14.5 Bridge Report System

14.5.1 Introduction

A good bridge inspection reporting system is essential and the bridge inspection reports shall be clear and complete, since they are an integral part of the life-long record file of the bridge.

Reports prepared by the inspector are one of the most important parts of Total Bridge Management System and shall be recorded in the uniform bridge inspection reporting system. The records in the report system are used as an administration tool including determination of the structurally deficiency of the bridge, evaluation of sufficiency rate for repair and rough cost estimate for bridge repair.

The Bridge Folder has dividers on which the various bridge record documents can be fastened in the specific order and stored on electronic media. The folder consists of the bridge inventory, bridge inspection record and the file of the record of repair work. The bridge inventory includes the bridge identification such as the name of the bridge, route number, coordinates and province, features of the bridge and dimension of the structure and visual data such as photos and bridge plans, if available. The bridge inspection record is the record of deterioration degree of bridge elements inspected by the inspectors. The data are entered directly from an input screen and the instructions for the coding guide are described step by step the data entry requirement in the Bridge Inspection Manual.

14.5.2 Forms

The data and information required in Costa Rica is listed from Form-1 to Form-7. The forms and necessary information are to be completed for each bridge and placed in each file of the Bridge Folder in the proper order. Specific forms and other information used to record necessary bridge data are briefly described below. The forms of the bridge holder from one to five are for the bridge inventory data and the forms from six to seven are for bridge inspection record.

1) Form-1 General Information of Bridge Inventory Record

This form presents the basic design data, deck geometry, clearance of road, and history of inspection and repair. Visual information including location map and panoramic view of bridge and the specific feature of the bridge are recorded in this form. The code for the location of a bridge, the bridge type and the type of pavement are instructed in the coding guide.

2) Form-2 Dimensions of the Super Structure

Dimensions of the superstructure are recorded in this form. The bridge, which consists in several types of bridge such as prestressed concrete bridge plus truss, could be recorded in this form. Codes for structure type, types of bearing, type of deck material are instructed in this manual and the inspector shall follow the instruction of the coding guide.

3) Form-3 Dimensions of the Substructure

Dimensions of the substructure are recorded in this form. Codes for materials, type of structure and types of bearing on a substructure are instructed in the coding guide of this manual.

4) Form-4 Bridge's Plans

The plans or as built drawings, if available shall be scanned into this form. In case that such drawings do not exist, it should be sketch with the dimensions of the bridge including total bridge length, component of the bridge, deck geometry, height of substructure and other special notes that shall be scanned into the file.

5) Form-5 Photos of Bridge

Photos which show the typical feature of the bridge shall be recorded in this form. The inspector must provide 400 dot x 600 dot digital color photographs of each bridge for the bridge Inventory file. Photos on this form do not necessarily need to be updated when the inspection is carried out. However, when the major repair works or reinforcement works are carried out, the photos on this form shall be renewed. The following photos must be presented.

1. A photo with the name of the bridge on a record plate of a bridge or a road sign. In case the name of the bridge is not available on the bridge, the inspector should write the name of the bridge on a paper with a clip board and photograph it.

2. A view of the road way along a centerline of a road way. The direction should be in the increasing station direction and the general condition of the pavement on the bridge shall be observed.

3. A view of the elevation of the bridge which show major components of the bridge.

4. An underside view of the bridge such as the floor system of the bridge.

5. Upstream river views which should be taken from the bridge deck.

6. A weight limits sign or a notice sign for the bridge. The signs should be legible in the photos.

6) Form-6 Condition Rating of the Bridge Elements

Inspectors shall carry out the bridge inspection through this condition rating form. The Evaluation criteria of the damages for bridge elements are described in the Coding Guide. The form should be completed according to each superstructure unit i.e. if the bridge consist of three types of superstructures, such as a steel truss bridge, a steel I girder and a concrete slab bridge, the inspector should prepare the records for the form-6 for each bridge component. The record of the damage should be renewed when the inspection is carried out.

The Condition Rating based on the field inspections can be considered as a "snapshot in time" and cannot be used to predict future conditions or the behavior of the structure. However, the Condition Ratings based on the inspections along with the written comment by the field inspector who act as a major source of information for the status of the bridge. The Condition Rating also helps in planning for any necessary repairs or modification. Condition Ratings are one digit numbers given by the field inspector to the various components of a bridge. They are intended to be objective and not distorted by personal beliefs or opinions. The conditions rating should be more consistent between inspectors given the same deficiency of the structural elements.

Condition Ratings are a measurement for the deterioration or damage and are not a measure of design deficiency. For instance, an old bridge designed for a lower load capacity but with little or no deterioration may have a good Condition Rating while a newer bridge designed for modern loads but with deterioration will have a lower Condition Rating.

There are fifteen component items covered in this form, each of which list two to nine deterioration effects. The Item Numbers relate to the entry of the data in the information system of the Bridge Inventory data. Each element is rated based on the independent consideration .For instance, poor or deficient secondary element such as a cross beam of the superstructure may cause the superstructure, the cross beam should have a poor rating even though there is no significant deterioration of the main members.

The Form-6 has a space for fully supportive written comments for each of the above features. These comments are required for any Conditions Rating of 4 or 5. More details on the Condition Rating for each Item are given in the instructions for the coding guide in the Inspection Manual.

7) Form-7 Photos of the Conditions on the Elements of the Bridge

The photos on this form should correspond to the Condition Rating on Form-6 and this form should be renewed when the inspection will be carried out. Not only should the photos of the elements of the bridge with major damages but also the bridge elements with no significant deterioration be recorded in this form. The photos in this form shall include

1. The expansion joints. If the joint is covered by the overlay pavement, the area where the expansion joint is supposed to exist should be photographed.

2. The bearings of the bridge. If there is not a bearing on a bridge, the boundary between a superstructure and a substructure should be photographed.

3. Underside view of a deck condition.

4. Underside view of a floor system.

5. The abutments of the bridge.

6. The approach embankment bound to the wing wall of an abutment showing slope erosions should be photographed.

7. Slope protection in front of the abutment

8. The piers of the bridge. Any scour or significant erosion that is present should be photographed.

9. If the pavement on the bridge is repaired by overlay, the thickness of the overlay of the pavement shall be examined and its thickness showing by a measure should be photographed.

10. The components with a major deteriorated condition. The photo should be taken of features which, in the opinion of the inspector, are unusual, non –standard, or poorly repaired.

Form - 1 General Information of the Bridge Inventory

INVENTARIO BASICO DE PUENTES

NOMBRE DEL PUENTE	Colorado River 001	LOCALIDAD	PROVINCIA	*	ADMINISTRADO POR	Colorado *	
No. DE LA RUTA	1 CLASIFICACION Primary *		CANTON	*	LATITUD NORTE	12 ' 34 " 56.7 '''	
KILOMETRO	35.756 km		DISTRITO	*	LONGITUD ESTE	12 ' 34 " 56.7 '''	

	DIA	MES	AÑO
FECHA DE DISEÑO	31	3	1968
FECHA DE CONCLUCION DE CONSTRUCCION	31	3	1970

ELEMENTOS BASICOS

DIRECCION DE LA VIA HACI	SAN JOSE	*
TIPO DE ESTRUCTURA	PUENTE	*
CARGA VIVA	H15-44	*
LONGITUD TOTAL	204.00	m
ESPECIFICACION	AASHTO	*
No. DE SUPER ESTRUCTURA	1	
No.DE TRAMOS	3	
No. DE SUB ESTRUCTURA	3	
LONGITUD DE DESVIO	SI 50	km
PENDIENTE LONGITUDINAL		%

FECHA DE ULT. PINTURA	DIA	MES	AÑO

SERVICIOS PUBLICOS			
1		3	
2		4	

CRUZA SOBRE	
1	Colorado River
2	

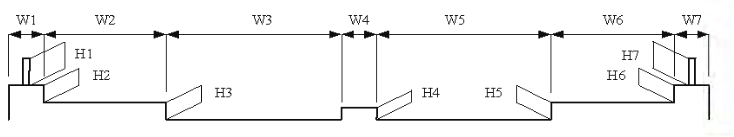
PAVIMENTO			
TIPO		ASFALTO	*
ESPESOR	ORIGINAL	75	mm
ESPESOR	SOBRECAPA	120	mm

CONTEO DE TRAFICO		
AÑO	1,940	Year
TOTAL DE VEHICULOS	15,355	Car
% DE VEHICULOS PESADOS	13.00	%

RESTRICCIONES		
POR CARGA	15.0	t
POR ALTURA	4.5	m
POR ANCHO	6.0	m

DIMENSIONES

ANCHO TOTAL	11.3 m			CALZADA	10.7 m		
ITEMS	1	2	3	4	5	6	7
W(m)	0.3	0.6	4.25	0	4.25	0.6	0.3
H(m)	0.49	0.35	0.24	0	0.24	0.35	0.49



CLARO LIBRE

ALTURA LIBRE VERTICAL			WAPROX	
	SUPERIOR	m		10.0 m
	INFERIOR	m		

ANTECEDENTES DE INSPECCION

DIA	MES	AÑO	INSPECTOR	TIPO DE INSPECCION
4	10	2005	Gabriela Jorge	Routine Inspection *
4	10	2000	Gabriela Jorge	Inventory Inspection *
				*

ANTECEDENTES DE REHABILITACION

DIA	MES	AÑO	ELEMENTOS	RESUMEN DE CONTRAMEDIDAS
4	10	2005	PAVIMENTO	Debido al daño severo, Pavimentar sobrecapa
4	10	2000	JUNTA DE EXPANSION	Cambiar debido al mucho desnivel de la junta de expansión

UBICACION

VISTA PANORAMICA

OBSERVACIONES

dificultar la inspección de sub estructura debido a la ubicación montañosa

Form - 2 Dimensions of the Super Structure

INVENTARIO BASICO DE PUENTES (DETALLE DE SUPERESTRUCTURA)

NOMBRE DEL PUENTE	Colorado River		001				*	ADMINISTRADO POR	Colorado	*		DIA	MES	AÑO
No. DE LA RUTA	1	CLASIFICACION	Primary	*	LOCALIDAD	PROVINCIA		*	LATITUD NORTE	12 '	34 "	56.7 "	FECHA DE DISEÑO	31	3	1968
KILOMETRO	35.756		km			CANTON		*	LONGITUD ESTE	12 '	34 "	56.7 "	FECHA DE CONCLUCION DE CONSTRUCCION	31	3	1970
						DISTRITO										

No DE ESTRUCTURA	No DE TRAMOS	ALINEACION DE PLANTA	VIGAS PRINCIPALES DE SUPERESTRUCTURA							
			MATERIALES		SUPERESTRUCTURA		TIPOS		LONGITUD TOTAL	TRAMO MAXIMO	ALTURA
1	1	*	Prestressed Concrete	*	Deck Truss	*	I Beam	*	204.00 m	50.00 m	2.45 m
2		*		*		*		*	m	m	m
3		*		*		*		*	m	m	m
4		*		*		*		*	m	m	m
5		*		*		*		*	m	m	m
6		*		*		*		*	m	m	m

No DE ESTRUCTURA	TIPO DE JUNTAS DE EXPANSION		LOSA			CARACTERISTICAS DE PINTURA						EMPRESA ENCARGADA
	UBICACION INICIAL	UBICACION FINAL	MATERIALES		ESPESOR	TIPO DE PINTURA	AREA PINTADA	FECHA DE ULT. PINTURA				
								DIA	MES	AÑO		
1	*	*	*		0.50 m	*	m2	31	3	1968		
2	*	*	*		m	*	m2					
3	*	*	*		m	*	m2					
4	*	*	*		m	*	m2					
5	*	*	*		m	*	m2					
6	*	*	*		m	*	m2					

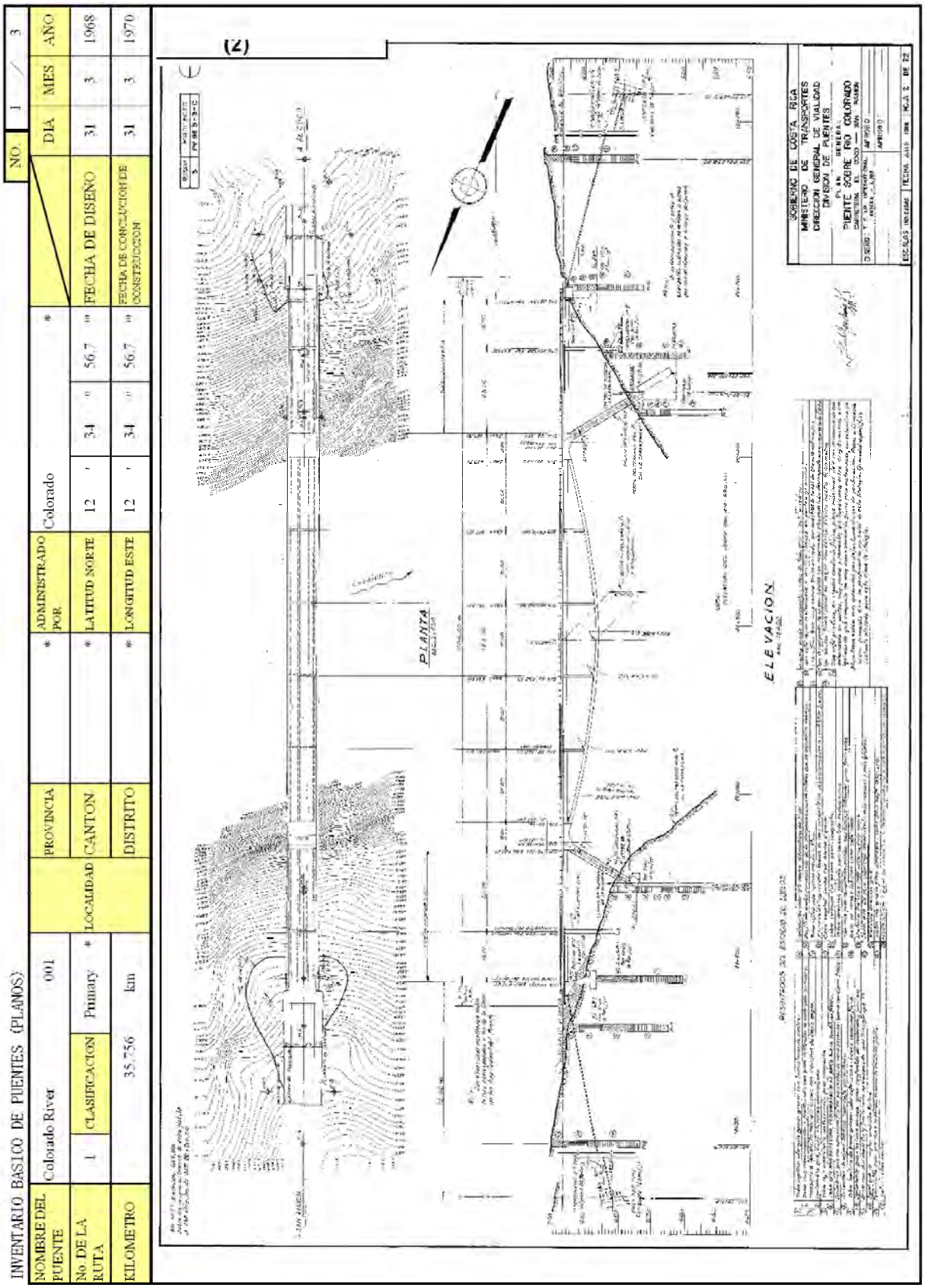
Form – 3 Dimensions of the Sub Structure

INVENTARIO BASICO DE PUENTES (DETALLE DE SUBESTRUCTURA)

NOMBRE DEL PUENTE	Colorado River	001		PROVINCIA		*	ADMINISTRADO POR:	Colorado	*		DIA	MES	AÑO
No. DE LA RUTA	1	CLASIFICACION	Primary	* LOCALIDAD	CANTON		*	LATITUD NORTE	12 '	34 "	56.7 ""	FECHA DE DISEÑO	31	3	1968
KILOMETRO	35.756		km		DISTRITO		*	LONGITUD ESTE	12 '	34 "	56.7 "	FECHA DE CONCLUCION DE CONSTRUCCION	31	3	1970

	BASTION - PILA					PILA					FUNDACION				APOYO	
No DE	MATERIALES		TIPO		ALTURA	FORMA		DIMENSIONES ANCHO	DIMENSIONES LARGO	TIPO	DIMENSIONES ANCHO	DIMENSIONES LARGO	TIPO DE PILOTES		TIPO	ANCHO DE ASIENTO
B1	Concrete	*	Rigid Frame	*	10.00 m	Multi Column	*	m	m	Spread Footing	m	m	Prestressed Concrete	*	*	5.3 m
B2	Concrete	*	Rigid Frame	*	5.00 m	Multi Column	*	m	m	Spread Footing	m	m	Prestressed Concrete	*	*	5.3 m
P1		*		*			*				m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m
		*		*			*			*	m	m		*	*	m

Form - 4 Plan of the Bridge



Form - 5 Photos of the Bridge

Form - 6 Condition Rating of the Elements of the Bridge

INSPECTION DE PUENTES (GRADO DE DAÑO)

No. DE ESTUCTURA: 1

NOMBRE DEL PUENTE	Colorado River	01	LOCALIDAD	PROVINCIA	ALAJUELA *	ADMINISTRADO POR	Region CONAVI *			DIA	MES	AÑO
No. DE LA RUTA	1	CLASIFICACION: Primary *		CANTON	GRECIA *	LATITUD NORTE	'	"	FECHA DE DISEÑO	1	7	1968
KILOMETRO	36.605	km		DISTRITO	PUENTE DE PIEDRA *	LONGITUD ESTE	'	"	FECHA DE CONCLUCION DE CONSTRUCCION			1974

TIPO DE DAÑO Y EVALUACIÓN DEL GRADO DEL DAÑO

Elemento								
1. PAVIMENTO	ITEM	1. ONDULACIÓN	2. ZURCOS	3. AGRIETAMIENTO	4. BACHES	5. SOBRECAPAS DE ASFALTO		
	EVALUACIÓN	1	1	3	2	1		
2. BARANDA (ACERO)	ITEM	1. DEFORMACIÓN	2. OXIDACIÓN	3. CORROSIÓN	4. FALTANTE			
	EVALUACIÓN							
3. BARANDA (CONCRETO)	ITEM	1. AGRIETAMIENTO	2. ACERO DE REFUERZO EXPUESTO	3. FALTANTE				
	EVALUACIÓN	1	1	1				
4. JUNTA DE EXPANSIÓN	ITEM	1. SONIDOS EXTRAÑOS	2. FILTRACION DE AGUAS	3. FALTANTE O DEFORMACIÓN	4. MOVIMIENTO VERTICAL	5. JUNTAS OBSTRUÍDAS	6. ACERO DE REFUERZO	
	EVALUACIÓN	1	5	1	1	5	1	
5. LOSA	ITEM	1. GRIETAS EN UNA DIRECCIÓN	2. GRIETAS EN DOS	3. DESCASCARAMIENTO	4. ACERO DE REFUERZO	5. NIDOS DE PIEDRA	6. EFLORESCENCIA	7. AGUJEROS
	EVALUACIÓN	1	1	2	2	1	3	1
6. VIGA PRINCIPAL DE ACERO	ITEM	1. OXIDACIÓN	2. CORROSIÓN	3. DEFORMACIÓN	4. PÉRDIDA DE PERNOS	5. GRIETAS EN SOLDADURA O PLACA		
	EVALUACIÓN							
7. SISTEMA DE ARRIOSTRAMIENTO	ITEM	1. OXIDACIÓN	2. CORROSIÓN	3. DEFORMACIÓN	4. ROTURA DE UNIONES	5. ROTURA DE ELEMENTOS		
	EVALUACIÓN							
8. PINTURA	ITEM	1. DECOLORACIÓN	2. AMPOLLAS	3. DESCASCARAMIENTO				
	EVALUACIÓN							
9. VIGA PRINCIPAL DE CONCRETO	ITEM	1. GRIETAS EN UNA DIRECCIÓN	2. GRIETAS EN DOS	3. DESCASCARAMIENTO	4. ACERO DE REFUERZO	5. NIDOS DE PIEDRA	6. EFLORESCENCIA	
	EVALUACIÓN	1	1	1	1	1	1	
10. VIGA DIAFRAGMA	ITEM	1. GRIETAS EN UNA DIRECCIÓN	2. GRIETAS EN DOS	3. DESCASCARAMIENTO	4. ACERO DE REFUERZO	5. NIDOS DE PIEDRA	6. EFLORESCENCIA	
	EVALUACIÓN	1	1	1	1	1	1	
11. APOYOS	ITEM	1. ROTURA DE APOYOS	2. DEFORMACION EXTRANA	3 INCLINACION	4 DESPLAZAMIENTO			
	EVALUACIÓN	1	1	3				
12. PARED CABEZAL Y ALETONES (BASTIÓN)	ITEM	1. GRIETAS EN UNA DIRECCIÓN	2. GRIETAS EN DOS	3. DESCASCARAMIENTO	4. ACERO DE REFUERZO	5. NIDOS DE PIEDRA	6. EFLORESCENCIA	7. PROTECCION DE TERRAPLÉN
	EVALUACIÓN	1	1	1	1	1	1	
13. CUERPO PRINCIPAL (BASTIÓN)	ITEM	1. GRIETAS EN UNA DIRECCIÓN	2. GRIETAS EN DOS	3. DESCASCARAMIENTO	4. ACERO DE REFUERZO	5. NIDOS DE PIEDRA	6. EFLORESCENCIA	7. PENDIENTE EN TALUDES
	EVALUACIÓN	1	1	1	1	1	1	1
	ITEM	8. INCLINACIÓN	9. SOCAVACIÓN					
	EVALUACIÓN	1	1					
14. MARTILLO (PILA)	ITEM	1. GRIETAS EN UNA DIRECCIÓN	2. GRIETAS EN DOS	3. DESCASCARAMIENTO	4. ACERO DE REFUERZO	5. NIDOS DE PIEDRA	6. EFLORESCENCIA	
	EVALUACIÓN	1	1	1	1	1	1	
15. CUERPO PRINCIPAL (PILA)	ITEM	1. GRIETAS EN UNA DIRECCIÓN	2. GRIETAS EN DOS	3. DESCASCARAMIENTO	4. ACERO DE REFUERZO	5. NIDOS DE PIEDRA	6. EFLORESCENCIA	7. INCLINACION
	EVALUACIÓN	3	1	1	1	1	1	1
	ITEM	8. SOCAVACIÓN						
	EVALUACIÓN	1						

