6.3 Hydrology

Hydrologic information, especially the flood data, are very important for this project. Knowledge on the present water quality characteristics of the rivers is also important.

6.3.1 Historical Flood Records

Historical data on flood observations were done for the Laoag River by taking the water levels at Gilbert Bridge for the past 37 years (1959 - 1996). Based on the recorded peak water levels, peak discharges caused by various typhoons with different return periods were estimated. The data showed that the peak discharge (10,900 m^3/s) of a 25-year flood is only 28% more than the peak discharge (8,500 m^3/s) of a 9-year flood. Information on the water levels and their corresponding peak discharges are presented in Table B.5 of the appendix.

6.3.2 Probable Flood Discharge

The probable flood discharges and hydrographs of the Laoag River Basin was estimated using the modified rainfall pattern of Typhoon Gloring (1996 occurence). This particular typhoon was selected by the JICA Study Team since there are no hourly rainfall distribution records available except for this typhoon and its total rainfall depth is large enough. The probable flood discharges for various return periods and the calculated discharges at the major points of the basin are presented in Figure B.5 of the appendix. The data showed that the peak discharge (8,900 m^3/s) of a 10-year flood is twice that of a 2-year flood for Laoag River.

6.3.3 Water Quality

Survey on the water quality characteristics of the Laoag River Basin and Daorao Creek of Laoag City was conducted from 9 February to 9 March 1997. Water samples were collected from ten (10) sampling stations. The parameters analyzed are pH, water temperature, conductivity, total phosphorus, BOD, total dissolved solids, total suspended solids, nitrate, oil and grease dissolved oxygen, salinity and total coliforms.

Almost all the parameters analyzed are within the DENR standards. The rivers of the Laoag River Basin consistently showed low values of the analyzed parameters. Results of the water characterization confirms that the water qualities of these rivers are still within the values of the parameters set for Class A waters. However, Daorao Creek registered relatively high values of the parameters analyzed. Compared with the rivers of the Laoag River Basin, the creek is considerably polluted.

Results of the detailed water quality study are presented in Appendix C. Coliform concentrations were observed to be high in the rivers during the February and March sampling period. Hence, resamplings were made in the month of June which showed values of 340 MPN/100 ml for the Laoag-Bongo River and 450 MPN/100 ml for the alluvial fan rivers. These values are below the maximum DENR standard for Class A fresh waters.

6.4 Oceanography

The oceanographic information relevant to the project are the presence of the sand dunes and the tidal water levels of the river mouth. As previously discussed, the mouth of the Laoag River is always clogged during the dry season and easily opened at an early stage of a large flood.

Sand dunes are present at both sides of the river mouth and along the coastal line extending over 1.5 kilometers. It is usually thought that a shoreline is a dynamic system that involves input of sediment from various sources. Normally, much of the sediment is derived from the land and delivered to the sea by major rivers - in this case the Laoag River System. However, previous study on these sand dunes by the Bureau of Mines and Geosciences (Miranda, 1997) was not extensive and did not produced any quantitative values for the rate of sediment movement.

Tidal Water Level

Variations on the tidal water level at the mouth of the Laoag River, as presented below, were estimated based on the datum line of the National Bench Mark and the data from NAMRIA (1996). The estimated mean sea level is - 0.302. Information of the other tidal water levels are presented in Table B.6 of the appendix.

6.5 Air Quality

Presently, most parts of the Laoag River Basin are still rural in character. Air pollution is therefore not a problem. Data from the DENR showed a Total Suspended Particulates (TSP) concentration range of 69 to 99 $\mu g/NCM$ in 1996. Expected concentration ranges for SO_2, NO_2, and TSP of the basin based on the consultants' experience are found in Table B.7 of the appendix.

6.6 Vegetation

The proposed project sites lie in existing rivers where there are existing dam infrastructures. The vicinity of these damsites are mostly developed rural areas where roads and irrigation canals have already been installed. Due to these, vegetation around the damsites and its vicinity vary but similarity is very close.

To determine the characteristic vegetation at the primary impact zone, plant samples were randomly collected at identified vegetation patches in the project site. These samples were classified and identified through the use of available references. Final confirmation has been done through samples kept at the National Herbarium/Botany Division of the Philippine National Museum.

The study indicated that there are no dipterocarp trees were found in the identified primary impact zone. Seventeen (17) species of plants were identified around the proposed damsites and none of these were considered threatened, endangered or rare species. These are presented in Appendix B. Of the 17 species of plants identified in the study area, 11 were non-dipterocarps, 4 species of bamboo, and 2 species of grasses. There is relatively low species diversity in the study area. Interview with local people within the project site indicated that the area is utilized as irrigation damsite for a number of years already.

The characteristic plant species of the primary impact zone were considered similar in most vegetated sections within 5 kilometer radius. This could be attributed to the morphological and physiological responses of the plants to climate. The homogenous climatic condition in most sections of the study area has caused very minimal observable biodiversity patterns attributed to low altitude and low soil fertility. Twenty four species of plants were identified outside the primary impact zone, within 5 kilometer radius of the project site. Of this number, 19 species were non-dipterocarps, 3 bamboo and two grasses. The difference in diversity among these sites is very small and may be attibuted to domesticated species of plants cultivated by residents around the existing damsites.

Ocular inspection within 10 km radius of the proposed project sites indicated that the floral composition of the area is mostly of secondary growth vegetation. This could be attributed to existing land use. As farmerlots abound in the vicinity of the dam sites, vegetation patches in the residential sites are mostly domesticated plants of medicinal and ornamental value.

Observations noted around the vicinity of the irrigation service area indicated that there are reforestation activities taking place as evidenced by the ipil-ipil, gmelina, yellow acacia, and eucalyptus trees planted on the roadsides.

Identification of terrestrial plant species found in the study area revealed that most of the samples were considered to have either medicinal or construction value aside from being edible for human consumption. However, the abundance of these species are rather low as they are found only in patches within the project site. This low abundance of economically important plant species is expected as the project area is considered a secondary growth vegetation.

Along the rivers identied as sites for the proposed sabo dams, the most conspicous features of tropical communities are the vast areas occupied by floating vegetation. This may take the form of free-floating types or of sud and meadow forming varieties. The same types of small free-floating plants tend to recur through out the river ecosystem. Principal among these are water hyacinth and kangkong which form extensive mats which choke waterways induce deoxygenated conditions. Water hyacinth can double in number every 8-10 days in warm nutrient rich waters.

Observations within the proposed sabo damsites revealed that the most dominant benthic plant species are the filamentous algae Lyngbya sp. Howver, these algal growth is found only in slow-flowing rivers and by the edges of the riverbanks where water movement is slower. Project sites where algal growth are found include Labugaon River, Papa Dam, Kauplasan Bridge and Gilbert Bridge.

Based on the vegetation survey conducted and available secondary information, no threatened, endangered or rare species of plants are identified in the project site.

6.7 Fish and Wildlife

From fisheries viewpoint, perrenial rivers may be classified into two major classes, *reservoir* and *flood* rivers. Reservoir rivers have stable flow throughout the year and fish communities of such systems are diversified with trophic specialization and well-defined food webs. These differ widely from the communities of flood rivers, behaviourally and dynamically, in that they tend resemble the populations of lakes rather than those of seasonally flowing waters.

The Laoag River and its tributaries can be considered flood rivers which exhibit large seasonal variations in rainfall over the basin which are transmitted downriver as a pulse of increased flow. As a result of this, lateral plains around the Laoag River have been formed which are submerged by overspill from the main channel. The great fluctuations in level cause a seasonal cycle of flood and drought over much of the area, although a core of permanent water does persist within the main river channels and the low-lying depressions of the floodplain itself. Extreme changes in water chemistry and primary production also occur throughout the cycle, giving rise to a constantly shifting pattern in the variety of ecosystems which make-up the river-floodplain complex. Organisms inhabiting these types of systems have had to adapt to spatial and temporal fluctuations which are perhaps unique in aquatic environments. The constantly shifting bed of the river, and the silting of old features and cutting of new ones, lead to the maintenance of the characteristically flat plain, while producing constant modifications in the detailed geography of the area. Sedimentary material brought downstream by the river is deposited at various places, the material is eroded by the lateral migration of the river channel in its valley and by the scour arising from flow over the surface during floods, forming bedrock boulders around the existing irrigation damsites.

