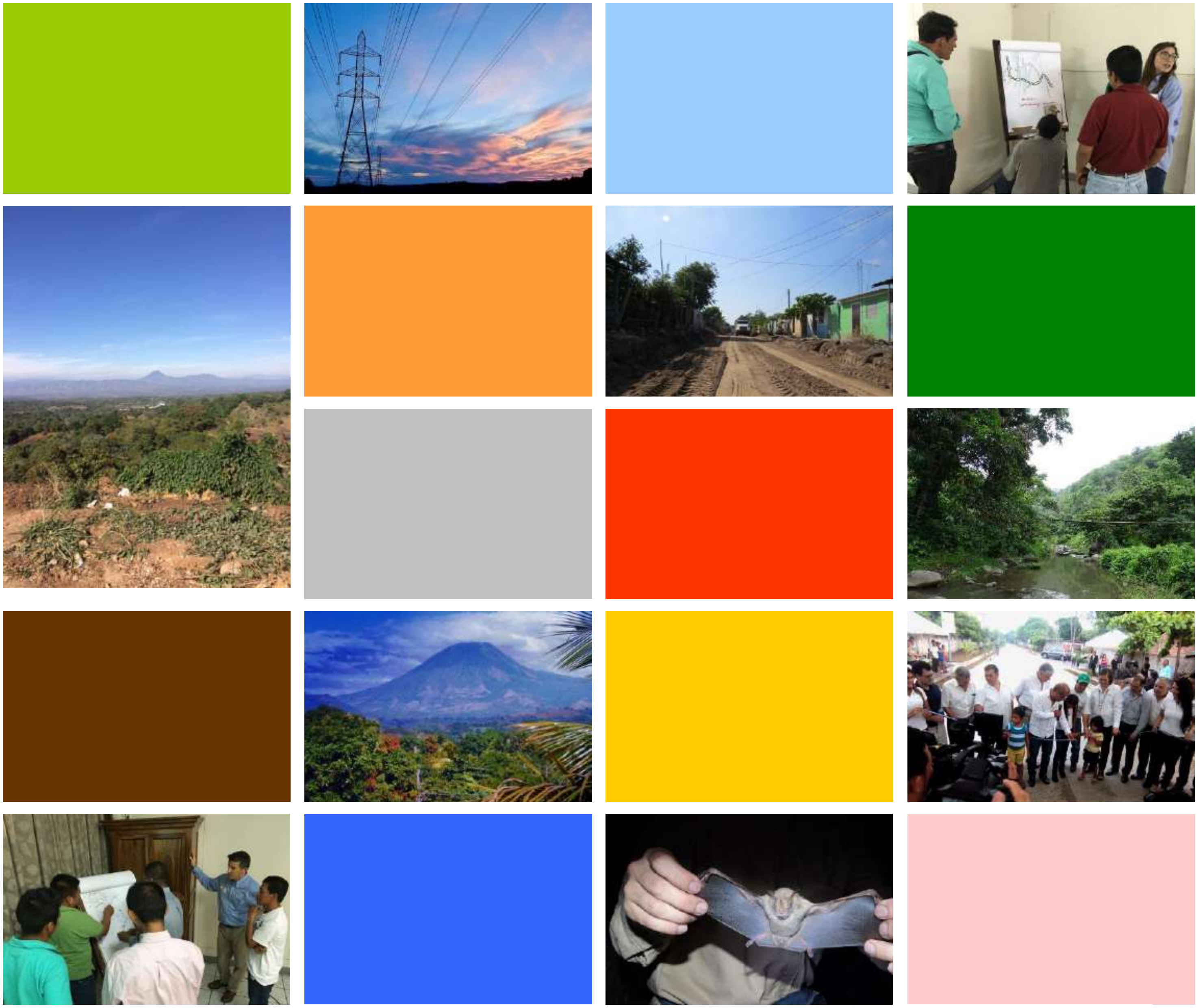

Energía del Pacífico

Environmental Impact Study

Volume I

Transmission Line Project Ahuachapán to Acajutla

January 2017

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LIST OF ACRONYMS

ADESCOS	Salvadoran Communal Development Associations (for its acronym in spanish) (Asociaciones de Desarrollo Comunales Salvadoreñas)
AIBR	Apaneca-Ilamatepec Biosphere Reserve
AIDS	Acquired Immunodeficiency Syndrome
AMSS	Metropolitan Area of San Salvador (for its acronym in spanish) (Área Metropolitana de San Salvador)
ANDA	National Administration of Aqueducts and Sewers (for its acronym in spanish) (Administración Nacional de Acueductos and Alcantarillados)
APLIC	Avian Power Line Interaction Committee
AQMN	Air Quality Monitoring Network
ASAPROSAL	Salvadoran Pro-Health Association (for its acronym in spanish) (Asociación Salvadoreña Pro-Salud)
BBC	British Broadcasting Company
BIRF	International Bank for Reconstruction and Development (for its acronym in spanish) (Banco International de Reconstrucción and Fomento)
CCAD	Central American Commission for the Development Environment (for its acronym in spanish) (Comisión Centroamericana de Ambiente de Desarrollo
CENTA	National Center of Agricultural and Forestry Technology "Enrique Álvarez Córdova" (for its acronym in spanish) (Centro Nacional de Tecnología Agropecuaria and Forestal "Enrique Álvarez Córdova")
CEPA	Autonomous Executive Port Commission (for its acronym in spanish) (Comisión Ejecutiva Portuaria Autónoma)
CFI	International Financial Corporation (for its acronym in spanish) (Corporación Financiera Internacional)
CH_4	Methane
CID	Integral Youth Development Center (for its acronym in spanish) (Centro Integral del Desarrollo Juvenil)
CLUSA	Cooperative of the United States of America (for its acronym) (Cooperativa de los Estados Unidos de América)
CO	Carbon Monoxide

CO_2	Carbon Dioxide
CODEM	Metropolitan Development Council (for its acronym in spanish) (Consejo de Desarrollo Metropolitano)
COMURES	Corporation of Municipalities of El Salvador (for its acronym in spanish) (Corporación de Municipalidades de El Salvador)
CSC	Salvadoran Coffee Council (for its acronym in spanish) (Consejo Salvadoreño del Café)
CSM	Military Health Command (for its acronym in spanish) (Comando de Sanidad Militar)
CT EDP	Energía del Pacifico Thermal Power Plant
dB	Decibels
DIA	Direct Influence Area
DO	Denomination of Origin
EAI	Enterprise for the Americas Initiative
ECOS	Family and Specialized Community Health Teams (for its acronym in spanish) (Equipos Comunitarios de Salud Familiar and Especializados)
EDP	Energía del Pacifico
EEUU	Estados Unidos de Norteamérica
EIS	Environmental Impact Study
EMP	Environmental Management Plan
ENSO	El Niño-Southern Oscillation
EPEA	Expected Peak Effective Acceleration
ETESAL	Transmitter Company of El Salvador (for its acronym in spanish) (Empresa Transmisora de El Salvador, SA de CV)
FAO	Food and Agriculture Organization
FISDL	Social Investment Fund for Local Development (for its acronym in spanish) (Fondo de Inversión Social para el Desarrollo Local)
FOSALUD	Solidarity Fund for Health (for its acronym in spanish) (Fondo Solidario para la Salud)
FUNDESYRAM	Foundation for Socioeconomic Development (for its acronym in spanish) (Fundación para el Desarrollo Socioeconómico)
FUSATE	Salvadoran Foundation for Elderly (for its acronym in spanish) (Fundación Salvadoreña de la Tercera Edad)

GDP	Gross Domestic Product
Gg	Giga grams
GHG	Greenhouse Gases
GIZ	German Cooperation
GPS	Global Positioning System
GRIS	GRIS, S.A De C.V.
GWM	Groundwater Masses
Ha	Hectares
HC	Hydrocarbons
HDI	Human Development Index
HFC	Hydrofluorocarbons
HIV	Human Immunodeficiency Virus
Hz	Hertz
IBA	Important Bird Area
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IFC	International Finance Corporation
IGN	National Geographic Institute (for its acronym in spanish) (Instituto Geográfico Nacional)
IIA	Indirect Influence Area
IPCC	Intergovernmental Panel on Climate Change
IPSFA	Social Security Institute of the Armed Forces (for its acronym in spanish) (Instituto de Previsión Social de la Fuerza Armada)
ISBM	Salvadoran Institute of Teacher Welfare (for its acronym in spanish) (Instituto Salvadoreño de Bienestar Magisterial)
ISDEMU	Salvadoran Institute for the Development of Women (for its acronym in spanish) (Instituto Salvadoreño para el Desarrollo de la Mujer)
ISRI	Salvadoran Institute of Integral Rehabilitation (for its acronym in spanish) (Instituto Salvadoreño de Rehabilitación Integral)
ISSS	Salvadoran Institute of Social Security (for its acronym in spanish) (Instituto Salvadoreño del Seguro Social)
IUCN	International Union for the Conservation of Nature

IUDOP	University Institute of Public Opinion (for its acronym in spanish) (Instituto Universitario de Opinión Pública)
JICA	Japan International Cooperation Agency (for its acronym in spanish) (Agencia de Cooperación Internacional de Japón)
km	Kilometers
KOICA	Korea International Cooperation Agency (for its acronym in spanish) (Agencia de Cooperación Internacional de Corea)
kV	Kilovolts
l/s	liters per second
LAPOP	Latin American Public Opinion Project
LNG	Liquid Natural Gas
LPPCN	Law of Protection to the Cultural Patrimony of the Nation (for its acronym in spanish) (Ley de Protección al Patrimonio Cultural de la Nación)
LULUCF	Land Use, Land Use Change and Forestry
m	Meters
m^2	Square Meters
m^3	Cubic Meters
m^3/s	Cubic Meters per Second
MAG	Ministry of Agriculture and Livestock (for its acronym in spanish) (Ministerio de Agricultura and Ganadería)
MARN	Ministry of Environment and Natural Resources (for its acronym in spanish) (Ministerio del Medio Ambiente and Recursos Naturales)
mG	MilliGauss
mg/l	Milligrams per Liter
MINE	Ministry of Economy (for its acronym in spanish) (Ministerio de Economía)
MINEC	Ministry of Commerce and Industry (for its acronym in spanish) (Ministerio de Comercio e Industria)
MINED	Ministry of Education (for its acronym in spanish) (Ministerio de Educación)
MINSAL	Ministry of Health (for its acronym in spanish) (Ministerio de Salud)
MITUR	Ministry of Tourism El Salvador (for its acronym in spanish) (Ministerio de Turismo El Salvador)

ml	Milliliters
MPHS	Multiple Purpose Household Survey
MPI	Multidimensional Poverty Index
msnm	Meters Above Sea Level
MSPAS	Ministry of Public Health and Social Assistance (for its acronym in spanish) (Ministerio de Salud Pública and Asistencia Social)
mT	Millitesla
MW	Megawatts
ND	Performance Standards
NMP	Most Potable Number
NOx	Nitrogen Oxides
NSO	Mandatory Salvadorian Rule (for its acronym in spanish) (Norma Salvadoreña Obligatoria)
OMS	World Health Organization (for its acronym in spanish) (Organización Mundial de la Salud)
ONG	Non governmental organization (for its acronym in spanish) (Organización No Gubernamental)
OPGW	Optical fiber composite overhead ground wire
PM 10	Particulate Matter Less Than 10 Micrometers
PM 2.5	Particulate Matter Less Than 2.5 Micrometers
PNUD	United Nations Development Program (for its acronym in spanish) (Programa de las Naciones Unidas para el Desarrollo)
PRD	Participatory Rural Diagnosis
PROCAFE	Salvadoran Foundation for Coffee Research (for its acronym in spanish) (Fundación Salvadoreñas para la Investigación del Café)
PVC	Polyvinyl Chloride
RA	Rainforest Alliance
ROW	Right of Way
SE	Substation
SECULTURA	Secretariat of Culture (for its acronym in spanish) (Secretaría de Cultura)

SIEPAC	System of Interconnection of the Countries of Central America (for its acronym in spanish) (Sistema de Interconexión de los Países de América Central)
SIGET	Superintendence of Electricity and Telecommunications (for its acronym in spanish) (Superintendencia General de Electricidad and Telecomunicaciones)
SINAMA	National System of Environmental Management (for its acronym in spanish) (Sistema Nacional de Gestión Ambiental)
SMP	Social Management Program
SNET	National Geological Service Seismology Area (for its acronym in spanish) (Servicio Geológico Nacional Área de Sismología)
SO_2	Sulfur Dioxide
TL	Transmission Line
TP	Tower
TSP	Total Suspended Particles
UNES	Salvadoran Ecological Unit (for its acronym in spanish) (Unidad Ecológica Salvadoreña)
UNESCO	United Nations Educational, Scientific and Cultural Organization
USACE	United States Army Corps of Engineers
USD	United States Dollars
VII	Value and Importance Index
WAP	Working Age Population
WQI	Water Quality Index
µT	Microtesla

TITLE AND AUTHORS

ENVIRONMENTAL IMPACT STUDY OF THE TRANSMISSION LINE OF AHUACHAPÁN TO ACAJUTLA

Holder

ENERGÍA DEL PACIFICO, Ltd. de C.V.

Ing. Alejandro Gustavo Alle

Legal Attorney

Authors

The study was prepared by a team of Salvadoran consultants with the support of several professionals from the company Environmental Resources Management, Inc. (ERM). The work team is presented below and the following pages include registration certificates as environmental service providers in the Ministry of the Environment and Natural Resources (MARN).

Name	Function	Registry
Specialists Registered in MARN		
Ing. Roberto Escalante	Chief Coordinator	RPSEA 0270
William Vaquerano	Biological Aspects	RPSEA 462
Massiel Ramos	Cultural Aspects	[a]Does not have
Ing. Federico Ildefonso Castellanos	Risks	RPSEA - 0006
Carlos Reyes	Socioeconomic Aspects	[a]Does not have
Collaborators of ERM		
Dr. Ricardo Calvo	Environmental Planning	N/A
Dr. Herbert Pirela	Physical Aspects	N/A
Lic. Lilian Flank Maggi	Planning	N/A
Lic. Isolina Sánchez	Socioeconomic Aspects	N/A
Dr. Robert Langstroth	Biodiversity	N/A
Dr. Manuel Roman	Cultural Aspects	N/A

[a] Archaeologists and sociologists have no record in the MAR

MINISTERIO DE MEDIO AMBIENTE Y RECURSOS NATURALES
UNÁMONOS PARA CRECER

RESOLUTION MARN-RPSEA-PN No. 13/2015

Ministry of the Environment and Natural Resources, San Salvador, twenty-fifth of February of two thousand and fifteen. Considering the measures promoted by ROBERTO ALFONSO ESCALANTE CACEROS, Civil Engineer, of the address of San Salvador, department of San Salvador, and with Single Personal Identity Document Number zero one three zero one one one three - three, who requests to this Ministry that in compliance with what is established in Article 47 of the General Regulation of the Law of the Environment, will be renewed His registration in the Registry of Service Providers of Environmental Impact Studies and Environmental Diagnostics and Environmental Assessment Audits. The Ministry of Environment and Natural Resources through the Directorate of Environmental Assessment and Compliance.

CONSIDERING THAT:

I. On October seven, nineteen hundred and ninety-nine, this Ministry issued the note MARN-DCA-EIA-721/99, in which it was resolved that the professional ROBERTO ALFONSO ESCALANTE CACEROS, was registered under the number TWO HUNDRED SEVENTY (270), as Service Provider of Environmental Impact Study, Environmental Diagnostics

II. On the nineteenth day of February of the year two thousand and fifteen, the application for renewal of the Service Provider Registry was submitted to this Ministry by engineer ROBERTO ALFONSO ESCALANTE CACEROS. It was verified that the documentation presented complied with the requirements established in Article 47 of the General Regulation of the Law of the Environment

THEREFORE:

In accordance with the provisions in the previous recitals, the Environmental Law and its General Regulations.

RESOLVES:

1. GROWING THE RENEWAL OF REGISTRATION WITH THE **NUMBER TWO HUNDRED SEVENTY (270)**, AS A SERVICE PROVIDER OF ENVIRONMENTAL IMPACT STUDY AND ENVIRONMENTAL DIAGNOSTICS, to the Civil Engineer, ROBERTO ALFONSO ESCALANTE CACEROS, Bearer of its Unique Identity Document Number Zero one three three one one one three three, who meets the requirements established in Article 47 of the General Regulation of the Law of the Environment.

2. The present resolution will have a validity of THREE (3) years from the date of its issuance, that is to say from the twenty-fifth of February of two thousand fifteen, to the twenty-fifth of February of the year two thousand and eighteen, once the term has expired, it must request its renewal, the presentation of the appropriate form and accompanying documentation to this State Ministry.

3. That the Environmental Service Provider will keep the same number with which it was Certified and Registered in this State Ministry.

4. That this resolution does not authorize the bearer to perform environmental technical services or activities related to Environmental Assessment Audits, only Environmental Impact Studies and Environmental Diagnostics.

5. The Service Provider of Environmental Impact Studies shall keep the reservation and professional secrecy of the information and documentation to which they have access for the provision of their services, in each particular case.

6. That any modification that the Service Provider intends to make to the present resolution, must request to the Ministry of Environment and Natural Resources by means of note with its respective annexes that justify this modification.

7. That the Service Provider can not be a reference of the holder in the Ministry of Environment and Natural Resources, to present or receive notifications or other documentation related to the Environmental Assessment Process, its role will only consist of the Preparation of the Environmental Impact Study , With the purpose of avoiding conflicts of interest.

8. That the Environmental Service Provider should not provide their telephone numbers or office address, as a place of notification, all of the above must be information of the Project holder.

9. That the Environmental Service Provider can only provide its services within its professional specialization.

10. That the Service Provider, that for any reason enters to work to the Ministry of Environment and Natural Resources, by any modality of contracting; Must submit an Affidavit, duly notarized with the list of Projects of Environmental Impact Studies in which it has participated directly or indirectly; And so it is also made known that in compliance with what is established in Article 43 of the General Regulation of the Environmental Law, if for any reason to enter this State Ministry, under any modality of contracting will be temporarily disabled for the Execution of Environmental Impact Studies and Environmental Diagnostics, while providing its service in this Institution.

11. The Environmental Service Provider must have basic knowledge of the legal system that regulates the activity, work or project in which the Environmental Impact Study and Environmental Diagnostics will be developed.

12. That the Environmental Service Provider submitted to this State Ministry documents confirming the renewal of the registration of the Registry of Environmental Studies and Environmental Diagnostic Services Providers and that it complies with the requirements established in Article 47 of the General Regulation of the Law of the Environment.

13. The Ministry may unsubscribe from the Registry to the Environmental Impact Assessment Service Provider for any of the following causes: a) For having provided false or notoriously incorrect information for registration, b) For presenting in the Environmental Impact Studies and in The Environmental Diagnostics, false or incorrect information or omit information due to negligence, bad faith or fraud, which entails the commission of an environmental infraction in accordance with Article 86 of the Environmental Law, c) For presenting Environmental Impact Studies that do not meet The relevant technical and scientific quality and that do not comply with the general characteristics established in the Law and its regulations, d) For non-compliance with the content of this resolution, e) And the others indicated in article 47 A, of the General Regulation of the Law of the Environment.

14. According to the details in the previous numeral the Ministry may at any time send to the Service Provider of Environmental Impact Study, administrative penalty notice for violation of the Environmental Law, which will also send a copy to your personal Service Provider file located in this Ministry. And if the non-compliance repeatedly persists, the Environmental Service Provider will be subject to the unsubscribe process that establishes the article 47 A, of the General Regulation of the Law of the Environment.

15. That the contents of note MARN-DCA-EIA-721/99, dated October seven, nineteen hundred and ninety-nine, is without effect.

The present Resolution are signed in two (2) original, and the same will come into effect from the day of its issuance. - **COMMUNICATE. - THE DIRECTOR GENERAL OF EVALUATION AND ENVIRONMENTAL COMPLIANCE, SILVIA MARGARITA HERNANDEZ DE LARIOS (f).**

MINISTERIO DE MEDIO AMBIENTE Y RECURSOS NATURALES
DIRECCIÓN GENERAL DE
EVALUACIÓN Y CUMPLIMIENTO AMBIENTAL
El Salvador, C.A.

Licenciada Silvia Margarita Hernández de Larios
Directora General de Evaluación y
Cumplimiento Ambiental

DGECA-GEA-KA-JS

Ministerio de Medio Ambiente
y Recursos Naturales

RESOLUTION MARN-RPSEA-PN No. 007/2014

Ministry of the Environment and Natural Resources, San Salvador, March thirty-one, two thousand and fourteen.. Considering the measures promoted by WILLIAM ORLANDO VAQUERANO HUEZO, Bachelor of Biology, from the San Salvador domicile, department of San Salvador, and with Single Personal Identity Document Number: zero one two eight nine four three four - two, who requests to this Ministry that in compliance with what is established in Article 47 of the General Regulation of the Law of the Environment, will be renewed His registration in the Registry of Service Providers of Environmental Impact Studies and Environmental Diagnostics and Environmental Assessment Audits. The Ministry of Environment and Natural Resources through the Directorate of Environmental Assessment and Compliance.

CONSIDERING THAT:

I. On October nine, two thousand two, this Ministry issued a note MARN-DGA-EIA-1656/2002, in which it was resolved that the professional WILLIAM ORLANDO VAQUERANO HUEZO, registered under number FOUR HUNDRED AND SIXTY TWO (462), as Service Provider of Environmental Impact Study, Environmental Diagnostics

II. On the twenty-sixth day of March of the year two thousand and fourteen, the application for renewal of the Service Provider Register was filed by the WILLIAM ORLANDO VAQUERANO HUEZO. It was verified that the documentation presented complied with the requirements established in Article 47 of the General Regulation of the Law of the Environment

THEREFORE:

In accordance with the provisions in the previous recitals, the Environmental Law and its General Regulations.

RESOLVES:

1. GROWING THE RENEWAL OF REGISTRATION WITH THE **NUMBER FOUR HUNDRED AND SIXTY TWO (462)**, AS A SERVICE PROVIDER OF ENVIRONMENTAL IMPACT STUDY AND ENVIRONMENTAL DIAGNOSTICS, to Mr. WILLIAM ORLANDO VAQUERANO HUEZO, bearer of his document Unique Identity Number zero one two eight nine four three four - two, who meets the requirements established in Article 47 of the General Regulation of the Law of the Environment.

2. The present resolution will have a validity of THREE (3) years from the date of its issuance, that is to say from the twenty-fifth of February of two thousand fifteen, to the twenty-fifth of February of the year two thousand and eighteen, once the term has expired, it must request its renewal, the presentation of the appropriate form and accompanying documentation to this State Ministry.

3. That the Environmental Service Provider will keep the same number with which it was Certified and Registered in this State Ministry.

4. That this resolution does not authorize the bearer to perform environmental technical services or activities related to Environmental Assessment Audits, only Environmental Impact Studies and Environmental Diagnostics.

5. The Service Provider of Environmental Impact Studies shall keep the reservation and professional secrecy of the information and documentation to which they have access for the provision of their services, in each particular case.

6. That any modification that the Service Provider intends to make to the present resolution, must request to the Ministry of Environment and Natural Resources by means of note with its respective annexes that justify this modification.

7. That the Service Provider can not be a reference of the holder in the Ministry of Environment and Natural Resources, to present or receive notifications or other documentation related to the Environmental Assessment Process, its role will only consist of the Preparation of the Environmental Impact Study , With the purpose of avoiding conflicts of interest.

8. That the Environmental Service Provider should not provide their telephone numbers or office address, as a place of notification, all of the above must be information of the Project holder.

9. That the Environmental Service Provider can only provide its services within its professional specialization.

10. That the Service Provider, that for any reason enters to work to the Ministry of Environment and Natural Resources, by any modality of contracting; Must submit an Affidavit, duly notarized with the list of Projects of Environmental Impact Studies in which it has participated directly or indirectly; And so it is also made known that in compliance with what is established in Article 43 of the General Regulation of the Environmental Law, if for any reason to enter this State Ministry, under any modality of contracting will be temporarily disabled for the Execution of Environmental Impact Studies and Environmental Diagnostics, while providing its service in this Institution.

11. The Environmental Service Provider must have basic knowledge of the legal system that regulates the activity, work or project in which the Environmental Impact Study and Environmental Diagnostics will be developed.

12. That the Environmental Service Provider submitted to this State Ministry documents confirming the renewal of the registration of the Registry of Environmental Studies and Environmental Diagnostic Services Providers and that it complies with the requirements established in Article 47 of the General Regulation of the Law of the Environment.

13. The Ministry may unsubscribe from the Registry to the Environmental Impact Assessment Service Provider for any of the following causes: a) For having provided false or notoriously incorrect information for registration, b) For presenting in the Environmental Impact Studies and in The Environmental Diagnostics, false or incorrect information or omit information due to negligence, bad faith or fraud, which entails the commission of an environmental infraction in accordance with Article 86 of the Environmental Law, c) For presenting Environmental Impact Studies that do not meet The relevant technical and scientific quality and that do not comply with the general characteristics established in the Law and its regulations, d) For non-compliance with the content of this resolution, e) And the others indicated in article 47 A, of the General Regulation of the Law of the Environment.

14. According to the details in the previous numeral the Ministry may at any time send to the Service Provider of Environmental Impact Study, administrative penalty notice for violation of the Environmental Law, which will also send a copy to your personal Service Provider file located in this Ministry. And if the non-compliance repeatedly persists, the Environmental Service Provider will be subject to the unsubscribe process that establishes the article 47 A, of the General Regulation of the Law of the Environment.

15. That the contents of note MARN-DCA-EIA -1656 / 2002, dated October nine, two thousand two, is without effect.

The present Resolution are signed in two (2) original, and the same will come into effect from the day of its issuance. - **COMMUNICATE. - THE DIRECTOR GENERAL OF EVALUATION AND ENVIRONMENTAL COMPLIANCE, SILVIA MARGARITA HERNANDEZ DE LARIOS (f).**

MINISTERIO DE MEDIO AMBIENTE Y RECURSOS NATURALES
DIRECCIÓN GENERAL DE
EVALUACIÓN Y CUMPLIMIENTO AMBIENTAL
El Salvador, C.A.

Lic. Silvia de Larios
Directora General de Evaluación y
Cumplimiento Ambiental

DGECA-GEA-GM-RO

MINISTERIO DE MEDIO AMBIENTE Y RECURSOS NATURALES
UNIDOS CRECEMOS TODOS

RESOLUTION MARN-RPSEA-PN No. 041/2014

Ministry of the Environment and Natural Resources, San Salvador, July ten, two thousand and fourteen. Considering the measures promoted by FEDERICO ILDEFONSO CASTELLANOS FUNES, Civil Engineer, of the domicile of Santa Tecla, department of La Libertad, and with a Single Personal Identity Document Number: zero zero six eight two zero one two – three, who requests to this Ministry that in compliance with what is established in Article 47 of the General Regulation of the Law of the Environment, will be renewed His registration in the Registry of Service Providers of Environmental Impact Studies and Environmental Diagnostics and Environmental Assessment Audits. The Ministry of Environment and Natural Resources through the Directorate of Environmental Assessment and Compliance.

CONSIDERING THAT:

I. On December First of nineteen hundred and ninety-eight, this Ministry issued the note MARN-CA-EIA-192/98, in which it was resolved that the professional FEDERICO ILDEFONSO CASTELLANOS FUNES, was registered under the number SEIS (0006), as Service Provider of Environmental Impact Study, Environmental Diagnostics

II. On June twenty-seventh of two thousand and fourteen, the Ministry of the Ministry of the Interior, the Engineer of the FEDERICO ILDEFONSO CASTELLANOS FUNES. It was verified that the documentation presented complied with the requirements established in Article 47 of the General Regulation of the Law of the Environment

THEREFORE:

In accordance with the provisions in the previous recitals, the Environmental Law and its General Regulations.

RESOLVES:

1. GROWING THE RENEWAL OF REGISTRATION WITH THE **NUMBER SIX (006)**, AS A SERVICE PROVIDER OF ENVIRONMENTAL IMPACT STUDY AND ENVIRONMENTAL DIAGNOSTICS, To the Civil Engineer, FEDERICO ILDEFONSO CASTELLANOS FUNES, bearer of his document Unique Identity Number zero zero six eight two zero one two - three, who meets the requirements established in Article 47 of the General Regulation of the Law of the Environment.

2. twenty-fifth of February of the year two thousand and eighteen, once the term has expired, it must request its renewal, the presentation of the appropriate form and accompanying documentation to this State Ministry.

3. That the Environmental Service Provider will keep the same number with which it was Certified and Registered in this State Ministry.

4. That this resolution does not authorize the bearer to perform environmental technical services or activities related to Environmental Assessment Audits, only Environmental Impact Studies and Environmental Diagnostics.

5. The Service Provider of Environmental Impact Studies shall keep the reservation and professional secrecy of the information and documentation to which they have access for the provision of their services, in each particular case.

6. That any modification that the Service Provider intends to make to the present resolution, must request to the Ministry of Environment and Natural Resources by means of note with its respective annexes that justify this modification.

7. That the Service Provider can not be a reference of the holder in the Ministry of Environment and Natural Resources, to present or receive notifications or other documentation related to the Environmental Assessment Process, its role will only consist of the Preparation of the Environmental Impact Study , With the purpose of avoiding conflicts of interest.

8. That the Environmental Service Provider should not provide their telephone numbers or office address, as a place of notification, all of the above must be information of the Project holder.

9. That the Environmental Service Provider can only provide its services within its professional specialization.

10. That the Service Provider, that for any reason enters to work to the Ministry of Environment and Natural Resources, by any modality of contracting; Must submit an Affidavit, duly notarized with the list of Projects of Environmental Impact Studies in which it has participated directly or indirectly; And so it is also made known that in compliance with what is established in Article 43 of the General Regulation of the Environmental Law, if for any reason to enter this State Ministry, under any modality of contracting will be temporarily disabled for the Execution of Environmental Impact Studies and Environmental Diagnostics, while providing its service in this Institution.

11. The Environmental Service Provider must have basic knowledge of the legal system that regulates the activity, work or project in which the Environmental Impact Study and Environmental Diagnostics will be developed.

12. That the Environmental Service Provider submitted to this State Ministry documents confirming the renewal of the registration of the Registry of Environmental Studies and Environmental Diagnostic Services Providers and that it complies with the requirements established in Article 47 of the General Regulation of the Law of the Environment.

13. The Ministry may unsubscribe from the Registry to the Environmental Impact Assessment Service Provider for any of the following causes: a) For having provided false or notoriously incorrect information for registration, b) For presenting in the Environmental Impact Studies and in The Environmental Diagnostics, false or incorrect information or omit information due to negligence, bad faith or fraud, which entails the commission of an environmental infraction in accordance with Article 86 of the Environmental Law, c) For presenting Environmental Impact Studies that do not meet The relevant technical and scientific quality and that do not comply with the general characteristics established in the Law and its regulations, d) For non-compliance with the content of this resolution, e) And the others indicated in article 47 A, of the General Regulation of the Law of the Environment.

14. According to the details in the previous numeral the Ministry may at any time send to the Service Provider of Environmental Impact Study, administrative penalty notice for violation of the Environmental Law, which will also send a copy to your personal Service Provider file located in this Ministry. And if the non-compliance repeatedly persists, the Environmental Service Provider will be subject to the unsubscribe process that establishes the article 47 A, of the General Regulation of the Law of the Environment.

15. That the contents of note MARN-CA-EIA-192/98, dated December First, nineteen hundred and ninety-eight , is without effect.

The present Resolution are signed in two (2) original, and the same will come into effect from the day of its issuance. - **COMMUNICATE. - THE DIRECTOR GENERAL OF EVALUATION AND ENVIRONMENTAL COMPLIANCE, SILVIA MARGARITA HERNANDEZ DE LARIOS (f).**

MINISTERIO DE MEDIO AMBIENTE Y RECURSOS NATURALES
DIRECCIÓN GENERAL DE
EVALUACIÓN Y CUMPLIMIENTO AMBIENTAL
El Salvador, C.A.

Lic. Silvia Margarita Hernández de Larios
Directora General de Evaluación y
Cumplimiento Ambiental

EXECUTIVE SUMMARY

1.0 PURPOSE AND NECESSITY OF THE PROJECT

The purpose of the Transmission Line Project (TL) is to deliver electrical power to the Ahuachapán Substation (SE), which is interconnected with the Central American Interconnection System (SIEPAC), with a voltage of 230 kilovolts (kV). The project also includes the 115-kV interconnection with the Acajutla SE to provide greater flexibility to the electricity distribution system in the country, as well as to make the necessary modifications and expansions in both substations, Acajutla and Ahuachapán.

2.0 DESCRIPTION OF THE PROJECT ANT ITS ALTERNATIVES

The project contemplates the construction of a double-stranded TL 230 kV of approximately 44 kilometers (km) in length. The TL is part of Energía del Pacífico's "LNG to Power" project, which consists of a) the construction of a Power Plant (Central / Thermal Energía del Pacífico Power Plant [CT EDP]) generating electricity, with a capacity of 380 megawatts (MW) based on natural gas, to be located in the Municipality of Acajutla, Department of Sonsonate, b) expansion of existing substations of Ahuachapán (230 kV) and Acajutla (115 kV), and c) the construction of the new Acajutla 230 kV electrical substation within the thermal power plant.

The TL starts at the Ahuachapán SE, located in the vicinity of Los Ausoles Geothermal Plant; then passes through the municipalities of Ahuachapán, Apaneca, San Pedro Puxtla, Santo Domingo de Guzmán, Sonsonate and Acajutla; reaching CT EDP, where the Acajutla SE will be built, which will have a double voltage transformation level, 230 kV for the interconnection with the Ahuachapán and SIEPAC substations and 115 kV for the interconnection at the Acajutla substation.

The project is located between the parallels 13° 35' 1.81"(Acajutla SE) and 13° 55' 21.39" (Ahuachapán SE) of north latitude and meridians 89° 49' 39.67" (Acajutla SE) at 79° 49' 2.65" (Ahuachapán SE) of west longitude (Figure 1).

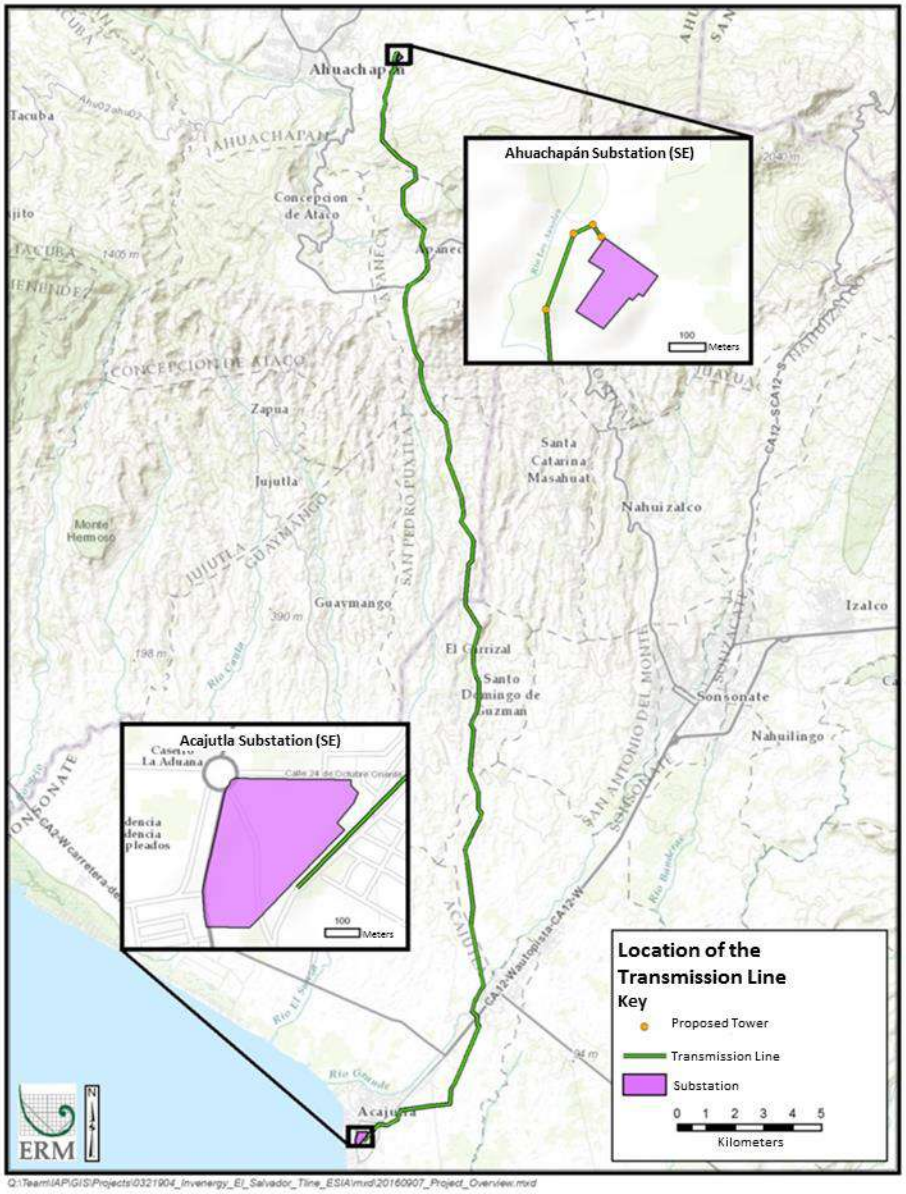

Figure 1 ***Location of the Transmission Line and Substations***

For this Environmental Impact Study (EIS), two types of area of influence have been defined as described below:

- Direct Influence Area (DIA): corresponds to the space within and near which the Project footprint will be located, where a direct impact is expected to occur. Within the area of direct influence evaluated, the footprint of the affected area is included: towers, substations, access roads and their right of way; in addition, of the areas where the different equipment and machinery (campuses) and substations were stored.

- Project Indirect Influence Area (IIA): defined as the physical space that may be potentially affected by any of the Project components, outside the Project area. The IIA was established as the space from the DIA boundary to the distance where 100m is covered on both sides of the Project alignment. For socio-economic aspects, the six municipalities covered by the Project are considered.

2.1 *PROJECT COMPONENTS*

The execution project of the CT EDP also includes the implementation of the following high voltage installations that allow the conection of the power plant with the electrical interconnected system of El Salvador:

- Expansion of existing Ahuachapán SE (230 kV) and Acajutla (115 kV);
- Building of a new electric SE power plant Acajutla 230 kV inside CT EDP territory;
- Building of a 115kV Transmission Line between CT EDP and Acajutla SE of 115kV; and
- Building of a 230 kV Transmission Line between Ahuachapán and Acajutla Substations of 230 kV.

For the purpose of this EIS, this Project considers the 230 kV Transmission Line between the Ahuachapán and Acajutla Substations, the construction of the new Acajutla electric SE 230 kV within the grounds of CT EDP, and the adequacy of Ahuachapán SE.

The necessary access network for the construction of the different components of the Project will be constituted by the following types of accesses:

- Main accesses, built from the existing public road network.
- Internal access, between the various work fronts and services.

It is estimated that the installation project for the Ahuachapán - Acajutla 230 Kv Transmission Line will last approximately 24 months.

2.2 *ALTERNATIVES CONSIDERED*

2.2.1 *Selection of Sites for Substations*

The positioning of the new bay in the Ahuachapán SE is the most suitable and optimal site for its connection with the lines coming from the Acajutla SE and minimizes the removal of vegetation near the plant. Acajutla SE will be built within the grounds dedicated to the construction of the Pacific Power Thermal Power Station in an industrial area of the city of Acajutla. The selection of the site optimized its connection with the TL of 230 kV towards the Ahuachapán SE and the substation Acajutla of 115 kV.

2.2.2 *Transmission Line*

Four possible main alternatives (traces) were identified for the transmission line connection from the Ahuachapán SE to the Acajutla SE. All the alternatives of route, from the exit in Ahuachapán travel approximately 33 km under the same trace. By design, the traces in this section vary between one and the other not more than 30 m, which is insignificant. The difference between the four traces is significant near the CT EDP and its connection with the Acajutla SE and also when crossing the city of Acajutla.

The traces selected were Trace 4, which was based on Trace 3 route, away from the City of Acajutla and the housing areas of Kilo 5, entering agricultural land and pastures, and looking for a new area to cross the Road of Acajutla. As a consequence, this trace would increase in length approximately 500 m in regard to Trace 3. The selection of location of the crossing of the Road to Acajutla was studied in detail so that the social impacts were minimal and for this reason Trace 4 was selected as the preferred one.

3.0 EXISTING ENVIRONMENTAL, SOCIAL AND CULTURAL CONDITIONS

3.1 *PHYSICAL ENVIRONMENT*

In the Project region, there are several geological faults with a preferential course towards the southeast. The surface local geology in the Project area is mainly a sequence of Quaternary units of the formations San Salvador (sedimentary) and Balsam (volcanic). The San Salvador Formation is the most recent and it mainly appears in the north and south of the TL. Formación el Bálsamo constitutes the deep foundation of the Project area; Emerges mainly in the central zone of the TL, and is constituted for the most part by a sequence of pyroclastic and epiclastic rocks, with intercalations of andesitic lava flows. Two physiographic provinces appear near or within the Project. The Antearco Chortis Region/Basin consists of a bas-relief area of coalescence of alluvial fans extending up to 70 km inland from the volcanic front.

Two physiographic provinces appear near or within the Project. The Antearco Chortis Region / Basin consist of a bas-relief area of coalescence of alluvial fans extending up to 70 km inland from the volcanic front. The Chortis Volcanic Front encompasses two major morphothectonic segments heading northwest: Guatemala Mountain Range, formed along the western margin of the highlands of the Chortis, and El Salvador Mountain Range, developed along the southern boundary faults of the Central Valley or graben. Both mountain ranges consist of aligned clusters of stratovolcanoes and boilers located along transverse faults that intersect the Chortis Volcanic Front.

Three topographic scenarios were identified along the line of the Project that are a clear reflection of the type of dominant landscape in the course of the line: a region with heavily undulating topography, a region with slightly wavy topography and a region with flat topography.

The types of soils that occur near or within the Project correspond to Latosoles Arcillo Rjizo, Andisoles, Grumosoles, Aluviales, Regosoles and Halomórficos, varying in texture and depth depending on the relief of the landscape. According to the agrological classification of soil / land use capacity of the MAG, the soils in the environment of the project trace correspond to Classes II-IV, VI-VII and soils in urban areas.

Due to their geographic location, TL and substations will be exposed to potential natural hazards primarily geophysical, such as volcanic eruptions, earthquakes and landslides.

The climate in the Project area is characterized as Hot Tropical Savannah or Hot Land with humid subtropical forest.

The study area of the Project crosses three basins: Paz, Cara Sucia-San Pedro and Grande de Sonsonate-Banderas. The main rivers and streams within the Project area are the Rio Grande of Sonsonate or SENSU, Cashalate River, Quebrada de Invierno, Camalote River and El Venado River.

The main aquifers near the Project area are:

- Aquifer of Ahuachapán Valley located at the foot of the Ahuachapán volcano and used to supply water to nearby cities and towns. The water depth is between 10 and 40 m with flows between 30 and 60 liters per second (l/s) (Dimas 2005).
- Sonsonate-Acajutla aquifer that originate in the area of recharge of the volcanoes of Santa and Izalco and they supply drinking water to the city of Sonsonate, water to small irrigation projects and to the industrial zone of Acajutla. The depth of groundwater in this aquifer ranges from 5 to 50 m and flows between 40 and 100 l/s are obtained.

In general terms, the air quality throughout the study area is good, given the conditions prevailing in the natural environment (pasture and natural vegetation, as well as agricultural and cultivated land). The main sources of pollution throughout the study area, but not yet affecting air quality, are the combustion of transport units (public and private) and the non-continuous or controlled burning of solid waste (Eg, Ahuachapán, Concepcion de Ataco, Apaneca, San Pedro Puxtla and Santo Domingo). However, for the Acajutla area, air quality is influenced by local industrial sources (eg, existing power plants, port activities) and seasonal agricultural activities (eg, burning of sugar cane season, field tillage and its preparation).

The threshold levels set out in the IFC Environment, Health and Safety (2007) guidelines were used to compare noise levels measured under existing conditions. The only daytime noise level data in the Project area were below the guidelines set by the IFC (55 dBA). On the other hand, night noise levels at three monitoring sites L1, L2 and L3 were above the IFC guideline.

3.2 *BIOLOGICAL ENVIRONMENT*

The baseline methodology of the biological components included tours along the Project area, including all TL right of way. Parcels of land, transects, auditory bands, visual encounters, and auditory and visual observation points were used. In order to determine species richness, abundance, diversity and importance, the relative abundance, the Shannon Wiener index, Simpson, Value and Importance Index (VII), and wealth indexes were estimated using the EstimateS 8.0 program.

For terrestrial fauna, the study was focused on vertebrate groups: mammals, birds, reptiles and amphibians. There were no collections, but capture and release on-site of species of fauna, especially the group of bats, to meet the scope of the study requested by MARN's technicians. The respective permit was obtained for the capture and release of fauna specimens.

For the vegetation, the field study was developed in the coffee plantation forest, patches of forest and cultivation areas in the area of influence of the project trace. The general types of vegetation include the following: Coffee plantations with polycultures (characterized by trees not very high (8-10 m), with a large number of young trees, fruit trees, timber and introduced to shade coffee plants, which produces rich and diverse structures in species, with a variety of trees), monoculture coffee plantations (where one or two species are planted to shade the coffee plantations) and grasslands (where the original vegetation has been transformed into agro-ecosystems that are currently used as paddocks and cultivated areas).

In the present study, a total of 123 families, 384 genders and 536 species (including subspecies, varieties and forms) of vascular plants were registered. Of the 536 species, 411 are native and 125 are exotic. Of the total species, 156 are trees (118 native and 38 exotic), 65 are shrubs (34 native and 31 exotic), 75 vines (67 native and 8 exotic), 29 ferns (28 native and one exotic) and 209 herbs (164 native and 45 exotic).

Ten species of trees and shrubs are classified as threatened in El Salvador and/or globally threatened according to IUCN (2016). Pacific mahogany (Swietenia humilis) and chaperno (Lonchocarpus rugosus ssp. apricus) are classified as endangered species by MARN.

Amphibians and reptiles were evaluated together. For this, linear transects were established on the trails or paths that are parallel to the traces of the transmission line. A total of 15 species of amphibians and reptiles distributed in 11 families and 14 genders were recorded. Most of the species recorded are common, with wide distribution at national level and high adaptability to areas disturbed by anthropogenic activity. However, the second most abundant species was the black-eyed tree frog (Agalychnis moreletii), a nationally threatened species that is on the IUCN's red list as a critically endangered species. The habitat with greater abundance of individuals and diversity of species was crop areas and the habitat with lower abundance was patches of natural forest.

In order to sample birds, observation points were established in which 15 minute stops per point were recorded and the species identified were recorded either by their morphological characteristics or by their singing. The points were established in the transects previously established for the other groups since at these points a high incidence of birds had been determined. A total of 39 bird species belonging to 26 families were recorded. The majority of recorded species are common, with wide distribution at national level and high adaptability to areas disturbed by anthropogenic activity. However, 4 species with threatened status were registered for El Salvador.

TL traverses part of the northwestern sector of the Area of Importance for (IBA) Los Cobanos between towers TP 136 and TP 145+100 m for a distance of approximately 2,890 m. IBAs are internationally recognized for their biodiversity values but are not natural areas protected by law in El Salvador.

In order to sample non-flying mammals, linear transects were established in which mammalian species were recorded by means of sightings or from traces, excreta or other traces indicating the occurrence of these species. A total of 14 species belonging to ten mammalian families were recorded, none of which are threatened or endangered on national or international lists.

For the sampling of the chiroptera, two mist nets (one of 9 m x 2.6 m and one of 12 m x 2.6 m) were placed at ground level around the points of the towers TP 2 - 3, TP 33 - 34, TP 36 and TP 44 - 44a. In total, 14 species of bats were recorded. The most abundant species was G. commissarisi, a species of nectarivorous habit.

Six species of fauna were detected in the category of Threatened according to the National Official List, of which one is Critically Endangered (CR) category according to the IUCN Red List:

Agalychnis moreletii

The black-eyed frog is an endemic species of Central America with Critically Endangered (CR) category worldwide due to chytridiomycosis, a disease that has caused the extinction of several species of amphibians worldwide.

Ctenosaura similis

Garrobo jiote or black iguana is a large lizard that inhabits much of Central America. It is categorized as Threatened nationally but is a least concern (LC) according to the IUCN Red List. It can be very abundant in anthropized habitats but is sensitive to hunting pressure as it is desirable for domestic and commercial consumption in El Salvador.

Brotogeris jugularis

This species of parrot or psittacida, known as catalan, is threatened at national level. The main risks for its conservation are the destruction of the habitat and the human predation since this species is usually captured at an early age in their nests (talchinol), soon to be commercialized in order to be restricted to the captivity.

Eupsittula canicularis

It is another species of parrot threatened at national level and popularly known as chocoyo. Like the previous species, its main risks are predation and loss of habitat.

Aulacorhynchus prasinus

The green toucan is a nationally threatened species but distributed between Nicaragua and San Luis Potosí in Mexico and of least concern category (LC) at the international level. During the field study, three individuals were observed in the patch habitat of natural forest and none in the shade or pastureland.

Chiroxiphia linearis

The jumping colilargo or toledo is a threatened species at the national level but distributed between Costa Rica and Oaxaca in Mexico and of least concern category (LC) at the international level. During the field study, 20 individuals were observed in patch habitat of natural forest and none in the shade or rangeland coffee plantation.

The vast majority of documented species have wide distributions in Central America or even North and South America. No endemic species of the country were registered.

There were no areas of singular importance for breeding, mating or hatching of fauna species within the Project area. However, two breeding sites were found for the frogs Agalychnis moreletii, a species that frequents shade coffee plantations and uses artificial stacks such as egg laying and tadpoles.

To evaluate the aquatic ecosystems, five rivers representative of the area of influence of the Project were chosen. The information reflects that there is little variability among the five rivers sampled, either in terms of the number of species or the number of plants found. Between 2 and 6 species of fish were found at each site. We found between 20 and 69 individuals in Sites 1, 2, 3 and 5, but only 3 individuals were found in Site 4. The diversity of macroinvertebrates at family level was similar among the five sampling sites, ranging from 22 to 24 families per site.

The project area crosses the Apaneca-Ilamatepec Biosphere Reserve in the northern part in two sectors: 9.28 km between towers TP 14 and TP 30 and 0.89 km between towers TP 56a and TP 59. In the southern sector, the TL would be within the Transition Area of the RBAI. In the northern sector, it would be within the Transition Area between TP 14 and TP 28 and within the Buffer Area between TP 28 and TP 39.

According to the Enterprise for the Americas Initiative (EAI), coffee plantations predominate in the vegetation of the transition zone of the RBAI and are part of the Mesoamerican Biological Corridor, whose function is to contribute to the flow of species of flora and fauna. The RBAI is one of two Biosphere Reserves in El Salvador.

3.3 *SOCIOECONOMIC AND CULTURAL ENVIRONMENT*

The Project carried out activities of identification and mapping of the social actors relevant to the Project, as well as those that have interest or influence in the Project. Those that have representations or actions in the area of influence were mapped out and with them semi-structured interviews, participatory rural diagnostic workshops and focus groups were carried out. The social and economic base line was focused on the six municipalities within two departments within which the Project is located: Ahuachapán, Apaneca, San Pedro Puxtla, Acajutla, Sonsonate and Santo Domingo de Guzmán. These municipalities are within the departments of Ahuachapán and Sonsonate. Acajutla and San Pedro Puxtla are the largest populated centers in the study area.

54 interviews with key informants were conducted to gain a better understanding of the issues that demanded greater knowledge. These interviews were conducted with community leaders, municipal officials, doctors, priests and teachers, among others. Three participatory rural diagnostic (PRDs) workshops were held as well as focus group sessions to

better understand the views, concerns and priorities of specific groups that might be affected by Project activities.

According to 2007 census, the population of the department of Ahuachapán was of 319,503 inhabitants, with a projected population of 359,418 inhabitants in 2016. The population growth rate in the period 1992-2007 was 1.38%. The population density in the department of Ahuachapán is of 258 inhabitants per square kilometer (km2); with 42.2% of the population in urban areas and 57.8% in rural areas. The municipality of Ahuachapán is the most populous municipality in the department. The municipality of San Pedro Puxtla is one of the least populated municipalities in the department.

The departments of Ahuachapán and Sonsonate experience high levels of emigration. During the participatory rural diagnoses developed in Ahuachapán and Apaneca, it was indicated that there was a flow of population favored by the greater security of these populations, and in the specific case of Apaneca, because of its location in the commercial transport lines with Guatemala.

At the national level, out of every 100 people who make up the working age population (WAP), 63 are employed and offering their labor power to the labor market; while 37 are not actively working, or looking for work and are therefore classified as Economically Inactive Population (EIP). This situation is repeated at the departmental level, where the number of EIPs is higher among women than men. The unemployment rate varies by department; Ahuachapán is one of the departments with the highest unemployment rate (9.3%). For its part, the department of Sonsonate reported an unemployment rate of 7%.

The main economic activity in the departments of Ahuachapán and Sonsonate is retail trade, manufacturing and services.

At the departmental level, the Apaneca-Ilamatepec mountain range, which passes through the departments of Ahuachapán and Sonsonate is one of the main coffee regions in the country. The main coffee producing departments in El Salvador are Santa Ana, Ahuachapán and Sonsonate.

Within the area of influence of the Project, the municipalities of Apaneca and Ahuachapán are the most touristy. The municipality of Apaneca is one of the pioneer municipalities in the tourist development of the country. The city of Acajutla is also a relevant tourist area, because of its location along *Ruta de las Flores.*

Ruta de las Flores is a tourist route of 36 km along the Apaneca Mountain Range. The route includes stops in different colonial cities, including the cities of Apaneca and Acajutla in the area of influence of the Project. The route is known for the beauty of its coffee plants when they bloom and the markets for handicrafts and typical furniture. In the department of Ahuachapán, the hot springs are another tourist attraction in the region. Based on an analysis of the area around one of the most well-known hot springs - Termales de Santa Teresa, near the city of Ahuachapán - there is a relatively established tourist infrastructure including a series of hotels and recreation centers.

Despite an improvement in the country's electricity supply, it remains limited compared to other countries in the area, mainly in rural areas. During the 2007 Census, about 87,000 households had no access to electricity.

Since the beginning of this decade, violence in El Salvador has been increasing, specially since 2008. The crimes of greatest incidence in the country are homicide and robbery. The phenomenon of maras[i] and extortion are common, to such an extent that in August 2015 the Supreme Court declared terrorist groups to the so-called Mara Salvatrucha and Barrio 18 gangs. According to interviews with representatives of the national police in the municipalities of San Pedro Puxtla, Santo Domingo de Guzmán and Ahuachapán, the municipality of Ahuachapán has the highest number of security personnel (80 security agents), who are sometimes accompanied by soldiers from Military Detachment No. 7. In 2014, 130 homicides in the department were registered. On the other hand, the municipality of Santo Domingo de Guzmán has the lowest number of security personnel (10 security agents). In Acajutla, they have 15 national and 6 municipal police officers.

3.3.1 *Cultural, Archeological, Ceremonial and Historical Resources*

The corridor proposed for the TL is relatively close to significant pre-hispanic resources such as Santa Leticia, San Benito, El Carmen, Tacuzcalco and Los Tablones. Of these, Santa Leticia is a place of first order in the vicinity of the present town of Apaneca, specially recognized

[i] Those stable youth groups that have a group identity built through participation in violent or criminal acts, and that offer some patterns of identification to its members that allow to organize their daily life.

by its "Barrigones", anthropomorphic sculptures carved on basalt or andesite and the remains of a village of hundreds of hectares of extension.

The baseline description below was developed from the following sources:

• Current knowledge about the region as identified through bibliographic search and consultations and conversations with national and international experts.

• Findings of a field survey campaign in the Project's area of influence.

Estimation of baseline conditions from the first two partial sources; that is, to calculate a possible but not yet confirmed inventory of resources present in the Project area for terrestrial and underground resources.

The baseline field survey identified a total of 13 archaeological resources.

4.0 IDENTIFICATION, DESCRIPTION AND EVALUATION OF ENVIRONMENTAL AND SOCIAL IMPACTS

This study analyzes the potential impacts, both positive and negative, of the construction and operation of the proposed Project; it also describes the control and mitigation measures that will be developed by EDP and other recommended complementary measures to avoid, minimize or mitigate possible negative impacts and expand positive ones. Impacts were classified based on 1) magnitude of potential impact and 2) Sensitivity / Vulnerability / Importance of Resource / Receptor. The final classification of impacts is done considering the implementation of the mitigation measures.

4.1 *IMPACTS ON THE PHYSICAL ENVIRONMENT*

- Leveling work, where required depending on the slope of the area, soil compaction and formwork; as well as the foundation of the towers and substations will not have significant impacts in the geology of the Project area.
- The construction of the Project will result in the alteration of approximately 34 hectares (ha) of land, mainly the area around the towers, substations, facilities and access roads. Without additional mitigation measures, soil erosion caused by construction activities

would have an impact of moderate significance (average magnitude; average sensitivity) on the soils of the Project. With the implementation of mitigation measures, the magnitude of the impact is expected to be reduced to small, reducing the significance of the impact to smaller.

- The risk of compaction of soils during construction and operation of the Project is expected to be insignificant (negligible magnitude; low sensitivity).
- Spill risk is estimated to be reduced to insignificant with the implementation of mitigation and control measures (negligible magnitude, low sensitivity)
- The implementation of control measures incorporated in the construction of TL will diminish the potential effect of natural threats to a lesser significance (small magnitude, medium sensitivity/vulnerability).
- With the implementation of control measures to reduce the emissions of gases produced by the combustion of hydrocarbons in engines and by suspended solids, the significance of the impact of the Project on air quality will be reduced to insignificant.
- With the implementation of control measures to mitigate changes in surface runoff, the impact will be reduced to insignificant.
- With the implementation of control measures to mitigate potential impacts on water quality, the impact will be reduced to insignificant.
- Since the use of water from rivers and/or streams is not contemplated for the tasks of the construction phase, the impact on the availability of water is insignificant. On the other hand, during the operation of the Project the requirements of supply are minimum so no impacts on the availability of water are foreseen.
- The impact of the noise caused by the corona effect, which is caused by the movement of ions and a sizzle produced by the electric discharges, is considered insignificant.
- With the implementation of control measures to reduce noise pollution along the TL and proposed infrastructure, the significance of impacts will be reduced to lesser and in some cases insignificant.

4.2 *IMPACTS ON THE BIOTETIC ENVIRONMENT*

- It is estimated that the Project will require the logging of about 3,599 trees. The significance of the impact on vegetation cover is classified as minor (minor magnitude, mean sensitivity). With the implementation of an environmental compensation program through the reforestation of trees (10 trees per cut tree) and shrubs (1 shrub per bush felled), the impact on the vegetation cover will be reduced to insignificant (insignificant magnitude, mean sensitivity).
- The number of individuals of tree and shrub species categorized as threatened or endangered will be insignificant in the context of global, regional and local populations of these species. With the implementation of compensation measures, the impact is expected to be positive because of the increase in populations of these species in reforestation areas.
- With the implementation of mitigation measures, the Project's residual impact on aquatic habitats will be insignificant (insignificant magnitude, medium sensitivity).
- The project's potential impacts on wildlife will be of short duration and limited in area, by which it is classified as small in magnitude and low in sensitivity to receiving species, resulting in insignificant impact.
- The Project may affect areas that are habitat for the black-eyed frog (Agalychnis moreletii), which is Critically Endangered by IUCN and Threatened by MARN. However, these habitats and individuals represent an insignificant fraction of their local population and will not affect the survival of the species. With the application of mitigation measures, the residual impact on the black-eyed frog will be positive because of the greater availability of habitats for its reproduction and the increase in forest cover in the Biosphere Reserve by the Ecological Compensation Program.
- Considering that the sensitivity of bird populations to collisions with the lines is considered average and that the magnitude of the impact is small, the impact is classified as minor. With the application of the proposed measures, the residual impact on birds by collision with the lines is classified as insignificant (insignificant magnitude, mean sensitivity).
- The risk of electrocution for large birds such as raptors is minimal. This risk does not require mitigation because it is insignificant (insignificant magnitude, medium sensitivity) and does not require specific measures of control and mitigation.

- A portion of the TL will be constructed and operated within the Transition Zone and the Buffer Zone of the Apaneca-Ilamatepec Biosphere Reserve. It is estimated that 194 trees will be felled in the Buffer Zone and 248 trees in the Transition Zone. Temporary areas will be rehabilitated and re-developed to complete construction of the Project. With the application of mitigation and reforestation measures, the residual impact of the Project on the Apaneca Biosphere Reserve - Ilamatepec is classified as positive.
- A section of approximately 2,890 m of transmission line crosses part of the northwestern sector of the Important Bird Area "Los Cobanos". There is a risk of collision of birds with the lines and the construction of the towers may result in the elimination of natural vegetation. With the application of the proposed mitigation measures, the residual impact of the Project on the Important Bird Area "Los Cobanos" is classified as positive.

4.3 *IMPACTS ON THE SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT*

In general, the impacts of the Project on the socio-economic environment will be positive, mainly due to the demand for labor and the requirement of other services (such as transport and food), especially during the construction phase. At the national level, the major contribution of the Project is the improvement of the reliability of the electricity supply in the national electricity system.

• For the construction and maintenance of TL and infrastructure, the Project will hire a labor force consisting mainly of workers from villages and municipalities in the area of influence of the Project and national specialized workers. It is expected that at the peak of construction there will be approximately 200 people employed for the construction of TL and infrastructure. This is a positive impact.

• For the operation of the Project, it is estimated that the labor requirement will be approximately 3 to 5 people. Majority of the workforce will be used during this phase. Unskilled labor will be used for periodic maintenance of the right of way and support activities (eg pruning and vegetation control in right of way and maintenance of roads).

• As a result of the Project, the growth of commercial, industrial and related services is expected. This impact is positive.

• Increased electricity supply is one of the main impacts of the Project. This impact has been rated positive.

• The Project has designed a citizen participation plan to ensure good relationships with the community. The magnitude of the potential impact of poor community relations with the Project during construction has been considered small, and the vulnerability of the population low. With the application of mitigation measures, the impact has been rated as insignificant. In the operation stage, impact is considered insignificant because the interactions of Project staff with communities will be minimal.

• One of the main negative effects during the construction phase is the effect on traffic routes. The impact is categorized as moderate during construction and insignificant during operation and abandonment.

• Along the route, 269 affected properties have been identified, representing 264 parcels of land. To date, we have 100% of the registry-cadastral verifications of the properties under the trace. The Project will require the rehousing of a family in Acajutla, in the Santa Emilia estate. During the construction phase, the impact is estimated to be of medium magnitude and low vulnerability. The impact is categorized as minor to insignificant in the stage of operation and abandonment.

The construction and operation of a transmission line entail, for safety, the restriction in the use of the ground for activities that are not compatible with the operation of the line. With the implementation of the mitigation measures, the magnitude of this impact is considered insignificant for all the stages, since it will start from a previous agreement, sealed through a legal contract, between the owners and the promoter of the Project.

- Considering the mitigation measures integrated in the design of the line layout, the magnitude of the impact on the visual quality of the Project area is considered medium and the vulnerability low. Therefore, this minor impact is considered.
- During the construction phase, occupational accidents can be generated, as well as effects on the community, such as an increase in the incidence of traffic accidents. After the application of the mitigation measures the magnitude of this impact is considered medium and the vulnerability is low, reason why the impact is categorized of minor significance in the construction stage. For the operation stage the impact is considered insignificant.
- The levels of exposure to the electromagnetic field generated by the TL that are anticipated for the nearest residences are considered to be below the international norm. Therefore, adverse health impacts as a consequence of the implementation of the Project are classified as insignificant.

4.3.1 *Impacts on Cultural, Archaeological, Ceremonial and Historical Resources*

Even after having conducted a surface survey along the entire trace, complemented by cabinet studies and a paleontological survey, there is a likelihood that cultural traces will be discovered during the excavation process. In the case of finding archaeological and / or cultural resources during the development of the Project, the necessary measures will be taken to minimize the impact on them. SECULTURA will be contacted to determine the course to follow in order to preserve and protect the resource. For this reason, this impact is classified as insignificant to minor, direct, localized, low intensity, of permanent duration, irreversible, mitigable and of possible occurrence.

5.0 CITIZENS QUERY

The Project has carried out an intense process of consultation and citizen participation. The elements of this process are as follows:

Information and socialization activities:

• Information to landowners. In September of the year 2015, field activities were started to establish relations with the population of the Project area. Approaches with owners / possessors were numerous, including owner / occupant identification visits, document collection, follow-up visits, disclosure of management progress information, notice of court date, negotiation and acceptance of appraisal, finally, the signature of writing and payment.

• Opening of the Project's offices in Sonzacate and Acajutla to assist the owners, receive any complaints or complaints, manage the job market, and maintain a connection with the community.

• Socializing with local authorities and community leaders. Since February 2016, a series of meetings have been held with local authorities and community leaders to present the Project, the process of developing the EIS and to collect information relevant to the baseline and the consideration of impacts.

Consultation with communities:

• During the baseline, the Participatory Rapid Diagnostic (DRP) methodology was applied to the six municipalities in the Project's area of influence.

Socialization of the study with the communities:

• After completing the studies that made up the ESIA, EDP socialized with the communities the results of the same, as well as the methodology used to carry out the impact analysis. This activity was carried out in the communities of Sonsonate and Apaneca on September 7 and 8, 2016 with the participation of members of the following communities: Ahuachapán, Apaneca, Acajutla, Santo Domingo de Guzmán, San Pedro Puxtla, Sonsonate and Las Tablas.

6.0 PROJECT ENVIRONMENTAL AND SOCIAL MANAGEMENT PROGRAM

EMP establishes environmental and social protection measures and contains a set of plans, specifications and guidelines aimed at preventing and controlling the environmental impacts, impacts and risks that will be generated during the implementation of the Project, both in its direct and indirect area of influence.

The main parties and their main functions of those responsible for the implementation of this LDC are:

• EDP, as the project proponent, is responsible for overall project oversight, ensuring compliance with environmental and social policies and obligations in the EMP, and ensuring that their commitments are met.

• Subcontractor is responsible for complying with the EMP and with the requirements established by EDP.

The implementation of the EMP will be carried out with the support of EDP's senior management, through the following organizational scheme:

• Project Manager

• Field Manager

• Community Link

• Construction Contractor

• Environmental Inspectors

The Project will have negligible or minor negative impacts, in addition to positive impacts. Most impacts to the physical environment will be adequately addressed through the implementation of typical construction measures and "best practices" typical of the industry. Inevitable biological impacts, such as the deforestation of trees and areas where black-eyed frogs reside, will be effectively offset by reforestation at a rate of 10 to 1 trees and the construction of stacks of water that provide space for reproduction of the black-eyed frog, resulting in a net positive effect. The project will have mostly positive social impacts, both direct (as local employment opportunities) and indirect (improving the availability of electricity), and negative impacts, such as the potential for traffic accidents or increased noise during construction, are moderate and will be effectively managed with the implementation of best practices. In its entirety, the Project is considered viable and positive for El Salvador.

While most management and impact mitigation measures include the implementation of good practices during construction, EMP includes the following special measures to compensate for unavoidable impacts:

• Reforestation plan: following the requirements of El Salvador, trees will be compensated in a proportion of 10 trees planted for each tree cut and one shrub planted for each shrub cut.

• Construction of stacks of water to provide areas for deposition of black-eyed frog eggs.

• To mitigate potentially negative social impacts, the Project will implement a Complaint Management Plan, as well as a Community Participation Plan.

• To avoid or minimize potential impacts on archaeological resources, EMP includes a Plan of Uncertain Findings.

The following table summarizes the main potential impacts of the Project, the proposed mitigation measures, and the significance of the impact after mitigation.

Summary of Project Potential Impacts and Proposed Mitigation Measures

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
Physical environment				
Construction	Increased erosion and sedimentation	• Terrain leveling; construction of towers, substations, access roads and facilities.	• Especially in areas with steep slopes, the possibility of building the bases of the towers on the existing relief will be evaluated or they will be installed on piles, without leveling the area. This minimizes the amount of soil to be affected. • Implement measures to control soil erosion, storm water management and sedimentation. These measures include the use of sediment fences, the installation of permanent and temporary drainage systems to manage runoff from construction sites and the use of sediment capture trenches; as well as the use of regulation dams to control water runoff, among others. • Use appropriate management practices during deforestation activities. For example, as far as possible, schedule construction activities during the dry season, especially in areas with steep slopes; limit deforestation and alteration only to the approved work area; minimize the area of vegetated soil within the approved work area as much as possible; and gradually stabilize and reforest the altered areas. • Revegetate slopes in areas where required. • Place surplus material in properly approved areas or reuse it as a filler. • Properly compact all material at the end of activities. • Once the construction phase is completed, those access routes and service routes that are not necessary for the project operation stage will be closed and restored to their original or better conditions; and • Communities' requests to maintain an open service path or route will be evaluated jointly with the competent authorities.	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
Construction / Operation	Pollution of soil	• The risk of contamination of soils by accidental spills of fuel and lubricants from equipment and machinery.	• The risk of contamination of soils by accidental spills of fuel and lubricants from equipment and machinery. • Maintenance of the equipment in good mechanical conditions, to avoid losses of fuel and lubricants that can contaminate the floors and be washed by the rains; • Any major maintenance of the equipment should be carried out in specialized workshops and not at the project site; • Adequacy of a specific area, with waterproofing protection, to carry out minor maintenance activities; and • Implementation of the Contingency Plan in case of spills (see Section 7.0 - Environmental Management Program).	**Insignificant**
Construction / Operation	Natural Threats	• Volcanic eruptions, earthquakes, seisms and landslides	• Design and construction of all facilities associated with proposed TL considering high safety factors and under local and international seismic protection codes and standards. • EDP has located the path of the TL trace outside the trajectories of lava flows and lahars of the two volcanoes near the TL, • Reveive slopes where excavation work has been done. If landslides prone to landslides, which to date after several visual scans have been found, stabilizations would be made. • Implementation of a contingency plan (see Section 7.0 - Environmental Management Program).	**Minor**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
Construction and operation	Alteration of air quality	• Emissions of gases and particles from equipment, machinery and vehicles (mobile sources) that use hydrocarbons as a source of fuel.	• The dust generated by the construction and transit of material loading trucks will be mitigated by the irrigation of roads and access to the right of way and within the right of way. Such irrigation will be by means of water pipes. • The use of any machinery, equipment, or vehicles that have fuel leaks, ruptures in combustion and exhaust systems, or problems in catalyst systems shall not be permitted. • Concentrations of PM10, particulate matter less than 2.5 microns aerodynamic diameter (PM2.5), volatile organic compounds, SO2, NO2 and CO will be monitored. • The carton of vehicles transporting debris, dirt or construction material should be fitted with a tarpaulin to prevent dust from escaping during its journey. In addition, protective tires will be covered during loading and unloading of materials to prevent them from throwing material when spinning. • Any vehicle, whether for transportation, forklift or maneuvering equipment, shall be driven into previously opened roads, gaps and roads designated for that purpose. • Equipment that operates on diesel and gasoline must have preventive maintenance to comply with applicable environmental regulations. • Gasoline equipment will have catalytic converters in good condition. Those that are maneuverable equipment (for example, forklifts and cranes) will adjust their operation to the guidelines of these measures. Catalytic converters or filters for diesel will be incorporated, as the case may be. • Establish speed limits for vehicles that circulate in populated areas as well as access to the project (maximum speed of 25 km/h). • Ensure that the vehicles and equipment to be used comply with the maintenance required by each equipment and will have: 1) specific maintenance requirements for each equipment, 2) inventory of equipment, spare parts and materials needed for maintenance; and 3) periodic lubrication.	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
			• Perform resistance testing of materials, galvanizing impregnation and other tests in the factory and not on site.	
Construction / Operation	Change in surface runoff	• Construction of towers, substations, access roads and facilities.	• Proposed facilities should have roof drains that collect the runoff water and direct it to the ground where they can continue their normal course. • Piping stormwater into roads through ditches, sewers, sediment barriers and settlers, among other devices to reduce the drag of solids to rivers and/or creeks. • In the parking and storage areas of machinery/equipment and in the open, suitable control systems such as hay bales should be placed to avoid contamination of runoff water. • If it is necessary to carry out ground leveling work for the foundation surface, these must be done in a way that does not alter the surface drainage conditions and do not leave areas that in future compromise the stability of the structure.	**Insignificant**
Construction	Changes in the quantity and quality of water	• Construction of towers, substations, access roads and facilities; accidental spills of chemicals, lubricants and fuels. • Earth movement. • Crossing of gulches by vehicles and machinery can introduce contaminants.	• The material generated from the excavation works will be removed from the excavation and deposited at a safe distance to avoid material falling into nearby rivers and/or ravines. The collection area of the material should be selected prior to the start of excavation work to prevent mounds of accumulated material from having any impacts on nearby rivers and/or streams. • Piping stormwater into roads through ditches and/or culverts, sediment barriers, and settlers, among other devices to reduce the flow of solids to rivers and/or streams. • In the parking and storage areas of machinery/equipment and in the open, suitable control systems such as hay bales should be placed to avoid contamination of runoff water. • Conduct domestic water management during the construction phase using portable sanitary modules, as described in Section 2.0 (Project Description). Use at least one portable toilet for	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
		• Three of the nine storage facilities or temporary storage areas are located within 100 m of a body of water.	every 15 people and give daily treatment with detergents and biodegradable additives to these sanitary modules. The solid waste from these toilets will be extracted by the company that rents these devices, as well as their disposal. • Comply with the manufacturer's guidelines for machinery and equipment used to prevent fuel spills. • Avoid vehicular traffic in riparian areas and avoid the use of machinery in the vicinity of watercourses. • Have a prevention plan; control and response to risks of spills including emergency response, cleaning and recovery of contaminated soils (see Section 7.0 - Environmental Management Program). • Use airtight barrels with device for transferring fuel for power generators.	
Construction / Operation	Increase the level of environmental noise and vibration	• Increased traffic of vehicles and machinery (heavy machinery and trucks) and use of equipment and machinery.	• Maintain maximum permitted noise levels within the values indicated by Salvadoran authorities or threshold levels of noise established by IFC. • Indicate all sites where they emit noises above 85 dBA, to avoid exposure of persons without properly certified hearing protection equipment. • Train all workers on techniques for the use and maintenance of hearing protection equipment (occupational safety) that should be required at all times during the exposure period. • Establish speed limits for vehicles traveling in populated areas (maximum speed of 25 km/h). • Maintain in good condition the damping systems of all vehicles, machinery and equipment used during the Project phases. • Design and implement a contingency plan and corrective measures to meet eventualities. • Study and use noise barriers or acoustic noise suppression devices when necessary. •	**Insignificant to minor**

Phase	Impact	Source of Impact	Proposed Mitigation Measures	Residual Significance of Impact After Mitigation
Biotic Environment				
Construction	Loss of plant cover	• Tree logging during construction and installation of towers and substations; construction of access roads and storage areas - campuses (towers and lifting cables).	• Optimize the design of the TL route and infrastructure to minimize impacts to natural forests. • Implement an environmental compensation program through reforestation of trees (10 trees per cut tree) and shrubs (1 shrub per bush cut). • If you cut trees whose timber is of commercial or utility value, you will consult with landowners to inquire if they are interested in retaining timber. The contractor will cut the logs to segments of appropriate size. • If the landowner is not interested in wood, the contractor may seek other ways to distribute the wood to entities that can be put to good use. • Other generated plant materials can be crushed on site and used to provide a layer of protection against erosion.	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
Construction	Loss of individuals from threatened or endangered species	• Tree logging during construction and installation of towers and substations; construction of access roads and storage areas - campuses (towers and lifting cables).	• Optimize the design of the TL route and infrastructure to minimize impacts to natural forests. • Prior to construction, count individuals of threatened and endangered species to be logged. • Implement an environmental compensation program through reforestation of trees (10 trees per cut tree) and shrubs (1 shrub per bush cut).	**Insignificant to Positive**
Construction	Contamination and degradation of aquatic habitats	• Tree cutting during construction and installation of towers and substations; Construction of access roads and storage areas - campuses. • Earth movement. • Crossing of gulches by vehicles and machinery can introduce contaminants. • Three of the nine storage facilities or temporary storage areas are located within 100 m of a body of water.	• The material generated from the excavation works will be removed from the excavation and deposited at a safe distance to avoid material falling into nearby rivers and/or ravines. The collection area of the material should be selected prior to the start of excavation work to prevent mounds of accumulated material from having any impacts on nearby rivers and/or streams. • Piping stormwater into roads through ditches, sewers, sediment barriers and settlers, among other devices to reduce the drag of solids to rivers and/or creeks. • In the parking and storage areas of machinery/equipment and in the open, suitable control systems such as hay bales should be placed to avoid contamination of runoff water. • Comply with the manufacturer's guidelines for machinery and equipment used to prevent fuel spills. • Avoid vehicular traffic in riparian areas and avoid the use of machinery in the vicinity of watercourses. • Have a prevention plan, control and response to risks of spills including emergency response, cleaning and recovery of contaminated soils (see Section 7.0 - Environmental Management Program).	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
			• Use airtight barrels with device for transferring fuel for power generators.	
Construction	Loss of habitat and black-eyed frog individuals	• Loss of habitat and mortality of individuals during construction activities.	• Campaigns for the capture and relocation of frogs in habitats to be affected by the Project. • Avoid impacts to your existing breeding sites. • Construct two water catchment piles in each area where the frog was documented to increase the availability of habitats for breeding the species (Santa Rita and Tequendama farms). The "piles" are artisanal structures used by coffee producers in the region to store water. Frogs use these piles as shelters and breeding grounds. Two piles constructed according to local custom should be installed with the following dimensions and materials: approximate dimensions - 2.5 m long x 1.5 wide x 1.6 m deep with a canopy roof and down pipe; and materials - building bricks, cement, sand, grooved sheets, nails and/or screws, with cement refining. • Reforestation of forest habitats in the Biosphere Reserve. • Educational conservation campaigns on the importance of the frog and the advantages of organic coffee cultivation without agrochemicals.	**Positive**
Operation	Collisions of birds with the transmission cables	• Collision with cables of the TL, mainly in the cables of guard for being of smaller diameter and less visibility.	• Installation of bird flight deterrents throughout the transmission line section of the IBA "Los Cobanos." • Installation of deterrents in the main crossings of rivers and streams.	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
Construction / Operation	Construction of TL in Apaneca-Ilamatepec Biosphere Reserve - Buffering zone and Transition zone.	• 194 Felling trees in the buffer zone and 248 trees in the Transition Zone. • TL installation, partially, within the limits of the Apaneca Biosphere Reserve - Ilamatepec.	• Installation of bird flight deterrents throughout the length of the transmission line within the IBA. • Minimize felling of trees and shrubs by positioning the towers outside areas of woody vegetation. • Minimization of the opening of new accesses and their rehabilitation and revegetation to finalize the construction of the Project. • Restoration of forests within the Reserve through the Environmental Compensation Program. • Training of workers on the importance of the Reserve and its conservation objectives. • Installation of information signals on public roads on the Reserve and its biodiversity values.	**Positive**
Construction / Operation	Construction of TL in an important bird conservation area 'Los Cobanos'	• Tree cutting in the bird conservation area. • Risk of collision of birds with transmission cables.	• Installation of bird flight deterrents throughout the length of the transmission line within the IBA. • Minimize felling of trees and shrubs by positioning the towers outside areas of woody vegetation. • Restoration of gallery forests within the IBA through the Environmental Compensation Program. • Training of workers on the importance of birds and their habitats. • Installation of informative signage about the IBA and its biodiversity values on Route 12.	**Positive**
Socioeconomic Environment				
Construction / Operation	Generation of temporary and permanent jobs	• Construction, operation and maintenance of TL and infrastructure.	• Recruitment of the labor force consisting mainly of workers of the towns and municipalities in the area of influence of the Project and national specialized workers.	**Positive**

Phase	Impact	Source of Impact	Proposed Mitigation Measures	Residual Significance of Impact After Mitigation
Construction / Operation	Regional economic stimulus	• Construction, operation and maintenance of TL and infrastructure.	• Growth in commercial, industrial and related services is expected	**Positive**
Operation	Increased power supply	• Operation of TL and infrastructure.	• Increased power supply.	**Positive**
Construction	Risk of conflicts between the local population and the Project	• Construction of TL and infrastructure.	• The Project has designed a citizen participation plan that establishes recurrent meetings to inform the progress of the Project. It has also established a grievance mechanism to have an open line of communication with communities. For more details, refer to Section 7.0 Environmental and Social Management Program. • Additionally, contractors will be required to abide by the workers' code of conduct and all employees will be required to induce community relations.	**Insignificant**
Construction / Operation	Risk of traffic accidents on public roads	• Traffic of vehicles and equipment during TL construction and infrastructure.	• The works will be programmed so as to always maintain the main communication channels enabled. The necessary precautions will be taken to avoid accidents, maintaining at all times adequate signage, both day and night, according to the rules of the competent authority complying with current regulations. It will be driven at a maximum speed of 25 km/h. At the end of the works to improve the roads, the cleaning and cleaning work will be carried out. • All personnel and Project contractors related to vehicle driving will undergo training for defensive driving (Smith System). It will ensure that the drivers have the Smith System certificate and if they do not have it, they will take a course. • All Project staff and Project vehicles will give the right of passage to all local people (for example, inhabitants of communities who are moving on foot). Project employees as well as subcontractors will be responsible for the traffic of their vehicles and will have to comply with the measures proposed	**Moderate – Construction. Insignificant – Operation.**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
			in the Environmental Management Plan and the Social Management Plan.	
Construction	Right of way purchase	• Resettlement of a house in Acajutla.	• Anticipate and avoid or, where this is not possible, minimize the adverse social and economic impacts arising from the acquisition or restrictions on land use: (i) compensating the loss of assets at replacement cost • The Project will make every effort to improve the living conditions of physically displaced persons by providing them with adequate housing with security of tenure in resettlement sites. • Development of the document developed the methodology for the "Zoning of Land Uses, Determination of Securities Ranges for Land and Infrastructure Compensation, Definition of Valuation Parameters and Negotiation Criteria", which establishes the limits or Land use classification boundaries, and value ranges for fair compensation for acquisitions or land use restriction resulting from Project implementation. • Resettlement activities will be carried out with appropriate dissemination of information, consultation and informed participation of affected persons. The Project Social Management team will ensure that these aspects are met. • It has an Office of Attention to Owners since September of 2015 which has among its functions: o Attention to the owners/owners of real estate located under the trace or any other person interested in obtaining information about the project. o Receipt of personal identification documents and property ownership. o Receipt of complaints and claims, not only by owners/owners of real estate, but also by any person who lives in the area of influence of the parcel of land, and who are directly involved who consider that they have suffered damage on their property by The teams that work in the field. This establishes a mechanism of	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
			complaints to file appeals and aims to resolve disputes in an impartial manner.	
Construction / Operation	Alteration of quality and visual fragility	• Clearing and clearing of vegetation • Earth movement • Rehabilitation and construction of access roads • Rise of the towers • Laying the conductors	• The line layout and the right of way corridor design have been optimized to minimize impact and preserve the visual quality of the natural environment. Elements of the natural environment (for example, points of tourist interest or natural observation, churches or buildings with historical and heritage value, peaks and mountains, among others) have been taken into account to avoid intersection with them. • Design of TL route near the edge of agricultural or forest parcel of land in order to hide the lines in the dark background.	**Minor**
Construction	Occupational accident risk	• Construction of TL and infrastructure.	• EDP will ensure that the working conditions in the Project comply with the occupational health and labor standards of El Salvador. • The staff must be qualified to carry out the activities of the Project. • All employees will receive training in Occupational Health and Safety. • The contractor company will provide personal protection equipment and tools in good condition to all workers according to the activities they carry out. • Personnel shall wear appropriate personal protective equipment at all times and work at heights shall be carried out with appropriate safety measures (harness, gloves and insulation clothing), in accordance with the applicable legal requirements in this area. • The staff will have adequate and sufficient means to ensure adequate hydration and at least one hour of rest during the day. • If there are torrential rains during the removal work for the installation of the line, the work must be done with extreme caution or even suspended, while the rain lasts to avoid soil trapping and runoff.	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
			• All workers should be made aware of the importance of complying with all the above-mentioned measures in order to ensure adequate waste management, personal protective equipment and work tools in good condition, and to safeguard and preserve the biological and Environmental aspects of the area. • All access points to the Project sites will be clearly marked and will have security personnel.	
Cultural, Archaeological, Ceremonial and Historical Resources (Cultural Heritage)				
Construction	Alteration of the context or state of resources of Pre-Hispanic cultural heritage	• Terrain leveling; excavation for bases of and construction of the towers, access ways and establishments.	• Line design and right of way corridor design have been optimized to minimize the impact on underground cultural heritage resources. The findings have been taken into account and a second phase of the survey will also be carried out with the participation of representatives of the Ministry of Culture. There will be monitoring for incidental findings and an awareness plan for workers during the construction process.	**Insignificant to moderate (depending on findings during fase II)**
Operation	Restriction of access to cultural heritage resources	• Restricted access in the vicinity of right of way.	• Communication channel will be established to ensure relevant research on the resources identified in the trace and restricted access will add an additional level of protection to documented resources.	**Positive**

1.0 INTRODUCTION

1.1 *PURPOSE AND NECESSITY OF THE PROJECT*

The Republic of El Salvador is promoting its economic and social development with development projects and the diversification of its sources of electricity generation to increase the reliability of the country's energy supply. The purpose of the Transmission Line (TL) Project is to deliver electrical power to the Ahuachapán Substation (SE), which is interconnected with the Central American Interconnection System (SIEPAC), with a voltage of 230 kilovolts (kV). The project also includes the 115 kV interconnection with Acajutla SE to provide greater flexibility to the electricity distribution system in the country, as well as to make the necessary modifications and expansions in both substations, both Acajutla and Ahuachapán.