COMENTARIOS

test

EVALUACIÓN	GRADO DEL DAÑO	SOCAVACION
1	Ningún daño visible	Sin Socavación
2	En pocos lugares	Tendencia a socavarse
3	En muchos Lugares	Socavación no peligroso
4	En menos de la mitad	Socavación peligroso
5	En la mayoría de las partes	Condición de Emergencia

FECHA INSPECCION			NOMBRE DE INSPECTOR	FIRMA
1	10	2005	Gabriela Jorge	

Form – 7 Photos of the Elements of the Bridge

INSPECTION DE PUENTES (FOTOGRAFIA)

									o. DE ESTUCTUR		NO.	1	/	3
NOMBRE DEL PUENTE	Colorado River	001		LOCALIDAD	PROVINCIA	*	ADMINISTRADO POR	Colorado	*			DIA	MES	AÑO
No. DE LA RUTA	1	CLASIFICACION	Primary *		CANTON	*	LATITUD NORTE	12 '	34 "	56.7 '''	FECHA DE DISEÑO	31	3	1968
KILOMETRO	35.756	km			DISTRITO	*	LONGITUD ESTE	12 '	34 "	56.7 '''	FECHA DE CONCLUCION DE CONSTRUCCION	31	3	1970

No.	1	UBICACION	DECK SLAB

NOTA		DIA	MES	AÑO
		31	3	1970

No.	2	UBICACION	BEARING

NOTA		DIA	MES	AÑO
		20	3	1970

No.	3	UBICACION	PIER

NOTA		DIA	MES	AÑO
		10	2	1970

No.	4	UBICACION	PIER

NOTA		DIA	MES	AÑO
		18	3	1970

No.	5	UBICACION	MEMBER OF RAMEN

NOTA		DIA	MES	AÑO
		31	3	1970

No.	6	UBICACION	MEMBER OF RAMEN

NOTA		DIA	MES	AÑO
		31	3	1970

CHAPTER 15 TOOLS FOR BRIDGE MAINTENANCE MANAGEMENT

15.1 Introduction

A guideline and two manuals are prepared in this study as tool to support the Bridge Maintenance activities. They are the Guideline for Bridge Maintenance, the Bridge Inspection Manual and the Manual for Bridge Management System and the outlines of each tool are as follows:

1) Bridge Inspection Manuals

The manual is prepared mainly for the bridge inspectors and bridge engineers. The manual instructs about how to implement the inventory survey, the procedures of the routine inspection and the methods to evaluate the bridge deteriorations.

2) Manual for Bridge Management System

The manual is prepared mainly for the system administrator and bridge engineers. The manual instruct the methods of operation and maintain Bridge Management System.

3) Guideline for Bridge Maintenance

The guide line is prepared mainly for the bridge engineers who engage the bridge maintenance activities. The guideline instructs the concept of the bridge maintenance, cause of the deterioration of a bridge, the method of the detailed inspection, the method of the loading test and the bridge repair method..

15.2 Bridge Inspection Manual

The main objectives of this manual are to describe the procedure and method for recording the bridge inventory and the appraisal of bridge deterioration. The manual also presents the responsibility and duties of the bridge inspector and shows how the inspector can prepare for the inspection and some of the major inspection procedures. The manual is a part of the total bridge management system of Costa Rica. The information presented through the bridge inspection is fundamental data for the total bridge management system. Therefore the bridge inspectors need to comprehend certainly the contents of the manual. The contents of the Bridge Inspection Manual are as follows and items described in the manual are covered by the orange colored area in the Figure 15.2.1.

1. Introduction of the technical term of the bridge.
2. Responsibilities of the Inspector
3. Method of the Inventory survey, and Bridge Inspection
4. Bridge Report System
5. Coding Guide for Bridge Inventory Data

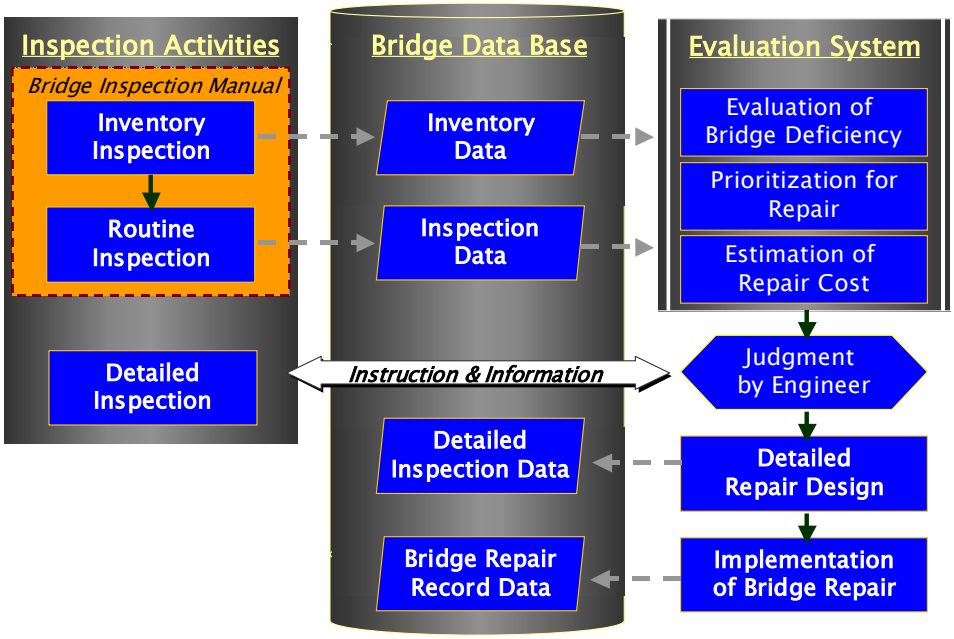


Figure 15.2.1. Items supported by the Inspection Manual

15.3 Operation Manual for Bridge Management System

The Bridge Management System is developed through the project as explained in Section 14.3 and the manual for the BMS are prepared for the system administrator and bridge engineers. The manual presents a concept of the system, process of a data registration, and the method of operation for the system.. The contents of the Operation manual for the BMS are as follows and items described in the manual are covered by the green colored area in the Figure 15.3.1.

1. Concept of the System
2. Function of the System
3. System Component
4. Tools for the System Development
5. Instruction for the system operation

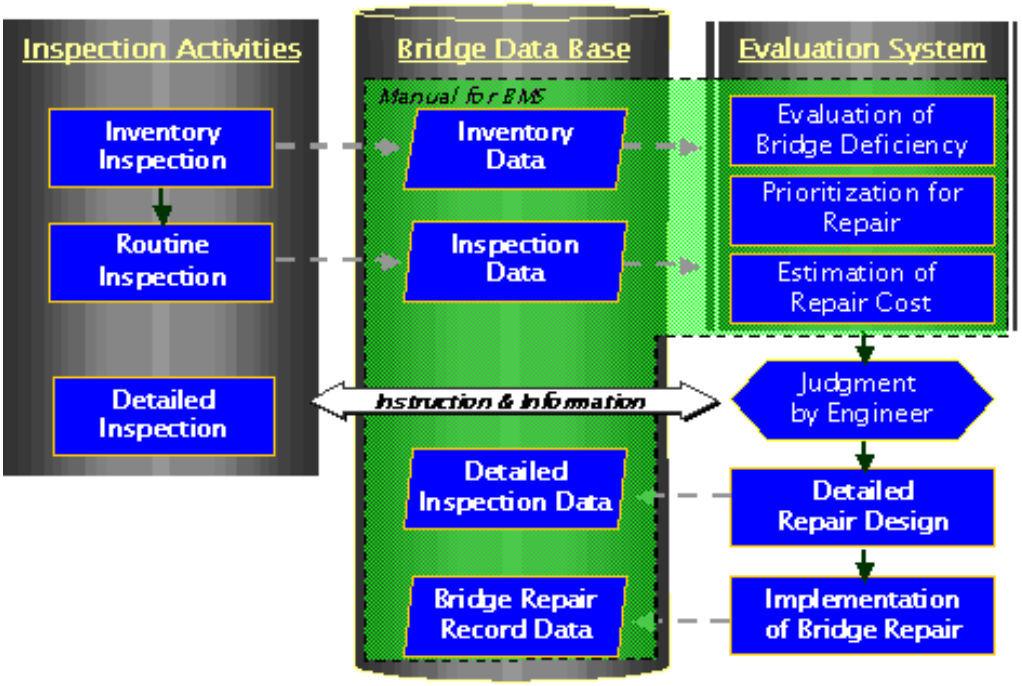


Figure 15.3.1. Items supported by the Operation Manual for BMS

15.4 Guideline for Bridge Maintenance

The Guideline for the Bridge Maintenance is prepared as a hand book for the engineers who may concern with bridge design and maintenance and as a reference book for the university student in the faculty of civil engineering. The guideline is written based on the results of the detail inspection of 29 bridges through the project. The contents of the Guideline for the Bridge Maintenance are as follows and the items described in the Guideline are covered by the pink colored area in the Figure 15.4.1.

1. The principles for the Bridge Maintenance including the performance level of a bridge and the maintenance procedure.
2. The evaluation method for the bridge deficiencies, the method for the prioritization of the bridge repair and the cost estimation of the bridge repair for the Bridge Management System.
3. The method of the detail bridge inspection
4. The standard repair and reinforcement method for bridges.
5. The method of the Loading Test

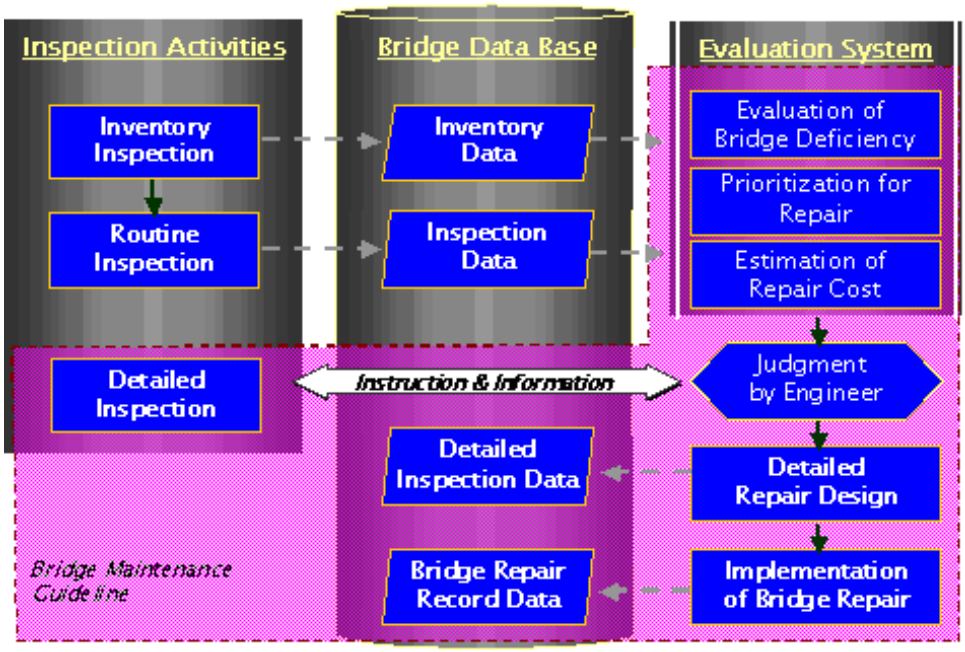


Figure 15.4.1. Items described the Guideline for the Bridge Maintenance

CHAPTER 16 TECHNICAL SUPPORT FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

16.1 Technical Support for the Implementation of Initial Environmental Examination

16.1.1 Introduction

1) Preface

The main objective of this entire master plan study is to strengthen the capacity development of the human resources for the bridge rehabilitation/maintenance program in Costa Rica. Within this study, 29 existing bridges were selected for this capacity development study initially by Costa Rica 's MOPT. After several field observations and preliminary engineering evaluation, ten bridges are chosen as pilot studies of this project.

As part of this capacity development study, this environmental study mainly focuses on both the preparation of appropriate environmental studies and its implementation of relevant environmental studies in order to satisfy both Costa Rican environmental laws/or regulations and JICA guidelines for environmental and social considerations (hereinafter referred to as JICA guidelines). It is noted that official license applications of selected 10 bridges, based on relevant Costa Rican environmental laws, are not to be initiated within this study, but following fundamental directions to the Costa Rican counterparts as part of the whole capacity development study are to be provided through the OJT- based program,

Direction 1. Identification of potential environmental impacts to be caused by the bridge rehabilitation program.
Direction 2. Preparation of appropriate environmental study based on Costa Rican environmental laws/regulations and JICA guidelines.
Direction 3. Preparation of stakeholders meeting and proper information disclosures process.
Direction 4. Preparation of successful environmental license application process.

As mentioned earlier, official environmental license application process based on Costa Rican EIA laws is scheduled to be initiated by the government of Costa Rica after the precise bridge rehabilitation plan based on this entire study is finalized, and this license application is to be carried out for each bridge, separately.

Another key objectives of this environmental study are also to identify potential environmental concerns at a sufficiently early stage in the project development. So, appropriate mitigation measures can be incorporated into the scheme selection, planning and design to ensure that it is environmentally sound, abiding by both Costa Rican environmental laws/or regulation and JICA guidelines. It allows the designers to address environmental issues in a cost effective fashion after all possible scheme and design alternatives are considered.

2) Outline

This report summarizes the results of the Initial Environmental Evaluation (IEE) which assesses the pros and cons of the bridge rehabilitation and maintenance program of selected 10 bridges of the national highway network in Costa Rica. Sections 16.1.2 and 16.1.3 describe the current environmental baseline, brief summary of current environmental condition and initial environmental evaluation results of selected 10 bridges based on the field inspection, respectively. Section 16.1.4 summarizes the environmental policy, legal and administrative framework. Outline of the environmental license application process based on current Costa Rica's environmental law is summarized in this section.

3) Engineering Option

(1) Bridge Selection

Based on AHP (Analytic Hierarchy Process) - bridge selection process, carried out in the engineering section of this report, ten bridges, listed in Table 16.1.1, are chosen for more detailed rehabilitation planning, maintenance and management study.

Table 16.1.1. Selected 10 Bridges

	Bridge Code	Bridge Name	Location	Preliminary Site Inspection
1	2	Aranjuez River	R 1	Jan/18/06, Jan/20/06
2	3	Abangares River	R 1	Jan/19/06, Jan/20/06
3	7	Azufrazo River	R 1	Jan/20/06
4	12	Puerto Nuevo River	R 2	Jan/24/06
5	16	Nuevo River	R 2	Jan/25/06
6	17	Chirripo River	R 4	Jan/27/06
7	19	Sarapiqui River	R 4	Jan/27/06
8	20	Sucio River	R 32	Jan/27/06, Jan/31/06
9	26	Chirripo River	R 32	Jan/31/06
10	29	Torres River	R 218	Feb/03/06

Note: "R 1" means "Route No. 1". Right of Way (ROW) of national roads in Costa Rica listed above (except R 218) is of 50 m while that for R 218 is of 24 m.

(2) Outline of Rehabilitation Planning, Maintenance and Management

Followings are the outline of on-going bridge rehabilitation and maintenance program, summarized through a series of intra-group discussions with the engineering staff of this study (note: see the engineering section of this main report for more detailed descriptions).

No large-scale earthwork/or construction activities (e.g., construction of new approach road and/or bridge pier and others) will be carried out within this bridge rehabilitation and maintenance study. The current national roads at each point have wide ROW (the ROW of the national roads except R 218 is of 50m), and each site has enough space for the bridge rehabilitation and maintenance works. So, it would be likely that construction yards to be required for each site's rehabilitation works can be established without expropriating any private lands temporally and/or permanently (note: see the engineering section of this report for more detailed descriptions). Thus, it can be said that no expropriation will be carried out/or required for this project. It shall be noted that specific size (i.e., in time and space) of

the construction yard to be required for each bridge rehabilitation work is to be figured out after the precise bridge rehabilitation plan based on this entire study is finalized.

Temporal traffic controls around those sites, that would cause traffic congestion to some extents, will be required during the rehabilitation period.

If it is found that the current bridge structures such as the bridge pier is not structurally robust enough to sustain future disasters such as severe earthquake and/or floods, certain scale of bridge rehabilitation/improvement work as well as relevant earthwork must be carried out. In case that a large-scale bridge improvement work must be done, it is likely that the risk of accidental spillage of chemical solvents that may be used for the bridge rehabilitation work would be increased while certain amounts of industrial/or construction wastes will be generated. So, appropriate environmental management program (e.g., the preparation of proper waste treatment facilities for possible industrial/or construction wastes and excavated soils, or the contingency plan for the accidental spill) shall be established in order to avoid/or lessen the negative impact on surrounding environment.

16.1.2 Brief Summary of Baseline Environment

1) Geography and Geology and Natural Disaster

Costa Rica has an unique biological diversity, which in part is due to its geological and geographical variety. From the geographical point of view, Costa Rica is a natural bridge connecting both North and South American continents. The frequent earthquakes are caused by activities of two main tectonic plates around Costa Rica (i.e., Cocos and Atlantic Plates, respectively). Small-scale tremors and earthquakes are common, and the earthquake occurred on April 22, 1991, was the last serious seismic catastrophe (7.4 in Richter scale). This earthquake caused severe damages on Atlantic zone of this country: 27 people dead, 400 injured and about 13,000 homeless in Limon Province.

Another geological features is the volcano, and Costa Rica has seven active volcanoes and sixties dormant/or extinct volcanoes. The last big eruption occurred in 1963 at the Irazu volcano.

Costa Rica is located at the tropical latitudes, and has two seasons: the dry season (December - April) and the rainy season (May - November). Annual precipitation around the Atlantic Region is varied between 4,000 mm/year and 7,000 mm/year while exceeds 2,500 mm/year around the southern region (more detailed descriptions of the precipitation in Costa Rica is summarized in the natural condition study section of this main report). The common areas on where floods and landslides occur are located in Atlantic, whereas the Northern Pacific region suffers from droughts.

Hurricanes is also one of disasters that cause significant damage across Central American Region. However, last few hurricanes did not cause much damage in Costa Rica but neighboring countries such as Nicaragua, El Salvador and Honduras had suffered severe ones.

2) Major Habitats and Common Vegetation

(1) Lowland Wet Forest

Costa Rica's lowland wet forest are classic tropical rainforests with emergent trees and deciduous or evergreen canopy trees reaching 40 - 55 m in height. Canopy trees have broad crowns while sub-canopy trees have broad or round crowns. Tree buttresses are very common and often extend high up on trunks. Palms are abundant, often with stilt roots. The ground in these forests is either mostly bare or sparsely covered with a herb layer. Vines and epiphytes are usually abundant. Biologically, these kinds of forests are probably the richest habitats on earth, supporting the most species of both plants and animals per unit area. Lowland wet forest is found in both the northern and southern Caribbean lowlands and in the southern Pacific lowlands [Beletsky, 2005].