The chemical composition of Laoag River depends on a wide variety of physical, chemical and biological features. However, three basic mechanisms control surface water quality. These are precipitation, the nature of bedrock and the evaporation-crystallization process. In most tropical rivers, the ionic composition of water derives primarily from the rain and the rock or sediments over which the river flows.

The degree of insolation, substrate composition, turbidity, ground- or rainwater inflows, wind, and vegetation cover, can all influence the temperature of water in rivers and floodplain lakes. Generally, surface water temperatures follow the ambient air tempereature closely, although under dry, hot conditions this is more likely to be correlated with air temperature minima owing to the cooling effect of evaporation. An annual cycle in which the dry season temperatures are higher than those in the wet season is common. At low latitudes river temperaturees are seasonally and diurnally stable, but at higher latitudes, temperatures fall sufficiently and vary to cause fish mortality. Water in the main channel of Laoag River rarely statefies as good mixing is maintained by the turbulence associated with river flow.

Conductivity is a measure of the total amount of ions present in a body of water and is therefore useful approximation to chemical richness. As a measure, however, it does not give an indication of the actual ionic composition of the water, and may therefore fail to convey information on limiting factors such as the lack of essential nutrients.

Differences in water type including pH, lead to variations in the fish species inhabiting various waters. In particular, distinctive communities are found associated with highly acidic waters. Savanna rivers are usually neutral or slightly alkaline. Because there is decaying vegetation in standing waters of the floodplain, slight gradients with higher pH values at the surface often exist. Gradients in pH also exist in water's edge where the newly flooded soil may produce either a local drop in pH. Experimental evidence confirmed that cow droppings raise the pH of water rapidly. However, the effects of these are temporary and more acid conditions are quickly restored.

The distribution of dissolved oxygen within the aquatic system is one of the main factors influencing the distribution of fish. As floodwater invade the floodplain, there is an initial rise in dissolved oxygen concentration but these fall swiftly as submerged vegetation begins to decay and only the later rise again to the higher levels maintained during the flood season.

Due to variations in physico-chemical characteristics of Laoag River and its tributaries, inland fishery production in these areas are very low, in addition to boulder bedrock formation which prevents a favorable habitat for fingerlling growth. Further, no considerable population of fish were noted during ocular inspection in the shallow and clear waters. Freshwater species of fish reported by the local people includes Hito (*Clarias batrachus*), Igat (*Anguila pacifica*), Gorami (*Trichogaster tricoptherus*)and Tilapia (*Tilapia nilotica*), Biya (Goby), and Bangus (milkfish).

Wildlife is likely affected by the past and existing land use in the area. Due to site utilization as irrigation dam, no wildlife has been identified in the proposed project sites. Likewise, no endangered, threatened or rare species of animals have been identified in these areas.

No significant bird population was noted in the identified primary impact zone. No bird calls were observed along the main roads. However, local residents have noted Cukcoo (Kakok), pigeon (Balud), pipit (Oriole), crow (Uwak), rails (Tikling), maya (Bilit China), quail (Pugo), wild chicken (labuyo) and martinez. Available secondary information indicated that there are no threatened, endangered or rare species of animals identified in the project sites.

Relatively little information is available on benthic fauna of slow-flowing, silt-laden rivers associated with floodplains. If this situation exist, it indicates a generally poor fauna consisting of a relatively small number of species. Studies conducted elsewhere indicated that the benthic fauna diminishes in diversity and abundance as the current slows.

On the floodplain itself, where seasonal dessication occurs small densities of pulmonate snails and clams are present at the bottom and surface of inundated areas.

6.8 Land and Resources Use

The Laoag River Basin covers an area of around 1,330 km². Its present land use is dominated by mountain area which is 70% of the total and followed by cultivated areas (18%). The riverbeds is only 4%. The remaining 8% are residential areas, lowland tree area, bush/grass land, riverwash area, and road/canal/creek areas. The existing land use map is shown in Figure B.6 of the appendix.

Soil and Land Capabilities

Land may be described in terms of its resource elements and support activities. The capacity to provide outputs, goods, and services is directly related to the ability to manage and protect these various resource elements and support activities.

Based on the soil classification standard set by the Bureau of Soils along the Cura River (Solsona and Dingras), the soils are formed mainly from alluvial or sediment deposits. The texture of the surface soils vary from clay to clay loam with brown to pale brown in color. The soil types are grouped in the Bantog and San Manuel series. The areas along the river are relatively flat and considered as the most productive lands of their respective localities.

The type of soils in the area are prone to erosion because these are structurally weak and unstable. Hundreds of hectares have already been lost through riverbank erosion. River overflows in the past have also caused the surface erosion even in the flat areas.

The land capability grouping is considered a combination of croplands and pasture land. These lands are suitable to all crops commonly grown in the locality. Land management requires only conventional farming inputs to make it productive. Occasional river overflow is a major problem in the nearly level or depression areas. Some farmers instituted overflow protection measures such as appropriate cropping systems to overcome the problem. Rice is best suited in this areas. However, other crops may be planted through proper choice of cropping patterns and conservation practices.

In the past, the lands along the river are major settlement areas. Settlers stay close to the riverbanks since the river is the major source of water for domestic purposes. In addition, the river is also a good source of fish.

Vegetation and Crops

Vegetation on the area varies with productivity and preferences among the settlers. In the croplands, the following crops are grown: rice (1-3 cropping per year), corn, peanut, mungbeans and other beans, tomato, cassava, eggplant, squash, water melon, singkamas, pepper, tobacco, garlic, onion.

Permanent crops and vegetation are interspersed within the settlement areas as part of their "home gardens". The commonly found permanent crops with economic importance are: mango (carabao and hawaiian), avocado, tamarind, santol, chico, cashew, banana, and pomelo. Forest species such as the different species of bamboo, agoho, auricauliformis, mahogany, eucalyptus, and Gmelina are also found.

Farm Systems

Agricultural crop production is the major use of the lands along the Cura river. Rice planting is 1 to 3 cropping every year. Three croppings is practiced in irrigated areas, especially those cultivated by the tenants, since the landowners do not ask for a share of the second and third croppings from these tenants.

Generally, the cropping pattern is riced-based with an all year round crop production. In the irrigated areas, the common cropping patterns are rice-vegetables-corn, rice-rice-vegetables, rice-rice-beans, rice-rice-rice. Cropping in the rainfed or unirrigated lands is more intensive and the type of crops grown are more variable. Farmers can grow more high value crops which can command higher income than rice. The common cropping patterns are rice-bean-vegetables, rice-vegetables-corn. Intercropping is a common practice especially those in the well drained areas, such as corn and peanut, vegetables and corn, beans and corn.

Rice is grown from July to September or October. The last rains of October and November can still sustain the crops following rice. The third cropping after rice are irrigated through overhead irrigation. Water is drawn from the river or deepwell (20 ft) through water pumps (5 to 7.5 HP). About 40% of the farmers in the locality own a water pump.

The irrigation systems of NIA has managed the water requirements of the farmers in the area. Some farmer groups still maintain the "Zanjera" especially those that cannot be serviced by the NIA projects.

Land Ownership Inventory

Lands along the river are privately owned. These are cultivated either by the owners themselves or their tenants. Many of these properties have portions lost to the widening river. Nevertheless, the owners still continue to pay their land taxes in the hope of retaining their ownership of the lost portions and thinking that they can use the area as quarry sites for aggregates. Present land values in the town of Solsona is around 25 to 60 pesos per square meter, while in the town of Dingras it is around 60 to 100 pesos.