Among the specific objectives of the Project are the following:

- To create the necessary technical and operational conditions to construct and install an aerial transmission line that will be connected to the Pacific Power Thermal Power Station (CT EDP) in Acajutla to its point of connection with Ahuachapán SE;
- To seek the development of the Project in harmony with the environment and defend the ecology, following the current environmental regulations, with the least possible impact to the environment and effectively implementing all appropriate and required mitigation measures;
- Ensure that SIEPAC will not be subject to possible instability or collapse problems at the time of the energy injection; and
- Stimulate the local economy through the generation of direct and indirect jobs and trade with local companies dedicated to the supply of construction and maintenance equipment, and companies dedicated to providing services.

In 2013, the Transmitter Company El Salvador (ETESAL), which is in charge of the maintenance and expansion of the electric power transmission system in El Salvador, carried out an electrical chargeability study and concluded that the point of optimal delivery of the electricity generated by the CT EDP would be the Electrical Power Ahuachapán. The study was reviewed by the General Superintendence of Electricity and Telecommunications (SIGET), which approved the connection point.

2.0 DESCRIPTION OF THE PROJECT AND ITS ALTERNATIVES

The main objective of the Project description is to identify the main characteristics and activities of the Project during the planning, construction and operation phases of the Project. In this way, activities that could have an impact on the physical, biological and social environment of the Project area can be evaluated and quantified.

The project contemplates the construction of a 230 kV double-ended TL of approximately 44 kilometers (km) in length. The TL is part of the "LNG to Power" Energía del Pacífico's project, which consists of a) the construction of a Power Plant (Energía del Pacífico Central/Thermal Power Plant [CT EDP]) generating electric power, with a capacity of 380 megawatts (MW) based on natural gas, to be located in the Municipality of Acajutla, Department of Sonsonate, b) expansion of existing substations of Ahuachapán (230 kV) and Acajutla (115 kV), and c) the construction of the new Acajutla 230 kV electrical substation within the thermal power plant.

TL starts at the Ahuachapán SE, located in the vicinity of Los Ausoles Geothermal Plant; then passes through the municipalities of Ahuachapán, Apaneca, San Pedro Puxtla, Santo Domingo de Guzmán, Sonsonate and Acajutla; reaching the CT EDP, where the Acajutla SE will be built, which will have a double voltage transformation level, 230 kV for the interconnection with the Ahuachapán and SIEPAC substations and 115 kV for the interconnection in the Acajutla substation.

2.1 *LOCATION AND COMPONENTS OF THE PROJECT*

2.1.1 *Location of the Project*

The project is located between the parallels 13° 34' 47" (Acajutla SE) and 13° 55' 19" (Ahuachapán SE) of north latitude and meridians 89° 49' 51" (Acajutla SE) at 89° 47' 23" (Ahuachapán SE) of longitude west. Table 2.1-1 includes the location of the towers and Figure 2.1-1 shows the location of the Project. Appendix P shows the aerial maps of the LDT route in detail by segment: segment A, 16.2 km (from TP 1 to TP 51); Segment B, 20.4 km (from TP 52 to TP 128); And segment C, 6.7 km (from TP 129 to TP 151).

The TL from its connection with the Ahuachapán SE up to Tower 1 (TP 1), the TL will be with aerial cables (approximately 100 meters [m]), providing for higher towers to avoid crossings with existing facilities.

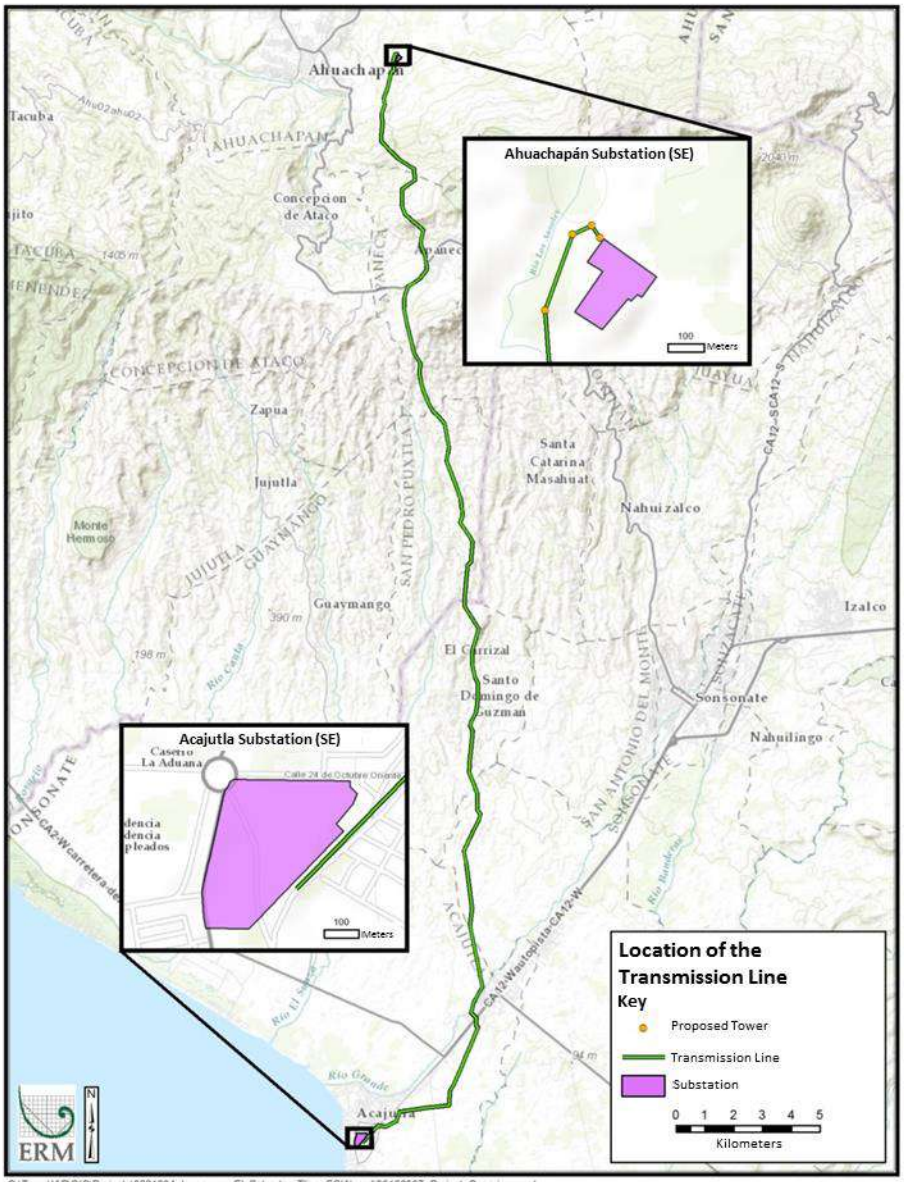

Figure 2.1-1 Location of the Transmission Line and Substations

The rest of the route will be aerial, with towers of varying height depending on the natural obstacles that the orography offers in order to adapt as much as possible to the terrain of the area. Where there are crossings with other distribution or transmission lines, it is planned to have towers of a higher height than the previous to be able to cross without affecting them.

Table 2.1-1 Number of Towers and their Coordinates

Tower Number	*Latitude X (meters)*	*Longitude Y (meters)*
TP 1	195434	1540991
TP 2	195379	1540966
TP 3	195303	1540757
TP 4	195332	1540390
TP 5	195238	1540352
TP 6	195190	1540111
TP 7	195111	1539782
TP 8	194961	1539444
TP 9	194999	1539221
TP 11	194881	1538899
TP 12	194914	1538588
TP 13	194884	1538249
TP 14	194858	1537960
TP 16	195198	1537587
TP 17	195440	1537332
TP 18	195700	1537165
TP 19	195994	1536985
TP 20	196025	1536593
TP 21	195795	1536436
TP 22	195565	1536278
TP 24	195558	1535699
TP 25	195684	1535406
TP 26	195851	1535253
TP 27	195933	1535178
TP 28	196292	1534849
TP 29A	196209	1534396
TP 29C	196346	1533980
TP 29F	196402	1533641
TP 29G	196399	1533469
TP 29I	196156	1533154
TP 29J	195959	1533037
TP 30	195758	1532919
TP 31	195614	1532477
TP 32	195612	1532134
TP 33	195645	1531928
TP 34	195698	1531637
TP 36	195775	1531309

Tower Number	*Latitude X (meters)*	*Longitude Y (meters)*
TP 37	195882	1530858
TP 38	195941	1530610
TP 39	196173	1530229
TP 40	196125	1529928
TP 41	196169	1529647
TP 42	196236	1529363
TP 44	196438	1528829
TP 44a	196581	1528562
TP 44b	196781	1528382
TP 45	196990	1528144
TP 45a	197029	1527909
TP 46	197141	1527311
TP 47	197093	1527102
TP 48	197036	1526868
TP 49	197170	1526503
TP 51	197318	1526099
TP 52	197468	1525694
TP 53	197510	1525533
TP 54a	197556	1525202
TP 56	197591	1524952
TP 56a	197495	1524708
TP 58	197822	1524207
TP 59	197932	1524037
TP 60	197915	1523873
TP 61	197888	1523605
TP 63	197866	1523325
TP 64	197728	1523199
TP 65	197725	1523041
TP 66	197699	1522805
TP 67	197657	1522418
TP 68	197615	1522042
TP 71	197641	1521767
TP 72	197788	1521532
TP 74	198105	1521022
TP 76	198000	1520658
TP 77	197953	1520493
TP 78	197896	1520295
TP 79	197868	1519794
TP 80	197960	1519347
TP 81	198049	1519148
TP 82	198064	1518943
TP 83	198050	1518509

Tower Number	*Latitude X (meters)*	*Longitude Y (meters)*
TP 84	198036	1518323
TP 85	197990	1518104
TP 86	197839	1517811
TP 87	197772	1517656
TP 89	197876	1517482
TP 90	197852	1517254
TP 91	197817	1516925
TP 92	197776	1516544
TP 94	197724	1516057
TP 95	197892	1515613
TP 96	197998	1515332
TP 97	197997	1515115
TP 98	197996	1514866
TP 99	197995	1514747
TP 100	198105	1514598
TP 101	198076	1514420
TP 102	197915	1514090
TP 103	197715	1513681
TP 105	197527	1513296
TP 106	197613	1512919
TP 107	197651	1512605
TP 108	197686	1512307
TP 110	197728	1511959
TP 111	197767	1511631
TP 112	197804	1511313
TP 113	197757	1511013
TP 114	197711	1510721
TP 114a	197790	1510326
TP 116	197863	1509966
TP 117	197935	1509606
TP 118	198007	1509246
TP 119	198081	1508881
TP 122	198139	1508592
TP 123	197973	1508309
TP 124	197830	1508065
TP 127	197734	1507695
TP 128	197929	1507496
TP 129	197896	1507251

Tower Number	*Latitude X (meters)*	*Longitude Y (meters)*
TP 130	197977	1507186
TP 131	197836	1506860
TP 132	197687	1506515
TP 133	197545	1506184
TP 134	197400	1505849
TP 135	197255	1505513
TP 136	197111	1505177
TP 137	196983	1505016
TP 138	196965	1504766
TP 139	196945	1504494
TP 140	196596	1504461
TP 141	196261	1504430
TP 142	195925	1504380
TP 143	195584	1504329
TP 144	195231	1504276
TP 145	195109	1503969
TP 146	194744	1503768
TP 147	194491	1503790
TP 148	194281	1503597
TP 149	194082	1503414
TP 150	193953	1503414
TP 151	193894	1503414

2.1.2 *Area of Influence of the Project*

The area of influence is defined as the geographical reference frame in which the environmental analysis and evaluation of the Project will be carried out. It is the territory where potentially the impacts of the work on the totality of the environment or on some of its physical, biological, socioeconomic or historical-cultural components are manifest.

The area of influence of the Project was estimated taking into account the extent and magnitude of the work, as well as safety standards established for this type of project. For this Environmental Impact Study (EIS) two types of influence area have been defined that are described below:

- Direct Influence Area (DIA): corresponds to the right-of-way strip of 38 meters wide, as well as the location of the towers, access roads and temporary areas of machinery collection and construction support. The width of the right of way complies with the maximum width set forth in Section 2 of the Rights of Way Constitution Act for National Electrification Works and provides a sufficient distance to provide sufficient space for construction and maintenance activities and to ensure That the electromagnetic field is insignificant at the edge of the right-of-way fringe.

- Project Indirect Influence Area (IIA): it is defined as the physical space that can potentially be affected by any of the Project components, outside the Project area. Consequently, the IIA is the territory in which the impacts occurring in a different location to where the action generating the environmental impact occurred and in a deferred time in relation to the moment in which the action provoking the impact occurred. This area must be demarcated, depending on the scope of the impact, with some type of delimitation, which may be geographic and/or political-administrative.

In the first instance, the following delimitation criteria are considered, not necessarily mutually exclusive:

• Areas with an administrative political definition. It refers mainly to the six municipalities that surround the area through which the project is taking place: Ahuachapán, Apaneca, San Pedro Puxtla, Acajutla, Sonsonate and Santo Domingo de Guzmán. These municipalities are within the departments of Ahuachapán and Sonsonate. Acajutla and San Pedro Puxtla are the largest populated centers in the study area.

• Relationships or direct flows between populated centers and economic and productive activities.

For this study, the IIA of the Project was determined primarily on the basis of socio-economic criteria, mainly near populated places, roads, properties and structures. In addition, environmental factors such as the presence of areas with forests and the existence of wildlife and protected areas were considered. In order to cover a representative surface of the environmental aspects in TL mentioned above, the IIA was established as the space from the boundary of the DIA to the distance where 100 m is covered on both sides of the Project alignment.

2.1.3 *Project Components*

The execution project of the CT EDP also includes the implementation of the following high voltage installations that allow the connection of the power plant with the electrical interconnected system of El Salvador:

- Expansion of existing substations of Ahuachapán (230 kV) and Acajutla (115 kV);
- Construction of a new electric power plant Acajutla 230 kV inside the grounds of the CT EDP;
- Construction of a 115kV Transmission Line between the CT EDP and the Acajutla SE of 115kV; and
- Construction of a 230 kV Transmission Line between the Ahuachapán and Acajutla substations of 230 kV.

For the purpose of this EIS, this project considers the Transmission Line 230 kV between the Ahuachapán and Acajutla substations, the construction of the new electric power plant Acajutla 230 kV within the grounds of the CT EDP, and the adequacy of Ahuachapán SE.

2.2 *AHUACHAPÁN AND ACAJUTLA SUBSTATIONS*

The CT EDP will be held in the city of Acajutla, Acajutla Municipality, on the Pacific coast of El Salvador. Energía del Pacifico will build a 380 MW Combined Cycle Power Plant with 19 MW engines. The Acajutla SE will be installed in the same plant, which includes the output of the transformers that raise the generating voltage to 230 kV. This substation will be of the compact type and will have two 230 kV line outputs to the Ahuachapán SE (Double Terna) and two 115 kV outputs to the Acajutla substation at 115 kV. These last two substations are owned by ETESAL (Transmitting Company of El Salvador, see Figure 2.2-1).

The Ahuachapán SE, located near the Los Ausoles Geothermal Plant, has a 230 kV key yard, the installation to the exterior of the plant and a switch-and-a-half bar connection system, should be extended through implementation of a bay for the connection of two 230 kV lines from the Acajutla SE 230 kV (see Figure 2.2-2).

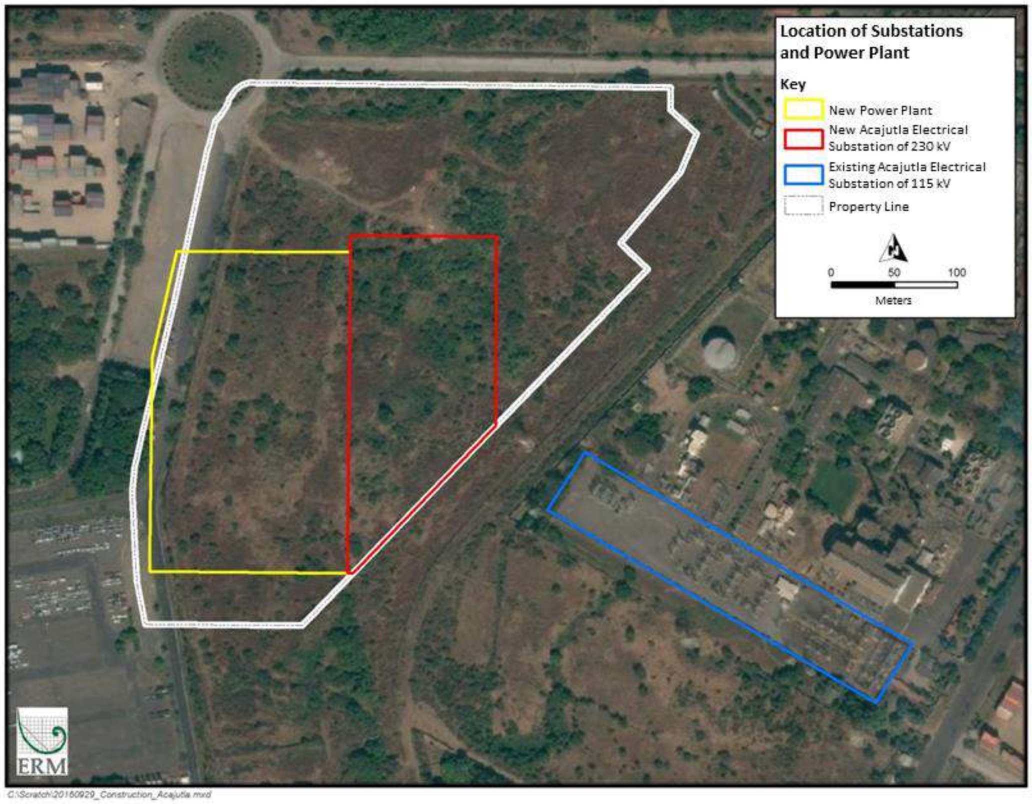

Figure 2.2-1 Location of the New Acajutla Electric Substation of 230 kV Within Energía del Pacífico Central Power Plant territory and Acajutla Substation of 115 kV

Figure 2.2-2 Location of Ahuachapán Electric Substation at Los Ausoles Geothermal Plant

2.3 *TRANSMISSION LINE 230 KV AHUACHAPÁN - ACAJUTLA*

The TL 230 kV between the Ahuachapán and Acajutla substations is located across the Pacific Ocean and crosses a coastal area and a mountainous area. It also runs an urban area and farmland. The output of the 230 kV two-thirds of the Acajutla SE will be made with aerial cable, to which the arrival at the Ahuachapán SE. The rest of the trace will be an aerial double terna with metallic structures.

The main characteristics of TL are:

- Rated voltage system: 230 kV
- System Frequency: 60 Hz (Hertz)
- Maximum voltage between phases: 245 kV
- Maximum power to be transmitted: 295 MW
- Approximate length: 44 km
- Number of ternas: 2
- Number of conductors per phase: 1
    - Configuration: Vertical for phases and horizontal for guard wires
- Guard cables: 2 [one of alumoweld (aluminum coated braided steel wires) and the other of OPGW ("optical fiber composite overhead ground wire") optical fiber]
- Structures: Self-supporting galvanized steel lattice type
- Number of structures: Approximately 139 lattice towers

2.3.1 *Main Characteristics of Transmission Line Structures*

2.3.1.1 Towers

For the installation of the project's aerial transmission line, the construction of 139 electric towers is planned. The towers shall be constructed of galvanized steel in latticework, in double-stranded configuration with vertical arrangement of the circuits, as shown in Figures 2.3-1 to 2.3-3.

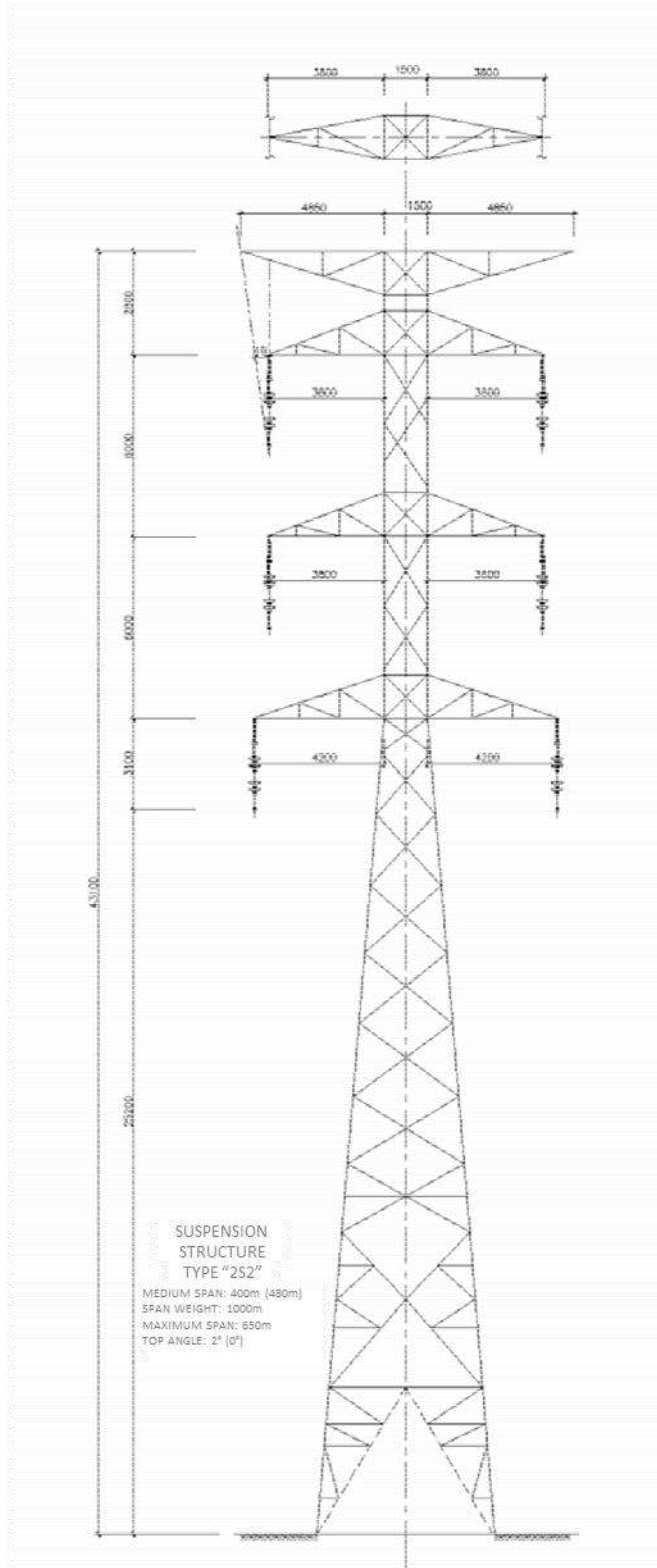

Figure 2.3-1 Suspension Tower 2S2

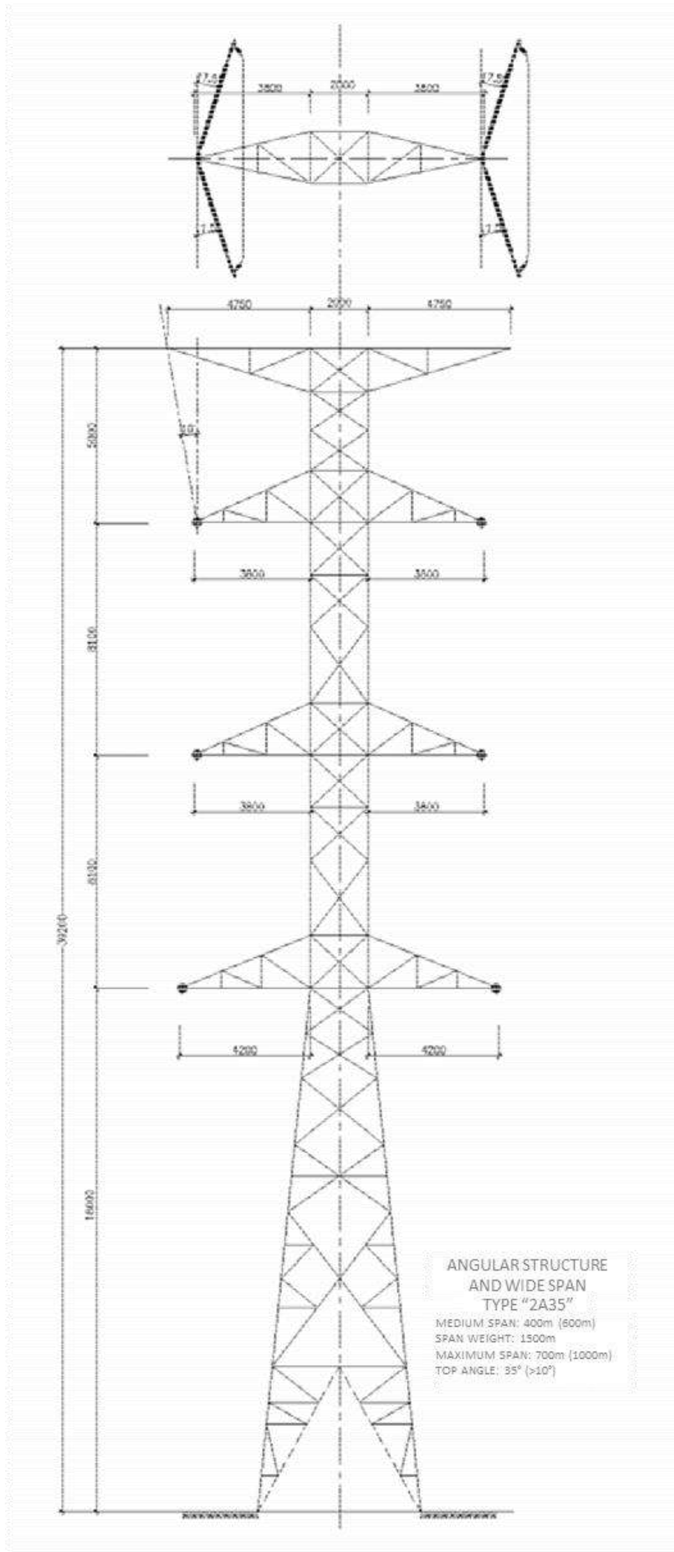

Figure 2.3-2 Angular Tower 2A35

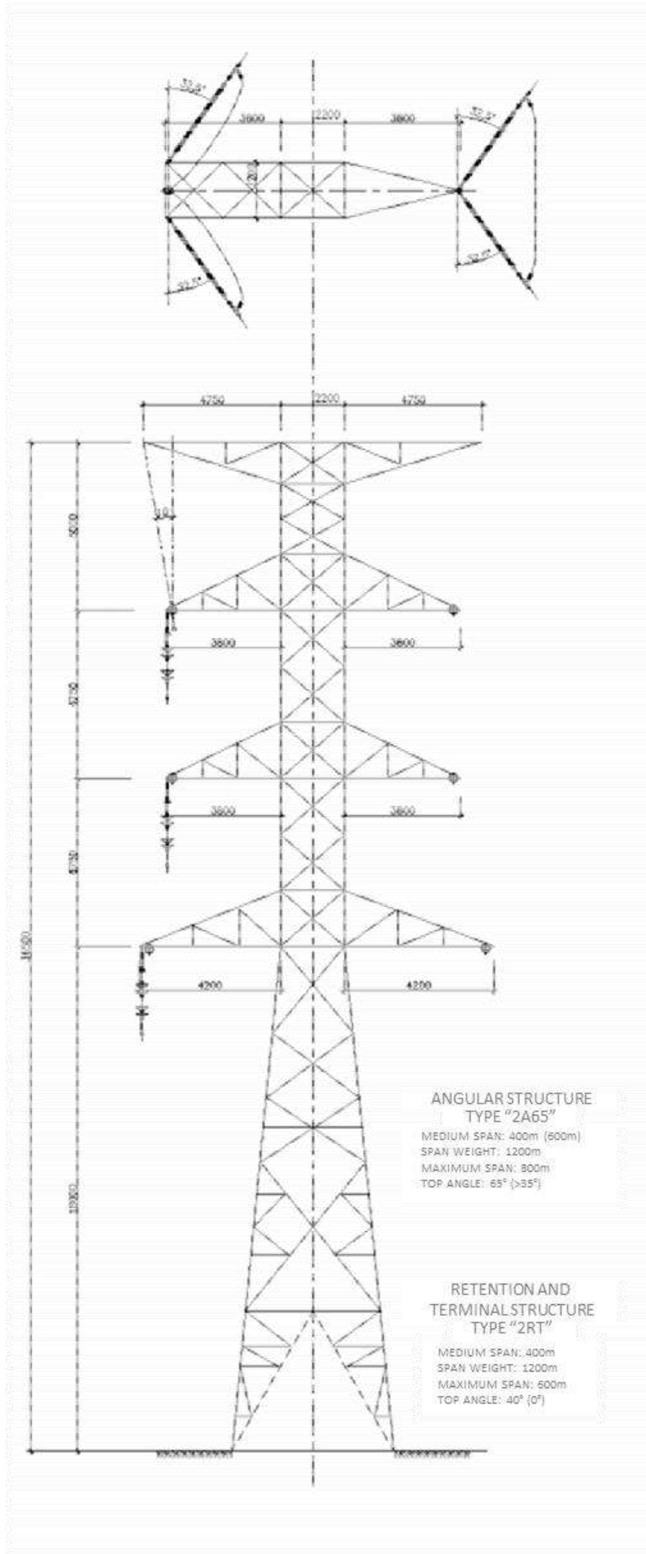

Figure 2.3-3 Tower 2S65 and Retention and Terminal Tower 2RT

2.3.2 *Foundation of the Towers*

- The available area for the foundations of the towers is 10 x 10 m (100 meters square [m^2]). The dimensions of the foundations for each type of tower strictly obey a civil-structural design which considers the loads or weights, tensions and efforts, as well as the conditions of the structures and terrain conditions, among others.
- The types of foundations consider the proper mixing of their components according to laboratory tests which determine the type and quantity of components (gravel, sand, cement, iron and sand). For the purposes of this study two classes of normal and special foundations are defined:
- **Normal:** those foundations that will be supported in the types of soils described by the study of previously developed soils, in the particular technical specifications or in the design drawings. Also, included in this group are foundations for which, due to local conditions of the terrain, it will be necessary to modify their design and adapt them.
- **Special:** are those foundations that will be supported by a special type of soil by its nature according to the result of the study of soils developed for the design, either by low support capacity or other conditions.

2.3.3 *Description of the Project Stages*

This section describes the stages of the Project including planning, construction of works and operation of the system. The number of personnel and their specialization vary from one stage to another.

This section also includes the dismantling and abandonment of temporary work areas during construction as the closing stage of the construction phase. The stage of abandonment of the work is not described since it must be in operation for more than 20 years. The main tasks and activities in stages are described below.

2.3.3.1 Planning

The planning stage includes site survey, topography survey, geotechnical/geological studies and soils, resistance analysis of existing materials and zoning of the terrain. These activities provide the basis for designing the location of the Project equipment: towers, drivers, roads and access.

During this stage, the estimated workforce is approximately 20 people. This staff will be responsible for collecting and elaborating the field information necessary to design TL. No works that may damage the environment, due to their occurrence and duration, will be executed at this stage.

The main activities to be carried out during the planning stage are described in the following sections:

Line Drawing Selection

It includes the development of the necessary engineering for the accomplishment of the topographic and geotechnical studies, investigations and calculations in order to design the tracing of the electrical line. This includes the definition of the different alternatives selected, analysis of each of them and verification in the field of their viability, both technical and the impacts that could be generated in the environment as well as acceptance by affected owners, to select the location of each component of the transmission line.

Geotechnical study

It is a local study to obtain the data and information base and to be able to specify the environmental conditions that will be applied to the design of the power line. The geotechnical study determines the bearing capacity of the soil and its geological characteristics to be able to design the components of the power line (for example, foundations of towers, study of the type section of the roads to be built and study of slope design, among others).

Topographical Survey

Topographic works included a topographic survey of the projected direct influence area. These topography works required a pruning and minimal felling to establish the visual within the study area to proceed to the study of sites, looking for the optimal solutions.

Selection of Power Line Components

With the previous data that were obtained, a selection of the components that conform the power line was made, according to the specifications given to fulfill the objectives of the Project.

Permit Management and Obtaining

Before starting any type of work in the area, you must obtain the respective permits of passage of the owners that will be affected. This entails initiating conversations with each of them, explaining what the Project and its activities are, its importance and the formal request to the owner by the promoter to access their land in order to carry out the relevant studies and execute the Project.

Some of the recommendations that will be derived from this EIS will be incorporated during the project planning and design stage, and others will be incorporated later. It will be considered as the final design, the version that has the approval and seals of the different competent entities.

2.3.3.2 *Construction*

The transmission line will be constructed using conventional construction methods, such as:

- Mobilization and construction of temporary and permanent facilities
- Recruitment of labor
- Cleaning of the right of way strip
- Access Routes - construction of temporary and permanent access roads
- Construction materials
- Construction of foundations
- Assembly and arming of the towers
- Laying of conductors and cables
- Emissions and waste management

Mobilization and Construction of Temporary and Permanent Installations

The first working groups to be mobilized to the Project site will carry out the preliminary work necessary to support the construction phase.

This preliminary work will consist of, but will not necessarily be limited to, the preparation of internal access roads and the temporary construction of personnel camps / locker rooms, storage yards and adequate disposal facilities, transfer of materials and general provisions to Patios of storage, as well as mobilization of machinery. All temporary structures will be prefabricated metal mounted on a platform of trucks of different tonnages.

In those cases, where it is necessary to open new access roads within private properties, they will be enabled by consensus with the affected owners, adjusting to their needs and conditions. It is anticipated that the construction of transmission lines will be extended for a period of 24 months.

Due to the proximity of the Project area to urban centers, it is anticipated that there will be no need to build temporary or permanent camps for the accommodation of contracted personnel for the construction of the Project. Instead, temporary shelters (a maximum of nine) will be built for the storage of tools, equipment and, among other things, will include spaces for workers to change clothes and clean up, in addition to portable toilets. The facilities will be supplied with water and appropriate collection of waste water and solid waste.

For the construction of the line, the option of less impact will be chosen. The construction contractor will be responsible for leaving the construction area equal to or better than as found at the time of its arrival at the place of work.

Recruitment of Manpower

The recruitment of personnel will follow the guidelines of the Ministry of Labor of El Salvador and the rules of procedures of the construction company. All labor necessary for the construction will be of local character, with the exception of the engineering personnel leading the Project; so there will be no employee camps.

In general, at this stage approximately 200 people will work. The workers must be qualified in techniques of civil construction, erection of towers and wiring, among others. Most of the jobs will be direct, within which there will be qualified personnel, such as engineers, middle technicians and masters of works and squares distributed between construction workers and helpers. The indirect jobs to be generated are 30 places, which will correspond to subcontracts and other services related to construction, such as transportation of materials, sale of meals, water supply and others.

Cleaning the Right of Way Strip

The work consists of clearing the land and removing the vegetation layer in the area where the towers are installed using construction equipment such as bulldozers or backhoes in poor access areas and tractors in those with better access. The rest of the right of way strip will be pruned where necessary. In those places where the felling of trees is required, the corresponding permit will first be obtained by MARN. Said logging shall be carried out manually by means of gangs equipped with chainsaws, with the prior authorization of the MARN. Stumps and roots will be removed in those sections where necessary.

Although the right of way of the transmission line will be 38 m wide, the nominal width of the laying will be between 10 and 12 m wide. Said width will be determined by the type of structure to be constructed. No logging is foreseen in the right of way belt. The pruning of trees that is necessary along the strip of right of way will be done in such a way that, without neglecting the safety distances, allow the trees that only need to be pruned, are not severely affected and die. In the cultivated areas will be followed the indications of the owners of the properties.

For the construction of the towers, an area of 10 m x 10 m will be used during construction, with a maximum area 35 m x 35 m around each tower to allow the hoisting and tensioning of the cables during construction. During the operation, an area of 7.5 x 7.5 m will be maintained for each tower.

Access roads

The access network necessary for the construction of the different components of the Project will be constituted by the following types of accesses:

- Main accesses, built from the existing public road network.
- Internal access, between the various work fronts and services.

In general, most of the towers have access roads, balated streets or dirt roads. Some towers do not have existing access; Such access shall be suitable for the construction stage. In addition, some accesses must be improved or extended for the circulation of the trucks. It is estimated that the traffic flow will be about 10 trucks per day per sector and/or tower.

During the maintenance stage, it will be 1 truck per month. Figure 2.3-4 shows the main (temporary and permanent) accesses to the Project.

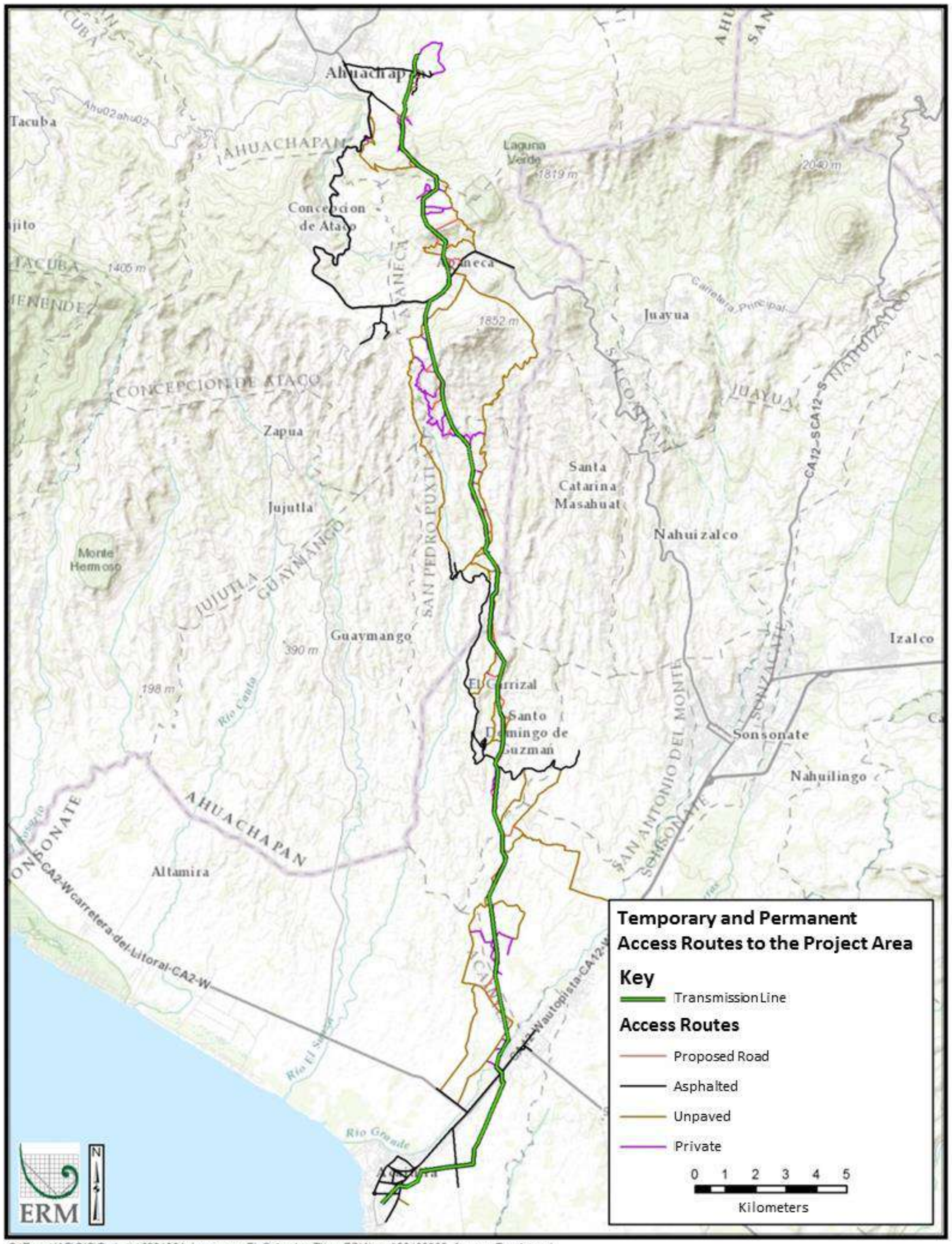

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Figure 2.3-4 Temporary and Permanent Access Routes to the Project Area

Construction of Towers Foundations

The excavations for each tower will be 10 m wide by 10 m long, with a depth varying between 3 and 6 m, depending on the type of soil.

Once the tower is built, the footprint area is 7.5 m wide by 7.5 m long, giving an area of 56.25 square meters.

Foundation

During the process of foundation of the towers, the following technical aspects are considered:

- Pre-excavation considerations;
  - Verification of location,
  - Tracing,
  - Security, and
  - Weather conditions;
- Works of excavation;
  - Signs of excavations,
  - Deposit of excavated material, and
  - Method and equipment;
- Completion of excavation;
- Preparation of the iron grill;
- Installing the Iron Grill;
- Process of casting - preparation of the mixture of cement and concrete; and
- Casting process - emptying.

Assembly and Arming of Towers

In the case of lattice towers, there are several methods of assembly and assembly in the industry. When it comes to assembly, these vary from manual assembly "piece by piece" to those assisted by helicopter. The method to be used will depend on variables such as: type of terrain, climatic conditions, restrictions of environmental regulations, access to the route of the line, program of execution of the builder, availability of manpower and equipment by the builder between others. However, it is expected that the assembly and reinforcement of the towers will be manual and crane assisted. The selection of the method to be occupied will depend on the parameters mentioned above. Appendix Q describes in detail the activities that relate to structure, tensioning and driver lifting between towers of the LDT.

Wiring of Conductors and Cables

The laying of phase conductors and guard conductor refers to all activities related to placing the conductors one by one in the chain of conductors and fittings. Electrical and hydraulic guidewires, brakes and "winch", with preferably electric motors driven by portable electric plants powered by gasoline combustion engines, are used for phase and guarding. (See Appendix Q)

For cable laying activities, small cranes of the appropriate capacity are used to transfer one by one the cable reels to be used in the area. The cable reel is placed in the right of way strip and entered by prepared accesses for the handling of materials and others. For the laying of cables, brake and winch equipment are anchored with wind-type auxiliary legs to the ground to avoid over-stressing of the conductors caused by accidental displacements of the equipment. (See Appendix Q)

Construction Materials

The main building element in civil works will be concrete and concrete blocks, as well as reinforcing steel rods for foundations.

The concrete, sand, gravel (crushed stone), additives and cement components will be moved, as and when required, from the cities of Acajutla or Sonsonate, approximately 19 km from the Project. The water for formulation and curing will be taken from small cisterns mounted on trucks.

To position the bodies of the towers, will use crane, trucks and four-wheel drive trucks, small concrete mixers, devices of traction of cables (winches) and other type of equipment that facilitate this work and assurance of the same with concrete. Here is some additional equipment to be used:

- For the improvement and opening of access roads and cleaning of the right of way: crawler tractors, front loaders and trucks for waste disposal.
- For the collection and transport of materials (cement, sand, crushed stone), metal profiles for the tower, fittings, insulators and cable reels, platform trucks and dump trucks will be used, as well as cranes and loaders.
- For the transportation of personnel will be used trucks or four-wheel drive trucks.
- For the handling and transport of fuel for power generators, sealed barrels with a device for the transfer of fuel will be used. These barrels will save fuel according to project needs.
- Materials will be transported using cargo trucks, and in some cases light trucks will be used. These include those used for the foundations of the tower, as well as fittings, insulators and cable reels for the assembly of the line.

Emissions and Waste Management

Atmospheric Emissions

Emissions to be generated will be by release of carbon monoxide from the cargo trucks, equipment and machinery needed to lift the armory of the towers. In addition, gas release will be generated by on-site painting of the armory.

Liquid Waste

To handle sewage water during the construction phase, portable sanitary modules will be used. There will be at least one portable toilet for every 15 people and will be given daily treatment with detergents and biodegradable additives. The company that rents these devices will be responsible for the final disposal of solid waste from these toilets.

Solid Waste

Solid waste such as cement packing bags will be used as caulking material in the formwork of smaller structural elements. Other materials such as wood residues from niveletas, formworks and similar works, will be stored in the collection sites and then delivered to the different municipalities for their proper treatment. The same treatment will be given to the debris and waste from construction. Solid waste from food or other activities during the construction stage will be stored in covered containers and will be delivered daily to the collecting trucks of the different municipalities. Solid waste of human origin will be handled in portable latrines, with the company in charge of providing this service who will take care of the disposition of the same, according to the conditions of its operating license.

Noise and Dust

Noise generated during construction will not exceed those established by any municipal ordinance or regulatory act. The dust generated by the construction and transit of material loading trucks will be mitigated by the irrigation of the roads and access to the right of way and within the right of way. Such irrigation will be by means of water pipes.

2.3.3.3 Operation and Maintenance of the Power Line Operation

Operation

Once the construction of the transmission line is completed, the last step before the start of operation is the tests. The transmission line will have preventive and corrective operation and maintenance protocols.

Tests

TL testing and commissioning includes the following and tests and inspections:

- Conduct an inspection of visual type the state of each of the structures that make up the TL;
- Documentation - the supporting documentation evidencing the construction process such as worksite logs is thoroughly reviewed;
- Measurement of ground resistance of each of the cable descramblings of the tower structure to the grounding rods;
- Optical fiber power tests;
- Testing of the chain of insulators;
- Sequence and phase continuity tests;
- "Hi-Potential" insulation test;

- Line lightning arrester test;
- Measuring line parameters;
- Rated voltage; and
- Thermography.

Line Maintenance

Periodic Reviews and Line Maintenance Work

Periodic inspections and preventive maintenance work respond to the annual maintenance program that will be developed for the transmission line. These activities follow the following stages of execution: inspection to determine maintenance and repair needs, execution of preventive maintenance activities on electrical components of the line during the summer (eg broken isolators, conductor damage, ground leads, of conductors, grid measurement to ground, application of paint, replacement of other deteriorated components); Preventive maintenance and repairs of structural components of the system during the rainy season (construction of deteriorated parts of structures, maintenance of foundations, especially in structures with more than 10 to 15 years).

Some of the repair and maintenance activities are performed and inspected by EDP staff, others are subcontracted. The normal equipment used in these usual repairs consists of an all-terrain vehicle, and the tools of the work, not being necessary the use of heavy machinery. All towers that have direct access will not have greater inconvenience of access for their maintaining. For towers that do not have assigned access roads, the crews must arrive through the right of way of passage to them for their maintenance.

Vegetation Control

During routine periodic checks the growth of the trees and climbers is monitored, which is expected to interfere, by its height or dimension, with the line. These feet shall be trimmed so that, as it grows, its branches approach the conductors at a distance less than that of safety.

In general, two pruning activities are carried out per year. The service will be subcontracted and inspected by technical staff of the Promoter or a subcontractor, following the technical specifications defined for such purposes.

This activity will be carried out by EDP or subcontractors, in relation to the management of pruning and logging permits and coordination of the accompaniment of MARN inspectors in the required inventories.

Maintenance of Drainage and Access Routes

The maintenance needs of drains and access roads depend on the design and construction conditions of these works. The maintenance actions of the drainage network and access roads are limited, due to the extension of the same.

Emissions and Waste Management

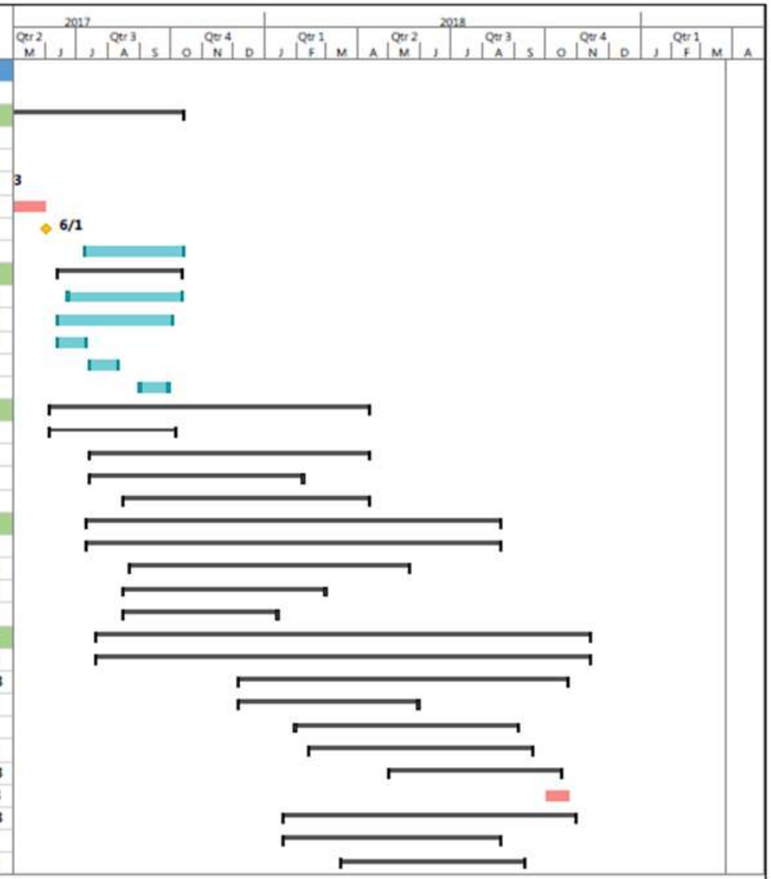
In the operation and maintenance stage of the Project, they will not generate atmospheric emissions, liquid waste or dust. Solid waste such as paper, cans and plastic originated from the maintenance of the transmission line; as well as any paper or derived plastic, will be placed in containers with lid separately and delivered to the different municipalities for their respective treatment.

The noise generated by the maintenance of the transmission line will not exceed those established by any municipal ordinance or regulatory act.

2.4 *SCHEDULE OF PROJECT IMPLEMENTATION*

It is estimated that the Transmission Line 230 Kv Ahuachapán-Acajutla Installation Project will last approximately 24 months (see Figure 2.4-1).

ID	Task Name	Duration	Start	Finish
1	**1 CONSTRUCTION PROGRAM FOR TRANSMISSION LINE AND SUB.**			
2				
3	**2 General & Legal**	**270 days**	**Mon 10/3/16**	**Fri 10/13/17**
4	2.1 RFP – EPC Tender (EPC = Engineering, Procurement and Construction)	107 days	Mon 10/3/16	Tue 2/28/17
5	2.2 EPC Contract Negotiation	23 days	Wed 3/1/17	Fri 3/31/17
6	2.3 EPC Contract Adjudgment	1 day	Mon 4/3/17	Mon 4/3/17
7	2.4 Negotiation of Financing and Financial Closure	42 days	Tue 4/4/17	Wed 5/31/17
8	2.5 NTP - Note To Proceed	1 day	Thu 6/1/17	Thu 6/1/17
9	2.6 Negotiation for Temporary Access (EDP) and Easement (ROW = Right Of Way)	70 days	Mon 7/10/17	Fri 10/13/17
10	**3 Surveys and Reports**	**88 days**	**Tue 6/13/17**	**Thu 10/12/17**
11	3.1 Geotechnical Report	4 mons	Fri 6/23/17	Thu 10/12/17
12	3.2 Topographic Survey	4 mons	Tue 6/13/17	Mon 10/2/17
13	3.3 Seismic Survey	1 mon	Tue 6/13/17	Mon 7/10/17
14	3.4 Electrical Resistivity Study	1 mon	Fri 7/14/17	Thu 8/10/17
15	3.5 On-site study to check existing Grounding Network	1 mon	Fri 9/1/17	Thu 9/28/17
16	**4 Engineering and Studies**	**224 days**	**Mon 6/5/17**	**Thu 4/12/18**
17	4.1 Extended Basic Engineering	**89 days**	**Mon 6/5/17**	**Thu 10/5/17**
29	4.2 Detail Engineering	**195 days**	**Fri 7/14/17**	**Thu 4/12/18**
30	4.2.1 Transmission Line	**148 days**	**Fri 7/14/17**	**Tue 2/6/18**
38	4.2.2 Electrical Substations	**172 days**	**Wed 8/16/17**	**Thu 4/12/18**
47	**5 Purchasing and Logistics**	**289 days**	**Tue 7/11/17**	**Fri 8/17/18**
48	5.1 Equipment	**289 days**	**Tue 7/11/17**	**Fri 8/17/18**
58	5.2 Towers and Structures	**195 days**	**Tue 8/22/17**	**Mon 5/21/18**
64	5.3 Cables	**141 days**	**Wed 8/16/17**	**Wed 2/28/18**
69	5.4 Ironworks and Accessories	**108 days**	**Wed 8/16/17**	**Fri 1/12/18**
74	**6 Construction**	**344 days**	**Thu 7/20/17**	**Tue 11/13/18**
75	6.1 Preliminary Activities	**344 days**	**Thu 7/20/17**	**Tue 11/13/18**
82	6.2 Transmission Line	**229 days**	**Wed 12/6/17**	**Mon 10/22/18**
83	6.2.1 Foundations	**125 days**	**Wed 12/6/17**	**Tue 5/29/18**
87	6.2.2 Mounting Towers	**155 days**	**Tue 1/30/18**	**Mon 9/3/18**
91	6.2.3 Installation of Ironworks and Accessories	**155 days**	**Tue 2/13/18**	**Mon 9/17/18**
95	6.2.4 Cable Mounting and Wiring	**120 days**	**Tue 5/1/18**	**Mon 10/15/18**
99	6.2.5 Signaling and Beaconing	15 days	Tue 10/2/18	Mon 10/22/18
100	6.3 Electrical Substations	**203 days**	**Thu 1/18/18**	**Mon 10/29/18**
101	6.3.1 Ahuachapán 230 kV Substation (Segment A)	**152 days**	**Thu 1/18/18**	**Fri 8/17/18**
108	6.3.2 Acajutla 115 kV Substation (Segment C)	**128 days**	**Thu 3/15/18**	**Mon 9/10/18**



Project: EDP_TLine_Subs_Constr
Date: Fri 10/28/16

Task	Inactive Task	Manual Summary Rollup	External Milestone	Manual Progress			
Split	Inactive Milestone	Manual Summary	Deadline				
Milestone	Inactive Summary	Start-only	Critical				
Summary	Manual Task	Finish-only	Critical Split				
Project Summary	Duration-only	External Tasks	Progress				

Page 1

ID	Task Name	Duration	Start	Finish
115	6.3.3 EDP 230/115kV Maneuver Court (along with Combined Cycle)	**186 days**	**Mon 2/12/18**	**Mon 10/29/18**
123	6.4 End of Mechanical Assembly (Infrastructure/Mechanical Completion)	1 day	Tue 10/30/18	Tue 10/30/18
124	**7 Start Up and Commissioning**	**104 days**	**Wed 10/31/18**	**Mon 3/25/19**
125	7.1 Testing – Substation 115kV and EDP Maneuver Court	30 days	Wed 10/31/18	Tue 12/11/18
126	7.2 Testing – Substation 230kV and EDP Maneuver Court	35 days	Wed 10/31/18	Tue 12/18/18
127	7.3 Testing – Transmission Line 230kV	40 days	Thu 11/1/18	Wed 12/26/18
128	7.4 Energization of the 115kV Substation in Acajutla	2 days	Thu 12/13/18	Fri 12/14/18
129	7.5 Energization of the 230kV Substation in Ahuachapán	2 days	Thu 12/20/18	Fri 12/21/18
130	7.6 230kV Energized System (Infrastructure Completion)	5 days	Thu 1/17/19	Wed 1/23/19
131	7.7 Acceptance of ETESAL (prior to the transfer of completed finished work)	20 days	Mon 1/28/19	Fri 2/22/19
132	7.8 Final Adjustments and Closing Contract with EPC Contractor	20 days	Mon 2/25/19	Fri 3/22/19
133	7.9 Commercial Operation Date (COD)	1 day	Mon 3/25/19	Mon 3/25/19

Project: EDP_TLine_Subs_Constr
Date: Fri 10/28/16

Task	Inactive Task	Manual Summary Rollup	External Milestone	Manual Progress
Split	Inactive Milestone	Manual Summary	Deadline	
Milestone	Inactive Summary	Start-only	Critical	
Summary	Manual Task	Finish-only	Critical Split	
Project Summary	Duration-only	External Tasks	Progress	

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Figure 2.4-1 Transmission Line 230 Kv Installation Project Schedule

2.5 ALTERNATIVES CONSIDERED

2.5.1 Selection of Sites for Substations

Ahuachapán electric power station, located near Los Ausoles Geothermal Plant, has a 230 kV key yard, the TL Project includes the extension of switch type busbar connection system and medium on the outside of the plant, by building a new bay for the connection of two 230 kV lines from the Acajutla SE 230 kV. The positioning of the bay is the most suitable and optimal place for its connection with the lines coming from Acajutla SE and minimizes the removal of vegetation near the plant.

Acajutla SE will be built within the grounds dedicated to the construction of CT EDP in an industrial area of the city of Acajutla. The selection of the site optimized its connection with the TL of 230 kV towards the Ahuachapán SE and the substation Acajutla of 115 kV. EDP evaluated the positioning of the substation minimizing the removal of vegetation and connection with the plant and chose the most appropriate locality.

2.5.2 Transmission Line

Four main possible alternatives (traces) were identified for the transmission line connection from the Ahuachapán SE to the Acajutla SE (see Figure 2.5-1). However, to reach these four main traces, EDP performed a detailed analysis, in which the area of the route of the trajectory was divided into sections where technical, topographical, environmental, social and abstention aspects were evaluated by some Owners in the Project area. In Appendix R the trace alternative analysis is presented in detail.

All the route alternatives, from the exit in Ahuachapán generally travel approximately 33 km under the same corridor. By design, the distance of the traces in this section varies between one and the other approximately 30 to 750 m, which is insignificant. The difference between the four traces is significant near the CT EDP and its connection with the Acajutla SE and also when crossing the city of Acajutla.

Figure 2.5-1 Considered Transmission Line Alternatives

In environmental terms, in general the traces in the municipality of Ahuachapán and Apaneca cross first-line coffee plantations. In the municipality of San Pedro Puxtla they cross smaller crops or of season (sugar cane) and in municipality of Santo Domingo de Guzmán, Sonsonate and northern part of Acajutla cross by seasonal crops and grasslands. In social terms, all traces pass through a small urban area of Ahuachapán; from there they do not cross communities or populated areas. The trails pass approximately 700 m from the urban center of San Pedro Puxtla, and about 500 m from the urban center of Santo Domingo de Guzmán. There are some parcels of land where the traces pass less than 100 m from a house, but are isolated; independently, the distances to these houses are large enough so that there are no impacts (see Figure 2.5-1).

As shown in Figure 2.5-2, all traces are separated upon reaching Acajutla. These differences are described below.

2.5.2.1 Trace 1

La Traza 1 leaves the field of the CT EDP in the north direction until arriving at Boulevard 25 de Febrero; There it changes direction towards the Road to Acajutla, towards the northeast, covering approximately 1.5 Km; Then it changes direction again, towards the northwest, and once outside the zone of influence of Acajutla, continues in direction towards Ahuachapán.

Trace 1 implies the resettlement in several crosses as they are the Colonies IVU, Acaxual No.4, the Parcelation San Emilio and the Lotification El Milagro. These resettlements and the intense fragmentation of the land would have affected several families. For this reason, this alternative was eliminated.

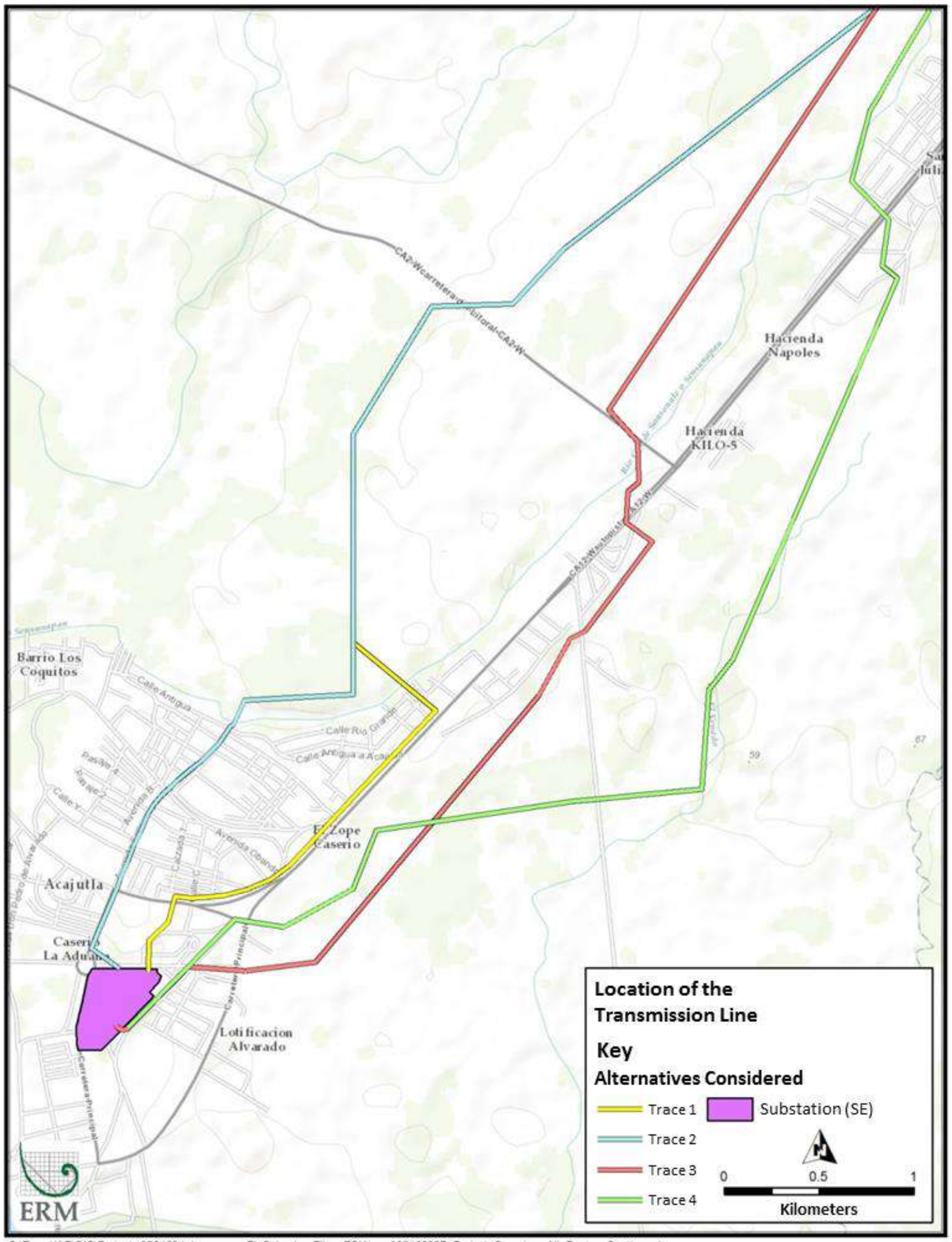


Figure 2.5-2 Alternatives of the Transmission Line in Acajutla Area

2.5.2.1 *Trace 2*

To minimize impacts to El Milagro Lotification, the alternative of Trace 2 sought to move away from this lotification, bordering it, and avoid transit through the colonies through which Trace 1 passed. The route of Trace 2 would use the central border of Boulevard Colonel Oscar Osorio, which later becomes Avenida Sensunapán, which is wide enough to place posts or even towers for the transmission line.

The use of thick posts of high altitude for the placement of the transmission line minimizes the impacts of the route; however, the construction of TL and the fact of crossing completely the City of Acajutla, increased the possibility that there is some type of opposition to the Project by the inhabitants, which led to eliminate this trace.

2.5.2.2 *Trace 3*

With Trace 3 it was tried to avoid completely the impacts in the City of Acajutla, bordering it by the east. This route would increase the length of the track by approximately half a kilometer, but would avoid affecting the City of Acajutla.

The route of Trace 3 leaves the CT EDT in an easterly direction, on Calle 24 de Octubre; then crosses Carretera a Acajutla and enters grassland or underutilized land; then it continues on the east, parallel to Carretera a Acajutla, crosses Calle a Los Cóbanos, arrives in areas near the community of kilometer 5 (Kilo 5) and crosses Carretera de Acajutla to the west, then Carretera del Litoral towards the north, heading already towards Ahuachapán.

This trajectory had enough viability with respect to the vicinity of Ciudad de Acajutla, but presented a social inconvenience when arriving at Kilo 5. The inconvenience was that it had to cross inhabited areas of Caserío Colima and Canton San Julián; in addition, certain private companies that refused the crossing permit would cross. These two situations resulted in the removal of Trace 3.

2.5.2.3 *Trace 4 – Selected Trace*

Trace 4 took as a base the route of Trace 3, moving away from Ciudad de Acajutla and the residential areas of Kilo 5, entering agricultural fields and pastures, and looking for a new area to cross Carretera de Acajutla. As a consequence, this trace would increase in length about 500 m with respect to Trace 3.

As with Trace 3, Trace 4 leaves the CT EDP on Calle 24 de Octubre in the eastbound direction; Then crosses Carretera a Acajutla, and enters grassland or underutilized land; then it continues parallel to Carretera a Acajutla, crosses Calle a Los Cóbanos; follow Carretera a Acajutla to the east, avoiding approaching Kilo 5, and finally find the optimal point to cross the road, heading west, finally heading towards Ahuachapán. The selection of the location of the crossing of Carretera a Acajutla was studied in detail so that the social impacts were minimal and for this reason Trace 4 was selected as the preferred one.

3.0 LEGAL AND REGULATORY FRAMEWORK OF EL SALVADOR

The applicable legal and regulatory framework refers to the legislative and regulatory requirements of the Salvadoran government.

3.1 COMPETENT AUTHORITY

In the Republic of El Salvador, public environmental management establishes general and specific competencies for different governmental bodies. These competencies fall mainly in centralized institutions, with specific responsibility for the use and management of territorial resources and the health of the population, but also environmental competences are recognized at local government level.

The main institutional bodies involved in environmental management are: The Ministry of Environment and Natural Resources (MARN), the Ministry of Public Health and Social Assistance (MINSAL), and the Ministry of Agriculture and Livestock (MAG).

3.2 MINISTRY OF ENVIRONMENT AND NATURAL RESOURCES

In accordance with the provisions of the national regulatory framework, MARN is the institution with the greatest environmental competence. This Ministry is responsible for the formulation, planning and implementation of environmental policies and the rational management of natural resources; having therefore the competence to apply the corresponding law and its regulation.

In order to implement environmental management, the Environmental Law has created a National Environmental Management System (SINAMA for its achronym in spanish), which, under the coordination of MARN, is composed of the environmental units of each Ministry, autonomous institutions and municipalities of the Republic. Its main function is to give effect to the principles, norms and guidelines of the environmental management of the State.

3.2.1 Ministry of Public Health and Social Assistance

In accordance with the Health Code, the Ministry of Public Health and Social Assistance is responsible for controlling the environmental conditions that may affect the health and well-being of the population, and it is mandatory to control the quality and use of chemicals which may constitute a risk to human health.

3.2.2 *Ministry of Agriculture and Livestock*

Due to the competencies of this Ministry in what concerns the management and use of water resources and the conservation and management of the country's forest resources, the respective Irrigation and Drainage Law; and Forest Law, confer powers on the granting of concessions for the use and exploitation of surface water for productive purposes and exploitation of underground sources; As well as in relation to the use of the forests and management of the forest resource.

3.2.3 *Municipalities*

At the local level, the Municipal Code is the legal instrument that confers powers to the municipalities of the country to manage the environmental resources of their territories, allowing them, in coordination with the centralized instances, to issue municipal ordinances related to the protection and conservation of natural resources and the environment. In the case of the present Project, the municipalities of Ahuachapán, Apaneca, San Pedro Puxtla, Acajutla, Sonsonate and Santo Domingo de Guzmán are responsible for granting permission for the execution of the actions that the transmission line project entails.

3.2.4 *Other Relevant Institutions*

In addition to the instances already mentioned, other entities also have competence in this Project, which although not directly related to environmental management, are related by the type of activity to be developed, the location of the activity and the type of services required. These institutions are mainly:

- Autonomous Port Executive Commission (CEPA). Institution responsible for the port development of the country and whose port area of La Union, the infrastructure corresponding to this project.
- Ministry of Economy (MINEC) (Directorate of Energy and Mines). Branch of the executive, responsible for the national energy development policy.
- General Superintendence of Electricity and Telecommunications (SIGET): That is the entity responsible for dictating and administering the regulation in the matter of electric energy

3.3 *PROCEDURE FOR OBTAINING ENVIRONMENTAL PERMIT*

The owner of any project must consult the Environmental Law if his work or project requires environmental permission. If so, this should request the corresponding form in the Directorate of Environmental Management of MARN, completing the following steps:

3.3.1 *Presentation of the Environmental Form*

The owner must duly complete the environmental form received, placing in it all the information requested, under an affidavit and presenting the corresponding annexes, which include:

- Plan of location of the work or project activity, clearly indicating access to it,
- Documents proving the ownership or type of tenure in which the activity, work or project will be developed, and
- Photocopy of identity document if it is natural person or deed of incorporation of the corporation or company, if it is legal person.

According to Article 22 of the Regulations to the Environmental Law, in a period not exceeding 20 working days, the MARN will notify the owner, the subsequent steps to follow to obtain the environmental permit.

According to the foregoing, if it is determined that for the execution of the Project no environmental permit is required, the holder will receive the corresponding notification. Otherwise, it will receive the terms of reference that the required EIS must meet.

3.3.2 *Elaboration of the Environmental Impact Study*

For the elaboration of the EIS, the holder must contract the services of a multidisciplinary team of professionals, who must develop the study according to the terms of reference received. The holder has the responsibility to know the content of the EIS and to agree with it, before submitting it to MARN for its evaluation.

3.3.3 *Analysis, Evaluation and Technical Opinion of the Environmental Impact Study*

Upon completing the evaluation process of the EIS, the MARN will notify the owner of the result obtained, which may be a technical opinion with observations or the requirement of environmental compliance bond to approve it. In the first case, the owner must satisfy the observations to continue with the process and in the second case he must render the corresponding bond as the final step of the process.

3.3.4 *Public Consultation of the Environmental Impact Study*

For those EIS whose results that reflect possibilities of affecting the quality of life of the population or of risks to human health and well-being or to the environment, through the MARN a public consultation will be organized so that the citizens express their concerns and take the necessary measures in the development of the project.

In this Project, the owner of the project will act in accordance with what is established in the corresponding resolution and the commitment to publish the results of the study in the most widely circulated newspapers in the country is accepted.

3.3.5 *Resolution, Compliance Bond and Environmental Permit*

In accordance with the Law, the evaluation and approval of the EIS, should not exceed a period of more than 60 working days, in the effective times that correspond to MARN and to make effective the environmental permit of this project, the holder must render the bond of faithful environmental compliance established by the MARN.

3.4 *GENERAL REGULATIONS*

In the national regulatory framework, based on what is expressed as the legal basis of the Magna Carta of the Republic, there are a number of laws that regulate its own area, the use, exploitation and management of renewable and non-renewable natural resources. Establishing in each case, the regulations applicable in the process of utilizing them, this framework stands out:

3.4.1 *Political Constitution of the Republic of El Salvador*

(**DECREE** No. 38 of December 15, 1983)

The Magna Carta of the Republic of El Salvador establishes as a duty of the State the protection of natural resources and the diversity and integrity of the environment, in order to guarantee sustainable development.

It is considered as a social interest the protection, conservation, rational use, restoration or substitution of natural resources, according to the terms established in the Law.

3.4.2 *Environmental Law*

(**DECREE** No. 233 of March 2, 1998)**.**

The purpose of this law is to develop the provisions of the Constitution of the Republic, regarding the protection, conservation and recovery of the environment; the sustainable use of natural resources to improve the quality of life for present and future generations; and regulate environmental management, public and private, and environmental protection as a basic obligation of the State, municipalities and inhabitants of the country; and to ensure the application of the international treaties or conventions concluded by El Salvador in this matter.

In their structure, they establish the general principles of environmental management in El Salvador, covering topics related to Environmental Policy, National Environmental Management System and citizen participation; to the prevention and control of pollution of renewable and non-renewable natural resources; management of protected natural areas and ecosystems; as well as environmental responsibilities.

Its Art. No. 4 declares of social interest, the protection and improvement of the environment. It establishes that public or municipal institutions are obliged to include in all their actions, plans and programs as a priority the environmental component; and that the Government is responsible for introducing measures that give an adequate economic valuation to the environment, according to the real value of the natural resources, assigned the rights of exploitation of them in such a way, that the citizen when acquiring them, use them with responsibility and sustainability.

To initiate operations of any activity, work or project, Art. 19 of the law establish that an environmental permit must be obtained and that it will correspond to the MARN, to issue such a permit, with approval of the corresponding EIS.

3.5 *REGULATIONS ASSOCIATED WITH THE PHYSICAL ENVIRONMENT*

In the area of regulations for social intervention on the physical environment, there are a series of laws and regulations, which address specific fields for the process of regulating the activities of the population, such as:

3.5.1 *Law of Irrigation and Drainage*

(**DECREE** No. 153 of November 11, 1970)

The purpose of this law is to regulate social actions in relation to the use of soil and water resources for the increase of agricultural productivity, for which purpose, it establishes norms oriented to the proper use of surface and groundwater, as well as the obligatoriness of treating the waste water, before discharge to the receiving bodies. The application of this Law has no relation with the project activities, since its infrastructure components, does not even consider works that have contact with bodies of water.

3.5.2 *General Law on Management and Promotion of Fisheries and Aquaculture*

(**DECREE** No. 637 of December 6, 2001)

This law regulates the fishing activities to assure the conservation and the sustainable development of the hydrobiological resources that owns the national territory, in waters jurisdictional of the sea, like in marine waters and inland water bodies; and designates the Ministry of Agriculture and Livestock (MAG), as the governing body and competent authority to apply its regulations.

Regarding hydrobiological resources (CAP II), Article 18 establishes that in order to determine the areas of aquatic reserve for the protection and conservation of hydrobiological resources, MAG will coordinate with MARN and other related institutions.

3.5.3 *Regulation on Water Quality, Discharge Control and Protection Areas*

(**DECREE** No. 50 of October 16, 1987).

It develops the principles contained in the Law on Integrated Water Resources Management and its Regulations, as well as Articles 100 and 101 of the Law on Irrigation and Drainage, concerning water quality, control of discharges and protection zones, with the purpose of avoiding, controlling or reducing pollution of water resources.

It establishes the mechanisms to take the appropriate and timely measures to regulate the activities that come to produce pollution of the waters and to harmonize the rational and integral use of the water resources with the protection of the quality of the same ones. Article 35, stipulates that discharges of solid, liquid or gaseous wastes can only be carried out when, in accordance with quality objectives, the physical-chemical and biological conditions of the receiving aquatic environment are not prejudiced. Also, it regulates the waste that is discharged to the sewer system, according to contaminant limits, established as control parameters in the same regulation.