(2) Lowland Dry Forest

Lowland dry forests consists of relatively low, mostly deciduous trees, and usually classified into following two layers: (1) trees reaching 20 - 30 m in height with large, broad crowns, and (2) trees reaching 10 - 20 m in height, more evergreen, with small crowns. Tree buttressing is relatively uncommon in dry forests. Vines are often present. Epiphytes are uncommon, but when present, bromeliads are the most conspicuous. These forests are not as species-rich as wet forests. Dry forest land also can be converted into the excellent agricultural land, and because of this, many of these forests throughout Central America have been cleared. Because dry forests have a more open, less dense structure than wet forests, wildlife observation therein is often much superior. Lowland dry forest occurs mainly in the northern Pacific lowland region [Beletsky, 2005].

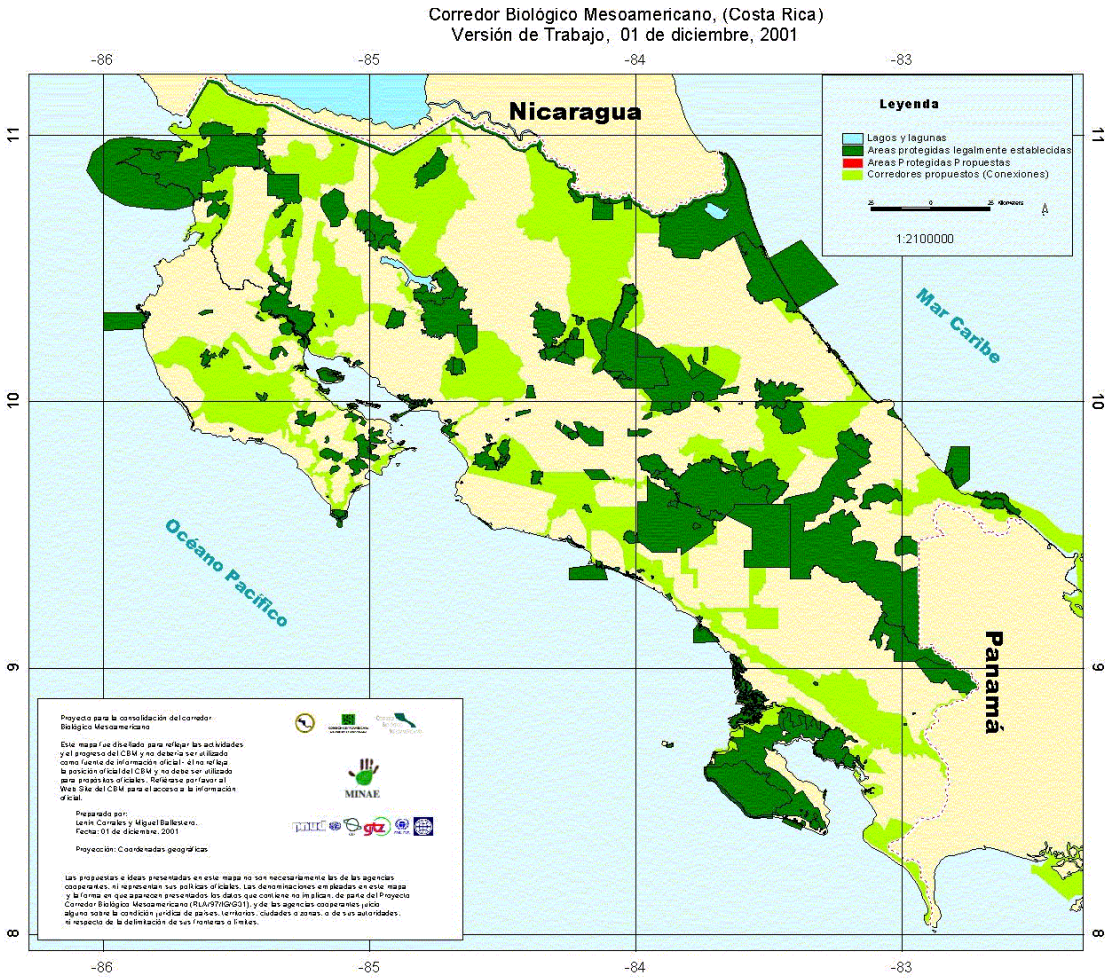
(3) Highland and Cloud Forest

A number of middle and high altitude rainforest occur on the slopes and the upper portion of Costa Rica's mountain ranges. These rainforests are mixed deciduous and evergreen in their lower reaches and uniformly evergreen in higher areas. Canopy height generally declines as the elevation increases, being varied between 30 and 40 m at lower levels while 20 and 30 m at higher elevations. In general, these forests have two layers: (1) canopy and sub-canopy, and (2) abundant vines. Tree buttressing is common in forest on mountains' lower slopes, but uncommon in higher elevation area. Epiphytes - orchids, bromeliads, mosses, and ferns - are profuse in most of these forests. Cloud forest occurs over the upper portions of mountains in area where cloud and fog persistently enshroud the landscape. Cloud forests are evergreen forests, with vines and epiphytes being very common. Highland forests occur throughout the slopes of Costa Rica's mountain range [Beletsky, 2005].

3) National System of Conservation Area

The National System of Conservation Areas (SINAC by its Spanish acronym) was established in order to coordinate the creation and implementation of environmental policies related with the sustainable use and management of natural protected areas in Costa Rica. This system (or agency) has developed a project to link geographically close groups of national parks and reserves, and national forests into several conservation areas. Currently,

SINAC has following 11 conservation areas across the country; i.e., (1) Guanacaste, (2) Arenal - Tilaran, (3) Arenal - Huetar Norte, (4) Tempisque, (5) Tortuguero, (6) Amistad Caribe, (7) Amistad Pacifico, (8) Osa, (9) Pacifico Central, (10) Cordillera Volcanica Central, and (11) Isla del Coco, and is headed by a Directorate, Technical Council and a local committee. Figure 16.1.1 shows the nationwide environmental protected area in Costa Rica



Note that blue zone: lake and lagoon, dark green zone: legally protected area, and light green zone: biological corridor that connects adjacent protected areas (dark green area).
Source: http:www.biomeso.net

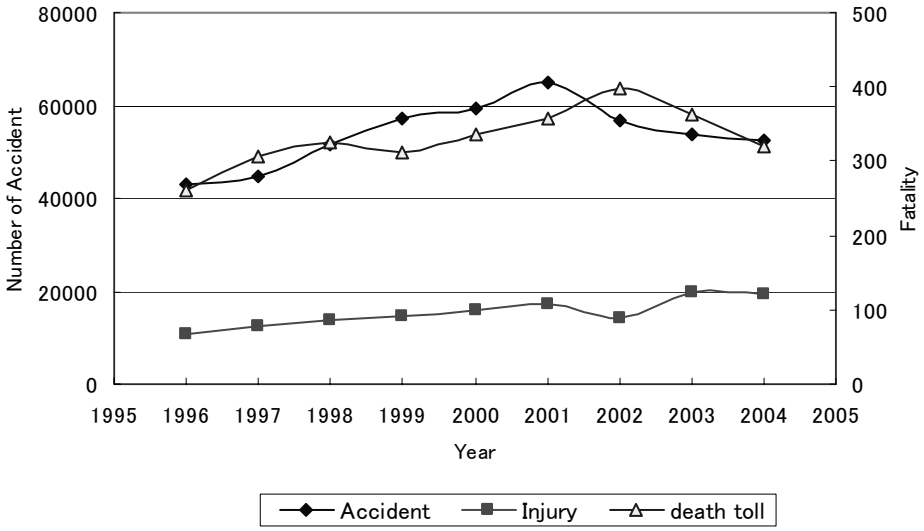
Figure 16.1.1. Nationwide Environmental Protected Areas in Costa Rica

4) National Parks System

The national park system in Costa Rica began in the 1960s, and there are about 26 national parks, comprising about 11 % of the country. In addition, there are many wild refuges, biological and forest reserves, monuments, and other protected areas in Costa Rica. As a result, more than 25 % of the country has been set aside for the conservation. In addition, there are various buffer zones such as indigenous reservations, described later, and those hike the total area of "protected" land to about 27 %. Small-scale farming, logging and other development are allowed within these buffer zones, so the environment therein is not completely protected.

5) Accidents

Figure 16.1.2 shows the nation-wide traffic accident statistics for last 9 years (1996 - 2004). As shown in this figure, it can be seen that the total number of traffic accident, injury and fatal accidents tend to decrease after Year 2002. This is mainly due to the nation-wide traffic safety campaign, mainly organized by Consejo Nacional De Seguridad Vial [MOPT, personal communication, 2006]. Throughout this campaign, the vehicle registration and I/M system was strengthened while the importance of the seat belt was widely recognized.



Source: ANUARIO ESTADISTICO DEL SECTOR TRANSPORTE-DIRECCION DE PLANIFICACION MOPT (MOPT, personal communication, 2006)

Figure 16.1.2. Nationwide Traffic Accidents (1996 - 2004)

6) CO_2 Loading

Figure 16.1.3 shows the time variation of estimated CO_2 emission loading generated in Costa Rica [Marland and Boden, 2005].

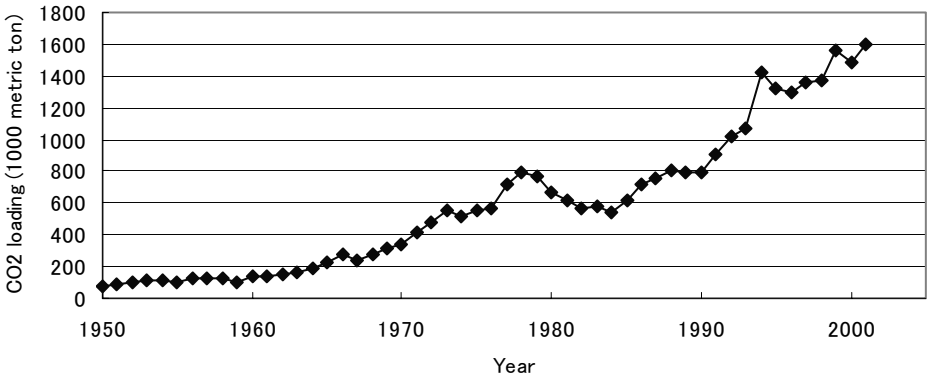


Figure 16.1.3. Time Variation of CO_2 Emission Loading from Costa Rica

7) People

Costa Rica is one of the homogeneous Central American nations in race as well as social class. The 1989 census classified 98 % of the population as "white" or "mestizo", and less than 2 % as "black" or "Indian". There are 22 Indian reserves in Costa Rica (see Table 16.1.2), and estimates of the indigenous population is varied between 5,000 and 30,000 (note that this population number depends on whether non pure-blooded Indians are included or not).

Table 16.1.2. Registered Indian Reserves in Costa Rica

	Name of Indian Reserve		Name of Indian Reserves
1	Guatuso (Malekus)	12	Curre
2	Matambu	13	Boruca
3	Quitirrisi	14	Terraba
4	Zapaton	15	Ujarras
5	Nairi-Awari (Baribilla)	16	Salitre
6	Chirripo	17	Cabagra
7	Bajo Chirripo	18	Tayni
8	Guaymi/Osa Oeninsula	19	Telire
9	Guaymi/Conte Burica	20	Cabecar - Talamanca
10	Guami/ Coto Brus	21	Bribri Talamanca
11	Guaymi/Abrojos Montezuma	22	Kekoldi (Cocles)

(Source: http://www.kytkascostarica.com/tribes.htm, 2006)

8) Child Labor and Trafficking

Survey results [Marschatz, 2004] shows that estimated total of 113,523 boys and girls aged 5 - 17 years old (10.2 % of total children population) are working in 2002. Boy's working rate is higher than that of girls (14.3 % and 5.8 %, respectively). Children's working rate increases significantly with the age, and the working rate in the rural area is almost three times higher than that of the urban area (15.5 % and 5.9 %, respectively). Among of the entire working children, 27.3 % are girls while 72.7 % are boys. It was also found that 49,229 working children (i.e., 43.4 % of the entire working children) are under the age 15, the minimum legal age required for the job market under certain conditions. The main industries where these working children are contained are as follows,

a. Agriculture, forestry, hunting and fishing (44.2 %)
b. Trade, hotels and restaurants (26.6 %)
c. Manufacturing industry (9.0 %)
d. Community, social and other services (9.6 %)

Child labor is closely related to the school non-attendance rate, and only 54.7 % of working children manage to attend and educational centers.

Also, several cases of the international child trafficking are reported [US Dept. of State, 2001], and most of their origins are Africa, Bolivia, China, Colombia, Cuba, Dominica and the Middle East.

9) Women's Status

In Costa Rica, the gender consideration have been absent from the development policies, plans and programs, in spite of the effort of various governmental and non-governmental organizations engaged in the search for the equality of opportunities. These started being institutionalized since 1975 with the creation of the first Women's Office which acquired the rank of National Women and Family Office in 1979 and of National Center for the Development of Women and the Family in 1986.

The poverty rate has been reduced considerably in the last decades from 55 % at the beginning of the 1980s, and has been varied between 18 % and 22 % recently. Nevertheless, the recent massive recuperation of the income and wage levels has not benefited the more vulnerable sections of the population. Among the poverty causes are the problems related to employment and remuneration. In 1993, 33 % of those employed earned salaries lower than the established minimum wage. This is specifically serious among the employed women in rural areas, and 60 % of which receive a salary lower than the minimum and only 34 % are paid a little more [FAO, 1997].

10) Infectious Diseases

It was reported that infectious diseases were responsible for about 2.7 % of all deaths registered between 1992 and 1995, with an annual mortality rate of about 1 per 10,000 population [Pan American Health Organization, 2001]. Among of them, insect-borne diseases such as dengue, described later, is still one of popular epidemic disease in Costa Rica. Here, recent trends of several insect-borne diseases and HIV are described, briefly.

(1) Chagas' Disease

Chagas' Disease is a parasitic infection that is transmitted by triatomine insects (reduviid bugs), which inhabit crevices in the walls and roofs of substandard housing in South and Central America. In Costa Rica, most cases occur in Alajuela, Liberia and Puntarenas.

(2) Dengue Fever

Dengue fever is a viral infection found throughout Central America. In Costa Rica, large-scale outbreak involving thousands of people occur every year. Dengue is transmitted by Aedes mosquitoes, which bite preferentially during the daytime and are usually found close to human habitations, often indoors. They breed primarily in artificial water containers such as jars, barrels, cans, cisterns, metal drums, plastic containers and discarded tires. As a result, dengue is especially common in densely populated, urban environment. Table 16.1.3 summarizes the total number of reported dengue cases during last 9 years (1993 - 2001).

Table 16.1.3. Annual Number of Dengue Cases reported to the Ministry of Health

1993	1994	1995	1996	1997	1998	1999	2000	2001
4,612	13,929	5,137	2,309	14,421	2,628	6,041	4,908	9,209

(Source, Ministry of Health, http://www.netsalud.sa.cr/ms/estadist.enferme/deng10.htm, 2006)

(3) Malaria

Malaria occurs in every country in Central America. It is transmitted by mosquito bites, usually between dusk and dawn. The risk is the greatest in the cantons of Los Chiles (Alajuela Province) and Matina and Talamanca (Limon Province). 3,998 Malaria cases are reported in 1999. Among of them, 1,170 cases were from Alajuela Province, and the Limon Province contributed 1,824 cases.

(4) Leishmaniasis

Leishmaniasis occurs in the mountainous and jungles of all Central American counties. The infection is transmitted by phlebotomine sandflies, which are about one third the size of mosquitoes. Most cases occur in newly cleared forest or areas of secondary growth. The highest incidence is in Talamanca (Limon Province).

(5) HIV/AIDS

This has been reported from all Central American countries. In Costa Rica, it was 1983 when the nation's first HIV/AIDS case was detected. Although this epidemic remains at low level spreading, there was a slight increase from 1998 to 2000. The Ministry of Health has officially recorded 1,992 AIDS cases since 1983. Among of them, 88 % of AIDS patients are male, but the prevalence among women is increasing (the male-to-female ratio is 5.2 : 1.0 in 1999).

16.1.3 Environmental Scoping and Screening.

1) Introduction

Preliminary environmental site inspection was carried out during both January and February of 2006, summarized in the Table 16.1.1. Based on major findings obtained from this preliminary environmental field inspection and current reports, the initial environmental examination of each bridge site is carried out separately, and potential environmental issues associated with the rehabilitation works to be carried out at each site are summarized. Basically, the examination is carried out for following two scenarios: i.e., (i) Do - Nothing scenario, and (ii) Do - scenario. Under Do - scenario, possible negative environmental impacts to be caused during and/after bridge rehabilitation work are identified, and those orders of the magnitude are evaluated qualitatively.

2) Initial Environmental Examination

(1) Site 2: Aranjuez River Bridge

The Aranjuez River Bridge is located at the open space of Puntarenas Province, the northwestern Pacific lowland region of Costa Rica. River channel around the bridge site is meandering, and due to a relatively steep riverbed slope, several traces of rapid flows, to be occurred during the rainy season, are recognized at the river. Debris transport process around

this site seems to be significant since many large-sized boulders are found at the riverbed. The riverine vegetation around this site is highly affected by that flood, somewhat by human activities, and several natural vegetation are remained around this site. No illegal squatter areas exist around this site, but several restaurants, tourist office, and houses exist at both sides of the bridge. Some portions of these private lands may exist within the current ROW of Route No. 1 (note: ROW is of 50 m). No school, church and/or hospital, that would require calm environment exist. No historical and/or cultural sites exist. Table 16.1.4 summarizes the preliminary environmental evaluation of the Aranjuez River Bridge Project.

Table 16.1.4. Initial Environmental Examination (Site 2: Aranjuez River Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	B
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	D
	Destruction of roadside vegetation.	D	D
	Disturbance to bird habitats or floodplain habitats.	D	D
	Disturbance to aquatic ecosystem/or habitats.	D	D
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	D	C
	Potential of increased vessel accidents.	D	D
13. Global warming	Increased CO_2 emission.	D	D
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	D
15. Local Economy	Possible impact on local employment and livelihood	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	C
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

(2) Site 3: Abangares River Bridge

The Abangares River Bridge is located at Puntarenas Province, the northwestern pacific lowland region of Costa Rica. River channel around the bridge site is meandering, and, due to a relatively steep riverbed slope, several traces of rapid flows, to be occurred during the rainy season, are recognized at the river. Debris transport process around this site seems to be significant since many large-sized boulders are found at the riverbed. The riverine vegetation around this site is highly affected by this flood, somewhat by human activities, and several natural vegetation are remained around this site. No illegal squatter areas exist around this site. One small-scale factory exists at the southern side (i.e., To San Jose) of the bridge while some roadside area of this northern side (i.e., To Nicaragua) seems to be privately owned (e.g., long fence is set up). Some portions of those private lands may exist within the current ROW of Route No. 1. Some parts of the current southern approach road (i.e., Route No. 1) is running through the cutting, so the local dispersion of the vehicular emission gas does not seem to be quick due to the poor local air circulation. No school, church and/or hospital, that would require calm environment exist. No historical and/or cultural sites exist. There is one big hole on the road surface around the southern side of this bridge, and traffic warning signs are installed for the driver. Table 16.1.5 summarizes the preliminary environmental evaluation of the Abangares River Bridge Project.

Table 16.1.5. Initial Environmental Examination (Site 3: Abangares River Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	C
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	D
	Destruction of roadside vegetation.	D	D
	Disturbance to bird habitats or floodplain habitats.	D	D
	Disturbance to aquatic ecosystem/or habitats.	D	D
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	B	C
	Potential of increased vessel accidents.	D	D
13. Global warming	Increased CO_2 emission.	D	D
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	D
15. Local Economy	Possible impact on local employment and livelihood	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Table 16.1.5. Initial Environmental Examination (Site 3: Abangares River Bridge: continued)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	C
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

(3) Site 7: Azufrazo River Bridge

The Azufrazo River Bridge is located at the open space of Guanacaste Province, the northwestern Pacific lowland region of Costa Rica. River channel around the bridge site is meandering, and several traces of rapid flows, to be occurred during the rainy season (e.g., the trace of a strong erosion mechanism), are recognized at the river. The sedimentation process around this site seems to be less significant although the flow seems to be stagnant when the site investigation was made (this observation was made on Jan/18/06). The riverine vegetation around this site is highly affected by this flood, somewhat by human activities, and several natural vegetation are remained around this site. Most of the river space is covered by the canopy of the riverine vegetation. This site may be located in the adjacent area of the Biological Corridor (i.e., light green zone of Figure 16.1.1). One gully (1.5 m x 1.5 m x 2.0 m) is developed at the northern side of this bridge. No illegal squatter areas exist around this site. Most of the roadside land use at both sides is for the livestock purpose (i.e., pasture) and no house/or factory exist at both sides of the bridge. Some portions of these pastures may exist within the current ROW of Route No. 1 (note: ROW is of 50 m). No school, church and/or hospital, that would require calm environment exist. No historical and/or cultural sites exist. Several parts of bridge fence were broken, presumably due to the traffic accident. Table 16.1.6 summarizes the preliminary environmental evaluation of the Azufrazo River Bridge Project.