Property Rights in Changing River Courses

Property ownership issues regarding the changing course of a river or its widening are clearly resolved by the Philippine Civil Code. Rivers are properties of public dominion (ownership of the state) since they are intended for public use as provided for by Article 420 of the Civil Code. Whenever a river, changing its course by natural causes, opens a new bed through a private estate, this bed shall become of public dominion (Article 462). The Supreme Court also ruled that the new river banks shall likewise be of public dominion.

River beds which are abandoned through the natural change in the course of the waters belong to the owners whose lands are occupied by the new course in proportion to the area lost. However, the owners of the lands adjoining the old bed shall have the right to acquire the same by paying the value which shall not exceed the value of the area occupied by the new bed (Article 461).

Article 461 of the Civil Code also applies to cases where the new river bed is itself abandoned because of another new change of course. In this case, the owner of the land flooded by the new change of course would own the newly abandoned river bed. However, if the river goes back to its old course (flooding the original bed), the owner of the land originally flooded would get back the ownership of the land that he had lost.

6.9 Socio-economic Aspects

Baseline information on the socio-economic aspects were obtained from various sources such as (1) interviews with key informants who are persons considered knowledgeable on the social services and environmental problems in the area, (2) various government agencies, and (3) the conduct of a sample survey using a household questionnaire in six barangays of the direct impact area. Results of the detailed socio-economic study are presented in Appendix D.

The most interesting socio-economic data is the flood experience of the people. Around 90% of the households in the surveyed barangays have experienced the flood in 1996 with an average flood water depth of 0.8 meter in front of each house which lasted an average of 3.8 days.

Only very few households escaped from the damage brought about by the flood. The children were the first to suffer with 62% of the households having at least one child absent from school with an average absence of 4.3 days. A damage of the house is being sustained by 47% and the farmland itself by 43 percent. Hence, the survey revealed the peoples aspirations of someday getting a relief from the disastrous annual flooding.

7.0 FUTURE ENVIRONMENTAL CONDITIONS WITHOUT THE PROJECT

Comparing the future conditions without the project against those conditions where the project is implemented is essential for weighing the project's benefits against its impacts. Hence, the future environmental conditions without the project are presented in this section.

7.1 Climate

Considering the available data, no sudden changes in the microclimate could be expected in the project area for the next five years. Gradual increase of local temperature is not expected since urbanization is not rapid. The basin would remain largely rural in character such that no significant changes in the environment is expected which may result to changes in temperature, wind direction and speed, etc.

7.2 Geology and Terrain

Without the proposed project, the basin is likely to remain the same for the next five years. There will be no changes in the topographic, physiographic, or geologic features of the area. The physical and chemical characteristics of the soil in the area are likely to remain the same.

7.3 Hydrology/ Fluvial Hydraulics

Without the project, stream flow would remain the same if there are no activities in the watershed. If DENR will continue its reforestation program, stream flows will have less sediment load. Any continued deforestation activities will surely affect the stream flow and possibly increase the sediment load.

Without the river improvement works, annual flooding below a 25-year flood will continue to cause havoc on the people and economy of the Laoag River Basin. Without the urgent drainage improvement works for Laoag City, urban wastewater flow in the creeks and drainage channels would still be the same. The area will still experience the backwater flow of Daorao Creek. The mouth of this creek will remain clogged.

7.4 Oceanography

With regards to oceanography, no significant change in hydrography is expected. The basin will continue to deliver a large amount of sediments to the coastal zone.

7.5 Air Quality

Air quality within the project site is expected not to change even without the project. It is projected that the presence of industrial sources emitting air pollutants will not drastically increase in the future.

7.6 Vegetation

Vegetation cover in the proposed project site is likely to remain the same without the proposed sabo dams. During dry summer months vegetation will exhibit withering due to limited amount of water. However, during the rainy season, growth will then be enhanced due to availability of water. However, during occurrence of floods, more siltation is likely to occur without the sabo dams.

The number of ornamental plants cultivated by the residents around the existing damsites will remain the same even without the proposed sabo dam project. This ornamental plants are likely to increase due to the present government campaign of community clean and green program.

7.7 Fish and Wildlife

The whole stretch of the Laoag River and adjacent tributaries will continue to have limited fish and wildlife population due to past and present land use. The present limited number of fingerlings observed around the existing damsites will remain as there is very limited nutrient available in the area.

The existing vegetation cover around the existing dams are likely to remain and may not be able to support wildlife species due to scarcity in number.

7.8 Land and Resource use

The mountain and cultivated areas will remain the dominant land uses of the basin. The annual impact of flooding will still restrict the economic development of the area, particularly the high flood intensity areas.

The issues regarding the changing river courses will still affect the property rights in areas along the rivers.

7.9 Socio-Economic Aspects

Without any major socio-economic inputs to the area, the present socio-economic conditions is expected to change slowly. There will be slow changes in such factors as population densities, employment situation, and housing facilities. However, the transportation and communication facilities will improve considering the invested resources in the area. Although the people in the outlying areas will continue to have rural lifestyles, the increasing influence of city life will be felt because of the proximity of these areas to Laoag City which is becoming more urbanized.

8.0 PREDICTION AND ASSESSMENT OF IMPACTS

A systematic identification, prediction, and evaluation of the project's potential impacts to the environment is presented in this chapter. Analyses were made on the potential impacts during construction and operation phases. Although project abandonment is quite remote, any abandonment decision in the future can easily be carried out since the project's construction materials are only concrete, steel, and aggregates. There will be no decontamination activities since toxic and hazardous wastes will not be present.

8.1 Assessment Approach

Analysis of the project's possible impacts to the environment was made by recognizing that the construction phase would mainly be site development and the construction of small concrete structures along the river banks and within the riverbeds, while the operation phase would be the use of these passive concrete structures. The analysis presents the effects of the unmitigated impacts. The necessary measures to reduce or eliminate the impacts will be discussed later under the Environmental Management Plan (EMP).

Identification of the potential environmental impacts was done comprehensively by evaluating the project's features and operations against the known list of potential impacts identified by various sources for this type of project. These sources include the environmental assessment guidelines prepared by international financing institutions such as the Asian Development Bank (ADB, 1990) and the World Bank (WB, 1991). Other information sources were also consulted (Canter, 1977; Carpenter and Maragos, 1989; IMC, 1982; Rau and Wooten, 1980; UDSI, 1974). A guideline using an impact network analysis for bank stabilization projects (USDD, 1977) was also consulted for the river improvement works.

Results of the impact analysis are presented in the form of a scaling checklist which indicates the nature of likely unmitigated impacts and their predicted significance.

Basic Difference of Sabo Dams

Environmental effects of water impounding projects have long been recognized. In fact, considerable attention has been given to these effects in the design of small dams (USDI, 1974). Most of the adverse impacts associated with dam projects are caused by large dam structures with the associated large water impoundment. Hence, environmental assessment guidelines prepared by international financing institutions such as the ADB and the WB have given heavy emphasis on major dam projects. These guidelines recognized that the construction and operation of large dams are the principal sources of impacts in hydropower projects. ***This is not the case for this project.***

An important consideration in the assessment of the impacts of the sabo dams is its inherent function as a sediment trap and not as a water impounding structure. Its volume of impounded water is quite small and will eventually represent only the void spaces of the sediments which is around 8% of the sedimentation volume for this project. Since the sediment is a main factor in the proposed use of sabo dams, a separate discussion on the sediment load and balance of the Laoag River Basin (JICA, 1997) is presented in Appendix E.

8.2 Construction Phase Impacts

Potential impacts during the construction phase are associated with the construction of the various structures. Most of these are short-term in nature. Identified potential impacts are presented in Table 8.1

TABLE 8.1

CONSTRUCTION PHASE IMPACTS

ACTIVITY	DIRECT IMPACT	NATURE	MAGNITUDE
Construction of the sabo dam, river works and temporary access roads	Fish and Wildlife Disturbance	Negative	Minimal
	Vegetation Loss	Negative	Minimal
	Air Pollution	Negative	Minimal
	Water Pollution	Negative	Moderate
	Soil Erosion	Negative	Moderate
	Noise Generation	Negative	Minimal
	Land Acquisition and House Relocation	Negative	Minimal
	Vehicular Traffic Congestion	Negative	Minimal
	Local Labor Employment	Positive	Significant

Unlike the construction of a large development affecting a wide landscape, this project covers only very small separate areas. In fact, the range of actual area to be occupied by each sabo dams will only be between 1,200 m^2 to 3,500 m^2. This is a very small area compared to a small building in Makati City which can occupy around 8,000 m^2. Based on these small areas, it is therefore easy to understand that there will be no extensive earth moving activities on a wide scale. Consequently, expected magnitudes of adverse construction impacts will be small.