Due to its nature, this project is not related to this regulation, since its activity does not affect the use of water.

3.5.4 *Health Code*

(**DECREE** No. 955 of April 28, 1988)

With regard to the environment, the Health Code regulates prohibitions for the discharge of liquid waste pollutants to natural bodies, without prior authorization from the Ministry of Health; It also states that waste that by its nature or characteristics of danger should not be delivered to public sewerage services must have a treatment system authorized by said ministry. In any case, its content is not applicable to the characteristics of the Project.

3.5.5 *Special Regulation of Technical Norms of Environmental Quality*

(**DECREE** No. 39 of May 31, 2000)

Its objective is to determine the guidelines for the establishment of environmental quality technical standards in receiving environments and the mechanisms for the application of these standards, relating to the protection of the atmosphere, water, soil and biodiversity.

In order to establish the prevention, mitigation or compensation actions referred to in Article 20 of the Environmental Law, Article 6 states that the owner of any activity, work or project referred to in Art. 21 of the same law, the following shall be incorporated into the respective EIS:

- Determination of the physical and chemical characteristics of the ecosystem and the receiving environment in the area of influence of the activity, work or project, as established in the technical and specific guidelines issued by the Ministry for the corresponding studies;
- Determination of the type, quality and quantity of the discharges or emissions of the activity, work or project and the technical evaluation of the same. Consideration should be given to minimizing the

generation of discharges or emissions in order to prevent contamination in the different media, and

- Determination of the impacts caused by the discharge or emission in the ecosystem and the receiving environment in the area of influence of the activity and describes in its field of application the procedures for its compliance and the provisions for its control.

The spirit of these regulations practically does not interfere with the activities of the Project.

3.5.6 *Special Regulations on the Comprehensive Management of Solid Wastes*

(**DECREE** No. 42 of May 31, 2000)

This regulation refers to the management of solid wastes of domicile, commercial, service or institutional origin; industrial wastes and non-hazardous solid waste.

3.6 *REGULATIONS ASSOCIATED WITH THE BIOTETIC ENVIRONMENT*

Due to the nature of the Project, there are three regulations associated to the biotic environment that are more relevant and that are susceptible to condition criteria for their construction and management, each of which define the limits and scope of social action in use of the territory's resources.

3.6.1 *Regulation for the Exploitation of Salted Forests*

(**DECREE** No. 53 of May 28, 1969)

This regulation establishes the requisites and formalities necessary for the authorization of the use of the wood extracted from the mangrove forests and the debarking of the salted wood; and at the same time establish the provisions for its use.

In this case, although the transmission line runs in the vicinity of masses of salted forest, its activity does not interfere with the use of that resource.

3.6.2 *Law on Wildlife Conservation*

(**DECREE** No. 844 of April 14, 1994)

This law aims at the protection, restoration, management, use and conservation of wildlife; Its scope includes the regulation of activities such as hunting, harvesting, marketing and other forms of use and exploitation of this resource.

Its relation to the activities of the Project is relative, because although it is true that in the transept that defines the axis of the transmission line, wild animal species circulate, most of them are of terrestrial habits and the operation of the infrastructure will not affect its subsistence.

3.6.3 *Forestry Law*

(**DECREE** No. 852 of May 22, 2002)

The purpose of this Law is to establish provisions that allow the increase, management and sustainable use of the country's forest resources and the development of the timber industry. It establishes that the forest resources are part of the natural heritage of the Nation and the State is responsible for its protection and management.

It declares the country's forestry development from the establishment of the plantation to the final harvest and all its forms of added value to be of economic interest. Likewise, it seeks to establish the conditions to stimulate the participation of the private sector in the reforestation of the national territory, either for productive or protective purposes, being excluded from this regulation the Natural Protected Areas and the salted forests.

This law defines a series of provisions related to the conservation and use of forests in salted forests and sweet forests, forest closures, management of protected areas, forest reserves and national parks, among others.

In the case of this Project, its applicability is related to the need to comply with the international standards of electric lines, where the existence of trees in the path of the transmission line can constitute risks to the safety of the people.

3.7 *REGULATIONS ASSOCIATED WITH CULTURAL AND SOCIO-ECONOMIC ASPECTS*

In the regulatory framework of El Salvador, the relationship with cultural and socio-economic aspects that could influence the execution of this project is based on occupational safety and health, protection of cultural heritage, urban planning and construction, as briefly stated below:

3.7.1 *General Regulations on Safety and Hygiene in Work Centers*

(**DECREE** No. 7 of February 2, 1971)

The purpose of this regulation is to establish the minimum safety and hygiene requirements that must be met for the development of occupational work in the workplace. Regulates aspects related to buildings, lighting, ventilation, temperature, humidity, noise, medical examinations, water services and sanitary measures, order and cleaning, preventive measures, work clothes and other aspects that guarantee the minimum occupational risk of citizens.

This regulation corresponds to the forecasts that must be taken into account in the process of construction and operation of the Project, in which case it must comply with what expressly stipulated in it.

3.7.2 *Special Law for the Protection of Cultural Heritage*

(**DECREE** No. 513 of May 13, 1993)

In its article, this law defines the current legal framework, related to the rescue, investigation, conservation, protection, promotion, encouragement, development, diffusion and valorization of the Cultural Heritage of the nation.

For purposes of law enforcement, objects of paleontological interest, property related to history, the proceeds of authorized and unauthorized excavations, as well as archaeological discoveries, duly proven antiquities, other values that identify the archaeological and paleontological history of our territory.

Due to the fact that in the construction process of the transmission line a certain number of excavations are required for the anchoring of the towers that support the high voltage wiring, it will be necessary to undergo the conditions determined by this regulation.

3.7.3 *Law of Urbanism and Construction*

(**DECREE** No. 232 of June 6, 1951)

This Law establishes the general requirements, standards and procedures to be followed by natural or legal persons, in order to obtain the necessary authorization for the development of urbanizations, subdivisions and all types of construction projects.

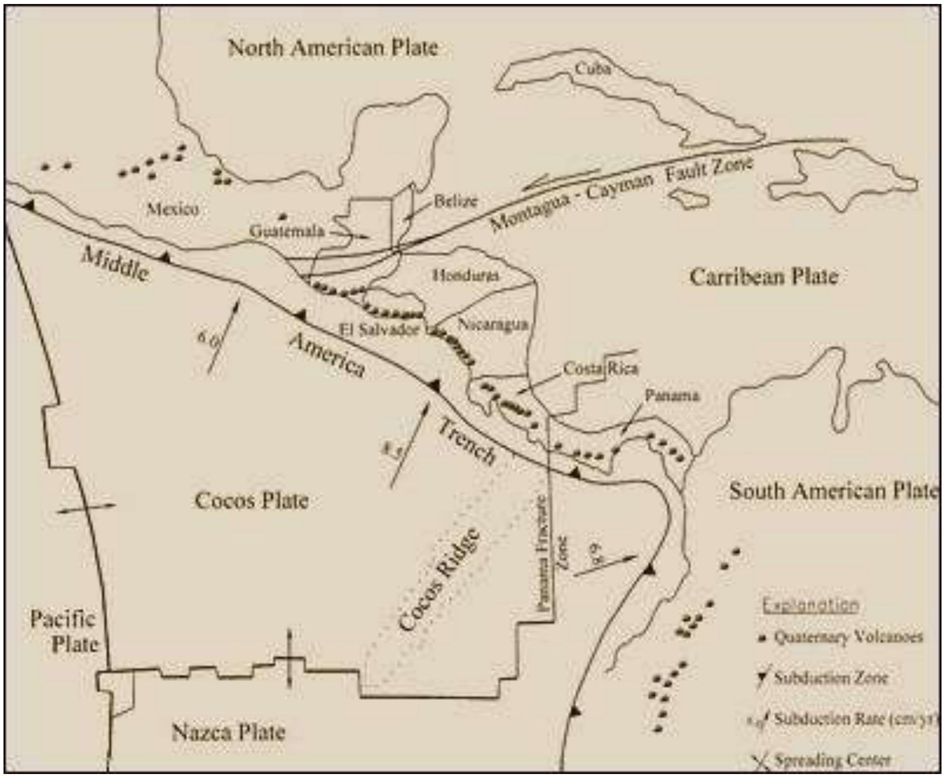
4.0 EXISTING ENVIRONMENTAL, SOCIAL AND CULTURAL CONDITIONS

This section describes the existing environmental, social and cultural conditions in the area of influence of the transmission line and electrical substations that make up the Transmission Line Ahuachapán to Acajutla 230 kV Project. For this description, both qualitative information and quantitative data were required, which were obtained through the review of primary and secondary sources that included: field visits and studies, sampling and interviews, among other methodological resources. The level of detail presented in this section, for each of the elements described, is in line with their importance in discussions of significant impacts and the need to develop preventive or mitigating measures.

4.1 *PHYSICAL ENVIRONMENT*

4.1.1 *Regional Tectonics and Geology*

Most of Central America, including El Salvador, rests on the Caribbean Plate (a relatively immobile tectonic plate). To the west of the Caribbean Plate is Los Cocos Plate, which is moving in a northeast direction. The subduction of Los Cocos Plate under the Caribbean Plate creates the deep middle American trench, which crosses the coast of El Salvador (see Figure 4.1-1). The tectonic plates active in Central America, as described in Subsection 4.1.2.1 Geomorphology, have generated a variety of topographies and landscapes, including a volcanic axis, the main feature of the landscape that is understood throughout the area from western Guatemala to western Panama. The volcanic axis in El Salvador (Volcanic Mountain Range) has about twenty-three volcanoes and a long history of earthquakes and volcanic eruptions.



Source: 40.91 South, 2014

Figure 4.1-1 Plate Tectonics of Central America

The region of the Project is affected by the presence of several geological faults with a preferential course towards the southeast. During the formation of the central valley of Central America (see Subsection 4.1.2.1 Geomorphology), the entire region was subjected to a phase of tectonic movements in the transition from the tertiary Pliocene to the Quaternary Pleistocene. All the original terrains were dislocated along lines with general east-west orientation, leaving areas sunk between raised blocks. These movements left areas of weakness through which the magmatic volcanic materials formed due to the fusion of the rocks originated by the subduction phenomenon occurred between Los Cocos Plate and the Caribbean Plate. Molten rock or magma ascends, forms magmatic chambers and then discharges as volcanism (Marshall, 2007).

The surface local geology in the Project area is mainly a sequence of Quaternary units of San Salvador (sedimentary) and Balsam (volcanic) formations (MARN, 2016, IGN, 2000) (see Figure 4.1-2).

San Salvador Formation is the most recent in geological terms and appears mainly in the northern and southern regions of the TL (see Figure 4.1-2). The younger materials it presents are unstable sediments because of its poor consolidation. To this formation belong the volcanic ash or white earth, which according to their granulometry were thrown by a series of violent eruptions of the caldera of the volcano Ilopango about 2000 years ago; the greater thicknesses of this material are located within the centers of effusion, diminishing from these; also, presents the alluvial deposits and concentrates the volcanic part consisting of basic effusive rocks, andesites and basalts.

The Balsam Formation, constitutes the deep foundation of the Project area; emerges mainly in the central zone of the TL (see Figure 4.1-2), and consists mostly of a sequence of pyroclastic and epiclastic rocks, with interleaves of andesitic lava flows.

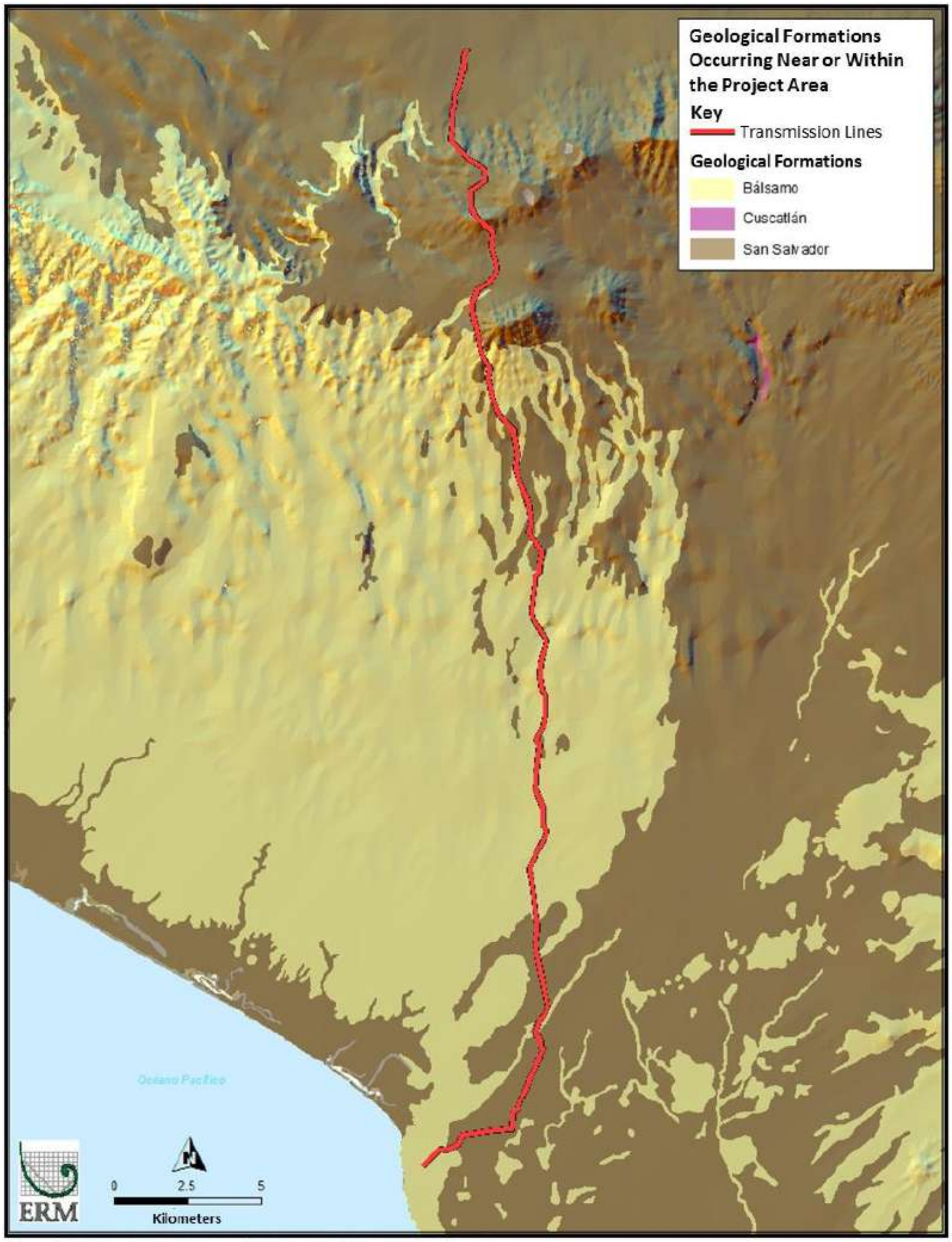


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Figure 4.1-2 Geological Formations Occurring Near or Within the Project Area

4.1.2 ***Geomorphology, Topography and Soils***

4.1.2.1 Geomorphology

Physiographic Provinces

El Salvador has four geomorphological provinces, which run east-west in bands that cross the country following more or less the coastline (Marshall, 2007). Two physiographic provinces appear near or within the Project (see Figure 4.1-3), which are described below:

Region/Basin Antearco Chortis: The province of the region Antearco Chortis consists of a bas-relief area of coalescence of alluvial fans that extend up to 70 km inland from the volcanic front. This broad alluvial plain was formed from volcanic eruptions and clastic sediments and debris deposited by rivers draining the interior volcanic highlands (see Figure 4.1-2). In general, the topography along the Antearco Chortis coast is relatively moderate, with localized minor faults affecting only the Quaternary strata. This low-relief coastal morphology contrasts sharply with the tectonically active coasts of Antearco Chorotega in southern Central America. In this region, active faulting and rapid rise have produced an abrupt coastal topography along the steep coast of Costa Rica and Panama.

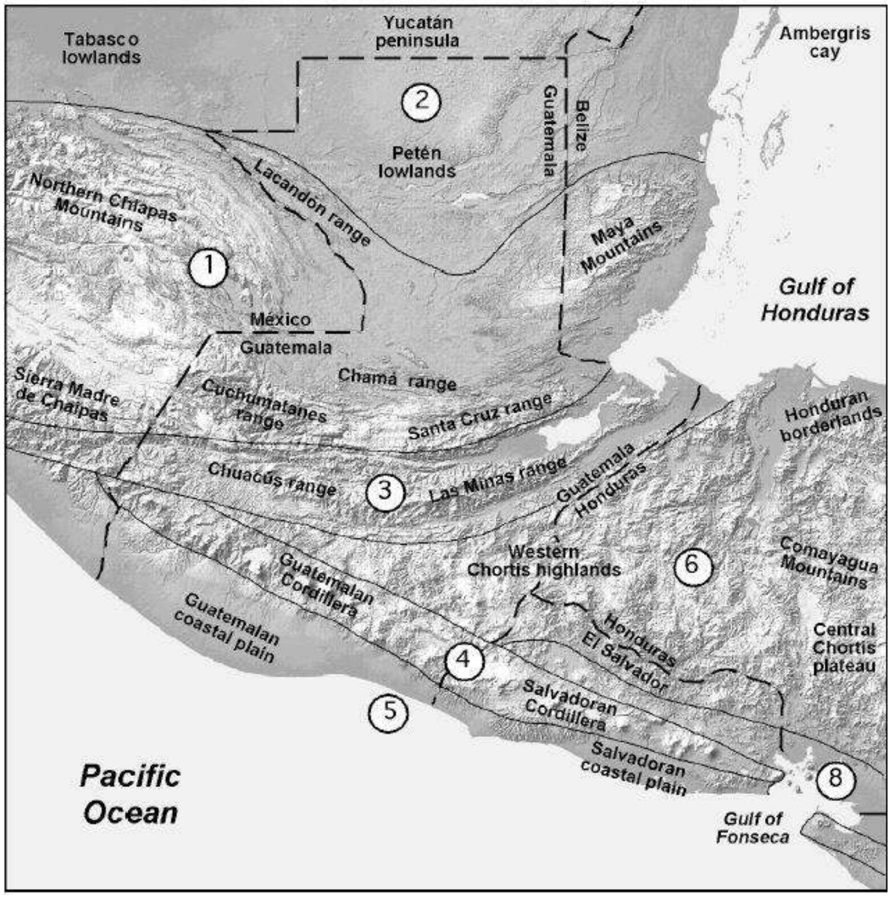
Chortis Volcanic Front: The province of the active Chortis Volcanic Front encompasses two major morphothectonic segments heading northwest: Mountain Range of Guatemala, formed along the western margin of the highlands of the Chortis, and Cordillera de El Salvador, developed along boundary faults south of the central valley. Both mountain ranges consist of aligned clusters of stratovolcanoes and boilers located along transverse faults that cut the volcanic front chortis.

Geomorphological Units

The geomorphological units that will be traversed by the proposed TL corridor include: The Coastal Plain and the Volcanic Mountain Range of El Salvador (see Figure 4.1-3).

Salvadoran Coastal Plain: The Coastal Plain unit is constituted by two strips. Its petrography is varied since on it have been deposited materials by the rivers that cross the region, forming alluvions, as well as deposits of old volcanic eruptions. The lands where the "LNG TO POWER" Project will be located, the Acajutla SE and part of the TL, are located in this unit.

Salvadoran Volcanic Mountain Range: This unit consists of thick and dense agglomerates of the Pliocene age, together with the thin layers of andesitic lava, tuff layers and interlayers of ignimbrites. Part of the TL and the Ahuachapán SE are located in this unit.



Source: Marshall, 2007

Figure 4.1-3 ***Physiographic Provinces in Northern Central America – (6) Highlands Chortis, (8) Nicaraguan Depression, (4) Chortis Volcanic Front, and Region Antearco Chortis – and Geomorphological Units that occur near or within the Project Area***

4.1.2.2 *Topography and Soils*

Topography

The relief of the lands along the TL presents variations, because the selected trace crosses a variety of landscapes and morphology. Along the Project line, three topographic scenarios are identified that reflect the type of dominant landscape in the line path (see Figure 4.1-4). These scenarios are:

Region with Strongly Rippled Topography: This region is mainly made up of mountain landscapes, hills and slopes of the volcanic mountain range of Salvador (See Figure 4.1-4), which generate a profuse network of shallow drainage and almost parallel or slightly radiated, which are oriented parallel to the axis of the TL, and are located mainly in the northern region of the trace. In this region, whose relief is undulating to strongly undulating, the dominant slopes range goes from 30 to 50% on the skirts and up to 70% on the slopes.

Region with Slightly Ondulated Topography: This region is characterized by a slightly undulating relief, which within the corridor of the TL corresponds to the terminal areas of the system of low hills that move from the northern slopes of the mountain range and are located mainly in the central sector of the TL in east-west direction of the TL axis. In this sector, the relief is relatively low and the terrain configuration is gently undulating, with dominant slopes of 15 to 30%.

Region with Plain Topography: In this region, the relief is flat and the topographic configuration varies from flat to slightly undulating, with slopes not exceeding 15%. The region is characterized by deposits that have been transported by the rivers that cross the region, forming alluviums. This region covers about half of the selected trace.

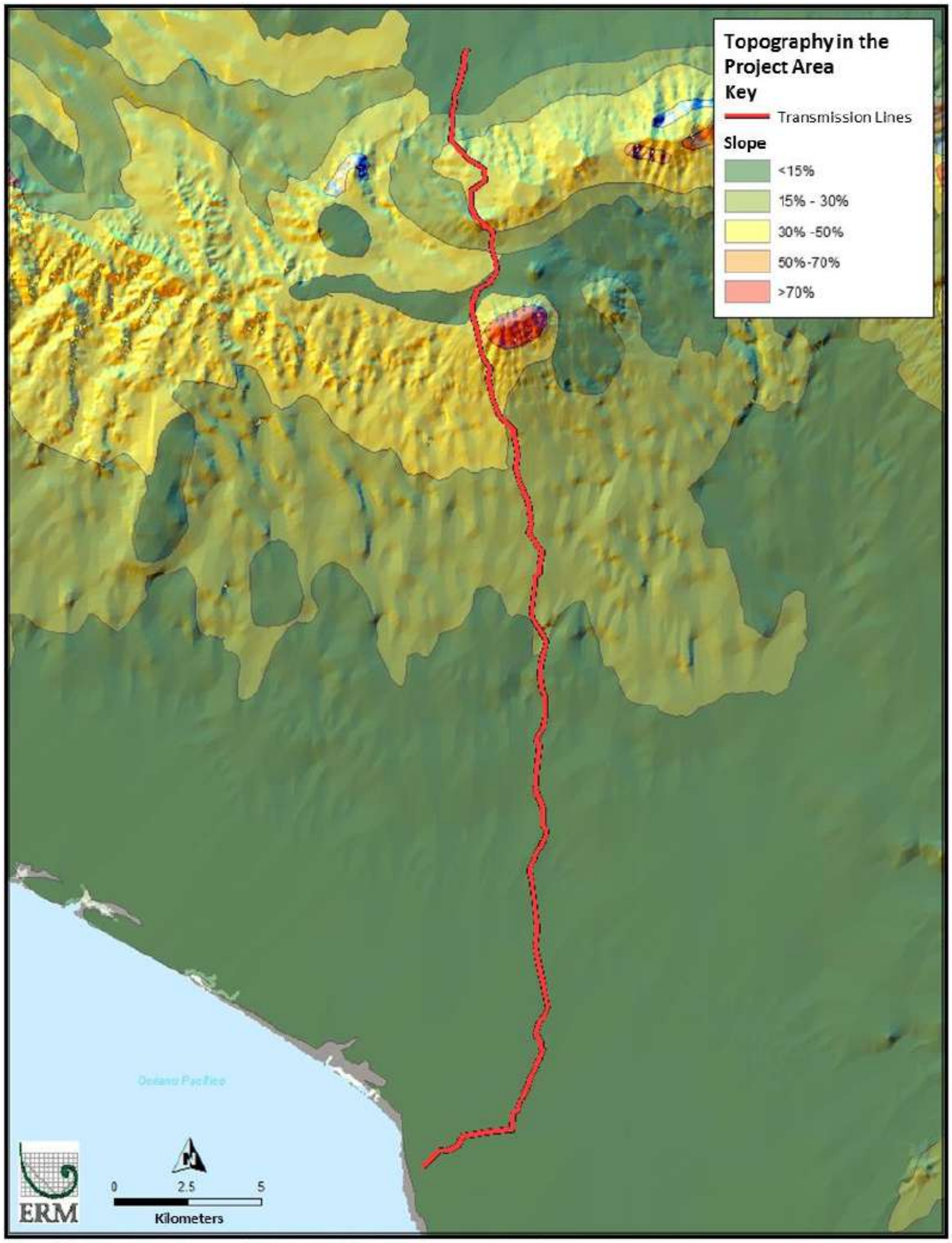


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Figure 4.1-4 Topography in the Project Area

Type of Soils and Usability

Type of Solis

The types of soils that occur near or within the Project correspond to Latosoles Arcillo Reddish, Andisols, Grumosols, Alluvial, Regosols and Halomorphic, varying in texture and depth Depending on the landscape relief (see Figure 4.1-5). The following is a general description of this type of soils according to MARN.

Latosoles Arcillo-Reddish: Reddish clay soils, located mainly in the Project area on mountain slopes. They are well developed with block structure with a generally red color, although sometimes they are yellowish or brownish. This coloration is mainly due to the presence of iron minerals of different types and degrees of oxidation. The surface texture is clay loam and the subsoil is clayey. The average depth is one meter, although in some places rock outcrops due to erosion. Fertility can be high on protected land and agricultural machinery can be used when the slope is moderate. They are soils suitable for almost all crops.

Andisols: Soils originating from volcanic ash, from different times and in different parts of the country, usually have a surface horizon between 20 and 40 centimeters (cm) thick, of dark color, open texture and granular structure. Its production capacity is high to very high productivity. According to the topography they are suitable for an intensive mechanized agriculture for all kinds of crops. In the Project area, these soils are mainly located on hills and mountains.

Grumosols: Very clayey soils gray to black with vegetation of hills, when they are very wet they are very sticky and very plastic. When they are dry they are very hard and crack. On the surface they are dark in color, but with little humus or organic matter. The subsoil is dark gray. They are very deep and little permeable so the infiltration of rainwater is very slow. Its potential use is moderate to low, not suitable for permanent crops of high commercial value because when they crack, they break the roots of plants. In the Project area, these soils are located mainly in the region of the interior plain.

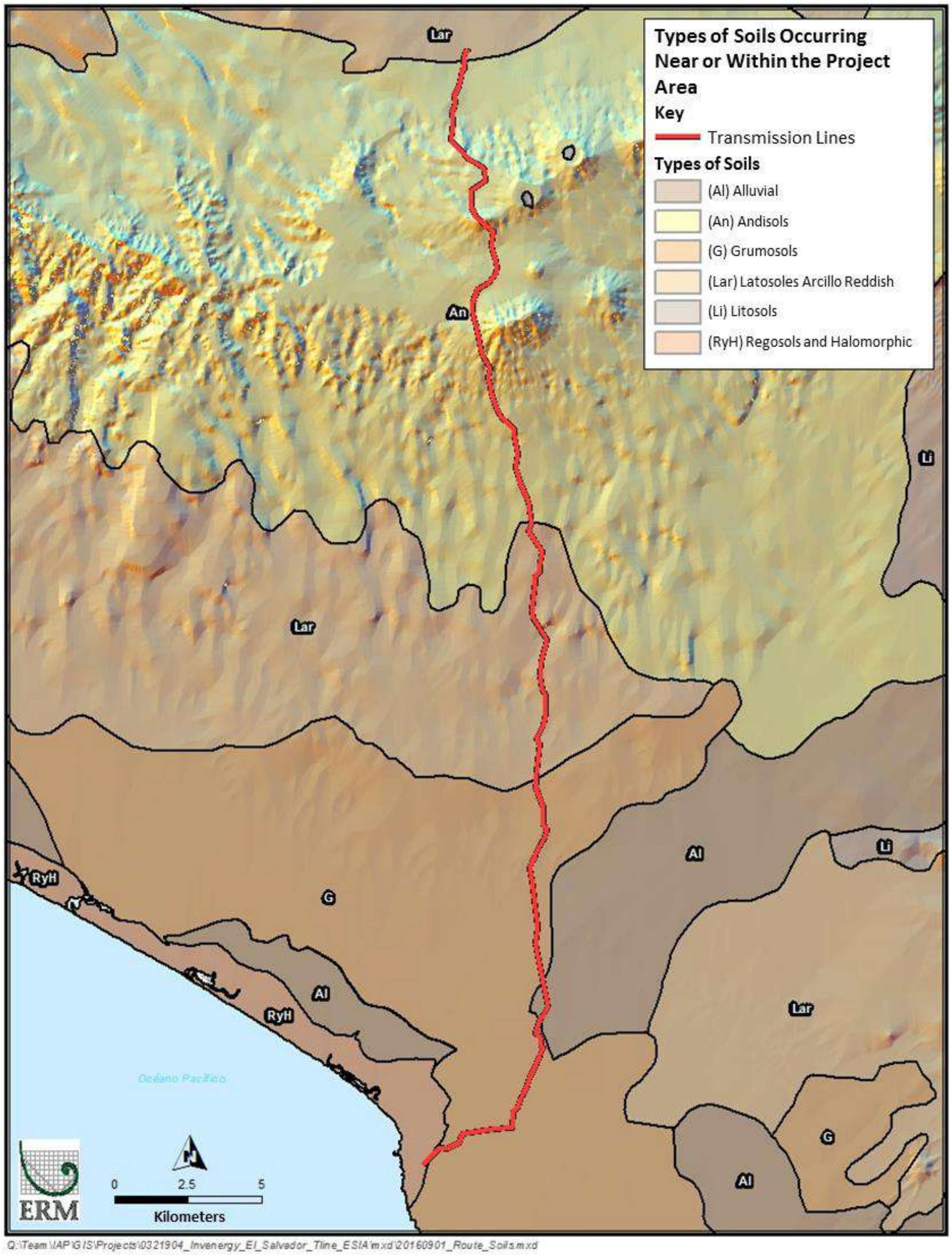

Figure 4.1-5 Types of Soils Occurring Near or Within the Project Area

Alluvial: soils of materials transported or deposited in the coastal plains and inland valleys. They are stratified alluviums of variable texture. They are recent or recently deposited soils and lack modifications of external agents (eg water, climate). They are located in areas that are slightly sloping or almost level in the coastal plains and inland valleys where the water table is close to the surface and drainage is generally poor. They are high productivity soils allowing intensive and mechanized agriculture, suitable for all kinds of crops.

Regosols: deep soils, young of loose or unconsolidated material. The surface horizon is usually about 10 to 20 cm thick, with a high content of organic matter. In El Salvador, it is always found in fine sandy material of gray color, loose. Given its precarious surface layer in the tops of the ripples of the coastal cords, it is recommended to use the Regosols only for permanent vegetation such as coconut, cashew or grass.

Halomorphic: Saline soils of gray-colored mangroves due to the anaerobic condition existing during their formation because they are frequently flooded. Its texture is variable, with silty texture, sandy and clayey strata in different position. The potential use of these soils is very poor for the production of agricultural crops; however, there are in the transition from mangroves to inland alluvial deposits the production of palm trees whose leaves are used for ranches and hats.

<u>Usability</u>

According to the Agrological classification of soil/land use capacity of the MAG (Bonifacio, 2004), the soils in the area of the Project trace correspond to Classes II-IV, VI-VII and soils in urban areas (see Figure 4.1-6).

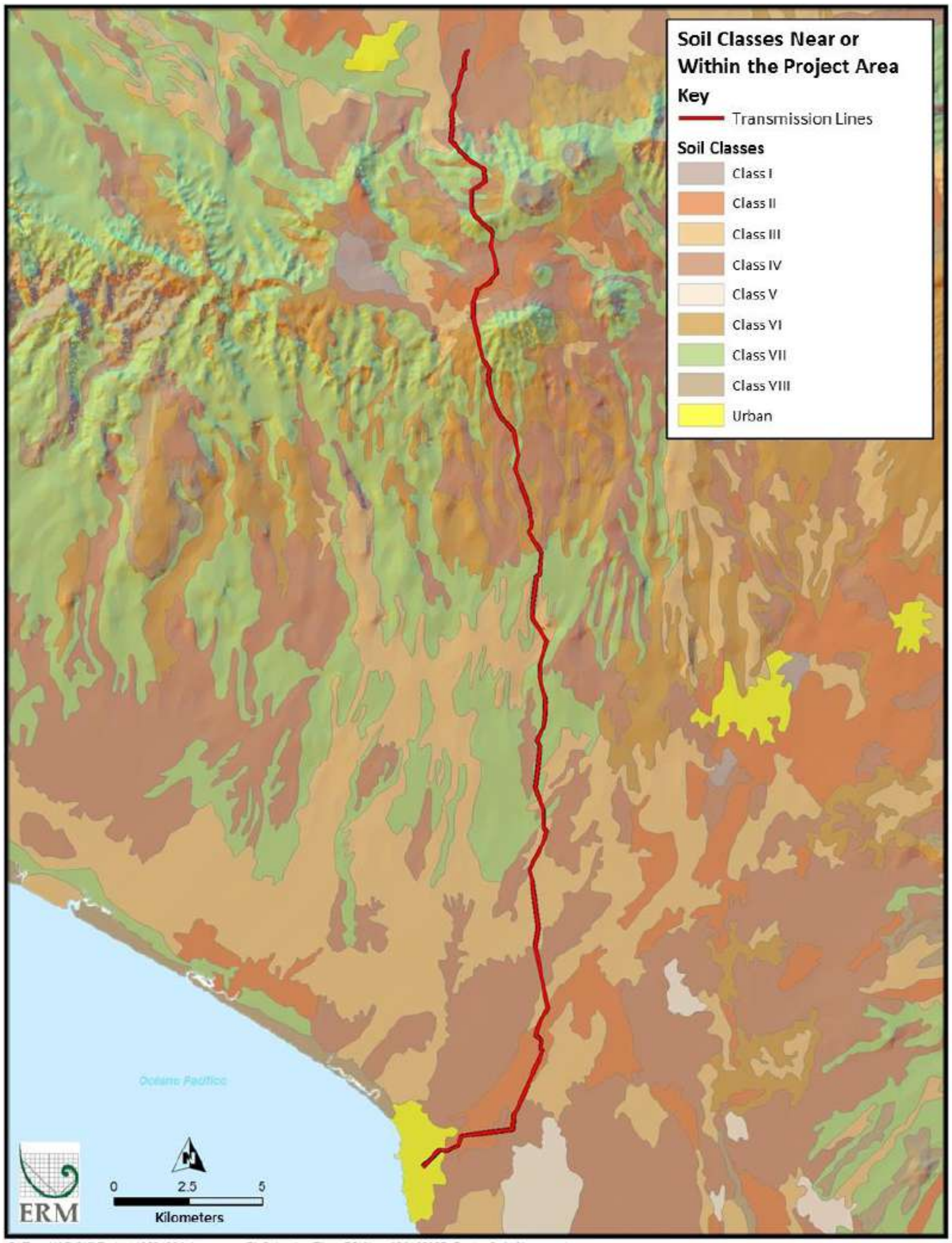

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Figure 4.1-6 Soil Use Capacity that Occur Near or Within the Project Area

Table 4.1-1 shows the types of soil in the TL trace corridor, the soil class and the area (based on a 38 m wide right of way) occupied by each class in relation to the footprint of the corridor. As can be seen in Table 4.1-1, most soils in the TL corridor are classified as Class IV and VII. The soils near and inside the substations are mostly classified as urban.

Table 4.1-1 Types and Classes of Soils in the Project Area

Type of Soil (see Figure 4.1-5)	*Class II (ha)*	*Class III (ha)*	*Class IV (ha)*	*Class VI (ha)*	*Class VII (ha)*	*Urban (ha)*
Aluvials	0.2	4.6	0.5	0	0	0
Andisols	5.0	3.2	27.9	5.6	25.5	0
Grumosols	21.4	18.4	8.4	0	3.5	1.6
Latosoles Arcillo Reddish	0	5.4	2.7	3.1	25.7	0
Regosols and Halomorphic	0	0	0	0	0	2.2
Total	***26.6***	***31.6***	***39.5***	***8.7***	***54.7***	***3.8***

Key: ha = hectares

4.1.3 *Amenazas Naturales*

Due to their geographic location, TL and substations will be exposed to potential natural threats mainly geophysical, such as volcanic eruptions, earthquakes and landslides. These threats are described below.

4.1.3.1 Volcanic Threats

Threat or volcanic hazard is the probability that materials ejected by an erupting volcano affect a specific area over a given period of time. There are several types of threats or hazards such as gas emissions, lava flows, pyroclastic (ballistic projection, ash fall), pyroclastic flows and lahars (debris flows), each of which presents characteristics and forms of displacement themselves, and therefore, have different effects. In the case of the TL Project, threats of lava flows, pyroclastic and lahars, and pyroclastic fall are the most important.

According to MARN records of the volcanic threat in El Salvador, Santa Ana volcano (approximately 19.3 km distance to the TL) and Izalco volcano (approximately 18.2 km away) are located in the Volcanic Cordillera in the northern area of the trace, are the closest active volcanoes that could affect TL (SNET, 2016; see Figure 4.1-7).

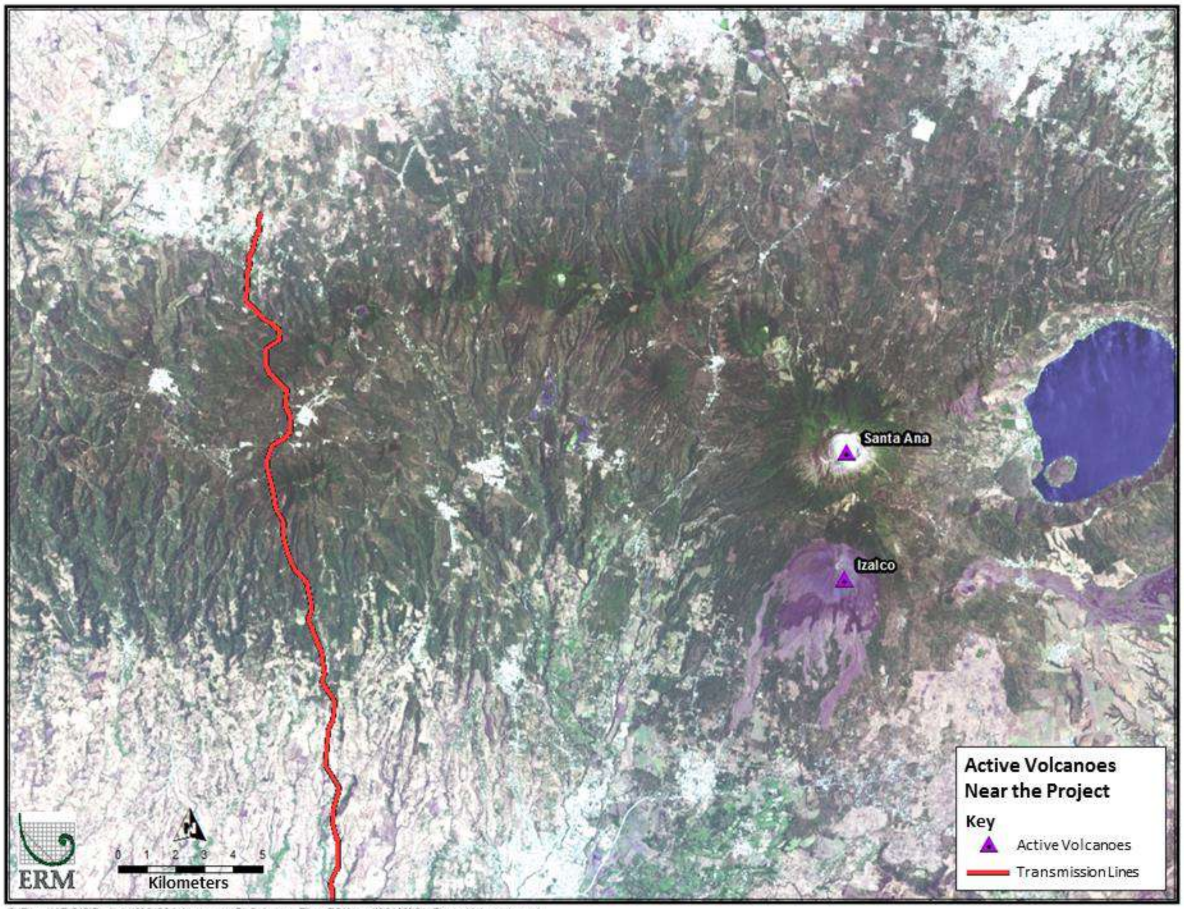


Figure 4.1-7 Active volcanoes Near the Project

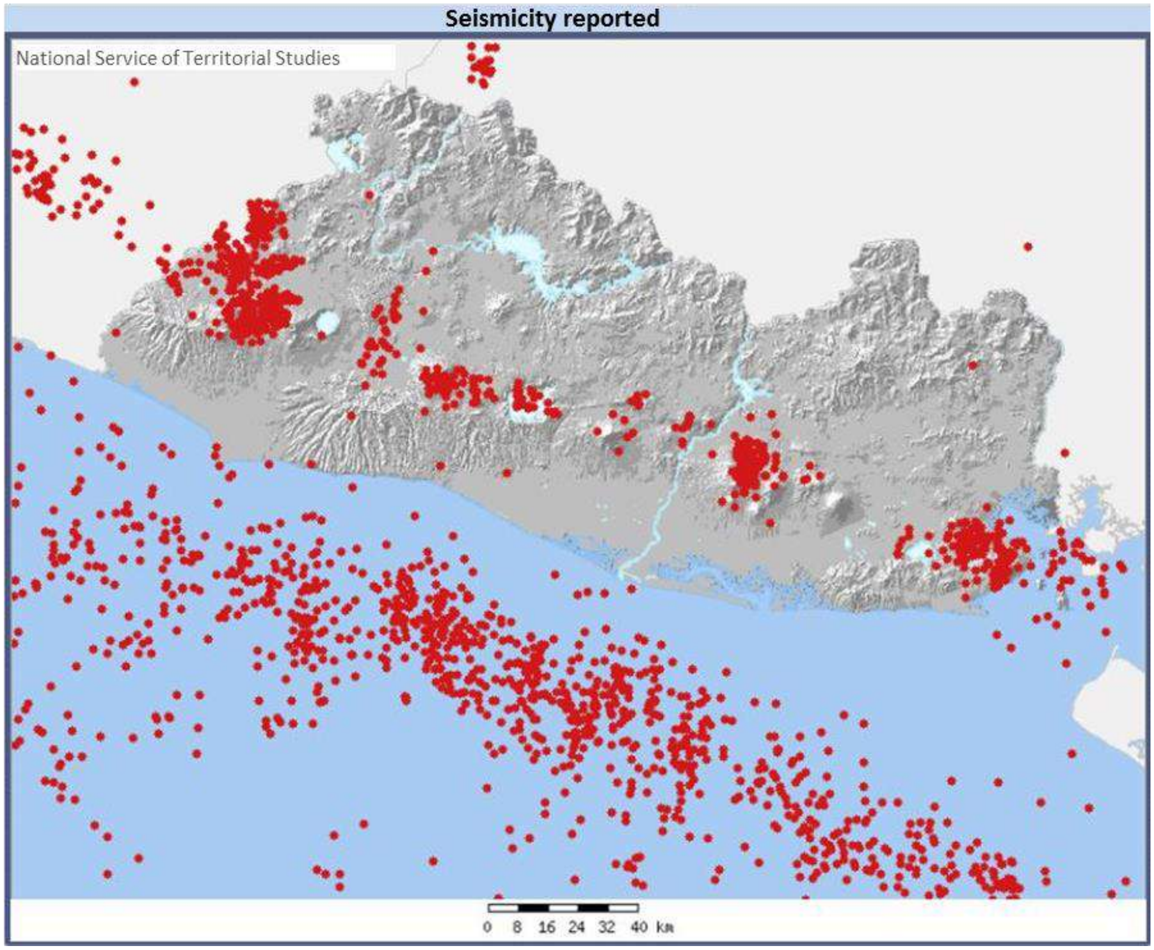
Santa Ana volcano or Ilamatepec is a stratum volcano located in the department of Santa Ana. At a height of 2,382 meters above sea level (masl), it is the highest volcano in the country. It lies immediately west of Coatepeque Lake. The last eruption of this volcano was recorded in 2005. The Izalco volcano is also a stratum volcano, located on the southern flank of Santa Ana volcano in Sonsonate department, at a height of 1,965 m. The last eruption was recorded in 1966.

4.1.3.2 Seismic Threat

In El Salvador, the seismic threat arises from two main sources: the subduction zone of the tectonic plates and the volcanic mountain range that is understood throughout Central America from western Guatemala to Panama. The TL trajectory traverses the geomorphological units coastal plain and volcanic mountain range. The volcanic mountain range is considered as the main seismogenic source in the Project area (see Figures 4.1-8 and 4.1-9). As can be seen in Figure 4.1-8, the SNET of El Salvador has recorded numerous earthquakes in the region of the volcanic mountain range in the Project area.

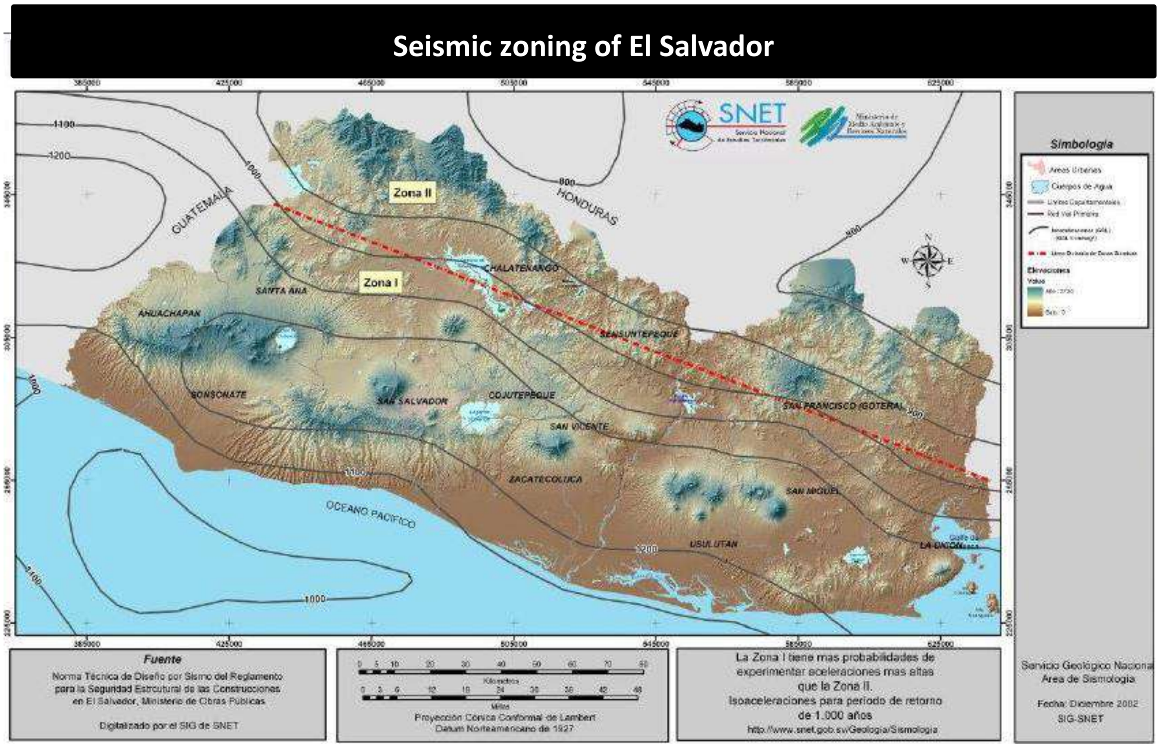
The seismic threat is a function of the magnitude of the earthquake and the distance from the point to the seismic source. Seismic motion is measured with maximum terrain acceleration and the seismic threat is evaluated in probabilistic terms: it is a common practice to define the seismic threat as expected peak effective acceleration (EPA) or maximum acceleration of the terrain with a probability of exceeding 10% in 50 years (which generally corresponds to the useful life of a normal structure). This threat level corresponds to the seismic movement that has a return period (an average interval between events) of 475 years.

According to the SNET El Salvador seismicity map (SNET, 2016), El Salvador is divided into two seismic zones (Zone I and Zone II) and are used in the construction of structures using the technical standard for earthquake design. The area of the Project is located in Zone I (see Figure 4.1-9), which corresponds to an EPA factor of 0.40 g (acceleration due to gravity of the earth, which equals the force g). Zone II has a factor of 0.30 g. expected peak effective accelerations of 0.34 to 0.65 g correspond to a Grade VIII seismic intensity on the Mercalli scale; and from 0.18 to 0.34 g at a seismic intensity of Grade VII on the Mercalli scale. Seismicity maps are used in the design of structures, including the design of electric towers.



Source: SNET, 2016

Figure 4.1-8 Seismicity Reported in El Salvador (2001 - 2006 Epicenters) in the Regions of the Subduction of Tectonic Plates and the Volcanic Mountain Range



Source: SNET, 2016

Figure 4.1-9 Seismic Zones in El Salvador

4.1.3.3 Landslide Threat

Land slipping is a type of land mass motion or movement, caused by the instability of a slope, and typically occurs by saturation of water during heavy rains and seismic movements. Important physical factors affecting landslides include geological structure, lithology, geomorphology, tectonics and slope.

As shown in Figure 4.1-10, which characterizes the configuration of areas susceptible to landslides that crosses the TL, the only important sites (areas with high and moderate susceptibility to landslides) that could have a significant effect on the occurrence of landslides includes areas north of the TL in the hills and mountain slopes and in the central area where the TL crosses area with alluvial formations.

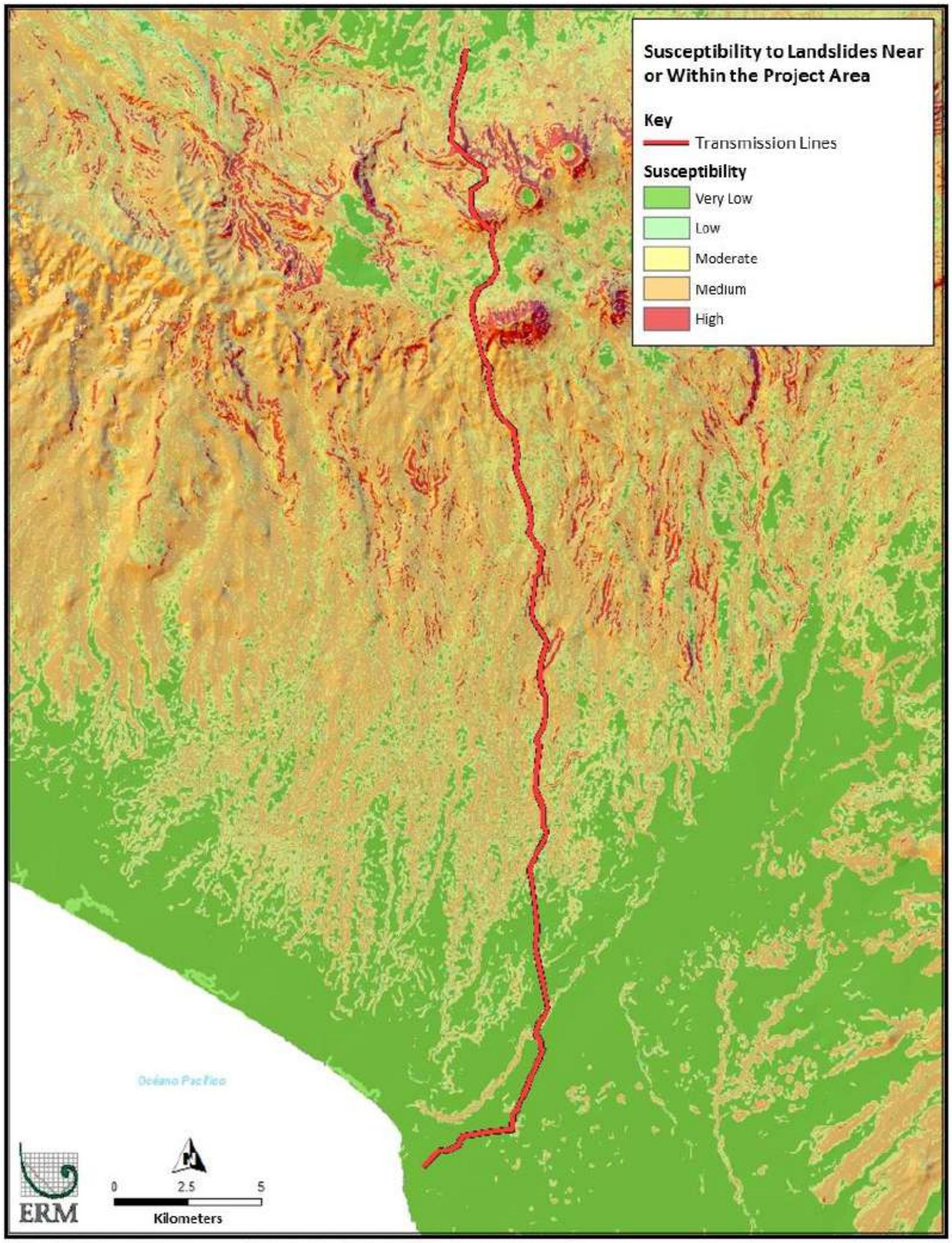


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Figure 4.1-10 Susceptibility to Landslides Near or Within the Project Area

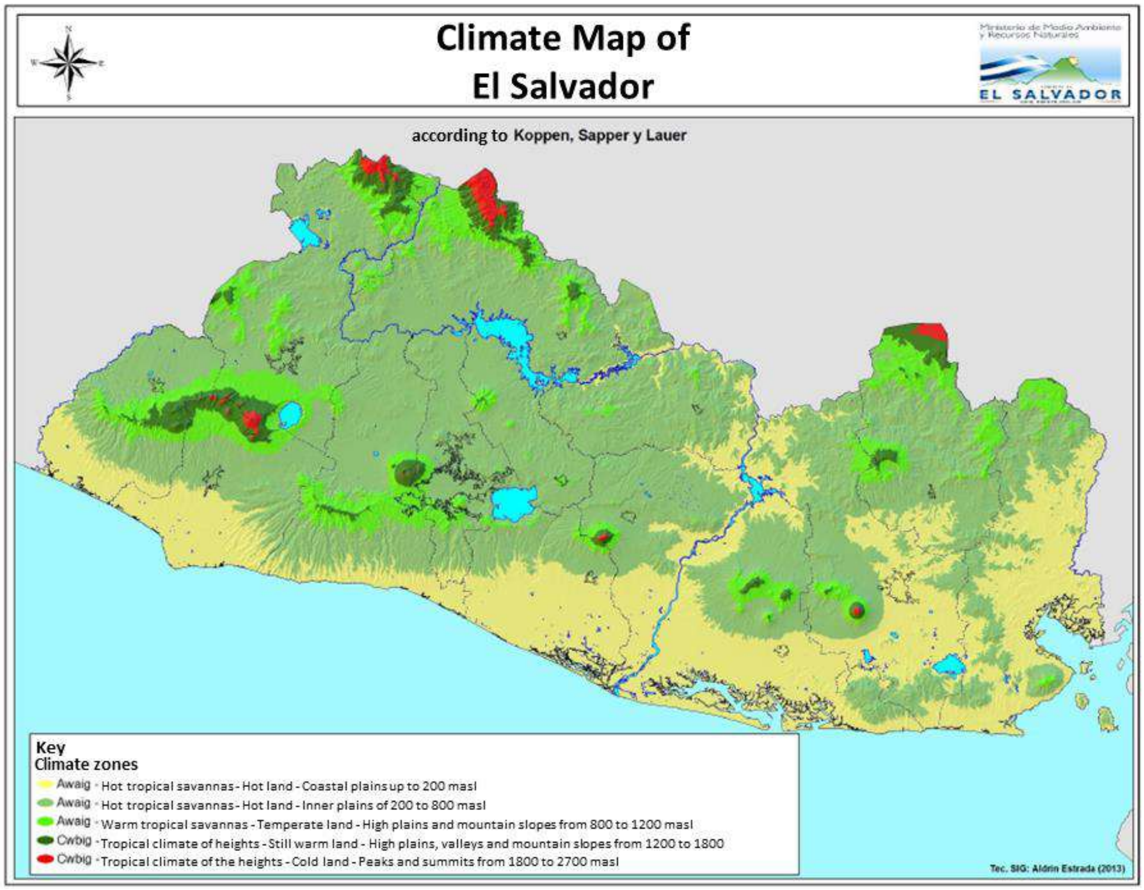
4.1.4 *Weather conditions*

This section describes the main climatic characteristics of the project area. The description was based on the use of official information generated by MARN for the departments of Sonsonate and Ahuachapán, where the Project will be located.

El Salvador is located on the outside of the climate belt of the Tropics of Cancer and Capricorn, which produces small changes in temperatures throughout the year (SNET, 2015). Contrary to the temperatures, the rains show great oscillations throughout the year, presenting a dry season and a rainy season. Figure 4.1-11 shows the climatic zones in El Salvador, which vary with elevation.

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2006), the following factors condition the climate regime in El Salvador:

- The relief of the country;
- The intertropical convergence zone;
- The trade winds;
- Tropical or Eastern waves;
- The influence of the Pacific Ocean breeze;
- Atltantic subtropical anticyclone or Bermuda;
- Cold fronts displaced by masses of cold and continental air of polar origin;
- Weak thermal centers with low atmospheric pressure; and
- • Cyclonic systems, such as tropical storms and hurricanes.



Source: SNET, 2015

Figure 4.1-11 Climate Zones of El Salvador

The climate in the Project area is characterized as Hot Tropical Savanna or Hot Land with humid subtropical forest (SNET 2015). Table 4.1-2 presents the two main meteorological stations (Ahuachapán [H-8] and Acajutla [T-6]) located within the Project area, which were used to characterize the climatological aspects of the area. The station of Ahuachapán is located in the outskirts of the city, near El Espino lagoon (Llano hamlet), in the central zone of the western region of the country. The station of Acajutla is located near the facilities of the Port, in the coastal zone of the western region of El Salvador.

Next, the climatological parameters of these two stations are described for a period of 39 years (1971-2010) according to what was reported by MARN (Araujo, 2016).

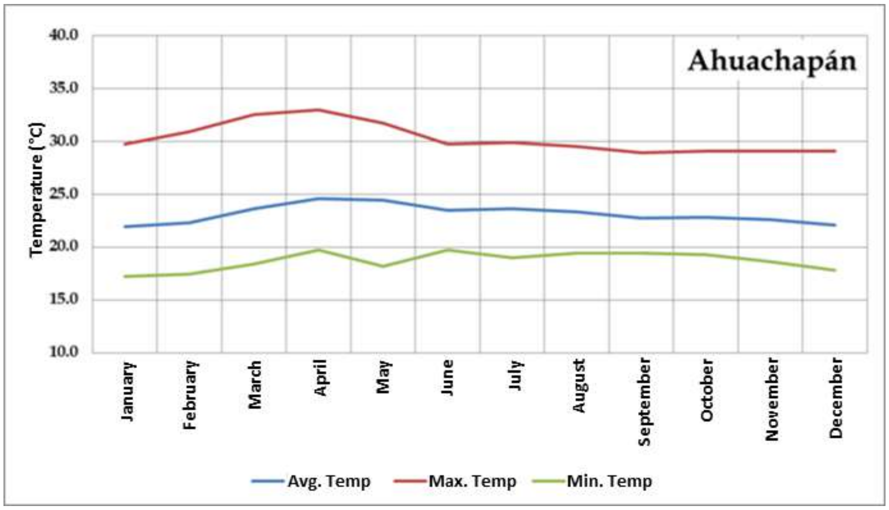
Table 4.1-2 Climatological Stations Within the Area of Study

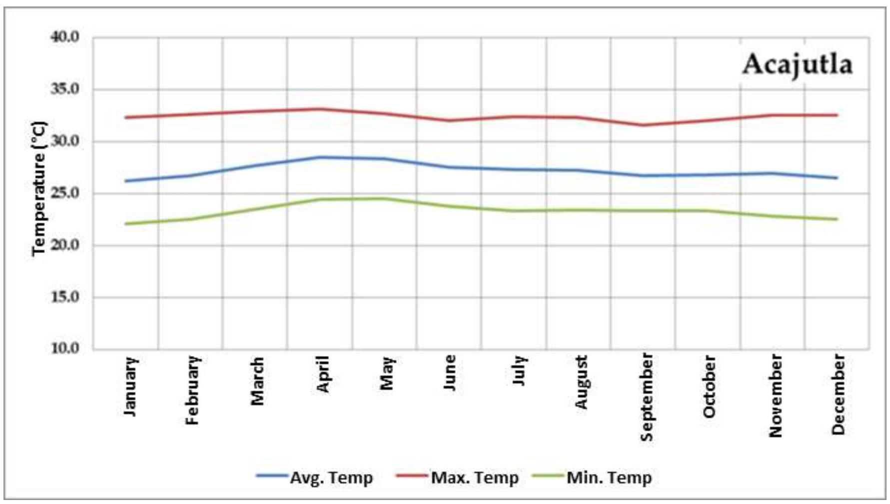
Station	Code	Coordinates	Elevation (masl)
Acajutla	T-6	13°34.3′ North Latitude 89°50.0′ West Longitude	15
Ahuachapán	H-8	13°56.6′ North latitude 89°51.6′ West Longitude	725

Key: masl = meters above sea level

4.1.4.1 *Temperature*

El Salvador has annual average temperatures of 24.8 °C, with average minimum temperatures of 23.8 °C in December and 23.9 °C in January due to the influence of cold winds caused by air incursions from the North. The warmest month is April with an average temperature of 26.4 °C (UNESCO, 2006). According to the records of Ahuachapán weather station, the average annual temperature is 27.2 °C (see Figure 4.1-12 and Table 4.1-3), while the average annual temperature in Acajutla is 23.1 °C (see Figure 4.1-12 and Table 4.1-4). In its annual climate bulletin, MARN (2014a and 2015a) reports that Acajutla (T6) station recorded the highest average annual ambient temperature of 2015, with a record of 29.0 °C; while Ahuachapán station recorded an annual average temperature of approximately 24.3 °C (Araujo, 2016).





Source: Araujo, 2016

Figure 4.1-12 Average Air Temperatures per Month Recorded at Ahuachapán Climatological Stations (above) and Acajutla (below) for the Period 1971-2010

Table 4.1-3 Average Climatological Data of the Ahuachapán Station for the Period 1971-2010

Parameters/Months	*Units*	*January*	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
Maximum Average Temperature	℃	29.7	30.9	32.5	33	31.7	29.7	29.9	29.5	28.9	29.1	29.1	29.1
Minimum Average Temperature	℃	17.2	17.4	18.4	19.7	18.2	19.7	19	19.4	19.4	19.3	18.6	17.8
Average Temperature	℃	21.9	22.3	23.6	24.6	24.4	23.5	23.6	23.3	22.7	22.8	22.6	22.1
Relative Humidity	%	65	63	66	66	75	81	76	80	84	79	70	66
Sunlight	hours/days	9.3	9.3	9.4	8.7	7	6.2	8	7.5	5.7	6.9	8.4	9.1
Cloud Cover	Octas	2.8	2.4	3.6	4.2	6.2	7.1	6.4	7.1	7.6	6.4	4.3	3.2
Wind Maximum Absolute Speed	km/hour	69.5	76.3	70.6	87.1	61.2	68.4	77	73	60.8	43.2	54	64
Wind Direction	---	NE	NE	NE-W	NE-W	W	NE-W	NE	NE	NE	NE	NE	NE

Source: Araujo, 2016
Key: NE= Northeast; W= West; km= Kilometers; ℃= degrees Celsius; octas (Eighth) = If the clouds cover the middle of the sky it is said that the cloudiness is of 4 octas.

Table 4.1-4 Average Climatological Data of the Acajutla Station for the Period 1971-2010

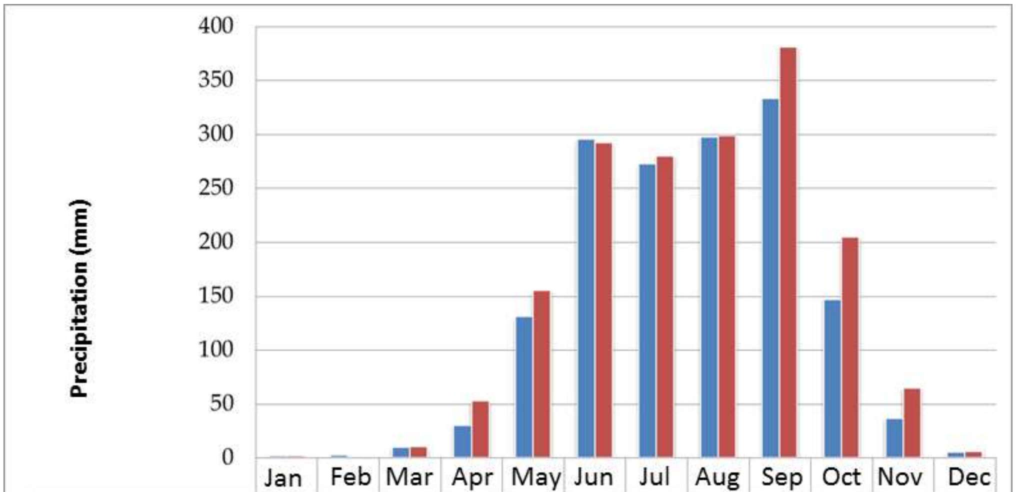
Parameters/Months	*Units*	*January*	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
Maximum Average Temperature	℃	32.3	32.6	32.9	33.1	32.7	32	32.4	32.3	31.6	32	32.5	32.5
Minimum Average Temperature	℃	22.1	22.5	23.5	24.4	24.5	23.8	23.3	23.4	23.3	23.3	22.8	22.5
Average Temperature	℃	26.2	26.7	27.7	28.5	28.3	27.5	27.3	27.2	26.7	26.8	26.9	26.5
Relative Humidity	%	69	69	40	73	77	80	78	79	82	80	73	70
Atmospheric pressure	mb	1010.1	1010.3	1009.6	1008.8	1008.4	1008.8	1009.7	1009.3	1008.7	1008.5	1009	1009.4
Cloud Cover	en /10	1.9	2.3	3.1	4.6	5.8	7.3	6.8	7.1	7.5	6.8	4.3	2.7
Wind Maximum Absolute Speed	km/hr	11.3	12.5	11.6	11.1	10.3	9.9	9.9	9.5	9.6	9.3	11	10.9
Wind Direction	---	NE	NE	NE	W	NE	E	NE-E	E	E	NE	NE	NE

Source: Araujo, 2016
Key: NE= Northeast; W= West; E=East; Km = kilometers; ℃ = degrees centigrade; Mb = millibars

4.1.4.2 *Precipitation*

According to the water balance prepared by UNESCO (2006) for El Salvador, rainfall in the country is of orographic origin (northern and coastal mountain ranges), convective (warming of air mass) and cyclonic (atmospheric systems such as tropical waves, low pressures and troughs). In El Salvador, there is a dry season and a rainy season, with their respective transition periods (November to April and May to October). In addition, there is a period of rain reduction between the months of July and August, which is called the canicus period. El Salvador is periodically affected by El Niño-Southern Oscillation (ENSO) phenomenon, which causes delay in the beginning of the rainy season and reduction in the duration of the rainy season, as well as a decrease in rainfall and extension of the heat stroke period.

Figure 4.1-13 shows the monthly precipitation averages based on historical data recorded by MARN (Araujo, 2016) during the rainy season in Ahuachapán and Acajutla for a period of 39 years (1971-2010). The highest rainfall is recorded in August and September of each year, when there is the highest probability of occurrence of tropical storms with torrential repercussions in the coastal zone. The average annual rainfall recorded at Ahuachapán and Acajutla stations is approximately 1,561 millimeters (mm) and 1,747 mm, respectively. However, in its annual climatological bulletin (MARN 2014a and 2015a) of 2015, MARN reported that the precipitation regime in these two seasons and in general was reduced compared to its normal climatological. The rain accumulated in 2015 in these two stations was approximately 1,470 mm for Ahuachapán and 1,250 mm for Acajutla.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ahuachapán (mm)	1.7	2.1	9.3	30.1	130.7	295.8	272.5	297.7	333.3	146.8	36.6	4.7
Acajutla (mm)	1.8	0.9	10.0	52.9	155.0	292.5	279.8	299.0	380.8	204.5	64.3	5.9

Source: Adapted from personal Communication with Araujo, 2016

Figure 4.1-13 Average Precipitation Recorded at Ahuachapán and Acajutla Climatological Stations for the Period 1971-2010

4.1.5 *Water Resources*

This section describes the baseline conditions of surface and groundwater within and near the Project area. The surface waters include the basins and micro-basins that cross the Project, as well as the rivers and/or ravines near the same. The groundwater includes the hydrogeological units and aquifers near the Project. The main sources of information used for this section are:

- Information generated by MARN;
- El Salvador National Geographic Institute "Ing. Pablo Arnoldo Guzmán";
- Information generated by the National Administration of Aqueducts and Sewers (ANDA) and the Swiss Cooperation;
- Information generated by MAG, General Directorate of Forest Management, Watersheds and Irrigation; and
- Among others (eg, UNESCO, University of El Salvador, etc.).

The following describes the current conditions of the water resources of the Project area.

4.1.5.1 *Watersheds and Subwatersheds*

El Salvador is divided into eleven hydrographic regions (MAG, 2012). The study area of the Project crosses three of them: Paz (region B), Cara Sucia-San Pedro (region C) and Río Grande de Sonsonate-Banderas (region D) showed in Figure 4.1-14. Table 4.1-5 presents the general characteristics of these three hydrographic regions.

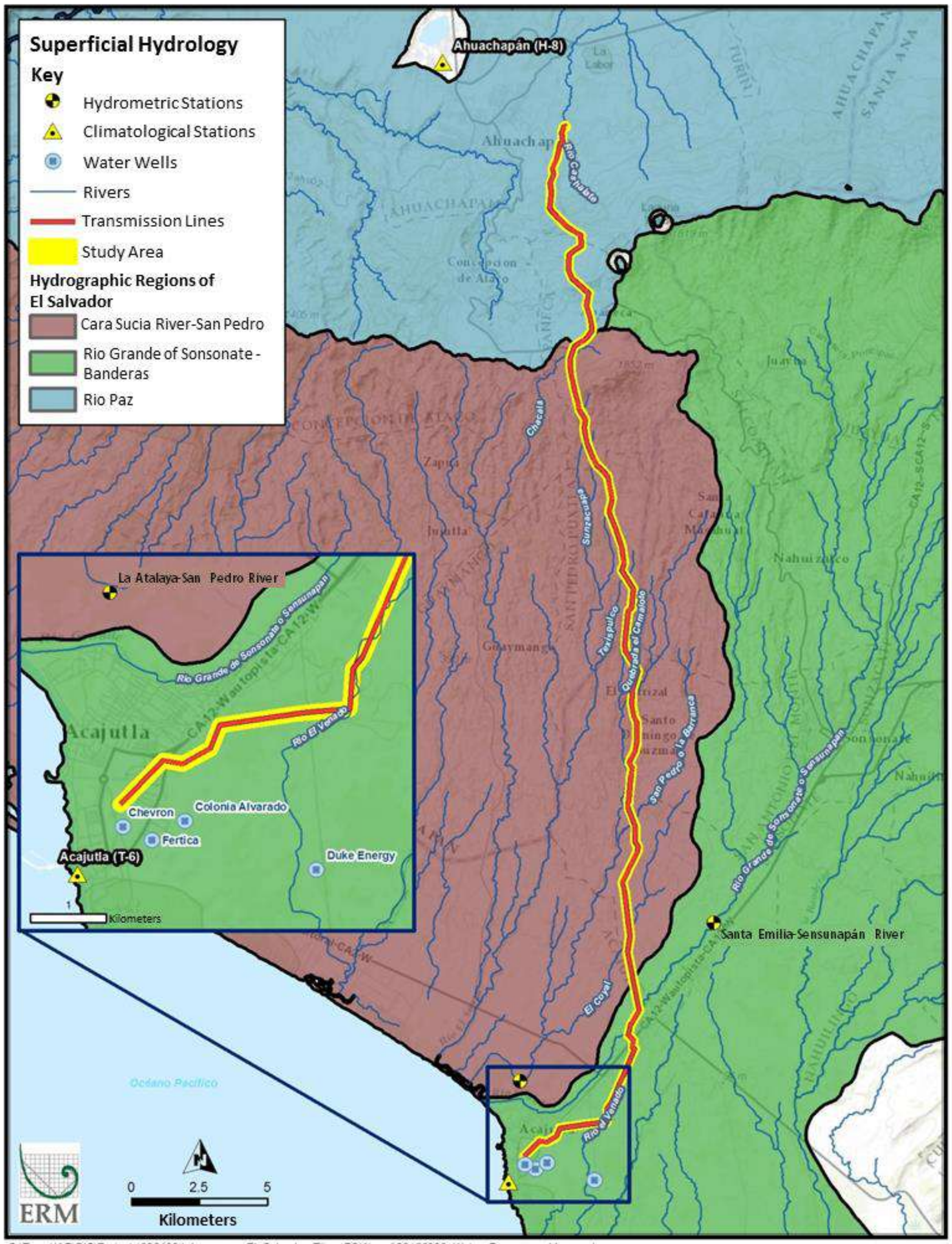


Figure 4.1-14 Hydrographic Regions in the Project Area

Table 4.1-5 Characteristics of the Main Hydrological Basins of the Project Area

Parameter	*Units*	*La Paz*	*Cara Sucia*	*Sonsonate-Banderas*
Area	km^2	2,011 (El Salvador-Guatemala); 919 (National)	768.0	778.43
Perimeter	km	268.0	228.1	107.5
Maximum lift	masl	2,365.0	1,436.8	1980.0
Soils	---	Latosols Arcillo Reddish, Litosols, Regosols, Grumosols and Alluvial	Latosols Arcillo Reddish, Litosols, Regosols, Grumosols and Alluvial	Latosols Arcillo Reddish, Litosols, Regosols, Grumosols and Alluvial
Annual Average Precipitation	mm	1400-2400	1400-2400	1400-2400
Climate Classification	---	Hot Land / Sizzling Temperate 16-28 ℃	Hot Land / Sizzling Temperate 16-28 ℃	Hot Land / Sizzling Temperate 16-28℃

Source: IGN, 2000 and UNESCO, 2006
Key: Km^2 = square meters; km = kilometers; masl = meters above sea level; mm = milímeters.

4.1.5.2 Rivers and Ravines

The main rivers and ravines within the Project area are Rio Grande of Sonsonate or SENSU, Río Cashalate, Quebrada de Invierno, Río Camalote and Río El Venado (see Figure 4.1-14). The main characteristics of these rivers are described below:

- Rio Grande of Sonsonate presents a permanent flow towards the Pacific Ocean;
- Cashalate River is part of Paz hydrographic region and has a permanent flow north to Paz River;
- Quebrada de Invierno is part of Cara Sucia-San Pedro hydrographic region and only has a flow during the rainy season, with a southward direction towards the Pacific Ocean;
- Río Camalote is part of Cara Sucia-San Pedro hydrographic region and presents a permanent flow southward to the Pacific Ocean; and
- El Venado River which is part of the Grande of Sonsonate-Banderas and presents a permanent flow south to the Pacific Ocean.

According to MARN data, there are no records of flows of the rivers and / or streams mentioned above. However, within the Sonsonate department, where a large part of the Project is located, there are two hydrometric (telemetric) stations that record flows of Sensunapán rivers (Santa Emilia station) and San Pedro (La Atalaya station). Table 4.1-6 presents a summary of the flows recorded in both hydrometric stations; while Table 4.1-7 presents a water balance for Río Grande of Sonsonate basin according to UNESCO (2006).

Table 4.1-6 Information of Hydrometric Stations close to the Study Area

Station	*River*	*Parameters*	*Units*	*Value*
Santa Emilia	Sansunapán	Multi-year average flow	m^3/s	---
		Registered maximum flow (11 October 2013)	m^3/s	310
		Registered minimum flow (April 27, 2014)	m^3/s	4.78
La Atalaya	San Pedro	Multi-year average flow	m^3/s	3.00
		Registered maximum flow (11 October 2013)	m^3/s	391.37
		Registered minimum flow (April 27, 2014)	m^3/s	0.44

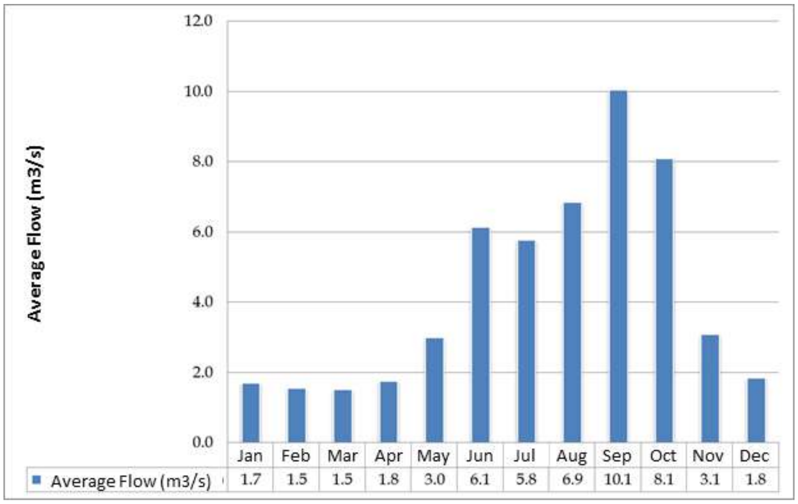
Source: Adapted from MARN, 2014b

Table 4.1-7 Water Balance for Río Grande of Sonsonate Basin

Basin	*Area (km^2)*	*Precipitation*	*Evaporation of water bodies*	*Real evaporation*	*Evaporation of urban areas*	*Surface runoff*	*Aquifer recharge*
		Millions of cubic meters (Mm^3)					
Río Grande of Sonsonate	220	458.72	0.37	187.23	2.33	180.64	88.15

Source: Adapted from UNESCO, 2006
Key: Km^2 = square kilometers

According to SNET database, there are no hydrometric stations that record flows for Rio Grande of Sonsonate, so it was necessary to estimate the annual and monthly mean flows using the mean annual regionalization equations and monthly distribution factors that apply to the Hydrological Region No. 1 (see UNESCO, 2006); the drainage area of Río Grande of Sonsonate basin of approximately 220 km2 was also used (see Table 4.1-7). Considering the above, the average flow rate for Río Grande of Sonsonate was estimated at 4.3 cubic meters per second (m3/s); while estimated average flow rates per month ranged from 1.5 to 10.1 m3/s (see Figure 4.1-15).



Source: Estimated by ERM

Figure 4.1-15 Estimated Average Flow for Rio Grande of Sonsonate

4.1.5.3 *Surface Water Quality*

According to MARN (2012) since 2006, permanent monitoring of water quality has been carried out in 123 sampling sites in 55 rivers in the Salvadoran territory. The main objective of this program is to assess its condition to allow the development of aquatic life and determine the use of watercourses.

There is no baseline of water quality for rivers and/or ravines located within the Project area. In order to have a general idea of the water quality within the municipalities close to the study area, general aspects of surface water quality outside the Project's area of influence are described below.

The MARN (2012) reports a water quality diagnosis of the rivers located within Sonsonate hydrographic region. This diagnosis concludes that according to the Water Quality Index (WQI) for 2011, the water quality of the rivers located in this region is good at two monitoring points, poor at six monitoring points and regular at nine monitoring points. Table 4.1-8 presents a summary of available water quality data for the main rivers/ravines near the Project area.