Table 16.1.6. Initial Environmental Examination (Site 7: Azufrazo River Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	C
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Table 16.1.6. Initial Environmental Examination (Site 7: Azufrazo River Bridge: continued)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	C
	Destruction of roadside vegetation.	D	C
	Disturbance to bird habitats or floodplain habitats.	D	C
	Disturbance to aquatic ecosystem/or habitats.	D	C
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	B	C
	Potential of increased vessel accidents.	D	D
13. Global warming	Increased CO_2 emission.	D	D
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	D
15. Local Economy	Possible impact on local employment and livelihood	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	C
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

(4) Site 12: Puerto Nuevo River Bridge

The Puerto Nuevo River Bridge is located at the foot of a steep cliff of the Terraba River gorge, Puntarenas Province, the southern region of Costa Rica. Confluence point with the Terraba River exists about 100 meter downstream side from this bridge. Massive blooms of algae are found within the flow of Puerto Nuevo River. River channel around the bridge site is meandering, and, due to a relatively steep riverbed slope, several traces of rapid flows, to be occurred during the rainy season, are recognized at the river. Debris transport process around this site seems to be significant since many large-sized boulders are found at the riverbed. The riverine vegetation around this site is highly affected by this flood, somewhat by human activities, and several natural vegetation are remained around this site. This site may be located in the adjacent area of the Biological Corridor (i.e., light green zone of Figure 16.1.1). One house exists at the northeastern side (i.e., To San Jose) of this bridge and some portions of this private land may exist within the current ROW of Route No. 2 (note: ROW is of 50 m). No illegal squatter areas exist around this site. No school, church and/or hospital, that would require calm environment exist. No historical and/or cultural sites exist. Table 16.1.7 summarizes the preliminary environmental evaluation of the Puerto Nuevo River Bridge Project.

Table 16.1.7. Initial Environmental Examination (Site 12: Puerto Nuevo River Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	B
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	C
	Destruction of roadside vegetation.	D	C
	Disturbance to bird habitats or floodplain habitats.	D	C
	Disturbance to aquatic ecosystem/or habitats.	D	C
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	C	C
	Potential of increased vessel accidents.	D	D
13. Global warming	Increased CO_2 emission.	D	D
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	D
15. Local Economy	Possible impact on local employment and livelihood	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	C
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

(5) Site 16: Nuevo River Bridge

The Nuevo River Bridge is located at the open space, Puntarenas Province, the southern Pacific lowland region of Costa Rica. River channel around the bridge site is meandering, and several traces of rapid flows, to be occurred during the rainy season, are recognized at the river (e.g., the occurrence of the scouring at the bridge pier). Most of the sedimentation deposit mainly consist of fine sand or silt. The riverine vegetation around this site is classified as floodplain flora and several natural vegetation are remained around this site. This site may be located in the adjacent area of the Biological Corridor (i.e., light green zone of Figure 16.1.1). One gas factory and several residential houses exist at the northwestern side (i.e., To

San Jose) of this bridge. Several fruit trees are planted between those housing/or facilities and the road bank, and some portions of these private lands may exist within the current ROW of Route No. 2 (note: ROW is of 50 m) while a large-scale banana plantation field exist at the southeastern side. No illegal squatter areas exist around this site. No school, church and/or hospital, that would require calm environment exist. No historical and/or cultural sites exist. Table 16.1.8 summarizes the preliminary environmental evaluation of the Nuevo River Bridge Project.

Table 16.1.8. Initial Environmental Examination (Site 16: Nuevo River Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	B
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	C
	Destruction of roadside vegetation.	D	C
	Disturbance to bird habitats or floodplain habitats.	D	C
	Disturbance to aquatic ecosystem/or habitats.	D	C
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	C	C
	Potential of increased vessel accidents.	D	D
13. Global warming	Increased CO_2 emission.	D	D
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	D
15. Local Economy	Possible impact on local employment and livelihood	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	C
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

(6) Site 17: Chirripo River Bridge

The Chirrippo River Bridge is located at the open space, Heredia Province, at the foot of the central valley region of Costa Rica. Due to a relatively steep riverbed slope, several traces of rapid flows, to be occurred during the rainy season, are recognized at the river. Debris transport process around this site seems to be significant since many large-sized boulders are found at the riverbed. The remnant of one old bridge pier is still remained at the downstream side of this bridge. The riverine vegetation around this site is highly affected by this flood (e.g., floodplain vegetation around the southern riverside), somewhat by human activities (e.g. area around the northern riverside), and several natural vegetation are remained around this site. This site may be located in the adjacent area of the Biological Corridor (i.e., light green zone of Figure 16.1.1). One quarry factory, the police checkpoint and its relevant facilities exist at the north side of this bridge. Some portions of these facilities may exist within the current ROW of Route No. 4 (note: ROW is of 50 m). A large-scale banana plantation field that seems not to exist within ROW of current Route No.4 exists at the south side of this bridge. No illegal squatter areas exist around this site. No school, church and/or hospital, that would require calm environment exist. No historical and/or cultural sites exist. Table 16.1.9 summarizes the preliminary environmental evaluation of the Chirripo River Bridge Project.

Table 16.1.9. Initial Environmental Examination (Site 17: Chirripo River Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	C
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	C
	Destruction of roadside vegetation.	D	C
	Disturbance to bird habitats or floodplain habitats.	D	C
	Disturbance to aquatic ecosystem/or habitats.	D	C
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	C	C
	Potential of increased vessel accidents.	D	D
13. Global warming	Increased CO_2 emission.	D	D
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	D
15. Local Economy	Possible impact on local employment and livelihood	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Table 16.1.9. Initial Environmental Examination (Site 17: Chirripo River Bridge: continued)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	B
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

(7) Site 19: Sarapiqui River Bridge

The Sarapiqui River Bridge is located at the open space, Heredia Province, at the foot of the central valley region of Costa Rica. The area around this bridge site is conserved as "Sarapiqui River Historical and Cultural Monument of Costa Rica" (the sign board was recognized within the field survey of January, 2006). The river around this site is meandering and the sedimentation process of sand and/or silt seems to be significant. The riverine vegetation around this site is classified as floodplain flora and several natural vegetation are remained around this site. Several natural fruit trees occur and small animals eating those fruits are observed within this field survey. This site may be located in the adjacent area of the Biological Corridor (i.e., light green zone of Figure 16.1.1). One gas station and one supermarket exist at the north side of this bridge. Some portions of these facilities may exist within the current ROW of Route No. 4 (note: ROW is of 50 m). Several river transports for the medical and the sightseeing purpose are observed. No school, church and/or hospital, that would require calm environment exist. During several field studies conducted within this study, it was found that illegal squatters may live under this bridge. Due to the poor design of the current bridge structure, the stability of the main slab does not seem to be good (when a heavy vehicle runs, both bridge edges tend to be lifted by several centimeters (note: see the engineering section of this main report for more detailed description). Table 16.1.10 summarizes the preliminary environmental evaluation of the Sarapiqui River Bridge Project.

Table 16.1.10. Initial Environmental Examination (Site 19: Sarapiqui River Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Table 16.1.10. Initial Environmental Examination (Site 19: Sarapiqui River Bridge: continued)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	B
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	C
	Destruction of roadside vegetation.	D	C
	Disturbance to bird habitats or floodplain habitats.	D	C
	Disturbance to aquatic ecosystem/or habitats.	D	C
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	B	C
	Potential of increased vessel accidents.	D	C
13. Global warming	Increased CO_2 emission.	D	D
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	B
15. Local Economy	Possible impact on local employment and livelihood	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	B
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	B
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

(8) Site 20: Sucio River Bridge

The Sucio River Bridge is located within Braulio Carrillo National Park, the central valley highland region of Costa Rica. River channel around the bridge site is meandering, and, due to a relatively steep riverbed slope, several traces of rapid flows, to be occurred during the rainy season, are recognized at the river. Debris transport process around this site seems to be significant since many large-sized boulders are found at the riverbed. Several surface damages (e.g., dents and scratches) due to the collision impacts of those transported debris/or boulders are observed at the upstream front of the bridge pier (note that opposite side (i.e., downstream side) of this pier has no severe dent and is relatively untouched). The confluence point of "yellow river" and "while river" is located at approximately 100 meter upstream side of this bridge. The riverine vegetation around this site is highly affected by this flood, and vast amounts of natural vegetation are remained around this site. Neither house nor facility

except two parking spaces at both sides of this bridge exists. No school, church and/or hospital, that would require calm environment exist. No illegal squatter areas exist around this site. Table 16.1.11 summarizes the preliminary environmental evaluation of the Sucio River Bridge Project.

Table 16.1.11. Initial Environmental Examination (Site 20: Sucio River Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	C
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	C
	Destruction of roadside vegetation.	D	C
	Disturbance to bird habitats or floodplain habitats.	D	C
	Disturbance to aquatic ecosystem/or habitats.	D	C
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	C	C
	Potential of increased vessel accidents.	D	D
13. Global warming	Increased CO_2 emission.	D	D
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	D
15. Local Economy	Possible impact on local employment and livelihood	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	B
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	B
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

(9) Site 26: Chirripo River Bridge of R32

The Chirripo River Bridge of Route No. 32 is located at the open space, Limon Province, Caribbean coast region of Costa Rica. River channel around the bridge site is meandering, and several traces of past flood events are recognized around this bridge site. Most of

riverside houses, built around the west river bank, have "pilotes style" in which several high pillars under the house floor are used in order to lessen damages of flood and/or inundation events. Currently, the riverbank improvement project is undertaken at the eastside of this river and the levee construction starts from this bridge site (entire construction distance is of 3,180 m, categorized as "MOPT urgent project"). The construction yard of this levee project is located around the eastern bridge site. This yard seems to have no interference with ROW of Route No. 32 (note: ROW is of 50 m).

Several large sandbars exist inside of the river, and most of the sedimentation deposit mainly consists of fine sand or silt. The riverine vegetation around this site is classified as floodplain flora and several natural vegetation are remained around this site.

One electric cable tower and residential complex bounded by a small natural bank exist at the west side of this bridge. Several fruit trees are planted between those housing/or facilities and the road bank, and some portions of these private lands may exist within the current ROW of Route No. 32 while a large-scale banana plantation field exist at the eastside. No illegal squatter areas exist around this site. Two oil pipelines are attached to this bridge. No school, church and/or hospital, that would require calm environment exist. No historical and/or cultural sites exist. There is one road surface gap or faulting at the west side of this bridge, and all vehicles tend to slow down to pass that gap safely. Table 16.1.12 summarizes the preliminary environmental evaluation of the Chirripo River (R32) Bridge Project.

Table 16.1.12. Initial Environmental Examination (Site 26: Chirripo River-R32 Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	B
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	D
	Destruction of roadside vegetation.	D	D
	Disturbance to bird habitats or floodplain habitats.	D	D
	Disturbance to aquatic ecosystem/or habitats.	D	D
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	B	C
	Potential of increased vessel accidents.	D	D
13. Global warming	Increased CO_2 emission.	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Table 16.1.12. Initial Environmental Examination (Site 26: Chirripo River - R32 Bridge: continued)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	D
15. Local Economy	Possible impact on local employment and livelihood	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	B
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

(10) Site 29: Torres River Bridge

The Torres River Bridge is located at the downtown of San Jose City, and the surrounding environment is classified as the mixed residential/commercial zone. One high school exists around the southern bridge side while one rotary club facility (i.e., Lions Club) exists at the north. Some portions of these private lands may exist within the current ROW of Route No. 218 (ROW of Route No. 218 is of 24 m). Frequent traffic circulation is observed at this bridge, and it can be said this bridge is one of important urban transport facilities. Two illegal squatters (both of them are Nicaraguan nationals: MOPT, personal communication, 2006) lived at each side of this bridge, respectively. Their two barracks were removed by the authority just before the physical strength tests, part of this study, were carried out (as of February, 2006). There is obnoxious mixed smell of littered garbage, compost smell of decayed plants, household effluents discharged from surrounding community and vehicular emission gas around the site, and, in particular, ex-illegal squatter's places have severe obnoxious smell. Several parts of the bridge fence were broken, presumably due to the traffic accident. No historical and/or cultural sites exist. Table 16.1.13 summarizes the preliminary environmental evaluation of the Torres River Bridge Project.

Table 16.1.13. Initial Environmental Examination (Site 29: Torres River Bridge)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
1. Air quality	Increased roadside air pollution.	C	C
2. Water Quality	Risk of pollution to major tributaries.	D	C
3. Soil and sedimentation	Potential for soil erosion.	D	C
	Occurrence of new sedimentation at downstream side.	D	C

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Table 16.1.13. Initial Environmental Examination (Site 29: Torres River Bridge: continued)

Environmental Factor	Descriptions of Impact	Do nothing	Do project
4. Waste Disposal	Generation of large amounts of construction wastes.	D	B
5. Noise/Vibration	Increased roadside noise and vibration	C	B
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork	D	D
7. Bad smell	Potential of newly creation of bad smell.	D	D
8. Topography and Geology	Creation of new inundated area	D	D
	Enhanced river bank erosion/scouring .	D	D
9. River bed	Disturbance to river bed condition.	D	D
10. Fauna/flora	Destruction of riverside/floodplain vegetation	D	D
	Destruction of roadside vegetation.	D	D
	Disturbance to bird habitats or floodplain habitats.	D	D
	Disturbance to aquatic ecosystem/or habitats.	D	D
11. Water Resources	Water quality degradation.	D	C
	Disturbance to regional groundwater flow.	D	C
12. Accidents	Potential of increased traffic accidents.	C	C
	Potential of increased vessel accidents.	D	D
13. Global warming	Increased CO_2 emission.	D	D
14. Involuntary Resettlement	Land expropriation due to construction yard	D	D
	Demolition of roadside houses.	D	D
	Demolition of illegal squatters' lots.	D	B
15. Local Economy	Possible impact on local employment and livelihood	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan	D	D
	Conflict with local development plans	D	D
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
18. Existing social infrastructures and services	Conflict with current local transport system	D	D
	Conflict with current local energy/ communication/water supply system.	D	D
19. the poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
22. Gender	Risk of WID-related issues	D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).	D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.	D	C
	Risk of HIV/AIDS	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

3) Summary of IEE

Here, based on IEE results of rehabilitation plans of selected 10 bridges, possible environmental impacts, commonly identified through all sites, are summarized in Table 16.1.14. It is noted that most of identified negative impacts to be caused by the proposed bridge rehabilitation project are evaluated as either of B or C. Also, most of B evaluations are related with construction activities, so it can be said those negative impacts are temporal ones. Table 16.1.15 summarizes more detailed descriptions of each potential negative impacts for both "Do - Nothing" and "Do - Project" scenarios, identified through all ten bridges.

Table 16.1.14. Summary of Potential Negative Impacts

	Bridge Name	Potential Negative Impacts							
		Do Nothing				Do Project			
		A	B	C	D	A	B	C	D
1	Aranjuez River	0	0	2	35	0	2	8	27
2	Abangares River	0	1	2	34	0	1	9	27
3	Azufrazo River	0	1	2	34	0	1	13	23
4	Puerto Nuevo River	0	0	3	34	0	2	12	23
5	Nuevo River	0	0	3	34	0	2	12	23
6	Chirripo River	0	0	3	34	0	2	12	23
7	Sarapiqui River	0	1	2	34	0	5	12	20
8	Sucio River	0	0	3	34	0	3	12	22
9	Chirripo River (R32)	0	1	2	34	0	3	7	27
10	Torres River	0	0	3	34	0	3	8	26

Note: 37 environmental evaluation factors are developed for this IEE.

Table 16.1.15. Breakdown of Each Potential Impacts

	Environmental Factors	Remarks of Possible Impacts
1	Air Quality	1. Increased roadside air quality degradation
2	Water Quality	1. Risk of water pollution to surrounding tributaries during rehabilitation. 2. Potential of water quality degradation due to erosion during/and after rehabilitation
3	Soil and Sedimentation	1. Potential for soil erosion during/and after rehabilitation. 2. Potential of sedimentation due to erosion during/and after rehabilitation.
4	Waste Disposal	1. Preparation of excavated soil dump site. 2. Proper treatment of industrial wastes to be generated during rehabilitation period.
5	Noise/Vibration	1. Noise and vibration during rehabilitation period. 2. Future roadside noise and vibration after rehabilitation.
6	Subsidence	Less significant
7	Bad Smell	Less significant
8	Topography/ Geology	Less significant
9	River Bed	1. Disturbance to the river bed condition.
10	Flora/Fauna	1. Destruction of natural floodplain vegetation. 2. Disturbance to birds and wildlife during rehabilitation period. 3. Risk of pollution to aquatic species during rehabilitation period.

Table 16.1.15. Summary of Possible Impacts (continued)

	Environmental Factor	Remarks of Possible Impact
11	Water Resources	1. Risk of pollution to the aquifer during rehabilitation period.
12	Accidents	1. Potential of increased traffic accidents during rehabilitation period.
13	Global Warming	Less significant
14	Involuntary Resettlement	Demolition of illegal squatters' lots.
15	Local Economy	Less significant
16	Land use and Utilization of local Resources	Less significant
17	Social Institutions	Less significant
18	Existing social infrastructures and services	Less significant
19	the poor, indigenous of ethnic group	Less significant
20	Misdistribution of benefit and damage	Less significant
21	Local Conflict of interests	Less significant
22	Gender	Less significant
23	Children's right	Less significant
24	Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.
25	Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases.

16.1.4 Environmental Organizations and Laws

1) Environmental Organizations

(1) SINA (National System of Environmental Organizations)

By the Law No.99 of 1993, the Ministry of Environment and National System of Environmental Organizations were established. Main objectives of SINA are as follows: (1) guaranteeing the public participation in the national environment and enewable natural resources policy, (2) insuring the right of every individual to enjoy healthy environment, and (3) protecting the natural heritage and the sovereignty of the nation.

(2) Organizations in National Level

- **The Ministry of Environment and Energy (MINAE by its Spanish acronym)**: The supreme organization of environmental administration mainly engaged in establishment of environmental policy on national level. Its principal obligations include design, planning and implementation of national policies related with the natural resources, energy, mining, and environmental protection.

- The Geology and Mines Direction: This direction belongs to MINAE and is responsible for issues related with the use of the river bed materials, exploration and extraction permits for the underground mineral extractions.

- **National Commission for the Management of Biodiversity**: An independent agency belonging to MINAE, and is responsible for the formulation of national policies relating to the conservation, sustainable ecological use and restoration of the biodiversity, in accordance

with conventions concerning biological diversity and other internationally corresponding agreements and treaties, as well as relating to national interests.

- National Technical Environmental Secretariat (SETENA by its Spanish acronym): An independent agency belonging to MINAE, and is responsible for reviewing, evaluating and monitoring the environmental impact assessment (EIA) while recommending relevant measures to minimize negative impacts on the environment.

- Ministry of Health: This Ministry is responsible for undertaking all actions, activities, and general and specific measures related with the conservation and the improvement of the environment while seeking the protection of the public health.

- Ministry of Agriculture: This Ministry is responsible for the monitoring and impose the land use limitation based on the geographical conditions, and the categorization into several land types such as the agriculture, livestock and forestry production-purposes.

(3) Organizations on Regional Level

- **Regional Environmental Council**: This council is responsible for the analysis, implementation and monitoring of environmental programs while encouraging the public involvement into relevant environmental activities (Chapter II of the Environmental Organization Law 7554 of September 28, 1995, described later).

2) Environmental Laws

(1) Constitution

The Constitution of the Republic of Costa Rica was revised in 1994 in order to incorporate a provision of the right to have a healthy and an ecologically-balanced environment for all people in Cost Rica. The main purpose of this constitutional provision is to ensure a healthy environment and protect against any infraction to this fundamental right, that would directly affect human beings, their health and their right to enjoy a clean environment (Article 50, Constitution of Costa Rica of 1949, amended in 1994). The Constitutional Court has guaranteed that the preservation and the protection of the environment is a fundamental right, and the transgression of this right is considered to be a constitutional violation (e.g., Decision 095 of 1995 of the Constitutional Court).