Fish and Wildlife Disturbance

During construction, the small number of fish near the sites will be affected by the activities in the riverbeds. Some forms of sedimentation will occur during the construction of the dam, this impact is expected to be only during the period and normal conditions will be restored after construction. Therefore affected animals will be restored in their natural habitat after sometime.

Vegetation Loss

Although most of the identified plant species in the primary impact zones of the project are considered economically important, the density of the affected species is considerably small as these are found only in patches within the project area. Most of these plant species are grasses, weeds and non-dipterocarp. No significant negative impact are expected in terms of vegetation cover as only a small section of the project site will be prepared for the structures.

Air Pollution

Air pollution would come from the use of heavy equipment and dust generation activities. Nevertheless, this will not be a nuisance to the public since houses are relatively far from the sites.

Water Pollution

Water pollution sources would be the dewatering work for structure foundations, earthwork operations adjacent to a stream, and aggregate processing.

Soil Erosion

Soil erosion might occur due to various earth moving activities. Erosion consequent to vegetation loss will be due to the required clearing for permanent works. However, the impact is expected to be moderate due to the small area required for the various structures.

Noise Generation

Operation of the various construction equipment will be the major source of noise pollution during construction. Construction equipment such as backhoes, cranes, and jack hammer have a range of 72 to 95 dBA (Canter, 1977). However, this noise would not be a nuisance to the public since houses are far from the sites.

Land Acquisition and House Relocation

Land acquisition for the proposed structures are quite small compared to the total area of the Laoag River Basin. The impact is therefore considered minimal. The river improvement works will require a total of 35.2 hectares of farm/bush land and 0.8 hectare of residential land. Only three houses will be relocated for the river improvement works. The Sabo dams will require some 1.5 hectares of farm/bush land without any houses to be relocated.

The urgent works for the Laoag Urban Drainage System will only require a total of 2.7 hectares of farmland/open space and 0.01 hectare of residential land. There will be no house relocation in this urgent works.

Vehicular Traffic Congestion

Construction activities are not expected to increase significantly the vehicular traffic volumes since the the construction sites are located in areas with very low vehicular traffic volumes. Impact on vehicular traffic congestion will therefore be minimal.

Local Labor Employment

Construction activities for the various structures will definitely require a large number of workers. The contractor will surely use the available local labor for these construction activities. Employment opportunities will substantially increase. The impact is obviously beneficial and significant.

8.3 Operation Phase Impacts

Potential impacts during the operation phase will be primarily due to the presence of the sabo dam as a barrier and the resulting small water impoundment. Analysis of possible impacts could be facilitated by a good understanding of the created pondage, water residence time, possible risk, and bank erosion. Hence, discussions concerning these topics are first presented.

Another important consideration in the assessment of the impacts of the sabo dams is its inherent function as a sediment trap and not as a water impounding structure.

8.3.1 Created Pondage

Construction of the dam will initially create an artificial pond at the dam's upstream side. However, the inundated area will be quite small due to the site's topography and the short dam height of few meters. The sheer smallness of the pondage area and volume would obviously generate minimal effects to the environment.

8.3.2 Water Residence Time

Water residence time is the mean theoretical time for water to stay in the impoundment. Table 8.2 presents the water residence time at various level of stream flows. All values are less than a day if the river flows are 60 times less than the 2-year flood flow. For flows that are 100 times less than the 2-year flood, only Labugaon, Madongan, and Papa have residence times that are more than two days. In the long-term, these residence times will be considerably less than two days since the impoundments volume will become small due to the deposition of the sediments. Eventually, the sedimentation area will be filled completely with sediments.

Table 8.2

ESTIMATED INITIAL WATER RESIDENCE TIME FOR SABO DAMS

RIVER	ESTIMATED RESIDENCE TIME (DAY)		
	2-YEAR FLOOD	60x LESS FLOW	100x LESS FLOW
Cura	0.012	0.71	1.19
Labugaon	0.022	1.30	2.16
Solsona	0.0059	0.35	0.59
Madongan	0.029	1.73	2.88
Papa	0.026	1.58	2.64

Note:
Values of the last two columns were computed based on flows that are 60 times and 100 times less than the flows of the 2-year flood.

Comparison with Table 8.3 suggests that the impoundment would operate similar to a water supply sedimentation basin and much different from a lake.

Table 8.3

WATER RESIDENCE TIME OF VARIOUS IMPOUNDMENT

IMPOUNDMENT	WATER RESIDENCE TIME	REFERENCE
Sedimentation Basins	1 - 10 hours	Tchobanoglous, 1992
Facultative Ponds	7 - 30 days	Metcalf & Eddy, 1979
Small Lakes	0.34 - 8.5 years	Goldman & Horne, 1983

8.3.3 Potential Risk of Sabo Dam

Unlike a dam that functions as a water reservoir, a sabo dam has a very low possibility of breaking and will not cause a disastrous situation in the event of failure. This is possible due to a very low dam height and a small water impounding volume. A sabo dam, as previously discussed, is not a water impounding dam. Its main function is to capture the sediments. A water impounding dam has a very high potential to cause a downstream disaster compared to a sabo dam due to its very high energy potential supplied by the impounded water.

Despite the low risk potential of a sabo dam, the scenario of a dam break situation was studied for this project.

<u>Possibility of Dam Break</u>

Dam break in a sabo dam could be due to a dam damage caused by the passage of debris flow. A debris flow could have tremendous destructive energy because of the massive movement of big boulders and gravel. However, debris flow may only occur in a steep valley with a slope of more than 25%. When this occurs, this type of flow will rush down through a channel with a slope of 7% to 25%. Then it will start depositing on the riverbed with a slope of less than 7% and may reach the channel with a 3% slope.

Fortunately, the proposed sabo dams for this project are located on a riverbed with a slope of less than 3%. Hence, it is very unlikely that a debris flow may eventually reach the proposed dam sites. The possiblity of flood water to damage the structures is also very low since its destructive energy is quite small compared to a debris flow. In addition, the selected sites for the dam structures have geologic formations that could sufficiently support the structures as presented in Figures A.9, A.10, and A.11 of Appendix A.

In view of the foregoing discussions, the possible occurence of a dam break is considered very remote. Future damage to some portions of the sabo dam due to serious scouring and collision of big boulders during floods can be avoided by proper design, construction, and maintenance/rehabilitation.

Dam Break Situation

Although the possibility of a dam break is considered very remote, its resulting effect is also being examined by estimating the equivalent thickness of channel aggradations. In this situation, the following may be expected in a worst case scenario:

- stored sediment in the dam will be released immediately to the downstream reaches during a sudden dam break;
- the released sediment will be deposited in the immediate downstream reaches with a steep channel from the sabo dam.

Table 8.4

ESTIMATES OF CHANNEL AGGRADATIONS DURING DAM BREAK

RIVER	DAM STORAGE (m^3)	CHANNEL DIMENSION (m x km)	DEPOSIT DEPTH (m)
Cura	391,000	220 x 1.0	1.8
Labugaon	1,043,000	250 x 2.0	2.1
Solsona	233,000	230 x 3.5	0.3
Madongan	2,192,000	300 x 5.5	1.3
Papa	707,000	220 x 2.5	1.3

The analysis showed that the channels in the immediate downstream reaches have enough capacity to absorb the released sediments from a dam break since the channels have depths greater than 2.0 meters.