Table 4.1-8 Water Quality Summaries of the Principal Rivers Near the Project Area

River	*Water suitable for Potabilization*	*Water with Environmental Quality*	*Water for Irrigation*	*Water for Recreational Activities*
Paz River	The lower middle part (Downstream of La Hachadura bridge). The main channel of Paz River is suitable for potabilization by conventional methods, since it presents high levels of fecal coliforms (up to 1700 MLN/100ml).	The results of the Diagnosis show that in general the water qualifies as "Regular" which limits the development of aquatic life.	In general, the water quality for irrigation is good and only in the upper part of the main channel of Paz River is the parameter of fecal coliforms out of norm with a value of 1700 MLN/100ml.	In basin of Paz River (downstream of La Hachadura bridge), they comply with the regulations for recreational activities involving human contact with water. The sites that do not comply correspond to those that present average levels of turbidity and a value of fecal coliforms of 1700 MLN/100ml.
Cara Sucia River			In general, the quality of the water for irrigation is good and in few cases, it has problems with pH, conductivity and high levels of sodium. A contamination problem for irrigation are high levels of fecal coliforms, ranging from 1300 MLN/100ml to 160,000 MLN/100ml.	In general, the water quality of rivers is not suitable for recreational activities involving human contact with water. Only the upper part of El Rosario River and Guayapa River comply with the regulations.

River	*Water suitable for Potabilization*	*Water with Environmental Quality*	*Water for Irrigation*	*Water for Recreational Activities*
Sansunapán, Cenizas Rivers	In the basin of "Río Grande of Sonsonate", the Sensunapán or Río Grande of Sonsonate and Ceniza River were evaluated. None of the evaluated sites fulfilled the capacity of raw water to be purified by conventional methods. BOD5 and phenol values ranging from 3.7 mg/L to 4.3 mg/L, respectively, indicating a high degree of organic contamination	The environmental quality of Río Grande of Sonsonate and Ceniza River ranges from Regular to Mala, being of better quality in the upper part of the basins, that is, it allows aquatic life, but in a very limited way.	In general, the water quality for irrigation is good except for the high levels of fecal coliforms, ranging from 5000 MLN/100ml to 160,000 MLN/100ml.	The waters are not suitable for recreational activities due to the high levels of fecal coliforms and low dissolved oxygen levels in Ceniza River.

Source: Adapted from MARN, 2012
Key: MLN/100 ml = Most Likely Number (MLN)/100 milliliters of total coliform bacteria

4.1.5.4 *Hydrogeology*

This section describes the main hydrogeological characteristics of the study area of the Project, considering the main aquifers and their susceptibility to be contaminated; a brief description of the quality of groundwater is also presented. Based on what has been reported by the United States Army Corps of Engineers (USACE, 1998), most of the aquifers in El Salvador are made up of lava flows and pyroclastic flows from the Middle Tertiary to the Recent Era, being San Salvador and Cuscatlán formations the most important aquifers in El Salvador.

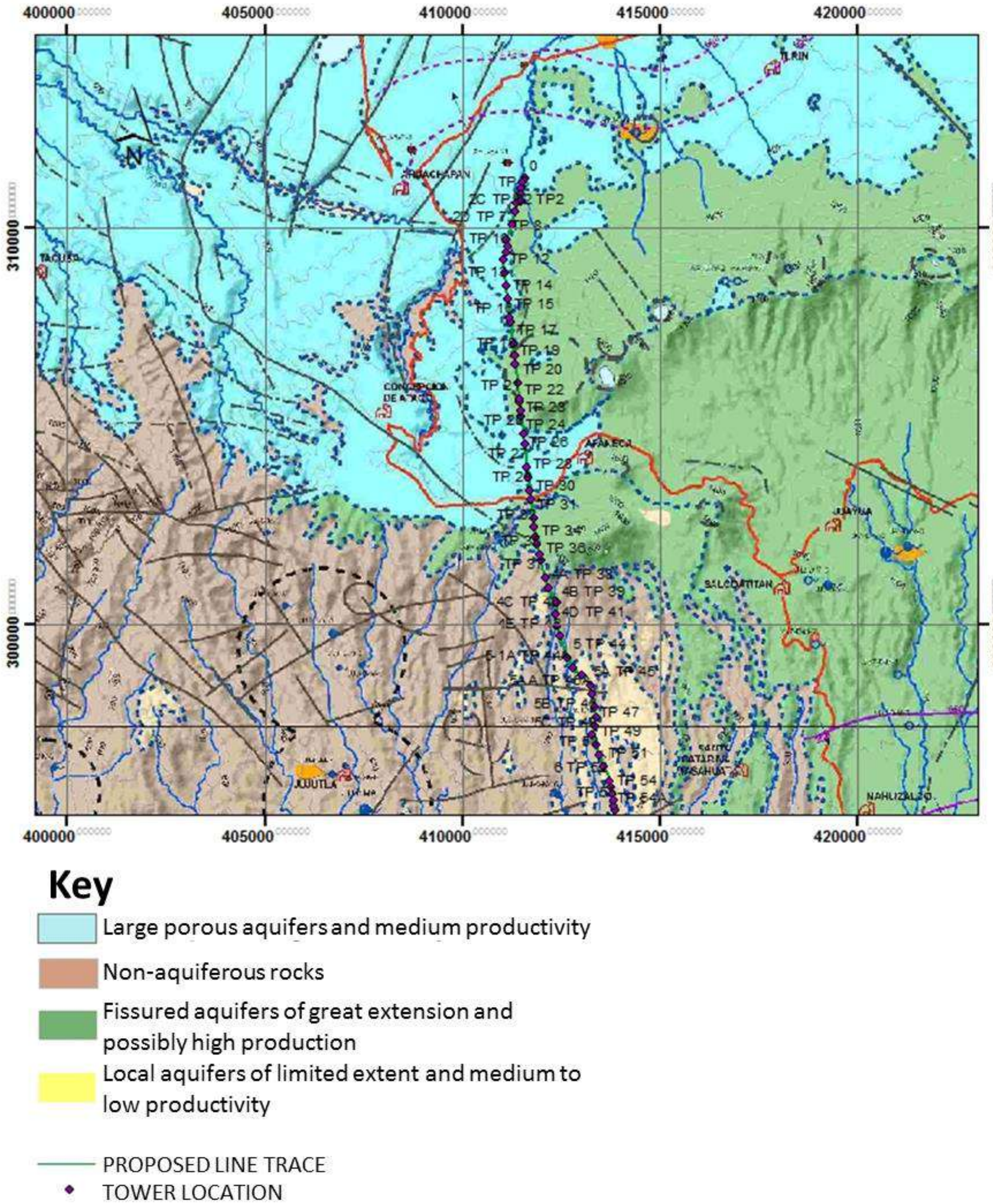
Table 4.1-9 presents a summary of the main characteristics of the hydrogeological units within the Project study area; while Figure 4.1-16 shows the location of such hydrogeological units.

Table 4.1-9 Description of Hydrogeological Units Within the Project Study Area

Hydrogeological Units	*Description*
Non-aquiferous rocks	It is composed of old lavas, melted tuff (ignimbrites) and agglomerates of tertiary age, which have very low hydraulic characteristics due to their high degree of weathering or decomposition, that is, they have been exposed to the most atmospheric agents which accelerate Its transformation into clays. Because of this, in most cases, the predominant factor in its classification as an aquifer is the age of the rock: the older the rock, the greater the degree of decomposition and compaction. However, the hydraulic properties of these materials may vary locally. The presence of cracks in old lava flows makes possible the existence of groundwater flows that transit in specific areas giving rise to local aquifers. These properties are not homogeneous and will depend on the degree of fracture of the rock and the presence of clays.
Local aquifers of limited extent and medium to low productivity	The sedimentary alluvial and eluvial deposits of San Salvador formation, which are in intercalation with reworked pyroclastics and Agglomerated Tufts, constitute a porous aquifer formed by materials that are the product of sequences of events of transport and sedimentation of materials. The limb that underlies the sediments is formed by lavas, tuffs and agglomerates of Bálsamo formation; they do not present homogeneity in their hydraulic characteristics. These depend on their degree of compaction and the presence of fractures. That is, they could also form isolated aquifers under special circumstances.

Hydrogeological Units	*Description*
Large porous aquifers and medium production	It consists essentially of loose and semi-composite structure materials; have a primary porosity, that is, they allow the storage and transit of groundwater through the spaces that exist between the grains that constitute them. The central part of Zapotitán Valley was formerly occupied by a lagoon, "during the lacustrine period muddy and turbid sediments were formed", for which there are sedimentary deposits of fluvial and lacustrine origin throughout the valley. Additionally, the volcanic activity of Coatepeque Caldera and the volcano of San Salvador has left deposits of pyroclastic materials and tufts of loose structure to semicompact, in addition to lava of compact structure, in alternation with the sedimentary deposits. Currently sediments of fluvial origin are visible on Río Colón riverbed and throughout the Zapotitán Valley. They consist of boulders, gravel, sand, silt and clays. They are composed basically of materials that have been dragged and deposited in alluvial terraces by the mentioned river. The lavas that have been found in perforations of the zone are of andesitic and basaltic character, in some points lava flows have been detected at depths between 70 m and 160 m.
Fissured aquifers of great extension and possibly high production	The porosity of these materials is secondary, that is, that groundwater circulates and is stored through fractures of the rock occurring after they were deposited. One of the basic characteristics of this type of aquifer is its great anisotropy, so its hydraulic characteristics can not be generalized for an entire area. They consist mainly of lavas of quaternary and tertiary age coming from nearby volcanic structures. It is also possible to find flows of lavas less recent belonging to the chain of tertiary material, located to the south of the land of the Project area that in spite of its age could be fractured giving the possibility of capturing and transmitting underground water.

Fuente: Adapted from MARN, 2014b



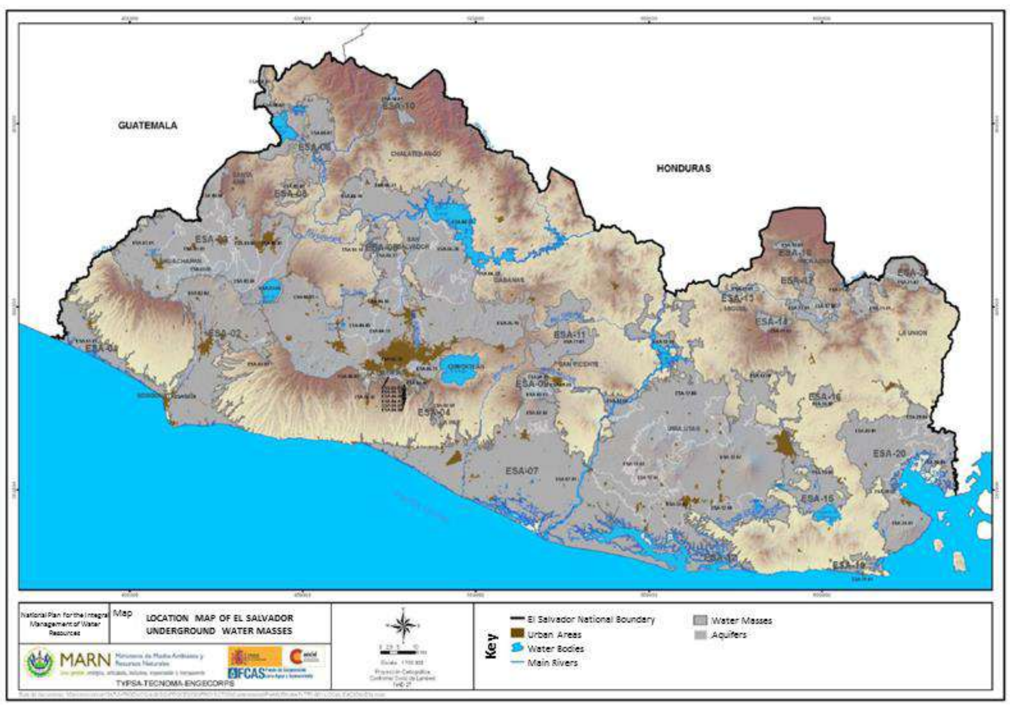
Source: Adapted from Hydrogeological Map of El Salvador ANDA, 2008.

Figure 4.1-16 Hydrogeological Units within the Area of Study

According to MARN (2014b), a total of 72 aquifers and 21 groundwater bodies (MASub) have been delimited in El Salvador. MASub are groups of aquifers that attend to their hydrogeological and hydrochemical behavior. The main aquifers of El Salvador are: the aquifer of San Salvador valley;

the aquifer of Zapotitlán valley; the aquifers in the valleys of Ahuachapán, Santa Ana, San Vicente and Usulután; the aquifer of San Miguel valley; the aquifer of West Coastal Plain; The Sonsonate aquifer; The aquifer of the Central Coastal Plain; and Río Lempa-Usulután coastal aquifer (UNESCO, 2006). Figure 4.1-17 showing the location of aquifers and MASub in El Salvador, as reported by MARN (2014b). The main aquifers near the Project area are:

- Aquifer of Ahuachapán valley that is located to the feet of Ahuechapán volcano and is used to supply water to cities and near towns. The water depth is between 10 and 40 m with flows between 30 and 60 liters per second (l/s) (Dimas 2005).
- Aquifer of Sonsonate-Acajutla that originate in the area of recharge of Santa Ana and Izalco volcanoes and serve to supply of drinking water to the city of Sonsonate, to small projects of irrigation and to the industrial zone of Acajutla. The depth of groundwater in this aquifer varies from 5 to 50 m and yields between 40 and 100 l/s (Dimas 2005). The aquifer is composed of recent alluvial sediments beginning in the northeastern part of the city of Sonsonate (Jovel-Campos et al., 2003).



Source: MARN, 2014

Figure 4.1-17 Groundwater Masses in El Salvador

4.1.5.5 Groundwater Quality

In general, groundwater quality in El Salvador is good, with notable exceptions for coastal, geothermal and densely populated areas. Also, many shallow aquifers are vulnerable to being contaminated, mainly due to poor management and waste disposal (USACE, 1998).

The quality of the groundwater near and within the Project area depends on the residence time it has had in the aquifer. For example, if water is older in the aquifer, it will surely have more associated elements.

Data from FERTICA well monitored by ANDA (Araujo, 2016) and three other wells located in Acajutla were monitored during the information surveys for the Environmental Impact Study of the Pacific Liquid Natural Gas (LNG) Plant (Energía Del Pacifico 2014). Figure 4.1-14 shows the location of these monitoring wells; while Table 4.1-10 and Table 4.1-11 present the groundwater quality parameters monitored in these wells, which are compared with the Salvadorean Mandatory Standard NSO 13.07.01: 08 water and drinking water (MINSAL, 2009). Based on this comparison of available groundwater quality data, only the microbiological parameters were above the NSO standard 13.07.01: 08 (total coliforms and fecal, see Table 4.1-11)

Table 4.1-10 Water Quality in Wells Located in Acajutla

Parameter	*Units*	*Maximum Admissible Limit*	*Colonia Alvarado*	*Duke Energy*	*Chevron*
pH	---	6.0-8.5	7.70	7.80	7.20
Odor	---	---	No Rejectable	No Rejectable	No Rejectable
True color	Pt-Co	15.0	1	0	1
Apparent color	Pt-Co	---	---	0	1
Turbidity	UNT	5.0	0.25	0	1.0
Total Dissolved Solids	mg/L	600	222	180	142
Total Alkalinity	mg/L	350	---	138	182.3
Total hardness	mg/L	400	102.80	94	110.6
Carbon dioxide	mg/L	---	---	8.41	24.5
Conductivity	µS/cm	400 [a]	---	360	285
Carbonate hardness	mg/L	---	---	94	110.6
Calcium	mg/L	75.0	---	17.6	23.3
Magnesium	mg/L	50.0	---	12.15	12.7
Total iron	mg/L	0.30	<0.05	---	0.16
Dissolved iron	mg/L	---	---	0	0.08

Parameter	*Units*	*Maximum Admissible Limit*	*Colonia Alvarado*	*Duke Energy*	*Chevron*
Total manganese	mg/L	0.10	0.05	---	0.15
Manganese dissolved	mg/L	---	---	0.0	0.10
Carbonatos	mg/L	---	---	0	0
Bicarbonatos	mg/L	---	---	138	182.3
Hidróxidos	mg/L	---	---	0	0
Cloruros	mg/L	25.0	---	18	25.8
Nitratos	mg/L	45.0	<1.0	0.08	0.02
Sulfatos	mg/L	250.0	15.70	13	3.6
Sílice	mg/L	125.0	---	91.98	25
Fluoruros	mg/L	1.5	---	0.31	0.5

Source: Adapted from Energía de Pacífico, 2014
[a] Standard CAPRE, 1994
Key: mg / L = milligrams per liter; µS/cm= microsiemens per centimeter; Pt-Co = platinum-cobalt scale (APHA) UNT = Turbidity Nephelometry Unit

Table 4.1-11 Water Quality in Fertica Well

Parameter	*Units*	*Maximum Allowed Limit*	*Perforated well FERTICA*
Date	—	—	March 26, 2013
pH	—	6.0-8.5	7.51
Total Alkalinity	mg/L	---	158
Total Solids	mg/L	---	296
Conductivity	µS/cm	400[a]	410
Total Dissolved Solids	mg/L	1000[b]	203
Total hardness as CaCO3	mg/L	500	114
Carbonaceous Hardness	mg/L	---	114
Non Carbonate Hardness	mg/L	---	0
Carbon dioxide	mg/L	---	6.8
Calcium	mg/L	---	22.4
Magnesium	mg/L	---	14.1
Total iron	mg/L	0.3	<0.05
Soluble iron	mg/L	0.3	< 0.05
Total manganese	mg/L	0.1	< 0.025
Soluble manganese	mg/L	---	< 0.025
Chlorides	mg/L	---	31.4
Silica	mg/L	---	40.8
Sulfates	mg/L	250	6.2
Fluorides	mg/L	1	0.5
Nitrates	mg/L	45	< 1
Total Coliform Bacteria	NMP/100 mL	< 1.1	> 8
Fecal Coliform Bacteria	NMP/100 mL	< 1.1	1.1

Parameter	Units	Maximum Allowed Limit	Perforated well FERTICA
Escherichia coli	NMP/100 mL	< 1.1	Absence

Source: Adapted from Araujo, 2016.
[a] Norm CAPRE, 1994
[b] Conditions of the country
Key: NMP/ 100 mL= Most likely number per 100 milliliters; cm= Microsiemens per centimeter; mg/L= Milligrams per liter; $CaCO_3$= Calcium carbonate.

4.1.5.6 Water Uses

According to the statistical bulletin of 2013 (ANDA, 2013), there was a total consumption of drinking water of approximately 222,366 thousand m3 of which the metropolitan population had a consumption of 51.2%, the central region 23.2%, the western region 15.4% and the eastern region 10.2% of the total consumption of the country. The project area is located within the western region, which recorded a water consumption of approximately 34,181 thousand m3, of which Ahuachapán recorded a consumption of 5,631 thousand m3 and Sonsonate 9,961 thousand m3. Table 4.1-12 presents a summary of drinking water consumption by user class based on ANDA statistical data for the year 2013. According to the Food and Agriculture Organization of the United Nations (FAO, 2016), 66% of water at the national level is used for irrigation, 22% in municipalities, 9% for the thermoelectric sector; while the remaining 3% is used for agriculture, livestock and industry.

Table 4.1-12 Drinking Water Consumption by User Class for the Year 2013

User	Volume in thousands of cubic meters	Percentage
Domicile	172,386	77.5
Central government	8,698	3.9
Autonomous institutions	1,194	0.5
Municipals	2,86	1.3
Marginal	6,581	3.0
Private operation	30,644	13.8
Total	***222,365***	***100***

Source: Adapted from ANDA, 2013

4.1.6 *Air Quality*

This section presents a description of the air quality and greenhouse gas (GHG) conditions of the baseline for the Project area. It is anticipated that air quality in the Project area will generally be affected by natural and anthropogenic emissions, such as:

- Dust dragged by the wind in the dry season;
- Dust created by driving vehicles on unpaved roads;
- Gas exhaust (industrial zone of Acajutla);
- Smoke from fires and burning of crops (eg sugar cane); and
- Combustion of fuels in engines.

Air quality conditions in El Salvador are verified through the measurement of particulate matter less than 2.5 micrometers (PM 2.5), which is considered the pollutant criterion that causes the greatest damage to human health. Since 2008, MARN has operated an air quality monitoring network (REDCA), which is located only in the metropolitan area of San Salvador. This network has three automatic stations located in the East of San Salvador (Don Bosco University), in Downtown San Salvador (Centro de Gobierno) and to the East of San Salvador (Consejo de Desarrollo Metropolitano (CODEM)). These stations are equipped to monitor carbon monoxide (CO), sulfur dioxide (SO2), nitrogen oxides (NOx) and particulate matter less than 10 and 2.5 micrometres (PM 10 and PM 2.5) (MARN, 2015c).

4.1.6.1 Sources of Emission

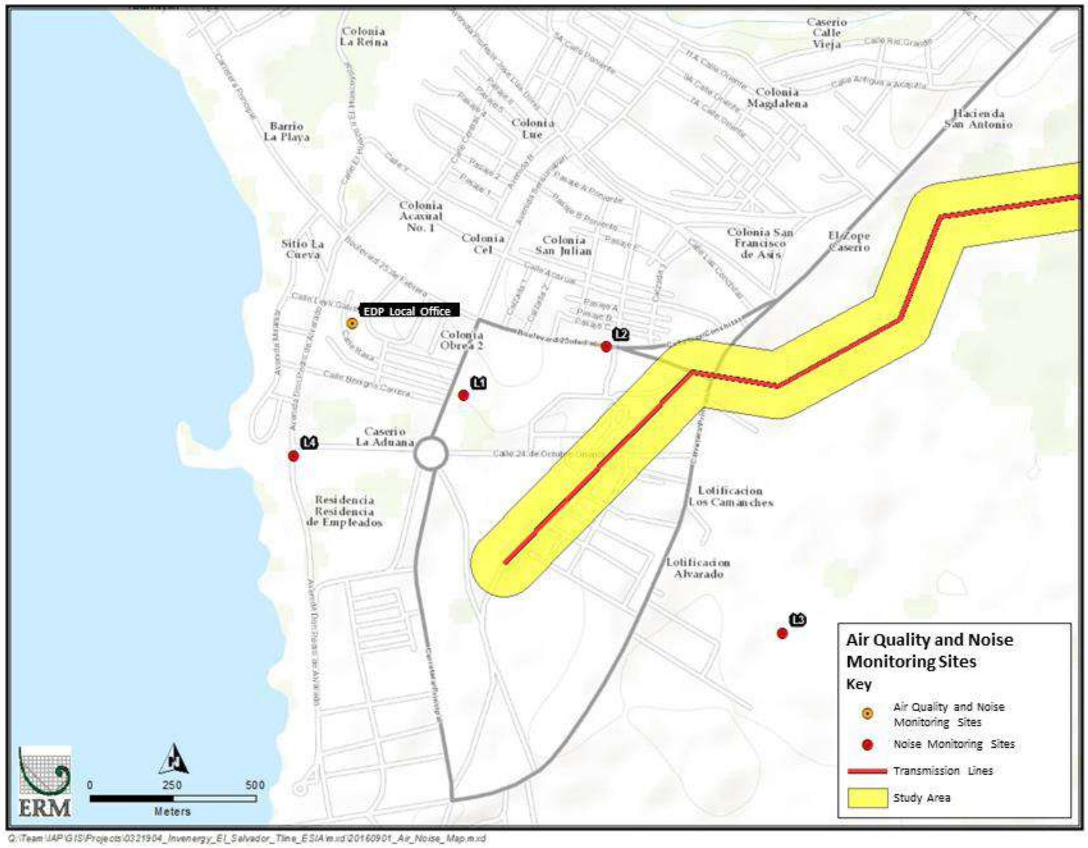
Within the department of Sonsonate, where the Project is located, there is no air quality monitoring stations operated by MARN. Air quality information for the entire study area is limited and focuses only on the municipality of Acajutla. According to the Environmental Impact Study prepared for the proposed Acajutla plant (Energía del Pacífico, 2014), baseline air quality monitoring was performed with indicators that included: nitrogen dioxide (NO2), carbon monoxide (CO), sulfur dioxide (SO2), total suspended particles (TSP), particulate matter less than 10 micrometers (PM 10) and particulate matter less than 2.5 microns (PM 2.5). The parameters monitored were compared to the air quality criteria established in the local guide titled NSO 13.11.01: 01 - Environmental Air Quality Atmospheric Emissions (Official Journal, 2003) and the Health, Hygiene and Environment Guidelines - Environmental Emissions Guidelines and Air Quality Standards established by the International Finance Corporation (IFC, 2007). Monitoring was performed with an instrument for particulate material (PST, PM10 and PM 2.5) and one for the other compounds. The location of monitoring site in Acajutla, which was selected considering proximity to sensitive receivers (residences, schools, etc.), presence of other significant sources of emissions (eg, port, existing power station), availability of a safe location for the equipment and access to a source of electricity; Is shown in Figure 4.1-18.

In general terms, the air quality throughout the study area is good, given the conditions prevailing in the natural environment (pasture and natural vegetation, as well as agricultural and crop land) as shown in Figure 4.1-19 and Figure 4.1-20. The main sources of pollution throughout the study area, but not yet affecting air quality, are the combustion of transport units (public and private) and the non-continuous or controlled burning of solid waste (eg, Ahuachapán, Concepción de Ataco, Apaneca, San Pedro Puxtla and Santo Domingo). However, for the Acajutla area, air quality is influenced by local industrial sources (eg, existing power plants, port activities) and seasonal agricultural activities (eg, burning of cane harvest season, field tillage and its preparation).

Table 4.1-13 Measured Air Quality Parameters in Acajutla

Compound	*Average Period*	*Concentration ($\mu g/m^3$)*	*Criteria ($\mu g/m^3$)*
Nitrogen dioxide	24- hours	27.4	150
	Annual	5.3[a]	100
Carbon monoxide	1-hour	681.2	40,000
	8-hours	563.1	10,000
Sulfur dioxide	24-hours	178.2	365
	Annual	34.2[a]	80
Suspended total particles (STP)	24-hours	372.2	260
	Annual	71.3a	75
Particulate matter <10 µm	24-hours	196.2	150
	Annual	37.6[a]	50
Particulate matter <2.5 µm	24-hours	34.1	65
	Annual	6.5[a]	15

Source: Adapted from Energía del Pacífico, 2014
[a] Annual concentrations calculated using 24 hours at an annual conversion factor of 0.1916
Key: $\mu g/m^3$= micrograms per cubic meter



Source: Adapted from Energía del Pacífico, 2014

Figure 4.1-18 Location of Air Quality Monitoring Sites and Noise Levels for the Liquefied Natural Gas Plant Project

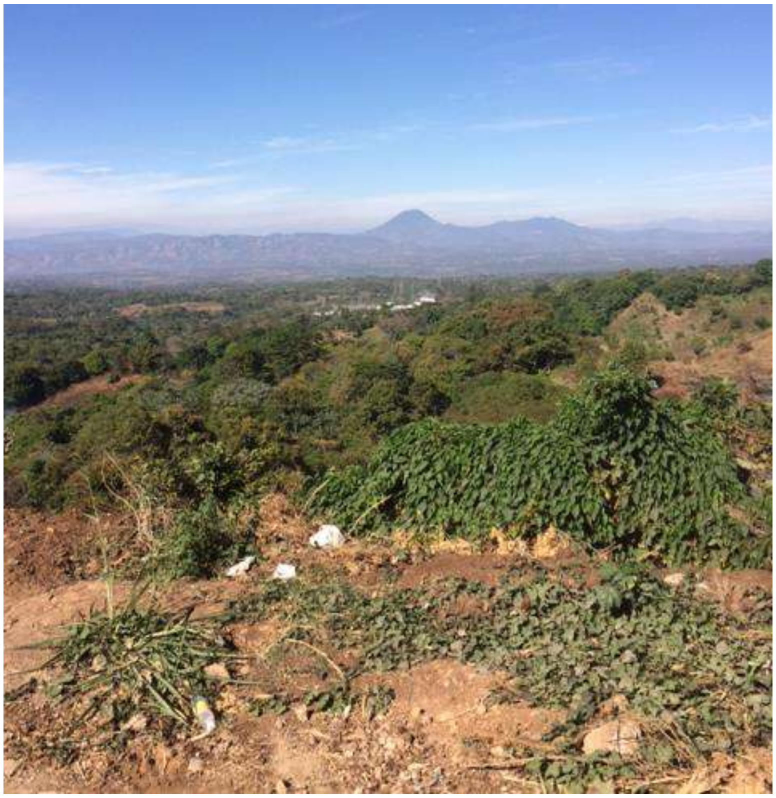


Figure 4.1-19 Panoramic View to Ahuachapán Substation

Figure 4.1-20 Lower Zone Acajutla Municipality

4.1.6.2 *Greenhouse Gases*

Greenhouse gases (GHG) are gases that absorb reflected solar radiation from the earth's surface and contribute to global warming. The three most common GHG gases are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Other GHGs such as hydrofluorocarbons (HFCs), water vapor and sulfur hexafluoride (SF6) are not so common and are generally limited to specific types of facilities (eg power generation facilities).

Historically and to date, El Salvador stands out for its low GHG per capita emissions, ranking 31st at the regional level with 1.8 tons of carbon dioxide equivalent per capita (tCO2e / hab), with the energy sector being the cause of the most of GHG emissions at the national level (Vicuña, 2014). However, the country is committed to the international effort to reduce GHG emission levels and is in the process of implementing a low emission development model (MARN, 2015d).

The GHG inventory update for El Salvador was developed in 2005[ii] through MARN and using the Intergovernmental Panel on Climate Change (IPCC) guidelines for national GHG inventories and the "Good Practice Guidance and Management of Uncertainty" in national GHG inventories (MARN, 2013a). The GHG inventory comprises the calculation of emissions in the following categories:

- Energy
- Industrial processes
- Farming
- Land use, land-use change and forestry (LULUCF)
- Waste

According to the MARN inventory (2013), the GHG estimate for 2005 was estimated at approximately 14,453 giga grams of carbon dioxide equivalent (GgCO2e). Emissions by sector were calculated as: 5,909 GgCO2e (energy), 442 Gg of CO2e (industrial processes), 3,115 Gg of CO2e (farming), 3,380 Gg of CO2e (land use, land use change and forestry - LULUCF) and 1,606 gg of CO2e (waste). Compared with the year 2000

[ii] El Salvador has three GHG inventories corresponding to the years 1994, 2000 and 2005.

inventory (13,942 Gg of CO2e), GHG emissions increased by approximately 3.7% due to increases in the energy, agriculture and waste sectors. However, LULUCF had a decrease in emissions compared to the year 2000.

4.1.7 *Noise*

This section describes the environmental noise for the Project study area. Also, a brief introduction on the basic concepts and terms related to noise is included. The noise measurements reported in this study were obtained from a cabinet review.

Noise is defined as an unwanted sound. The loudness/sonority of the sound is measured in decibels (dB). Changes in sonority are described on a logarithmic scale (decibel scale). Since the decibel scale is logarithmic, noise levels do not add up or change according to simple linear arithmetic. Therefore, adding the levels of two equal noise sources results in a doubling of the sound energy, which gives a combined noise level of 3 dB higher than the individual levels. For example: 70 dB plus 70 dB equals 73 dB, not 140 dB. The sound measurement is tuned using a weighted scale A, which focuses on a range between 1000 and 8000 cycles per second. These cycles represent frequencies of sound more audible to the human ear; therefore, unless otherwise noted, all decibel measurements presented in this report are weighted according to curve A (dBA) on a logarithmic scale. Since sound often varies over time, statistical (or metric) parameters are used to measure and describe the sound.

El Salvador does not have noise standards and therefore the threshold levels set out in the IFC Environment, Health and Safety guidelines (2007) were used to compare noise levels measured under existing conditions. According to IFC (2007) the noise levels generated by a project should not exceed the levels presented in Table 4.1-14 or result in a maximum increase of 3 dB background noise at the nearest receiver. The IFC guidelines identify two classes or groups of recipients, habitational or residential land uses, institutional and educational uses; and the second group that includes industrial and commercial land uses. As can be seen in Table 4.1-14, noise levels for residential receivers are more restrictive.

Table 4.1-14 Noise Threshold Levels Established by the International Finance Corporation

Receiver	*One hour L_{Aeq} (dBA)*	
	Daytime 07:00-22:00	*Overnight 22:00-07:00*
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Source: Adapted from IFC, 2007
Key: dBA = decibels weighted according to curve A; LAeq = Equivalent continuous level (dBA).

The only data of noise levels along the Project area correspond to those measured in the proximity to the existing power plant in Acajutla during the elaboration of the Environmental Impact Study of the same. The locations of sampling points in Acajutla were carried out in 4 sites with 3 RION NL-22 sound level meters equipped with windshields, microphone extension cable, protective case and a data logger. The microphones were placed 1.5 m from the ground approximately. Monitoring results and their comparison with daytime and night noise criteria of the IFC are presented in Table 4.1-15; while the location of the monitoring points is presented in Figure 4.1-18 (Energía del Pacífico, 2014). As can be seen in Table 4.1-15 the daytime noise levels at the four monitoring points were below the guidelines set by the IFC (55 dBA). On the other hand, night noise levels at the L1, L2 and L3 monitoring sites were above the IFC guideline (45 dBA) and therefore the applicable criterion for this zone will be the minimum values measured at those sites (See Table 4.1-15).

The noise levels in this area are indicative of an acoustic environment dominated by low frequency noise with some tonal characteristics. The low-frequency aspect of noise is most noticeable at night when background noise due to road traffic or urban buzzing in general is lower and the dominant source of noise is from the Duke Energy Power Plant (Energía del Pacífico, 2014). In general, the sources of noise in the study area correspond mainly to rural settlements and to low-moderate traffic typical of natural and agricultural areas. The main sources of noise come from the road to Acajutla and small urban centers close to the project area (eg, Ahuachapán, Concepcion de Ataco, Apaneca, San Pedro Puxtla and Santo Domingo).

Table 4.1-15 Summary of Background Noise Monitoring in the Acajutla Area

Monitoring point	*Date*	*Per hour Leq (dBA)*					
		Daytime 07:00-22:00			*Overnight 22:00-07:00*		
		Maximum	*Minimum*	*Applicable standard*	*Maximum*	*Minimum*	*Applicable standard*
1 (Residential area to the northwest)	April 9-13, 2014	63.8	48.3	55	63.9	50.3	50.3
1 (Residential area to the north)	April 9-13, 2014	66.1	53.9	55	62.6	53.6	53.6
3 (Residential area to the southwest)	April 9-10, 2014	67.3	52.8	55	61.7	55.5	55.5
4 (Area close to craft pier)	April 11-13, 2014	62.6	46.2	55	58.9	43.9	45

Source: Adapted form Energía de Pacífico, 2014
Key: dBA = Decibels weighted according to curve A; LAeq = Equivalent continuous level (dBA)

4.2 *BIOLOGICAL ENVIRONMENT*

The baseline methodology of the biological components included tours in the Project area, including all TL right of way. Parcels of land, transects, auditory bands, visual encounters, and auditory and visual observation points were used. In order to determine the richness, abundance, diversity and importance of the species, relative abundance, Shannon Wiener, Simpson, Value and Importance Index (VII) and wealth indexes were estimated using the EstimateS 8.0 program.

For terrestrial fauna, the study focused on vertebrate groups: mammals, birds, reptiles and amphibians. There were no collections, but capture and release on site of species of fauna, especially the group of bats, to meet the scope of the study requested by the technicians of MARN. The respective permit was obtained for the capture and release of specimens of fauna.

4.2.1 *Flora and Fauna*

4.2.1.1 *Vegetation and Terrestrial Flora*

Plant Cover Units

Based on Landsat satellite imagery, the University of Maryland has analyzed global forest cover for 2014 (Hansen et al., 2013). For the Project area, these images cover according to the density of woody elements (trees and shrubs, see Figure 4.2-1):

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Figure 4.2-1 Classification of Habitats in the Project Area

In satellite imagery, there are areas that appear to be natural forests but actually shade-grown coffee plantations under cover of trees. In the available images, it is not possible to determine whether a forest is natural or a coffee plantation. Based on measurements of sections of Google Earth Pro imagery for the year 2016, it is estimated that the area of natural forest remaining within the right of way strip is less than 18 ha in total. The figures estimated above include rows of trees and riparian or gallery forests in pasture and crop areas.

According to the 2004 national inventory of land use, there were areas of coffee plantations, natural forests, grasslands and urban areas within the Project's area of influence. The field study was developed in the coffee plantation forest, forest patches and growing areas in the area of influence of the project trace.

Methodology

The study area comprises part of the western section of Sierra de Apaneca in the southwest of El Salvador, in the departments of Sonsonate and Ahuachapán. This area houses the largest coffee growing landscape in El Salvador, and contains some patches of natural forest located between coffee plantations.

The sites sampled belong to three altitudinal zones. The lowlands, until approximately 700 masl, belong to the Ecoregion Dry Forests. The average elevations, until approximately 1900 masl, belong to the Ecoregion of the Humid Forest. The highest peaks contain forest of fog, and belong to the Forest Ecoregion Montanes. Coffee is grown from about 400 m to about 1700 m, and on more than 90% of the surface within this altitudinal range.

For the study of flora, all cultivated areas/pastures, coffee plantations and forest patches that were within the area of influence of the Project were sampled (see Figure 4.2-2). A total of 30 sampling sites were established, with 10 sites in each type of coverage: i) forest fragments, ii) coffee farms and iii) extension areas used for pasture or basic grain production. The sampling sites were parcels of land of 0.1 ha (10 m x 100 m) randomly placed within each type of cover.

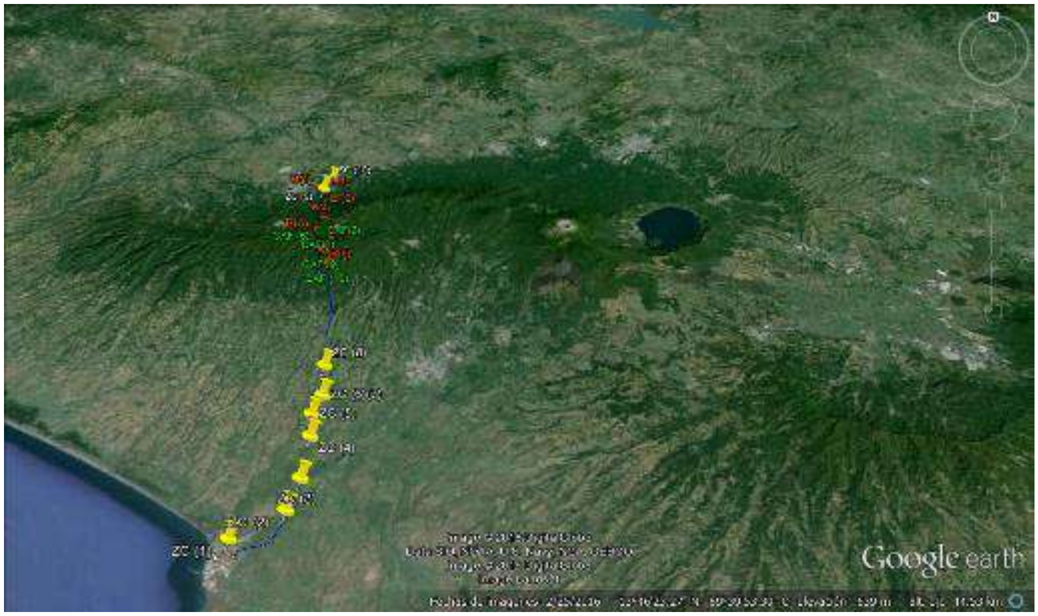


Figure 4.2-2 Location of the 30 Flora Sampling Sites along the Transmission Line Route

Diversity and Abundance of Flora

To develop a list of tree species, during tours of the area of influence of the Project, all species of trees with a diameter at breast height of 5.0 cm or more were noted. For each species, the scientific name was registered and, where possible, the common name. In the case that the plant could not be identified immediately, some important characteristics were noted, photographed and identified using keys and specialized literature.

To calculate the structure and floristic composition of the patches of forest, coffee plantations and cultivation areas, a survey was carried out at the sampling sites of 0.1 ha. The ten sites by type of vegetation give a total of 10,000 m2 (one hectare) per habitat. The circumference at chest height was measured for each tree of 16 cm or more in circumference. With these data, the VII was calculated for the main woody species. Likewise, coffee shrubs were sampled in the 10 parcels of land corresponding to the habitat of coffee plantations in order to obtain densities per hectare, basal area per hectare and number of shrubs.

With the information recorded in the samplings, we determined the abundance, richness and diversity value index. For alpha diversity, the Shannon-Wiener index was used. Absolute (n) and relative (%) abundance of aquatic organisms recorded in the study were also determined. The methodology for calculating the indices is described in Appendix A - Vegetation and Flora Report.

4.2.1.2 *Structure of Vegetation*

The general types of vegetation include the following:

Coffee plantations with Polycultures

This category is characterized by trees not very high (8-10 m), with large number of young trees, fruit trees, timber and introduced to shade the coffee plants, which produces rich and diverse structures in species, with great variety of trees. However, they are not very complex in their physiognomy and include many introduced species that are not from the region (see Figure 4.2-3).

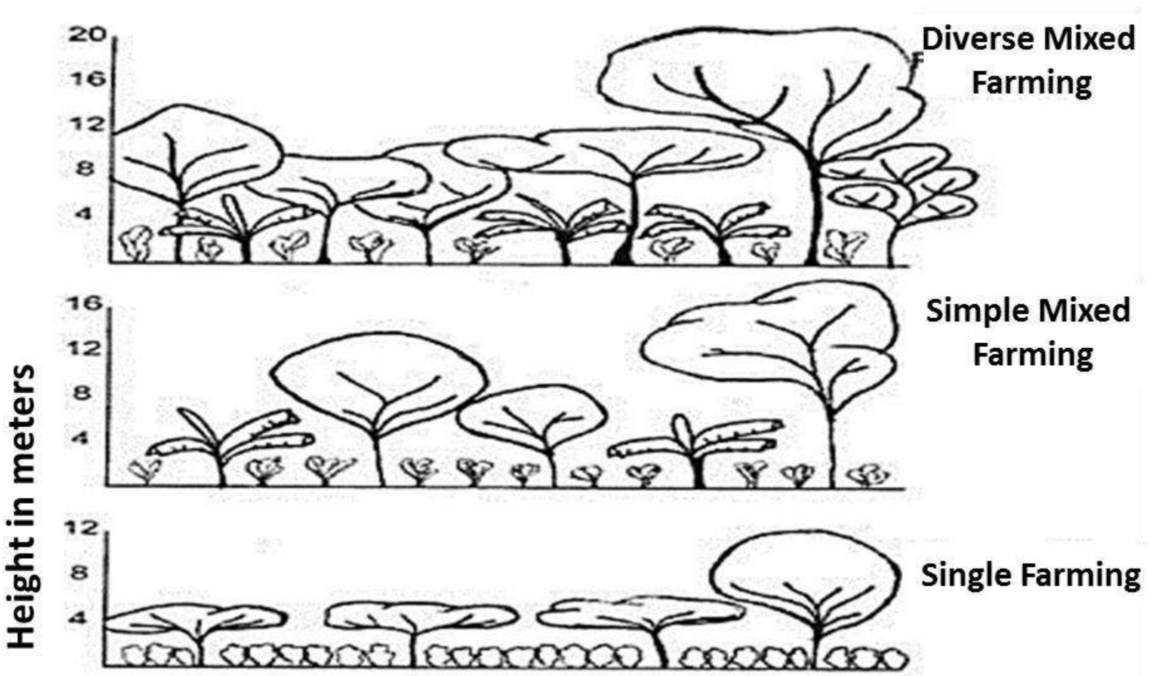


Figure 4.2-3 Scheme of Coffee Plant Structures Present in the Area of Influence of the Project

Coffee Plantations with Monocultures

In this type of coffee farm, it is frequent that trees of one or two species are planted to give shade to the coffee trees. These farms have the simplest structures: with a density of 216 trees per hectare, with an average height of 4.8 m, with thin trunks of average diameter of 17.7 m, without epiphytes, with an average coverage of 65%, although the density of coffee plants per hectare is the highest on farms and can reach 4,300 individuals per hectare (see Figure 4.2-3).

Grasslands

In these areas, the original vegetation has been transformed into agro ecosystems that are currently used as paddocks and growing areas. The sites are dominated by herbaceous vegetation of the families Poaceae, Euphorbiaceae and Asteraceae, and some tree species.

The herbaceous species sampled from the families Poaceae, Euphorbiaceae and Asteraceae include species ideal for warm climates, do not tolerate shade, grow very well under the sun and under the traditional management of the farmer after producing seed is dried. They are among the first species to regrow when the rain begins.

Tree species are found mainly in live fences. These species are well adapted to a wide range of soils in humid to sub-humid climates, including moderately acidic and infertile sites. They are favored by human disturbances and have colonized large areas following the destruction of native forest. These species are a major component of fallows that follow tomb and burn agriculture, probably because of their fire tolerance: after a fire, these species sprout vigorously when the rainy season begins.

In the present study, a total of 123 families, 384 genera and 536 species (including subspecies, varieties and forms) of vascular plants were registered. Of the 536 species, 411 are native and 125 are exotic. Of the total species, 156 are trees (118 native and 38 exotic), 65 are shrubs (34 native and 31 exotic), 75 vines (67 native and 8 exotic), 29 ferns (28 native and one exotic) and 209 herbs 164 native and 45 exotic). The complete list of species is given in Appendix A.

Many of the trees are relatively large and appear to be very old, so they are likely to be in the area since this was a forest, because having recalcitrant seeds does not germinate in dry, open or sunny places. In addition, they appear to be at the upper limit of their altitudinal distribution and also grow in places somewhat removed from the ravines, so it is difficult to suppose that they have been brought there by watercourses.

Some species such as wattle (Acacia polyphylla) and laurel (Cordia alliodora) are typical of areas of early succession. The mothercatchers (Gliricidia sepium), both peccary and paternal (Inga spp.), are native to the country, but in the area they are cultivated for their properties to improve soils through the fixation of Nitrogen and its edible fruits. Some trees, like the amates (Ficus spp.), although dispersed by birds and have relatively fleshy infructescences, are also characteristic of the early stages of regeneration of a forest.

Many of the trees that were detected in the inventory were located only in the ravines. Trees such as the cold ground anona (Annona muricata), the chaperone (Lonchocarpus rugosus ssp. Apricus), nixtamal (Margarida nobilis), chulumuyo (Rollinia mucosa) and palanco (Sapranthus palanga) were only found growing in or near the riverbed of the ravines. To these others like Crudia acuminata, although they grow in other places, are more common in the ravines. Also, some vines like Aristolochia grandiflora were only observed in these places. These observations indicate the importance of ravines as a micro that are important for the conservation and restoration of the forest.

4.2.1.3 *Exotic and Invasive Species*

A total of 123 species of exotic plants were identified (see Appendix A). Some of these species only propagate vegetatively by means of cuttings or rhizomes, since they do not count here with suitable pollinators. Some of the vegetatively propagated are floripundia (Brugmansia candida and B. suaveolens), izote (Yucca guatemalensis) and veraneras (Bougainvilaea spp.), which although they may persist for a long time in abandoned forests and orchards, do not spread other than vegetative and therefore do not represent a danger to native biodiversity. However, a total of 39 species were identified as dangerous invasive species according to the list of invasive plants of the International Union for Conservation of Nature (IUCN) (http://www.issg.org/database/welcome/).

4.2.1.4 *Species Threatened or Endangered*

Ten species of trees and shrubs (see Table 4.2-1) are classified as threatened in El Salvador (MARN, 2015) and/or globally threatened according to IUCN (2016). Pacific mahogany (Swietenia humilis) and chaperno (Lonchocarpus rugosus ssp. Apricus) are classified as endangered species by MARN.

Table 4.2-1 Threatened Species Found Within the Project Area

Specie	*Common name*	*ES*	*IUCN*	*Family*	*Habit*
Astronium graveolens Jacqu.	Glassywood	A	NE	Anacardiaceae	Tree
Cedrela odorata L.	Cedar	A	VU	Meliaceae	Tree

Specie	*Common name*	*ES*	*IUCN*	*Family*	*Habit*
Diphysa americana	Guachipelín	A	NE	Fabaceae	Tree
Eugenia salamensis (Standl.) McVaugh		A	EN	Myrtaceae	Bush
Eugenia sasoana Standl. & Steyerm.		A	NE	Myrtaceae	Bush
Juglans olanchana Standl. & L.O. Williams	Walnut	A	EN	Juglandaceae	Tree
Lonchocarpus rugosus ssp. apricus (Lundell) M. Sousa	Chaperno	EN	LC[a]	Fabaceae	Tree
Myroxylon balsamum var. pereirae	Balm	A	NE	Fabaceae	Tree
Quercus skinneri Benth.	Oak	A	VU	Fagaceae	Tree
Swietenia humilis Zucc.	Mahogany	EN	NE	Meliaceae	Tree

[a] At species level. IUCN has not evaluated the subspecies of L. rugosus.
Key: ES: Category in El Salvador; IUCN: IUCN global category; A: Threatened (MARN, 2015); EN: ("Endangare") in danger; LC ("Least Concern"); NE: Not evaluated; VU: ("Vulnerable"), According to: (IUCN, 2016).

4.2.1.5 Floristic Analysis - Structural

Importance Value Index (IVI)

The IVI is a parameter that estimates the contribution or ecological significance of each species in the community; the maximum value is 300%. The closer a species comes to this value, the greater its ecological importance and floristic dominance over other species present and equal to the sum of dominance, abundance and frequency.

The IVI data for the most representative species in the parcels of land are summarized in Table 4.2-2.

Table 4.2-2 Importance Value Indices of the Most Representative Arboreal Species (according to the results obtained from IVI) Present in the Parcels of Land of Structural Floristic Analysis

Specie	*Family*	*Average Circumference (cm)*	*Total Basal Area (cm²)*	*Relative Basal Area*	*Abundance*	*Relative Abundance*	*Frequency*	*Relative Frequency*	*IVI*
Inga vera	Fabaceae	63	27057.30	30.73	33	27.73	0.75	18.99	77.45
Inga punctata	Fabaceae	107	14659.64	16.65	20	16.81	0.50	12.66	46.12
Inga oerstediana	Fabaceae	91	9506.90	10.80	11	9.24	0.35	8.86	28.90
Persea americana	Lauraceae	159	6615.35	7.51	3	2.52	0.15	3.80	13.83
Trophis racemosa	Moraceae	44	1754.07	1.99	7	5.88	0.20	5.06	12.94
Dendropanax arboreus	Araliaceae	245	5713.44	6.49	2	1.68	0.10	2.53	10.70
Crudia acuminata	Fabaceae	182	5045.21	5.73	2	1.68	0.10	2.53	9.94
Syzygium jambos	Myrtaceae	32	2348.21	2.67	4	3.36	0.15	3.80	9.83
Gliricidia sepium	Fabaceae	115	3675.70	4.17	3	2.52	0.10	2.53	9.23
Trichilia havanensis	Meliaceae	40	648.40	0.74	4	3.36	0.15	3.80	7.90
Zanthoxylum kellermanii	Rutaceae	161	2866.48	3.26	2	1.68	0.10	2.53	7.47
Nectandra martinicensis	Lauraceae	95	945.08	1.07	3	2.52	0.15	3.80	7.39
Psidium guajava	Myrtaceae	54	698.37	0.79	3	2.52	0.15	3.80	7.11
Mangifera indica	Anacardiaceae	61	668.87	0.76	3	2.52	0.15	3.80	7.08
Tabebuia rosea	Bignoniaceae	32	530.34	0.60	3	2.52	0.10	2.53	5.66
Eremosis triflosculosa subsp. Triflosculosa	Asteraceae	32	387.38	0.44	2	1.68	0.10	2.53	4.65
Sideroxylon capiri subsp. tempisque	Sapotaceae	141	1582.08	1.80	1	0.84	0.05	1.27	3.90

Specie	*Family*	*Average Circumference (cm)*	*Total Basal Area (cm²)*	*Relative Basal Area*	*Abundance*	*Relative Abundance*	*Frequency*	*Relative Frequency*	*IVI*
Spondias purpurea	Anacardiaceae	36	181.77	0.21	2	1.68	0.05	1.27	3.15
Cecropia obtusifolia	Cecropiaceae	101	811.77	0.92	1	0.84	0.05	1.27	3.03
Licania platypus	Chrysobalanaceae	100	795.77	0.90	1	0.84	0.05	1.27	3.01
Vernonia patens	Asteraceae	69	378.87	0.43	1	0.84	0.05	1.27	2.54
Sapindus saponaria	Sapindaceae	65	336.21	0.38	1	0.84	0.05	1.27	2.49
Calophyllum brasiliense var. rekoi	Clusiaceae	51	206.98	0.24	1	0.84	0.05	1.27	2.34
Quercus skinneri	Fagaceae	45	157.58	0.18	1	0.84	0.05	1.27	2.29
Cedrela odorata	Meliaceae	38	111.91	0.13	1	0.84	0.05	1.27	2.23
Castilla elastica	Moraceae	37	108.94	0.12	1	0.84	0.05	1.27	2.23
Cordia alliodora	Boraginaceae	33	86.66	0.10	1	0.84	0.05	1.27	2.20
Croton reflexifolius	Euphorbiaceae	33	84.05	0.10	1	0.84	0.05	1.27	2.20
Lycianthes heteroclita	Solanaceae	32	81.49	0.09	1	0.84	0.05	1.27	2.20
Total			***88044.85***	***100.00***	***119***	***100.00***	***3.95***	***100.00***	***300.00***

Key:
cm = Centimeter.
cm² = Square centimeter.
IVI = Importance Value Index.

More than half of the IVI, i.e. the ecological weight of the species, is represented by only three species: pepeto (Inga vera), cuje or guamito (Inga punctata), and cujinicuil (Inga oerstediana). The three species, although native to the country, are grown in the area to shade coffee and contribute to soil improvement through nitrogen fixation.

Coffee Plantation Condition

- As a result of the floristic analysis, the following parameters were found in the 10 parcels of land with coffee plantations (total area of 10,000 m2): Average number of coffee shrubs per ha - 2,979
- Average shrub diameter (cm) – 8.0
- Basal area in 1 ha (m^2) - 17.2

4.2.2 ***Fauna***

4.2.2.1 Amphibians and Reptiles

Methodology

Amphibians and reptiles were evaluated together. For this purpose, linear transects were established on the trails or roads that are parallel to the traces of the transmission line, in which the time of travel is taken as a sampling unit (one hour per transept, see Appendix B - Report on Terrestrial Fauna), Making an intensive search of these organisms under logs, rocks and litter (see Figures 4.2-4 to 4.2-7).

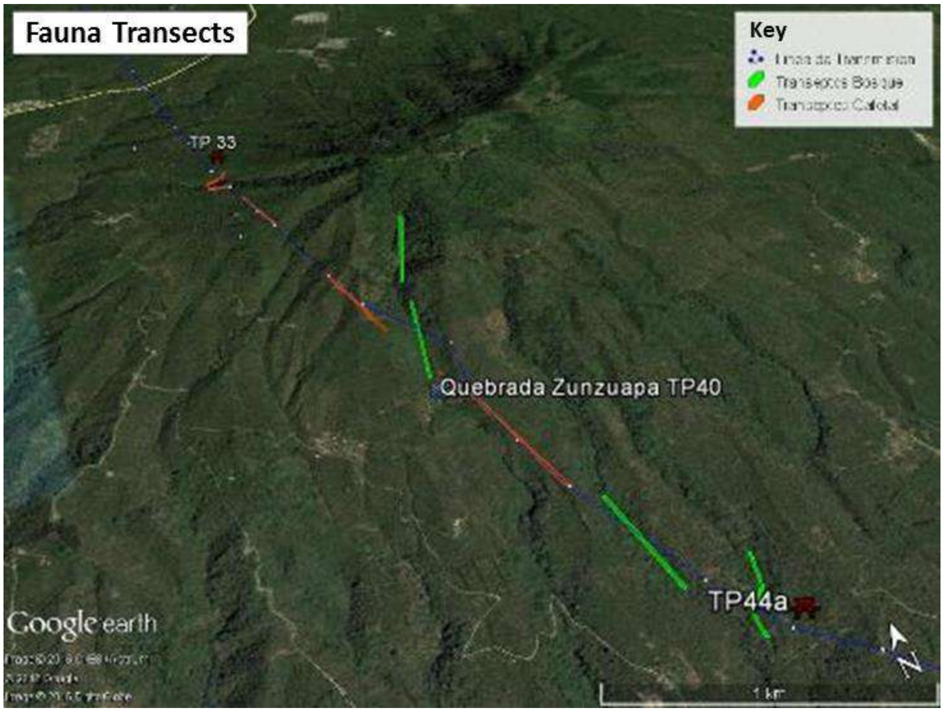


Figure 4.2-4 Transects Established for the Sampling of Herpetofauna in the Sector of Apaneca to San Pedro Puxtla for the Project

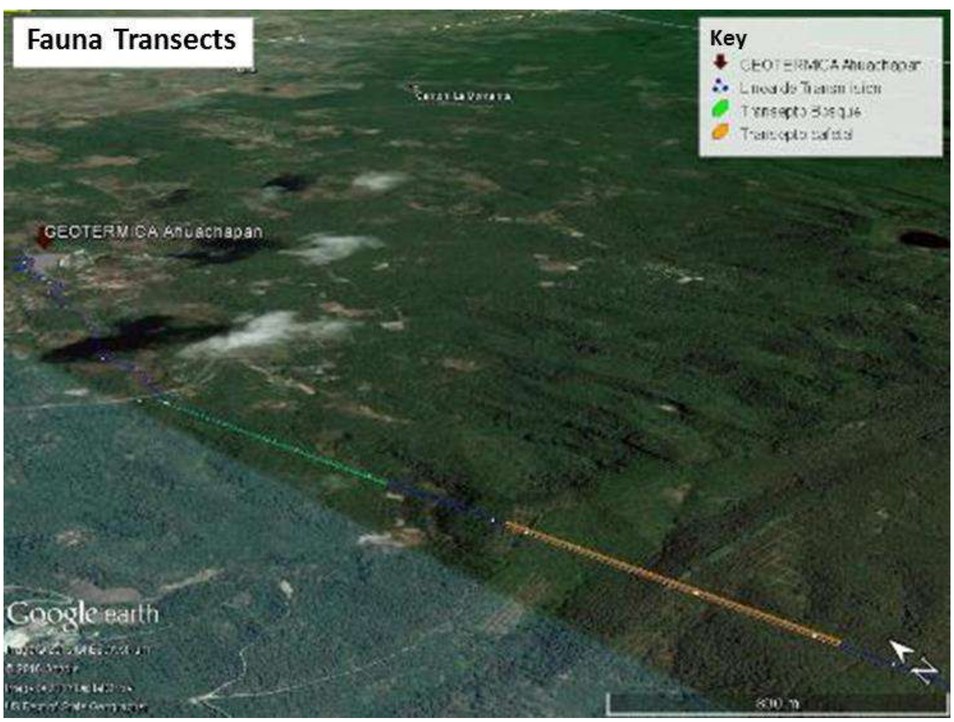


Figure 4.2-5 Transects Established for Herpetofauna Sampling in the Ahuachapán Sector for the Project

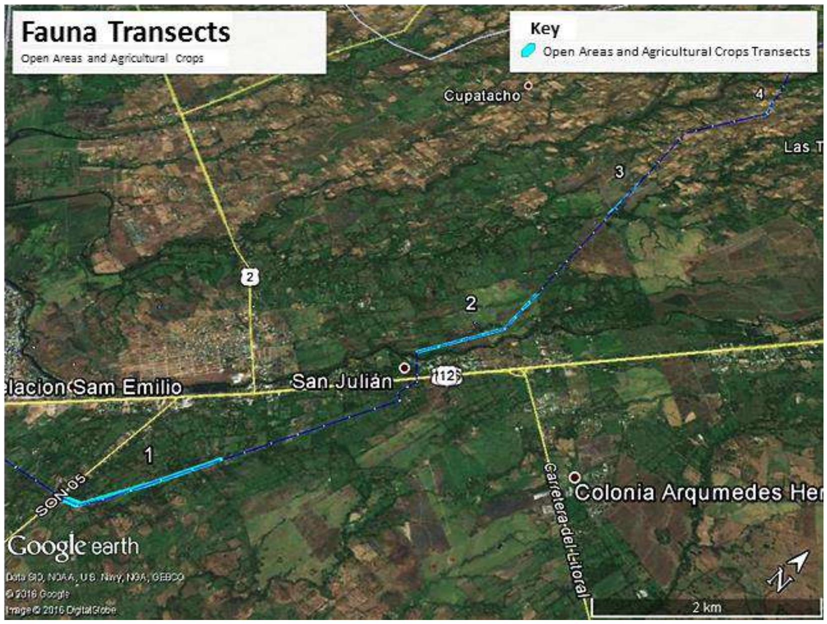


Figure 4.2-6 Transects Established for Herpetofauna Sampling in the Acajutla Sector towards Santo Domingo de Guzmán for the Project, May-June 2016

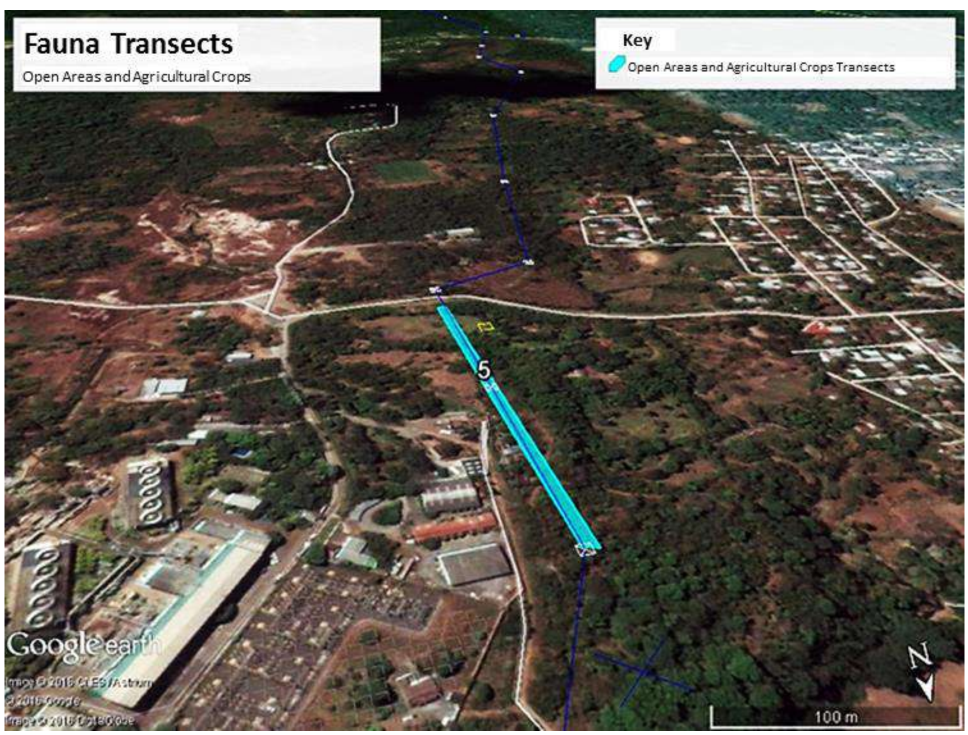


Figure 4.2-7 Transects Established for Herpetofauna Sampling in the Ahuachapán Sector for the Project, May-June 2016

Samplings for the reptile case were conducted from 8:00 am to 1:00 pm and from 2:00 pm to 4:00 pm and for the amphibian case nocturnal sampling was performed from 8:00 pm to 10:00 pm. During amphibian sampling, attempts were also made to locate reptile species with nocturnal habits.

Results

A total of 15 species of amphibians and reptiles were recorded in 11 families and 14 genders (see Table 4.2-3 and Figure 4.2-8). Most of the species recorded are common, with wide distribution at national level and high adaptability to areas disturbed by anthropogenic activity. However, the second most abundant species was the black-eyed tree frog (Agalychnis moreletii), a nationally threatened species that is on the IUCN's red list as a critically endangered species. The habitat with the highest abundance of individuals and species diversity was crop areas and the habitat with the lowest abundance was patches of natural forest (see Figure 4.2-1).

Table 4.2-3 Herpetofauna Species Registered During the Study Completed for the Project, May-June 2016

Order	Family	Specie	Common Name	ES	IUCN
Class Amphibia					
Anura	Bufonidae	*Incilius coccifer*	Southern Roundgland Toad	NA	LC
		Rhinella marina	Cane Toad	NA	LC
	Craugastoridae	*Craugastor loki*	Common Leaf-litter Frog	NA	LC
	Hylidae	*Agalychnis moreletii*	Black-Eyed Tree Frog	A	CR
		Scinax staufferi	Stauffer's Longnosed Treefrog	NA	LC
		Smilisca baudinii	Common Tree Frog	NA	LC
	Leptodactylidae	*Leptodactylus melanonotus*	Black Jungle-Frog	NA	LC
	Leiuperidae	*Engystomops pustulosus*	Tungara Frog	NA	LC
	Ranidae	*Lithobates maculatus*	Highland Frog	NA	LC
		Lithobates forreri	Forrer's Grass Frog	NA	LC

Order	Family	Specie	Common Name	ES	IUCN
Class Reptilia					
Squamata	Iguanidae	*Ctenosaura similis*	Black Spiny-tailed Iguana	A	LC
	Corytophanidae	*Basiliscus vittatus*	Brown Basilisk	NA	LC
	Dactyloidae	*Anolis wellbornae*	Bebeleche	NA	NE
	Phrynosomatidae	*Sceloporus malachiticus*	Green Spiny Lizard	NA	LC
	Teidae	*Holcolsus undulatus*	Rainbow Ameiva	NA	LC

Key: ES = Category in El Salvador; IUCN = IUCN global category; A = Threatened; LC = Least Concern; CR = Critically Endangered; and NE: Not evaluated.

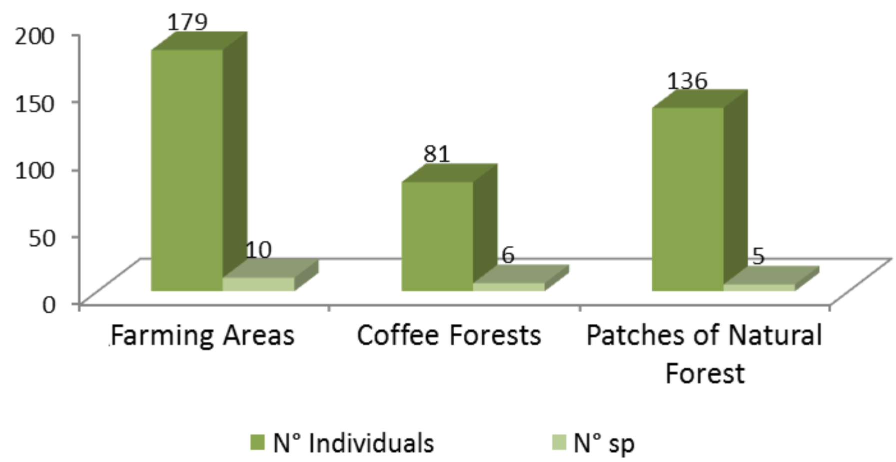


Figure 4.2-8 Numbers of Individuals and Herpetofauna Species Registered in the Various Sampling Habitats, May 2016

As shown in Figure 4.2-9, the species *Craugastor Loki* and *Agalychnis moreletii* (see photos in Figures 4.2-10 and 4.2-11) were the most abundant during the evaluation carried out in the forest and coffee plantation belt.

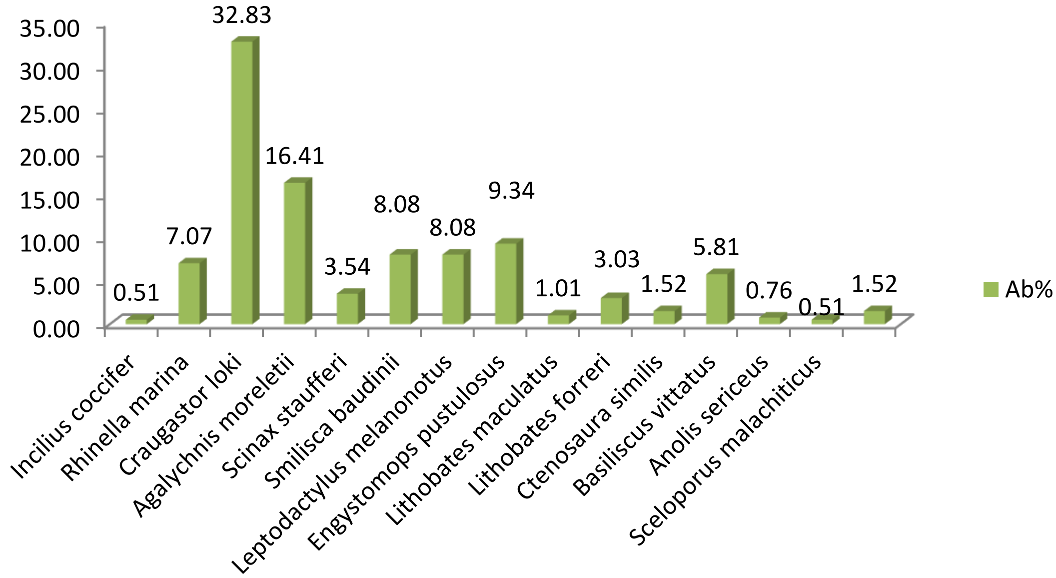


Figure 4.2-9 Relative Abundances of Herpetofauna Species Registered During the Study, May-June 2016

Figure 4.2-10 Individual of Agalychnis moreletii Captured at the Coffee Plantation during the study, May-June 2016

Figure 4.2-11 Craugastor Loki individual in Coffee Plantation Leaf During the Study Realized for the Project, May 2016

4.2.2.2 Birds

Methodology

In order to sample birds, observation points were established in which 15 minute stops per point were recorded and the species identified were recorded either by their morphological characteristics or by their song. The points were established in the previously established transects for the other groups since at these points a high incidence of birds had been determined (see Figures 4.2-12 and 4.2-13).

The tours were made during the hours when the weather conditions were favorable, performing a sampling at dawn from 5:00 am to 8:00 am and in the afternoon from 4:00 pm to 6:00 pm.

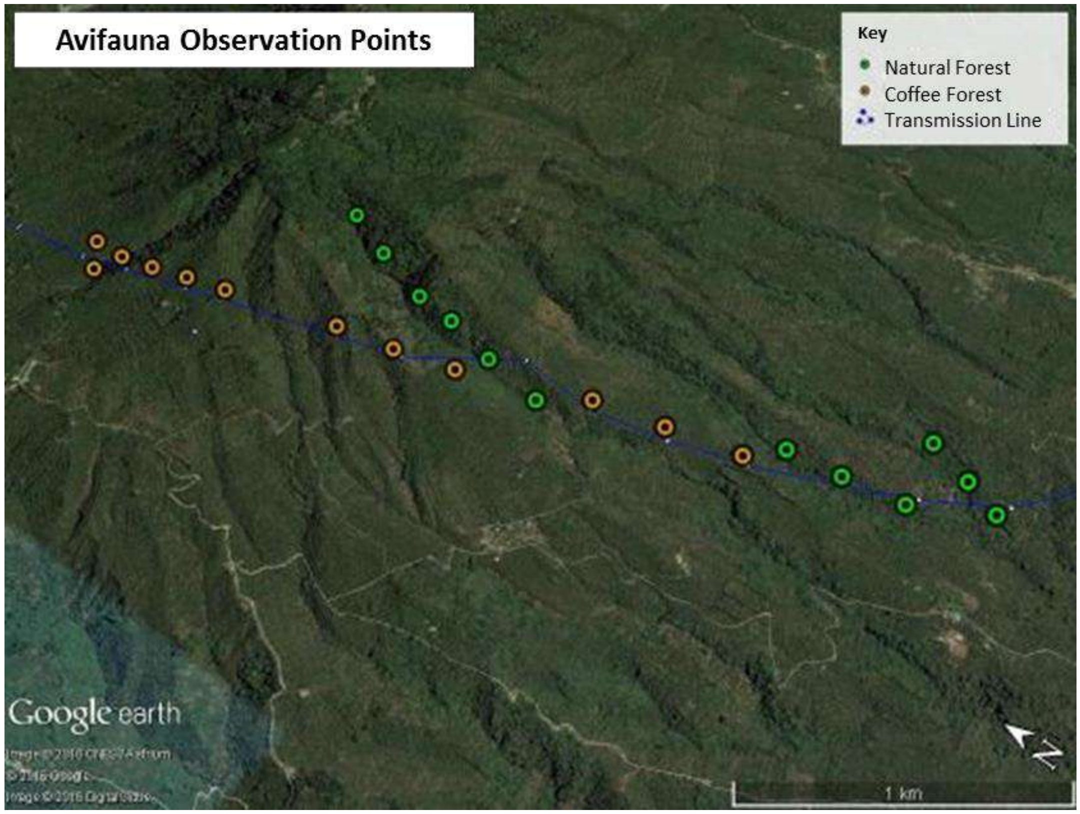


Figure 4.2-12 Observation Points Established for Avifauna Sampling in the Sector of Apaneca to San Pedro Puxtla Project

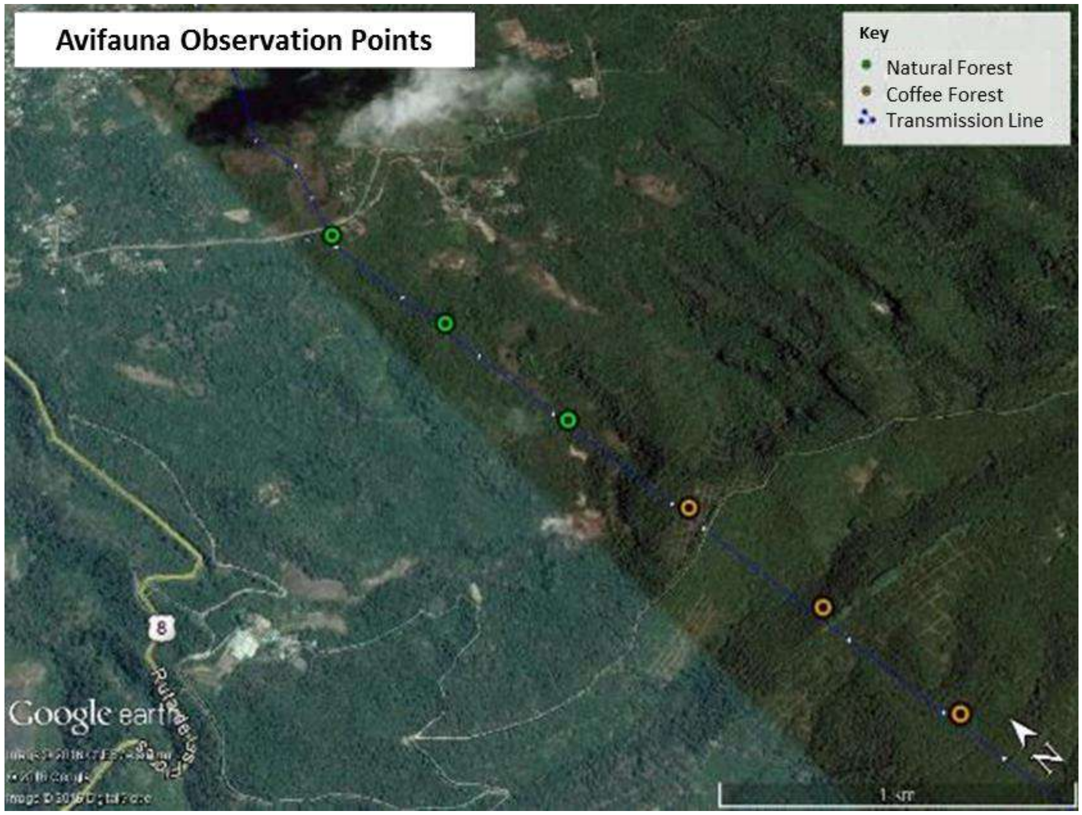


Figure 4.2-13 Observation Points Established for Avifauna Sampling in the Project's Ahuachapán Sector

Results

A total of 39 bird species belonging to 26 families were recorded (see Table 4.2-4). The majority of recorded species are common, with wide distribution at national level and high adaptability to areas disturbed by anthropogenic activity. However, 4 species with threatened status were recorded for El Salvador (MARN, 2015, see Section 4.2.14 - Threatened and Endangered Species). The most abundant species during this study were Zenaida asiatica, Cathartes aura, Quiscalus mexicanus and Brotogeris jugularis. Most species had an intermediate abundance and some had only one observation. The highest number of species and individuals was recorded in areas of agricultural crops with a high degree of anthropogenic activity (see Figure 4.2-14).

Table 4.2-4 Registered Bird Species, May - June 2016

Specie	*Common Name*	*ES*	*IUCN*	*C*	*PB*	*AA*	*Total*	*AG*
Bubulcus ibis	Cattle egret	NA	LC	0	0	6	6	0.98
Cathartes aura	Turkey vulture	NA	LC	0	0	55	55	9.02
Buteo magnirostris	Roadside hawk	NA	LC	0	1	9	10	1.64
Geranospiza caerulescens	Crane hawk	NA	LC	0	0	1	1	0.16
Herpetotheres cachinnans	Laughing falcon	NA	LC	3	0	0	3	0.49
Jacana spinosa	Mesoamerican Jacana	NA	LC	0	0	8	8	1.31
Zenaida asiatica	White-winged dove	NA	LC	9	17	94	120	19.67
Patagioenas flavirostris	Red-billed pigeon	NA	LC	6	5	1	12	1.97
Columbina inca	Inca dove	NA	LC	0	0	12	12	1.97
Columbina talpacoti	Ruddy ground dove	NA	LC	0	0	23	23	3.77
Brotogeris jugularis	Tovi parakeet	A	LC	30	0	0	30	4.92
Eupsittula canicularis	Half-moon conure	A	LC	0	0	7	7	1.15
Piaya cayana	Squirrel cuckoo	NA	LC	2	1	0	3	0.49
Crotophaga sulcirostris	Groove-billed ani	NA	LC	0	0	16	16	2.62
Tyto alba	Barn owl	NA	LC	0	0	1	1	0.16
Nyctidromus albicollis	Pauraque	NA	LC	0	0	2	2	0.33
Amazilia rutila	Cinnamon hummingbird	NA	LC	0	3	0	3	0.49
Trogon elegans	Elegant trogon	NA	LC	6	3	0	9	1.48
Eumomota superciliosa	Turquoise-browed motmot	NA	LC	5	2	7	14	2.30
Chloroceryle americana	Green kingfisher	NA	LC	0	0	3	3	0.49
Aulacorhynchus prasinus	Emerald toucanet	A	LC	0	3	0	3	0.49
Pteroglossus torquatus	Collared aracarí	NA	LC	0	5	0	5	0.82
Melanerpes aurifrons	Golden-fronted woodpecker	NA	LC	3	2	7	12	1.97
Chiroxiphia linearis	Long-tailed manakin	A	LC	0	20	0	20	3.28
Pitangus sulphuratus	Great kiskadee	NA	LC	3	4	12	19	3.11
Calocitta formosa	White-throated magpie-jay	NA	LC	15	3	6	24	3.93
Riparia riparia	Sand martin	NA	LC	0	0	7	7	1.15
Campylorhynchus rufinucha	Rufous-naped wren	NA	LC	5	0	12	17	2.79
Turdus grayi	Clay-colored thrush	NA	LC	5	3	20	28	4.59
Setophaga petechia xantholora	American yellow warbler	NA	LC	8	2	4	14	2.30
Setophaga magnolia	Magnolia warbler	NA	LC	0	10	0	10	1.64
Cyanerpes cyaneus	Red-legged honeycreeper	NA	LC	4	0	0	4	0.66
Thraupis abbas	Yellow-winged tanager	NA	LC	2	0	0	2	0.33
Volatinia jacarina	Blue-black grassquit	NA	LC	0	0	11	11	1.80

Specie	*Common Name*	*ES*	*IUCN*	*C*	*PB*	*AA*	*Total*	*AG*
Sporophila torqueola	White-collared seedeater	NA	LC	0	0	4	4	0.66
Dives dives	Melodious blackbird	NA	LC	2	3	4	9	1.48
Quiscalus mexicanus	Great-tailed grackle	NA	LC	7	3	25	35	5.74
Icterus gularis	Altamira oriole	NA	LC	5	4	14	23	3.77
Euphonia hirundinacea	Yellow-throated euphonia	NA	LC	8	17	0	25	4.10
Total Individuals				128	111	371	–	–
Total Species				20	21	28	–	–

Key: E.S: Salvadoran status: NA: Not threatened; ES: Category in El Salvador; IUCN: IUCN global category; LC: Least Concern; C: Coffee Plantation; PB: Forest patch; AA: Agricultural areas; AG: General abundance (%).