(2) Law of Environmental Organization (Law # 7554 of September 28, 1995)

This law provides a general descriptions of entire environmental organization, aiming to integrate and coordinate the different environmental norms across the relevant legal framework. The Law includes general environmental principles and regulates a broad range of issues such as environmental impact assessment, biodiversity, pollution and the establishment of new institution.

This law defines the environments "common property of all people in Costa Rica" and

determine that "State and each individual must participate in activities of the conservation and sustainable use". In additions, it states that everyone has the right to enjoy a healthy and ecologically sustainable environment as well as an obligation to maintain and protect that environment (consistent with Article 50 of the Constitution).

This law also includes the disposition of the National Technical Environmental Secretariat, SETENA, described earlier, which is the agency responsible for the reviewing, evaluating and monitoring of the environmental impact assessment in Costa Rica (Chapter IV of this law).

(3) Law of Environmental Impact Assessment (Law #31849 of 2004)

This law describes both the fundamental framework and the outline of the EIA process to be required for all development projects in Costa Rica. More detailed descriptions of entire environmental license application process implemented in Costa Rica will be provided in following section.

(4) Biodiversity Law of 1997

Main objectives of this law are to integrate the conservation and use of the components of the biodiversity in the development of socio-cultural, economic and environmental policies, to promote the active participation of all sectors of society in the conservation and ecological use of the biodiversity, and to establish sustainable use of the resources as well as to distribute in an equitable manner the benefits and derived costs. This law applies to the components of the biodiversity that are found under the sovereignty of the State, as well as to the processes and activities carried out under its jurisdiction or control, independently from those effects which manifests themselves inside or outside zones subject to the national jurisdiction.

Besides, there are another several important laws/or regulations such as Forestry Law, Water Law, Soil Conservation Law of 1973, Fishery Law of 2004 and General Health Law (Law # 5395 of October 30, 1973) in Costa Rica. It is quite essential to scrutinize those laws/or regulations before applying environmental license of this bridge rehabilitation project.

(5) Environmental Criteria

a) Noise/Vibration

Table 16.1.16 summarizes the noise environmental standard implemented in Costa Rica. The information of the noise zone classification currently used in USA is attached in Appendix for the comparison. It is unknown whether any specific roadside noise standard exists or not.

Table 16.1.16. Noise Environmental Standard in Costa Rica (dBA)

Zone	Leq (dBA)	
	6:00 - 18:00	18:00 - 6:00
Residential Area	65	40
Working Environment	65	40

Source: Decree # 18209-S

No environmental standard for the vibration exists in Costa Rica [Ministry of Health,

personal communication, 2006]. The environmental standard implemented in Japan is attached in Appendix for the comparison.

b) Air

Table 16.1.17 summarizes the A/Q environmental standard implemented in Costa Rica.

Table 16.1.17. Environmental Standard (Air Quality, ug/m^3)

	1-hour	8-hour	24 - hour	Annual
TSP	**	**	240	90
PM10	**	**	150	50
SO_2	**	**	**	80
CO	40,000	10,000	**	**
O_3	160	**	**	**
NO_2	400	**	**	100
Lead	**	**	**	0.5

Source: No. 30221-S, published in El Alcance # 25 from La Gazette # 57 of 2002

c) Water Quality

In Costa Rica, four different sets of the water quality criteria, corresponding to following environmental purposes, are established,

Level 1: Basic Water Quality Control Program

Level 2: Improved Water Quality Control Program

Level 3: Advanced Water Quality Control Program (mainly for drinking purpose)

Level 4: Special Water Quality Control Program.

Table 16.1.18 summarizes the W/Q environmental standard for Level 1 implemented in Costa Rica. Based on this Level 1 criteria, compound water quality criteria for higher level purpose is applied (e.g., additional sets of the water quality parameter are to be introduced as the inspection level is increased).

Table 16.1.18. Water Quality Standard for Level 1 purpose

	Parameter	Recommended Values	Maximum Admissible Values
1	pH	6.5	8.5
2	Odor	Must be acceptable	Must be acceptable
3	Flavor	Same as above	Same as above
4	Color (mg/L: U - Pt - Co)	5	15
5	Turbidity (UNT)	< 1	5
6	Conductivity (uS/cm)	400	
7	Coli-form (MPN/100 ml)	Absent	Absent
8	Cl (residual, mg/L)	0.3	0.6

(Source: No. 32327-S, Regulation for Drinking Water Quality)

d) Visual Contamination.

No laws/ or regulations referring the specific conservation and/or protection methods of the visual resources exist in Costa Rica. However, recently, several environmental concerns related with the conservation of the visual resources are aroused. For example, when ICE had telecommunication-related construction works inside the national park, they selected a green

colored pipeline/or cables in order to establish the visual harmonization with a surrounding scenery of the national park [Rojas, personal communication, 2006].

3) Environmental License

(1) Project Categorization

According to the Cost Rican EIA law, mentioned earlier, following four categories are specified, depending on the significance of possible environmental impacts to be caused by the proposed project,

Category A: Project that would cause severe adverse effects on the surrounding environment.

Category B1: Project that would cause major adverse effects on the surrounding environment.

Category B2: Project that would cause minor adverse effects on the surrounding environment.

Category C: Project that would cause less significant adverse effects on the surrounding environment.

Sub-classification of Categories B1 and B2 depends on the current and/or future land use condition of the study area of concern [Rojas, personal communication, 2006]. Final project categorization will be carried out by SETENA after the official application of the environmental license, using D1 (Category-A, -B1 and -B2 Projects) or D2 forms (Category-C Project) is made by the project owner and the quantitative valuation of the potential negative impacts to be induced by the proposed project is completed.

(2) Competent Authorities

SETENA, mentioned earlier, is responsible for the relevant administration of the EIA evaluation process based on the Costa Rican EIA law. The environmental license application process of the proposed project is examined by the preliminary commission. This preliminary commission consists of following seven organizations: i.e., (1) SETENA, (2) National Institute of Water Supply and Sewage, (3) Ministry of Heath, (4) Ministry of Agriculture and Livestock, (5) Ministry of Public Works and Transport, (6) Costa Rican Institute of Electricity, and (7) National Council of Rectors.

(3) Environmental License Application Process

a) Outline of Entire License Application Process

Basically, the environmental license application process in Cost Rica consists of following three steps; i.e., (i) the submission of the environmental application form (i.e., D1 and/or D2 form, depending on the potential significance of potential environmental impacts) to SETETNA and the preliminary evaluation of a submitted D1 and/or D2 forms, (ii) the

secondary evaluation of EIA report and/or other relevant materials such as EIA D/F report, and (iii) the implementation of the environmental monitoring program. Once granted, the license itself will be valid for two years from the commencement of relevant activities. The project owner has to re-apply for the new license from the scratch if the granted one is expired without any activities.

b) Preliminary Evaluation

i) Categories B2 (that complies with land use/or the land control plan of SETENA) and C Projects

Followings are the outline of the environmental application process for Categories B2 (that complies with land use/or the land control plan of SETENA) and C projects,

a) Project owner has to submit D2 form to SETENA, the local governmental office of the Ministry of Health or other designated agencies (when D2 form is received by the local governmental office of the Ministry of Health or other designated agencies, a submitted D2 form is to be passed forward to SETENA within five working days).
b) After SETENA receive D2 form, SETENA will start its examination process. Usually, this examination process is to be completed within 10 days.
c) Environmental license will be granted if SETENA concludes contents of a submitted D2 form are satisfactory.

ii) Categories A, B1 and B2 (that does not comply with the land use/or land control plan of SETENA) Projects

Followings are the outline of the environmental application process for Categories A, B1 and/or B2 (that does not comply with the land use/or land control plan of SETENA) projects,

a) Project owner has to submit D1 form to SETENA.
b) Upon reviewing a submitted D1 form, if SETENA concludes more information is need for precise impact evaluation of the proposed project, SETENA will conduct their own independent studies.
c) Based on contents of a submitted D1 form and information gathered through SETENA's independent studies, the order of the magnitude of the possible negative impacts to be caused by the proposed project is to be quantitatively re-examined. This quantitative valuation process shall be carried out by the MINAE-registered environmental firm. Based on this final evaluation results, SETENA may change the category of the proposed project, that was given initially. If the category must be changed, then, SETENA will inform the preliminary commission and explain reasoning why SETENA concludes that re-categorization of the proposed project would be necessary.
d) After the preliminary review by SETENA is completed, its final evaluation result will be passed forward to the preliminary committee. Upon examining those results, the preliminary committee will formulate the ToR of the required environmental studies within 1 week. Usually, this examination process is to be completed within three weeks.

c) Secondary Evaluation

i) Category B2 Project

a) The project owner has to submit an official declaration form (i.e., Declaracion Jurada de Impacto Ambiental) to SETENA. SETENA examines this submitted declaration form within 1 week.
b) Environmental license will be granted within 1 week if SETENA concludes contents of submitted declaration form are satisfactory.
c) Otherwise, SETENA is to inform the project owner that contents of submitted declaration form are unsatisfactory within 15 days, and advise the project owner to revise/or correct contents of submitted declaration form for certain periods of time until this revised declaration form become satisfactory and acceptable for SETENA.
d) Environmental license will be granted if SETENA concludes contents of submitted revised declaration form are satisfactory.

ii) Category B1 Project

a) The project owner has to submit environmental prediction and management proposal (i.e., P-PGA document; Pronostico - Plan de Gestion Ambiental) to SETENA. SETENA examines this submitted declaration form within 4 weeks.
b) SETENA is to provide the environmental guideline to the project owner within 2 weeks if SETENA concludes contents of submitted P-PGA are satisfactory. Based on this environmental guideline, the project owner has to prepare for the official declaration form (i.e., Declaracion Jurada de Impacto Ambiental).
   b-1) Otherwise, SETENA is to inform the project owner that contents of submitted P-PGA are unsatisfactory, and advise the project owner to revise contents of submitted P-PGA document for certain periods of time and to submit additional information and/or study results as "ANNEX" report.
   b-2) Project owner can re-submit the revised P-PGA document, so-called "Annex P-PGA" report, to SETENA only once. SETENA will re-examine this submitted "Annex P-PGA" report within 2 weeks.
   b-3) SETENA is to advise the project owner to submit the declaration form with relevant directions (e.g., SETENA will advise what kind of information shall be incorporated within the declaration form) if SETENA concludes contents of a submitted "Annex P-PGA" report are satisfactory. Otherwise, a whole license application process will be invalid.
c) SETENA examines this submitted declaration form. Environmental license will be granted if SETENA concludes contents of a submitted declaration form are satisfactory.
d) Otherwise, SETENA is to inform the project owner that contents of a submitted declaration form are unsatisfactory, and advise the project owner to revise contents of a submitted declaration form until contents of the revised declaration form become satisfactory and acceptable for SETENA.
e) Environmental license will be granted if SETENA concludes contents of a revised declaration form are satisfactory.

iii) Category A Project

a) The project owner has to submit the draft final (D/F) report of EIA to SETENA. SETENA examines this submitted EIA D/F report form within 10 weeks.

b) SETENA is to provide the environmental guideline to the project owner within 2 weeks if SETENA concludes contents of a submitted EIA D/F report are satisfactory. Based on this environmental guideline, the project owner has to prepare for the official declaration form (i.e., Declaracion Jurada de Impacto Ambiental).

b-1) Otherwise, SETENA is to inform the project owner that contents of a submitted EIA D/F report are unsatisfactory, and advise the project owner to prepare an additional and/or supplemental EIA report for certain periods of time. The length of this study period is to be determined, depending on the complexity and working loads of an additional and/or supplemental EIA.

b-2) Project owner can submit this additional and/or supplemental EIA report as "Annex EIA report" to SETENA only once. SETENA will re-examine this submitted "Annex EIA report" within 5 weeks.

b-3) SETENA is to advise the project owner to submit the declaration form with relevant directions (e.g., SETENA advise what kind of information shall be incorporated within the declaration form) if SETENA concludes contents of a submitted "Annex EIA" report are satisfactory. Otherwise, a whole license application process will be invalid.

c) SETENA examines this submitted declaration form. Environmental license will be granted if SETENA concludes contents of a submitted declaration form are satisfactory.

d) Otherwise, SETENA is to inform the project owner that contents of a submitted declaration form are unsatisfactory, and advise the project owner to revise contents of a submitted declaration form until contents of the revised declaration form become satisfactory and acceptable for SETENA.

e) Environmental license will be granted if SETENA concludes contents of a revised declaration form are satisfactory.

(4) Public Involvement

According to Costa Rican environmental laws, all stakeholders concerned with any development projects (i.e., any individuals/groups/organizations and/or agencies) have the right to obtain relevant information related with the proposed development project. Basic approaches of the public involvement implemented in Costa Rica are i) the public review of relevant documents/or reports from SETENA, ii) meetings/or hearing with the preliminary commission of SETENA or other competent sections of SETENA, and (iii) the public audience. Based on both type and scale of the proposed project and its significance of the possible impacts to be caused by the proposed project, SETENA is to figure out a suitable ways of the public involvement. Basically, the public audience is required only for Category-A project [Rojas, personal communication, 2006].

16.2 Technical Support for ToR Development of Environmental Study

16.2.1 ToR of Relevant Environmental Study

1) Outline

This chapter summarizes several key directions and concepts for ToR development of environmental studies to be required for the environmental licenses application for the proposed bridge rehabilitation plans. In 16.2.1, suitable ways of the environmental license approach abiding by both Costa Rican EIA Law and JICA Guideline are discussed. Then, based on both engineering features of the proposed bridge rehabilitation plans and the significance of potential negative impacts to be associated with this rehabilitation plan, the comprehensive list of relevant environmental subtasks are presented. These subtasks are key components of entire EIA study, and covers from, for example, field surveys to impact assessment studies. Preliminary results of the project categorization of each bridge rehabilitation plan, one of important steps in the entire license application process, are presented, too. Selected mitigative measures to be associated with the protection of roadside air quality, noise, water resources, soil and biological environment, would be crucial environmental factors within the license application process, are summarized in 16.2.2. Key directions and concepts of the formulation of the environmental management program and relevant environmental monitoring activities are summarized in 16.2.3 and 16.2.4, respectively.

2) Environmental License Application Process for this Bridge Rehabilitation Plan

It is essential to formulate appropriate ToR of a successful EIA study in order to achieve smooth environmental license application process for the implementation of entire bridge rehabilitation plan. In both Costa Rican EIA Law and JICA Guideline, entire flowchart of the environmental examination and license approval process is similar although there are slight differences in the project categorization of any infrastructure development projects, described later, and the way of the integration of relevant public involvement processes, described in earlier.

Basically, there are following two ways of applying the environmental license for the proposed rehabilitation plan.

(1) One License Application for All Rehabilitation Plans

First approach is to apply one overall environmental license for entire bridge rehabilitation plans. In this approach, only one-time license application is necessary. However, if unexpected problem due to the inappropriate reporting and/or poor documentation of relevant application materials may be found in the middle of the evaluation process of any bridges, entire evaluation process will be suspended temporally. Consequently, it may cause some delays for the implementation of the entire rehabilitation plan.

(2) Separate License Application for Each Rehabilitation Plan

Second approach is to apply the environmental license for each bridge, separately. Within this approach, ten different EIA studies will be conducted, so that, ten licenses shall be obtained for the entire bridge rehabilitation works. Suppose unexpected problems and/or difficulties were found within the evaluation process of any poorly-documented bridges and, consequently, evaluation processes of those bridges may be suspended temporally. Even under this bad situation, the license application process for the other well-documented bridges can proceed independently as planned. By this approach, the risk associated with previous approach, mentioned earlier, can be controlled and resultant delay for the entire bridge rehabilitation plan can be minimized to some extents.

Throughout a series of discussion with the Preliminary Commission of SETENA (Technical Secretary of the Environment) and MOPT counterparts, it was agreed that the latter license application approach (i.e., apply for the environmental license for each bridge site, separately) seems to be appropriate for this proposed bridge rehabilitation plan.

3) Scoping for Environmental Study

Main objectives of the EIA study are to collect current baseline environmental information, carry out relevant environmental field surveys (e.g., roadside noise study, water quality study and others), evaluate the significance of potential environmental impacts to be caused by the proposed rehabilitation plan at three different phases (i.e., pre-rehabilitation, rehabilitation, and operation phases), prepare environmental mitigation measures and establish environmental management program including environmental monitoring program during both implementation and operation phases.

In general, environmental studies to be required for the environmental license application can be classified into following two categories: i.e., (1) IEE and (2) full-scale EIA. Based on the engineering features of the bridge rehabilitation plan and the overall significance of each potential environmental impacts to be associated with the implementation of those rehabilitation measures, selection of each IEE/or EIA study shall be discussed (i.e., project categorization, to be described later), and then, entire framework of relevant environmental studies and its license application process shall be delineated. Priorities of relevant site-specific environmental subtasks such as the water quality, the roadside noise and other relevant studies shall be evaluated based on contents of each bridge rehabilitation plan. Major engineering features of entire bridge rehabilitation plan are to be summarized in following section.

4) Bridge Rehabilitation Plan

(1) Summary of Bridge Rehabilitation Plan

Table 16.2.1. summarizes the outline of the proposed bridge rehabilitation plan for the selected 10 bridges. Beside these rehabilitation measures, summarized in this table, both injection and filling measures are to be carried out to some extents at all 10 bridges in order to repair cracks, commonly found at all bridge facilities. Also, paintings are to be carried out for all steel bridges. More detailed information of each rehabilitation measures is summarized

in the engineering section in this report.

Table 16.2.1. Rehabilitation Policy for Selected 10 Bridges

	Bridge Name	Outline of Rehabilitation Measures
1	No.2 Aranjuez River (Route 1)	Slab Deck - Replacement (Precast Slab) Floor System - Stringer Addition & Rearrangement Floor System - Stringer Continuation Main Girder - Member Addition Accessory - Expansion Joint - New Installation Accessory - Flexible Railing Installation Accessory - Asphalt Paving & Waterproofing Prevention System for Bridge Falling Down - Girder Connection - Concrete Block Pier - Concrete Jacketing Foundation - Footing Widening Prevention System for Bridge Falling Down - Bridge Seat Widening - Abutment & Pier
2	No.3 Abangares River (Route 1)	Slab Deck - Replacement (Precast Slab) Floor System - Stringer Addition & Rearrangement Floor System - Stringer Continuation Main Girder - Cover Plate Fixing, Diaphragm Rearrangement Accessory - Expansion Joint - New Installation Accessory - Flexible Railing Installation Accessory - Asphalt Paving & Waterproofing Prevention System for Bridge Falling Down - Girder Connection – Chain Type Foundation - Footing Widening Prevention System for Bridge Falling Down - Bridge Seat Widening - Abutment & Pier
3	No.7 Azufrado River (Route 1)	Slab Deck - Slab Thickness Increase Main Girder -Girder Height Increase Main Girder - Steel Plate Bonding Accessory - Expansion Joint - New Installation Accessory - Flexible Railing Installation Accessory - Asphalt Paving & Waterproofing Pier - Concrete Jacketing
4	No.12 Puerto Nuevo River (Route 2)	*For Steel I-Beam* Slab Deck - FRP Bonding Main Girder - Prestressing (Out Cable) Accessory - Expansion Joint - New Installation Accessory - Flexible Railing Installation Accessory - Asphalt Paving & Waterproofing Prevention System for Bridge Falling Down - Girder Connection - Chain Type Foundation - Footing Widening Prevention System for Bridge Falling Down - Bridge Seat Widening - Abutment & Pier *For Reinforced Concrete I-Beam* Slab Deck - FRP Bonding Main Girder - Steel Plate Bounding Accessory - Expansion Joint - New Installation Accessory - Flexible Railing Installation Accessory - Asphalt Paving & Waterproofing Prevention System for Bridge Falling Down - Girder Connection - Concrete Block Foundation - Footing Widening Prevention System for Bridge Falling Down - Bridge Seat Widening - Abutment & Pier
5	No.16 Nuevo River (Route 2)	Slab Deck - Slab Thickness Increase Main Girder - Steel Plate Bonding Accessory - Expansion Joint - New Installation Accessory - Asphalt Paving & Waterproofing Prevention System for Bridge Falling Down - Girder Connection - Concrete Block Pier - Concrete Jacketing Foundation - Footing Widening Foundation - Additional Pile Installation Prevention System for Bridge Falling Down - Bridge Seat Widening - Abutment
6	No.17 Chirripo River (Route 4)	Accessory - Expansion Joint - Replacement Accessory - Asphalt Paving & Waterproofing Pier - Rolling Stone Protection

	Bridge Name	Outline of Rehabilitation Measures
7	No.19 Sarapiqui River (Route 4)	Slab Deck - FRP Bonding Main Girder - Steel Plate Replacement Accessory - Expansion Joint - New Installation Accessory - Asphalt Paving & Waterproofing Prevention System for Bridge Falling Down - Girder Connection - Chain Type Foundation - Additional Pile Installation Prevention System for Bridge Falling Down - Bridge Seat Widening - Abutment & Pier
8	No.20 Sucio River (Route 32)	Accessory - Expansion Joint - Replacement Accessory - Asphalt Paving & Waterproofing Pier - Rolling Stone Protection
9	No.26 Chirripo River (Route 32)	Slab Deck - FRP Bonding Accessory - Expansion Joint - New Installation Accessory - Asphalt Paving & Waterproofing Prevention System for Bridge Falling Down - Girder Connection - Chain Type Prevention System for Bridge Falling Down - Bridge Seat Widening - Abutment & Pier
10	No.29 Torres River (Route 218)	*For Prestressed Concrete I-Beam L=30m* Slab Deck - FRP Bonding Main Girder - FRP Bonding Accessory - Expansion Joint - New Installation Accessory - Asphalt Paving & Waterproofing Pier - Concrete Jacketing Foundation - Footing Widening Prevention System for Bridge Falling Down - Bridge Seat Widening - Abutment & Pier *For Prestressed Concrete I-Beam L=17m* Slab Deck - FRP Bonding Accessory - Expansion Joint - New Installation Accessory - Asphalt Paving & Waterproofing Pier - Concrete Jacketing Foundation - Footing Widening Prevention System for Bridge Falling Down - Bridge Seat Widening - Abutment & Pier

(2) Construction Activities associated with Bridge Rehabilitation Plan

Table 16.2.2. summarizes major construction activities and/or steps to be taken during/and after the implementation period. More detailed descriptions of the entire implementation schedule are summarized in the engineering section of this report. Table 16.2.3. summarizes the classification results of the rehabilitation measures by the type of the construction activity, that would cause negative impacts on the surrounding environment to some extents under some non-preferable scenarios (e.g., accidental spill/or leakage of hazardous materials). For example, a rehabilitation measure such as the enhancement of the slab thickness would use certain amounts of a fresh concrete. Under the worst scenario, some portions of those construction materials/or chemicals may be accidentally discharged/or leaked into the surrounding tributary system, and would cause local water quality degradation. Project owners shall always be careful about the risk of those accidents while an appropriate contingency program shall be established prior to the entire rehabilitation work as precaution.