8.3.4 River Bank Erosion

Generally, river channels in the alluvial fans have many distributary channels (braided river courses). The proposed river improvement works will stabilize the channel by integrating the many distributary channels inorder to prevent land loss and flood damage. Stabilizing the channel will increase the possibility of bank erosion due to the following: (1) flood discharge will increase and (2) shear stress of flood water will also increase in proportion to the converging flood water in the main channel. Based on the field survey, the following sites are possible points of river bank erosion: (1) immediate downstream of the alluvial fan apexes and (2) around hinge points of riverbed slopes.

8.3.5 Identified Impacts

The proposed project is checked against the list of potential impacts for this type of project as discussed previously. This approach makes a comprehensive evaluation of the impacts that the project are likely to generate. Results of the evaluations are presented in Table 8.5.

Table 8.5

SCALING CHECKLIST FOR OPERATION PHASE IMPACTS

IMPACT AREA	DIRECT IMPACT	NATURE	MAGNITUDE
HYDROLOGY / FLUVIAL HYDRAULICS/ EROSION	decrease deposition of large size sediments at the fan apexes	positive	significant
	reduce channel shifting	positive	significant
	increase the sediment transport capacity in the downstream rivers	positive	significant
	reduction in riverbed aggradation	positive	significant
	increase in river bank erosion at critical sites	negative	moderate
	reduction of groundwater recharge	negative	minimal
	decrease supply of sand to the coastal area	negative	minimal
	Improve flow of the creeks and drainage channels of the Laoag City drainage sub-project are	positive	significant
	Prevents flooding in the Laoag City drainage sub-project area	positive	significant
WATER QUALITY	Improve the clarity of downstream waters	positive	significant
	Contributes to long-term eutrophication	---	no effect
	Improve the water quality of the creeks and drainage channels of Laoag City (Daorao Creek area)	positive	significant

AIR QUALITY/ MICROCLIMAT E	Generation of air pollutants	no effect	---
	Alteration of microclimate	no effect	---
	Reduction in foul odor emitted by the channels of the built-up area in the Laoag City drainage sub-project	positive	significant
NOISE	Increase in noise levels	no effect	----
GEOLOGY / SEISMOLOGY	Induced seismicity	no effect	---
ECOLOGY	Loss of wildlands and wildlife habitat	no effect	---
	Improvement in the spawning grounds for fisheries	positive	significant
AESTHETICS	Reduce the aesthetic appeal of the landscape at the dam site	negative	minimal
	Visual impairment of any historical, archaelogical, and cultural resources	no effect	---
	Improve the aesthetic appeal of the creeks and channels of the Laoag City drainage sub-project	positive	significant
NATURAL RESOURCE USE	Loss of fishing area	no effect	---
	Impairment of navigation	no effect	---
	Damage to economically valuable natural resources	no effect	---
	Increase use of farm lands	positive	significant
	Increase the available residential land in Laoag City	positive	significant

SOCIO-ECONOMIC	Land acquisition and house relocation	negative	minimal
	Loss of historic and cultural area	no effect	---
	Reduce flood associated health risk	positive	significant
	Reduce economic loss associated with flood damage	positive	significant
	Disruption/destruction of tribal/indigenous groups	no effect	---
	Increase available land for farming	positive	moderate

Fluvial Hydraulics

The trapping of sediments by the Sabo dams and the streamlining of the rivers through the river improvement works will generally improve the fluvial hydraulics through a decrease in the deposition of large size sediments and increase the sediment transport capacity of the rivers. This will lead to a reduction in riverbed aggradation as discussed in Appendix E. The trapping of the cobbles and boulders will also reduce the channel shifting.

However, the improve flow conditions will increase the possibility of a moderate increase in river bank erosion at critical sites as discussed in Section 8.3.4. Effect on the supply of sand from the Laoag River to the coast will be minimal since the estimated reduction of sediment runoff to the sea will only be 5 percent annually, while the existing stored sand in the rivers will slowly be released by the improved flow conditions.

Impact on groundwater recharge will be minimal since the total subsurface area to be impeded by each Sabo dam relative to groundwater flow will be quite small compared to the available area of the rivers. The revetment works of the rivers will also have minimal effect on groundwater flow since it will not extend deeper below the ground to impede the subsurface flow from the rivers.

The urgent drainage improvement works for Laoag City will improve the wastewater flow in the creeks and drainage channels. This will help avoid the backwater flow of Daorao Creek. The mouth of this creek will also be unclogged.

Water Quality

Except for improving the clarity of the downstream river waters from the Sabo dams, the Sabo dams and river improvement works will not alter the water quality. These structures will not contribute to any long-term eutrophication of the rivers.

The urgent drainage improvement works for Laoag City will improve the water quality of the open channels in the built-up areas by the installation of the interceptor pipes which will convey the urban wastewater to the downstream sections.

Air Quality/Microclimate

The Sabo dams and river improvement works will not generate any air pollutants nor lead to the alteration of the microclimate.

During summer, the stagnant wastewater in the open channels of the built-up areas in the drainage project target areas for Laoag City are emitting foul odor. The installation of the interceptor pipes which will convey the urban wastewater to the downstream sections will help eliminate this problem.

Noise

The project components are passive concrete structures. These will not therefore increase the sound levels of the surrounding areas.

Geology/Seismology

Induced seismicity by the weight of the dam structure and the impounded water is not expected since dam sizes and heights are quite low. In fact, a study on a 90-meter high dam with a storage volume of 48 million m^3 indicated a relatively very small induced seismicity (Electrowatt, 1991). The storage volume of this 90-meter dam is 22 times that of the largest Sabo dam of the proposed project.

Ecology

Use of the sabo dams will improve the situation of the aquatic ecosystem by trapping the sediments. It will therefore improve the spawning grounds for fisheries. It is well known in the study of river ecosystems that the sediment bedload of rivers are quite destructive since it is not readily carried in suspension but is gradually washed along the bottom. It is transported downwards rolling or sliding on the surface of the riverbed. As particles roll and tumble along, they scour organisms from the rocks. They also bury and smother the bottom life and fill in the hiding and resting places for fish and crayfish. Aquatic plants and other organisms are prevented from reestablishing themselves because the bottom is a continually a shifting bed of sand.

The Sabo dams will also improve the clarity of the downstream river waters. The clear waters would be able to support the producer organisms, such as algae and other aquatic plants, that attach to rocks or root in the bottom. These producers and miscellaneous detritus will in turn support a complex food web including bacteria, protozoa, worms, insect larvae, snails, fish, and crayfish. These organisms keep themselves from being carried away by attaching to rocks. Fishes can take shelter behind or under the rocks. Clay and other particles in suspension not only make the water look muddy, they reduce light penetration and the rate of photosynthesis. As the sediment settles, it coats everything and continue to block photosynthesis. It also kills the aquatic animals organisms by clogging their gills and feeding structures. Eggs of fish and other aquatic organisms are particularly vulnerable to smothering by sediment.

In general, the proposed structures will not cause the loss of wildlands and wildlife habitat since there are none in the proposed sites for the sabo dam and river structures.

<u>Aesthetics</u>

The Sabo dams may reduce the aesthetic appeal of the site landscape. However, it may also be viewed as a good aesthetic situation since the sabo dam will create a new landscape with artificial water falls through the continuous water spill over the dam crest.

The aesthetic appeal of the open channels of the built-up areas in the drainage project target areas for Laoag City will improve through the removal of the stagnant urban wastewater.

There will be no effect on the visual aspects of any historical, archaelogical, and cultural resources since there none in the proposed sites. No river structures are proposed in Sarrat, while the proposed dikes in Dingras is small and far any cultural and historical ruins. Sarrat and Dingras are the two areas with some cultural and historical sites.

<u>Natural Resource Use</u>

The project will not lead to the loss of fishing areas. On the contrary, it will improve the fishing areas as discussed in the ecological impacts. It will not also impair river navigation since the selected dam sites are not navigable. River navigation activities are actually absent in the project area. No valuable natural resources will be damaged. Use of farm lands will improve since a significant area will be protected from the annual inundation.