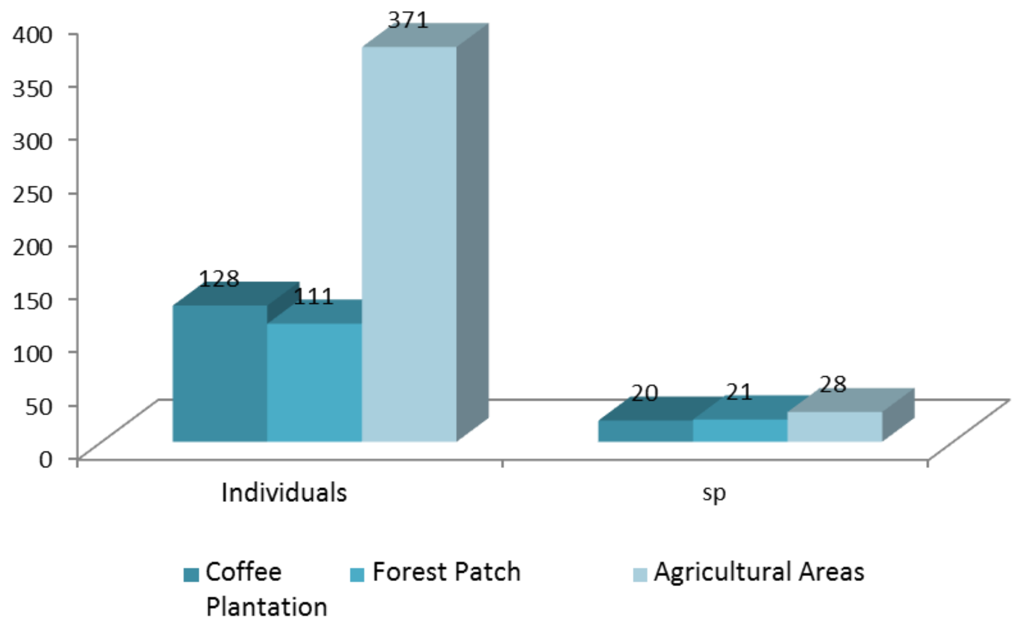
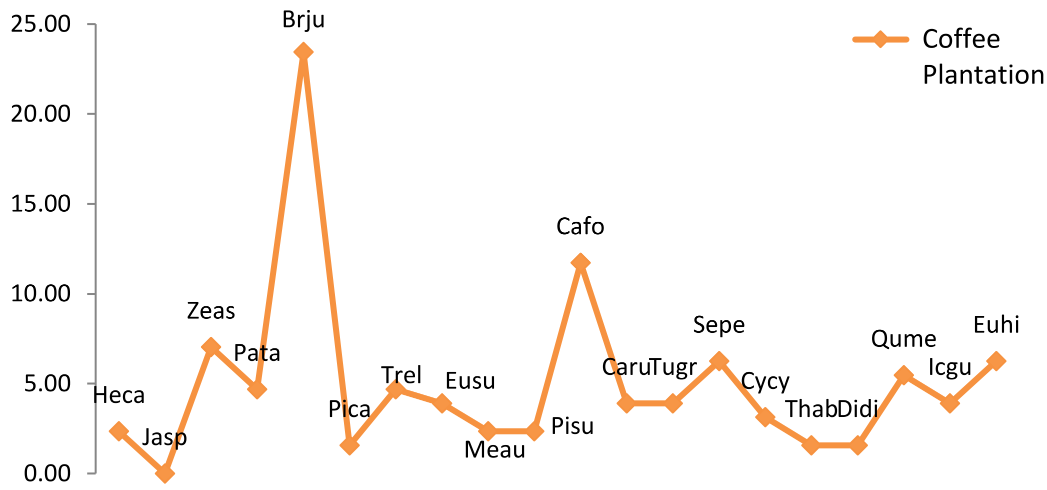


Figure 4.2-14 Numbers of Individuals and Species of Avifauna Registered in the Different Sampling Habitats, May-June 2016

Coffee Plantations

In the coffee plantation area, the species Brotogeris jugularis is the predominant species, followed by Calocitta Formosa (see Figure 4.2-15). The first is the only threatened species at the national level that was recorded in coffee plantations. Tree species that provide shade to coffee provide shelter, food and nesting and resting areas for both resident and migratory species.



Key: Heca: Herpetotheres cachinnans; Zeas: Zenaida asiática; Pata: Patagioenas flavirostris; Brju: Brotogeris jugularis; Pica: Piaya cayana; Trel: Trogon elegans; Eusu: Eumomota superciliosa; Meau: Melanerpes aurifrons; Pisu: Pitangus sulphuratus; Cafo: Calocitta Formosa; Caru: Campylorhynchus rufinucha; Tugr: Turdus grayi; Sepe: Setophaga petechia xantholora; Cycy: Cyanerpes cyaneus; Thab: Thraupis Abbas; Didi: Dives dives; Qume: Quiscalus mexicanus; Icgu: Icterus gularis; Euhi:Euphonia hirundinacea

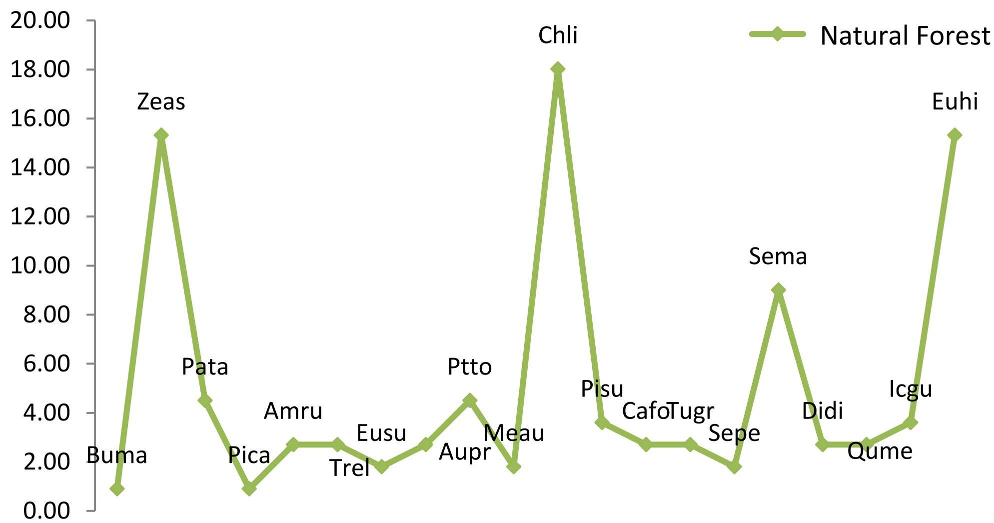
Figure 4.2-15 Rank Chart-Abundance of Bird Species in Coffee Forests (May 2016)

Natural Forest

In the areas of natural forest, 21 bird species were observed, two of which are threatened at the national level: *Aulacorhynchus prasinus* (green toucan) and *Chiroxiphia linearis* (jumping collarejo or Toledo).

The most abundant species were *Chiroxiphia linearis*, *Asian Zenaida* and *Euphonia hirundinacea*, respectively (see Figure 4.2-16).

These forest relics, known as machorras in the coffee plantations, are very scarce since most of the area is cultivated. However, these spaces are not suitable for coffee growing, are important for species of forest specialists and have a greater floristic diversity, including species important for conservation.



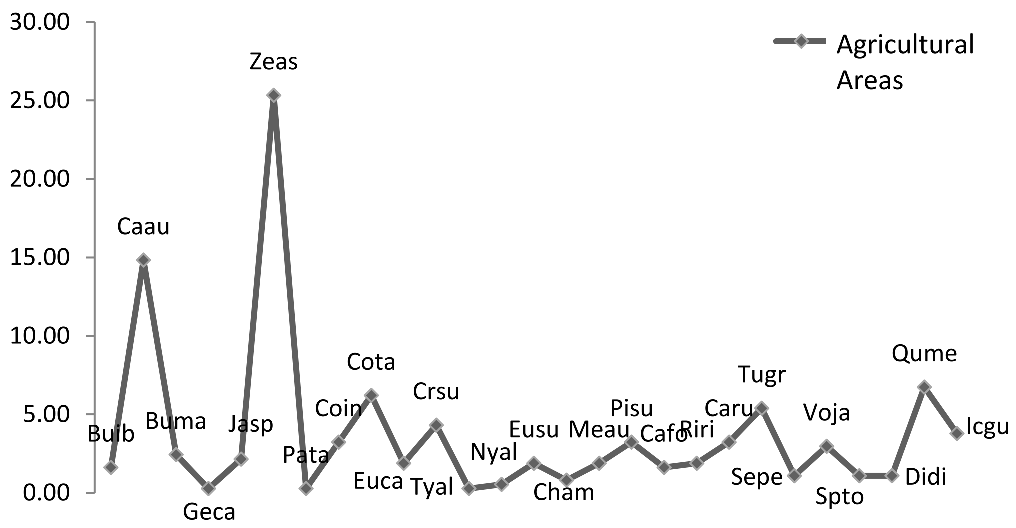
Key: Buma: Buteo magnirostris ; Zeas: Zenaida asiática; Pata: Patagioenas flavirostris; Pica: Piaya cayana; Amru: Amazilia rutila; Trel: Trogon elegans; Eusu: Eumomota superciliosa; Aupr: Aulacorhynchus prasinus; Ptto: Pteroglossus torquatus; Meau: Melanerpes aurifrons; Chli: Melanerpes aurifrons; Pisu: Pitangus sulphuratus; Cafo: Calocitta Formosa; Tugr: Turdus grayi; Sepe: Setophaga petechia xantholora; Sema: Setophaga magnolia; Didi: Dives dives; Qume: Quiscalus mexicanus; Icgu: Icterus gularis; Euhi:Euphonia hirundinacea.

Figure 4.2-16 Rank Chart-Abundance of Species of Birds in Natural Forests (May-June 2016)

Agricultural Areas

This habitat recorded the largest number of species (28), including a threatened species: guayabero or chocoyo (*Eupsittula canicularis*).

The most abundant species for this habitat were *Asian Zenaida* (white-winged dove) and *Cathartes aura* (Redhead aura or zunche) (see Figure 4.2-17).



Key: Buib: Bubulcus ibis; Caau: Cathartes aura; Buma: Buteo magnirostris; Geca: Geranospiza caerulescens; Jasp: Jacana spinosa; Zeas: Zenaida asiática; Pata: Patagioenas flavirostris; Coin: Columbina inca; Cota: Columbina talpacoti; Euca: Eupsittula canicularis; Crsu: Crotophaga sulcirostris; Tyal: Tyto alba; Nyal: Nyctidromus albicollis; Eusu: Eumomota superciliosa; Cham: Chloroceryle americana; Meau: Melanerpes aurifrons; Pisu: Pitangus sulphuratus; Cafo: Calocitta Formosa; Tugr: Turdus grayi; Sepe: Setophaga petechia xantholora; Didi: Dives dives; Qume: Quiscalus mexicanus; Icgu: Icterus gularis

Figure 4.2-17 Rank Chart-Abundance of Bird Species Agricultural Areas (May-June 2016)

Areas of Importance for Bird Conservation

Important Bird Areas (IBAs) are internationally recognized for their biodiversity values but are not protected natural areas by law in El Salvador. The IBA "Los Cobanos" is an area of coastal plain (7,000 ha) containing fragments of savannas (Crescentia alata), secondary dry forest, gallery forest and freshwater marshes scattered in a grazing landscape (BirdLife International, 2016). The fragments of dry forest contain a typical bird community of the Arid Pacific Rim biome. The gallery forests have colonies of the Mexican cacique or Aliamarilla (Cacicus melanicterus), the only population in all El Salvador of a species of wide distribution in Mexico and with category of Least Concern according to the IUCN (BirdLife International, 2016). TL traverses part of the Northeast sector of the IBA between towers TP 136 and TP 145 + 100 m for a distance of approximately 2,890 m.

4.2.2.3 Non-flying Mammals

To sample these species, linear transects were established in which the mammalian species present were recorded through sightings or from traces, excreta or other traces indicating the occurrence of these species.

The same transects destined for herpetofauna were used (see Figures 4.2-4 to 5.2-7). Camera traps placed at strategic sites, such as tracks made by animals, were also used (Figure 4.2-18).

Figure 4.2-18 Camera Trap Used for the Registration of Mammal Species

Sampling Schedules

Mammals were sampled during the day from 08:00 am to 12:00 pm and from 2:00 pm to 4:00 pm. Night sampling were also performed from 8:00 pm to 2:00 am.

Results

A total of 14 species belonging to ten mammalian families were recorded, none of which are threatened or endangered on national or international lists (see Table 4.2-5).

Table 4.2-5 Species of Registered Mammals, May 2016

Family	*Specie*	*Common Name*	*ES*	*IUCN*	*C*	*PB*	*AA*	*Total*
Canidae	*Urocyon cinereoargenteus*	Gray fox	NA	LC	0	0	5	5
Dasypodidae	*Dasypus novemcinctus*	Nine-banded armadillo	NA	LC	7	9	6	22

Family	Specie	Common Name	ES	IUCN	C	PB	AA	Total
Dasyproctidae	*Dasyprocta punctata*	Central American agouti	NA	LC	0	4	0	4
Didelphidae	*Didelphis marsupialis*	Common oposum	NA	LC	3	1	8	12
Didelphidae	*Philander opossum*	Gray four-eyed oposum	NA	LC	0	0	5	5
Felidae	*Puma yagouaroundi*	Jaguarundi	NA	LC	0	1	0	1
Geomyidae	*Orthogeomys sp*	Pocket gophers	NA	LC	6	4	0	10
Leporidae	*Sylvilagus floridanus*	Eastern cottontail	NA	LC	3	1	5	9
Mephitidae	*Spilogale putorius*	Eastern spotted skunk	NA	LC	0	2	1	3
Mephitidae	*Mephitis macroura*	Hooded skunk	NA	LC	0	0	1	1
Procyonidae	*Procyon lotor*	Raccoon	NA	LC	0	0	11	11
Procyonidae	*Nasua narica*	White-nosed coati	NA	LC	0	6	0	6
Procyonidae	*Potus flavus*	Kinkajou	NA	LC	0	1	0	1
Sciuridae	*Sciurus variegatoides*	Variegated squirrel	NA	LC	1	1	1	3
Total					***20***	***30***	***43***	***93***
Species					***5***	***10***	***9***	***14***

Key: ES: Category in El Salvador; IUCN: IUCN global category; NA: Not threatened; LC: Least Concern; C: Coffee Plantation; PB: Patch of natural forest; AA: Agricultural Areas.

Populations of Mammals in the Different Sampling Habitats

The greatest number of species was located in areas of natural forest. However, a greater number of individuals were obtained in the sampled agricultural areas (see Figure 4.2-19). These areas recorded a high number of individuals due to being adjacent to small rivers and ravines where the species of this group find good conditions for their subsistence.

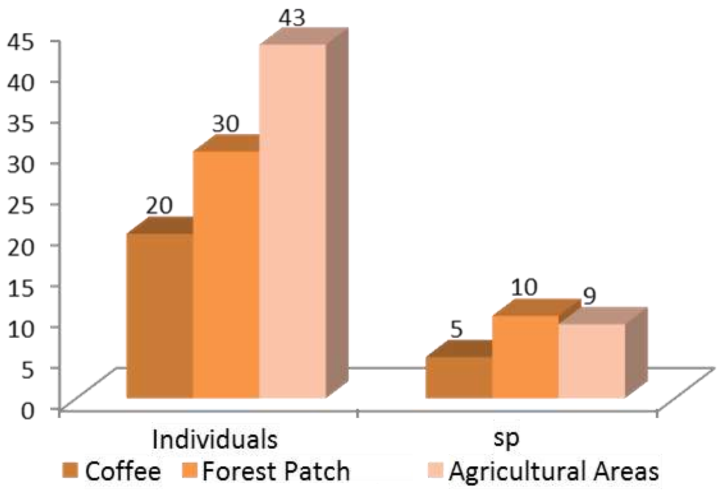
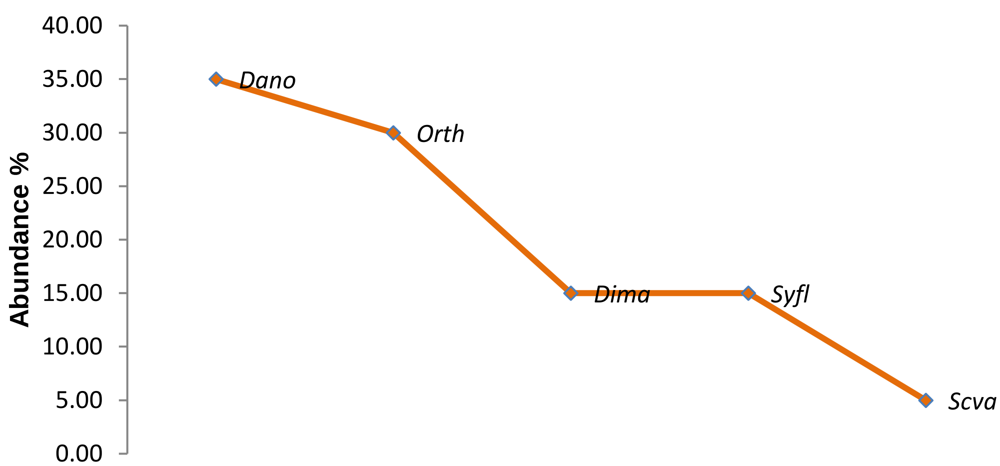


Figure 4.2-19 Numbers of Individuals and Species of Mammals Registered in the Different Habitats, May - June 2016

<u>Coffee Plantation</u>

Coffee plantations are often ideal sites for the occurrence of mammals. In the present study five species were recorded, of which the most abundant were *Dasypus novemcinctus* and *Orthogeomys sp*. (Figure 4.2-20). Most of these individuals were recorded from traces.



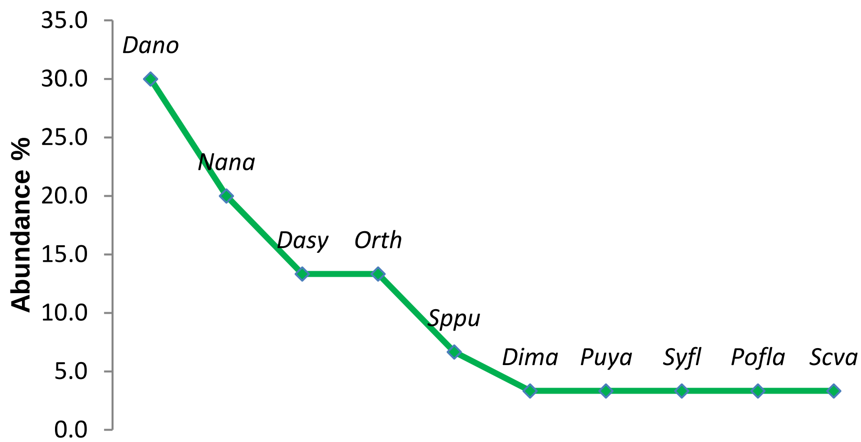
Key: Dano: Dasypus novemcinctus; Dima: Didelphis marsupialis; Orth: Orthogeomys sp; Syfl: Sylvilagus floridanus; Scva: Sciurus variegatoides

Figure 4.2-20 Rank-Abundance Chart of Mammal Species in Coffee Forest (May 2016)

Natural Forest

Ten species were recorded in the natural forest. As in the areas of coffee plantation, the most abundant species was *Dasypus novemcinctus*, a species quite common in the area.

Another abundant species was *Nasua narica* (pezote). This species was recorded in the patch of forest located in the farm El Naranjo. In this same area, we found one more species of the same family (Procyonidae), *Potus flavus*, known as mycoleón (see Figure 4.2-21).



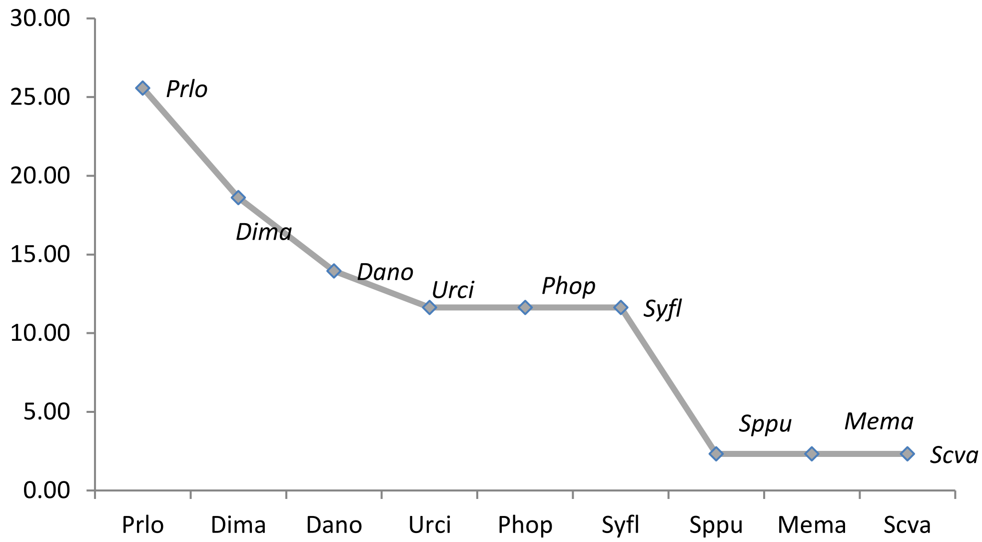
Key: Dano: Dasypus novemcinctus; Dasy: Dasyprocta punctata; Dima: Didelphis marsupialis; Puya: Puma yagouaroundi; Orth: Orthogeomys sp; Syfl: Sylvilagus floridanus; Sppu: Spilogale putorius; Nana: Nasua narica; Pofla: Potus flavus; Scva: Sciurus variegatoides.

Figure 4.2-21 Rank-Abundance Chart of Mammalian Species in Natural Forest Patches (May 2016)

Agricultural Areas

Agricultural areas are usually areas that, because of the food layout, contain many species of mammals. However, these can become a problem because of the damage they cause to crops.

The most abundant species was *Procyon lotor*, which is normally associated with habitats with high availability of water. Less abundant species are *Mephitis macroura* and *Spilogale putorius*, both species of skunks common in these habitat types (see Figure 4.2-22).

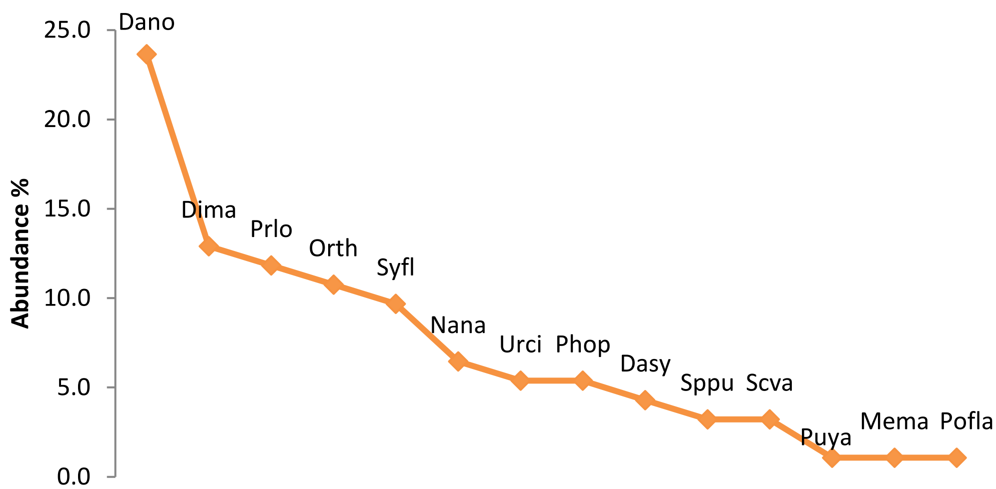


Key: Urci: Urocyon cinereoargenteus; Dano: Dasypus novemcinctus; Dasy: Dasyprocta punctata; Dima: Didelphis marsupialis; Phop: Philander opossum; Puya: Puma yagouaroundi; Orth: Orthogeomys sp; Syfl: Sylvilagus floridanus; Sppu: Spilogale putorius; Mema: Mephitis macroura; Prlo: Procyon lotor; Nana: Nasua narica; Pofla: Potus flavus; Scva: Sciurus variegatoides

Figure 4.2-22 Rank-Abundance Chart of Mammal Species in Agricultural Areas (May 2016)

Abundance of mammal species in the Project's area of influence

A total of 14 mammal species were recorded for the project's area of influence, with the most abundant being *Dasypus novemcinctus* (cuzuco), *Didelphis marsupialis* (tacuazin) and *Procyon lotor* (raccoon). The three species less abundant during this research were *Puma yagouroundi* (cat zonto), *Mephitis macroura* (skylark) and *Potus flavus* (mycoleón, see Figure 4.2-23).



Key: Urci: Urocyon cinereoargenteus; Dano: Dasypus novemcinctus; Dasy: Dasyprocta punctata; Dima: Didelphis marsupialis; Phop: Philander opossum; Puya: Puma yagouaroundi; Orth: Orthogeomys sp; Syfl: Sylvilagus floridanus; Sppu: Spilogale putorius; Mema: Mephitis macroura; Prlo: Procyon lotor; Nana: Nasua narica; Pofla: Potus flavus; Scva: Sciurus variegatoides

Figure 4.2-23 Rank-Abundance of Mammalian Species Chart (May-June 2016)

4.2.2.4 Chiroptera

Methodology

For the sampling of the chiroptera, two mist nets (one of 9 m x 2.6 m and one of 12 m x 2.6 m) were placed at ground level around the points of the towers TP 2 - 3, TP 33 - 34, TP 36 and TP 44-44a (see Table 4.2-6). The distance between each net was at least 150 m and was located in places with a reasonable amount of vegetation and/or on roads that could possibly serve as passage tunnels for bats. Sampling was conducted from 6:30 p.m. to 11:00 p.m., checking each net at 30 minute intervals, removing them from the sites at the end of catches (see Figure 4.2-24).

For each captured bat, measurements of forearm, weight, sex, and reproductive status were recorded using standard methodologies (Kunz, 1988; Jones et al., 1996). Photographs were taken of their characteristic traits and identified using the Medellín field guide, Arita and Sánchez (2007). Later they were released in the neighborhoods where they were captured. In addition, at each sampling site, geographical references were taken from each point with a Garmin eTrex 20 Worldwide Handheld Navigator GPS.

Figure 4.2-24 Positioning of Mist Nets at Sampling Points Near to Proposed Towers TP 2 and TP 3

In the vicinity of TP 139 tower in the Acajutla area an ultrasound recorder for monitoring of Song Meter SM3 bats was used (see Figure 4.2-25). The equipment was located in an open area and was programmed using monitoring methodologies (Víquez & Arias, 2015) and the recordings were made from 6:00 pm to 5:00 am, removing the equipment from the site the following day and georeferenced the sampling point.

Recordings were analyzed using the Analook program to obtain sonograms that were used to identify species of insectivorous bats by Miller (2003).

Figure 4.2-25 Installation of Acoustic Equipment SME3 and Analysis of Sonograms

Table 4.2-6 Geographic Location of Chiroptera Sampling Points

Date	*Sampling Point*	*Sampling Point*	*Coordinate N*	*Coordinate W*	*Height (m)*
05/28/2016	Span TP 2-3	PLT 1	13°55'06.4''	89°49'09.9''	771
05/28/2016	Span TP 2-4	PLT 2	13°55'07.6''	89°49'10.1''	767
05/28/2016	Span TP 2-3	PLT 3	13°55'04.8''	89°49'08.9'	777
05/29/2016	Span TP 33-34	PLT 4	13°50'21.0''	89°48'53.7''	1436
05/29/2016	Span TP 33-34	PLT 5	13°50'20.0''	89°48'54.8''	1435
05/30/2016	TP 36	PLT 6	13°49'26.8''	89°48'42.0''	1179
05/31/2016	Span TP 44-44a	PLT 7	13°48'32.4''	89°48'15.6''	966
06/01/2016	TP139	PLT 8	13°36'04.6''	89°47'49.6''	58

Results

In total, 14 species of bats were recorded (see Table 4.2-7). The most abundant species was *G. commissarisi* (N: 25), a species of nectarivorous habits.

Nine of the registered species are of frugivorous habits, including species of the genera *Artibeus, Dermanura* and *Sturnira* considered as tolerant or adaptable to disturbed environments (Fleming, 1986; Galindo-González, 2004; Sosa *et al*., 2008), so it is considered that the areas could house shrubs (genders *Solanum, Piper, Cestrum*) or trees (genders *Ficus, Inga, Cecropia, Psidium, Spondias, Persea* among others) that can provide food to the frugivorous species (Sosa et al., 2008).

The mist net method yielded a total of 63 individuals belonging to 12 species of bats, eight genders and two families. The method of acoustic monitoring produced 636 recordings belonging to 9 species of insectivorous bats, 6 genders and 4 families.

Nine species were recorded for points VT2-3, VT33-34 and TP 139, being the most diverse. However, it should be considered that for TP 36 (N: 2) and TP 44-44a (N: 5) points, miscalculations were encountered with climatic conditions whereby sampling had to be interrupted prematurely. The complete results of the study of bats are presented in Appendix C.

Table 4.2-7 List of Species of Bats by Points of Placement of Towers in the Project (May 2016)

Family	Specie	Common name	Habit	MRN				MA
				VT2-3	VT33-34	T36	VT44-44a	T139
Phyllostomidae	*Phyllostomus discolor*	Pale spear-nosed bat	OM				X	
	Glossophaga commissarisi	Commissaris's long-tongued bat	NE	X	X			
	Glossophaga soricina	Pallas's long-tongued bat	NE	X				
	Artibeus inopinatus	Honduran fruit-eating bat	FR	X				
	Artibeus jamaicensis	Jamaican fruit bat	FR	X	X	X	X	
	Artibeus lituratus	Great fruit-eating bat	FR	X	X		X	
	Chiroderma salvini	Salvin's big-eyed bat	FR	X	X			
	Dermanura aztecus	Aztec fruit-eating bat	FR				X	
	Dermanura toltecus	Toltec fruit-eating bat	FR		X			
	Platyrrhinus helleri	Heller's broad-nosed bat	FR	X	X			
	Sturnira hondurensis	Honduras yellow-shouldered bat	FR		X	X		
	Sturnira parvidens	Northern yellow-shouldered bat	FR	X	X		X	
Mormoopidae	*Pteronotus davyi*	Davy's naked-backed bat	IN					X

Family	*Specie*	*Common name*	*Habit*	*MRN*				*MA*
				VT2-3	*VT33-34*	*T36*	*VT44-44a*	*T139*
	Pteronotus gymnonotus	Big naked-backed bat	IN					X
	Pteronotus personatus	Wagner's mustached bat	IN					X
Emballonuridae	*Saccopteryx bilineata*	Greater sac-winged bat	IN					X
Molossidae	*Molossus molossus*	Velvety free-tailed bat	IN					X
	Molossus sinaloe	Sinaloan mastiff bat	IN					X
Vespertilionidae	*Myotis nigricans*	Black myotis	IN					X
	Myotis keaysi	Hairy-legged myotis	IN	X				
	Lasiurus intermedius	Northern yellow bat	IN					X
	Rhoggessa bickhami	Beckhams Little Yellow Bat	IN		X			X
Total		**–**	**–**	***9***	***9***	***2***	***5***	***9***

Key: MRN: Mist Net Method; MA: Acoustic monitoring; OM: Omnivore; NE: Nectariferous; FR: Frugivore; IN: Insectivorous; VT2-3; VT33-34; T36; VT44-44a; and T139

4.2.2.5 *Threatened and Endangered Species*

Six species of fauna were identified in the category of Threatened according to the National Official List (MARN, 2015), of which one is Critically Endangered (CR) according to the IUCN Red List (see Table 4.2-8).

Table 4.2-8 Species of Fauna in Threatened or Endangered Categories found on the Transmission Line, May - June 2016

Order	*Family*	*Specie*	*Common Name*	*National Category*	*Category IUCN*
Class Amphibia					
Anura	Hylidae	*Agalychnis moreletii*	Black-eyed tree frog	T	CE
Class Reptilia					
Squamata	Iguanidae	*Ctenosaura similis*	Black spiny-tailed iguana	T	LC
Class Birds					
Psittaciformes	Psittacidae	*Brotogeris jugularis*	Orange-chinned parakeet	T	LC
	Psittacidae	*Eupsittula canicularis*	Orange-fronted parakeet	T	LC
Piciformes	Ramphastidae	*Aulacorhynchus prasinus*	Emerald toucanet	T	LC
Passeriformes	Pipridae	*Chiroxiphia linearis*	Long-tailed manakin	T	LC

Key: T: Threatened; CE: Critically Endangered; LC: Least Concern; IUCN: International Union for the Conservation of Nature.

Amphibians

Agalychnis moreletii

The black-eyed frog (see Figure 4.2-26) is an endemic species of Central America with a category of Critically Endangered (CE) worldwide due to chytridiomycosis (Santos-Barrera et al., 2004), a disease that has caused Extinction of several amphibian species worldwide. In El Salvador, in 2009 it was considered as a common species in the western central zone of the country in natural forests but also in shade coffee farms (Herrera & Henríquez, 2009). It was registered in two places where the transmission line passes on the Santa Rita and Tequendama farms. In both sites, adults and tadpoles were found in reservoir piles, as well as several ovipostures in the leaves of the trees that surrounded the pools. According to Leenders & Watkins-Cowell (2004), most of the tadpoles of this species were collected in artificial ponds and coffee laundries (see Figure 4.2-27) and reproduction seems to be continuous in El Salvador.

Figure 4.2-26 Adult Agalychnis moreletii Frog Registered during the Study, May and June 2016

Figure 4.2-27 Oviposture of Agalychnis moreletii Found in Reservoir Pile during the Study, May and June of 2016

Reptiles

Ctenosaura similis

Garrobo jiote or black iguana is a large lizard that inhabits much of Central America. It is categorized as Threatened Nationwide (MARN, 2015) but is a species of least concern (LC) according to the IUCN Red List. It can be very abundant in anthropized habitats but is sensitive to hunting pressure as it is desirable for domestic and commercial consumption in El Salvador (Stephen et al., 2011).

Birds

Four species with threatened status at the national level were observed (MARN, 2015). None of the bird species is threatened on the IUCN Red List.

Brotogeris jugularis

This is a species of parrot or psittacida, known as "catalnica", which is threatened at national level. The main risks for its conservation are the destruction of the habitat and the human predation since this species is usually captured at an early age in their nests (talchinol), soon to be commercialized in order to be restricted to the captivity.

Eupsittula canicularis

It is another species of parrot threatened at national level and popularly known as "chocoyo" (see Figure 4.2-28). Like the previous species its main risks are predation and habitat loss.

Note: Species Evaluated with Least Concern (LC) by IUCN But is in Appendix II of CITES and Threatened by MARN, 2015e.

Figure 4.2-28 Eupsittula canicularis – Photographed in the Project Area, May-June 2016

Aulacorhynchus prasinus

The green toucan is a nationally threatened species but distributed between Nicaragua and San Luis Potosí in Mexico and of least concern category (LC) at the international level. During the field study, three individuals were observed in the patch habitat of natural forest and none in the shade or pastureland.

Chiroxiphia linearis

The long-tailed manakin is a threatened species at the national level but distributed between Costa Rica and Oaxaca in Mexico and of least concern category (LC) at the international level. During the field study, 20 individuals were observed in patch habitat of natural forest and none in the shade or pastureland.

4.2.2.6 Endemic or Restricted Distribution Species

The vast majority of documented species have wide distributions in Central America or even North and South America. No endemic species of the country were registered. However, species with geographically restricted areas of distribution were found. For example, the *Agalychnis* moreletii frog has a global distribution area of less than 36,000 km2 (Morrison et al., 2012) and the *Anolis* wellbornae lizard is located in an area of less than 48,000 km2 in dry forest remnants of the Pacific, (ERM own elaboration). Species of terrestrial vertebrates with distribution areas have been recognized as potential indicators of sensitive habitats by the multilateral banks and financial institutions of the Principles of Ecuador.

4.2.2.7 *Breeding, Mating and Hatching Areas*

There were no areas of singular importance for breeding, mating or hatching of fauna species within the Project area. However, two breeding sites of the *Agalychnis moreletii* frogs were found, a species that frequents shade-grown coffee plantations and uses artificial stacks such as egg laying sites and tadpoles.

4.2.2.8 *Migratory Corridors*

El Salvador is located on an important corridor for migratory birds. However, the Project area is not recognized as an area of particular importance for migratory birds.

4.2.2.9 *Important Areas for Fauna*

The habitats of the Project area are mostly coffee plantations, anthropogenic grasslands and crop fields that are not relevant to the native fauna of the region. The most important habitats are in creeks forests where species of native fauna can be found. As mentioned above, the most important sites are the habitats of the frogs *Agalychnis moreletii*, a species in critical danger of extinction according to the IUCN.

4.2.2.10 *Permissible Limits of Physicochemical Parameters*

Regarding potential sources of physicochemical risks of the Project for biodiversity, only the generation of electric and magnetic fields by the high voltage lines can be mentioned. Despite significant research efforts in Europe and the United States, environmental or exposure levels that are harmful to wildlife species have not been documented.

4.2.3 *Terrestrial Ecosystems*

El Salvador is located in the Neotropical region comprising the American tropics from northern Mexico to central Argentina (Morrone, 2001).

Within the project area stands out the volcanic complex of Santa Ana, of which the Santa Ana Volcano or Ilamatepec constitutes the nucleus. This volcano originated in the Pleistocene period (between 2 and 1 million years ago), before the explosive events of the Coatepeque caldera (its last eruption was in 2005). The volcanoes of Izalco, Cerro Verde, San Marcelino and others are "parasitic" to the mother volcano (UNESCO, 2007b).

According to the classification of Dinerstein Ecoregions and terrestrial and aquatic ecosystems of the classification available for the Mesoamerican Region defined by the Central American Commission on Environment and Development (CCAD) in 2000, it is observed that there are three ecoregions present in the Biosphere Reserve Apaneca - Ilamatepec, which is the most important and representative area from the point of biodiversity that crosses the Project: the Central American Montane Forest, which is in a vulnerable state, the Central American Dry Forest and the Central American Oak Forest both in Critical/Vulnerable worldwide.

In Central America, the description of terrestrial ecological formations has been based mainly on the classification system of the Life Zones of Holdridge et al. (1971) and Holdridge (1978).

This method assumes that vegetation classes vary according to certain climatic and altitudinal gradients. Therefore, it should be noted that the Holdridge system is predictive rather than descriptive. Holdridge et al. (1971) state that a global system of life zones can be established on the basis of precipitation and temperature. This classification system uses the concept "biotemperature", which takes into account the optimal temperature range for plants. A second factor of temperature that takes into account is the decrease of the temperature when increasing the elevation. A third factor is evapotranspiration, for which it developed its own formula. Holdridge then associated a typical vegetation type with the different life zones he had identified based on precipitation; biotemperature, altitude, and evapotranspiration (see Figure 4.2-29).

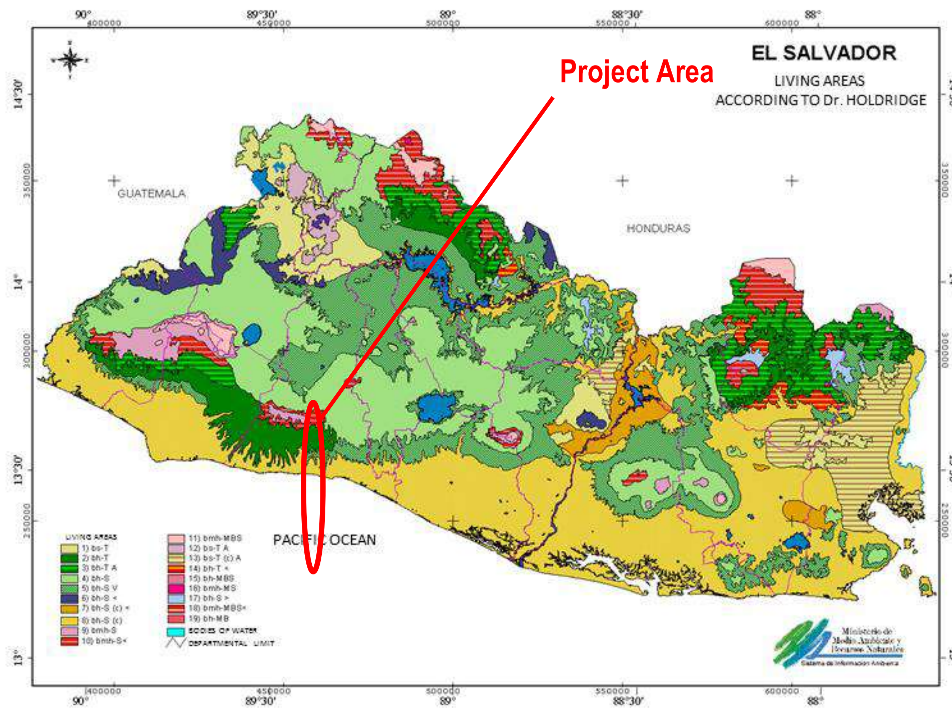


Figure 4.2-29 Life Zones or Plant Formations According to Holdridge

The TL Project crosses the following life zones of Holdridge:

- Hot humid subtropical forest bh-S (c)
- Humid subtropical forest, transition to tropical bh – S
- Tropical humid forest bh – T
- Tropical humid forest, transition to subtropical bh – T
- Very humid subtropical forest, transition to humid bmh – S
- Very humid subtropical low montane forest bmh – MBS
- Subtropical very humid forest bmh – S

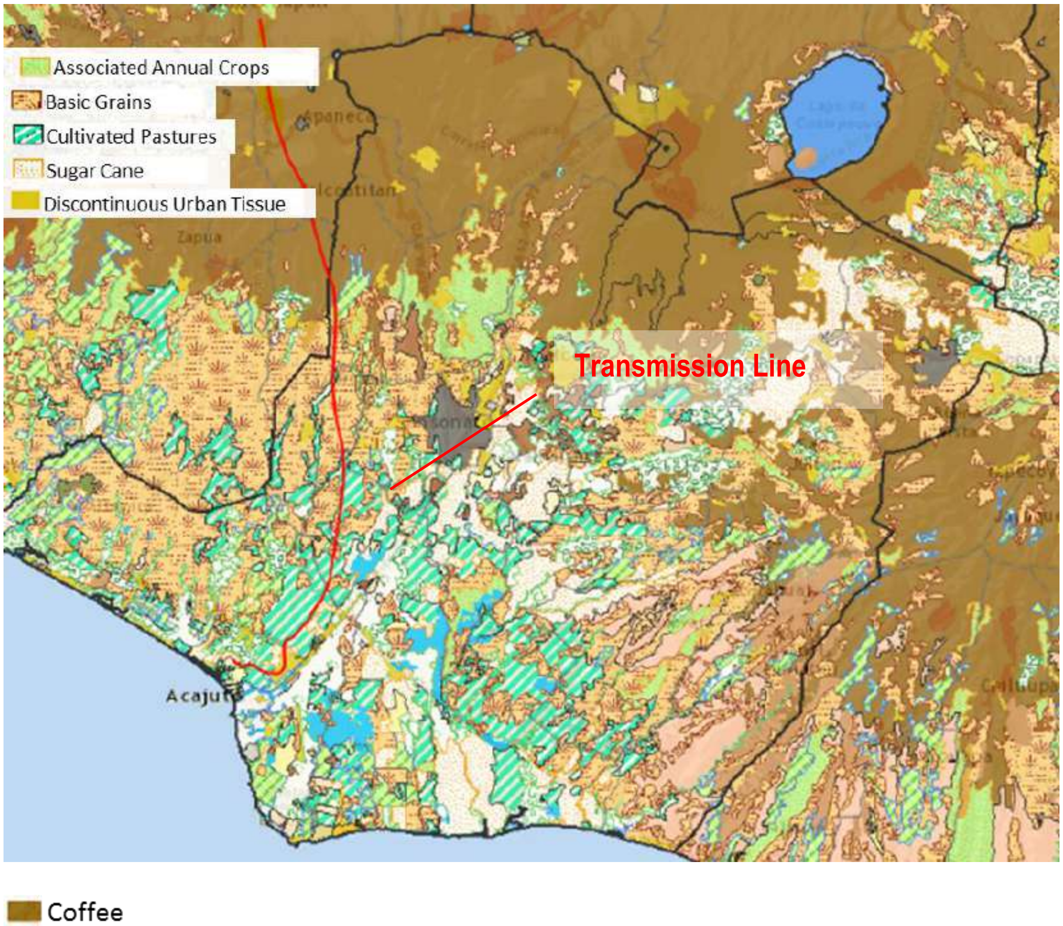
Koeppen classification is based on temperature and annual rainfall distribution. In view of the relationship between temperature and height, the latter can also be taken as a criterion of climatic division.

Most of El Salvador is included in the type of climate of warm tropical savannas, with dry season with average temperatures of the coldest month greater than 18˚C and average temperatures of the hottest month above 22˚C, coastal plains up to 200 m and inland valleys up to 800-900 m.

In the mountains and valleys between 800 and 1,200 m, the climate of warm tropical savannas predominates, with average temperatures of the warmer month lower to 22.0 ˚C, and above the 1,200 m, the high tropical climate with average temperatures of the coldest month below 18.0˚ C. According to Sapper-Lauer, three high-temperature floors can be identified, or levels with the same temperature conditions: hot land up to 900 m, soil temperate and cold ground above 1,800 m.

Due to the special conditions caused by the presence of the ocean, with its damping effect, the coastal zone up to 200 m can be considered as a special climatic unit, which is differentiated by the attenuated temperature regime compared to the interior valleys.

Currently agricultural ecosystems or agro-ecosystems represent the main land use in El Salvador; three quarters of the national territory would be occupied by agro-ecosystems (National Biodiversity Strategy, 2013). According to the above, the project traces through agro-ecosystems: coffee, annual crops associated with permanent crops, basic grains, cultivated pastures, sugar cane and discontinuous urban fabric (see Figure 4.2-30).



Source: Map of the own elaboration with base data of the Program of Visualization of Geographic Information of Environmental Assessment (VIGEA), MARN. June 23, 2013.

Figure 4.2-30 Land Use in the Project Influence Area

4.2.4 ***Aquatic Ecosystems***

4.2.4.1 Context

The slopes of the volcanic sierras of the Pacific slope of Central America make up generally small river basins with rivers and ravines of relatively short length. This region is known ictiogeographically as the Chiapan-Nicaraguan Province and is characterized as relatively poor with few species and low level of endemism (Bussing, 1998; Chicas Batres & Gonzálvez Leiva, 2009).

4.2.4.2 *Methodology*

Through a preliminary route of the TL proposed route, five representative rivers were chosen for the characterization of the aquatic ecosystems of the Project's area of influence (see Figure 4.2-31).

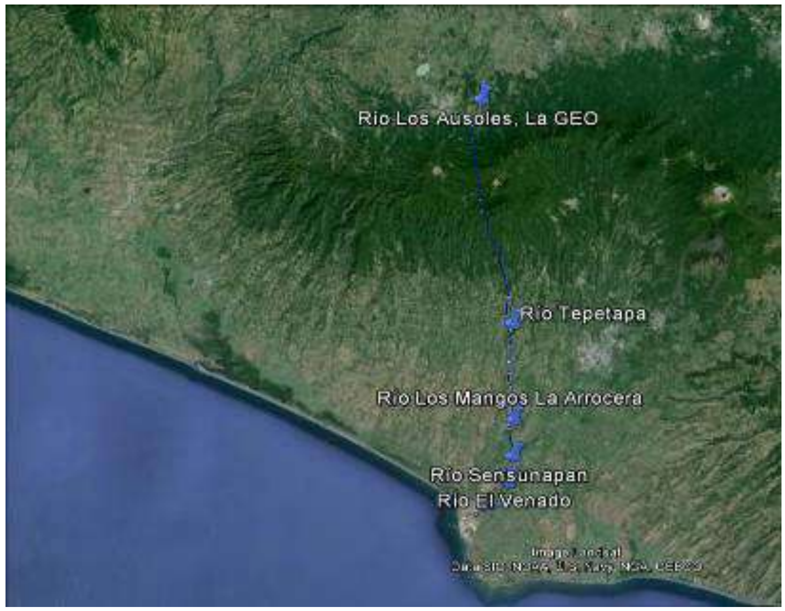


Figure 4.2-31 Identification of Sampling Sites in the Influence Area of the Project

The sampled sites are:

- **Site 1:** Los Ausoles River: 753 meters above sea level (masl), 13°43'0.7; 89°49'10.2"
- **Site 2:** Tepetapa River: 233 meters above sea level (masl), 13°44'01.2"; 89°47'40.4"
- **Site 3:** El Mango River – La Arrocera: 77 meters above sea level (masl), 13°39'12.8"; 89°47'36.2"
- **Site 4:** Sensunapan River: 73 meters above sea level (masl), 13°37'23.2"; 89°47'37.6"
- **Site 5:** El Venado River: 58 meters above sea level (masl), 13° 36'04.2"; 89°47'51.2"

The description of each of the sampled sites is presented in Appendix D.

Sampling of Aquatic Plants

Five sampling sites were selected along the project's area of influence, identifying for each sampling site a location representative of the conditions of the section of the river to be sampled. 50 m long sections were selected that reflect the floristic composition and abundance of species in moderate rapids, backwaters, pools and riparian conditions that generate shade and light zones.

In each site a non-destructive quantitative sampling was performed with the aid of a PVC tube quadrant of 50 cm per side with twelve replicates (Lot and Chiang, 1986); placing the quadrant on the aquatic vegetation at each sampling site (see Figure 4.2-32). The aquatic plants contained in each quadrant were reviewed and they were taken to a procedure of identification of species for later statistical analysis to estimate frequency and percentage of abundance.

Figure 4.2-32 Quadrant Used to Measure the Coverage of Aquatic Vegetation at Each Sampling Site

Fish Sampling

Firstly, representative sections of the river were identified approximately 50 m linear with typical features, considering fast, moderate displacement waters, backwaters and pools, and shady and luminous environments. For fish sampling, two sampling techniques were combined: 1) a total of 12 effective hauls were carried out in each section with cast-net of a 2.6 x 4.5 m wingspan, a 0.3 mm gauge monofilament thread and 1/4" mesh light (See Figure 4.2-33) and 2) Use of the "D" net, performing samplings of five minutes with three repetitions until covering all the micro habitat of the section of the river. After identifying and photographing the fish, they were returned to the aquatic ecosystem.

Figure 4.2-33 Cast-net Hauls for Sampling Fish

Sampling of Aquatic Macroinvertebrates

We proceeded to select a section of river not exceeding 50 m in length. The river section of the selected site was divided into three parts as closely adjacent as possible and in each of these parts was intensively sampled for a period of five minutes per sub-sample, for a total of 15 minutes for the three sub-samples.

Figure 4.2-34 Multihábitat Sampling of Aquatic Macroinvertebrates Through the Use of "D" Net

Sorting and Processing of Data Obtained in Field

All information obtained at the field level was duly ordered in Excel databases for analysis and interpretation. With the information recorded in the samples, it was possible to determine the abundance, richness and diversity value index, which were processed in Excel spreadsheets. For alpha diversity, the Shannon-Wiener and Simpson indices were used, depending on the data obtained. The absolute (n) and relative (%) abundance of aquatic organisms recorded in the study were determined. The description of the calculations is presented in Appendix D.

4.2.4.3 *Results and Discussion*

Estimating Diversity and Abundance of Aquatic Vegetation

The information reflects that there is little variability among the five rivers sampled, either in terms of the number of species or the number of plants found. The largest number of species with the highest number of plants was found in Quebrada El Venado (Site 5, see Table 4.2-9). This site has abundant sunlight and vegetation around the river (see Figure 4.2-35), unlike the other sites, which are totally shaded. The shade is usually limiting for the growth of some aquatic plants.

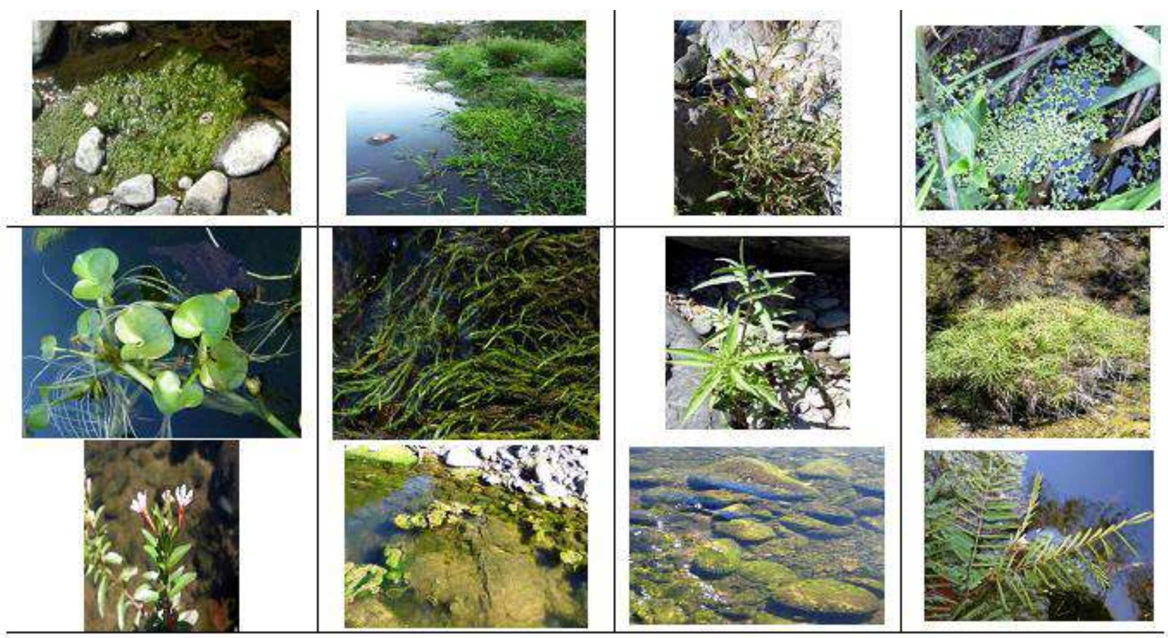
Table 4.2-9 Amount and Percentage of Dominance of Aquatic Plants Found at Each of the Sampling Sites of the Influence Area of the Project

Species	*Amount and Percentage of Plant Dominance by Species*									
	S1		*S2*		*S3*		*S4*		*S5*	
	#	%	#	%	#	%	#	%	#	%
Aeschynomene sensitiva	0	0	0	0	5	18	0	0	7	14
Cuphaea carthagenensis	0	0	4	8	0	0	2	17	0	0
Fontinalis bogotensis	0	0	1	2	9	32	3	25	2	4
Heteranthera reniformis	0	0	0	0	0	0	0	0	3	6
Lemna aequinoctialis	0	0	1	2	2	7	5	42	2	4
Eclipta prostrata	2	6	4	8	0	0	0	0	3	6
Ludwigia erecta	2	6	5	10	0	0	0	0	2	4
Cyperus alternifolius	3	9	4	8	1	4	0	0	2	4
Paspalum repens	4	12	4	8	3	11	2	17	8	16
Spirogyra sp and *Cladophora sp* (lama)	6	18	8	17	1	4	0	0	5	10

Species	Amount and Percentage of Plant Dominance by Species									
	S1		S2		S3		S4		S5	
	#	%	#	%	#	%	#	%	#	%
Spirogyra sp (Algae)	7	21	9	19	0	0	0	0	6	12
Cladophora sp (Algae)	10	29	8	17	7	25	0	0	10	20
Number of species per site	***7***	–	***10***	–	***7***	–	***4***	–	***12***	–
Total plants per site	***34***	–	***48***	–	***28***	–	***12***	–	***50***	–

Key: S= Sampling site; #= Amount/Number; %= Percentage

The most abundant plants and/or algae in each of the sites sampled with their respective percentage of predominance among plant organisms found (see Figure 4.2-35) were: in Site 1: *Cladophora sp.* (29%) and *Spirogyra sp*. (21%); Site 2: *Spirogyra sp.* (19%) and *Cladophora sp*. (17%); Site 3: *Cladophora sp* (25%); and *Aeschynomene sensitive* (18%); Site 4: *Lemna aequinoctialis* (42%) *Fontinalis bogotensis* (25%), *Paspalum repens* (17%) and Site 5: *Cladophora sp.* (20%) and *Paspalum repens* (16%). Table 4.2-10 details the species with their respective families.



Key: a) Spirogyra sp and Cladophora sp (lama), b) Paspalum repens, c) Ludwigia erecta, d) Lemna aequinoctialis, e) Heteranthera reniformis, f) Fontinalis bogotensis, g) Eclipta prostrata, h) Cyperus alternifolius, i) Cuphaea carthagenensis, j) Spirogyra sp. (algae), k) Cladophora sp. (algae) and l) Aeschynomene sensitiva

Figure 4.2-35 Different Kinds of Aquatic Plants and Algae Found in the Samples of the Five Rivers within the Area of Influence of the Project

Table 4.2-10 Species and Families of Aquatic Flora of the Rivers Sampling in the Trace of the Project

Species	*Families*
Aeschynomene sensitiva	Fabaceae
Cladophora sp. (Algae)	Cladophoraceae
Spirogyra sp. (Algae)	Zygnemataceae
Cuphaea carthagenensis	Lythraceae
Cyperus alternifolius	Cyperaceae
Eclipta prostrata	Asteraceae
Fontinalis bogotensis	Fontinalaceae
Heteranthera reniformis	Pontederiaceae
Lemna aequinoctialis	Lemnaceae
Ludwigia erecta	Onagraceae
Paspalum repens	Poaceae
Spirogyra sp. and Cladophora sp. (lama)	Cladophoraceae and Zygnemataceae

Diversity and Abundance of Fish

We found between 20 and 69 individuals in Sites 1, 2, 3 and 5, but only 3 individuals were found in Site 4. Two to six species were found at each site (see Table 4.2-11).

Table 4.2-11 Number of Species and Individuals of Fish Found at the Hydrobiological Sampling Sites of the Project Influence Area

Family	*Specie*	*Site 1*	*Site 2*	*Site 3*	*Site 4*	*Site 5*
Aroidea	*Ariopsis guatemalensis* (Blue sea catfish)	0	0	0	0	0
Cichlidae	*Amatitlania nigrofacsiata* (Convict cichlid)	6	1	22	0	20
Cichlidae	*Amphilophus macracanthus* (Blackthroat cichlid)	0	0	1	0	0
Cichlidae	*Cryptoheros cutteri* (Blue Eyed Cichlid)	0	0	0	0	9
Characidae	*Astyanax aeneus* (Banded tetra)	16	0	2	1	2
Poeciliidae	*Heterandria anzuetoi* (chimbolo)	10	8	33	2	3
Poeciliidae	*Poecilia gillii* (Mollies)	0	1	0	0	2
Poeciliidae	*Poeciliopsis pleurospilus* (Largespot livebearer)	0	10	11	0	16
Number of species per site		***3***	***4***	***5***	***2***	***6***
Total fish sampled per site		***32***	***20***	***69***	***3***	***52***

Estimates of the Diversity and Abundance of Aquatic Macroinvertebrates

The diversity of macroinvertebrates at the family level was similar among the five sampling sites, ranging from 22 to 24 families per site (see Table 4.2-12). However, an appreciable variation was found in the abundance of sampled individuals, with 672 organisms collected in Río El Mango-La Arrocera and only 122 organisms in Río Tepetapa, with between 195 and 290 in the other sites. In addition, dominant families vary at each site (see Table 4.2-12).

Table 4.2-12 Diversity and Abundance of Aquatic Macroinvertebrates of the Rivers of the Area of Influence of the Project

	Sampling places				
	Site 1	***Site 2***	***Site 3***	***Site 4***	***Site 5***
Ratings	***Río Los Ausoles***	***Río Tepetapa***	***Rio El Mango – La Arrocera***	***Río Sensunapán***	***Río El Venado***
Total families of aquatic macroinvertebrates	22	23	24	24	24
Total abundance of aquatic macroinvertebrate individuals	234	122	672	195	290
Relative abundance of aquatic macroinvertebrate individuals	0.88	1.05	1	0.95	1
Dominant aquatic macroinvertebrate families	Staphylinidae (37.18%), Leptohyphidae (17.52%), Hydropsychidae (11.54%)	Dryopidae (40.52%), Coenagrinidae (8.62%), Leptophlebiidae (7.76%), Hebridae (6.90%)	Hydropsychidae (27.98%), Gerridae (12.05%), Philopotamidae (10.12%), Leptohyphidae (9.97%), Dryopidae (8.78%), Baetidae (5.65%), Elmidae (5.51%)	Veliidae (36.92%), Caenidae (22.05%), Leptohyphidae (10.77%), Baetidae (7.69%), Coenagrionidae (3.08%)	Veliidae (20.00%), Hydropsychidae (15.17%), Calopterygidae (10.69%), Gomphidae (6.55%), Leptophlebiidae (6.55%)
Shannon Index H[a]	**2.21**	**2.29**	**2.45**	**2.08**	**2.65**
Simpson Index	***Dominance***	***0.19***	***0.2***	***0.13***	***0.21***
	Diversity	***0.81***	***0.8***	***0.87***	***0.79***

Key: Shannon Index H[a]: The value of the index is normally represented as H and in natural ecosystems varies between 0 and 6. The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1.

4.2.5 ***Protected Natural Areas and Fragile Areas***

4.2.5.1 Delimitation of Protected Natural Areas, Buffer Zones, Areas of Influence and Areas of Conservation

The area of the Project crosses in the northern part the Apaneca-Ilamatepec Biosphere Reserve which has seven core zones, with different conservation objectives, represented ecosystems and extensions. Los Volcanes Complex with 2,185 ha is the largest protected area of the Apaneca Biosphere Reserve - Ilamatepec and has an approved Management Plan within the Biosphere Reserve. In 2003, and according to the Management Plan (MARN - AECI, 2003), it was assigned the category of National Park. It has two main objectives: the protection of natural resources and access by the public for recreational purposes.

There are two bodies of water that are national assets established as protected natural areas of the state. The land areas bordering these bodies of water are also protected areas, but the territory is owned by the Municipal Governments. The body of water and its basin form part of the core areas of the Biosphere Reserve. They are Laguna Las Ninfas with 124 ha, and Laguna Verde with 115 ha.

The remaining three protected areas are small patches of remnant ecosystems, surrounded by shaded coffee plantations. These protected natural areas, which constitute the terrestrial ecosystems that surround Laguna Las Ranas, a small body of water in the north-central area of the Biosphere Reserve in the vicinity of Laguna Las Ranas; are the following: 1) Buenos Aires and El Carmen of 66 ha, with remnants of evergreen forest and marshy meadows surrounding Laguna Las Ranas; 2) San Francisco El Triunfo with 35 hectares of evergreen forest, and 3) San Rafael Los Naranjos, a small patch of evergreen forest of 38 ha, located a little further away from the body of water (UNESCO, 2007a) (see Figure 4.2-36).

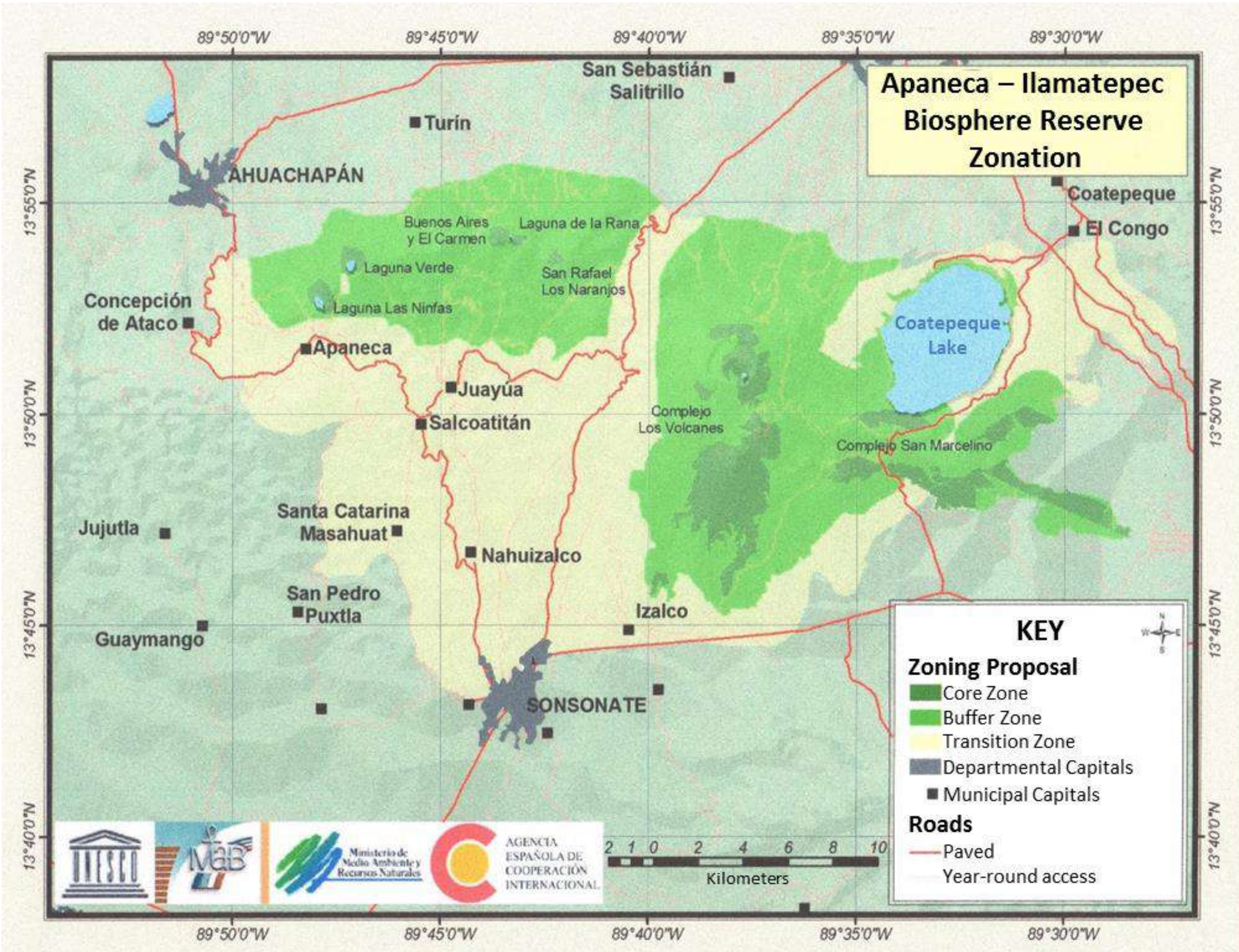


Figure 4.2-36 Zonation of the Apaneca Biosphere Reserve - Ilamatepec

The buffer zones are shaded coffee plantations (74%), aquatic ecosystems (9%) and natural terrestrial ecosystems (10%). Considering the portions of plantations and agroforestry systems, 85% of the buffer zone area maintains a forest structure that favors the reduction of the edge effect on the core areas of the Reserve and the connectivity of the natural ecosystems that these contain (UNESCO, 2007a).

In transition areas, as in buffer zones, the landscape matrix is shaded coffee plantations that account for 68% of the area in transition zones. Except for small spaces of non-interconnected gallery forests, there are no remnants of natural forests in this sector. Almost 12% is destined to crops of basic grains, and it is in this sector that the most important settlements are located covering 3% of the area of this zone.

The Protected Natural Area closest to the trajectory of the transmission line is Laguna de Las Ninfas, passing this approximately 1.1 km west-northwest of the protected area.

South of Acajutla, the northwestern boundary of "Complejo Los Cobanos" Protected Natural Area, which protects coastal and marine habitats, is located about 3.8 km south of the last TL tower.

4.2.5.2 *Specific Location and Boundaries of Protected Natural Areas and Other Fragile Areas*

TL traverses the Apaneca - Ilamatepec Biosphere Reserve (AIBR) in two sectors: 9.28 km between towers TP 14 and TP 30 and 0.89 km between towers TP 56a and TP 59 (see Figure 4.2-37).

In the southern sector, the TL would be within the Transition Area of the AIBR. In the northern sector, it would be within the Transition Area between TP 14 and TP 28 and within the Buffer Area between TP 28 and TP 39.

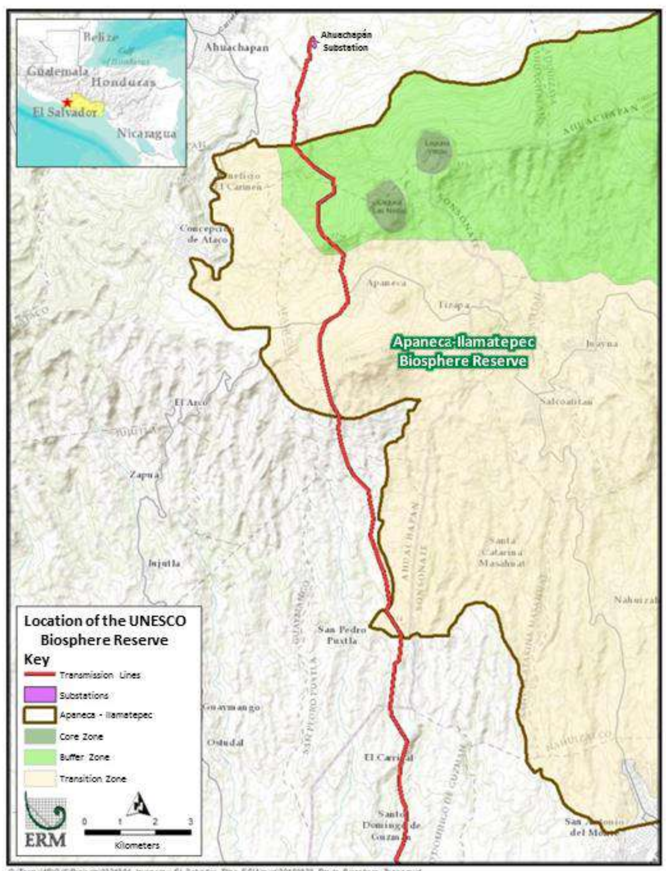


Figure 4.2-37 Zones of the Apaneca-Ilamatepec Biosphere Reserve and the Proposed Transmission Line

Although it has no legal status, we consider here the "IBA" as a fragile area. IBAs are internationally recognized for their biodiversity values but are not natural areas protected by law in El Salvador. The IBA "Los Cóbanos" is a terrestrial zone other than "Complejo Los Cóbanos" Protected Natural Area that protects coastal and marine habitats. According to BirdLife International (2016), this area of coastal plain (7,000 ha) contains fragments of savannas (*Crescentia alata*), secondary dry forest, gallery forest and freshwater marshes scattered in a grazing landscape. The fragments of dry forest contain a community of birds typical of the Arid Pacific Rim biome, and the gallery forests have colonies of the mexican cacique or aliamarilla (*Cacicus melanicterus*), the only population in all of El Salvador (BirdLife International, 2016), a kind of widespread distribution in Mexico with the category of Least Concern according to the IUCN. The TL crosses part of the IBA sector between the TP 136 and TP 145 + 100 m towers for a line distance of approximately 2,890 m, near the routes CA 12 and SON 05.

4.2.5.3 *Priority Status of Protected Natural Area and Ecosystem Services Provided*

According to the Enterprise for the Americas Initiative (EAI [3]), coffee plantations predominate in the vegetation of the transition zone of the AIBR and are part of the Mesoamerican Biological Corridor, whose function is to contribute to the flow of species of flora and fauna. The AIBR is one of two Biosphere Reserves in El Salvador.

The IBA "Los Cobanos" in one of 20 IBAs in El Salvador. It does not present populations of globally threatened species. In terms of ecosystem services, the IBA provides services associated with open grazing landscapes and agriculture with remnants of forests and natural savannas.

4.2.5.4 *Special Management Considerations Established for the Conservation of the Protected Natural Area and/or Fragile Area*

Within the AIBR and the IBA "Los Cóbanos", it will be sought to avoid and minimize the felling and clearing of natural vegetation in the right of way belt. In consultation with the MARN and the EAI, it will seek to reforest areas that reestablish the connectivity of the forest ecosystem

[3] http://www.fiaes.org.sv/apaneca-ilamatepec/

within the AIBR. These measures will result in net gains for the flora, fauna and ecological processes of these areas through an increase in the area of forest habitats and populations of threatened species.

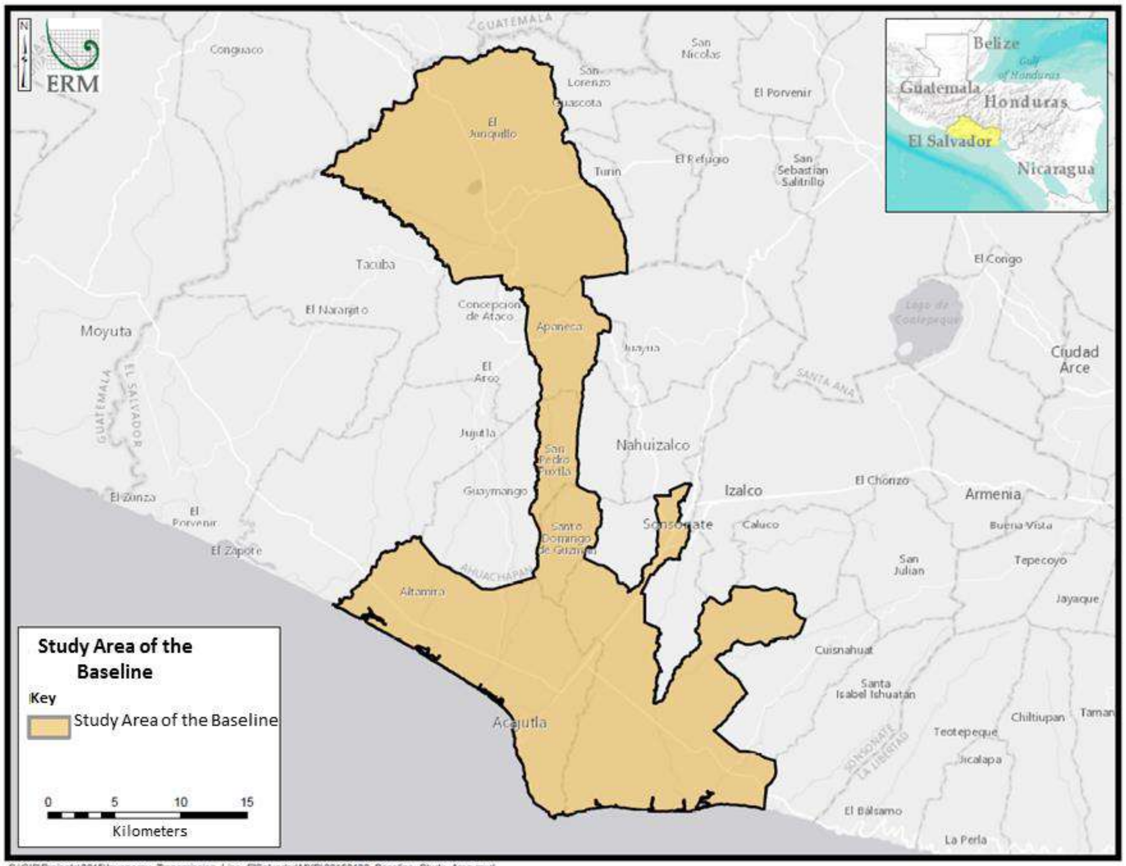
4.3 *SOCIOECONOMIC AND CULTURAL ENVIRONMENT*

4.3.1 *Social Actors*

The Project carried out activities of identification and mapping of the social actors relevant to the Project, as well as those that have interest or influence in the Project. Those who have representations or actions in the area of influence were mapped and with them were carried out semi-structured interviews, participatory rural diagnostic workshops and focus groups. The section below explains the methodology used and a detailed description of the process of identification and relationship with social actors is presented in *Section 6 - Citizen Consultation*.

4.3.2 *Introduction*

This section describes the socio-economic conditions in the Project's area of study. The social and economic baseline focuses on the six municipalities within two departments within which the Project is located. The six municipalities are: Ahuachapán, Apaneca, San Pedro Puxtla, Acajutla, Sonsonate and Santo Domingo de Guzmán. These municipalities are within the departments of Ahuachapán and Sonsonate. Acajutla and San Pedro Puxtla are the largest populated centers in the study area. See Figure 4.3-1 for more information on the study area.



Source: ERM, 2016

Figure 4.3-1 Baseline Study Area

The communities through which the Project passes in each municipality are listed in Table 4.3-1.

Table 4.3-1 Communities through which passes the Project

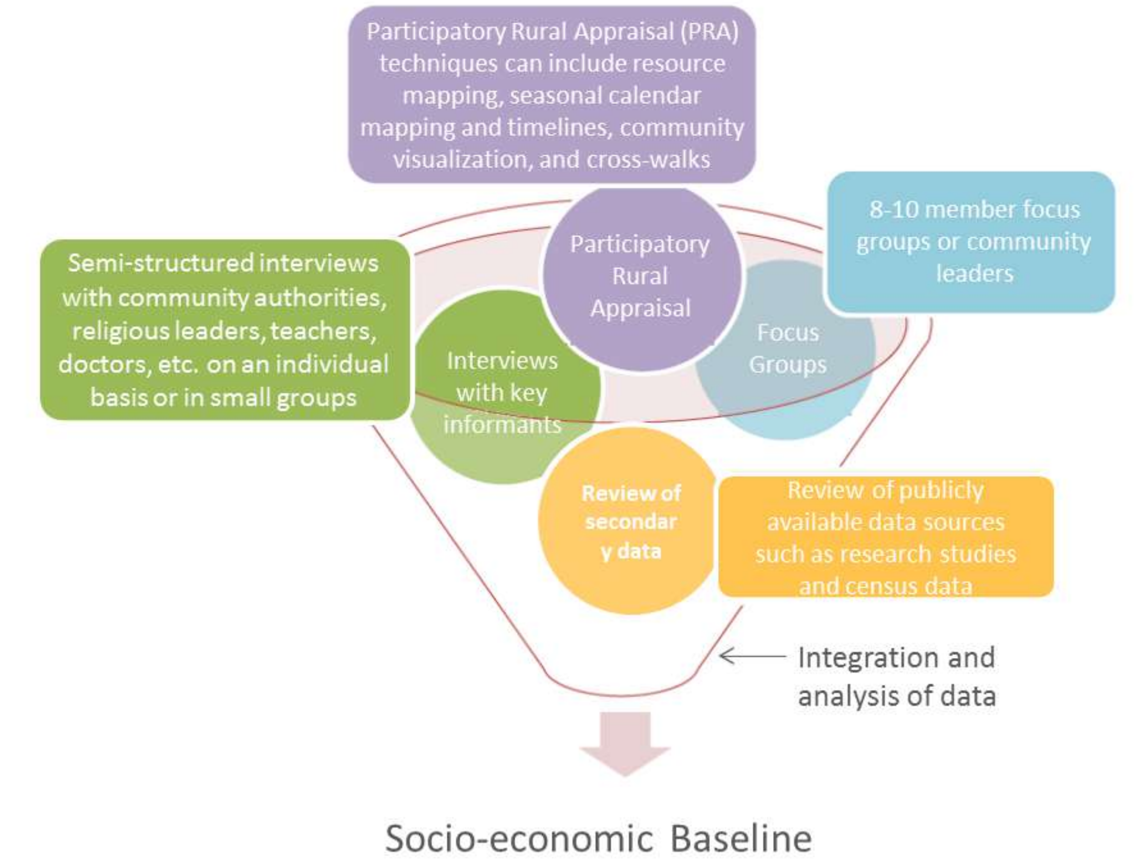
Municipality	*Communities*
Ahuachapán	• Cantón Santa Rosa Acacalco • Cantón Los Magueyes • Cantón El Barro: Bélgica, La Conejera, Barro Blanco and Agua Caliente • Lotificación Las Arboleda
Apaneca	• Cantón El Saltillal: Fincas El Saltillal, Finca El Naranjo • Cantón San Ramón: Finca Himalaya, El Paraje, Los Claveles (or as Sintegual) • Cantón San Ramoncito: El Cerro, San Francisco, Las Brisas, Sisiniapa • Cantón El Tronconal • Cantón Quezalapa: Cerro Grande, Sihuata • Cantón Tequendama
San Pedro Puxtla	• Finca Miramar • San Rafael, La Concepción

Municipality	*Communities*
	• Cantón El Durazno: Los Cocos, Los Limos, El Rosario • Finca Santa Elena 1 • Cantón Huachipilin: Las 4 Reinas, Las Tres Ceibas • Cantón Texispulco: The second
Santo Domingo de Guzmán	• Cantón El Carrizal: El Camalote, Tepechapa • Cantón El Caulote: Portion 2, Las Cruces, Sesecapa • Los Arcos, La Barranca • Cantón El Zope • Cantón Las Tablas
Sonsonate	• Cantón: El Carrizal • Cantón Las Tablas: Hacienda Santa Clara, Caserío La Barranca • Cantón El Coyol
Acajutla	• Hacienda El Coyol • Hacienda Jordania • Cantón San Julián: Hacienda San Jorge, Kilo 5, Hacienda Kilo 5, Lotificación El Corralón

Source: ERM, 2016

4.3.3 *Methodology*

The baseline of socioeconomic factors was developed using mixed methods (see Figure 4.3-2). The approach emphasized the convergence of diverse sources of information, each with its individual strengths and limitations.