It shall be noted that precise quantities of required construction materials, those delivery/storage plans, and temporal and spatial scales of each activities are to be determined based on more detailed rehabilitation plan of each bridge as well as the implementation schedule. If some portions of on-going rehabilitation plan are changed, up-to-date engineering information (i.e., changes in bridge rehabilitation plans) shall be feedbacked to the ToR development work promptly, and if possible, relevant suggestions/or advices shall be delivered back to the engineering study in order to make entire bridge rehabilitation plans environmentally friendly.

Table 16.2.2. Summary of Major Construction Activities

Project Step	Major Rehabilitation Activities
Before Implementation	1. Set-up of construction yard and/or camp 2. Site clearance (e.g., removal of surrounding vegetation) 3. Construction of approach road 4. Establish treatment method of construction wastes 5. Prepare contingency plan for accidental events.
During Implementation	1. Earthwork 2. Use of fresh concrete and/or chemicals 3. Treatment of construction wastes 4. Delivery of construction material and/or waste. 5. Traffic Diversion 6. Periodical Monitoring
After Implementation	1. Removal of construction yard and/or camp 2. Re-vegetation of construction sites (if necessary) 3. Periodical Monitoring

Table 16.2.3. Categorization of Rehabilitation Measures by Construction Activity Type

Construction Activity	Rehabilitation Measures
Use Fresh Concrete	Slab Deck - Slab Replacement Slab Deck - Slab Thickness Increase Pier - Bridge Seat Widening Pier - Concrete Jacketing Abutment - Bridge Seat Widening Foundation - Footing Widening Foundation - Additional Pile Installation
Do Earthwork	Abutment - Slope Protection Foundation - Footing Widening Foundation - Additional Pile Installation
Use chemicals/glues/solvent	Slab Deck - FRP Bonding Bridge Painting (only for all Steel Bridges)

5) ToR Development for EIA Study

(1) Introduction

Here, several directions for ToR development of the environmental studies to be required for the license application are presented. First of all, entire framework of required environmental study shall be well discussed and determined (i.e., project categorization). Within this step, selection of IEE/or full-scale EIA study is usually carried out, based on entire significance of potential negative impacts to be caused by the implementation of bridge rehabilitation project.

After entire framework of relevant environmental studies is delineated, selection of relevant environmental subtasks such as the water quality study is to be carried out. Throughout this selection process, priorities of relevant environmental subtasks are evaluated, depending on the significance of negative impacts identified at each site, and then, site-specific ToR of environmental study to be required for the license application for the each bridge rehabilitation plan can be formatted. For example, if the potential environmental impact regarding the cultural heritage factor at the bridge of concern is evaluated as "Category D" in its IEE results, priorities of relevant environmental surveys and impact assessment studies would be low. Thus, it can be said that it is not necessary to incorporate those two elaborate studies within the ToR of an appropriate environmental study.

On the other hand, if the potential environmental impact regarding the flora/fauna factor at the other bridge of concern is evaluated as "Category A" in its IEE results, priorities of relevant environmental surveys and impact assessment studies would become high. Consequently, relevant biological environmental survey and impact assessment study shall be incorporated within the ToR of suggested environmental study.

(2) Generic ToR

Here, selected lists of environmental subtasks to be contained within a generic ToR of EIA study are summarized in Tables from 16.2.4. to 16.2.8. Several useful remarks, suggestions or comments obtained through consultations with environmental sections of governmental organizations such as SETENA, MINAE (National Laboratory of Materials and Structural Models), MOPT and other relevant agencies or organizations are incorporated within the content of this generic ToR.

Table 16.2.4. summarizes the key component subtasks to be carried out within a typical full-scale EIA study. Some of those subtasks can be simplified or skipped within IEE-level study. Table 16.2.5. summarizes the list of typical key environmental factors for the baseline environmental information collection activity. This information collection work is usually carried out within both IEE and full-scale EIA studies. Some of those environmental information such as meteorological and/or hydrological information are periodically monitored by public organizations. So, it may be beneficial and economical to use those databases for the baseline environmental information collection if sites of concerns are located close to those periodically monitored areas.

When direct baseline data such as the water quality of adjacent tributaries are needed for more adequate evaluation of current environmental condition, survey programs of relevant field surveys must be incorporated within the entire ToR of environmental study. Appropriate survey programs (e.g., both spatial and temporal scale of those field studies as well as parameters to be measured) must be adequately figured out, based on the significance of relevant potential negative impacts its available budget (note: several field surveys cost a lot). Sample descriptions of selected bio-physical and socio-cultural environmental field surveys are presented in Tables 16.2.6. and 16.2.7., respectively. Figures 16.2.1. and 16.2.2. show sample results of the roadside noise survey and its relevant traffic volume counting, respectively. This roadside noise survey was carried out within the environmental study of JICA-funded bridge construction project [JICA, 2006]. Figure 16.2.3. shows the selection flowchart of relevant environmental field surveys.

Within current reports of full-scale EIA studies for the transport-related infrastructure development project, several quantitative impact assessment studies are carried out for more elaborated impact evaluation. For example, when the study area is located inside/or near to residential areas and the order of the magnitude of the current and/or predicted traffic demand are large, the roadside air quality and noise/vibration prediction studies are carried out in order to evaluate the potential negative impact of concern under different scenarios quantitatively, and to select suitable mitigative measures. Selected impact assessment studies such as the roadside air quality prediction study and the noise/vibration prediction studies, conducted within EIA study, are summarized in Table 16.2.8. Figure 16.2.4. shows the sample output of the roadside noise impact prediction study. This noise impact prediction study was

carried out within the environmental study of JICA-funded urban transport (buslane) construction project [JICA, 2004].

Vehicular emission study is useful for the new bridge/or road construction project that would cause significant change in regional transport situation (e.g., great reduction/or increase of total amount of vehicle-kilometers). Figure 16.2.5. shows the selection flowchart of relevant environmental impact assessment studies.

(3) Project Categorization

Figure 16.2.6. shows the flowchart of the project categorization, specified within the current Costa Rican EIA Law. ToR-Final of relevant EIA/or IEE study to be required for the environmental license application shall be developed through a series of consultation process with SETENA at the early stage of the project cycle. Within this categorization step, all infrastructure development projects are categorized into four categories, described earlier (see IEE study section of this main report for more detailed information). Using this flowchart, it would be easier to obtain preliminary knowledge of the categorization of each bridge rehabilitation plan, and thus, be helpful to develop an appropriate ToR of environmental study to be required for the environmental license application process.

Preliminary project categorization of selected bridges is carried out, based on both the engineering features of the bridge rehabilitation plans and the significance of associated potential environmental impacts. Table 16.2.9. summarizes preliminary categorization results of each bridge rehabilitation work, depending on both engineering features of the proposed rehabilitation plan for each sites (see Tables 16.2.1., 16.2.2. and 16.2.3.) and the significance of potential environmental impacts (see Tables 16.1.14 and 16.1.15). From this result, it can be said that all selected 10 rehabilitation plans are categorized into “Category B1” by Costa Rican EIA Law while “Category B” by JICA Guideline. Thus, it can be said that IEE-level studies are appropriate for the application of the environmental license of this proposed bridge rehabilitation plan. It is noted that this tentative preliminary result is obtained throughout a series of consultation process with SETENA [Rojas, personal communication, 2006].

Currently, regional governments are applying the official approval of each region’s land-use plans to SETENA. If those land-use plans are approved, some of those categorization results, mentioned above, may be downgraded to “Category B2” [Rojas, personal communication, 2006].

This project categorization steps, described here, is applicable for other different bridge rehabilitation/or construction plan.

Table 16.2.4. Major Environmental Tasks to be required for the Environmental Study

	Environmental Tasks
1	**Descriptions of Current Environment Condition** Collect environmental baseline information and describe current 1) bio-physical and 2) socio-cultural environmental condition.
2	**Field Environmental Survey** Carry out following environmental surveys, 1) Roadside Air Quality 2) Roadside Noise/Vibration 3) Water Quality Survey 4) Biological Survey 5) Preliminary Cultural Surveys
3	**Environmental Impact Assessment** Evaluate potential environmental impacts of three project stages such as 1) pre-rehabilitation phase, 2) rehabilitation phase, and 3) operational phase shall be described. Besides, following impact assessment studies shall be conducted in order to stress out the advantage/disadvantage of the proposed project quantitatively. 1) Biological Impact Assessment Study 2) Vehicular Emission Study 3) Air Quality Prediction Study 4) Noise Prediction Study 5) Vibration Prediction Study 6) Run-off (road surface drainage) Study 7) Socio-Economic Impact Study
4	**Environmental Mitigation** Describe comprehensive, effective measures of the mitigation of negative impacts for the pre-rehabilitation, rehabilitation and operation phases of the project
5	**Environmental Management** Establish appropriate environmental management plan. Specific objectives of this plan are to 1) define organizational and administrative arrangements for the environmental monitoring, including the definition of responsibilities of staff, coordination, liaison and reporting procedures, and 2) to discuss procedures for pro-active environmental management, so that potential problems can be identified and mitigation measures to be adopted prior to the construction commencement.
6	**Environmental Monitoring** Establish appropriate environmental monitoring program. The scope of the monitoring plan are 1) to identify the monitoring tasks, 2) to identify the nature and the schedule of the monitoring, and 3) to identify samples to be taken for analysis and parameters to be measured.

Table 16.2.5. Descriptions of Current Environment Condition

1. Bio-Physical condition
(1) Regional hydrology, (2) Water quality of surface/subsurface water, (3) Air quality (4) Regional drainage, (5) Roadside noise/vibration/air quality, (6) Climate, (7) Geology (8) Disaster Records, (9) Soil, (10) Biological Environment
2. Socio-Cultural condition
(1) Cultural resources, (2) Visual resources, (3) Land take/resettlements, (4) Illegal squatter (5) Land use, (6) Water use, (7) School, hospital, park, library, religious facilities. (8) Waste Disposal Site, (9) Vehicle Registration, (10) Vehicle Inspection/Maintenance Program (11) Clean Fuel Program, (12) Sewage system

Table 16.2.6. Field Environmental Survey (Bio-Physical)

1. Roadside Air Quality
Carry out 24-hours continuous survey at several points around the study site. Parameter: PM10, PM2.5, CO, HC, NO2, SO2, and wind data
2. Roadside Noise
Carry out 24-hours continuous survey at several points around the study site (parameter: Leq)
3. Roadside Vibration
Carry out 24-hours continuous survey at several points around the study site (parameter: L_{10})
4. Water Quality Survey
Carry out surface/subsurface water quality survey at several points around the study site. Parameters: 1) pH, 2) turbidity, 3) DO, 4) BOD, 5) COD, 6) Temperature, 7) SS
5. Biological Survey
Carry out scientific description of the flora/fauna as well as other natural resources and habitats. Prepare both vegetation map and impact-identification methods in order to provide a systematic base for qualitatively delineating potential impacts to be caused by the proposed project.

Table 16.2.7. Field Environmental Survey (Socio-Cultural)

1. Preliminary Cultural Surveys
Carry out cultural environment study to describe the current existing cultural resources, which include architectural, historical, and archeological sites as well as areas of unique importance because of their ecological, scientific, or geological information around the study area, and to qualitatively identify the potential impacts of the proposed project on those cultural resources.

Table 16.2.8. Impact Assessment Study

1. Biological Impact Assessment Study (e.g., habitat-based methods or model approaches)
Discuss the relationship between the land use and habitat change under several project scenario. The impacts shall be quantified where possible, with qualitative descriptions provided for those impacts which can not be quantified.
2. Vehicular Emission Study
Evaluate the amount of vehicular emission to be generated by the regional future traffic and transport condition around the study area, and carry out a comparative study under following two scenarios; i.e., **with-** and **without** proposed project.
3. Air Quality Prediction Study
Evaluate the roadside air quality to be generated by the future traffic and transport conditions around the study site and find out suitable impact mitigation measures within this project.
4. Noise Prediction Study
Evaluate the sound pressure level to be generated by the future traffic and transport conditions around the study site and find out suitable impact mitigation measures within this project. Basically, the noise impact prediction study is carried out for daytime and nighttime transport conditions, respectively.
5. Vibration Prediction Study
Evaluate the vibration level to be generated by the future traffic and transport conditions around the study site and find out suitable impact mitigation measures within this project. Basically, the vibration impact prediction study is carried out for daytime and night-time transport conditions, respectively.
6 Run-off (road surface drainage) Study
Evaluate the impacts of the proposed project (or activity) on regional drainage system quantitatively, using computer simulation models.
7. Socio-Economic and Socio-Cultural Impact Study

Evaluate the impacts of the proposed project (or activity) on several socioeconomic and socio-cultural factors such as (1) regional economy, (2) land use and utilization of local resources, (3) gender, (4) children's right (e.g., child labors), and (5) resettlement.

Table 16.2.9. Project Categorization (tentative)

		Costa Rica Categorization			
		A	B1	B2	C
JICA Categorization	A	****	****	****	****
	B	****	No.2 Aranjuez No.3 Abangares No.7 Azufrado No.12 Puero Nuevo No.16 Nuevo No.17 Chirripo No.19 Sarapiqui No.20 Sucio No.26 Chirripo-R32 No.29 Torres	****	****
	C	****	****	****	****

Note: Categorization class indicated in the row and column correspond to that of JICA Guideline (i.e., categories A, B and C) and Costa Rican EIA Law (i.e., categories A, B1, B2 and C), respectively.

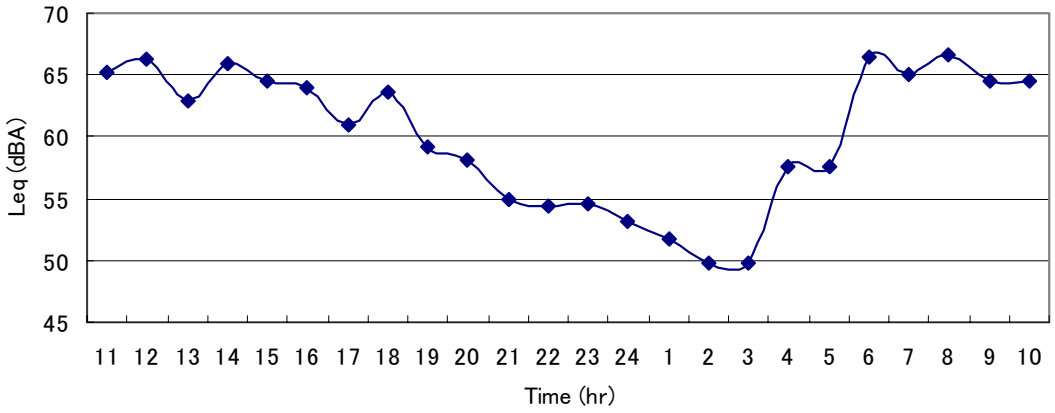
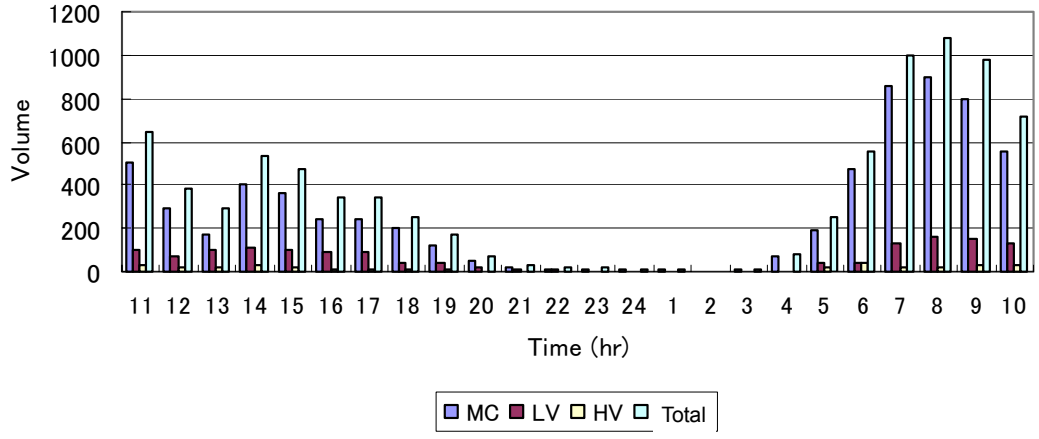


Figure 16.2.1. Noise Measurement Results (East Side of Neak Loeung, June/03/05)



Note that MC, LV and HV indicate “Motor Cycle”, “Light Vehicle” and “Heavy Vehicle”, respectively.