The urgent drainage improvement works for Laoag City will make available additional residential lands which are frequently flooded by Daorao Creek.

8.3.6 Socio-economic Impacts

Demography

During the construction phase, employment will be generated. If all of these workers will be recruited from the direct impact area, the existing population growth pattern will not be disturbed. There will be no drastic addition to the population size. However, outmigration may be reduced because the job opportunities will serve as an attraction for the potential migrants to stay. It may even encourage those who have already migrated to return to the direct impact area. The labor requirements during the construction phase should be sufficiently met by the work force pool in the direct impact area, beacuse although unemployment is high underemployment is prevelent. This is due to the seasonality of farm work which is the dominant work available in the direct impact area. Thus, there is no reason to recruit from outside the impact area and increase its population.

If workers should be recruited from outside and will temporary reside in the construction site, the short-term impact is population expansion in the work area. The population expansion would be greater if the outside workers will bring in their respective households into the site. There will be four additional migrants for every worker because an average household has five members (NSO, 1996). If the workers from outside will not take residence in or near the construction site, and commute from their present residence, they would merely add to the day-time, but not to the night-time population of the area. In any case, the increase in population will automatically increase the population density in the impact area.

During the operation phase, the number of workers to be employed by the proposed project will be considerably pared off. The facilities emplaced in the direct impact area will be maintained by a limited number of persons and they are most likely employees of the DPWH. Thus, the manpower requirement at this phase will only slightly alter the population characteristics of the impact area.

There is a possiblity that the project may become a factor for in-migration because the minimization of flooding will make the direct impact area more attractive for human habitation. The higher safety level from flood may encourage industrial and commercial establishments to locate there. These establishments will themselves become an attraction for higher in-migration. But such possibility may be deflected by the relative scarcity of land in the area and its already high density. It can be noted that non-ownership of homelot is already at 26% and tenancy is already at 32% inspite of the absence of big landholdings.

The salaries and wages paid to the persons who will be employed during the construction and operation phase will increase the capability of the economically active adults to support their dependents. It will not affect the existing dependency ratio. The increased capability of the economically active adults will enable them to support longer years of schooling. In the long run, the salaries and wages paid off by the proposed project will have an impact on the educational attainment of the population in the direct impact area if its labor pool is employed. If outside workers are brought in, this impact will not redound in the direct impact area. Furthermore, the workers who will be brought in will alter the sex ratio around the construction site. There will be a preponderance of males over females. This situation can create conflicts between the outside workers and local population.

Housing Characteristics

If the outside workers who are employed during the construction phase will reside in the site, the demand for housing and associated utilities (such as toilets, water, electricity and cooking fuel) would intensify. This means that the number of housing structures near the site will increase. If the concerned municipal government has no zoning plan or cannot strictly impose such a plan, clusters of structures without adequate provisions for space and sanitation may sprout near the construction sites. Furthermore, the occupants of these new structures may compete for water supply. This problem will be avoided or much reduced if the workers are recruited from the site. At present, water for domestic use is already difficult to obtain from some parts of the direct impact area. No relocation of houses is seen.

During the operation phase, the impact on housing may l be felt in the direct impact area. The higher level of safety from flooding may l make it more attractive for house building. In this case, the project will contribute to the increase in the demand for housing that will raise the land values. The result will be be an increase in the number of housing structures. If the land values will increase, it may l decrease the ownership rate of houses because homelot will become less affordable. The reduced affordability will produce renters and squatters. The salaries and wages paid to local labor if they are hired during the construction phase may increase their capacity to afford better housing materials.

Housing Utilities

The proposed project will prevent the contamination of drinking water which happens everytime there is a flood. The households in the direct impact area are susciptible to diseases acquired from contaminated water because 29% of them still obtain it from dug wells. The project will also safeguard the toilets from flood. There had been outhouses serving as toilets which were carried by flood waters. The project has no effect on the type of lighting and cooking fuel used by the households.

Social Service

If there are outside workers, they will increase the number of users of the existing social services (health centers, electricity, transportation and garbage collection). More so if they bring over the other members of their households. The increase of the population without a corresponding revision of additional housing and community services will certainly lower the existing health and sanitation levels. The problems that will be generated from employing outsiders will have long-term negative impact if these outsiders will decide to stay in the area even after the completion of the construction phase.

In the long-term, proposed project will extend the lifesapan of public infrastructure and will eliminate the flood-caused disruption of the delivery of social services. The flood has been observed to have destroyed roads, cut bridges, carried away school buildings and rendered useless the health centers. The destruction of these infrastructures means more expenses on the part of the government. Thus, the project will save the government money spent on the rehabilitation and replacement of infrastructure destroyed by floods.

Employment and Income

If the project will employ local residents during the construction phase, a transfer of funds in the form of salaries and wages from the project to the local economy will occur. Because an average family in Locos Norte spends 50.8 % of the income on food (NSO, 1994), at least half of the total amount paid in the form of salaries and wages will redound to the food-producers. These include the farmers, fishermen and small-scale food processors. The result is a second wave of positive economic impact in the local communities. The other half of the amount will go to an assortment of expenses such as housing (9%), transport (3%), clothing (4%) and education (3%) which may or may not be spent within the direct impact area.

If workers are recruited from outside, they will be remitting much of their money back to their families. The more outsiders will be employed, the less funds will go into the local economy. The transfer of funds will be confined to the expenditures of these outside workers within the project site.

Income of the local government units (LGU) in the direct impact area will likewise increase if the land values in the area will increase and the areas formerly lent useless by the floodwaters will be made productive again. The greatest source of local government revenue is real estate tax. The minimization of flood will expand the area subject to real estate tax.

Farming and Fishing

During the construction phase, the food producers will benefit from the increase in demand. The persons who will be transferred from farming and fishing to wage employment will cease to produce food and will become mere consumers. Their consumption will serve as a conduit to transfer funds from the project to the local producers. Disruption of fishing activity may also occur during the construction phase, but fishing may resume during the operation phase.

During the operation phase, the project will save a large amount of money from destroyed farmland and farm produce. In the six barangays where the household survey is undertaken, the farmland of 54% of the households sustained damage and 68% lost their farm produce. The damage amounts to P13, 485 per household whose farm is destroyed and the crop loss amounts to 4,588 per household. It is estimated that that the destruction of farmland accounts for 43.3 percent of the total flood damage cost in the direct impact area. Crop loss accounts for 18.5 percent (Table 8.6).

Table 8.6

Estimated Flood Damage Cost in the Surveyed Areas

Damaged Items	Percentage of Affected Sample Households (%)	Cost of Damage Per Sample Household (in pesos)
Human Life		
Death	-	-
Injury	8	3,854
Disease	25	1,008
Housing		
Structure	47	3,467
Furnitures	18	3,428
Appliances	11	6,389
Others	5	2,383
Assets		
Livestock	13	3,120
Poultry	33	603
Farm land	54	13,485
Fam produce	68	4,588
Fish pond	1	10,000
Productive Time		
School days	62	2,239
Workdays	40	662
Businessdays	9	4,851
Total		

Cultural Minorities

The project will emplace a Sabo dam in Carasi where the Isneg are mostly found. The construction of the sabu dam may temporarily displace the existing fishing activities. In the long-term the project has no impact on their life tyle.

Archeological and Historical Sites

The potential archeological sites are expected to be mostlikely found in the coastal areas. In this case, these sites are safe from the earthmoving facilities which will carried out during the construction phase of the project. Although the direct impact area has no historical sites, it will protect the Spanish period churches which are found in the direct impact area from destructive floods.

Health

By reducing the contamination of drinking water, the proposed project will decrease the incidence of water-borne diseases. It is not expected to have any negative impact on health unless laborers from outside the province are brought in during the construction phase. In this case, these laborers may bring in diseases which they contracted from their place of origin and introduce it to the local population.

Perception and Attitude

The proposed project responds to the top-ranking problem in the direct impact area: flooding. This is the reason behind the total support of the households in the six barangays surveyed on the project. The implementation of the project will further improve the attitude of residents in the direct impact area towards the government.