Source: ERM, 2016

Figure 4.3-2 Methods of Data Collection

Table 4.3-2 lists the departments, municipalities, populations and communities in the Project study area and indicates the sources of data and methods used in each.

Table 4.3-2 Methods of Collecting Primary Information Employed in the Project Area

Municipality	*Focus Groups*	*Number of Interviews with Key Informants*	*Participatory Rural Diagnostic Workshops*	*Impact Workshops*
Department of Ahuachapán				
Ahuachapán		21	1	1
Apaneca		4	1	1
San Pedro Puxtla	1	4	1	1
Department of Sonsonate				
Acajutla		10	1	1
Santo Domingo de Guzmán		8	1	1
Sonsonate		7	1	1
Total	***1***	***54***	***6***	***6***

Source: ERM, 2016

4.3.3.1 *Interviews with Key Informants*

Interviews were conducted with key informants in order to gain a better understanding of the issues that demanded greater knowledge. These interviews were conducted with community leaders, municipal officials, doctors, priests and teachers, among others. The information obtained from these interviews complemented the results of household surveys, since they provided more integrated perspectives on the conditions in the municipalities, often focusing on specific topics (eg health, transportation, education).

The consultant team conducted 54 interviews with key informants. See *Section 4.3.1, Social Actors*, for more information and Appendix E, Focus Group Minutes and Key Informant Interviews, to learn the documentation of interviews with key informants.

4.3.3.2 *Participatory Rural Diagnosis (PRD)*

Three PRD workshops were held. The general objective of the PRD was to obtain information about the community through a representative group from each community. Through this exercise, we sought to obtain firsthand information on the socio-economic and ecological situation of the communities. In addition, it sought to identify development opportunities in the communities, so that the Project could begin to define its social investment program.

4.3.3.3 *Focus Groups*

Focus group sessions were held to better understand the views, concerns and priorities of specific groups that could be affected by Project activities.

4.3.4 ***Political-Administrative Division in the Study Area***

The departments of Ahuachapán and Sonsonate are located in the western part of the Republic of El Salvador (see Figure 4.3-3). The Department of Ahuachapán has an extension of 1,239,60 km² and limits to the north and west with the Republic of Guatemala, the northeast with the department of Santa Ana, the east with the department of Sonsonante and the south with the Pacific Ocean.

Source: SNET, 2016

Figure 4.3-3 Political-Administrative Division of El Salvador

The department has 12 municipalities: Ahuachapán, Apaneca, Atiquizaya, Concepcion de Ataco, El Refugio, Guaymango, Jujutla, San Francisco Menéndez, San Lorenzo, San Pedro Puxtla, Tacuba and Turin. The three municipalities that are within the area of influence of the Project are: Ahuachapán, Apaneca and San Pedro Puxtla (see Figure 4.3-3).

The Department of Sonsonate covers an area of 1,225.77 km2 and is bordered to the north and west by the department of Ahuachapán, to the north by the department of Santa Ana, to the east by the Department of La Libertad, and to the south by the Pacific Ocean. The department has 16 municipalities: Acajutla, Armenia, Caluco, Cuisnahuat, Izalco, Juayúa, Nahuizalco, Nahuilingo, Salcoatitan, San Antonio del Monte, San Julián, Santa Catrina Masahuat, Santa Isabel Ishuatán, Santo Domingo de Guzmán, Sonsonate and Sonzacate. The three municipalities that are within the area of influence of the Project are: Acajutla, Santo Domingo de Guzmán and Sonsonate (see Figure 4.3-4).

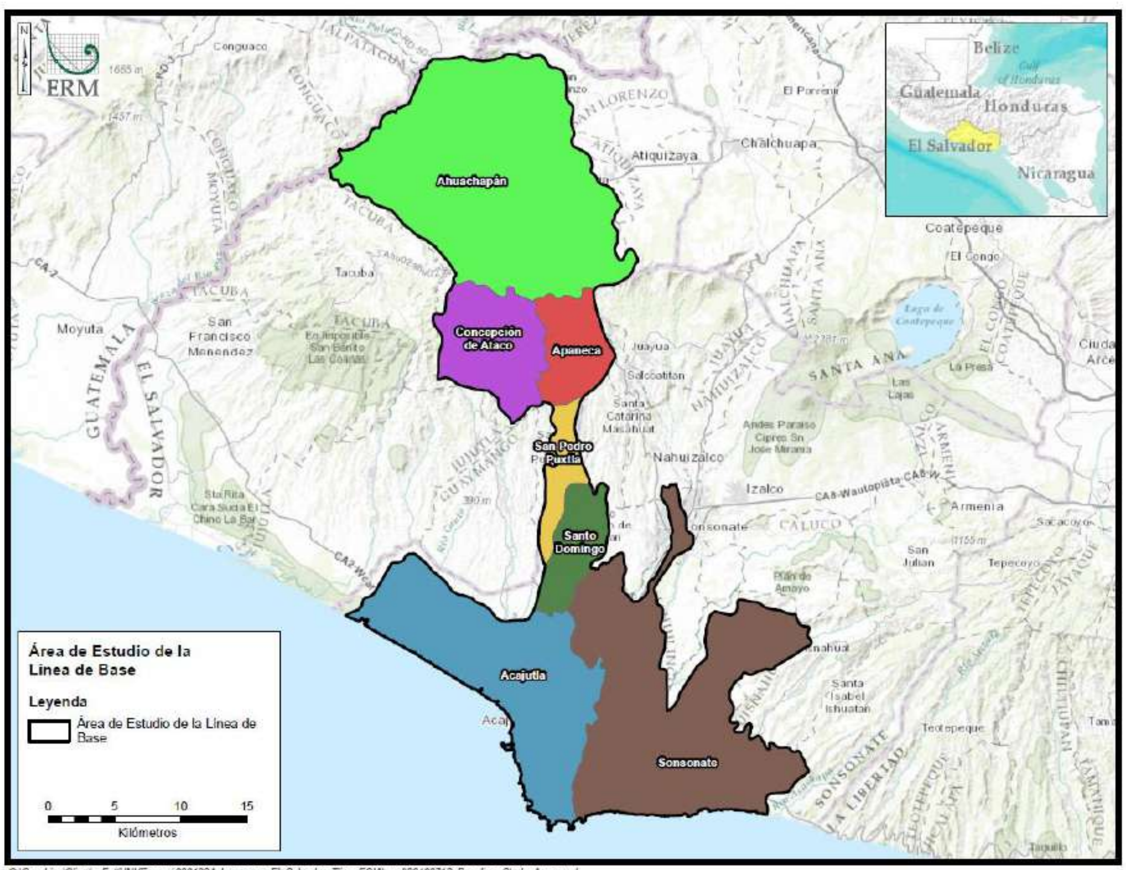


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Figure 4.3-4 Municipalities in the Area of Influence

4.3.5 *Population and Demography*

4.3.5.1 Population and Growth Trends

According to the last census of 2007, the population of El Salvador is 5,744,113 inhabitants. According to projections made by the General Directorate of Statistics and Censuses (DIGESTYC), it is estimated that in 2016 the total population of the country will be 6,520,675 inhabitants. The average annual growth rate for El Salvador was 0.3% for the period 2011-2015 (IBRD 2015); In line with the projected decline in the overall fertility rate of 2.5 children per woman in the period 2003-2008 (FESAL 2008) to 1.87 children per woman in the period 2015-2016 (DIGESTYC 2014) . El Salvador is considered an expulsion country, confirmed by the total population born in El Salvador and registered in the US, which increased from 787,711 in 2000 to 1,146,688 in 2010 (DIGESTYC, 2014). See Section 5.4.5.8 Migration for more information on national and departmental migration.

The population density in El Salvador is 304 inhabitants per km2. 62.3% of the population are in the urban area and 37.7% in the rural area (EHPM, 2015). There are departments that concentrate large population groups (such as San Salvador, La Libertad, Sonsonate, Santa Ana and San Miguel) and others that are sparsely inhabited (such as Cabañas, San Vicente, Morazán and Chalatenango). 27.5% of the country's total population (EHPM, 2015) is concentrated in the Metropolitan Area of San Salvador (AMSS).

Life expectancy at birth has been steadily rising and, according to the most recent projections, is estimated to be 66.5 years for men and 75.9 for women (DIGESTYC 2014). The infant mortality rate is 23.0 of deaths of children under one year for every 1000 live births for males and 18.8 for deaths of children under one year for every 1000 live births for females.

According to the 2007 census, the population of the department of Ahuachapán was 319,503 inhabitants, with a projected population of 359,418 inhabitants in 2016 (DIGESTYC 2014). The population growth rate in the period 1992-2007 was 1.38% (DIGESTYC, 2007), in line with the overall fertility rate of 2.5 children per woman (FESAL, 2008), which is one of the highest in the country (see Table 4.3-3).

Table 4.3-3 Population for Department and Municipality - Ahuachapán

Departments/ Municipalities	*Total*			*Area*					
				Urban			*Rural*		
	Total	*Men*	*Women*	*Total*	*Men*	*Women*	*Total*	*Men*	*Women*
Department of Ahuachapán	319,503	155,159	164,344	134,925	63,620	71,305	184,578	91,539	93,039
Municipality of Ahuachapán	110,511	52,808	57,703	63,981	29,898	34,083	46,530	22,910	23,620
Municipality of Apaneca	8,383	4,088	4,295	2,943	1,380	1,563	5,440	2,708	2,732
Municipality of San Pedro Puxtla	7,773	3,880	3,893	1,887	936	951	5,886	2,944	2,942

Source: DIGESTYC, 2007

The population density in the department of Ahuachapán is 258 inhabitants per square kilometer (km2); with 42.2% of the population in urban areas and 57.8% in rural areas (DIGESTYC, 2007). The municipality of Ahuachapán is the most populous municipality in the department. The municipality of San Pedro Puxtla is one of the least populated municipalities in the department.

According to data from the 2007 census, the population in the department of Sonsonate is 438,960 inhabitants, with a projected population of 501,780 inhabitants in 2016 (DIGESTYC, 2014). The population growth rate for the period 1992-2007 was 1.35% (DIGESTYC, 2008). Sonsonate had a total fertility rate of 2.5 children per woman in 2007 (FESAL, 2008) and 2.03 children per woman for the period 2015-2016 (DIGESTYC, 2014, see Table 4.3-4).

Table 4.3-4 Population for Department and Municipality - Sonsonate

Departments/ Municipalities	*Total*			*Area*					
				Urban			*Rural*		
	Total	*Men*	*Women*	*Total*	*Men*	*Women*	*Total*	*Men*	*Women*
Department of Sonsonate	438,960	212,252	226,708	261,348	123,954	137,394	177,612	88,298	89,314
Municipality of Sonsonate	71,541	34,117	37,424	49,129	22,943	26,186	22,412	11,174	11,238
Municipality of Acajutla	52,359	25,561	26,798	25,237	12,146	13,091	27,122	13,415	13,707
Municipality of Santo Domingo de Guzmán	7,055	3,398	3,657	2,277	1,054	1,223	4,778	2,344	2,434

Source: DIGESTYC, 2007

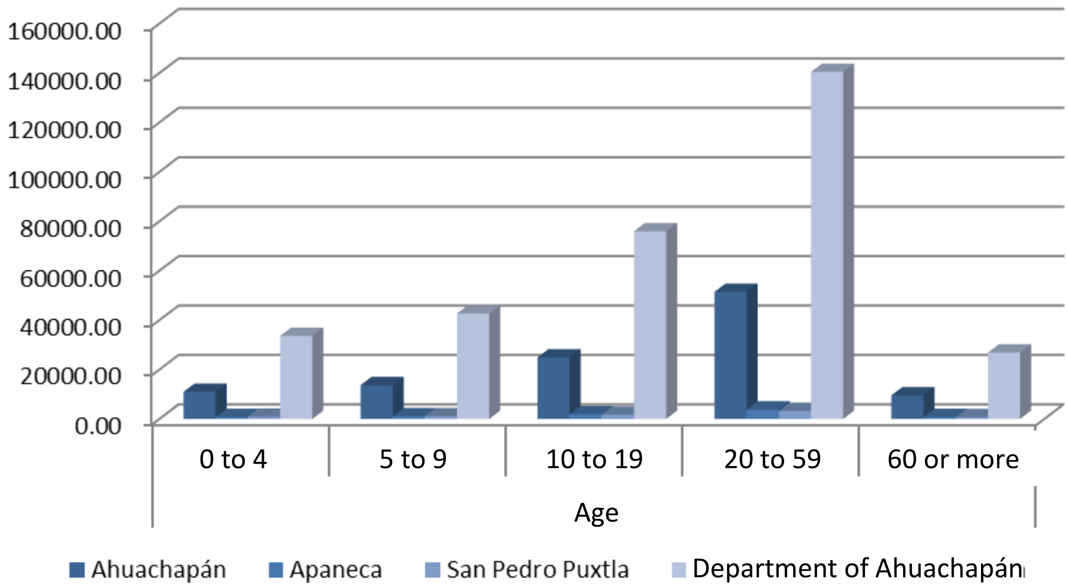
The population density in the department of Sonsonate is 358 inhabitants per km2, with 59.5% of the population in urban areas and 40.5% in rural areas (DIGESTYC, 2007). The municipality of Acajutla is the second most populous municipality in the department, after the municipality of Izalco. Salcoatitán is the municipality less populated in the department of Sonsonate followed by the municipality of Santo Domingo de Guzmán.

4.3.5.2 Distribution of Population by Sex and Age

The 2007 census reported a higher number of women (52.7%) than men (47.3%) (DIGESTYC, 2007), which is a change from the 1992 census which reported approximately the same number of men as women. This change may reflect the emigration of Salvadorans to the outside, which is greater among men. The change may also reflect increased male mortality due to armed conflict, suicides, motor vehicle crashes, occupational accidents, and other factors affecting males rather than females.

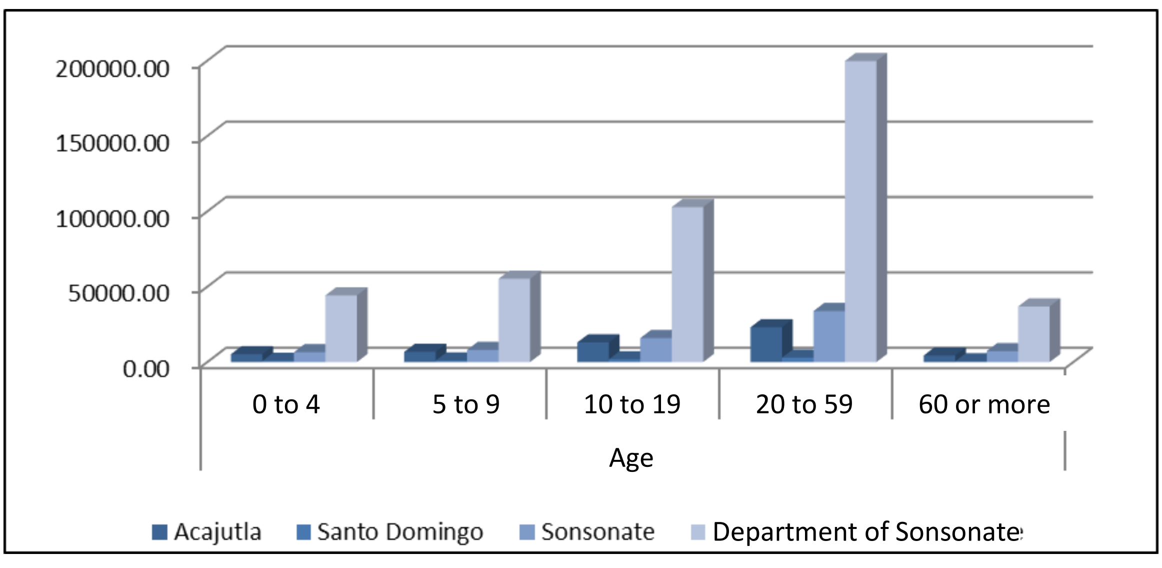
In relation to the distribution of the population by age, El Salvador continues to be a relatively young country, although the base of the pyramid has been reduced as a result of the decrease in the fertility rate. However, the vast majority of the population continues to be in the age range of 0 to 20.

Consistent with the results at the national level, the departments of Ahuachapán and Sonsonate reported a higher number of women than men in the 2007 population census. Likewise, these departments are mostly young areas with a large part of the population concentrated in the ages 0 to 19. See Figures 4.3-5 and 4.3-6 for more information on the distribution of the population by age in the different municipalities in the area of influence.



Source: Prepared by ERM with information from DIGESTYC, 2007

Figure 4.3-5 Distribution of Population by Age in the Department of Ahuachapán by Municipalities



Fuente: Prepared by ERM with information from DIGESTYC, 2007.

Figure 4.3-6 Distribution of Population by Age in the Municipalities of Acajutla, Santo Domingo and Sonsonate, Department of Sonsonate

4.3.5.3 Ethnicity

During the 2007 census, information was collected on the race and/or ethnic group of the Salvadoran population. This information was obtained from self-identification by individuals as belonging to an ethnic group. The vast majority of Salvadorans identify them as "mestizos" (see Figure 4.3-7). A small percentage of the population identified as "black" (0.13%) or belonging to an "ethnic group" (or indigenous people) (0.2%).

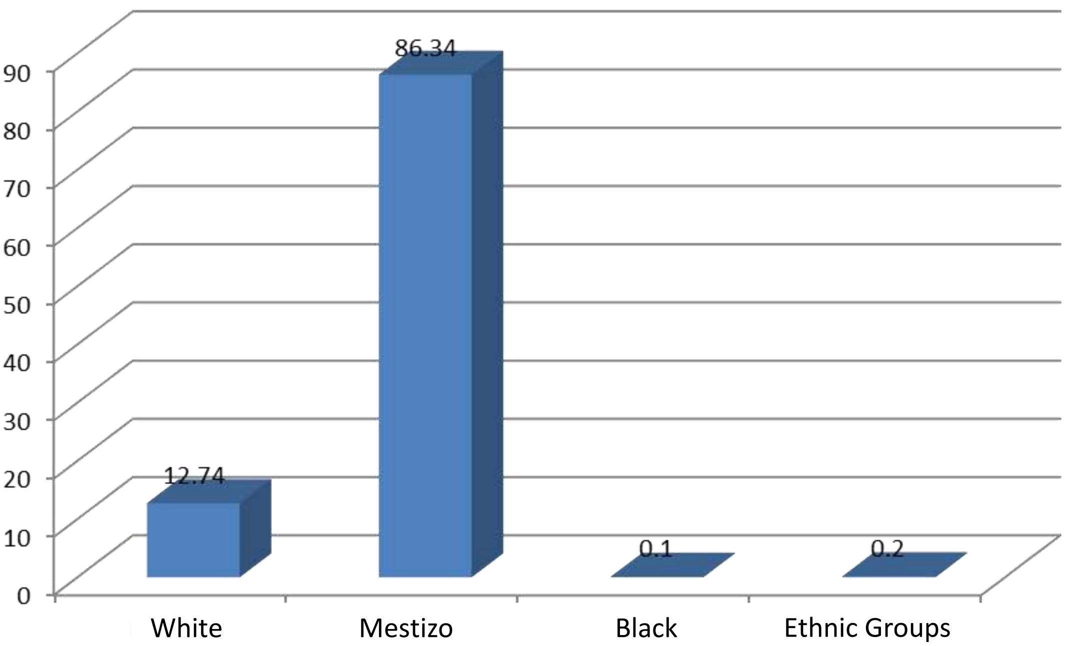


Figure 4.3-7 Percentage Distribution of Population by Race and Ethnic Group, 2007 Census

At the municipal level, the population is classified according to the data presented in Figure 4.3-8 below.

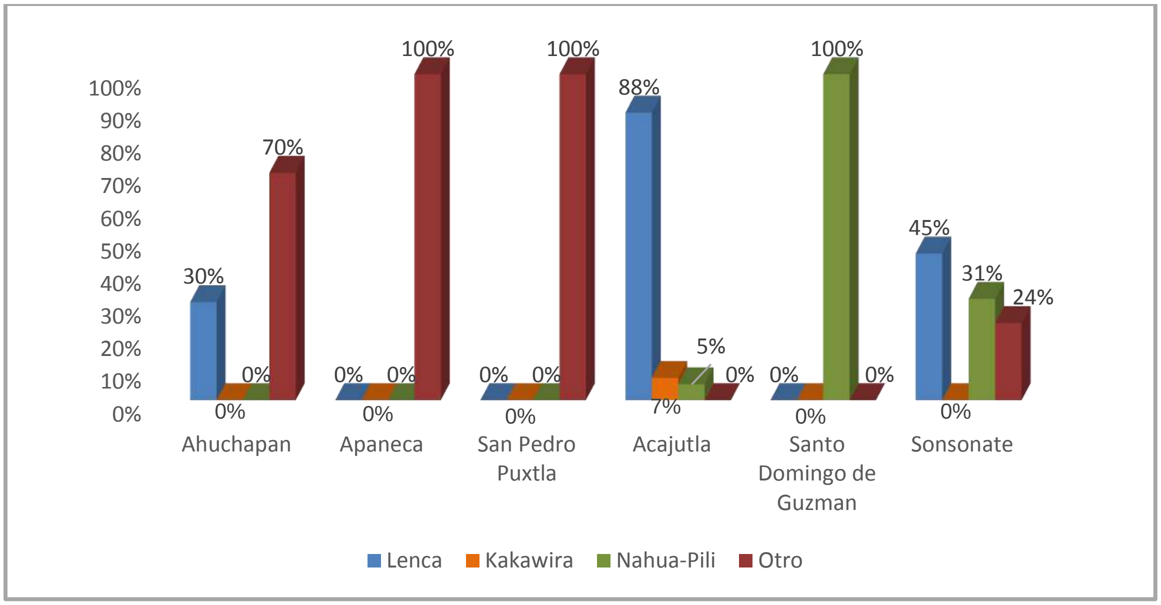


Figure 4.3-8 Percentage Distribution of Population by Race and Ethnic Group at Municipal Level, 2007 Census

4.3.5.4 *Indigenous Populations*

The categories of people are defined as ethnic groups that are denominated based on the perceptions of social experiences and ancestry, whose members belong to ethnic groups that consider themselves as participants in a history and cultural traditions that distinguish their group of others. The three largest indigenous peoples in El Salvador are: Lenca, Kakawira (also known as Cacaopera) and Nahua-Pipil. See Table 4.3-5 for more information on the number of people living in municipalities influenced by the indigenous population to which they belong.

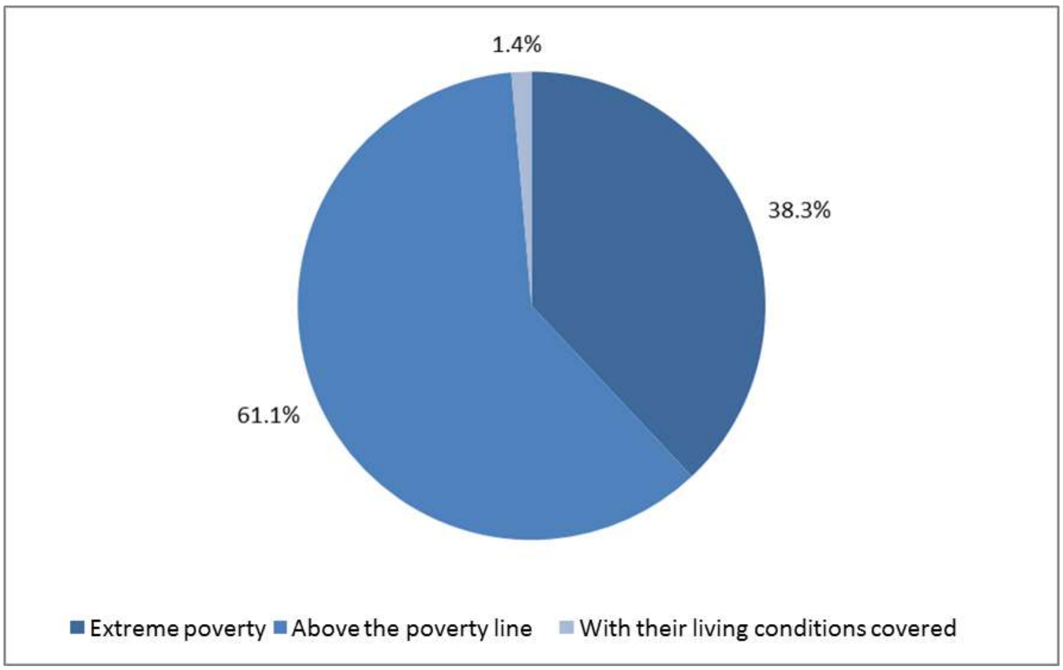
Table 4.3-5 Indigenous Population by Sex and Municipality

Departments/Municipalities	*Indigenous Population*											
	Lenca			*Kakawira (Cacaopera)*			*Nahua-Pipil*			*Other*		
	Total	*Men*	*Women*	*Total*	*Men*	*Women*	*Total*	*Men*	*Women*	*Total*	*Men*	*Women*
Department of Ahuachapán	44	23	21	2	1	1	17	9	8	99	51	48
Municipality of Ahuachapán	16	11	5	-	-	-	-	-	-	37	20	17
Municipality of Apaneca	-	-	-	-	-	-	-	-	-	1	-	1
Municipality of San Pedro Puxtla	-	-	-	-	-	-	-	-	-	1	-	1
Department of Sonsonate	207	102	105	13	9	4	1,403	688	715	321	156	165
Municipality of Acajutla	90	46	44	7	5	2	5	2	3	-	-	-
Municipality of Santo Domingo de Guzmán	-	-	-	-	-	-	8	7	1	-	-	-
Municipality of Sonsonate	91	45	46	-	-	-	63	29	34	48	27	21

Source: ERM 2016 based on 2007 census

In 2003, the World Bank estimated the percentage of indigenous people in El Salvador between 10 and 12% (IBRD, 2003). However, this percentage was not verified by a population census. The 2007 census reported that ethnic groups (or indigenous peoples) account for only 0.2% of the total population.

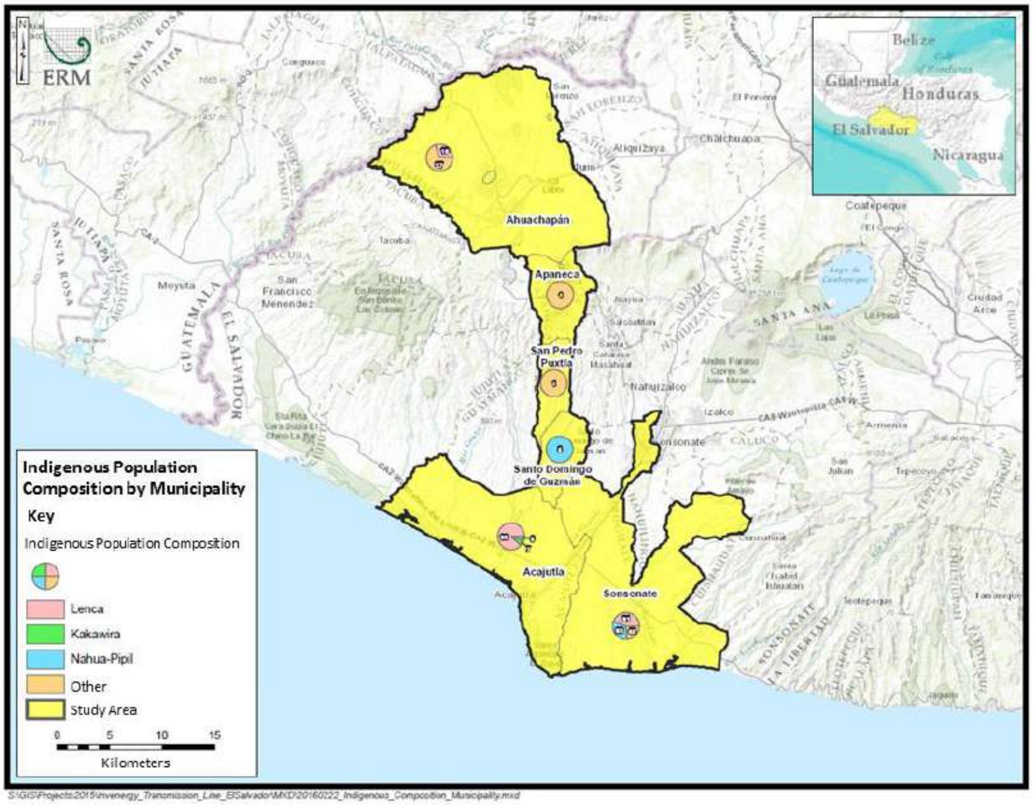
Indigenous peoples and communities in El Salvador live in extreme poverty (IBRD, 2003). 61.1% of indigenous peoples in 2003 were classified as living "in poverty" according to their working conditions, housing and their access to public services (IBRD, 2003, see Figure 4.3-9). The main source of income for these peoples is the subsistence agricultural economy, specifically the cultivation of corn and beans. Other sources of income include hourly work on coffee farms or as agricultural laborers during the growing season. A small number of indigenous people work as artisans.



Source: ERM developed with IBRD information, 2003

Figure 4.3-9 Socioeconomic Classification of the Indigenous Family

According to Table 4.3-5 a number of indigenous communities inhabit the municipalities in the study area; specifically the municipalities of Ahuachapán, Acajutla, and Sonsonate. The highest concentration of indigenous communities is in the municipality of Sonsonate (see Figure 4.3 10).



Source: ERM, 2016

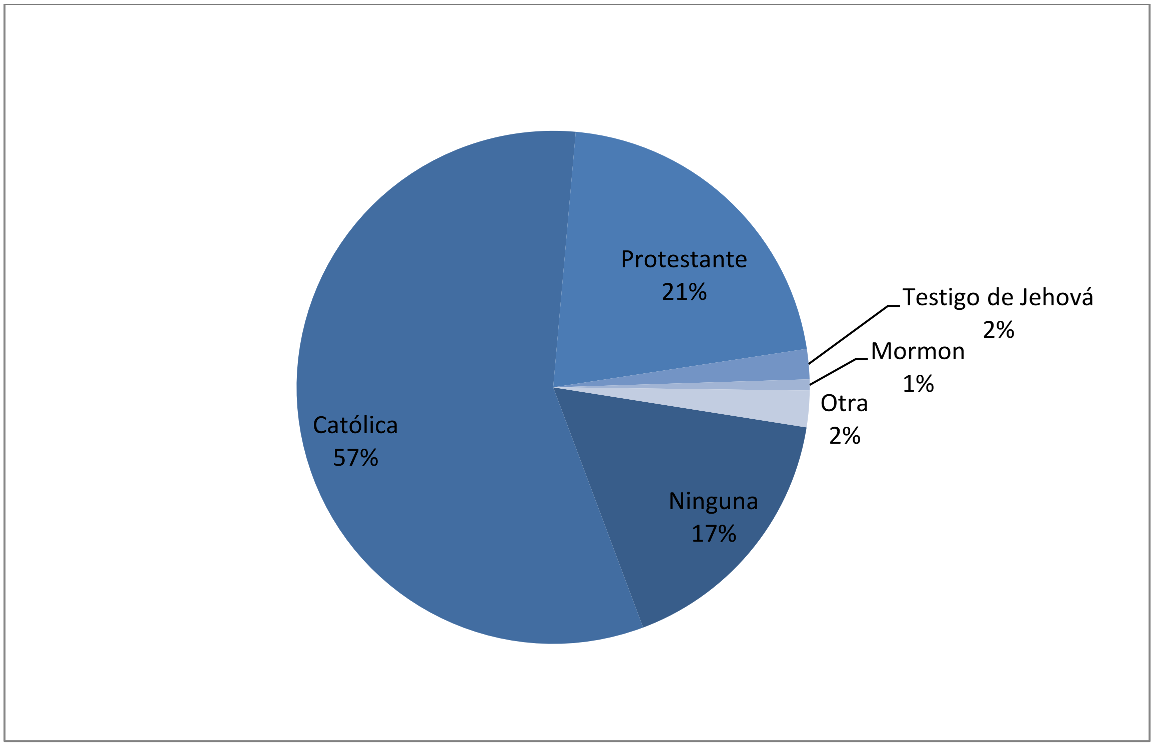
Figure 4.3-10 Map of the Indigenous Territories in the Area of Influence

4.3.5.5 Language

Spanish is the official language in El Salvador, with a small percentage of indigenous communities whose first language is Nahuat. This indigenous language survives only among some Nahuatl families mainly in the western part of the country. Between the Lencas and the Kakawira survive only a few words. However, there is evidence of the struggle for their language by Lencas and Kakawira who have used information from the results of anthropologists working in the region to develop worksheets for learning and spreading their language (IBRD, 2003).

4.3.5.6 Religion

The great majority of the inhabitants of El Salvador identify themselves as Catholics, followed by Protestants and those who do not profess any religion (see Figure 4.3-11).



Source: ERM developed with information from the CIA, 2003

Figure 4.3-11 Religion that Professes the Population in El Salvador, 2003

4.3.5.7 Level of Poverty and Human Development

The World Bank classifies El Salvador as a "middle-income" country. In 2015 the government adopted a new poverty measurement methodology called the Multidimensional Poverty Index (MPI) which considers social and economic factors (eg food insecurity, unemployment and exposure to environmental damage and risks, among others) to determine if a home is poor or not. According to the results of multidimensional poverty measurement, of the total Salvadoran households, 35.2% are multidimensionally poor (STTP and MINEC-DIGESTYC, 2015). This is equivalent to approximately 606,000 households, where about 2.6 million people reside.

The multidimensional poverty rate in rural areas is 58.5%, and in urban areas it is 22.5% (STTP and MINEC-DIGESTYC, 2015). At the national level, four departments recorded more than half of the households in situations of multidimensional poverty: La Paz, La Unión, Morazán and Ahuachapán.

The department of Ahuachapán reported a MPI of 52.7%, with 66.1% of poor households located in rural areas and 36% in urban areas. In the department of Sonsonate, the MPI was 41.5%, with 59.7% of poor households located in rural areas and 29.7% in urban areas (STTP and MINEC-DIGESTYC, 2015).

In 2013, the Human Development Index (HDI) in El Salvador was 0.662 points, an improvement over the year 2012, when it stood at 0.660 (UNDP, 2014). At the departmental level, the HDI is 0.694 in the department of Ahuachapán and 0.731 in the department of Sonsonate (UNDP, 2009). Even with an improvement in the national HDI, El Salvador remains one of the countries in the region with the lowest economic growth, and where more than half of the population that is of working age continues to be underemployed or unemployed (UNDP, 2014). See *Section 4.3.9.1 Economically Active Population*, for more information.

4.3.5.8 Migrations

El Salvador is the Central American country with more migrants per year. It is estimated that between 1970 and 1990 approximately 10% of the country's total population migrated (Funkhouser 1995). According to the percentage of the population of Salvadoran origin registered in other countries, it is believed that the number of annual emigrants continues to be significant, with an estimated 300 daily people leaving El Salvador (La Opinión 2013), although this number has not been verified by a population census. The country of preference for Salvadoran emigrants is the United States. Other popular destinations are Spain, Guatemala, and Mexico. According to the immigration figures estimated in the 2007 census, the vast majority of Salvadoran emigrants are men, although the last five years have seen an increase in the number of women and children emigrants due to gang violence and organized crime.

At the national level, the transfer of individuals from rural to urban areas has been increasing in search of better work and access to public services.

> *"There is a lot of migration from other areas. People come to have a safe place to live (Lourdes, Colon)."(Participatory Rural Diagnosis, Apaneca, June 2016).*

The departments of Ahuachapán and Sonsonate experience high levels of emigration (see Table 4.3-6). This Table 4.3-6 does not include individuals who emigrated to another country, therefore, it is considered that the number may be significantly higher. No updated information was found at the departmental level for the last eight years. However, during the participatory rural diagnoses developed in Ahuachapán and Apaneca, it was indicated that there was a flow of population favored by the greater security of these populations, and in the specific case of Apaneca, because of its location in the commercial transportation lines with Guatemala.

Table 4.3-6 Internal Migratory Balance: Ahuachapán and Sonsonate - 2007 Census

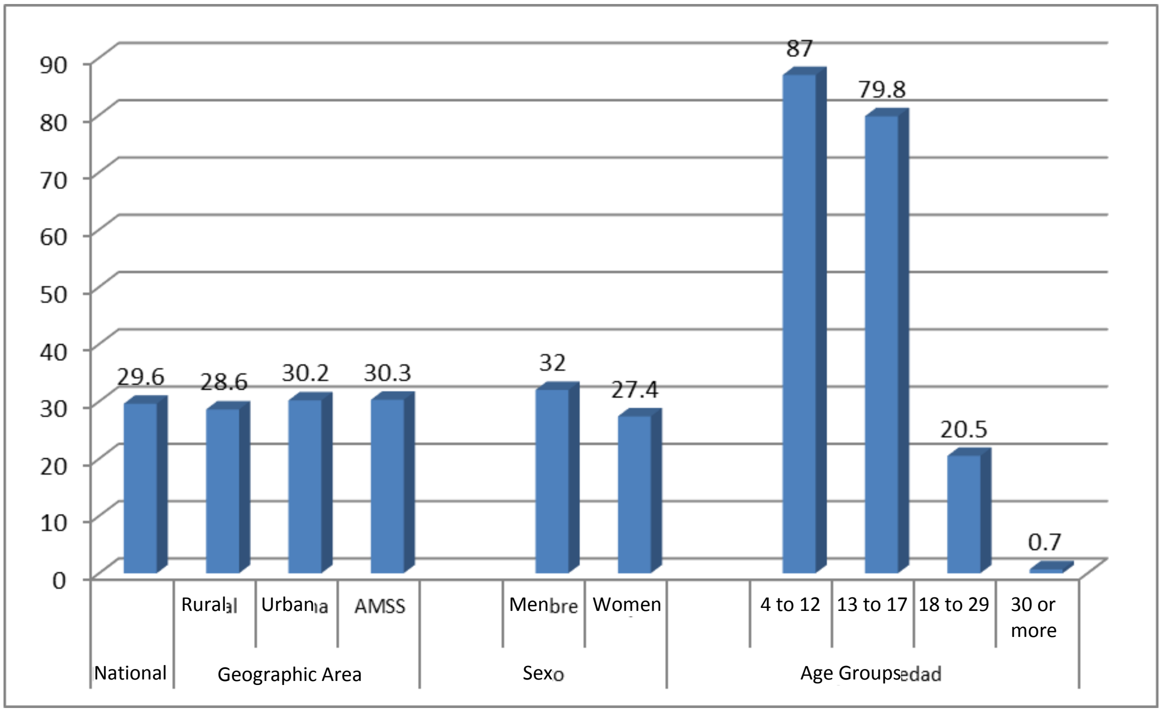
Departments	*Internal Migratory Balance*	*Foreign Population*	*Total Migrants*
Ahuachapán	-25,343	1,363	-23,980
Sonsonate	-9,808	1,170	-8,638

4.3.6 *Education*

4.3.6.1 Schooling and Attendance

Despite a substantial improvement in coverage, literacy levels and access to education centers between 2000 and 2014, education in El Salvador still shows a low level of schooling, high rates of grade repetition, high drop out rate (The higher the grade, the lower the number of students) and large gaps between urban and rural areas.

The school attendance rate of the population of four years and more for 2014 was 29.6%, which represents a total of 1,768,346 people attending a formal educational center in El Salvador (EHPM, 2012). There are gaps in school attendance rates by geographic area and sex. Figure 4.3-12 shows the school attendance rate of the population aged 4 and over by area, sex, and age group.

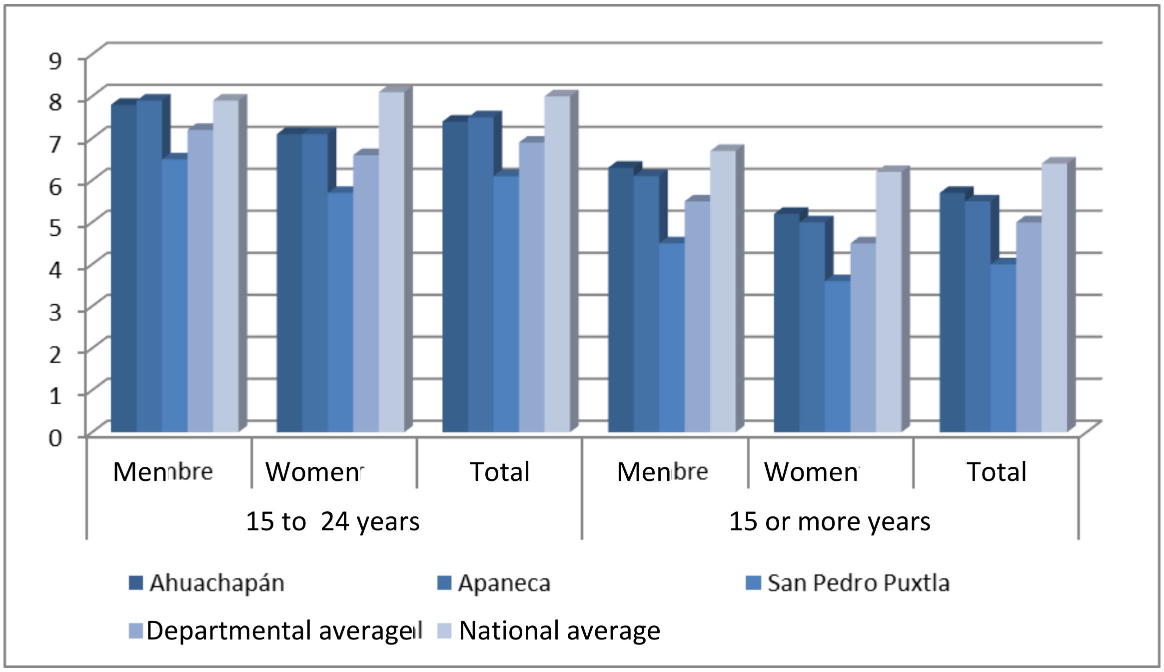


Source: ERM developed with information from EHPM, 2012

Figure 4.3-12 Rate of School Attendance of the Population of Four Years and More by Area, Sex and Age Groups in El Salvador

Between 2000 and 2014, there were great advances in the net rates of school attendance in the country, particularly with respect to the net attendance rate in the third cycle (from 70 to 90), which increased by 17.9 percentage points and with respect to the net high school attendance rate, which increased by 10.7 percentage points (EHPM, 2012). In addition, these increases show the almost absence of gender disparities, which means that there is a significant increase in the number of women attending one or more levels of education.

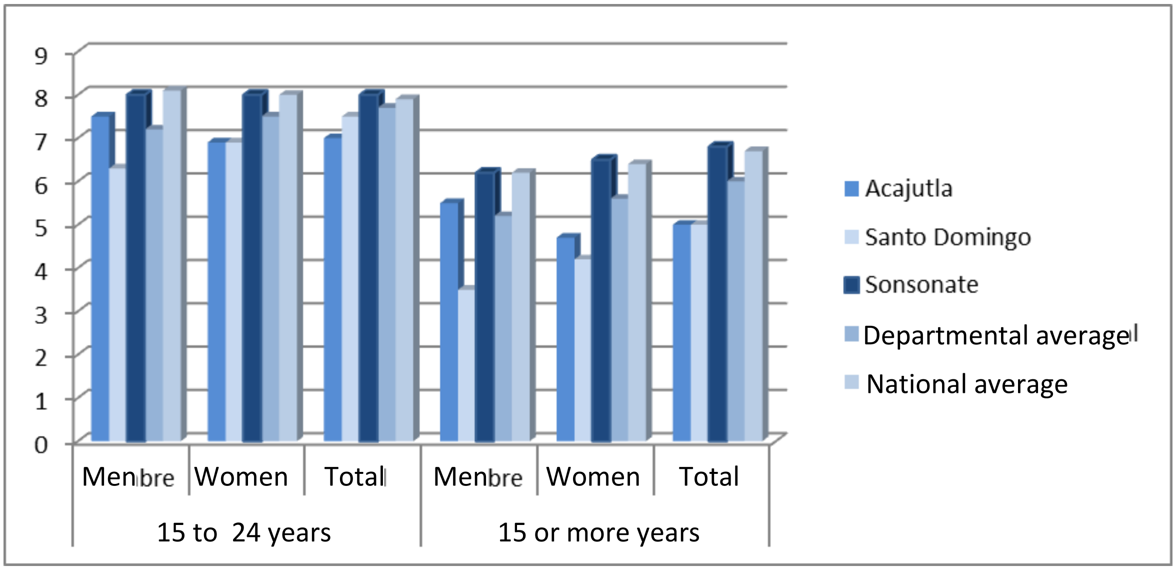
According to 2007 census data, the population aged 15-24 has a 6.9 grade level average, which means they are 1.5 degrees below the national average in that age range (MINED, 2009). This number is lower for women who reported in 2009 an average schooling of 6.6 versus an average schooling of 7.2 years reported by men. Figure 4.3-13 shows the average schooling in the department of Ahuachapán for the municipalities in the study area.

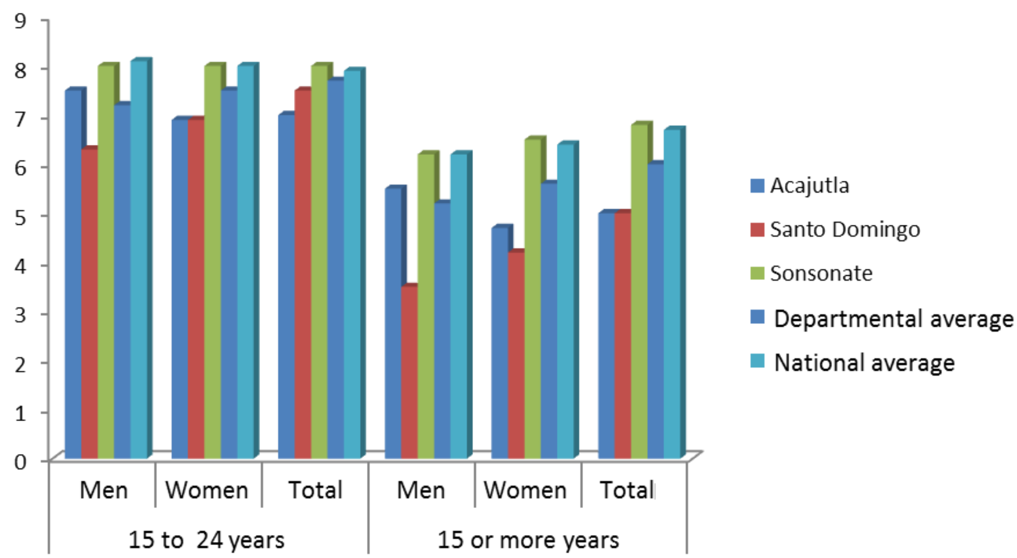


Source: Elaboration by ERM based on DIGESTYC data, 2007

Figure 4.3-13 Years of Average Schooling of the Three Municipalities in the Department of Ahuachapán, by Sex and Age, 2007

In the department of Sonsonate, the population aged 15-24 years of age has 7.5 degrees of schooling on average, which means they are 0.5 degrees below the national average in that age range (MINED, 2009). As in the case of the department of Ahuachapán, this number is lower in the case of women who reported, in 2009, an average schooling of 7.2 against 7.7 years reported by men. Figure 4.3-14 shows the average schooling in the department of Ahuachapán for the municipalities in the study area.





Source: Elaboration by ERM based on DIGESTYC data, 2007.

Figure 4.3-14 Years of Average Schooling of the three Municipalities in the Department of Sonsonate in 2007 according to Sex and Age Ranges

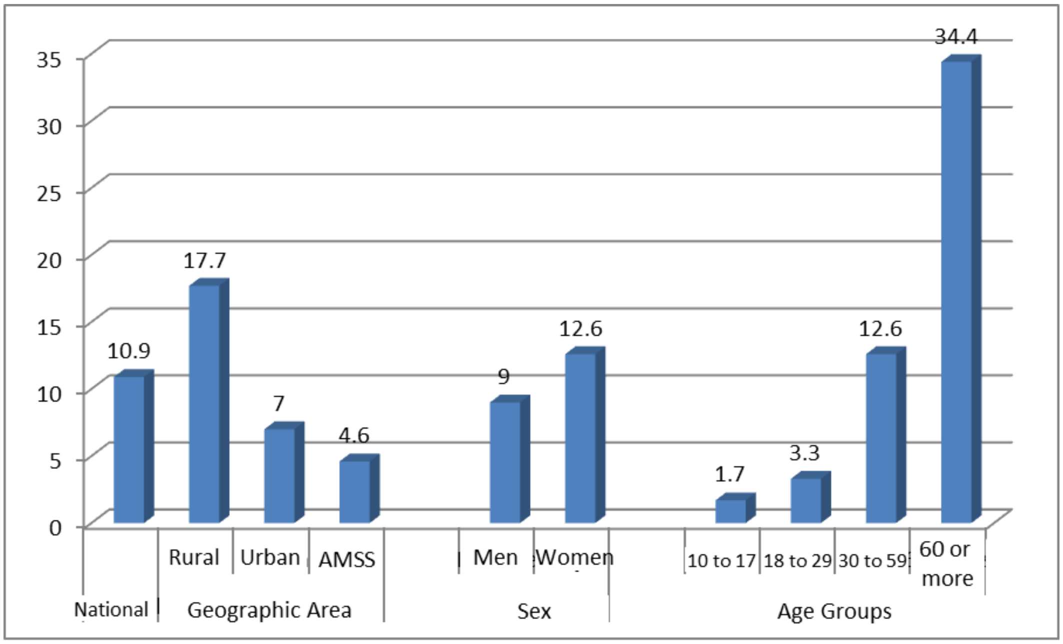
Data collected as part of the individual interviews, corroborated the existence of large gaps in school coverage between urban and rural areas. In the municipalities of Ahuachapán and Santo Domingo de Guzmán, the average transit time between home and school is between 30 and 40 minutes and the vast majority of schools are located in urban areas. All people consulted during the data collection process rated the education their children have access to as "good."

The three schools visited during the field work in the municipalities of Ahuachapán and Santo Domingo de Guzmán reported a dropout rate of 2 to 7 percent. The main causes of school dropout, identified in interviews with key informants were: change of address, delinquency and family breakdown. Based on the pedagogical services available in these two municipalities only the people in the municipality of Ahuachapán answered "yes" to the following question: do you consider that there are prepared professionals who will be able to benefit from the job offer generated by the Project? Those interviewed in Santo Domingo de Guzmán do not consider that residents of this municipality can benefit from the project's labor supply with the exception of some jobs that do not require specialization.

According to the EHPM of 2012, El Salvador needs to make a great effort and dedicate enough investment to prepare the young population of these municipalities, so that they can take advantage of the opportunities emanated from new economic activities and more lucrative jobs, based on the dynamics of Import and export of goods, and the provision of services.

4.3.6.2 Literacy and Education Level

The total illiteracy rate of the population aged 10 years and over in El Salvador is 10.9%. By sex, the illiteracy rate of the female population is 12.6%, while for male peers it is 9.0% (EHPM, 2012). There are also gaps in terms of geographic area of residence and age group (see Figure 4.3-15). Differences were also reported in the illiteracy rate among the different departments of the country.



Source: ERM developed with information from EHPM, 2012

Figure 4.3-15 Population Illiteracy Rates of 10 Years and More by Area, Sex and Age Groups - El Salvador

The department of Ahuachapán reported a high illiteracy rate, in relation to the national average, with a 13.6% illiteracy rate for the population aged 10 years and over (EHPM, 2012). This rate is 4.1 percentage points higher than was reported in the 2007 population census. The most recent information on illiteracy rates at the municipal level (see Table 4.3-7) corresponds to the 2007 population census. Both these numbers have certainly increased in the last eight years based on the new rate of illiteracy at the departmental level.

Table 4.3-7 Literacy and Illiteracy of the Department of Ahuachapán Year 2007, by Municipalities in the Area of Study and Age Ranges

	15 to 24 years				*15 or more years*			
	Literate		*Illiterate*		*Literate*		*Illiterate*	
Municipality	*Population*	*%*	*Population*	*%*	*Population*	*%*	*Population*	*%*
Ahuachapán	19,758	92.3	1,645	7.7	57,629	79.5	14,869	20.5
Apaneca	1,440	92.3	120	7.7	4,386	80.3	1,076	19.7
San Pedro Puxtla	1,372	89.1	167	10.9	3,373	70.2	1,430	29.8
Departmental Rate	**55,869**	**90.3**	**5,992**	**9.7**	**151,537**	**75.1**	**50,158**	**24.9**
National Rate	**894,564**	**93.3**	**64,268**	**6.7**	**2991,963**	**81.5**	**676,908**	**18.5**

Source: ERM based on DIGESTYC data, 2007.

The level of illiteracy is higher in women than in men. In the municipalities of Ahuachapán, Apaneca and San Pedro Puxtla both sexes reported, in 2007, illiteracy rates higher than the national average.

The department of Sonsonate reported an illiteracy rate of 12.1% among the population aged 10 years and over, a figure that is moderately high in relation to the national average (EHPM, 2012). This rate is 7.5 percentage points higher than in the 2007 population census. The most recent information on illiteracy rates at municipal level (Table 4.3-8) corresponds to the 2007 population census; therefore, these numbers have certainly increased in the last eight years based on the new rate of illiteracy at the departmental level.

Table 4.3-8 ***Literacy and Illiteracy of the Department of Sonsonate Year 2007, by Municipalities in the Area of Study and Age Ranges***

	15 to 24 years				*15 or more years*			
	Literate		*Illiterate*		*Literate*		*Illiterate*	
Municipality	***Population***	***%***	***Population***	***%***	***Population***	***%***	***Population***	***%***
Acajutla	8,323	91.1	813	8.9	24,780	77	7,306	22.8
Santo Domingo	1,168	92.1	100	7.9	2,848	69	1,269	30.8
Sonsonate	11,669	93.9	761	6.1	39,427	84	7,693	16.3
Departmental Rate	***70,668***	***92.5***	***5,723***	***7.5***	***217,620***	***79.4***	***56,440***	***20.6***
National Rate	***894,564***	***93.3***	***64,268***	***6.7***	***2991,963***	***81.5***	***676,908***	***18.5***

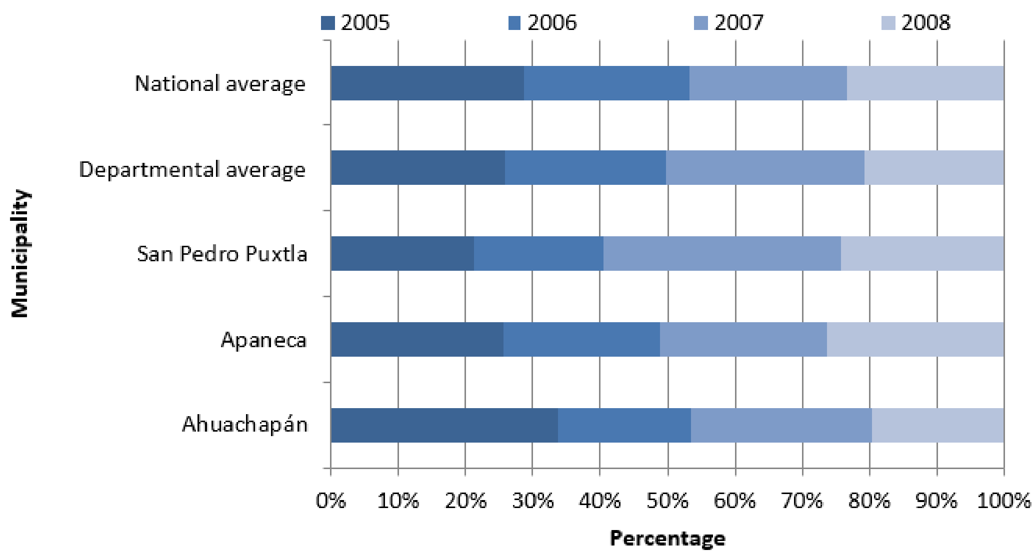
Source: ERM based on DIGESTYC data, 2007.

As in the department of Ahuachapán, illiteracy levels in the department of Sonsonate are higher in women than in men. Both sexes reported illiteracy rates higher than the national average in the three municipalities in the study area, although not at the same level as the department of Ahuachapán.

4.3.6.3 School Dropout Rates

The dropout rate in El Salvador is high relative to other countries in the Latin American and Caribbean region. 64% of young people enter secondary school in El Salvador, while the region's average is close to 89% (MINED, 2014). In 2008, only 60% of people between the ages of 20 and 24 completed at least nine years of education while 40% had at least 11 years of education. The high dropout rate has economic and social consequences in the country. For example, a considerable number of young people with no secondary education encounter difficulties in finding employment and usually end up working in the informal sector (MINED, 2014). The main reason for dropout in the last five years is delinquency, which has resulted in home and/or school changes which increase the chances of school dropout. At the departmental level, the most recent data correspond to 2009.

Traditionally, the dropout rate in the department of Ahuachapán is below the national average. The dropout rate of the traditional education system is higher in women than in men and more significant for those attending a public rather than a private school. Figure 4.3-16 shows the dropout rate for municipalities in the area of influence.



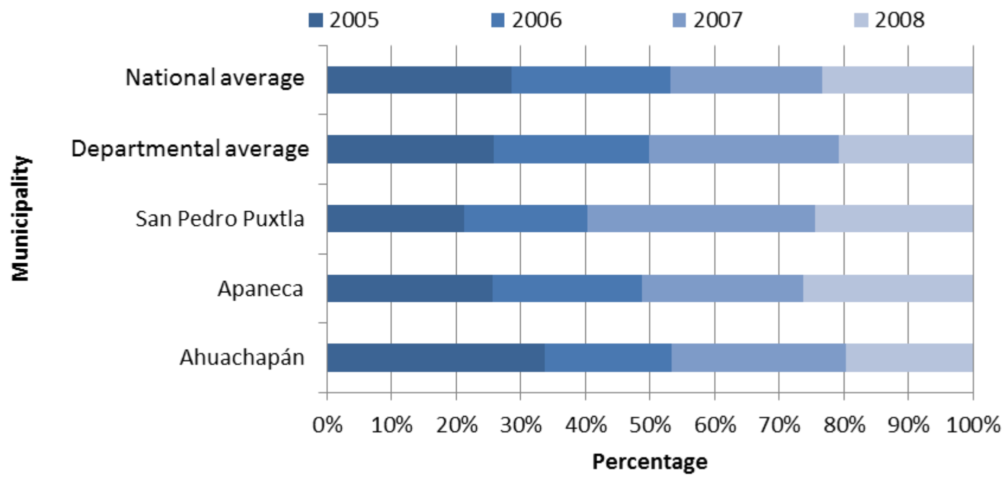
Source: Prepared by ERM with information from MINED, 2009

Figure 4.3-16 Percentage of Desertion of the Traditional Education System in the Department of Ahuachapán, by Municipality (2005 - 2008)

In the department of Sonsonate, the dropout rate is also below the national average. As in the case of Ahuachapán, the number of women dropping out of school is higher than the number of men and there is a lower number of school dropouts in those who attend private rather than public schools. During the participatory rural diagnosis, it was suggested that lack of access to educational institutions, and early pregnancy in some cases, were common causes of school dropout.

"There is enough desertion, there are families that have to move, and there is no university. When they finish, the young people go to Sonsonate or to San Salvador. "(Participatory Rural Diagnosis, Acajutla, June 2016).

Figure 4.3-17 shows the dropout rate for municipalities in the area of influence.

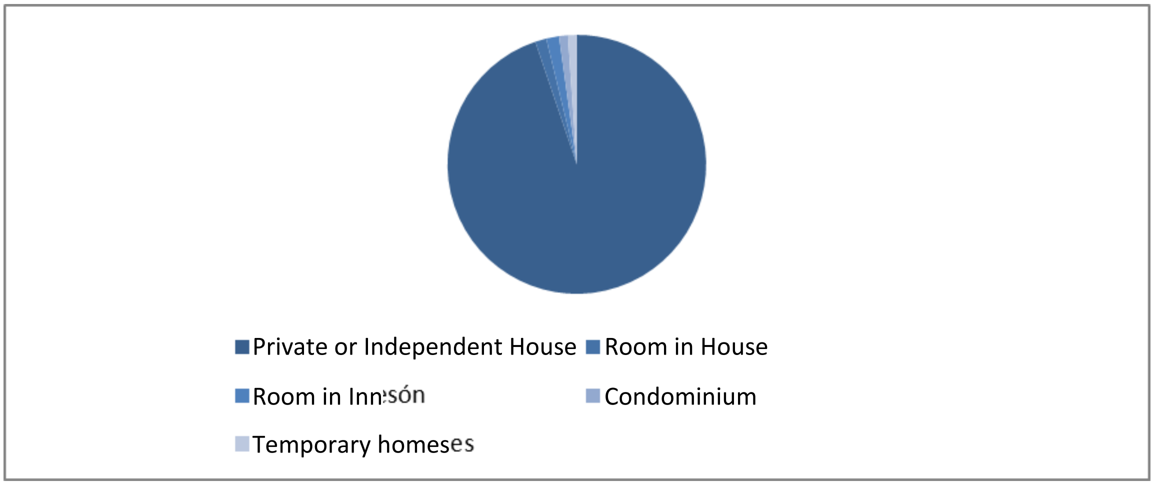


Source: Prepared by ERM with information from MINED, 2009

Figure 4.3-17 Percentage of Desertion of the Traditional Education System in the Department of Sonsonate, by Municipality (2005 - 2008)

4.3.7 *Housing*

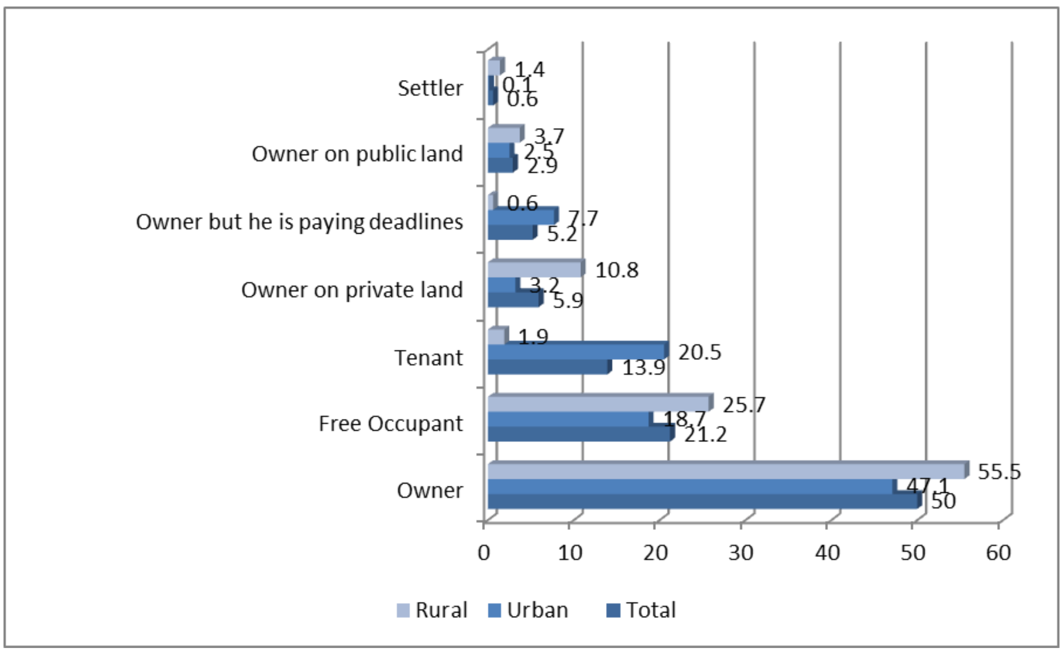
The number of households at the national level is 1,722,075 (EHPM, 2012). The majority of these households correspond to a private or independent house with a small percentage of households corresponding to a piece at home, piece in porterhouse and to condos. Also, a limited percentage of inhabitants reported living in temporary homes (for example, apartments, houses or makeshift ranches). According to data from the Social Mobility Survey (PNUD and ESEN, 2013), the rural population has fewer opportunities to improve their housing than the urban population (44% versus 61%). Figure 4.3-18 reflects the type of housing at the national level.



Source: EHPM, 2012

Figure 4.3-18 Type of Housing Nationwide, 2014

At the national level, more than half of the inhabitants own their homes (EHPM, 2015). Most homeowners who report ownership of their homes are located in rural areas. The number of free residents is also higher in rural areas. Figure 4.3-19 reflects households by tenure, by urban or rural area.



Source: EHPM, 2015

Figure 4.3-19 Percentages of Households by Type of Housing, According to Geographical Area, 2014

4.3.7.1 *Housing Characteristics*

At the national level, most homes have concrete walls, cement brick floors, and metal foil roofs. Variations in housing construction materials are significant between urban and rural areas. Specifically, housing in urban areas has more durable materials such as concrete walls and cement floors. Table 4.3-9 indicates the percentage and frequency, by materiality, of households at the national level.

Table 4.3-9 Materials Used for the Construction of Houses, by Department, 2014

Predominant Material		*Geographic area*					
		Frequency			*Percentage*		
		National	*Rural*	*Urban*	*National*	*Rural*	*Urban*
Walls	***Total***	***1722,075***	***609,310***	***1112,765***	***100***	***100***	***100***
	Concrete	1261,978	314,129	947,849	73.3	51.6	85.2
	Bahareque	47,763	34,520	13,243	2.8	5.7	1.2
	Adobe	259,345	174,386	84,959	15.1	28.6	7.6
	Wood	25,648	19,395	6,253	1.5	3.2	.6
	Metal Sheet	103,863	49,528	54,335	6.0	8.1	4.9
	Thatch or palm	5,187	4,930	257	0.3	0.8	0.0
	Waste materials	10,221	6,627	3,594	0.6	1.1	0.3
	Other	8,070	5,795	2,275	0.5	1.0	0.2
Floor	***Total***	***1722,075***	***609,310***	***1112,765***	***100***	***100***	***100***
	Ceramic brick	274,369	52,273	222,096	15.9	8.6	20
	Ladrillo de cemento	718,308	136,975	581,333	41.7	22.5	52.2
	Clay brick	6,968	4,444	2,524	0.4	0.7	0.2
	Cement	416,087	207,735	208,727	24.2	34	18.8
	Dirt	298,843	201,735	97,108	17.4	33.1	8.7
	Other	7,500	6,523	977	0.4	1.1	0.1
External Roof	***Total***	***1722,075***	***609,310***	***1112,765***	***100***	***100***	***100***
	Concrete slab	34,336	1,841	32,495	2.0	0.3	2.9
	Clay or cement roof tile	420,442	251,134	169,308	24.4	41.2	15.2
	Asbestos or cement fiber sheet	578,205	66,849	511,356	33.6	11	46
	Metal Sheet	684,542	286,301	398,241	39.8	47	35.8

Predominant Material		Geographic area					
		Frequency			Percentage		
		National	Rural	Urban	National	Rural	Urban
	Thatch or palm	1,638	1,379	259	0.1	0.2	0.0
	Waste materials	2,324	1,437	887	0.1	0.2	0.1
	Other	588	369	219	0.0	0.1	0.0

Source: EHPM, 2015

At municipal level, the municipalities of Apaneca and Acajutla have the highest percentage of houses with concrete walls (75 and 73.5% respectively). On the other hand, the municipalities of Santo Domingo de Guzmán and San Pedro Puxtla have the highest percentage of wood walls (50 and 60% respectively). The municipality of San Pedro de Puxtla also has the highest percentage of dirt floors (66.7%) followed by the municipality of Ahuachapán (34.5%). The municipality of Apaneca has the highest percentage of brick floors (58.3%) and most of the homes in the six municipalities have metal sheet roofs. Table 4.3-10 indicates the percentage and frequency, by materiality, of households at the municipal level.

Table 4.3-10 Materials Used for the Construction of Houses, by Municipality, 2014

Walls							
Municipality	*Concrete*	*Bahareque*	*Adobe*	*Wood*	*Metal Sheet*	*Thatch or Palm*	*Waste Materials*
Acajutla	73.52%	0.38%	12.91%	2.27%	9.86%	0.35%	0.00%
Ahuachapán	55.77%	0.69%	32.94%	2.74%	5.26%	-	0.68%
Apaneca	75.00%	-	-	25.00%	-	-	-
San Pedro Puxtla	26.67%	-	-	60.00%	13.33%	-	-
Santo Domingo de Guzmán	41.67%	-	50.00%	8.33%	-	-	-
Sonsonate	77.45%	-	11.22%	2.67%	7.95%	-	0.72%

Floor						
Municipality	*Ceramic brick*	*Cement brick*	*Clay brick*	*Cement*	*Dirt*	*Other*
Acajutla	9.15%	32.45%	0.39%	39.28%	18.17%	0.56%
Ahuachapán	11.40%	27.11%	-	26.55%	34.50%	0.44%
Apaneca	25.00%	58.33%	-	16.67%	-	-
San Pedro Puxtla	6.67%	6.67%	-	20.00%	66.67%	-
Santo Domingo de Guzmán	33.33%	-	-	41.67%	25.00%	-
Sonsonate	15.5%	47.9%	-	16.8%	19.8%	-

Roof							
Municipality	***Concrete slab***	***Clay or cement roof tile***	***Asbestos or cement fiber sheet***	***Metal Sheet***	***Thatch or Palm***	***Waste Materials***	***Other***
Acajutla	-	8.65%	35.83%	55.24%	0.27%	-	-
Ahuachapán	0.68%	13.96%	10.53%	74.55%	-	-	0.28%
Apaneca	-	25.00%	16.67%	58.33%	-	-	-
San Pedro Puxtla	-		6.7%	93.3%	-	-	-
Santo Domingo de Guzmán	-	16.7%	25.0%	58.3%	-	-	-
Sonsonate	1.96%	7.00%	36.73%	54.04%	-	0.28%	-

Source: EHPM, 2015

Participants in the Participatory Rural Diagnosis attributed the poor quality of housing and the lack of health of the dwellings to the incidence of diseases:

> *"We have an epidemic of influenza by the climate, we create ourselves an unhealthy environment, for example the walls in the houses are of sheets and they become an oven. There is a climate change, companies have a lot to do and the same farmers as well and there should be more awareness." (Participatory Rural Diagnosis, Santo Domingo de Guzmán, June 2016.)*

4.3.7.2 *Types of Housing Ownership*

Of the national households, 50% own their homes, 21.2% are free occupants, 13.9% are tenants, 5.9% are owners in private land, 5.2% are owners and are still paying their home, 2.9 % owned on public land (EHPM, 2015, see Table 4.3-11 and Figure 4.3-20).

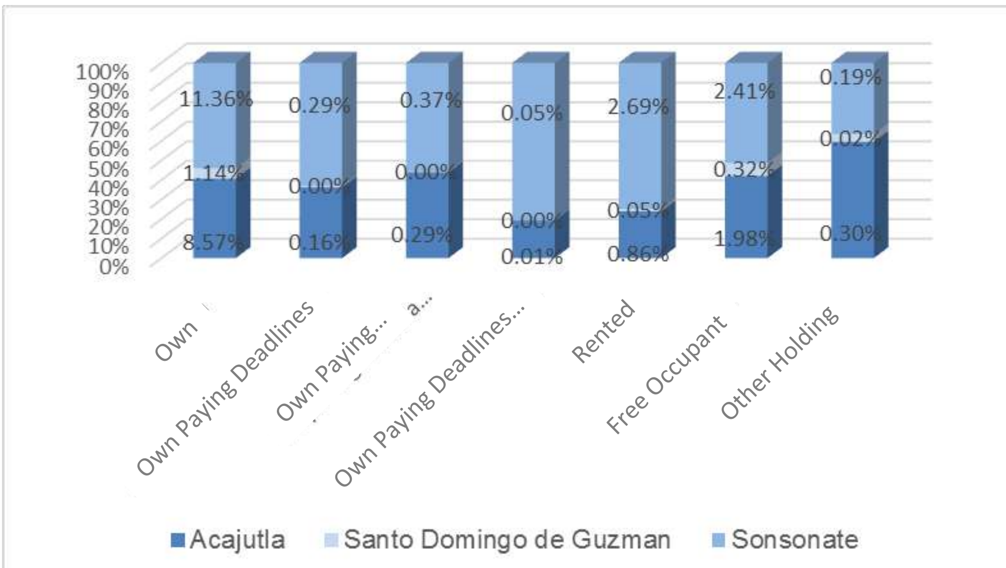
At the departmental level, in the department of Ahuachapán the property of the house is greater than in Sonsonate, although with a small difference.

Table 4.3-11 Types of Housing Ownership

Types of Housing Ownership	*Department*	
	Ahuachapán (%)	*Sonsonate (%)*
Proper	67.40	67.16
Own Paying Deadlines to Public Institutions	1.38	1.87
Own Paying for Private Institutions	2.14	4.21
Own Paying NGO Deadlines	0.13	0.34
Rented	7.44	9.76
Free Occupant	18.32	15.24
Other Holding	3.19	1.42
Total	***100***	***100***

Source: Census of Population and Housing, 2007.

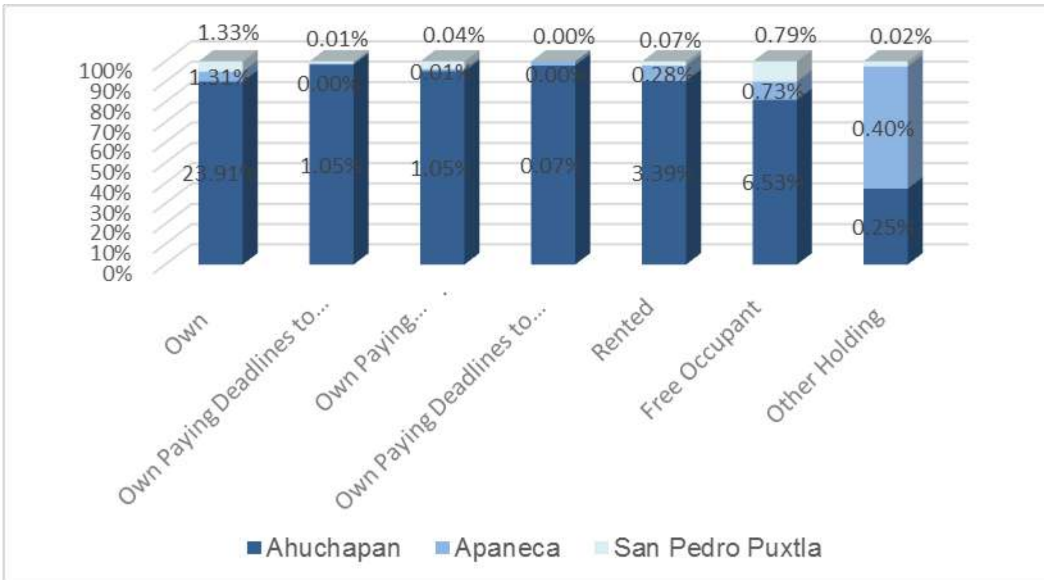
At the municipal level, the Tables below present the property data.



Source: Census of Population and Housing, 2007

Figure 4.3-20 Types of Housing Tenure by Municipality. Municipalities of the Department of Sonsonate

In the department of Ahuachapán, tenure is more common, with Ahuachapán being the municipality with the highest number of houses owned as shown in Figure 4.3-21 below.



Source: Census of Population and Housing, 2007

Figure 4.3-21 Types of Housing Tenure by Municipality. Municipalities of the Department of Ahuachapán

4.3.7.3 *Further observations on the relocation of dwellings due to the Project*

For the preparation of this baseline, the route of the transmission line was crossed and a reconnaissance visit (June 2016) was carried out to the farms and cantons near the transmission line. The proposed line would follow, in large part, a route away from houses and towns. The length of the TL is 44 km approximately, and passes through the municipalities of Ahuachapán, Apaneca and San Pedro Puxtla in the department of Ahuachapán, and the municipalities of Santo Domingo de Guzmán, Sonsonate and Acajutla in the department of Sonsonate, with a total of 269 properties identified under the map.

It has been identified a house that is located within the right of way strip and that will be necessary to resettle to realize the work. This case is located in parcel of land 246 in which tower 128 is projected, boundary between Section B and Section C in the Acajutla Exit sector, identified as Rea-6. Figure 4.3-22 below shows the location of the dwelling.

The collection of information has been carried out, in order to socio-economically characterize the family to be displaced and thus define their eligibility, compensation and assistance. This information is presented in Appendix F - Letters Interviews.

Source: GRIS, 2016

Figure 4.3-22 Location of the Houses within the Right of Way Strip in Ahuachapán

4.3.8 *Health*

The Public Health System in El Salvador is made up of the Ministry of Health (MINSAL), the Salvadoran Social Security Institute (ISSS), the Solidarity Fund for Health (FOSALUD), the Military Health Command (CSM), the Salvadoran Institute of Welfare Magisterial (ISBM) and the Salvadoran Institute for Integral Rehabilitation (ISRI).

Mortality and Morbidity

The epidemiological profile of the country shows infectious diseases, mainly of the respiratory and digestive apparatus. In recent years, injuries from external causes as a result of violence have increased.

The list of leading causes of mortality in El Salvador reflects an increasing prevalence of noncommunicable diseases and injuries. In women, the first causes of death are acute myocardial infarction and diabetes mellitus. Among men the two leading causes of death are gun injuries and motor vehicle accidents, which together account for almost 20% of total deaths. The third leading cause of death is chronic renal failure.

At the departmental level, perinatal mortality-related causes continue to be highest among women. However, deaths from cancer such as leukemia and lymphomas and other chronic diseases such as diabetes mellitus and AIDS have all become relevant. Other diseases, common in the area of influence, include diseases like dengue, pneumonia, tuberculosis and HIV/AIDS.

During participatory rural diagnosis, participants identified kidney disease, diabetes, high blood pressure, intestinal parasitism and respiratory diseases and skin infections as common diseases. During the interview with Acajutla's intermediate family health unit, the first four causes of mortality in 2015 were acute myocardial infarction, unspecified septicemia, renal failure and other heart diseases. In 2016 the leading causes of mortality so far this year are septicemia in the first place, ischemic heart disease, head trauma and endocrine, nutritional and metabolic diseases.

It was also indicated that the most common causes of morbidity in the year 2016 were acute upper respiratory infections, acute pharyngitis and tonsillitis, dental caries, diarrhea of presumed infectious origin, diabetes mellitus, essential hypertension and parasitism.

4.3.8.1 Health Facilities

Health facilities in the area of influence are limited. The municipalities of Ahuachapán, Apaneca and San Pedro Puxtla, in the department of Ahuachapán, have a total of eleven health facilities, while the municipalities of Acajutla, Santo Domingo de Guzmán and Sonsonate, in the department of Sonsonate, and have eight health facilities according to available information. Most health facilities correspond to Health Units or to Health Homes. The municipalities of Ahuachapán and Sonsonate each have one hospital. The type of health service by municipality is presented in Table 4.3-12.