Figure 16.2.2. Traffic Volume Count (East Side of Neak Loeung, East Side, June/03/05)

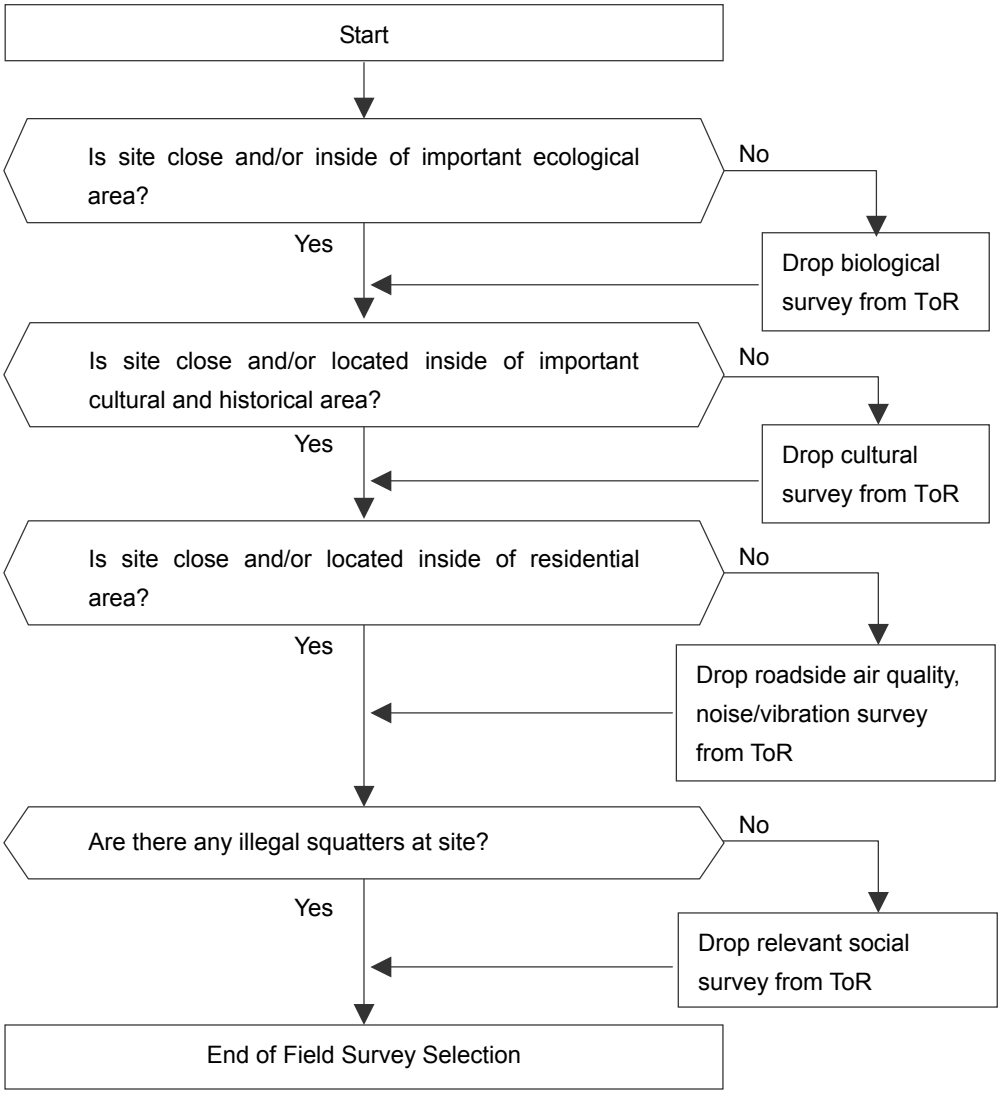
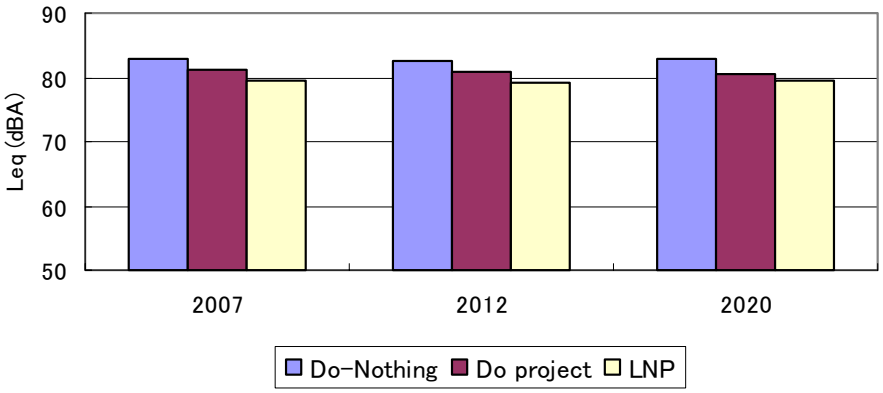


Figure 16.2.3. Environmental Field Survey Selection Flowchart



Note: Leq value under different scenarios are presented. "LNP" indicates Low Noise Pavement case

Figure 16.2.4. Noise Prediction Study Result

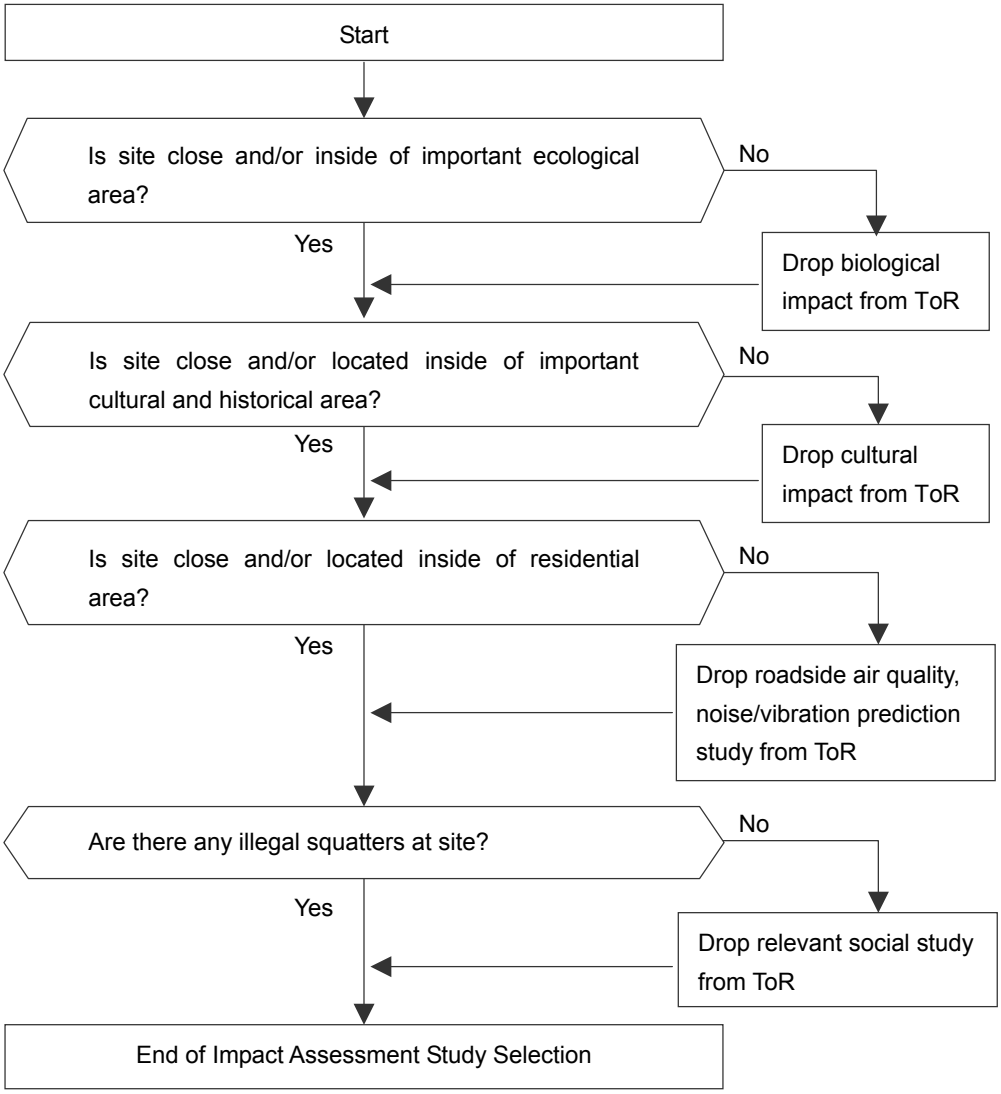
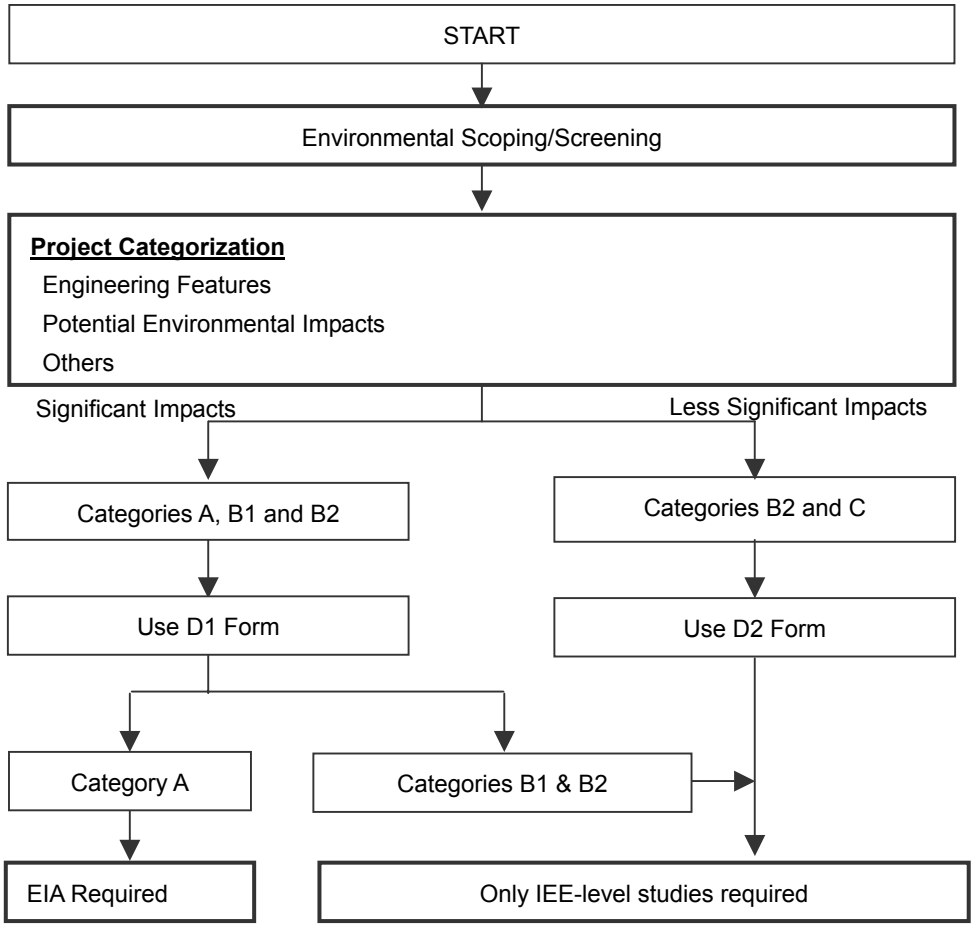


Figure 16.2.5. Environmental Impact Assessment Study Selection Diagram



Note: This project categorization scheme is mainly based on the Costa Rican EIA Law (hereinafter referred to as CR-EIA). Category A, classified within CR-EIA is almost equivalent to Category A of JICA Guideline. Similarly, Category C of CR-EIA is almost equivalent to Category C of JICA Guideline. Both D1 and D2 Form are official environmental license forms, specified by CR-EIA Law.

Figure 16.2.6. Flowchart of Environmental Scoping/Screening Process

16.2.2 Selected Mitigation Measures

1) Introduction

Here, several mitigative measures/or directions regarding the protection of the air quality, water resources, soil erosion, noise erosion and biological environment, that would be crucial environmental factors within the environmental study of the proposed bridge rehabilitation plan, are summarized, separately. These mitigation measures, summarized in this section, are commonly used in similar bridge and road development projects and would be applicable for the future bridge rehabilitation plans.

2) Air Quality

Impacts of vehicular emission-related pollution can be prevented and/ore reduced by both shifting traffic routes away from populated areas and by reducing the traffic congestion. As a general rule, avoiding densely populated sites means fewer potential impacts and less-prioritized need for traffic management measures. Table 16.2.10. summarizes several project-specific design improvements to limit vehicular air pollution.

Table 16.2.10. Project-Specific Mitigation Measures for Air Quality

- Select road alignments which avoid passing close to housing, school and workplace.
- Provide sufficient capacity to avoid traffic congestion, even with projected increase in traffic flow. Traffic management provisions shall ensure that vehicles operate at peak efficiency in populated areas.
- Avoid placement of busy intersections, tunnel vents and openings near housing, schools or workplaces.
- Take account of prevailing wind direction within the design of roads and road features, including refueling stations, near population centers.
- Avoid steep grades and sharp curves which would promote deceleration, acceleration and shifting whenever possible.
- Seal high-use dirt roads, where they pass through populated areas, to control dust.

Source: World Bank, 1997

3) Water Resources

Table 16.2.11. summarizes several common mitigative measures for the protection of the water resources

Table 16.2.11. Water-Resources Protection-related Mitigative Measures

- **Flow Speed Control:** Water speed reduction measures (e.g., grasses) can be substantially reduce potential impacts.
- **Settling Basins:** Settling basins are sometimes used to remove silt, pollutants, and debris from the road run-off water before it is discharged to adjacent streams or tributaries. Would be the most appropriate when downstream environment is particularly sensitive or when the levels of silt or pollutants are particularly high. On-going maintenance may be required when large amounts of silt are deposited.
- **Paving:** Section of dirt and gravel roads prone to erosion and potential source of the sediment can be paved to reduce the amount of the sediment produced. This is especially relevant near the water crossings.
- **Infiltration Ditch:** Infiltration ditches can be used to reduce overland flow by encouraging the movement of run-off down through the soil profile. The volume of flow in downstream drainage structures is reduced, the flow of pollutants is localized, and the groundwater can be recharged.
- **Oxidating Macrophytes:** Oxidating macrophytes, such as cattails in temperate climates, can be used to remove some pollutants naturally from settling basins.
- **Water Collection, Control, and Treatment:** A relatively expensive option for polluted run-off from pavements and slopes, but may be called for in particularly sensitive areas.

Source: World Bank, 1997

4) Soil Erosion

There is a wide range of techniques designed to reduce the risk of damaging the soil and to fit the project into its surrounding environment with the minimal adverse effects. Simple techniques such as replanting will be effective in many situations, whereas more sophisticated techniques, such as retaining walls, are used only in the most difficult cases. Table 16.2.12. summarizes several mitigation measures for the soil erosion.

Table 16.2.12. Soil Protection related Mitigation Measures

- **Replanting:** Replanting cleared areas and slopes is the most effective action to be taken in reducing erosion and stability problems. It shall be undertaken as early as possible in the rehabilitation process, before erosion becomes too advanced; to be most effective, it shall be done immediately after the disturbance takes place. Vegetation shall be selected to serve a specific engineering function. In some cases, a short-lived engineering structure, such as a woven wattle fence, is installed along with vegetation that can take over the function of the structure in time.
- **Engineering Measures:** In any cases, vegetation alone may not be enough to prevent erosive damage to slopes, and various engineering measures may be required to complement or replace it. The use of slope retaining techniques may be necessary when
  1) Slopes are unstable because they are too high and steep.
  2) Climatic conditions are such that establishment of vegetation is slow/or impossible.
  3) There is a risk of internal erosion or localized rupture because of drainage difficulties.
  4) It is necessary to decrease the amount of earthwork because the road width is limited.
- **Drainage Improvement:** A major factor in the prevention of the soil erosion and siltation of the watercourses is the control of the volume, location, and speed of water flows in the vicinity of exposed soils and slopes. Some important drainage mitigation measures include;
  1) Cut-off drains to catch water before it reaches critical areas, and diverging drains, which avoid excessive concentration of flow.
  2) Concrete dissipation structures designed to slow fast-running storm water in drains, and hence reduce its downstream erosive potential.
  3) Natural materials for energy dissipation in drains, including various combinations of sticks, hay bales, rocks, and plantings. Most of these require on-going maintenance.
  4) Settlement basins, which allow silt, pollutants and road rubbish to settle out of run-off water before it flows into downstream watercourses.

Source: World Bank, 1997

5) Noise

Noise problems can be avoided by improving the road structure, moving the road alignment or diverting traffic away from noise-sensitive areas, using bypass roads. Choosing alignments which minimize steep slopes and sharp corners, especially at sensitive locations, can also prevent noise problem. Table 16.2.13. summarizes several noise mitigation measures.

Table 16.2.13. Noise Mitigation Measures

- **Vehicular Measures:** Most vehicle noise can be reduced at the source, for example, through vehicle construction, selection of tires and exhaust systems, as well as vehicle maintenance. Control of vehicle noise emission can be attempted using vehicle design rules and in-use noise regulations and enforcement.
- **Road Surface Design and Maintenance:** The application of a bituminous surface layer over worn concrete roadways is effective in reducing frictional noise. The use of open-graded asphalt and the avoidance of surface dressings may also be effective in reducing frictional noise in sensitive areas. Generally, smooth, well-maintained surfaces such as freshly laid asphalt without grooves and cracks will keep noise to a minimum.
- **Road Geometry:** Road design shall avoid steep grades and sharp corners to reduce noise resulting from acceleration, braking, gear changes and the use of engine brakes by heavy trucks at critical locations.

- **Noise Barrier:** Noise barriers are among the most common mitigative measures used. They are the most effective if they break the line of sight between the noise source and the receptors being protected, and if they are thick enough to absorb or reflect the noise received.
- **Insulation:** Building façade insulation such as double window glazing is an option usually adopted as a last resort in order to dampen noise in buildings. It is most likely to be needed in cases where noise impacts result from an unforeseen expansion of traffic volume along existing roads.

Source: World Bank, 1997

6) Biological Environment

Sensitive natural environments shall be identified early in the planning process when planning new roads or changes in its road width or alignment, so that alternate routes and more environmentally-friendly designs may be considered. Whenever possible, road developments shall be located more than one kilometer away from the sensitive areas to avoid severe impacts on flora and fauna. Water crossings shall be minimized, and buffer zones of undisturbed vegetation shall be left between roads and watercourses. Groundwater recharge areas shall be avoided, and major roads shall not be constructed through national parks or other protected area. Table 16.2.14 summarizes several common mitigation measures for the protection of the biological environment.

Table 16.2.14. Mitigation Measures for the Protection of Flora/Fauna

- **Pre-engineering Road Cross-Section Design:** Road section can be modified to reduce the impact on the environment, for example, by using narrower widths, lower vertical alignments, small cuts and fills, flatter side slopes, and less clearing of existing vegetation. Narrower right-of-way and lower vertical alignment may make crossing easier for animals that find roads a physical or psychological barrier. Also, providing longer sight lines for drivers can reduce collisions with animals by allowing more reaction time.
- **Planting:** Planting in road right-of-way and adjacent areas can help to support local flora and fauna. In some cases, planting may provide additional habitats and migration routes for local animals, while also guarding against erosion. Border plant species may need to be chosen for resistance to wind or fire in some areas. Planting shall be done wherever possible with native species, which are likely to require little maintenance and may prove beneficial in maintain ecosystem integrity. In cases where non-native species are deemed essential, careful monitoring shall be planned in order to ensure that they do not compete too successfully with native species and spread uncontrollably.
- **Animal Crossing:** Animal crossing can be used to assist the migration of animals. At important crossing points, animal tunnels or bridges have sometimes been used to reduce collision rates, especially for protected or endangered species. Tunnels are sometimes combined with culverts or other hydraulic structures. These measures are expensive and used only at a few locations where they are both justified (by the importance of the animal population and the crossing route) and affordable (relative to the project cost and available funds). In forested areas, especially tropical ones, reducing the width of vegetation clearance in selected areas may allow trees to touch over the roadway, providing a means of crossing for canopy dwellers.
- **Fencing:** Fencing or plant barrier can reduce the risk of collisions between animals and vehicles. In some cases, semi-permeable fencing is used, which excludes species that are more likely to be involved in collisions while letting less problematic species through. Fences may interfere with the migratory patterns of animals, or may simply shift the points where migratory pattern conflict with traffic patterns along the route. Fencing may also, in some cases, interfere in predator-prey relationships, allowing predators to gain significant advantage because prey escape routes are restricted.
- **Water Crossing:** Aquatic ecosystem are particularly sensitive to road development, and there are a number of ways in which impacts can be lessened. Standing water can be bridged instead of filled. Stream re-channeling shall be avoided as much as possible, but where it must be done, efforts shall be made to recreate lost channel diversity. Careful attention shall be paid to erosion control techniques near watercourses. Culverted crossings shall be designed with the needs of migratory aquatic species in mind.
- **Traffic Control Measures:** Reduction of the speed limit may reduce the rate of collisions between vehicles and animals. Some jurisdictions apply lower speed limits, particularly at night and in areas of frequent animal crossings. Signs warning motorists of the presence of animals in places where animal corridors cross the road may also help to reduce collisions. Roadside reflectors may be used to scare animals away from the roadway when vehicles approach at night.

Source: World Bank, 1997

16.2.3 Environmental Management Plan (EMP)

The main purpose of the EMP is to ensure that the various environmental protection measures selected through the project planning phase are implemented during the rehabilitation/or construction phase properly, so that the environmental degradation and pollution resulting from rehabilitation activities will be minimized.

In general, any environmental management programs shall be carried out as an integrated part of project planning and its execution, making a significant and continuous contribution to the overall development of the scheme. It must not be regarded merely as an activity limited to monitoring and regulating activities using a pre-determined checklist of required actions. Rather, it must interact dynamically as the project implementation proceeds, dealing flexibly with environmental impacts – both expected and unexpected as they arise. For this reason, the plan provides for periodic audits, which will evaluate compliance of on-site environmental management practices with the EMP requirements and also to refocus the plan itself in the light of experience and issues arising. Specific objectives of this plan are to:

1. Define organizational and administrative arrangements for the environmental monitoring, including the definition of responsibilities of staff, coordination, liaison and reporting procedures.