Experience with Flooding

The proposed project is expected to significantly halt the flooding in the direct impact area. The result will be the prevention of flood damage. It is presently estimated that the flood damage in the direct impact area is significant. If the flood can be controlled, the amount can be saved and diverted to productive uses. The impact of the flood on the household is comprehesive: health, housing, economic assets and productive time. The amount of the flood damage is expected to increase in the future as population grows and the economy expands.

8.4. Abandonment Phase Impacts

The people of the Laoag River Basin will surely wish for the permanent presence of the proposed structures since these will be constructed to protect them from the annual flooding. Presence of the structures will have a significant influence on the economic and social activities of the Laoag River Basin. With a safer place, the economic activities in the basin is expected to progressively increase in the future. Hence, future abandonment of the project is a remote possibility. However, any abandonment decision in the future for the removal of the structures can easily be carried out since the project's construction materials are only concrete, steel, and boulders. There will be no decontamination activities since toxic and hazardous wastes will not be present.

Abandonment of the Sabo dams will only lead to its deterioration over a very long period of time. Without maintenance, the dam could still perform its intended function. There are number of small water impounding dams that are still structurally sound after 50 years without maintenance. However, in the event of a dam break, the stored sediments will just be released slowly to the downstream portions of the rivers. It will slowly move until the riverbed at the dam site will reach a relatively stable slope in terms of sediment transport.

9.0 ENVIRONMENTAL MANAGEMENT PLAN

This section deals with the Environmental Management Plan (EMP). It is the plan on what to do with the potential impacts identified and discussed in Section 8.0 (Prediction and Assessment of Impacts). The purpose of the EMP is to enhance the beneficial impacts and to lessen the adverse impacts. The EMP is broken down into the following components:

- Impact Management
- Impact Monitoring
- Institutional Plan

Discussions on residual impacts and contingency plans are presented at the end of the section for impact management.

9.1 Impact Management

Management of the impacts will be implemented through the proposed impact mitigating measures.

9.1.1 Mitigating/Enhancement Measures for the Construction Phase

Construction activities for the proposed structures will not affect a wide landscape and are not expected to cause significant adverse impacts as previously discussed in Section 8.2. This is due to the small area to be occupied by the structures. For the sabo dams, the range of actual area to be occupied by each dam will only be between 1,200 m^2 to 3,500 m^2 and is very small compared to a small city building which can occupy around 8,000 m^2.

Fortunately, duration of the impacts identified for the construction phase are all short-term in nature and the adverse ones can easily be mitigated. Only the temporary soil erosion and water pollution are expected to have moderate magnitudes.

<u>Socio-related Issues</u>

Although the construction activities are expected not to significantly affect the people, the proponent and its constructors shall quickly address any construction related issues or problems to be raised by the people. This shall be done with the help of the concerned barangay officials. The Environmental Coordinator of the proponent shall actively participate in the resolution of the issues/problems.

Land Acquisition and House Relocation

It should be noted that at present the proposed project is still in the planning phase with the recent completion of the master plan preparation. Negotiations for land acquisition and house relocation will therefore be made during the pre-construction phase. However, during the negotiation period, the proponent shall work closely with the respective property owners to effect a just compensation for the affected properties. Future negotiations are expected to move smoothly since the required areas are quite small and only three houses will be relocated.

Fish and Wildlife Disturbance

Expected impact is minimal and temporary as discussed in Section 8.2. Restoration of affected animals to their habitat is expected after the construction.

Vegetation Loss

The extent of vegetational loss would be small and insignificant. Nevertheless, construction activities will be conducted in such a way that any unnecessary destruction, scarring, or defacing of the natural surroundings in the vicinity of the work will be prevented. The contractor's camp, shop, office, and yard area shall be located and arranged in a manner to preserve trees and vegetation to the maximum practicable extent. Upon completion of the construction, the following will be implemented, (1) all work areas will be smoothed and graded in a manner to conform to the natural appearance of landscape, (2) all exposed areas will be replanted, reseeded, or otherwise corrected, (3) all camps, storage, and construction buildings, including all unused construction materials and debris shall be removed from the site.

Air Pollution

The extent of air pollution would also be minimal and temporary. During construction, methods of cement storing and handling will include means of eliminating dust discharges. Water sprinkling will be used in areas where heavy dust generation is expected to affect the people. Equipment and vehicles that show excessive emissions of exhaust gases due to poor engine adjustments and operating conditions shall not be operated unless corrective repairs of adjustments are made.

Water Pollution

Construction activities shall be done by methods that will prevent entry or spillage of solid matter, contaminants, debris, and other objectionable pollutants and wastes into the river. Pollutants and wastes refer to the refuse, garbage, cement, concrete, oil and other petroleum products, aggregate processing tailings. Dewatering works for structure foundations or earthwork operations adjacent to the river will be conducted in a manner to prevent muddy water eroded materials from entering the river by construction of intercepting ditches, bypass channels, barriers, or settling ponds. Wastewaters from aggregate processing or other construction operations will not be discharged to the river without the use of settling ponds. Mechanized equipment will not be operated in flowing water except as necessary to construct crossings or to perform required construction.

Noise Generation

Noise levels as discussed in Section 8.2 will be tolerable. Nevertheless, equipment with less noise generation will be used during construction.

Local Labor Employment

Beneficial impact on local labor employment will be enhanced by requiring the constructors to give priority to the local workers in hiring the required construction work force. Close coordination between the constructors and the local officials will be made.

Soil Erosion

Soil erosion is consequent to vegetation loss. Hence, mitigating measures for this impact are the same measures identified for vegetation loss.

9.1.2 Mitigating/Enhancement Measures for the Operation Phase

Mitigating measures for the operation phase are essentially long-term in nature.

River Bank Erosion at Critical Sites

As discussed in Section 8.3.4, the proposed river improvement works will stabilize the channel but may possibly increase the river bank erosion at the: (1) immediate downstream of the alluvial fan apexes and (2) around hinge points of riverbed slopes. To mitigate this impact, river bank protections at these sites will be designed with due consideration to the expected hydraulic force. The design will therefore ensure adequate river bank protection.

Positive Impacts

The proposed project will positively improve the fluvial hydraulics through reduction in channel shifting and reduction in riverbed aggradation. This will lead to an improvement in the ecology of the river. This positive impact can be enhanced by the local people through the avoidance of overfishing.

Use of the sabo dams will improve the clarity of the downstream river waters. Consequently, it will help improve the situation of the aquatic ecosystem. The clear waters would be able to support the producer organisms, such as algae and other aquatic plants, that attach to rocks or root in the bottom. These producers and miscellaneous detritus will in turn support a complex food web including bacteria, protozoa, worms, insect larvae, snails, fish, and crayfish. These organisms keep themselves from being carried away by attaching to rocks. Fishes can take shelter behind or under the rocks.

9.1.3 Residual Impacts

The expected adverse residual impacts during the construction phase are those associated with water pollution and soil erosion as discussed in Section 8.2. However, these are considerably not alarming as these will be temporary and on manageable levels. The ecological impact is also manageable as only a small area will be affected and can easily recover.

Long-term adverse impacts are all minimal in magnitude as previously discussed. It is therfore expected that any residual magnitudes during the operation phase will also be at acceptable levels. Diligent monitoring will ensure that these levels will be maintained.

9.1.4 Contingency Plans

Large-scale contingency plans due to the presence of the sabo dams are not necessary since the proposed dams will not create or lead to hazardous conditions. It is also not a potential direct source of pollutants. Hazards generated in large dam projects are not expected in this project since the proposed dam height is very short and the impoundment volume is very small. There will be no large amount of water to be released since a sabo dam is a sediment trap and not a water impounding structure. As previously discussed, the channels in the immediate downstream reaches have enough capacity to absorb the released sediments from a dam break.

<u>Dam Safety</u>

Serious problems are not expected in maintaining dam safety against failures since dam size is quite small. Dam safety is assured through proper design and construction. Studies on dam safety revealed that if the rock floor is properly cleaned and prepared, the bond obtained between concrete and rock can be so efficient that failure will take place only by a shearing fracture of solid rock mass or of the concrete (Legget and Karrow, 1983).