Table 4.3-12 Type of Health Service by Department and Municipality

Department	Municipality	Hospitals	Health Units	Health House	Integral Center for Maternal and Child Health and Nutrition (CIAMIN)	Rural Nutrition Centers (CRN)
Ahuachapán	Ahuachapán	1	2	2	0	0
	Apaneca	0	2	1	1	0
	San Pedro Puxtla	0	2	0	0	0
Sonsonate	Acajutla	0	2	Information not available	0	1
	Santo Domingo de Guzmán	0	1	0	0	0
	Sonsonate	1	2	0	1	0

Source: Prepared by ERM with data of the EHPM, 2015

As shown in Table 4.3-12, the number of Units and Homes of Health means that this is the type of health institution most frequented in the departments of Ahuachapán and Sonsonate, followed by hospitals and private clinics. At the municipal level, the most consulted health facilities continue to be the Units and Homes of Health with the exception of the municipality of Apaneca where the most visited health facilities are hospitals. Table 4.3-13 presents information on the type of health facility consulted by individuals with a disease or symptom. No information was found for the municipality of San Pedro Puxtla.

Table 4.3-13 Place Where People with Any Disease or Symptom, by Sex According to Department, were consulted, 2014a

Department[b]	Place where consulted	Sex		
		Men	Women	Total
Ahuachapán	MSPAS Hospital	441	1727	2168
	Health unit or health home of MSPAS	7636	8541	16177
	ISSS Hospital	214	648	862
	Medical units, community or business clinics ISSS	690	1115	1805
	Military Hospital	0	0	0
	Public Hospital	2128	1898	4026
	Magisterial Welfare	180	182	362
	NGO´s	333	333	666

Department[b]	Place where consulted	Sex		
		Men	Women	Total
	Pharmacy	0	0	0
	House of the healer or natural clinic	43	0	43
	House of the sick or injured	37	113	150
	Others	123	0	123
	Total	***11825***	***14557***	***26382***
Sonsonate	MSPAS Hospital	1288	1695	2983
	Health unit or health home of MSPAS	7805	9684	17489
	ISSS Hospital	2567	1036	3603
	Medical units, community or business clinics ISSS	1487	1102	2589
	Military Hospital	112	0	112
	Public Hospital	2421	3576	5997
	Magisterial Welfare	58	290	348
	NGO´s	422	346	768
	Pharmacy	466	0	466
	House of the healer or natural clinic	0	0	0
	House of the sick or injured	42	0	42
	Others	142	58	200
	Total	***16810***	***17787***	***34597***

Source: EHPM, 2015
Key: MSPAS = Ministry of Public Health and Social Assistance.
[a] The data presented in this Table corresponds to the number of visitors, to different health facilities, by gender. It is possible that an individual has visited more than one medical facility.
[b] The department corresponds to the domicile of the visitor and not to the location of the medical facility.

Table 4.3-14 shows the places of consultation by municipality, according to disease or symptom and disaggregated by sex.

Table 4.3-14 Place Where People with Any Disease or Symptom, by Sex According to Municipality, were consulted, 2014a

Municipality[b]	Place where consulted	Sex		
		Men	Women	Total
Acajutla	MSPAS Hospital	160	107	267
	Health unit or health home of MSPAS	1407	1193	2600
	ISSS Hospital	145	76	221
	Medical units, community or business clinics ISSS	114	0	114
	Military Hospital	0	0	0
	Public Hospital	401	504	905
	Magisterial Welfare	0	0	0

Municipality[b]	Place where consulted	Sex		
		Men	Women	Total
	NGO´s	237	61	298
	Pharmacy	0	0	0
	House of the healer or natural clinic	0	0	0
	House of the sick or injured	42	0	42
	Others	32	0	32
	Total	***2538***	***1941***	***4479***
Ahuachapán	MSPAS Hospital	195	1163	1358
	Health unit or health home of MSPAS	2443	2686	5129
	ISSS Hospital	0	333	333
	Medical units, community or business clinics ISSS	575	920	1495
	Military Hospital	0	0	0
	Public Hospital	508	407	915
	Magisterial Welfare	0	97	97
	NGO´s	333	333	666
	Pharmacy	0	0	0
	House of the healer or natural clinic	0	0	0
	House of the sick or injured	0	0	0
	Others	0	0	0
	Total	***4054***	***5939***	***9993***
Apaneca	MSPAS Hospital	78	0	78
	Health unit or health home of MSPAS	0	78	78
	ISSS Hospital	0	0	0
	Medical units, community or business clinics ISSS	0	0	0
	Military Hospital	0	0	0
	Public Hospital	78	78	156
	Magisterial Welfare	0	0	0
	NGO´s	0	0	0
	Pharmacy	0	0	0
	House of the healer or natural clinic	0	0	0
	House of the sick or injured			
	Others	0	0	0
	MSPAS Hospital	0	0	0
	Total	***156***	***156***	***312***
San Pedro Puxtla	MSPAS Hospital	-	-	-
	Health unit or health home of MSPAS	-	-	-
	ISSS Hospital	-	-	-
	Medical units, community or business clinics ISSS	-	-	-
	Military Hospital	-	-	-
	Public Hospital	-	-	-

Municipality[b]	*Place where consulted*	*Sex*		
		Men	*Women*	*Total*
	Magisterial Welfare	-	-	-
	NGO´s	-	-	-
	Pharmacy	-	-	-
	House of the healer or natural clinic	-	-	-
	House of the sick or injured	-	-	-
	Others	-	-	-
	Total	***-***	***-***	***-***
Santo Domingo de Guzmán	MSPAS Hospital	0	0	0
	Health unit or health home of MSPAS	720	180	900
	ISSS Hospital	0	0	0
	Medical units, community or business clinics ISSS	0	0	0
	Military Hospital	0	0	0
	Public Hospital	0	0	0
	Magisterial Welfare	0	0	0
	NGO´s	0	0	0
	Pharmacy	0	0	0
	House of the healer or natural clinic	0	0	0
	House of the sick or injured	0	0	0
	Others	0	0	0
	Total	***720***	***180***	***900***
Sonsonate	MSPAS Hospital	0	537	537
	Health unit or health home of MSPAS	1302	1658	2960
	ISSS Hospital	878	322	1200
	Medical units, community or business clinics ISSS	0	360	360
	Military Hospital	112	0	112
	Public Hospital	625	1173	1798
	Magisterial Welfare	0	0	0
	NGO´s	185	122	307
	Pharmacy	0	0	0
	House of the healer or natural clinic	0	0	0
	House of the sick or injured	0	0	0
	Others	0	0	0
	Total	***3102***	***4172***	***7274***

Source: EHPM, 2015

[a] The data presented in this Table corresponds to the number of visitors, to different health facilities, by gender. It is possible that an individual has visited more than one medical facility.

[b] The municipality corresponds to the domicile of the visitor and not to the location of the medical facility.

According to information gathered in the field, the municipality of Ahuachapán has all basic medical services (eg, pediatrics, dentistry, mental health services and radiology); however, in cases of emergencies "red code", which corresponds to potentially fatal emergencies, the medical units of the municipality of Ahuachapán transfer the patients to the regional hospital in the Department of Santa Ana. Both institutions consulted in the municipality of Ahuachapán reported public health programs, such as vaccination brigades, and access to the necessary training to carry out their work. This information was also expressed during the participatory rural diagnosis, where some of the participants in all the workshops agreed on a decrease in the quality of medical care.

> *"The medical attention is deplorable. To get to the health unit takes you from 6 am to 7 pm. In San Salvador [for example] a man died waiting to be attended. I went into an operation at 6 am and was attended the next day at 6 am [24 hours later]."(Participatory Rural Diagnosis, municipality of Sonsonate, June 2016).*

However, most participants agreed that there have been health programs and improved access to health services, especially in rural areas.

> *In reality, there have been good health programs, such as the ECOS [Community Health and Family Specialized Teams] (health program towards the cantons). (Participatory Rural Diagnosis, municipality of Sonsonate, June 2016).*

> *"Now the approach is preventive, education we want to reduce maternal and child mortality has been reduced. There are health promoters, in places where they did not arrive before. Now they come."(Participatory Rural Diagnosis, Acajutla municipality, June 2016).*

4.3.8.2 Medical Insurance

Most people in the departments of Ahuachapán and Sonsonate do not have any type of medical insurance. In those cases, where individuals do have health insurance, the most common type of health insurance is national health insurance provided by the Salvadoran Institute of Social Security (ISSS). In both departments, the number of men with some form of health insurance is higher than the number of women. Table 4.3-15 presents the type of health insurance by department, by sex.

Table 4.3-15 Type of Medical Insurance by Sex According to Department

Department	Health insurance that the population has [a]	Sex		
		Men	Women	Total
Ahuachapán	ISSS quotient	15427	4628	20055
	ISSS beneficiary	5794	14359	20153
	ISSS retired	1250	379	1629
	Welfare magisterial	858	1538	2396
	IPSFA	1939	218	2157
	Collective	0	0	0
	Individual (Private)	0	210	210
	Does not have	145579	159401	304980
	Other	0	0	0
	Total	***170847***	***180733***	***351580***
Sonsonate	ISSS quotient	34962	14456	49418
	ISSS beneficiary	10107	30395	40502
	ISSS retired	3257	2020	5277
	Welfare magisterial	2310	3534	5844
	IPSFA	1994	1767	3761
	Collective	0	0	0
	Individual (Private)	539	113	652
	Does not have	181440	205610	387050
	Other	0	0	0
	Total	***234609***	***257895***	***492504***

Source: EHPM, 2015

[a] The different categories of health insurance have been established according to the data provided by the Ministry of Health.

At the municipal level, the medical coverage data is similar to that at the departmental level. The vast majority of people do not have any type of health insurance and the most common type of medical coverage is provided by the ISSS. In two of the municipalities, Ahuachapán and Sonsonate, individuals with individual private health insurance were found. According to the sample design of the Multiple Purpose Household Survey (EHPM), not all municipalities have the volume of data necessary to establish that, statistically, the results reflect the socioeconomic conditions of the vast majority of households. For this reason, some of the information presented in Table 4.3-16 shows anomalies. However, the EHPM is one of the few sources of information available in El Salvador at the municipal level.

Table 4.3-16 Type of Health Insurance According to Municipality

Municipality	*Health insurance that the population has [a]*	*Sex*		
		Men		*Men*
Acajutla	ISSS quotient	3738	1033	4771
	ISSS beneficiary	1273	4173	5446
	ISSS retired	683	0	683
	Welfare magisterial	58	294	352
	IPSFA	158	314	472
	Collective	0	0	0
	Individual (Private)	0	0	0
	Does not have	22915	24306	47221
	Other	0	0	0
	Total	***28825***	***30120***	***58945***
Ahuachapán	ISSS quotient	7749	2253	10002
	ISSS beneficiary	3379	7945	11324
	ISSS retired	730	188	918
	Welfare magisterial	194	485	679
	IPSFA	898	145	1043
	Collective	0	0	0
	Individual (Private)	0	210	210
	Does not have	48898	47409	96307
	Other	0	0	0
	Total	***61848***	***58635***	***120483***
Apaneca	ISSS quotient	312	0	312
	ISSS beneficiary	156	234	390
	ISSS retired	0	0	0
	Welfare magisterial	0	78	78
	IPSFA	0	0	0
	Collective	0	0	0
	Individual (Private)	0	0	0
	Does not have	1248	1092	2340
	Other	0	0	0
	Total	***1716***	***1404***	***3120***
San Pedro Puxtla	ISSS quotient	0	192	192
	ISSS beneficiary	192	0	192
	ISSS retired	0	0	0
	Welfare magisterial	0	0	0
	IPSFA	0	0	0
	Collective	0	0	0
	Individual (Private)	0	0	0

Municipality	Health insurance that the population has [a]	Sex		
		Men		Men
	Does not have	4992	8256	13248
	Other	0	0	0
	Total	***5184***	***8448***	***13632***
Santo Domingo de Guzmán	ISSS quotient	1080	0	1080
	ISSS beneficiary	180	1080	1260
	ISSS retired	0	0	0
	Welfare magisterial	0	0	0
	IPSFA	0	0	0
	Collective	0	0	0
	Individual (Private)	0	0	0
	Does not have	2700	4320	7020
	Other	0	0	0
	Total	***3960***	***5400***	***9360***
Sonsonate	ISSS quotient	6490	2605	9095
	ISSS beneficiary	1320	5786	7106
	ISSS retired	562	715	1277
	Welfare magisterial	496	988	1484
	IPSFA	173	224	397
	Collective	0	0	0
	Individual (Private)	539	113	652
	Does not have	26305	30947	57252
	Other	0	0	0
	Total	***35885***	***41378***	***77263***

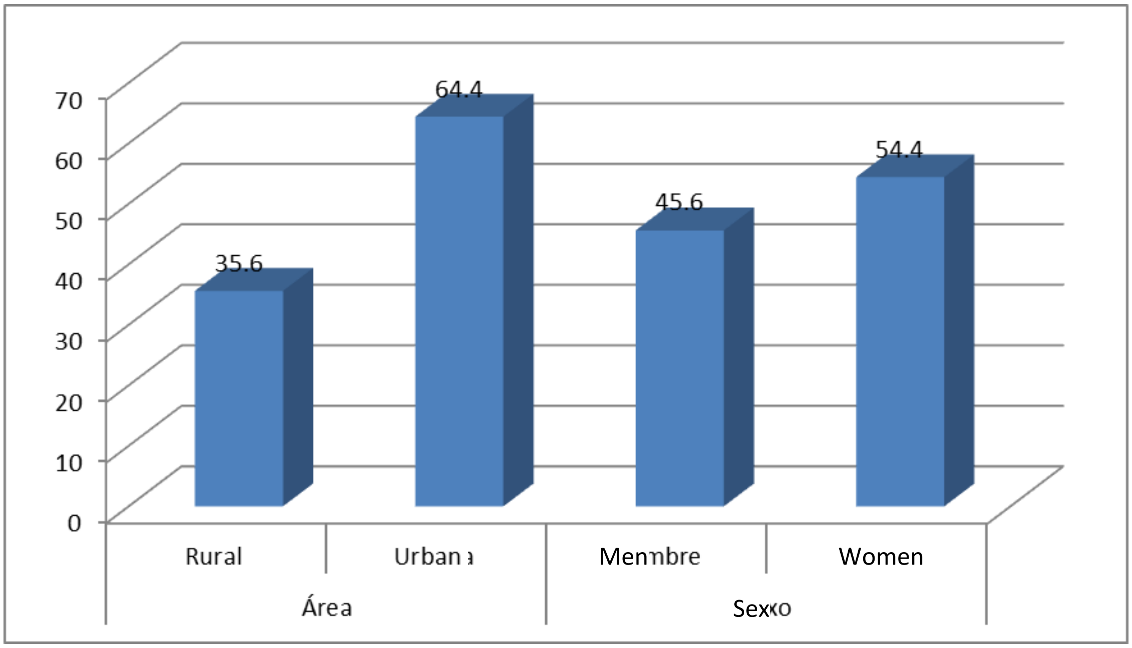
Source: EHPM, 2015

[a] The different categories of health insurance have been established according to the data provided by the Ministry of Health.

4.3.9 **Productivity and Economy**

4.3.9.1 Economically Active Population

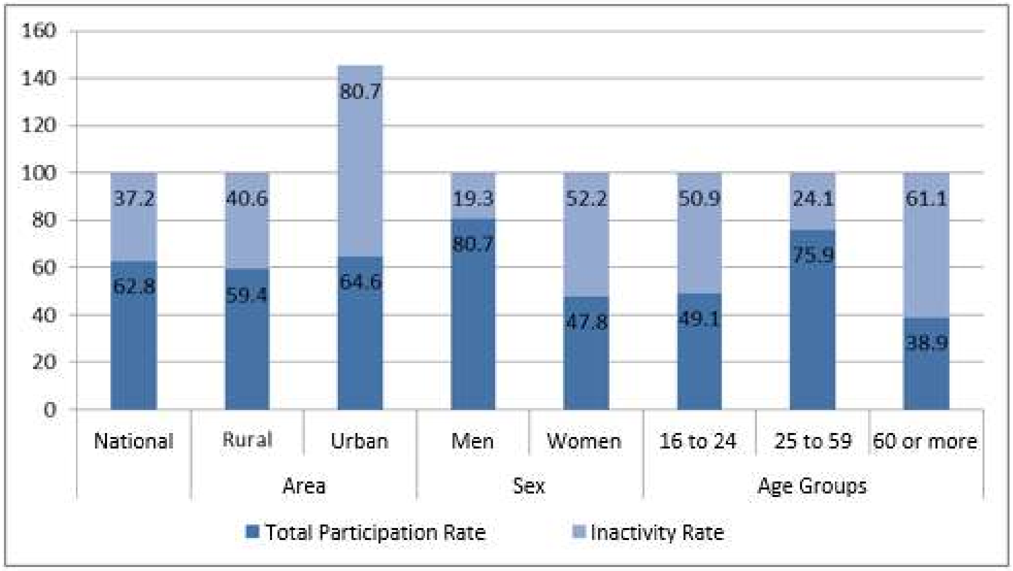
In El Salvador, the Working-Age Population (WAP) is defined as 16 years old. According to the EHPM 2015, WAP represents 71% (4,527,736) of the total population. The vast majority of this population resides in urban areas and, as shown in Figure 4.3-23, are women. The vast majority of WAPs are young people between the ages of 16 and 39 (56.8%) followed by people between 40 and 59 years of age (27%) and finally people aged 60 and over (16.2%). This distribution is similar between men and women (see Figure 4.3-23, EHPM, 2015).



Source: EHPM, 2015

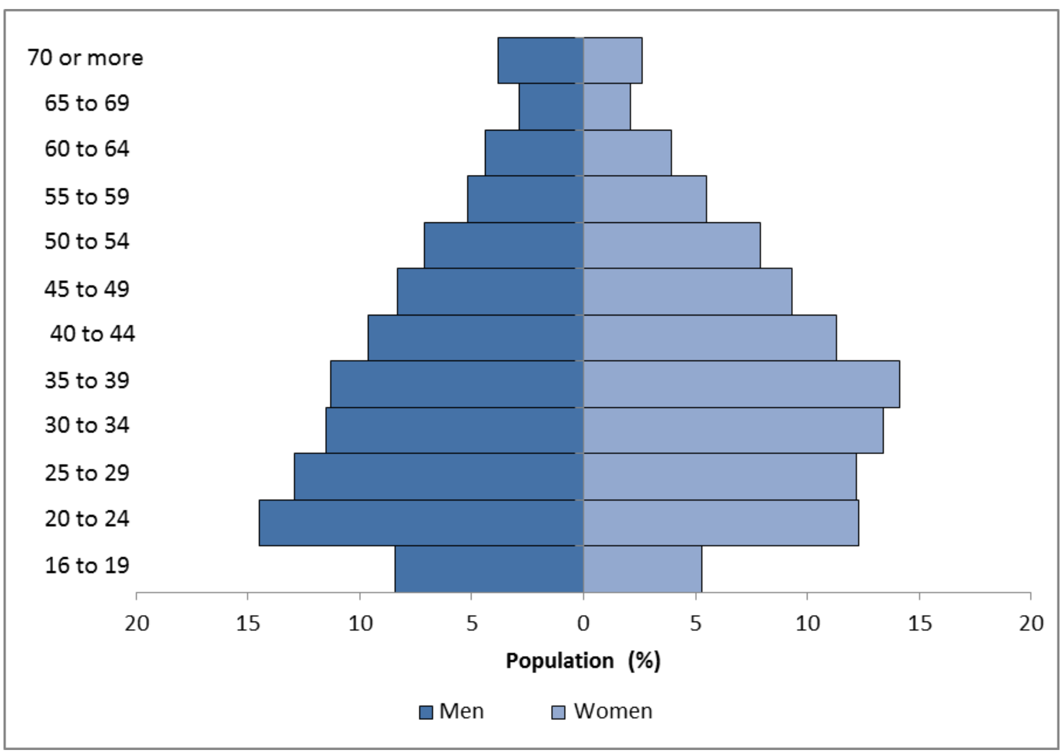
Figure 4.3-23 Distribution of Working-Age Population (WAP) According to Geographic Area and Gender, 2014

A comparison between WAP and the Economically Active Population (EAP) shows that at the national level of every 100 people who form WAP, 63 are employed and offer their labor force to the labor market; while 37 are not actively working, or looking for work and are therefore classified as Economically Inactive Population (EIP). This situation is repeated at the departmental level, where the number of EIPs is higher among women than men (EHPM, 2015). Figure 4.3-24 reflects the WAP by activity condition, according to area, sex and age groups. The EAP in El Salvador consists of 2, 842,997 people, of whom 58.5% are men and 41.5% are women (EHPM, 2015). 66.3% of the EAP resides in the urban area while 33.7% reside in the rural area. Figure 4.3-25 reflects the age ranges of the EAP. The behavior of this distribution is similar between men and women.



Source: EHPM, 2015

Figure 4.3-24 Working Age Population (WAP) by Activity Condition, by Area, Sex and Age Groups (Percentage), 2004



Source: EHPM, 2015

Figure 4.3-25 Pyramid of the Economically Active Population, 2014

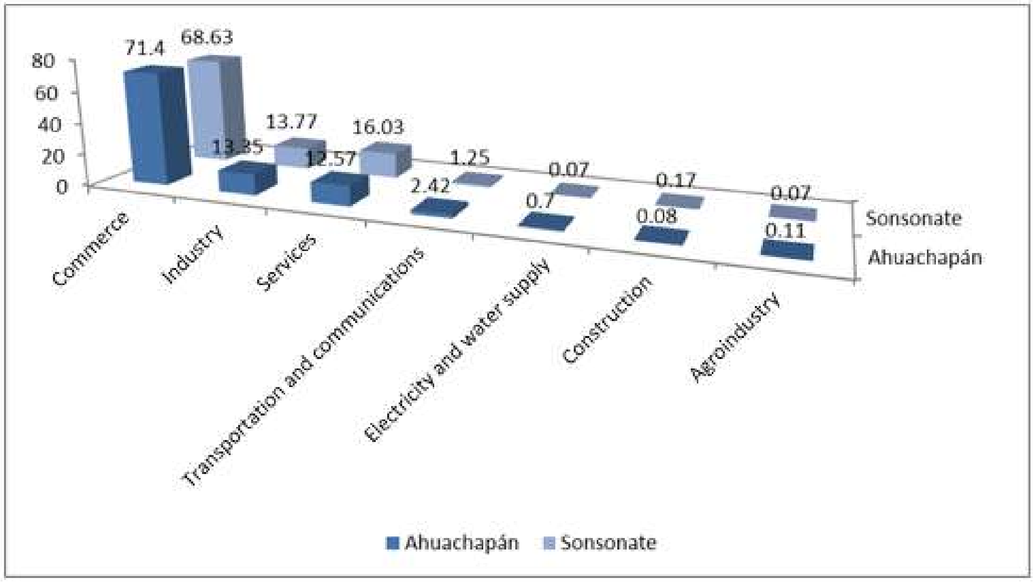
The occupancy rate of the EAP for 2014, which represents the degree of effective use of human resources available for work, is 93%. This means that out of every 100 people 93 are employed (EHPM, 2015). The percentage of persons employed was higher in the urban area (93.3%) than in the rural area (92.5%); and higher among women (95.3%) than among men (91.4%) (HHPM, 2015). These figures reflect, in turn, the unemployment rate, which in 2014 was 7%. The unemployment rate varies by department; Ahuachapán is one of the departments with the highest unemployment rate (9.3%). For its part, the department of Sonsonate reported an unemployment rate of 7% (EHPM, 2015).

4.3.9.2 Branches of Economic Activity

The four most important branches of economic activity in El Salvador are commerce, hotels and restaurants (30.5%), agriculture and livestock (17.9%), manufacturing (15%) and communal health and social services (7.7%) (EHPM, 2015). Disaggregation by geographical area reflects slight differences. In the rural area, the three branches that absorb the largest number of employed population are agriculture and livestock, commerce, hotels and restaurants, and manufacturing. In the urban area, the branches that absorb most of the employed population are: commerce, hotels and restaurants, manufacturing industry, and communal, social and health services (EHPM, 2015).

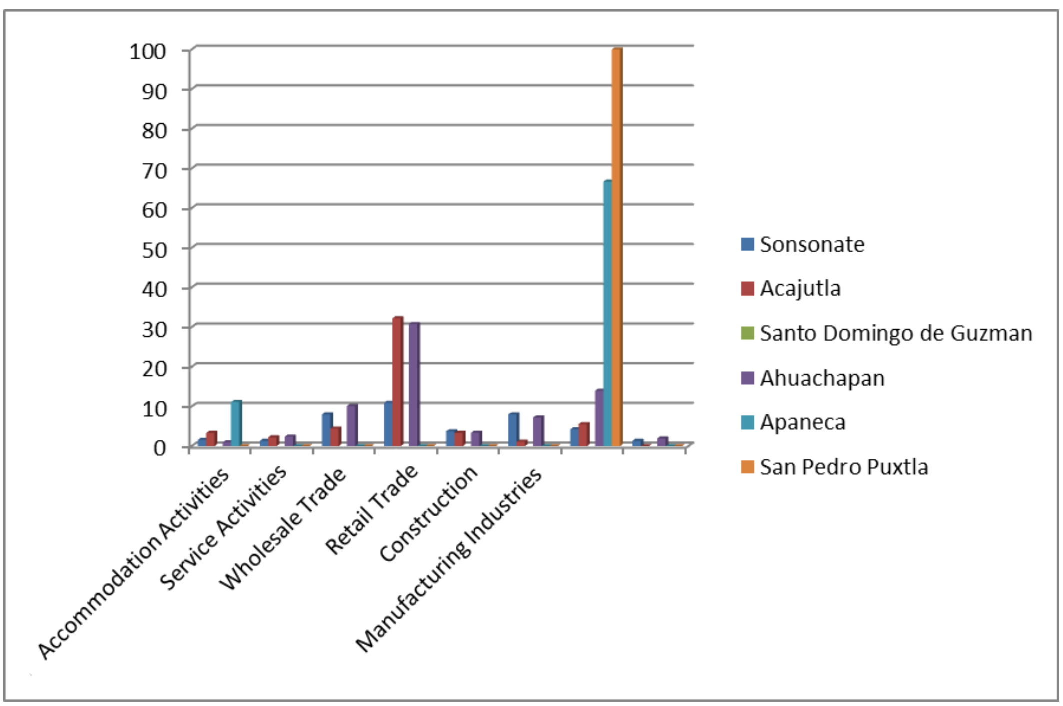
The main economic activity in the departments of Ahuachapán and Sonsonate is retail trade, manufacturing and services. Figure 4.3-26 shows the percentage of these activities in the area of influence.

At the departmental level the main economic activities are agriculture and trade. Industrial activities have also gained momentum, especially in the areas of: food products (coffee, sugar and preserves), textiles (cotton processing) and tobacco (cigarette) manufacturing. Both departments have the optimum conditions for this type of industries (like climate and labor market); the department of Sonsonate that has the port of Acajutla (see Figure 4.3-27).



Source: Prepared by ERM with data of DIGESTYC, 2009 – 2011

Figure 4.3-26 Main Economic Activities, by Department 2009 - 2011



Source: Elaboration ERM based on the EHPM, 2011
[a] No information found for Santo Domingo de Guzmán

Figure 4.3-27 Main Economic Activities, by Municipality, 2011[a]

At the municipal level, the most common economic activity is agricultural production, followed by retail trade. In the municipalities of Ahuachapán and Apaneca, the businesses associated with accommodation, food and beverage services are also relatively significant, while construction in the departments of Acajutla, Sonsonate and Santo Domingo de Guzmán is the third most important economic activity (DIGESTYC, 2011). According to information collected in the field, a high percentage of women participate in agricultural production in the municipalities of San Pedro Puxtla and Santo Domingo Guzmán.

4.3.9.3 *Business Network*

The six municipalities in the area of influence have four types of companies: big, medium, small and microenterprise. Big companies are those with more than 100 employees; medium, if they have 50 to 99; small, those with 10 to 40 employees and micro enterprises that work with less than 10 people. Table 4.3-17 reflects the type of company by number of employees in the reference municipalities.

Table 4.3-17 Type of Companies by Number of Employees

Municipalities	*Big*	*Medium*	*Small*	*Micro Enterprises*
Ahuachapán	22.0%	1.3%	10.85	65.9%
Apaneca	22.7%	0.0%	4.50%	72.7%
San Pedro Puxtla	5.30%	0.0%	5.30%	89.50%
Acajutla	19.1%	3.2%	11%	66.7%
Santo Domingo de Guzmán	30.0%	0.0%	0.0%	70.0%
Sonsonate	25.75	3.60%	8.30%	62.5%

Source: Prepared by ERM based on the EHPM, 2015.

Small and micro enterprises predominate in the business structure in Central America, representing a high percentage of existing units, with a significant contribution to employment. Table 4.3-18 below provides data for members of the Chamber of Commerce by municipality.

Table 4.3-18 Distribution by Sector of Affiliates to the Chamber of Commerce, by Municipality[a]

Sectors	Municipalities											
	Ahuachapán		Apaneca		San Pedro Puxtla		Acajutla		Santo Domingo de Guzmán		Sonsonate	
Service	63	30.29%	3	33.33%	0	0%	48	53.33%	–	–	125	33.33%
Commerce	128	61.54%	6	66.67%	2	100%	41	45.56%	–	–	216	57.60%
Industry	17	8.17%	0	0%	0	0%	1	1.11%	–	–	34	9.07%
Total	208	100%	9	100%	2	100%	90	100%	–	–	375	100%

Source: Prepared by ERM based on the Economic Directory, 2011
[a] The percentages are based on the total economic activity of the municipality.
[b] No information was found for the municipality of Santo Domingo de Guzmán.

4.3.10 Agricultural and Industrial Activity

Until the late 1970s, El Salvador was considered a predominantly agricultural country, since the agricultural sector accounted for about 25% of the Gross Domestic Product (GDP) and was responsible for more than 50% of jobs in the country (MAG, 2007). The importance of the agricultural sector began to decline in the 1980s, partly as a result of the loss of human capital caused by the massive internal and external migration of rural youth. However, the agricultural sector continues to be an important sector in the national economy as seen in Tables 4.3-19 and 4.3-20. In 2007, the agricultural sector accounted for about a quarter of the country's labor force and a third of export earnings (MAG, 2007).

Table 4.3-19 Number of Exports by Department, according to Agricultural Items, May 2006 to April 2007

Agroindustriales Annually	*Total Exports - Ahuachapán*	*Total Exports - Sonsonate*
Sesame	**95**	**94**
Peanut	**11**	
Tobacco		**2**
Jamaica Rose	**2**	**5**
Soy	**3**	**6**

Semi-Permanent and Permanent Agroindustrial	*Total Exports - Ahuachapán*	*Total Exports - Sonsonate*
Sugar Cane	133	160
Balm	2	85
Cashews		1
Tule		71
Noni	6	13
Cocoa		3
Achiote		2
Castilla Rod or Wicker		2
Eucalyptus	4	1
Common reed		9
Macadamia	2	
Balsam (organic)		1
Other agroindustrial crops	*Total Exports - Ahuachapán*	*Total Exports - Sonsonate*
Bamboo, Long curcum	2	
Total	260	455

Source: Agricultural Census, 2007

Table 4.3-20 presents the agroindustrial production by municipality, according to the agricultural census of 2007.

Table 4.3-20 Semi-Permanent and Permanent Agroindustrial Production, by Municipality, May 2006 to April 2007[a]

Semi-Permanent and Permanent Agroindustrial	*Ahuachapán*	*Apaneca*	*San Pedro Puxtla*	*Santo Domingo de Guzmán*	*Sonsonate*	*Acajutla*
Sugar cane	449.28	0	0	20	6047.4	370.52
Noni	1.50	0	0	0	0.47	1.30

Source: Agricultural Census, 2007
[a] Production in apples

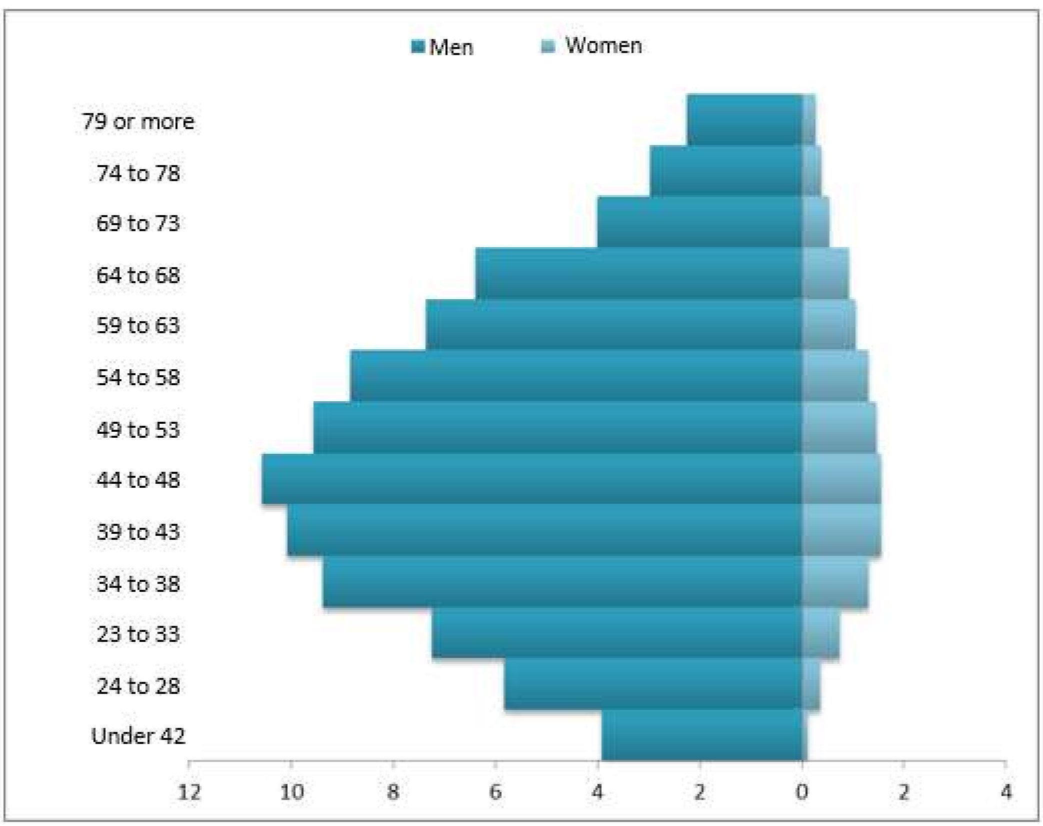
During the participatory rural diagnosis, the participants indicated that in general the areas of cultivation were mixed, which included vegetables, basic grains and livestock. Burning was also recognized as a standard practice, although there are initiatives of new practices of municipalities for soil protection. A participant from Santo Domingo de Guzmán, relates the agricultural calendar as follows:

> *"Corn crops (April-May); Sorghum (September-October); Grass (cattle pasture) (April - October); soazo; peppers, tomatoes, beans "(Participatory Rural Diagnosis, Santo Domingo de Guzmán, June 2016).*

The industrial activity in El Salvador is established during the first half of the twentieth century with the production of beer for local consumption. Beginning in 1950, Salvadoran industry expanded rapidly with the establishment of sugar mills and the production of cigarettes and cement, among others (ASI, 2005). Today, industry continues to be significant in the national economy and represents an important sector for the country's workforce.

4.3.10.1 *Crops*

In general, the most cultivated agricultural products in El Salvador are basic grains, coffee, sugar cane and cotton. According to the agricultural census of 2007 - 2008, the vast majority of producers in El Salvador are small producers with backyard production. These producers are mostly men, with an average age of 49 years (MINE, 2008). Figure 4.3-28 reflects the main characteristics of agricultural producers at the national level, by age group according to sex.

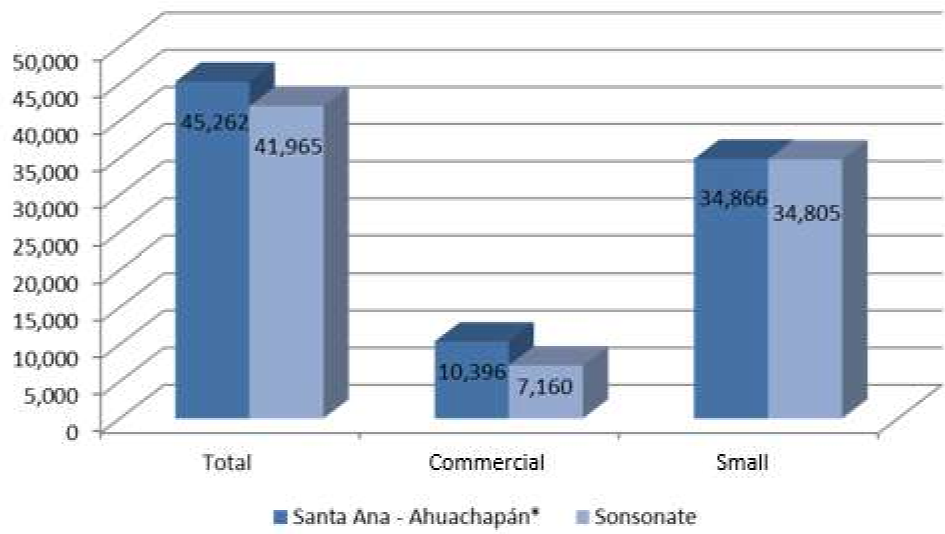


Source: Prepared by ERM based on information from MINE, 2008

Figure 4.3-28 Salvadoran Producers by Age Group According to Sex (2007 - 2008)

At the departmental level, the 2007 - 2008 agricultural census reported a total area planted between 48,587 - 68,385 Acres[4] (Ac) for the department of Ahuachapán and between 39,466 - 48,586 Ac for the department of Sonsonate, suggesting that these are agricultural departments (MINE, 2008). In the department of Ahuachapán, the basic grain crop represents between 25% and 34% of the area sown, while in the department of Sonsonate, basic grains represent between 20% and 24% of the area planted (MINE, 2008). For example, in Santo Domingo, as reported in the participatory rural diagnostic workshop, corn crops are made from April to May, sorghum between September and October and grass, or pasture for cattle is left between April and October.

In line with the results at the national level, most of these producers are small commercial producers. Figure 4.3-29 shows the number of commercial and small agricultural producers by department.

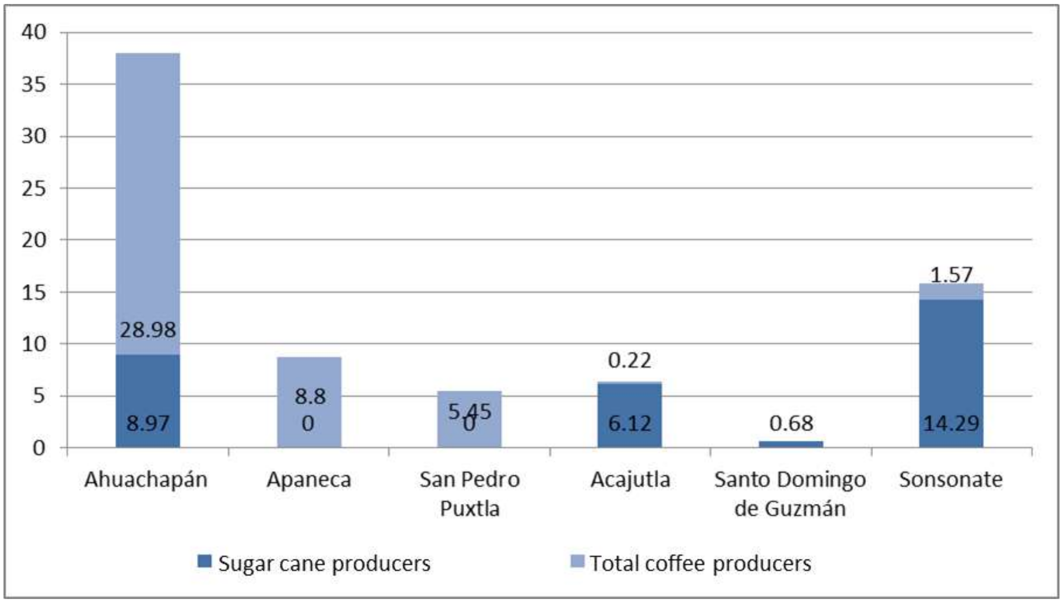


Source: Prepared by ERM with MINE data, 2007 - 2008
** The agricultural census 2007 - 2008 does not disaggregate the data for the departments of Santa Ana and Ahuachapán*

Figure 4.3-29 Commercial Agricultural Producers and Small Producers, by Department (2007 - 2008)

[4] One acre in El Salvador equals 0.7 hectares.

Coffee and sugarcane crops are also important at the municipal level, particularly in the department of Ahuachapán where there are 28.98% of coffee producers and 8.97% of sugarcane producers. Figure 4.3-30 shows the percentage of coffee and sugar producers by municipality.



Source: Prepared by ERM based on information from the Agricultural Census, 2007-2008

Figure 4.3-30 Percentage of Producers of Coffee and Sugar Cane by Municipality, 2007 – 2008

In general terms, the use of productive resources in the municipalities in the area of influence, respond to the quality of the soil present, in particular considering that the management of the indicated crops, is carried out with little or no technology that allows greater advantage.

4.3.10.2 Coffee

For many years, coffee has been one of the main export agricultural products in El Salvador. In the 70's, El Salvador was able to position itself among the three largest coffee producers in the world, exporting more than 230 million gold kilograms in the 70's. Currently, El Salvador exports an average of 69 million gold kilograms to the main coffee consuming countries, which comes mainly from 6 coffee-growing mountains with more than 160,000 hectares. El Salvador is globally recognized for the Bourbon variety, which positions the country as a gourmet coffee niche.

Figure 4.3-31 reflects the different coffee varieties and their growing areas in the national geography.

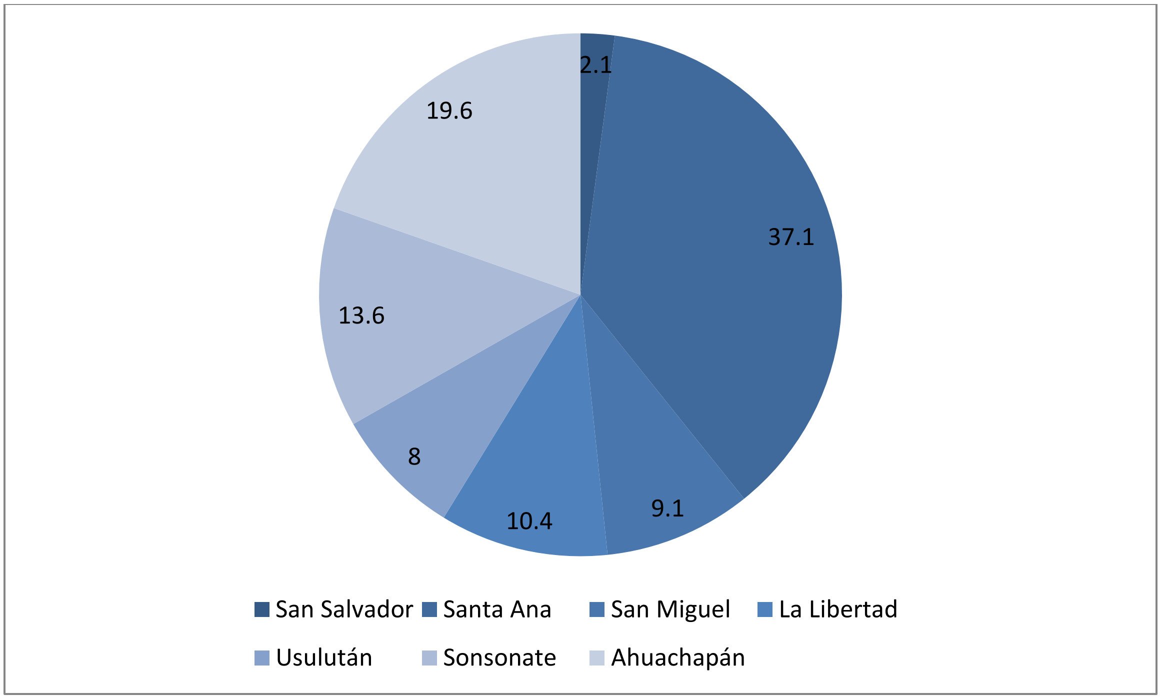
In addition, coffee growing in El Salvador is an important activity for the economic, social and environmental sustainability of the country. According to PROCAFE, coffee production in El Salvador is the main source of income for more than 23,000 producers, of which 77.24% are represented by small and micro-producers with farms of up to 7 hectares (PROCAFE, 2005). It is estimated that of these producers depend on a total of 77,652 people from their family group based on the EHPM in which each household integrates 4.28 members (DIGESTYC, 2007). In terms of employment, it is estimated that the coffee crop generated a total of 46,258 jobs in the period 2014/2015 with a projected increase of approximately 3,700 jobs for the coffee year 2015/2016 (CENTA, 2015).

Source: Comercial Exportadora S.A. de C.V.

Figure 4.3-31 Coffee Growing Areas El Salvador

At the departmental level, the Apaneca-Ilamatepec mountain range, which passes through the departments of Ahuachapán and Sonsonate is one of the main coffee regions in the country. In line with this, the main coffee producing departments in El Salvador are Santa Ana, Ahuachapán and Sonsonate (CSC, 2013).

Figure 4.3-32, reflects an approximation of coffee production in El Salvador by department.



Source: Prepared by ERM based on date of CSC, 2013

Figure 4.3-32 Coffee Production in El Salvador by Department, 2013

Salvadoran coffee in the area of the Apaneca-Ilamatepec sierra received in May 2014 the inscription of the securitization of the grain with denomination of origin (DO). The DO serves to designate the origin of a product, whose quality or characteristics are due only to the geographical environment where it is cultivated, including climate and soil. In addition, it certifies that the producers comply with the international quality standards. According to La Prensa, the potential of producers with DO is 3,100 in approximately 3,170 coffee farms distributed in the chain of hills[5]. At the national level, 31 coffee growers have the Rainforest Alliance (RA) label which recognizes sustainable agricultural, environmental and economic yields[6]. Many of these coffee growers are located in the Apaneca-Ilamatepec mountain range where coffee is grown in forests with protected species.

During the participatory rural diagnosis, it was reported that in Ahuachapán coffee cultivation had declined due to the value quotation and that instead it had been migrated to cocoa cultivation.

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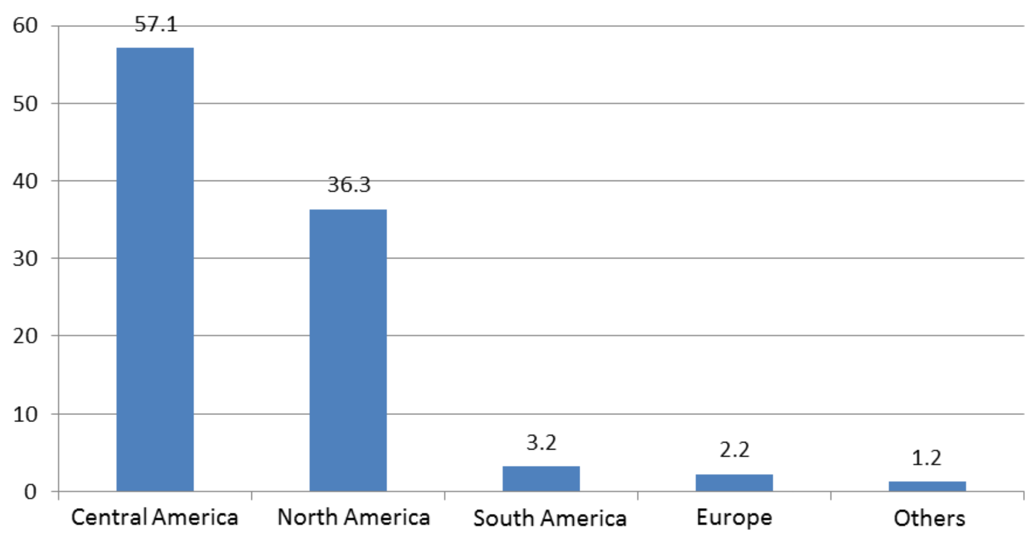
[5] *La Prensa*, Visited: http://www.laprensagrafica.com/2014/05/26/cafe-apaneca-ilamatepec-respaldado-por-su-origen

[6] *El Financiero* http://www.elfinancierocr.com/ef_archivo/2011/diciembre/25/negocios3007542.html

"Coffee crops have declined by 50% because of the value of coffee, the descendants of coffee growers have migrated, cocoa is being sown, and production is paralyzed when they no longer receive support."(Rural Diagnosis Participatory, Ahuachapán, June 2016.)

4.3.11 *Tourism*

Tourism, as an economic activity in El Salvador, has been developing during the last decade acquiring greater relevance for the economy of the country. According to data from the Ministry of Tourism (MITUR), tourism management indicators in El Salvador show an increase in the income level to US $ 1,107.43 million, the highest in the last 11 years, and the arrival of visitors to more than 1,886 thousands with growth of 3.5%, compared to 2013 (MITUR, 2014). In addition, this same industry generated on average 48,415 direct jobs during 2014, equivalent to 7.2% of total national employment (MITUR, 2014). Figure 4.3-33 reflects the regions where these tourists are received.



Source: Prepared by ERM with date of MITUR, 2014

Figure 4.3-33 Regions Where Tourists Arrive in El Salvador, 2014

Within the area of influence of the Project, the municipalities of Apaneca and Ahuachapán are the touristiest. The municipality of Apaneca is one of the pioneer municipalities in the tourist development of the country, which has generated a benefit for the entire western region as it is a source of work and investment. The city of Acajutla is also a relevant tourist area, because of its location along Ruta de las Flores. The Table 4.3-21, reflects the tourist attractions, by municipality.

Table 4.3-21 Atractivos Turísticos, por Municipio, 2009

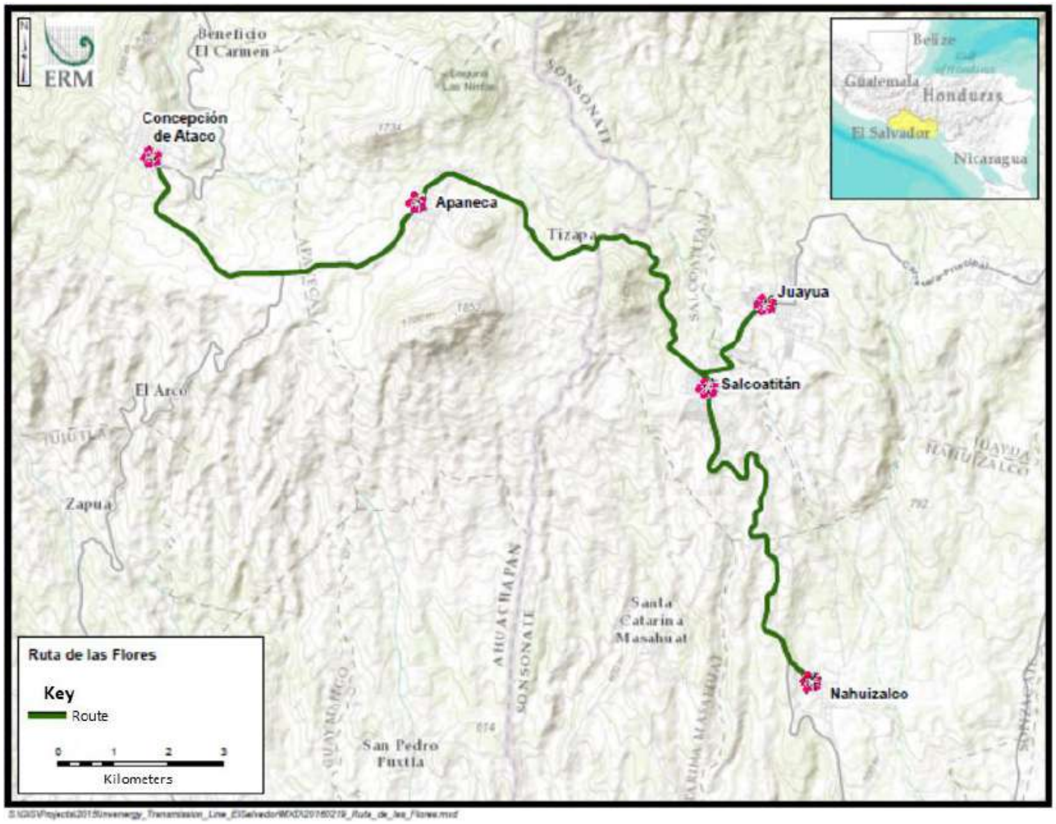
Municipality	*Tourist Attractions*
Ahuachapán	• Ausoles (inc. Central geothermal) • Laguna el Espino • Lagunas del Llano and de Morán • The jumps of Atehuacillas and Malacatiupán • Pasaje la Concordia • Cultural murals • La Asunción church
Apaneca	• Balneario de San Andrés (source of hot springs) • Laguna verde of Apaneca • Laguna las Ninfas • Archaeological site Santa Leticia • The Ruta de las Flores
San Pedro de Puxtla	• Jump of Tequendema (Located on the Zahuapan River) • Viewpoint of La Cruz
Acajutla	• Acajutla port and dock.
Santo Domingo de	• Walter falls: El Saltón and El Escudo • Cueva del Ishtishe • El Arco (Rock formation) • Jumps Texishpulco and Tepechapa
Sonsonate	• Colonial churches of El Pilar, La Santísima Trinidad and Santo Domingo • Beaches: Barra Salada, Barra Ciega and Los Cóbanos

Source: Prepared by ERM with data from UNDP, 2009

4.3.11.1 Tourist Attractions

Ruta de Las Flores

Ruta de Las Flores is a tourist route of 36 km along the Apaneca Mountain Range (see Figure 4.3-34). The route includes stops in different colonial cities, including the cities of Apaneca and Acajutla in the area of influence of the Project. The route is known for the beauty of its coffee plants when they bloom and the markets for handicrafts and typical furniture. A number of associated establishments, such as restaurants, hotels and providers of additional activities (eg. mountain biking, horse riding and hiking to waterfalls) benefit from Ruta de Las Flores, which is the largest tourist attraction in the region (MITUR, 2014).



Source: ERM, 2016

Figure 4.3-34 Map of "Ruta de Las Flores"

Hot Springs

In the department of Ahuachapán, the hot springs are another tourist attraction in the region (see Figure 4.3-35). Based on an analysis of the area around one of the most well-known hot springs - Santa Teresa Hot Springs, near the city of Ahuachapán - there is a relatively established tourist infrastructure including a series of hotels and recreation centers.

Source: La Prensa Gráfica, 2016

Figure 4.3-35 Santa Teresa Hot Springs in Ahuachapán

According to information collected in the field, the most common type of tourism in the municipalities of Ahuachapán, San Pedro Puxtla and Santo Domingo de Guzmán is ecotourism and holiday tourism. The tourism unit in the municipality of Ahuachapán reported between 20,000 to 30,000 tourists a year, while the municipalities of San Pedro Puxtla and Santo Domingo de Guzmán reported between 1,000 and 5,000 visitors per year. The hot springs mentioned above are the main tourist attraction in the municipality of Ahuachapán and one of the reasons why the number of tourists to this municipality is significantly higher.

4.3.11.2 Origin and Destination of the Tourist

There were discrepancies in the information related to the percentage of foreign and domestic tourists in the municipality of Ahuachapán. According to the tourism unit in the national mayoralty, 70% of visitors to the municipality of Ahuachapán are foreigners while dating from the hot springs of Santa Teresa, the main tourist attraction in the municipality, reported a total of 40% of foreign visitors. In the municipalities, San Pedro Puxtla and Santo Domingo de Guzmán 90% of the visitors are national.

In the municipality of Ahuachapán, the municipal mayoralty reported that the vast majority of visitors come from the US, France and Japan and that the average time in the municipality is one month. On the other hand, data from the hot springs of Santa Teresa, suggest that most foreign visitors come from other countries in Latin America. In the municipalities of San Pedro Puxtla and Santo Domingo de Guzmán most of the foreign visitors come from the US, Canada and Spain and the average stay is 8 to 15 days.

In conversations with key informants, an increase in hotel demand was reported in the municipality of Ahuachapán, while the municipalities San Pedro Puxtla and Santo Domingo Guzmán reported no changes in the hotel profile in the last five years. According to the information gathered in the participatory rural diagnosis, in Sonsonate the tourist area is being implemented, which includes a historical park and focuses on providing a cultural tourism experience. Table 4.3-22 describes the main tourist destinations in the municipalities of Ahuachapán, San Pedro Puxtla and Santo Domingo de Guzmán identified in conversations with key informants.

Table 4.3-22 Top Tourist Destinations by Municipality According to Key Informants, 2016

Municipality	*Main Tourist Destination*
Ahuachapán	• Ruta Termal • Ruta del Café • Alicante • Cabañas de los ausoles
San Pedro Puxtla	• Mirados de la Cruz • Pool of Zapote • Colonial Church • El Salto de Tequendama
Santo Domingo de Guzmán	• El Salto Escuco, • Salto de Tepechame • La Poza Encantada • Colonial Church • El Arco Natural • La Alfarería • La Cuna Natural

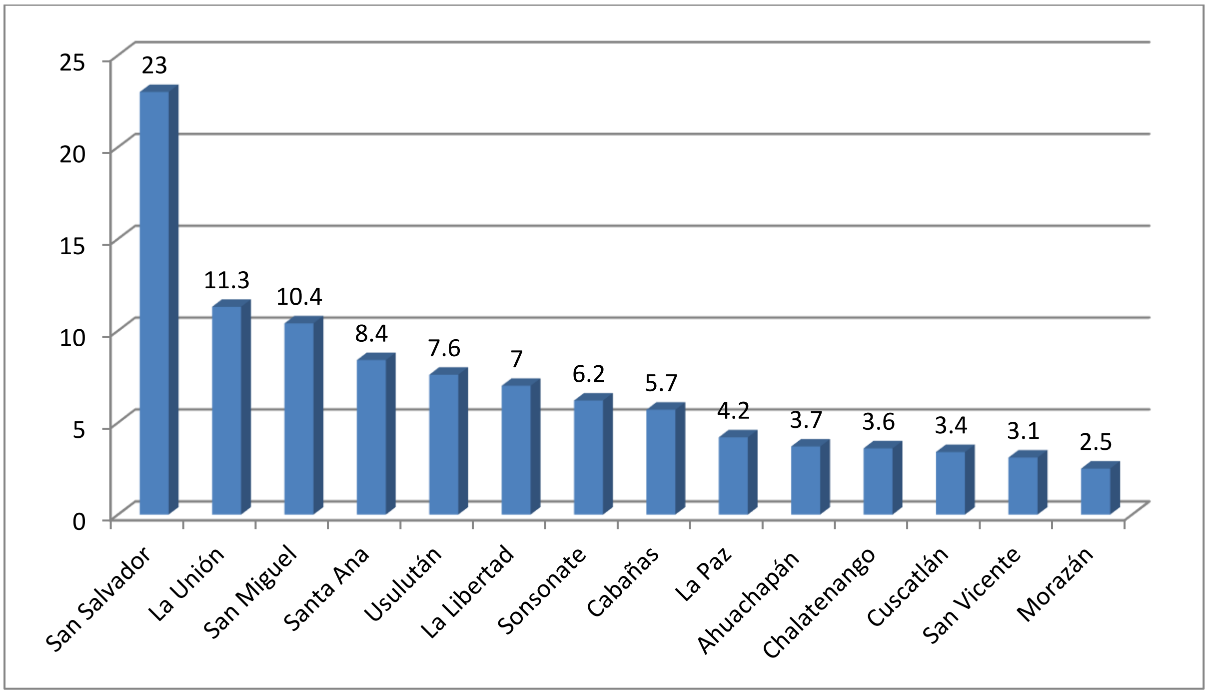
Source: ERM, 2016

According to information collected in the field, the time of greatest tourist activity in the municipality of Ahuachapán is from May to September, particularly the month of August. Similarly, the time of greatest tourist activity in the municipalities of San Pedro Puxtla and Santo Domingo are Easter, the month of August and the holidays at the end of the year.

None of the three municipalities (Ahuachapán, San Pedro Puxtla and Santo Domingo) reported threats to the tourism sector following the Project, although the individuals interviewed in the municipalities of San Pedro Puxtla and Santo Domingo de Guzmán stated that they did not know the Project in detail.

4.3.12 *Remittances*

El Salvador is one of the countries with the largest remittances in the world. The Central Bank estimates that remittances in El Salvador reached USD $ 3,969.1 million for 2013, equivalent to more than 16 GDP points (BCR, 2015). Approximately 19.8% of Salvadoran households are recipients of remittances (DIGESTYC, 2012). Between 10,000 and 20,000 households receive remittances in the departments of Ahuachapán and Sonsonate, a relatively small number when compared to the departments of Santa Ana, San Miguel and San Salvador where between 30,000 and 60,000 households receive remittances (BCR, 2015). The total population of these departments is one of the reasons for the high percentage of annual remittances and the fact that the migration phenomenon has been more intense in some departments than in others. Figure 4.3-36 shows the percentage of remittances by department.



Source: Prepared by ERM with data of BCR, 2015

Figure 4.3-36 Percentage of Remittances by Department, 2012

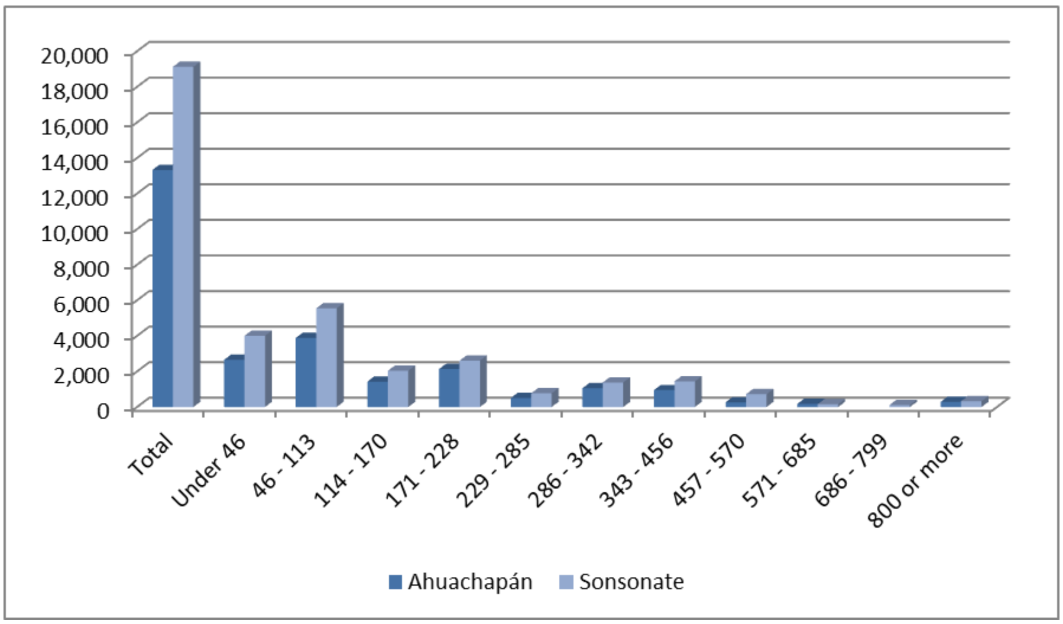
La Table 4.3-23 a continuación muestra el porcentaje de personas receptoras de remesas en el área de influencia del Proyecto.

Table 4.3-23 Percentage Remittance Receivers by Municipality

Municipalities	*Number of People*	*% Of People Receiving Remittances*
Ahuachapán	110511	5.80%
Apaneca	8383	4.50%
San Pedro Puxtla	7773	3.30%
Santo Domingo de Guzmán	7055	5.70%
Sonsonate	71541	9.90%
Acajutla	52359	8.30%

Source: Elaborated by ERM with database of the Almanac Human Development Status in El Salvador January 2009

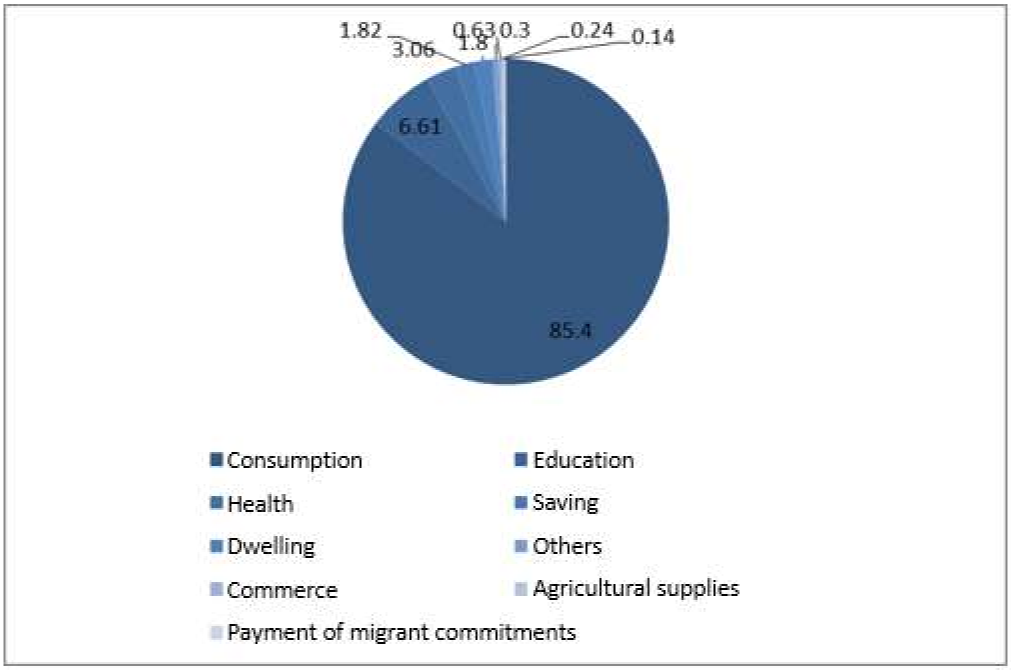
Of the households in the departments of Ahuachapán and Sonsonate receiving remittances, the vast majority receive between $ 46 to $ 113 USD (EHPM, 2012). Figure 4.3-37, reflects the total number of households receiving remittances monthly for tranches of remittances in dollars, according to department in 2012.



Source: EHPM, 2012

Figure 4.3-37 Households receiving Monthly Remittances for tranches of Remittances in US Dollars, according to Department, 2012

The main use of remittances is consumption, with 85.4% of the total. Other destinations of remittances are education, health and housing, as can be seen in Figure 4.3-38.



Source: EHPM, 2012

Figure 4.3-38 Destinations of Family Remittances, 2012

At the municipal level, the municipality of Ahuachapán receives the highest number of remittances by number of people, while the municipality of Santo Domingo de Guzmán receives the lowest percentage of remittances. The main use of remittances at the municipal level is consumption followed by health and housing.

4.3.13 *Social Infrastructure*

4.3.13.1 Access Roads

In the last 10 years, El Salvador has managed to build a road network paved with reasonable levels of service. However, the distribution throughout the territory is not uniform, particularly in the rural area. The state of the rural network becomes critical in the six months of rainy season each year, reducing accessibility, limiting the development of productive activities or access to basic social services, as well as increasing transportation costs and travel times.

In general, the territory seems to be articulated "outwardly" as detailed in the Monograph on Human Development and the Millennium Development Goals for the Municipality of Acajutla (2006). The main roads are the CA-8 that runs from San Salvador to the Department of Sonsonate, through Ataco Connection and Apaneca.

Route RN 15Sr, which runs close to San Pedro Puxtla and Santo Domingo de Guzmán, and which connects to Acajutla with the Carretera del Litoral and CA 12S, also known as Carretera Acajutla, which connects to the CA-8. In the vicinity of Ahuachapán, route 13. And undoubtedly, the best known is La Ruta de Las Flores, which runs for 36 km along the mountain range of Apaneca. Figure 2.2-4 shows the main access roads in the municipalities of the project's area of influence.

In relation to the internal roads of the municipalities, most of the roads are in bad condition or are inaccessible at some times of the year. During the baseline interviews, numerous accesses and roads were mentioned that had little or no signaling, gutters or pavement. For example, in Apaneca, the urban road network consists of 70% of paved streets, 15% of cobbled streets and 15% of rocky streets mostly in poor condition. There is also a system of rural streets and a network of neighborhood roads that unites and communicates in an accessible way the majority of Cantons and Hamlets of the Municipality. 90% of the streets are dirt, generally easily passable in the summer but become difficult to access during the winter, so you need four-wheel drive vehicles in the area.

4.3.13.2 *Traffic and Vehicle Flow*

During the interviews, the opinions regarding the flow of vehicles were varied. In Acajutla, we were informed that they did not have statistics in the municipality, that the data were at the national level managed by the deputy ministry of transport. However according to their own calculations, 100% of the traffic, 60% was industrial, 25% of inhabitants, 10% of collective services and 5% corresponding to passenger cars (Interview with municipal mayor representative, June 2016) . Santo Domingo and Sonsonate did not have statistics or information on traffic and vehicle flow; however, we were told that traffic accidents were not common.

4.3.13.3 *Traffic Accident Statistics*

There are no specific statistics of the Project area and the access roads to this area. However, according to the information collected in the field, in the department of Ahuachapán approximately 35 traffic accidents per month occur. The vast majority of these accidents are minor (or "slight") collisions. The main causes of these collisions are excessive speed or drunk drivers. In the first three months of 2016, 148 accidents were reported in the department of Ahuachapán.

According to information provided by the social promoter of the municipality of Acajutla, most traffic accidents are caused by speeding, lack of respect for traffic signage, lack of road education and pedestrian imprudence.

4.3.13.4 *Public Transport*

According to statistics from the general direction of land transport, the existing public transport terminals at the departmental level are located in (see Figure 4.3-39):

Sonsonate

- SEDAS, S.A. DE C.V. calle a Nahuilingo, cantón Las Delicias, contiguous to municipality and department of Sonsonate
- ETA, S.A. DE C.V. Final calle 15 de Septiembre, colonia Angélica, municipality and department of Sonsonate

A*huachapán*

- METAPAN- SAN FRANCISCO MENENDEZ CARRETERA CA-2 kilómetro 110, cantón Cara Sucia
- UTUA, S.A. de C.V. Kilometro 99, carretera Panamericana municipality and department of Ahuachapán

According to the Apaneca Municipal Strategic Plan 2008-2017, the municipality has a public transport service that carries out the Sonsonate-Juayua-Apaneca-Ataco-Ahuachapán Route and vice versa, through route 249, which establishes a route every 45 Minutes, being Terminal de Sonsonate its exit point.

Source: ERM, 2016

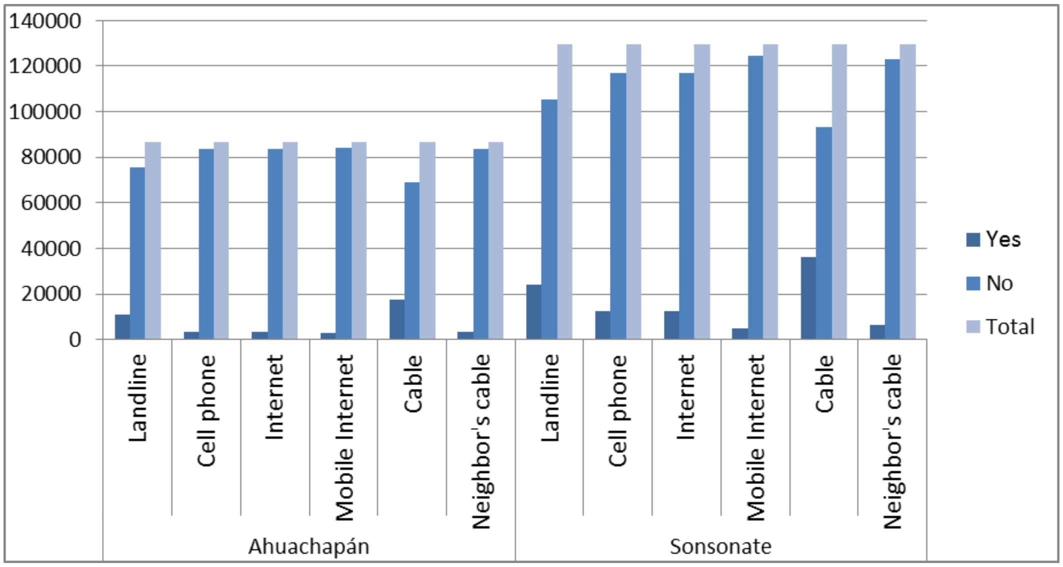
Figure 4.3-39 Apaneca Route Public Transport

In addition, there is urban transport that runs the Ahuachapán-Ataco-Apaneca route and vice versa, which establish a route every 30 minutes, being the point of departure and arrival, the Salvadoran Institute of Social Security Ahuachapán. The municipality does not have mototaxis service at an internal level. There is no public transport service to the different cantons and hamlets of the municipality.

During the interviews conducted it was possible to find out that in San Pedro Puxtla public transport connects mainly with Sonsonate and that it is limited. So, other means that are used are bicycle, car, truck or by horse. Also in Sonsonate, there is only one bus that offers services with specific schedules from 6 am, 1 pm and 4 pm.

4.3.13.5 *Telecommunications*

Telephone coverage is widespread in the area for both cell phones and landlines. This coverage is more extensive in Sonsonate than in Ahuachapán, as can be seen in Figure 4.3-40.



Source: Prepared by ERM with data of the EHPM, 2015

Figure 4.3-40 Types of communication and number of households by department, 2014

Table 4.3-24 below presents data on the type of communication of households by municipality.

Table 4.3-24 Tipos de Comunicación and Número de Hogares por Municipio, 2014

Municipality	*Type*	*Types of Communication that Homes Have by Town*		
		Yes	*No*	*Total*
Acajutla	Landline	2708	13006	15714
	Cell Phone	1201	14513	15714
	Internet	1201	14513	15714
	Mobile Internet	553	15161	15714
	Cable	5316	10398	15714
	Neighbor's Cable	661	15053	15714
Ahuachapán	Landline	4057	26702	30759
	Cell Phone	896	29863	30759
	Internet	896	29863	30759
	Mobile Internet	818	29941	30759
	Cable	6880	23879	30759

Municipality	Type	Types of Communication that Homes Have by Town		
		Yes	No	Total
	Neighbor's Cable	706	30053	30759
Apaneca	Landline	390	546	936
	Cell Phone	156	780	936
	Internet	156	780	936
	Mobile Internet	78	858	936
	Cable	390	546	936
	Neighbor's Cable	156	780	936
San Pedro Puxtla	Landline	0	2880	2880
	Cell Phone	0	2880	2880
	Internet	0	2880	2880
	Mobile Internet	0	2880	2880
	Cable	0	2880	2880
	Neighbor's Cable	0	2880	2880
Santo Domingo de Guzmán	Landline	360	1800	2160
	Cell Phone	180	1980	2160
	Internet	180	1980	2160
	Mobile Internet	0	2160	2160
	Cable	720	1440	2160
	Neighbor's Cable	0	2160	2160
Sonsonate	Landline	6608	15415	22023
	Cell Phone	3985	18038	22023
	Internet	3985	18038	22023
	Mobile Internet	546	21477	22023
	Cable	8913	13110	22023
	Neighbor's Cable	1791	20232	22023

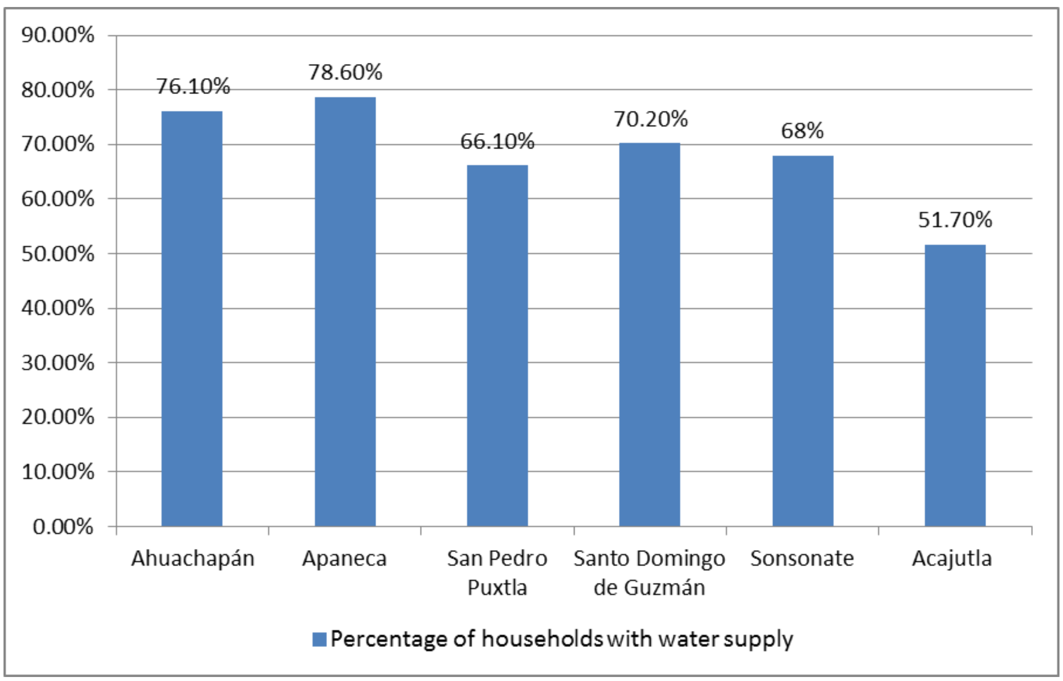
Source: Prepared by ERM with data of the EHPM, 2015

4.3.14 ***Public Health Infrastructure***

4.3.14.1 *Water and Drinking Water Treatment*

Access to water and sanitation is quite limited in the country. In 2007, only 44% of rural households were supplied with water through pipeline, of which not all were regularly served, and 18% did not have any type of health service (DIGESTYC, 2007) . Despite an urban coverage of 81% of potable water services, the continuity of drinking water supplied in most of the towns served by the National Water and Sewer Administration (ANDA) varies from 16 hours to less than 4 hours per day.

Figure 4.3-41 reflects deficiencies in the availability of drinking water in the municipalities of Acajutla and San Pedro Puxtla. The municipalities with the highest percentage of household water are the municipalities of Ahuachapán and Apaneca, with 76.10 and 78.60% respectively. To complement the analysis, Figure 4.3-41 presents the type of water supply in homes without water in the departments of Ahuachapán and Sonsonate. In the department of Ahuachapán, the vast majority of people use the haulage of a neighbor's pipeline as their main source of water, followed by the water eye, river or ravine and the use of a pillar or public jets. In the department of Sonsonate, a large number of people use a private protected well, followed by the use of a neighbor's pipeline and, finally, the use of a well with private pipe.

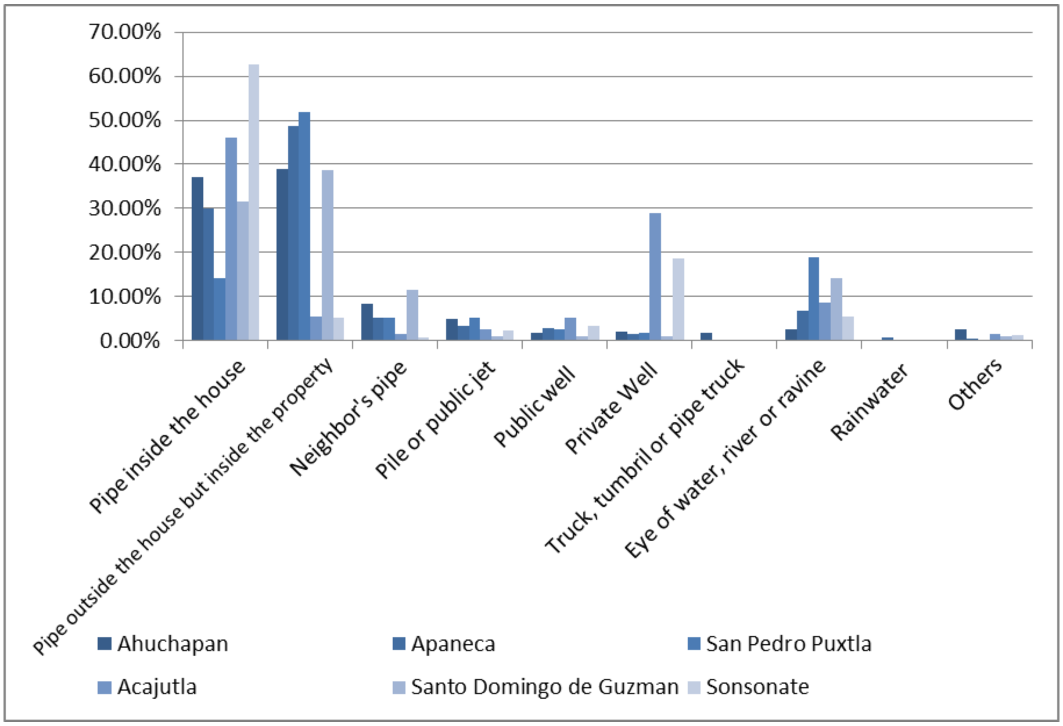


Source: Elaboration of ERM with database of the Almanac Status of Human Development in the Municipalities of El Salvador, 2009

Figure 4.3-41 Percentage of Homes with Household Water by Number of Homes, 2009

According to the participants of the participatory rural diagnosis, in Santo Domingo the quality and quantity of water has decreased due to the drought of the upper parts of the river basin. In Sonsonante, indicated that depending on the geography did have water resources but that is not suitable for human consumption because it is contaminated by pesticides and coliforms. In Apaneca it was indicated that the water comes from the sector of Ataco and that the water of the birth La Gloria is of good quality as the eyes of water.