2. Discuss procedures for pro-active environmental management, so that potential problems can be identified and mitigation measures adopted prior to the construction commencement.

16.2.4 Environmental Monitoring

Main objectives of the environmental monitoring are to provide a continuous feedback on the project implementation to identify actual or potential successes/or problems at early stage, to implement timely adjustments to whole project management work, and is to develop a cost-effective approach to monitor the contractors' environmental performance. Monitoring is a continuous assessment of the project implementation and must be an integrated part of good management during the rehabilitation.

The objective of the monitoring system is to assist the project management through:

1. Defining requirements and procedures for the environmental monitoring (type of equipment to be used, monitoring schedule, parameters to be monitored and so on).
2. Identifying targets and objectives for the project implementation.
3. Keeping environmental records for the project evaluation.
4. Identifying problems arising from the project, and figuring out procedures for the environmental remediation in the event of the pollution or similar incidents.
5. Providing readily available results of related environmental analysis for the decision-making.

The scope of the monitoring plan is:

1. To identify the monitoring tasks during the construction phase.
2. To identify the nature and the schedule of the monitoring.
3. To identify samples to be taken for analysis and parameters to be measured.

It is recommended that monitoring results shall be put into the public domain periodically and/or presented at the public involvement-related meetings in order to share common knowledge of the rehabilitation project and enhance the deep understanding of projects among various stakeholders.

16.2.5 Conclusion

It is quite essential to prepare a sufficient ToR of the environmental study at the early stage of project cycle. Otherwise, smooth environmental license application process as well as a prompt set-up of comprehensive environmental management program in that various stakeholders may participate would be difficult, and sometime would take more time and money. As a final reminder, ToR-Final of relevant IEE study to be required for the environmental license application process must be developed throughout a series of consultation process with SETENA.

16.3 Stakeholder Meeting

16.3.1 Introduction

1) Outline

Within this bridge rehabilitation study, three (3) stakeholder meetings were held, based on JICA Guideline (see Table 16.3.1.). Major objectives of this stakeholder meeting are to enhance the public participation from various stakeholders with different backgrounds, establish comprehensive information disclosure, share common knowledge and understanding about the proposed project among stakeholders, and to make the smooth establishment of consensus. Summary of each stakeholder meeting is described in following section, separately.

Table 16.3.1. Schedule of Stakeholder Meeting

	Date	Place	Main Topics
1	Feb/21/06 (Tue) 9:00 am - 0:00 pm	MOPT	- Project outline - Environmental and Social Consideration - Costa Rica EIA Law & JICA EIA Guideline
2	Jun/08/06 (Thu) 9:00 am - 0:00 pm	CIC	- Results (major findings) of IEE - Miscellaneous
3	Oct/11/06 (Wed) 1:30 pm – 3:00 pm	CIC	- Progress of Bridge Rehabilitation/Improvement Plan - Review of Q/A session of previous stakeholder meetings. - Explanation of updated Project Homepage (JICA Guideline-based stakeholder meeting) - Major environmental issues to be associated with each bridge rehabilitation plan. - Key Directions and Concepts of ToR Development - Preliminary Project Categorization Results - Miscellaneous

MOPT: Ministry of Public Works and Transport, CIC: Civil Engineer's Association of CFIA (Colegio federado de Ingeniero y Arquitectos de Costa Rica)

2) Information Disclosure

The importance of information disclosure of the proposed development project is stressed out within JICA Guideline. Within this study, following information are put at the MOPT's homepage and can be downloaded for any parties and/or individuals who are interested in this proposed study from this website (see Table 16.3.2.).

Table 16.3.2. Homepage for Stakeholder Meeting

	Descriptions
Homepage address	www.mopt.go.cr/jica-mopt/index.html
List of information	1. Announcement of each Stakeholder Meeting 2. Program of each stakeholder meeting (English & Spanish) 3. Presentation materials used at each stakeholder meeting 4. Contents of Q/A sessions (English & Spanish) 5. Lists of Attendants 6. Photo Records

16.3.2 Summary of Stakeholder Meeting

1) 1st Stakeholder Meeting

(1) Outline of 1st Stakeholder Meeting

1st stakeholder meeting was held on February 21, 2006 at the conference room of MOPT, San Jose. Table 16.3.3. summarizes the outline of this 1st meeting. Registration started at 8:30 a.m. of February 21 and the whole process of this stakeholder meeting was video taped.

Originally, 74 stakeholders were selected from various organizations/ agencies/ schools/ NGOs/ groups/ communities and others, and then, invitation letters were sent to those selected stakeholders. List of selected stakeholder is shown in the Homepage. It turned out that 49 people attended at the 1st stakeholder meeting on February 21, 2006.

Table 16.3.3. Outline of 1st Stakeholder Meeting

(1) Registration
(2) Opening Remarks
(3) Explanation of Project Outline
(4) Explanation of JICA Guideline for Environmental and Social Considerations
(5) Coffee Break
(6) Q/A Session
(7) Closing Remarks

(2) Summary of Minutes of Meeting

Presentation materials used in this stakeholder meeting are shown in the Homepage. There are 16 questions about this proposed project and detailed descriptions of this Q/A session are shown in the Homepage (see Table 16.3.4.).

Table 16.3.4. Categorization of Questions

Topics	Number of Question
General	7
Environmental and social aspects	7
Finance	2
Total	16

2) 2nd Stakeholder Meeting

(1) Outline of 2nd Stakeholder Meeting

2nd stakeholder meeting was held on June 08, 2006 at the conference room of CIC (Civil Engineer's Association) of CFIA (Colegio federado de Ingeniero y Arquitectos de Costa Rica), San Jose. This stakeholder meeting was co-organized with the capacity development seminar, held at the same place on the same day. 33 people participated this combined seminar/meeting event. Table 16.3.5. summarizes the outline of this 2nd meeting, co-organized with the Capacity Development Seminar.

Table 16.3.5. Outline of combined 2nd Stakeholder Meeting

(1) Registration
(2) Opening Remark
(3) 2nd Stakeholder Meeting
・Results and/or major finding of IEE
(4) Capacity Development Seminar (part 1)
(5) Coffee Break
(6) Capacity Development (part 2)
(7) Q/A Session
(8) Closing Remark

(2) Summary of Minutes of Meeting

Presentation materials used in this stakeholder meeting are shown in the Homepage. It turned out that no question was made from the floor, but later, there was one letter comment for this stakeholder meeting. That comment was mainly concerned with shipping of fruits and vegetable, major products of southern parts of Costa Rica.

3) 3rd Stakeholder Meeting

(1) Outline of 3rd Stakeholder Meeting

3rd stakeholder meeting was held on October 11, 2006 at the conference room of CIC (Civil Engineer's Association) of CFIA, San Jose. This stakeholder meeting was co-organized with the capacity development seminar, held at the same place on the same day. 25 people participated this combined seminar/meeting event. Table 16.3.6. summarizes the outline of this 3rd meeting, co-organized with the Capacity Development Seminar.

Table 16.3.6. Outline of combined 3rd Stakeholder Meeting

(1) Registration
(2) Opening Remark
(3) 3rd Stakeholder Meeting
- Progress of Bridge Rehabilitation/Improvement Plan
- Review of Q/A session of previous stakeholder meetings
- Explanation of updated Project Homepage (JICA Guideline-based stakeholder meeting)
- Major environmental issues to be associated with each bridge rehabilitation plan
- Key Directions and Concepts of ToR Development
- Preliminary Project Categorization Results

(4) Coffee Break
(5) Capacity Development (part 2)
(6) Q/A Session
(7) Closing Remark

(2) Summary of Minutes of Meeting

Presentation materials used in this stakeholder meeting are shown in the Homepage. It turned out that two questions was made from the floor, and most of them were mainly concerned with the restructuring of the current administrative framework of MOPT, the Government of Costa Rica.

CHAPTER 17 CONCLUSIONS AND RECOMMENDATIONS

17.1 Conclusions

17.1.1 Study Recap

1) Attainments

Consequently that capacity gaps and major issues on the bridge maintenance are minutely assessed and screened out during the study period, an synthetic program for bridge maintenance improvement has been concretely formulated and set about launching under the concept of the Program-Project-Management.

The bridge maintenance program is undertaken by the Bridge Maintenance Consulting Group (BMCG) as described thoroughly in Chapter 6, and is expected to render total efficacy to the Organizational level as well as the social/institutional level in need of the improvement. Simultaneously, diverse training activities have been duly experienced as trial inputs throughout the Technical Training Program stated in Chapter 7.

In particular mentions over those trial inputs, the loading test enforced on 2 bridges as well as the detailed design provided for rehabilitation, reinforcement and improvement work of 10 bridges deserve to be largely featured herewith. These two activities are completed with successful outputs grounded on consistent technical efforts of the mutual collaboration between the Counterpart and the Study team, which are described in detail in Chapter 10 and 11 respectively.

It is a significant attainment that considerable technical and administrative competences for the Counterparts have reached a worthwhile enhancement especially on the individual level.

2) Tasks Remaining

As results of the monitoring and evaluations specify in detail at Chapter 6, however, it is not that a desirable level of the capacity development has been embodied on all of three targeted levels.

Individual capacity level, which results satisfactory at the early stage of the capacity development in terms of the technical competences, is expected to be further enhanced shifting to rather practical, hands-on stages of technical aspects based on trial inputs that the training program earlier described has widely rendered.

It is generally recognized that technical competences on the bridge engineering are neither to be piled up nor to gain the summit one day for another. There are still tasks remained on the transition which basic skills, acknowledge and tools outputted such as the comprehensive Manuals & Guideline are allowed to take root in engineers and to infiltrate into the far advanced level of the capacity for this particular country and/or regions.

Organizational, institutional and social capacity levels are just set on a starting line to elaborate and roll-play their implementation plans formulated by BMCG under the bridge

maintenance program.

Since it is crucial for the BMCG to be formed with members sector-widely and inter-institutionally summoned due to roles and tasks specified on the modular projects, there might be uncertain factors on managerial aspects to enforce the program plans. Close enlacement and coordination among the members, budgetary arrangements are indispensable factors to be secured.

17.1.2 General Descriptions

As stated over previous chapters, the "Capacity Development in Bridge Rehabilitation Planning, Maintenance and Management Based on 29 Bridges of National Highway Network" has commenced and efficaciously expanded on strengthening capability of the maintenance of bridge in Costa Rica. Along with a technical examination for the rehabilitation of 29 bridges inclusively the design for repair works of the 10 selected bridges, which represent structural features of totality, as well as multiple advocacy activities for the Asset Management, awareness and comprehension on the concept of Capacity Development have been extensively rewarded with positive results and efficacy.

Now that the Capacity Development for the Bridge Maintenance has indeed commenced to deepen understandings amongst governmental agencies, academic and/or non-governmental institutions, it shall be high time that the Government of Costa Rica squarely persists in facing this significant issue with firm political visions and commitments.

The sustainability of the capacity development is a key word. It shall be essential that outcomes/outputs from the study are to be initiatively taken over by the Counterparts afterwards withdrawal of the external technical assistance, and that necessary follow-up cares are to be fed strategically into not long but short-mid term perspectives.

17.2 Recommendations

17.2.1 Overview of the Study

(a) Implementation of Comprehensive Bridge Maintenance Program via Formulation of Full-scale Work Breakdown Structures & Operation Plans for 5 Integrated Modular Projects

Based on the proposed preliminary work breakdown structures (WBS) and plan of operations (PO) for 5 integrated modular projects which are integral components of the bridge maintenance improvement program, MOPT and CONAVI, under the assistance of the members of 5 working groups of the Bridge Maintenance Consulting Group (BMCG), are required to formulate the full-scale and detailed WBS and PO for each modular project, thereby providing the clear-cut road map to achieve the ideal bridge maintenance program. These full-scale and detailed WBS and PO will be utilized as basis of the budget request for the financial year 2008 to 2012.

(b) Smooth Continuous Operation of BMCG & 5 Working Groups

While the BMCG acts as an advisory and consulting body to strengthen the institutional capacity of the newly established direction of bridges of MOPT and the planned department of bridge conservation of CONAVI, 5 working groups of the BMCG are responsible for the implementation of 5 integrated modular

projects. The smooth and regular operation of the BMCG as well as 5 working groups is absolutely required for the actual implementation of 5 integrated modular projects. Strong commitment by each member, protocols for procedures, and clear-cut demarcation of responsibilities among members are essential ingredients for the success of the smooth operation of the BMCG and 5 working groups. Especially, since the members of the BMCG are normally engaged in the original works of the organizations which they belong to, those organizations will be required to provide necessary back-stop services to the members.

(c) Individual Capacity Improvement of MOPT & CONAVI Officials (Implementation of Modular Project 1)

Individual capacities of MOPT and CONAVI officials should be steadily improved by a series of seminars as well as on-the-job training opportunities in the following fields so as to meet the demand of the institutional strengthening of MOPT and CONAVI.

i) Individual capacity improvement in the field of inspection & diagnosis

Appropriate periodical inspection and diagnosis of the existing bridges are basic and integral capacities for the bridge maintenance. The collected and diagnosed data of the existing bridges are obtained from the periodical inspections by the proper inspection manual which was drafted during the study period.

ii) Individual capacity improvement in the field of BMS operation & prioritization

A Bridge Management System (BMS) is a cardinal tool for the bridge maintenance practices. The BMS allows MOPT and CONAVI to analyze the priority selection of the bridges to be repaired and reinforced based on the database formatted by the BMS operation manual. The BMS itself should be flexibly and continuously updated in response to the identified operational problems, and the operation of the BMS should be linked with the improvement of inspection and diagnosis practices.

iii) Individual capacity improvement in the field of planning & bridge maintenance

In response to the results of the priority selection of bridges, the planning, designing, and implementation of repairs and reinforcement after the detailed inspections should be implemented. A series of these bridge maintenance practices should be implemented in compliance with the drafted guideline for the bridge maintenance. Since the bridge maintenance technologies can be acquired by ***learning by doing*** process, ample opportunities for on-the-job basis training should be continuously provided so as to generate sufficient qualified staff.

(d) Strengthen New Strategy for MOPT Bridges & Create Proposed Bridge Conservation Department for CONAVI

i) Demarcation of responsibilities between MOPT & CONAVI Bridge Conservation Department

In accordance with the proposed demarcation of responsibilities between MOPT and CONAVI, MOPT and CONAVI are required to jointly work for streamlining the workflows of both new bridge-related organizations.

ii) Strengthen new strategy for MOPT bridges & create CONAVI Bridge Conservation Department

Since the current bridge design department of MOPT is being upgraded to the new direction of bridges from the financial year 2007, this strong momentum for the institutional reform should be utilized at maximum to obtain ample financial and human resources for the bridge maintenance. In addition, the new

department of bridge conservation of CONAVI is being proposed together with the ideal organizational structure, while CONAVI has not been specifying the details of the new department. Although the required number of staff, the proposed organizational structure, the required budget for the new direction of bridges of MOPT as well as the proposed department of bridge conservation of CONAVI are estimated, there are sizable gaps between the required scale of budgets and the requested amounts of budgets. The detailed organizational structures, the number of staff by expertise, the step-by-step enlargement of the total number of staff, and the budgetary arrangement for the operational and personnel costs should be finalized in close relations with planning and financial authorities.

(e) Long-term Human Resources Development & Technical Information Exchanges (Implementation of Modular Project 3)

The long-term human resources development which provides ample candidates for staff of MOPT and CONAVI officials as well as the private sector in the field of bridge maintenance is a key to the sustainable bridge maintenance. A couple of universities such as the University of Costa Rica can be regarded as candidate academic institutions to supply qualified graduates for the required engineers through relevant new courses in the field of bridge engineering and maintenance. The scale, schedule and budgetary plan for new courses at these universities should be designed taking into account the domestic demand and market size of the bridge construction and maintenance. At the same time, by using opportunities on the technical commission of PPP on the highway network, a series of technical information exchanges in the field of bridge maintenance should be promoted among the PPP member countries as the follow-up activities after the PPP regional seminar held in December 2006. Furthermore, the periodical domestic technical information exchanges among the public sector, the academic institutions and the private sector in the field of bridge engineering and maintenance should be also implemented.

(f) Improvement of Regulations & Standards (Implementation of Modular Project 4)

Relevant regulations and standards in the field of bridge designing and procurement procedures under the both public and concessionaire projects should be significantly improved by reviewing existing regulations and standards. Although the inspection manual, the BMS operation manuals and the guideline for the bridge maintenance are all drafted during the study period, relevant regulations and standards are not sufficiently improved. Especially, special attentions must be paid on the bridges which have been and will be constructed under the concession projects so as to make those concessionaires appropriately make use of the drafted inspection manual as well as the guideline for the bridge maintenance, thereby these bridge maintenance practices by concessionaires being complied with those of the regular public investment projects.

(g) Promotion of Advocacy of Government Officials & Public Relations (Implementation of Modular Project 5)

Since the budgetary arrangement is a key to the implementation of 5 integrated modular projects, especially, the individual capacity improvement (the modular project 1) and the institutional reform of MOPT and CONAVI (the modular project 2), the understanding on the importance of asset management by top government officials as well as the strong political commitment to the resource allocation for the bridge maintenance is essential for the sustainable bridge maintenance. At the same time, in an attempt to promote the understanding by taxpayers as well as bridge users on the importance of the bridge maintenance, various domestic public relations activities should be implemented by using available media and channels. The well-balanced budget allocation between the constructions of new bridges and the maintenance of existing bridges should be recognized by both

government officials and taxpayers through these advocacy and public relations activities.

(h) Continuous Monitoring & Evaluation on Outcomes for Capacity Development Process

The outcomes of the capacity development through the implementation of 5 integrated modular projects are required to be periodically monitored and evaluated to ensure that the capacity development process is on the right truck in accordance with the proposed monitoring and evaluation procedures. Benchmarks as performance indicators for monitoring and evaluation will be continuously updated for the feedbacks to the capacity development activities. A couple of officials who are proficient in project management framework tools such as PDM, WBS and PO should be stationed in the monitoring unit of the secretariat of the BMCG.

17.2.2 Deflection of Pre-stressed Concrete Box Girder Bridges

Deflection can be observed at the central span of two pre-stressed concrete box girder bridges: Bridge No.17 (Rio Chirripo, about 20cm) and Bridge No.20 (Rio Sucio, about 27cm). Potential causes of deflection are as follows:

- Lack of concrete box girder strength
- Decrease in the elastic modulus of concrete box girders
- Lack of introduced tension of PC cables
- Abnormal progress in concrete creep
- Insufficient quality control during construction

The results of investigations into the above-mentioned potential causes of deflection for Bridge No. 17 and No. 20 are described below.

(a) According to a detailed inspection conducted by the Study the following can be stated:
- There is no abnormal cracking.
- There is no abnormal carbonation.
- There is no abnormal vibration due to vehicles passing.

(b) According to a concrete core boring test for Bridge No.20 and a Schmidt Hammer test for both Bridge No. 17 and No. 20 the following can be stated:
- The concrete strength of the bridge bodies satisfies required levels.
- The elastic modulus of boring core specimens satisfies required levels.

(c) According to a structural analysis and loading test for Bridge No.17 the following can be stated:
- Required stiffness was confirmed and is the same as that of the drawings

The above analyses indicate that Bridge No.17 and No.20 satisfy the necessary structural requirements, except for the deflections observed at the central spans, and will therefore be able to serve traffic safely. It is thought that the observed deflections are due to insufficient quality control during construction. However, this is an assumption as there are no original construction plans and construction records available. Note that the load carrying capacity of the bridges for HS20+25% was checked in the structural analysis using a model based on original design drawings.

Given the preceding, the Study Team is of the opinion that Bridge No.17 and No.20 can serve the public safely in the future. However, it is recommended that the deflections of these bridges be measured for

change at least once every year.

17.2.3 Ensuring Sufficient Funding for Bridge Rehabilitation & Reinforcement

The Study Team has examined and compiled concepts and methodologies on the proper rehabilitation and reinforcement of the Study bridges that will produce substantial benefits for the public. It is recommended that the public be made conscious of this via an awareness campaign to ensure sufficient future funding for these structures.

17.2.4 Environmental Management

Throughout this IEE study, it was found that potential impacts to be caused by the proposed bridge rehabilitation program such as the impacts on the water quality would not be negligible at the construction phase. Also, several bridge sites may be located in the adjacent of the important biological corridor (Figure 16.2.1), and thus, would become critical discussion points at both construction and operation phases. ToR of this further environmental study shall be developed based on Costa Rican EIA law as well as relevant laws/or regulations such as the biodiversity law, and then, relevant environmental studies shall be carried out based on the developed ToR.