Construction Supervision of Sabo Dams

Preventing the failure of a dam is to a great extent dependent on the activities during the construction period. It is therefore necessary that the designer is given the opportunity to keep in close contact with the construction activities since the performance of the completed structures can be very different from what he anticipated.

Some geotechnical experts have noted that practically all the failures of the foundations of dams and other hydraulic structures can be attributed to unjustified confidence in assumptions of some kind. Consequently, the successful performance of a dam depends on many details of design and construction that cannot be adequately covered by the plans and specifications before the dam site is stripped.

The possibility of a dam failure could then be reduced by appropriate field observations during the contruction period. In this regard, Terzaghi and Peck (1967) have recommended that supervision of dams during construction should carefully consider the following aspects: (1) sumping operations, (2) contact areas, (3) construction materials, and (4) means for the prevention of piping.

Sumping operations refers to the excavation and unwatering of the site which precedes the dam construction. The designer should examine the site after it has been stripped. Whatever the subsoil conditions may be, the means for prevention of piping must be fully permanently adequate. In addition, the designer should also make sure that a continuous record is kept of all those significant details of design and construction that were not covered by the original plans and specifications.

River Improvement Works

Presence of the river improvement works should not make the people become complacent about future flooding events. The people and the local government units should be aware that the degree of protection to be provided by this project ***is based on a calculated risk and not an attempt to provide absolute flood control***. It is therefore important that they will understand that floods greater than the design flood (25-year flood) may also occur. In view of this, the LGUs and concerned government agencies should continue their disaster planning relative to unusually large floods.

9.2 Impact Monitoring and Reporting Plans

The proposed impact monitoring and reporting plans are intended for the continued observation and evaluation of the mitigated impacts during the construction and operation phases. The proponent will closely coordinate with the DENR and the LGUs on the monitoring and reporting activities. It shall provide the DENR with a quarterly environmental status report during the construction period and an annual report during the operation phase. For a smooth implementation of the project, the proponent will appoint an Environmental Coordinator for proper coordination with the DENR and the LGUs.

9.2.1 Construction Phase

Water pollution and soil erosion are the most important impacts during construction. These impacts will be the main focus of the monitoring activities. All impacts and the identified mitigating measures will be closely monitored by the local government officials and the downstream users. Hence, the constructors and project proponent shall closely coordinate with said interested monitoring parties. The project proponent will also closely monitor its constructors to ensure the implementation of the mitigating measures.

In addition, the project proponent shall regularly inform the DENR Regional Office on the progress of the construction activities. Any new environmental issues that will arise and associated with the project shall promptly be referred to the DENR.

9.2.2 Operation Phase

All impacts during the operation phase will be monitored closely. Changes in the hydrology and water quality aspects will be the main focus of the observations. In addition, the DENR shall also be provided with a copy of the annual inspection report of all structures.

Only the turbidity levels will be checked for the rivers since the Sabo dams and river improvement works will not alter the water quality except for improving the clarity of the downstream waters as discussed in Section 8.3.5. Turbidity levels will be checked twice annually. For the Daorao Creek, DPWH shall coordinate with the DENR for its monitoring.

The DPWH shall monitor the river morphology and hydrology. During the conduct of the JICA Study, three automatic stream gauging stations and staff gauges were installed at Gilbert Bridge, Cauplasan Bridge, and Solsona Irrigation Dam. Six additional water gauging stations (staff gauges) will be installed in other sites. The DPWH shall also monitor the riverbed variation of the Cura/Labugaon, Solsona, Madongan, and Papa. Cross-sectional survey will be conducted regularly for some river sections. The budget for these monitoring activities are presented in Table 9.1

Table 9.1

BUDGET FOR MONITORING ACTIVITIES

MONITORING ACTIVITIES	ANNUAL BUDGET (Pesos)
Water quality surveys	100,000
Riverbed surveys	70,000
River flow survey	100,000

9.3 Institutional Plan

This institutional plan discusses the necessary organizational and human resources components in implementing the environmental aspects of the project. Proper coordination between the project proponent, Local Government Units (LGUs), and the DENR is very important for a smooth implementation of the project. This will ensure the expeditious action on any environmental issues or problems that will arise during the construction and operation stages of the project. The proponent shall therefore appoint an Environmental Coordinator (EC) who shall be responsible for all environmental matters regarding the project.

Environmental Coordinator

The EC shall be tasked with the following:

- coordinate with the LGUs and the DENR on the environmental aspects of the pre-construction and construction activities of the project
- monitor all activities relative to the Environmental Compliance Certificate (ECC) stipulations to ensure compliance of all requirements
- coordinate with the DENR on all environmental monitoring activities
- actively participate in the periodic consultations with all concerned sectors on the various environmental impact issues of the project
- maintain records on all matters concerning the environmental aspects of the project
- prepare a monthly environmental status report of the project during the construction phase and consolidate these reports for a quarterly submittal to the DENR
- prepare an annual environmental status report of the project during the operation phase.

10. PUBLIC PARTICIPATION AND SOCIAL ACCEPTABILITY

Recent imlementation of the revised rules and regulations for the EIS System embodied in DENR's DAO No.37 series of 1996 has given more emphasis on public participation and social acceptability. In this regard, the project proponent and consultants have conducted a number of activities concerning public information, scoping sessions, and public consultations. These were intended to ensure the social acceptability of the proposed project and pave the way for a smooth project implementation. These activities are described in detail in Appendix G - "Process Documentation Report (Scoping and Public Consultation)".

An important aspect in public participation and social acceptability for this project is the identification of the stakeholders as defined by DAO 96-37. The major stakeholders are the people living in the areas to be protected against the annual flooding who are represented by the local government units since the project is basin wide in scope. Concerned government agencies are also stakeholders such as NIA, PPDO, DENR, and NEDA.

10.1 Public Participation

The public participation process aims at giving the people of the project area the opportunity to influence major decisions that affect them. Its goal is to enable the people to take responsibility for environmental protection and management through active involvement in decision making. It will reduce the level of misinformation/distrust and help identify the concerns of affected groups. In line with the objectives, the conduct of a community meeting is part of the proofs for a transparent community-based process of public participation.

The most important activity concerning public participation was the public consultation meeting held at the Laoag ampitheater last 30 May 1997. The said meeting was attended by representatives of the stakeholders, Ilocos Norte DENR PENRO Office, and the DENR's Region I Office.

During the meeting, officials of the proponent asked the participants if they have any fears or apprehensions regarding the various structures to be constructed under the proposed project. The participants did not express any fears nor interpose any objection to the proposed structures. They only asked for clarifications on few items. The positive response of the people showed their eagerness to see a project that could provide them with a reliable relief to their annual flooding experience.

10.2 Social Acceptability

The social acceptability aspect is hinged on the fact that the public is convinced on the overall consequence of the project as beneficial to most people, directly or indirectly, affected by it. Social acceptability is therefore not a problem in this project since the proposed structures are intended to provide the public with protection from floods or reduce the risks of flooding. Implementation of the project will significantly help in the economic development of the Laoag River Basin.

Proofs on the social acceptability of the project are the LGU endorsements presented in Appendix H. All the Mayors of the project area have endorsed the proposed project for the issuance of the required Environmental Compliance Certificate (ECC) by the DENR. These are the City of Laoag and the municipalities of San Nicolas, Sarrat, Piddig, Carasi, Dingras, Solsona, Marcos, Banna, and Nueva Era. These local governments certified that they interpose no objection to the proposed project after due consultation with their constituents.

Acceptance of the project by the people living in areas heavily affected by previous floods was determined through the conduct of a perception survey last February 1997. Results of the perception survey in these areas showed an enthusiastic project acceptance by the people. Of those surveyed, nobody is against the project since around 90% of these households experienced the flood in 1996 and sustained some flood damage. Details of the socio-economic and perception surveys are presented in Appendix D.

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