Figure 4.3-42 presents the type of water supply in homes that do not have household water, according to the municipality.

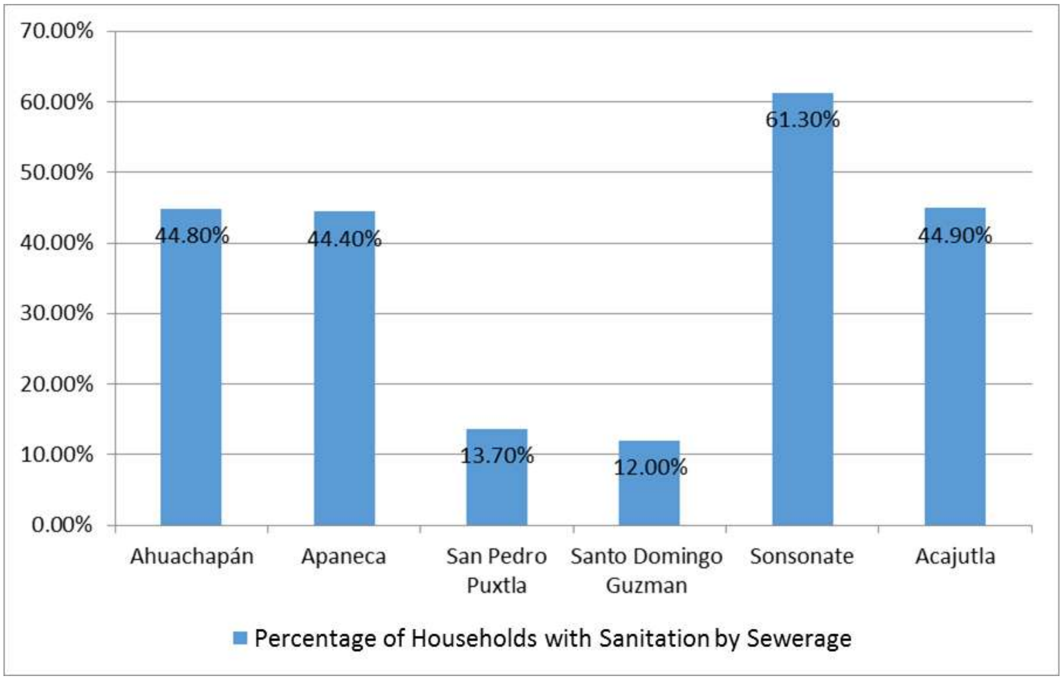


Source: Census of Population and Housing, 2007

Figure 4.3-42 Type of Water Supply in Homes without Home Water, by Municipality

4.3.14.2 *Treatment and Management of Wastewater*

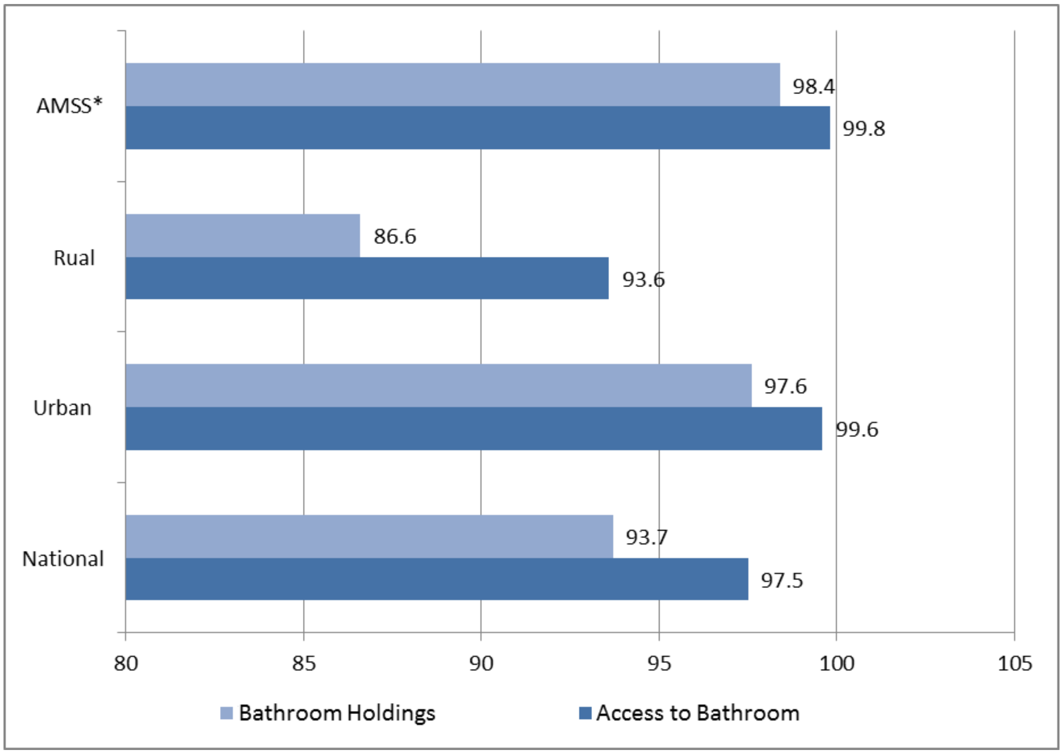
The percentage of dwellings with sanitation by sewage in the six municipalities in the area of influence is limited. In the municipalities of Santo Domingo de Guzmán and San Pedro Puxtla less than 15% of the houses have sanitation by sewage system and only in the municipality of Sonsonate more than 50% of the houses have this type of service. Figure 4.3-43, details the percentage of houses with sewerage sanitation.



Source: Elaboration of ERM with database of the Almanac Status of Human Development in the Municipalities of El Salvador, 2009

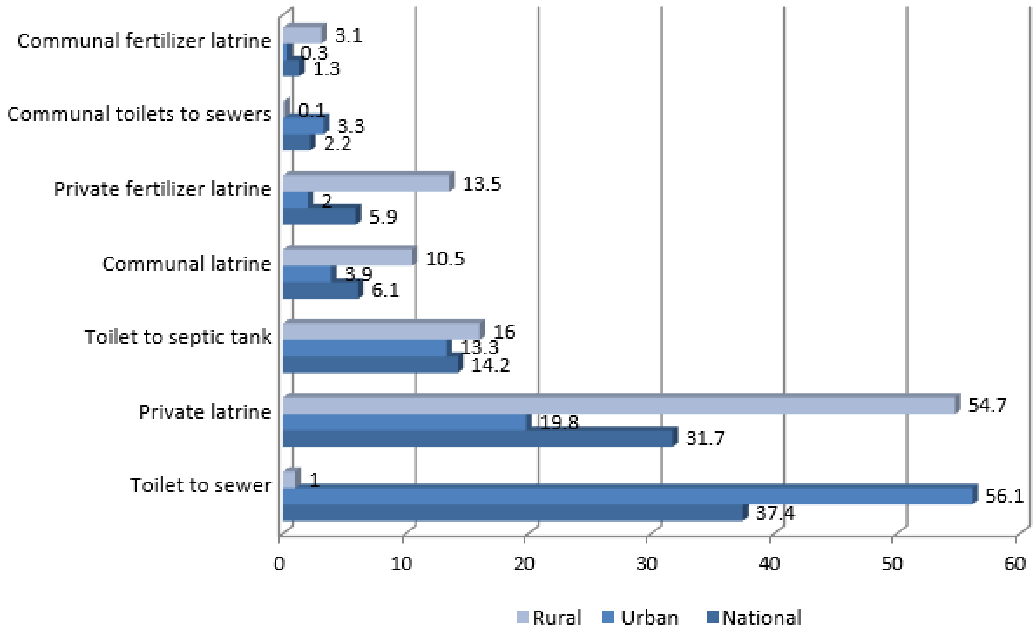
Figure 4.3-43 Percentage of Housing with Sanitation by Sewage, 2009

EHPM of 2014 reveals that the percentage of households with health service tenure (inside or outside the home) is 93.7% nationally. Access to health services, including through a relative or friend, is highest in the metropolitan area of San Salvador, followed by urban areas and, finally, rural areas. The type of health services that are accessible also varies according to the national geography. In urban areas, 56.1% of inhabitants have access to a toilet in the sewage system, while in urban areas 54.7% of the inhabitants have access to private latrines. Figures 4.3-44 and 4.3-45, reflect the percentage of households with access and possession of health services, by geographical area, and the type of health service.



Source: EHPM, 2015
Key: AMMS = Metropolitan Area of San Salvador*

Figure 4.3-44 Homes with Access and Tenancy of Health Service, According to Geographical Area, 2014

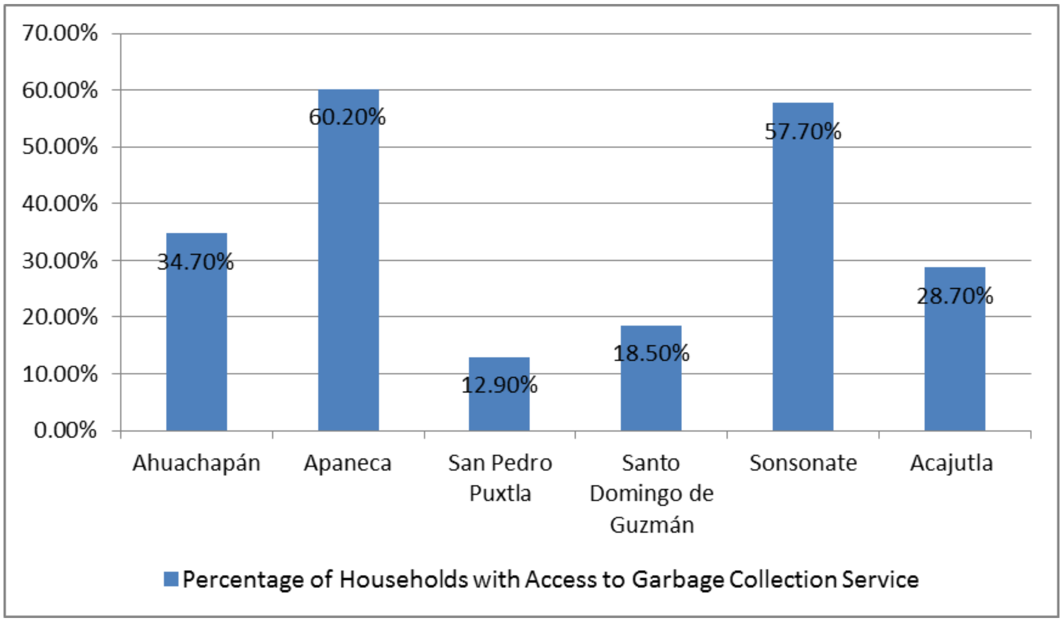


Source: EHPM, 2015

Figure 4.3-45 Households by Type of Health Service to Which They Have Access, According to Geographical Area, 2014

4.3.14.3 Solid Waste Management and Treatment

In Apaneca 60.20% of homes have a garbage collection service and in Sonsonate the percentage reaches 57.70%. However, data for the other four municipalities continues to indicate gaps in household infrastructure. In the municipalities of San Pedro Puxtla and Santo Domingo de Guzmán, less than 15% of the homes have garbage collection services. Figure 4.3-46, details the percentage of households with access to this service by municipality.



Source: Elaboration of ERM with database of the Almanac State of Human Development in the Municipalities of El Salvador, 2009

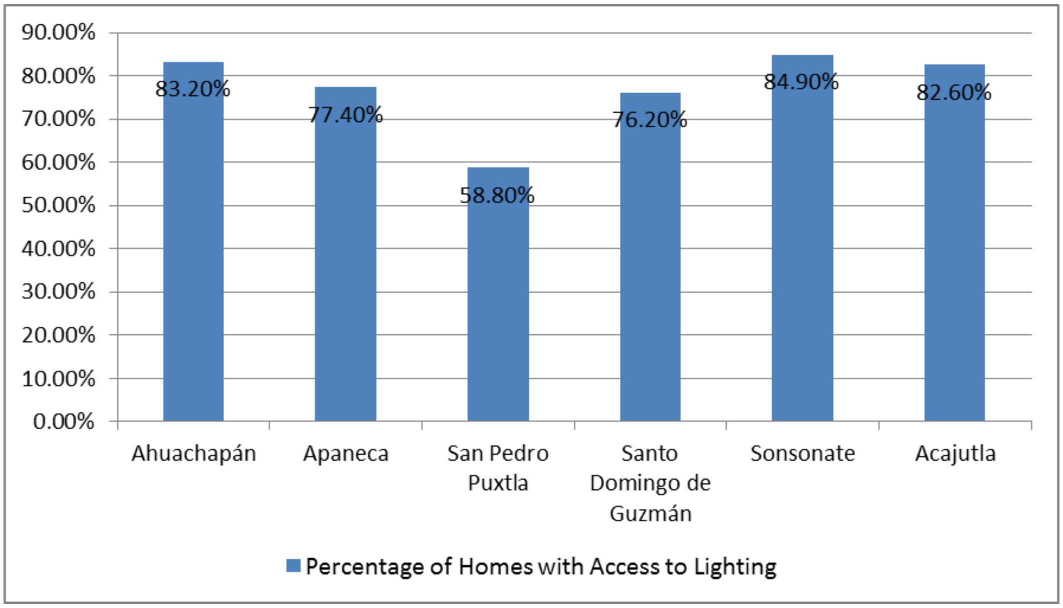
Figure 4.3-46 Percentage of Households with Access to Garbage Collection Service, 2009

4.3.15 *Energy Infrastructure*

4.3.15.1 Electricity

Despite an improvement in electricity supply in the country, it is still limited compared to other countries in the area, mainly in rural areas. During the 2007 Census, about 87,000 households had no access to electricity. Figure 4.3-47, reflects the percentage of households with access to lighting service by municipality.

According to the official report on the State of Human Development in El Salvador (2009), more than half of the homes in the municipalities in the area of influence have lighting. The municipality of Sonsonate has the highest percentage of houses with lighting (84.90%) and the municipality of San Pedro Puxtla has the lowest percentage (58.80%). Despite having a low percentage of homes with access to waste collection and sewage collection services, the municipality of Santo Domingo de Guzmán reported a significant number of homes with lighting (76.20%).



Source: Elaboration of ERM with database of the Almanac Status of Human Development in the Municipalities of El Salvador, 2009

Figure 4.3-47 Percentage of Homes with Lighting, 2009

4.3.15.2 Fuel

In all municipalities in the Project's area of influence, propane gas was reported as the most commonly used fuel type. Fuelwood was also recorded as a common fuel type and, for example, during the participatory rural diagnosis in Ahuachapán, it was reported that fuelwood consumption has increased by 80-90%. A small number of people reported not using any fuel.

Table 4.3-25 shows the type of fuel used in the houses in the area of influence of the Project.

Table 4.3-25 Type of Fuel Used by Households, by Municipality, 2009

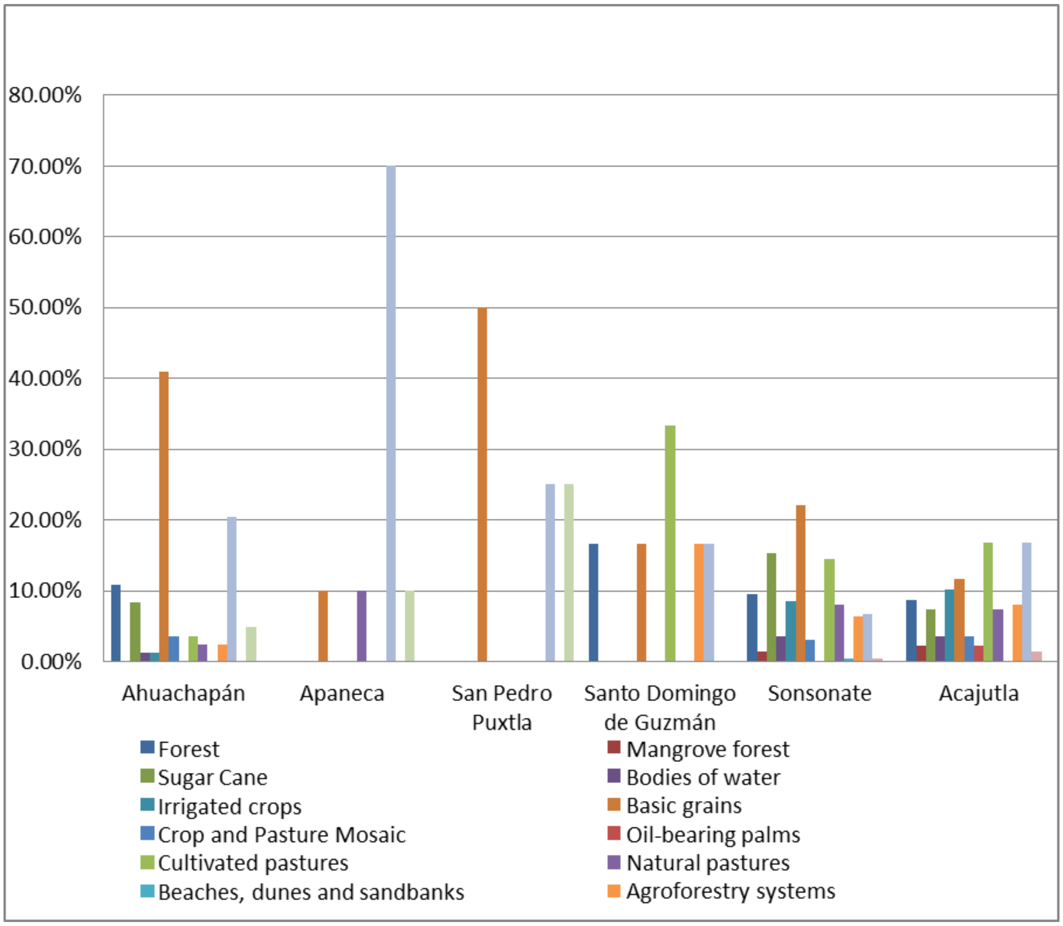
Municipality	*Detail*	*Number of households*
Acajutla	Electricity	0
	Kerosene (gas)	0
	Propane gas	12,966
	Firewood	2,415
	Charcoal	0
	None	333
	Other	0
	Total	***15,714***
Ahuachapán	Electricity	0
	Kerosene (gas)	0
	Propane gas	25,469
	Firewood	3,820
	Charcoal	0
	None	1,470
	Other	0
	Total	***30,759***
Apaneca	Electricity	0
	Kerosene (gas)	0
	Propane gas	780
	Firewood	156
	Charcoal	0
	None	0
	Other	0
	Total	*936*
San Pedro Puxtla	Electricity	0
	Kerosene (gas)	0
	Propane gas	1,920
	Firewood	960
	Charcoal	0
	None	0
	Other	0
	Total	***2,880***
Santo Domingo de Guzmán	Electricity	0
	Kerosene (gas)	0
	Propane gas	1,620
	Firewood	540
	Charcoal	0
	None	0
	Other	0
	Total	***2,160***

Municipality	*Detail*	*Number of households*
Sonsonate	Electricity	237
	Kerosene (gas)	0
	Propane gas	18,727
	Firewood	2,451
	Charcoal	0
	None	608
	Other	0
	Total	***22,023***

Source: Almanac Status of Human Development in the Municipalities of El Salvador, 2009

4.3.16 *Soil Use*

According to data from the European Environment Agency, soil uses in El Salvador vary significantly between rural areas, where the most common use corresponds to productive activities (agriculture), and urban areas, where most common soil use is a mixture of urban tissue, crops and pastures. In the municipalities of the area of influence, with the exception of the municipality of Apaneca, agriculture (specifically the cultivation of basic grains) is the most common land use. The cultivation of sugar cane is significant in the municipalities of Santo Domingo de Guzmán, Sonsonate and Acajutla, while the use of soil in the municipality of Apaneca is, in the majority, urban fabric. Only the municipalities of San Pedro Puxtla and Ahuachapán have a significant percentage of forest. Figure 4.3-48 illustrates the type of soil uses by municipality.



Source: ERM, 2016

Figure 4.3-48 Types of Uses of Soils by Municipality

Figure 4.3-49 shows the soil uses in the area of influence of the Project, as well as the type of crop that is carried out.

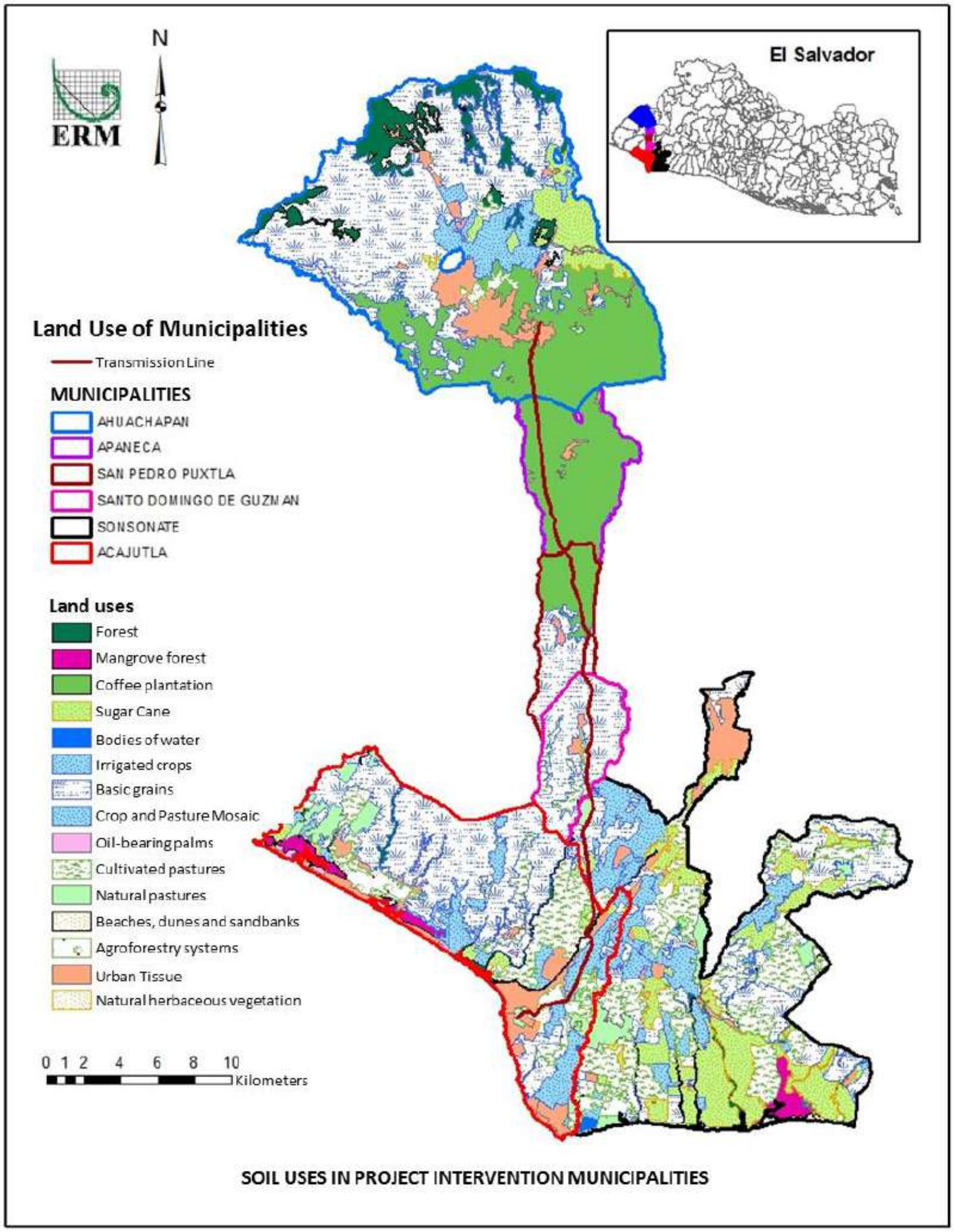


Figure 4.3-49 Soil Use in Municipalities

4.3.17 ***Institutions and Social Networks***

4.3.17.1 *Religious Organizations*

The main social networks in El Salvador were identified as the family and the church. In the area of influence of the Project these conditions are similar to the rest of the country. As mentioned above, the Catholic religion continues to be the most predominant religion in El Salvador. Cultural expressions and festivals of the municipalities of the area of influence are intimately related to Catholicism. Based on fieldwork, it is known that there are a multitude of churches in the area of influence. The Church of God, the Jehovah's Witnesses, the Apostles and Prophets Church, the Adventist Church, the Lutheran Church, the Holy Baptist Church, the Prince of Peace Church, the Pentecostal Church, the Assemblies of God, the Church of Universal Prophecy and the Church of Latter-day Saints. Figure 4.3-50 shows some of the churches in the municipalities of Ahuachapán, San Pedro Puxtla and Santo Domingo de Guzmán.

Ahuachapán	
	
Catholic Church	*Amosite Church*
	
First Baptist Church	*Church of the Saints of the Last Days*

Elim Church

Universal Church

Santo Domingo de Guzmán

Seventh-day Adventist Temple

Evangelical Monte Gerizim Temple, Assemblies of God

Glory to Christ, Christ Calls You

Prince of Peace Church

<table>
<tr><td></td><td></td></tr>
<tr><td>Catholic Parish Church</td><td>Mount Horeb Evangelical Church, Mission</td></tr>
<tr><td colspan="2">San Pedro Puxtla</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td>God's Church</td><td>Church of God is Love</td></tr>
</table>

Source: ERM, 2016

Figure 4.3-50 Churches, by Municipality, 2016

According to interviews with representatives of three religious institutions in the municipalities of Ahuachapán and Santo Domingo de Guzmán there are four Catholic parishes in the municipality of Ahuachapán while the municipality of Santo Domingo de Guzmán has only one evangelical church. The great majority of those attending these churches correspond to individuals of various Christian denominations who attend the parish closest to their home. In the two municipalities Sunday is the day where the highest percentages of individuals gather in the parishes.

4.3.17.2 *Civil Society Organizations*

In the municipalities of the area of influence there are different non-governmental organizations dedicated to the provision of social services, such as Doctors of the World, Geologists of the World, Red Cross or Funsalproded, among others. Other civil organizations include community associations, where community dwellers in neighborhoods, settlements, villages and cantons meet to discuss problems and needs of their community. Generally, mayoralties municipalities are in charge of accrediting and encouraging the formation of these Salvadoran Community Development Associations (ADESCOS) in the cantons and hamlets that request it. The establishment as ADESCOS allows these organizations to seek financing for their communal projects of water, electricity and latrines, among others. Chapter 8 Public Participation describes the identified organizations. Table 4.3-26 lists the organizations present in the municipalities of Ahuachapán, San Pedro Puxtla and Santo Domingo de Guzmán according to interviews with key stakeholders.

Table 4.3-26 Present Organizations in the Municipalities of the Area of Influence

Institution	*Performing Main Activity*
Ministry of Livestock (MAG)	Provide assistance to programs of agricultural development and control and management of natural resources.
Ministry of Health (MINSAL)	Provide medical assistance to urban and rural areas.
Attorney General of the Republic	Persecute federal order crimes.
Attorney for the Defense of Human Rights	Ensures the rights of men, women, children and young people.
Salvadoran Institute of Social Security (ISSS)	Health care service for public employees and affiliated private sector.
Integral Youth Development Center (CID)	It helps young people with behavior problems.
National Center of Agricultural Technology	Technical assistance to farmers.
Immigration Office	Assistance on the customs measures of entry and exit of the country.
Terrestrial Customs	Control the inputs and outputs of both goods and individuals.
Fire Department	Ensure the safety of the population and of the forest areas in irrigation of fires and other emergencies.
Departmental Governance	Control the work carried out by the different communes of the different municipalities.
Salvadoran Foundation for the Elderly (FUSATE)	Provide support and security to the elderly.
Civil National Police (PNC)	Provide security to the entire population.
National Post Office Branch	Provide national and international courier service.
Citizen Security	Form citizen security groups in the urban and rural sector to safeguard their resources.
Social Investment Fund for Municipal Development	Provide financial support to a variety of projects including local development assistance.
Ministry of Tourism	Information and assistance on tourist sites of the municipality.
Ministry of Education (MINED)	Assistance to the educational centers of the municipality.
Corporation of Municipalities of El Salvador (COMURES)	Support of guilds of the municipalities.
Departmental Council of Mayors	Support to municipal mayoralties.
Salvadoran Ecological Unit (UNES)	NGO dedicated to the protection and conservation of the environment in El Salvador.
Foundation for Socioeconomic Development (FUNDESYRAM)	Assistance for socioeconomic development and environmental restoration (urban and rural).
CARITAS	Assistance to vulnerable people.
Cooperative of the United States of America (CLUSA)	National cooperation for corporate assistance.
Salvadoran Pro-Health Association (ASAPROSAL)	Medical assistance in rural areas.
Social Investment Fund for Local Development (FISDL)	Financial investment for local development.
Salvadoran Red Cross	Prevent and alleviate human suffering.
Korea International Cooperation Agency (KOICA)	Financial assistance for social development programs.

Institution	*Performing Main Activity*
Japan International Cooperation Agency (JICA)	Financial assistance for development programs.
German Cooperation (GIZ)	Financial assistance for development programs.
Salvadoran Foundation for Coffee Research (PROCAFE)	Private institution dedicated to the research and transfer of technology related to coffee.

Source: ERM, 2016

4.3.18 *Citizen Security and Crime*

The deteriorating economic situation in the country has exacerbated the lack of opportunities for access to formal employment and social services for the general population and for young people in particular. Since the beginning of this decade, violence in El Salvador has been increasing, especially since 2008. The most prevalent crimes in the country, according to data from the General Direction of Prisons are homicide and robbery (Ministry of Justice and Public Security, 2012). The phenomenon of maras[7] and extortion are common, to such an extent that in August 2015 the Supreme Court declared terrorist groups to the so-called Mara Salvatrucha and Barrio 18 (BBC Mundo 2015) gangs. With some 72,000 members, the Salvadoran gangs are responsible for 16 daily murders, 220 in just one week - the deadliest of the century and 3,828 dead in 2015 (BBC Mundo, 2015).

At the national level, 12.46% of Salvadorans reported being victims of a robbery (LAPOP, 2012). This is equivalent to approximately 779,000 Salvadorans. However, there were only 5,521 denunciations reported in official administrative records (Judicial Branch 2012). As to the homicide rate, in January 2010, 72 homicides were reported for every 100,000 people (UNDP 2011). In addition, 90% of the population reported feeling insecure in public places (IUDOP, 2009, Prado, 2009).

According to interviews with representatives of the national police (PNC) in the municipalities of San Pedro Puxtla, Santo Domingo de Guzmán and Ahuachapán, the municipality of Ahuachapán has the highest number of security personnel (80 security agents), who are sometimes accompanied by soldiers of the Military Detachment No. 7. In 2014, 130 homicides were reported in the department (see Tables 4.3-27 and 4.3-28).

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[7] Those stable youth groups that have a group identity built through participation in violent or criminal acts, and which offer patterns of identification to their members that allows them to organize their daily lives.

Table 4.3-27 Homicides in the Department of Ahuachapán, by Municipality and Sex, 2014

Department	Municipality	Year	Sex			
		Number	M	W	NA	Total
Ahuachapán	Ahuachapán	23	22	1		23
	Apaneca	1	1			1
	Atiquizaya	19	17	2		19
	Concepción De Ataco	2	2			2
	El Refugio	8	8			8
	Guaymango	3	3			3
	Jujutla	12	9	3		12
	San Francisco Menéndez	28	24	4		28
	San Lorenzo	9	9			9
	San Pedro Puxtla	2	2			2
	Tacuba	16	15	1		16
	Turín	7	6	1		7

Source: PNC, 2016
Key: M = Men; W = Women; NA = Not Available.

On the other hand, the municipality of Santo Domingo de Guzmán has the lowest number of security personnel (10 security agents). In Acajutla they have 15 national and 6 municipal police. The number of homicides in 2014 in Acajutla was 24 (see Table 4.3-28). The total departmental reached 299 people.

Table 4.3-28 Homicides in the Department of Ahuachapán, by Municipality and Sex, 2014

Department	Municipality	Year	Sex			
		Number	M	W	NA	Total
Sonsonate	Izalco	68	64	4	–	68
	Nahuizalco	50	47	3	–	50
	Armenia	43	41	2		43
	Sonsonate	33	28	5	–	33
	Acajutla	24	20	4	–	24
	San Julián	18	16	2	–	18
	Juayua	15	15	–	–	15
	Caluco	14	14	–	–	14
	Nahulingo	11	11	–	–	11
	Sonzacate	7	5	2	–	7
	San Antonio Del Monte	5	5	–	–	5
	Santa Isabel Ishuatan	4	4	–	–	4
	Salcoatitan	3	3	–	–	3
	Cuisnahuat	2	2	–	–	2

Department	Municipality	Year	Sex			
		Number	M	W	NA	Total
	Santa Catarina Masahuat	1	1	–	–	1
	Santo Domingo De Guzmán	1	1	–	–	1

Source: PNC, 2016
Key: M = Men; W = Women; NA = Not Available.

All municipalities reported not having the necessary staff to cover all areas. The most relevant safety aspects in these three municipalities are: accident prevention, homicide and robbery. In Acajutla, vehicle theft and gang activity were reported as common crimes. Extortions were mentioned as common. The municipality of Ahuachapán also reports the drug traffic in the borders as one of the main security problems in the municipality. In interviews with the secretary of the Court of Peace in Santo Domingo, it was pointed out that the main problem in the municipality is the friction between the neighbors for property issues and trespassing, inheritance and land rights disputes, among others.

Data collected in the field suggest changes in crime rates in the last five years. All municipalities reported a significant increase in the number of homicides in rural areas as a result of gangs or criminal gangs (maras). In addition, there was an increase in the presence of gangs (maras) in rural areas. Table 4.3-29 illustrates those sites in the municipalities of Ahuachapán, San Pedro Puxtla and Santo Domingo de Guzmán, which were reported during interviews with key informants as particularly dangerous.

Table 4.3-29 High Risk Areas, by Municipality, 2016

Municipality	*High Risk Areas*
Ahuachapán	• Colonia Zacamil • Los Magueyes • Colonia San José • Markets • Casería La Laguna • Rural área of El Barro, El Campestre, Tacuba and Atiquizaya • The road Santa Ana – Ahuachapán.
San Pedro Puxtla	• El Cortez • El Durazno • La Concepción
Santo Domingo de Guzmán	• El Zarsal • The border between San Pedro Puxtla and Santo Domingo de Guzmán.

Source: ERM, 2016

4.3.18.1 Gender Violence

The second national report on the situation of violence against women in El Salvador (ISDEMU, 2010) identifies gender violence as a public security problem in the country. In 2010 there were 33 violent deaths of women in Ahuachapán, and 79 in Sonsonate (ISDEMU, 2010). There are no data at the municipal level.

The women's unit in Acajutla is created in 2009. In the interview with the Coordinator of the Unity of Women in Acajutla tells us that:

> *"Through the collection of statistical data from some institutions (Courts, Police, and ISDEMU-Salvadoran Institute for the Development of Women), on the demands made by women who have suffered some type of violence, have succeeded in supporting these women, offering Information on their rights, alternatives for economic independence and finally including them in small business development programs "(Semi-structured interview, June 2016).*

A series of programs have been developed, such as training programs to obtain economic autonomy or the formation of student circles in violence prevention with schools.

4.3.19 ***Landscapes and Views***

The area where the project will be developed is located in the departments of Ahuachapán (in the municipalities of Ahuachapán, Apaneca and San Pedro Puxtla) and Sonsonate (in the municipalities of Santo Domingo de Guzmán, Sonsonate and Acajutla). This part of the western section of the Sierra de Apaneca, in the southwest of El Salvador, houses an extensive coffee growing landscape and contains patches of natural forest located between the coffee plantations.

Throughout the project line, three well-defined topographic (altitudinal) scenarios were identified, constituting three relatively homogeneous regions in landscape and agricultural management (see *Section 4.1.2.2 - Topography and Soils*). These three regions are:

Middle-High Mountain Region: This region is mainly made up of mountain landscapes, hills and slopes of the Salvadoran volcanic mountain range that generate a profuse network of shallow drainage and almost parallel or slightly radiate. These are oriented parallel to the TL axis, and are located mainly in the northern region of the trace, which belongs to the Humid Forest and Mountain ecosystem. In this region, the TL corridor crosses first-line coffee plantations in the municipalities of Ahuachapán and Apaneca (see Figure 4.1-4).

Lower Mountain Region: This region is characterized by a slightly undulating relief that, within the corridor of the TL, corresponds to the terminal areas of the system of low hills that move from the northern slopes of the mountain range and are located mainly in the central sector of the TL in east-west direction of its axis. This region belongs to a Humid Forest ecosystem, and the TL corridor crosses by minor or seasonal crops in the municipality of San Pedro de Puxtla and seasonal crops and pastures in the municipality of Santo Domingo de Guzmán (see Figure 4.1- 4).

Coastal Plain Region: This region is characterized by a flat relief and the topographic configuration that varies from flat to slightly undulating, with slopes that do not exceed 15%. In this region, the corridor of the TL crosses the municipalities of Sonsonate and the northern part of Acajutla by seasonal crops and pastures. In the southern part of the municipality of Acajutla, the corridor crosses the urban area of Acajutla. This region belongs to a dry forest ecosystem (see Figure 4.1-4).

4.3.20 *Cultural, Archaeological, Ceremonial and Historical Resources*

The systematic record of cultural, archaeological, ceremonial and historical (cultural heritage) resources in El Salvador is limited and most formal studies and their results remain the exclusive domain of a relatively small group of specialists. Monumental settlements such as San Andrés, Tazumal and Cerén of the Post-Classic Maya Period are widely considered significant. However, the Pipiles (Nahoa) are the pre-Hispanic group with which the Salvadorans identify more strongly. With a boom around 1200 AC, the Pipil material culture is quite common, although scarcely associated with monumental architecture. The Pipiles arrived in El Salvador from the central valley of Mexico after the Mayan decline and their lithic and ceramic artifacts are highly valued for their aesthetic quality as well as indicators of regional chronological horizons.

The corridor proposed for TL is relatively close to significant pre-Hispanic resources such as Santa Leticia, San Benito, El Carmen, Tacuzcalco and Los Tablones. Of these, Santa Leticia is a place of first order in the vicinity of the present town of Apaneca, especially recognized by its "Barrigones," anthropomorphic sculptures carved on basalt or andesite and the remains of a village of hundreds of hectares of extension.

The baseline description below was developed from the following sources:

- Current knowledge about the region as identified through bibliographic search and consultations and conversations with national and international experts.
- Findings of a field survey campaign in the Project's area of influence.
- Estimation of baseline conditions from the first two partial sources; that is, to calculate a possible but not yet confirmed inventory of resources present in the Project area for terrestrial and underground resources.

Through the bibliographic search and consultation with experts, 30 archaeological sites were identified and cataloged in the National Cultural Heritage Registry in the vicinity of the Project area. To these are added the results of the baseline recognition, which identified 13 new terrestrial cultural resources, all of them archaeological prehispanic. No living heritage resources or architectural heritage resources were identified. It is considered that all cultural resources identified in the Project area are of medium or low sensitivity.

A bibliographic search and consultations with the Directorate and specialists of the Museum of Natural History of El Salvador were also carried out to complete the paleontological inventory of the project area.

4.3.20.1 *Methodology*

The baseline study of cultural heritage was carried out in three phases:

- Background Investigation
- Field Surveys
- Data Analysis

In the following sections, a brief explanation of each of these phases is provided.

Definitions of Cultural Heritage Resources

In the study, the following definition of cultural heritage is used:

- Objects, properties, sites, structures or groups of tangible structures, movable or immovable structures with archaeological (prehistoric), paleontological, historical, cultural, artistic and religious values.
- Natural features or unique tangible objects embodying cultural values, such as landscapes, groves, rocks, lakes and waterfalls.

Based on baseline field results, the following project specific resource categories have been used:

- **Isolated Cultural Heritage Resource:** An individual cultural resource not associated with any additional cultural resource or feature of cultural landscape. Examples of isolated cultural heritage resources include individual archaeological artifacts, an individual sanctuary along a path, an isolated tomb, an isolated rock cairn or a small mound of stones. It is also called an "isolated finding".
- **Cultural Heritage Site:** A group of resources or related cultural heritage artifacts, or a single or complex large cultural heritage resource, with well-defined boundaries. Examples of cultural heritage sites include a spatially discrete archaeological dispersion of artifacts, a dispersion of artifacts and associated mounds, a historical dwelling and associated structures, a cemetery, a church and associated structures, or a group of works 9f historical engineering associated with a banana plantation. It is also called "site".
- **Group of Cultural Heritage Sites:** A group of cultural heritage resources or related cultural heritage sites. Examples include multiple artificial mounds connected by a diffuse dispersion of artefacts, a series of dispersions of archeological artifacts separated by arbitrary boundaries created by differences in surface visibility, a group of historical constructions and structures (eg a historic district), a series of

archaeological sites temporarily related to adjacent geographic features, or a group of sites or locations or ritual sites that include a sacred landscape.

Cultural Heritage Site Groups usually consist of multiple Cultural Heritage Sites and Isolated Cultural Heritage Resources; here is called each part of the whole greater "Site Group Component". These categories encompass a wide variety of archaeological, historical and living cultural heritage resources.

Background Investigation

A cultural heritage background survey was conducted prior to field surveys with these objectives:

- Collect information on the location and characteristics of known cultural heritage resources.
- Identify specific known cultural heritage resources in areas affected by the Project.
- Determine the geographic coverage of previous cultural heritage surveys.
- Develop a cultural context for El Salvador in which to assess the importance of the new resources identified during the field survey.

The background research was divided into three categories: archeology, architectural heritage and paleontological heritage.

<u>Archeology</u>

Bibliography and reports of previous academic research in El Salvador were examined. The objectives of the bibliographic analysis were to confirm and document our understanding of the regional cultural context, to gather details about the chronological periods established in the archeology of El Salvador and to gather information on archaeological resources previously identified in the country. The bibliographic analysis provided data on the geographical extent of previous archaeological research. He also confirmed that much of the best-known research has focused on the remnants of Mayan communities and monumental architecture; while relatively little research has been conducted focusing on the later Pipil-Nahoa occupation.

The governing body for matters related to tangible cultural heritage is the Secretary of Culture of the Presidency (SECULTURA) through its archeology section. SECULTURA has established a classification based on the chronology, scale and monumentality of cultural heritage sites. However, classification procedures, regulations or formal rules have not been published. However, it is routine that only archaeological sites with a certain level of monumentality (first order) are excavated or investigated, while the rest are only located, classified and recorded.

In total, 26 categories of possible archaeological resources were identified, including: isolated finding, artifact dispersal, stone mound, mound of dirt, isolated megalith, megalith complex, sepulcher, tomb, cemetery, cave, rock shelter, shells, rock carvings, cave paintings, camp, farmhouse, workshop, elite residence, room to be determined, fortress, domestic structure, religious structure, dump, open oven, closed oven, ball court.

In this way, a total of 30 sites previously documented in the National Cultural Heritage Registry were reviewed, all included in Appendix J, Previously Documented Cultural Heritage Resources. SECULTURA classifies one of these pre-hispanic sites, Santa Leticia in Apaneca, as first order, the rest are classified as pre-hispanic second order.

<u>Architectural Heritage</u>

Prior to the field survey, the team contacted staff from the Department of Archeology of the Ministry of Culture (SECULTURA), the Head of the National Museum of Natural History (who coordinates Paleontology activities in the country), and internationally recognized experts on cultural heritage resources and the archaeological potential of the direct influence area. The team also carried out a cabinet study to identify heritage resources with historical value for El Salvador, whether officially recognized or not.

<u>Paleontological Heritage</u>

Before the field survey, the team contacted the Director of the National Museum of Natural History (who coordinates Paleontology activities in the country) and internationally recognized experts on the paleontological heritage resources of the direct influence area. A joint study of field and cabinet was coordinated, to be carried out by assigned personnel of the Museum.

Field Surveys

The baseline team consisted of three Salvadoran specialists and the Principal Investigator, who has a PhD specialized in Latin American archeology, with extensive experience in Central America. The baseline survey consisted of two field survey efforts: one for archeology and one for paleontological heritage. The archaeological survey along the trajectory on which the right of way of the right of way could be established was divided into sections defined by the location of the proposed towers. The paleontological heritage field survey consisted of a baseline survey register in parallel with the archaeological work. Sites of living heritage, such as cemeteries, shrines and monuments, were recorded as they were being found.

<u>Archeology</u>

The archaeological survey was of non-intrusive pedestrian or "on foot" recognition. The field team systematically walked through the prospection areas and surveyed the soil surface for evidence of cultural heritage resources, such as dispersions of artifacts, remnants of structures or ruins, or modifications of the natural landscape features made by humans. When archaeological resources were found, they were documented in the field through narrative notes, digital photographs and portable Global Positioning System (GPS) units. A systematic strategy established by Sanders, Parsons and Santley (1979) but quantitatively developed (Drennan et al., 2003; Haller, 2004; Roman-Lacayo, 2013) was used to establish a comparative numerical figure for the relative densities of the findings. In summary, surface fragments were interpreted as indicators of pre-Columbian and historical human activity. The distribution density thereof can be used as a measure of relative occupancy intensity. In general, more intensive occupations are related to greater permanence over time, or greater access to these resources or both. The areas to be characterized were divided into arbitrary parcels of land of 100 meters long by 38 meters wide of the right of way (0.38 ha). Two types of surface materials were collected: general and systematic. The entire route was made in 25 sections, called T1-T25 and associating each finding with its georeferenced position, parking in accordance with the topographic demarcation and assigning a corresponding single ordinal.

When a member of the team found ceramic or lytic fragments, the point was marked with GPS (using WGS84) and the surrounding area was examined more closely to establish if the density was greater than 1 m2. If the density was lower, a general collection was made, marking the area of the parcel of land up to 20 objects per parcel. When the density was higher, a systematic collection was made at a point where a circle of three meters in diameter (7,065 m2) could be established within which all anthropic materials were collected. In this way, it is possible to establish the relative density for each parcel of land in a systematic way, including distributions of diagnostic materials. This general field survey strategy was adapted to the local conditions of each section in the trace.

Each lot, representing a collection unit, was labeled with its position, date, method of collection (general or systematic) in a bag (or more when the quantity or size of objects required it).

In addition to the surface collections, observations were made of vestiges such as mounds, peculiar distributions of materials, and other features that in El Salvador typically indicate anthropic activity in the historic and pre-Columbian past. All of them were photographed and georeferenced to facilitate future use of the information.

A broad criterion was used in the classification of the region of the direct impact area of the project, using as main indicators the use of the soils and associated vegetation, as well as their elevation, precipitation regime and average temperature. Because of the ease of mobilization on the ground, three areas were established to simplify the context on which the field work was developed:

- **Lowlands (about 24 km):** The flatter terrain (between 0 and 600 meters above sea level) and relatively with less vegetation in the Project area allowed the prospecting team to easily move along the road network and close to the urban areas of Acajutla and Sonsonate, wich allowed the team to examine a wide variety of types of archaeological sites. The transects covered a lot of agricultural land in dry weather. This area begins in Acajutla, through Sonsonate and ends within the municipality of San Pedro Puxtla.

- **Forested Transition (approximately 5 km):** This area is characterized by a remarkable increase in both vegetation density and elevation (from 600 to 900 meters above sea level). Similarly, a change in crops and species is apparent. The road network is still extensive and reliable enough to provide access to the proposed route. The nearest towns are Ahuachapán, Santa Catarina Masahuat and San Pedro Puxtla.

- **Highlands / Plateau (12 km):** Due to the usually thick vegetation of this area of study that exceeds 900 meters above sea level, the ubiquity of coffee plantations, decidedly different precipitation regime and topographic accidents, this area was the one that comparatively more time required to transit it. The team had to identify and focus on areas where vegetation was limited (as this allowed for sufficient surface visibility to inspect the ground for artifacts and other evidence of cultural heritage resources). As a result, prospecting focused on areas where vegetation had been cleared. The nearest towns are Apaneca and Quezalapa.

Historical Heritage

The historical heritage field survey was carried out along with the work of archaeological reconnaissance, taking into account the current norms, the type of representative buildings that have been recognized or studied, retained or preserved. No additional buildings or resources of interest, such as cemeteries, statues, parks, roads or landscape features, were documented.

Living Heritage

The specific value and sensitivity of living cultural heritage sites in El Salvador is based on a combination of aspects of local and regional communities, including spiritual, cultural and historical traditions. As the patterns of use and sensitivity of the sites may be much localized, they are not usually documented. No churches, sanctuaries or cemeteries were identified either during reconnaissance or in the relevant documentation.

Paleontological Heritage

The specific value and sensitivity of paleontological heritage sites in El Salvador is based on opportunistic findings and the corresponding mapping of the geological profiles corresponding to the paleontological study. The reasoning is that soils created in the last 10 millennia, through volcanism and sedimentation will scarcely contain fossiliferous resources. No paleontological resources were identified either during reconnaissance of land or the revision of relevant profiles, maps or documentation.

Analysis of Data

After the field component of the baseline survey, the team synthesized the information collected, generating a database (see Appendix K), which contains locations and general descriptions of each of the archaeological heritage sites that were found. The team also analyzed and, when possible, established associated dates for artifacts collected at archaeological sites found throughout the Project area. Photographs of the sites and data collected at each site were compared with existing historical and archaeological records from the pre-hispanic period and other historical periods in order to obtain comparative conclusions and to evaluate the findings.

<u>Archeology</u>

The archaeological survey team recorded thirteen archaeological sites. The boundaries of site groups were determined, in part, by a dense concentration of ceramic dispersions, termed "site group components". It was determined that five of the findings require a second polling phase prior to the construction of the towers to comply with SECULTURA guidelines and the spirit of the applicable law.

<u>Architectural Heritage</u>

No architectural heritage site locations were recorded during the field work.

Artifact Analysis

At the conclusion of the field effort, all archeological artifacts were transported to the Archeology Workshop I, located at the Technological University of El Salvador in San Salvador. There, the artifacts were washed, cataloged and analyzed. Two major types of artifacts were analyzed: ceramic artifacts, such as pottery fragments, and stone or "lytic" artifacts. Lithic artifacts consisted mainly of two categories: worked and polished stone. Lithic artifacts consisted of stone tools, carving residues, chips and debris created during the manufacture of stone tools. The polished stone is formed by wearing or smoothing the surface of the stone to make tools, such as hoes and metates (ancient grinding stones).

Among ceramic artifacts, various design elements and ceramic technology were examined, including pulp and paste materials, slip, application features, carving, etching, painting and any other ornamental feature present. Later, these characteristics were compared with typologies of pre-Columbian ceramics to establish the dates of each piece. The references used for the classification are widely accepted as for the cataloging and regional chronology of diagnostic materials (Balfet, Fauvet-Berthelot and Monzón, 1992, Heras and Martínez, 1992, Sharer 1978, Valdivieso, S.F.). Once assigned to a period, ceramic artifacts were used to determine the approximate dates of occupation or use of the sites from which they were extracted.

Limitations

The greatest limitation was the method of non-intrusive surface survey. Several cultural heritage resources in the study area were identified through fortuitous "windows", such as agricultural quarries, trenches or roadblocks. These fortuitous findings confirmed the presence of under-surface cultural materials that could not be detected by surface recognition. Access to some areas was not allowed by landowners. The impassable terrain, such as very dense weeds and areas of extreme slope, also limited the areas that the prospecting team was able to investigate.

The paleontological heritage resources were documented opportunistically during the baseline survey of archaeological heritage and through a screening of the data of the National Museum of Natural History and its possible intersection with the project trace. The baseline survey clearly identified the absence of paleontological or fossiliferous stratigraphic profiles exposed in the project area.

4.3.20.2 Sensitivity Assessment of Cultural Heritage Resources

The sensitivity of a resource was evaluated taking into account its scientific, historical, cultural, artistic or religious importance for local, national and international stakeholders. This methodology was developed combining the guidelines of national cultural heritage legislation and international good practices.

The Salvadoran cultural heritage legislation was used to determine the importance of the cultural heritage resource for local and national stakeholders. The Law on Protection of Cultural Patrimony of the Nation (LPPCN), published in 1993 (Legislative Decree No. 513 Special Law on the Protection of the Cultural Heritage of El Salvador (April 22, 1993). The LPPCN defines cultural property as:

- Paleontological: all fossilized organisms;
- Archaeological: all pieces, instruments, structures, remains or vestiges from extinct cultures;
- Historical: real estate or part of them, and movable property that are directly linked to the political, economic or social history of El Salvador; and
- Artistic: the properties or objects that, due to their origin as a product of human activity, constitute true values of the fine arts or national art, whether plastic, literary, architectural, etc.

The definition of cultural property of the LPPCN was used to identify the types of cultural heritage resources that the government of El Salvador considered of national importance sufficient to guarantee national protection. In consideration of the level of national protection established by the LPPCN, any cultural heritage resource that complies with the definition of cultural property was evaluated at least as a low sensitivity resource. In addition, international standards were applied to determine which of the resources identified were of medium or high sensitivity, including the concepts of replicable, non-replicable and fundamental cultural heritage of the International Finance Corporation (IFC, 2012):

- **Replicable cultural heritage:** Tangible forms of cultural heritage that can be transferred to another location or can be replaced by a similar structure or natural features to which cultural values can be transferred through appropriate measures. Archaeological or historical sites may be considered replicable when the eras and particular cultural values they represent are already well represented in other sites or structures that have been studied or recorded.

- **Non-replicable cultural heritage:** Can be related to the social, economic, cultural, environmental and climatic conditions of past peoples, their evolving ecologies, adaptation strategies and old forms of environmental management, where cultural heritage is unique or relatively unique in the period it represents, or cultural heritage is unique or relatively unique in linking several periods in the same site.

- **Fundamental cultural heritage:** Consists of one or both of the following types of cultural heritage: the internationally recognized heritage of communities that use or have used cultural heritage for long-term cultural purposes or legally protected cultural heritage areas, including those proposed by local governments for such designation.

In order to evaluate the possible scientific or cultural value of a resource according to whether it represented common or unique resources, the concepts of replicable, non-replicable and fundamental cultural heritage were used. The degree to which particular types were well represented or recognized at the local, national and international level was incorporated into the resource sensitivity assessment. One type of resource that is well known in the Lowlands prospecting area, for example, could be rare or unique in the Highlands prospecting area, which would result in different levels of sensitivity of specific resources.

Table 4.3-30 is a summary of the different categories and characteristics of each level of cultural heritage sensitivity that was used during the baseline survey.

Table 4.3-30 Summaries of Categories and Characteristics for Each Level of Sensitivity or Value of Cultural Heritage

Sensitivity of Cultural Heritage Resource	*Definition*
Low	The resource is a cultural property as defined by the LPPCN. The resource can be moved to another location or can be replaced by a similar resource, or is of a type that is common in the surrounding region; the resource has no cultural or historical value for local, national or international stakeholders, or has limited value; or the resource has limited scientific value or similar information can be obtained from numerous resources. The resource is classified as replicable cultural heritage.

Sensitivity of Cultural Heritage Resource	*Definition*
Medium	The resource is a cultural property as defined by the LPPCN. The resource can be moved or replaced, or data and artifacts can be retrieved with the advice of the stakeholders; the resource also has considerable cultural or historical value for local or national stakeholders; or the resource has considerable scientific value but similar information can be obtained from a limited number of other resources. The resource is classified as non-replicable cultural heritage.
High	The resource is a cultural property as defined by the LPPCN. In addition, the resource can not be transferred or replaced without a great loss of historical value or culture, the specific legal situation of the site prohibits the direct impact or invasion of the area of the resource or protection; the resource has considerable value for local, national and international stakeholders; or the resource has exceptional scientific value and the types of similar resources are rare or non-existent. The resource is classified as fundamental cultural heritage.

4.3.20.3 Cultural Heritage Resources Identified Previously

As part of the baseline study, an extensive literature review was conducted to obtain available information on the cultural heritage resources previously recorded in the Project area. Information collected included data on resources such as pre-Columbian and historic archaeological sites, both existing and previously demolished structures, and settlement patterns and trading routes of the pre-Columbian and historic periods that were used throughout the extensive history of the country.

Archeology

In the analysis of the bibliography data were recorded on 30 archaeological resources previously recorded in the municipalities of Acajutla, Santo Domingo de Guzmán, Apaneca and Ahuachapán (see Appendix J and Appendix K). These include a rock art site, three Colonial archaeological sites and 26 prehispanic archaeological sites. Santa Leticia in Apaneca is considered of first order and is inside a private archaeological park. The rest are considered second order. Up to fourteen attributes could be documented for each resource, including: Site identification; name of the site; reference; site function; site use behavior; type of site; artifact density; site size; site significance, date of foundation; date of abandonment; cultural period; latitude; length. However, because of the type of resources, the methodology of analysis and the relative scarcity of diagnostic material, in all instances only nine were documented. The chronological detail will be available in the final report including Phases I and II of recognition, which will be delivered to SECULTURA at the conclusion of the second Polling Phase.

The database indicates the locations of known archaeological resources compared to the Project area to identify possible impacts on previously recorded sites.

4.3.20.4 *Field Prospecting Results*

The baseline field survey identified a total of 13 archaeological resources. Table 4.3-31 provides a summary of the amount of total resources in the survey area of the prospection.

Table 4.3-31 Number of Patrimonial Resources Identified in the Area of Influence by Region

Area	*Cultural Heritage Resources*			*Total*
	Archaeological	*Living Heritage*	*Architectural Heritage*	
Lowlands	9	-	-	9
Forested Transition	3	-	-	3
Highlands	1	-	-	1
Total	**13**	**-**	**-**	**13**

5.0 IDENTIFICATION, DESCRIPTION AND EVALUATION OF ENVIRONMENTAL AND SOCIAL IMPACTS

5.1 *INTRODUCTION*

This section examines the potential impacts, both positive and negative, of the construction and operation of the proposed Project; also describes the control and mitigation measures that will be developed by EDP and other recommended complementary measures to avoid, minimize or mitigate the possible negative impacts and expand the positive ones.

5.1.1 *Methodology for Impact Assessment*

Information on the possible impacts generated by the activities necessary to construct and operate the Project was obtained from various sources, including consultations with EDP and local sources; meetings with local interest groups; scientific studies and environmental impact studies for similar projects around the world.

For the evaluation of the impacts associated with the activities of the Project, professional criteria, fieldwork and the analysis of the professional team's office were used. The following sections define the methodology used to identify and evaluate the possible impacts of the Project.

Impact assessment was done through the following steps:

1. Characterization of the baseline: the conditions existing before the Proyect is developed and its effects occur;

2. Identification of the sources of impacts and impacts that are produced by the Project;

3. Classification of impacts before applying any mitigation measure;

4. Mitigation measures to attend the impact; and

5. Classification of impacts after mitigation in order to produce a classification of the "residual".

5.1.2 *Criteria for Classification of Impacts*

The impacts were classified based on (1) the magnitude of the potential impact and (2) the Sensitivity/Vulnerability/Importance of the Resource/Receptor.

The magnitude of each impact was assessed using criteria identified in the Table 5.1-1. Criteria may vary as resource-specific criteria exist to determine the magnitude of an impact (eg, water quality criteria). Colors are used to help the reader review the relative magnitude of impacts.

The magnitude is a function of the following characteristics of impacts:

- Reach/Coverage
- Duration
- Scale
- Frequency
- Probability (only for those unplanned events)

The magnitude of impacts takes into account the different dimensions of a particular impact in order to classify the impact in a spectrum ranging from insignificant to large. Some of the impacts will translate into changes in the environmental and socio-economic environment that may be immeasurable, undetectable or within a normal range of natural variation. These impacts are characterized as of insignificant magnitude. In the case of positive impacts, it is sufficient to indicate that the Project will have a positive impact, without characterizing the exact degree of positive change that is likely to occur.

Table 5.1-1 Classifications of Magnitude

Insignificant	Ningún cambio perceptible en las condiciones de línea base.
Small	Noticeable change in baseline conditions and/or is likely to be within the applicable rules and standards for the use mode.
Medium	Obvious change of baseline conditions and/or is likely to approximate applicable rules and standards for the use mode.
Big	Significant change compared to baseline conditions and/or is likely to exceed applicable rules and standards for the use mode.

5.1.3 *Sensitivity / Vulnerability / Importance of Impact*

There are several factors that define the sensitivity/vulnerability/importance of the resource/recipient, which can be physical, biological, cultural or human.

- When the resource is physical (for example, a body of water), its quality, sensitivity to change and importance at local, national and international scale is considered.
- When the resource/receptor is biological or cultural (for example, the aquatic environment), its importance and sensitivity to the specific type of impact (eg local, regional, national or international importance) is considered.
- When the receptor is human, the vulnerability of the larger person, community or social group is considered.

There are other factors that can also be taken into account to characterize sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder opinion and economic value. As in the case of magnitude, sensitivity/vulnerability/importance classifications are universally consistent, but the definitions of these classifications may vary according to the type of resource/receptor. The universal sensitivity/vulnerability/importance classifications are:

- Low
- Medium
- High

5.1.4 *Determination of Significance of Impact*

Once the characterization of the magnitude of the impact and the sensitivity/vulnerability/importance of the resource/receptor is completed, the significance can be assigned for each of the impacts. The significance of the impact can be assigned by an array similar to Table 5.1-2.

Table 5.1-2 Classification of Significance of Impact

		Sensitivity / Vulnerability / Resource/Receptor Importance		
		Low	***Medium***	***High***
Magnitude of Impact	Insignificant	Insignificant	Insignificant	Insignificant
	Small	Insignificant	Minor	Moderate
	Medium	Minor	Moderate	Higher
	Big	Moderate	Higher	Higher

The significance of the impacts considered the application of certain control measures and therefore the resulting significance is residual (after the application of the measures).

5.1.5 *Matrix of Potential Interactions*

As a first approximation for impacts identification, the matrix of interactions of type Leopold modified was used. Table 5.1-3 presents the interactions between Project activities and environmental factors assigned to environmental and social impacts.

In each of the tables that are crossed in the matrix, the combinations of factors and components are indicated according to the possibility of identifying a possible significant or non-significant affectation. The boxes marked in blue represent those interactions whose effects are expected to be significant. The gray boxes represent those interactions whose effects are not expected to be significant and the blank cells represent the absence of interaction. Within each cell is identified whether the possible effect has a positive (P) or negative (N).

Table 5.1-3 Matrix of Interactions

Receptor Group			*Environmental Aspects (Biological and Physical)*									*Socioeconomic and Cultural Aspects*							
Activities		Geology and Topography	Soils	Natural Threats (Volcanic Eruptions, Earthquakes and Landslides)	Air Quality	Water Resources	Noise and Vibrations	Flora	Fauna	Aquatic Ecosystems	Protected and Fragile Areas	Landscape	Land Use	Traffic	Tourism	Jobs	Economy	Community Health	Cultural Resources
Construction Stage	Demolition and dismantling of previous structures		P		N		N												
	Flattening, leveling and compaction	N	N		N	N	N	N	N	N	N	N							
	Cutting and stripping of right-of-way wiring towers and substations		N		N	N	N	N	N	N	N	N	N						
	Previous studies and topography															P			
	Mobilization of resources (equipment, materials, posts, etc.)		N		N		N		N	N				N				N	
	Construction of internal roads		N		N		N	N	N	N	N		N	N					N
	Construction of internal roads		N		N		N						N						N
	Grouting and assembling of support towers and other equipment in the substations		N				N					N	N						
	Construction of concrete bases for towers and equipment in substations		N				N		N				N						
	Dress of the structures		N		N		N					N							
	Aerial network stretching and tensioning						N					N						N	
	Handling and disposal of waste and cutting and stripping material				N	N		N	N	N	N			N		P		N	

Receptor Group			*Environmental Aspects (Biological and Physical)*									*Socioeconomic and Cultural Aspects*							
	Activities	Geology and Topography	Soils	Natural Threats (Volcanic Eruptions, Earthquakes and Landslides)	Air Quality	Water Resources	Noise and Vibrations	Flora	Fauna	Aquatic Ecosystems	Protected and Fragile Areas	Landscape	Land Use	Traffic	Tourism	Jobs	Economy	Community Health	Cultural Resources
	Recruitment and transportation of personnel (administration, operatives, labor, etc.).				**N**									**P**		**P**	**P**		
Operation Stage	Electrical transmission and substations								**N**			**N**					**P**		
	Correction, cleaning and maintenance				**N**			**N**	**N**	**N**	**N**	**N**	**N**			**P**			
Stage of Abandonment	Dismantling of electrical equipment, poles and wiring						**N**											**N**	
	Waste management and disposal		**N**			**N**												**N**	
	Cleaning and rehabilitation of the site		**P**		**P**	**P**		**P**	**P**	**P**	**P**	**N**	**N**			**P**			

5.2 *IMPACTS ON THE PHYSICAL ENVIRONMENT*

5.2.1 *Geology, Topography and Soils*

5.2.1.1 Potential Impacts on Geology

Leveling works, where required depending on the slope of the area, soil compaction and formwork; as well as the foundation of the towers and substations will not have significant impacts in the geology of the Project area. Excavations for each tower will occur within an area of approximately 10 m wide by 10 m long, with a depth varying between 3 and 6 m, depending on the type of soil. Once the tower is built, the footprint area is 7.5 m wide by 7.5 m long, giving an area of approximately 56 square meters (m2). Therefore, the impacts to the geology and topography of the region caused by the construction of TL and infrastructure are expected to be insignificant (insignificant or small magnitude, low sensitivity).

5.2.1.2 Potential Impacts on Topography and Soils

During construction, the following project activities may affect soils: installation of towers and equipment in substations, removal of vegetation in substations and in the area of towers and right of way; the construction of access roads to the TL construction zone; leveling, filling and compaction of the terrain; the waste and disposal of excavated material; the formwork and foundation of towers, poles and patios; as well as the assembly of structures. Potential impacts include mainly erosion, compaction and soil contamination.

During the operation of the Project, maintenance activities, mainly periodic traffic of vehicles can affect the soils in the access roads and right of way.

Erosion

The construction of the Project will result in the alteration of approximately 34 hectares (ha) of land, mainly the area around towers, substations, sites and access roads (see Table 5.2-1). Potential impacts of soil erosion are greater in areas with moderately sloping hillsides (hillsides with slopes equal to or greater than 30 percent) and where soil erosion potential is medium to high. Within the Project area, there are areas that have hillsides with slopes greater or equal to 30 percent and where the potential for soil erosion is medium or high because of its nature. Approximately 7 ha of slope soils with slopes greater than or equal to 30 percent will be affected by the Project's proposed construction activities (see Table 5.2-1).

Table 5.2-1 Summary of Total Hectares Potentially Affected by Project Construction

Installation	*Total Area Altered Approximate (ha)*	*Altered Area with Slopes> 30% and with Medium or High Erosion Potential (ha)*	*Percentage of Total Affected Area that Has High or Medium Erosion Potential*
Towers	1.4	0.3	0.9
Proposed Roads	9.4	2.6	7.8
Roads to be improved	15.2	3.3	9.9
Campuses	4.5	0.5	1.5
Substations	3.0	0.0	0.0
Total	***33.5***	***6.7***	***20.0***

ha = hectares

Approximately 20% (per area) of the soils to be altered are in steep slopes with medium or high erosion potential (see Table 5.2-1). Without additional mitigation measures, soil erosion caused by construction activities would have an impact of moderate significance (meadium magnitude, meadium sensitivity) on the grounds of the Project.

To reduce the significance of soil erosion impacts during TL construction, EDP will implement best practices in the industry. The following mitigation measures will be incorporated during the design and construction of the Project:

- Especially in areas with steep slope, the possibility of building the bases of the towers on the existing relief will be evaluated or installed on piles, without leveling the area. In this way, the amount of soil to be affected is minimized.
- Implement measures to control soil erosion, rainwater management and sedimentation. These measures include the use of sediment fences, the installation of permanent and temporary drainage systems to manage runoff from construction sites and the use of sediment capture trenches; as well as the use of regulation dams to control water runoff, among others.

- Use appropriate management practices during deforestation activities. For example, as far as possible, schedule construction activities during the dry season, especially in areas with steep slopes; limit deforestation and alteration only to the approved work area; minimize the area of vegetated soil within the approved work area as much as possible; and stabilize and progressively reforest altered areas.
- Revegetate slopes in required areas.
- Deposit surplus material in properly approved areas or reuse it as filling material.
- Compress all material properly at the end of activities.
- Once the construction phase is completed, those access routes and service routes that are not necessary for the project operation stage will be closed and restored to their original or better conditions; and
- Community requests to maintain an open service path or route will be evaluated jointly with the competent authorities.

With the implementation of these measures, the magnitude of the impact is expected to be reduced to small, reducing the significance of the impact to *minor*.

Compaction

The movement of heavy machinery needed to support construction activities can also increase the risk of soil compaction. At the same time, soil compaction can affect hydrology and water infiltration and lead to loss of soil productivity. Since the soils of the Project area are mainly clays and sands, which are less susceptible to compaction, and considering the surface area that could be affected by the movement of limited machinery, it is expected that the risk of compaction of soils during construction and project operation is *insignificant* (insignificant magnitude; low sensitivity).

Soil Potential Contamination

During construction and operation of TL, there is also the risk of contamination of soils by accidental spills of fuel and lubricants of equipment and machinery.

To minimize the possibility of contamination of soils by accidental spills, control measures will be implemented, including:

- Maintenance of the equipment in good mechanical conditions, to avoid losses of fuel and lubricants that can contaminate the floors and be washed by the rains;
- Any major maintenance of the equipment should be carried out in specialized workshops and not in the Project site;
- Adequacy of a specific area, with waterproofing protection, to carry out minor maintenance activities; and
- Implementation of the Contingency Plan in case of spills (*see Section 7.0 - Environmental and Social Management Program*).

According to the implementation of these measures, the risk of spills is estimated to be reduced to insignificant (insignificant magnitude, low sensitivity).

5.2.2 *Natural Threats*

Due to its geographical location, El Salvador is exposed to geophysical threats, such as volcanic eruptions, seismic movements and landslides (*see Section 4.1.3 - Natural Threats*). The Project itself is vulnerable to these natural disasters, which could affect the TL, substations and proposed infrastructure during its construction and operation.

According to MARN records on the volcanic threat in El Salvador, Santa Ana volcano (approximately 19 km distance to the TL) and Izalco volcano (approximately 18 km of distance) are located in the Volcanic Mountain Range in the Northern area of the trace, are the closest active volcanoes that could affect TL (*see Figure 4.1-7*). In addition, seismicity in the region where the Project will be located is characterized, like the rest of the country, by the periodic occurrence of earthquakes and a high seismicity rate.

As described in *Section 4.1.3.3 - Landslides*, landslides are the other natural hazard occurring in the Project region. The only areas with high and moderate susceptibility to landslides are located north of the TL, in the hills and mountain slopes, and in the central area where TL crosses areas with alluvial formations.

To minimize the risk of natural threats, EDP has designed and constructed all facilities associated with the proposed TL considering high safety factors and under local and international seismic protection codes and standards. In addition, EDP has located the path of the TL trace outside the path of the lava flows and lahars of the two volcanoes near the TL (*see Figure 4.1-7*), and will revegetate the slopes where excavation work has been carried out. In case of landslide-prone areas, which to date after several visual scans have not been found, stabilizations would be made.

In addition to the risk prevention measures incorporated into the project design, EDP will prepare an emergency plan to respond to any natural disaster. During the construction and operation of the Project, EDP and its contractors will apply the emergency plan in case of a natural disaster (*see Section 7.0 - Environmental Management Program*).

The implementation of these control measures incorporated in the TL construction will diminish the potential effect of natural threats to a *minor* significance (small magnitude, medium sensitivity/vulnerability).

5.2.3 *Air Quality*

The electricity transmission and distribution sector does not usually generate significant levels of emissions to the atmosphere or effluents (IFC, 2007). Potential impacts on air quality will occur mainly during the construction phase of the Project. Air quality could be altered due to emissions of gases and particulates from equipment, machinery and vehicles (mobile sources) that use hydrocarbons as a source of fuel. In addition, it will be generated. Atmospheric pollutants that could be generated during construction activities include mainly hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO2), oxides of nitrogen (NOx), sulfur oxides (SO2) and particulate matter (PM10).

The transit of vehicles through the different accesses to the construction zones for the transportation of the construction material and the equipment that compose the Project, the removal of the waste material from the construction area; as well as equipment, machinery and vehicles involved in all Project activities, will generate emissions that will temporarily increase the concentration of particles in the air (particles, dust and soil, among others).

Another activity that has the potential to alter the quality of the air, are dirt movements for the preparation of the site where it is proposed to locate the facilities of the towers for the TL and the equipment for proposed substations. This activity also has the potential to contribute to the increase of emissions of particulate matter to the atmosphere.

It is anticipated that the construction of the TL and proposed infrastructure will be extended for a period of twenty-four months. During this time, it is estimated that the vehicular flow will be about 10 trucks per day per sector and/or tower. On the other hand, during the maintenance stage, a truck flow is estimated for each month or two months. Some of the vehicles and machinery being used are included in Table 5.2-2.

Table 5.2-2 Vehicles and Machinery to be used during Construction

Vehicles and Machinery	
• 5 backhoe loaders • 4 bulldozers • 4 shovel loaders (front-end loaders) • 1 scraper • 3 motor graders • 12 dump trucks • 2 vibrating roller compactors • 1 pneumatic roller • 1 single drum road roller • 5 manual road roller • 1 hydraulic rock drill • 3 water tank trucks • 2 trucks for fueling machinery	• 3 75 ton cranes • 2 200 ton cranes • 3 forklifts • 2 tanker trucks for asphalt mixtures • 1 cement floor stabilizer • 1 concrete plant • 10 concrete trucks • 3 autobombes • 3 hydraulic elevators with basket for workers • 6 gondolas to transport equipment and electrical material

Fuel consumption is estimated to be as follows:

- Estimated consumption of 2500 cubic meters (m3) of diesel during the construction stage for cranes and excavation equipment.
- Estimated consumption per day of 5 m3 of diesel.
- Estimated gasoline consumption has not been defined to date by the developer.

Without the implementation of any mitigation measures, the significance of the impact on air quality by the emission of hydrocarbon combustion pollutants and the air pollution by suspended solids is *moderate*. This significance of the impact is based on a) the high sensitivity of social receptors (as certain stretches of the TL are close to population nuclei) and environmental (flora and fauna species), and b) The small magnitude of the impact because the effects on the environment will be temporary, direct and localized.

EDP will implement the following control and mitigation measures to minimize impacts to air quality during the construction, operation and abandonment stages of the Project:

- The dust generated by the construction and transit of material loading trucks will be mitigated by the irrigation of the roads and access to the right of way and within the right of way. This irrigation will be by means of water tank trucks.
- The use of any machinery, equipment or vehicles that have fuel leaks, ruptures in the combustion and exhaust systems, or problems in the catalyst systems will not be allowed.
- Concentrations of PM10, particulate matter less than 2.5 microns aerodynamic diameter (PM2.5), volatile organic compounds, SO2, NO2 and CO will be monitored.
- The box of vehicles transporting debris, soil or construction material must have a canvas cover adjusted to prevent the dust from escaping during its journey. In addition, tires will be covered during loading and unloading of materials to prevent them from throwing material when spinning.
- Any vehicle, whether for transportation, forklift or maneuvering equipment, shall be driven into the designated tracks, gaps and paths previously opened.
- The equipment that operates with diesel and gasoline, must have a preventive maintenance to comply with the applicable environmental regulations.
- The gas equipment will have catalytic converters in good condition. Those that are maneuverable equipment (for example, forklifts and cranes) will adjust their operation to the guidelines of these measures. Catalytic converters or filters for diesel will be incorporated, according to the case.
- Establish speed limits for vehicles traveling in both populated areas and access to the Project (maximum speed of 25 km/h).
- Ensure that the vehicles and equipment to be used comply with the maintenance required by each equipment and will have: 1) specific maintenance requirements for each equipment, 2) inventory of

equipment, spare parts and materials needed for maintenance; and 3) periodic lubrication.

- Perform resistance testing of materials, galvanizing impregnation and other tests at the factory and not on site.

The implementation of these control measures to reduce the emissions of gases produced by the combustion of hydrocarbons in motors and by suspended solids will reduce the significance of the impact to *insignificant*.

5.2.4 ***Water Resources***

Potential impacts of the construction and operation of the Project on water resources include change in surface runoff, water availability and alterations to surface water quality.

Transmission line projects may require the construction of corridors that could disrupt watercourses and require the removal of riparian vegetation (IFC, 2007). Besides, there is the potential that sediment and erosion from construction activities and runoff from rainwater may increase the turbidity of surface watercourses.

5.2.4.1 Change in Surface Runoff

Changes in surface runoff due to the construction of transmission line towers and substations will be minimal. The permanent compaction and waterproofing of surfaces, mainly at the base of the towers and substations, reduces infiltration and, therefore, increases surface runoff. Also, the construction of temporary facilities (maximum of 9 proposed work fronts) will create impermeable surfaces. The affected areas are localized and it is estimated that the effect on runoff in the total area of the Project is of *minor* significance, since the magnitude of the impact is considered small and the rivers and/or ravines close to the impermeable surfaces of the Project have a medium sensitivity, considering its environmental and social importance.

EDP will implement and incorporate the following control and mitigation measures to minimize impacts on water resources:

- Campuses should have roof drains that collect the runoff water and direct it to the ground where they can follow their normal course.

- Canalizing rainwater in substations to roads through ditches, sewers, sediment barriers and settlers, among other devices, so as to reduce the entrainment of solids to rivers and/or ravines.
- In the outdoor parking and storage areas of machinery/equipment, suitable control systems such as hay bales should be placed to avoid contamination of the runoff water.
- In case it is necessary to carry out ground leveling work for the foundation surface, these must be done in a way that does not alter the surface drainage conditions and do not leave areas that in the future compromise the stability of the structure.

The implementation of these control measures to mitigate changes in surface runoff will reduce the impact to *insignificant*.

5.2.4.2 Changes in Water Quantity and Quality

Due to the nature of the proposed Project, it is anticipated that the main impacts on water quality will be generated mainly during the construction phase. As described in *Section 4.1.5 (Water Resources)*, the Project's area of study crosses three important hydrographic regions; Paz (region B), Cara Sucia-San Pedro (region C) and Grande de Sonsonate-Banderas (region D), which are shown in Figure 4.1-14. According to *Section 2.0 (Project Description and its Alternatives)*, of the 139 towers to be constructed, only 24 will be placed close to a permanent water course (at a distance of 100 m or less), as shown by Figure 4.1-14. Besides, the two new access roads are adjacent to bodies of water and another crosses San Rafael river. Substations are not located near watercourses.

Three of the nine proposed sites or temporary storage areas are located within 100 m of a body of water and they also present a risk of contamination if adequate prevention and control measures are not implemented.

Potential impacts on rivers include deterioration of water quality due to runoff from soil contaminated by unforeseen events, such as accidental spills of chemicals, hazardous materials and fuels associated with the operation of heavy machinery and equipment will be used mainly during the construction phase of the Project. Another factor that has the potential to alter the water quality of these watercourses is the increase of solids produced by the morphological modification and/or drainage patterns in flooded areas, the clearing of the areas where these towers would be located near to bodies of water, including their areas of right of way, as well as the preparation of the foundation surface.

It is expected that without the implementation of any mitigation measures, the significance of changes in water quality will be *insignificant-minor* because the magnitude of the impact is small and the water quality of the rivers or ravines near the towers of the TL proposed, have a medium sensitivity for their importance of aquatic biodiversity.

Although no significant impacts on the water quality of the rivers and/or ravines near the towers or areas used as right of way are expected, preventive measures will be applied for the crossing of such watercourses. Some of these measures are:

- The material generated from the excavation work will be removed from the excavation and deposited at a safe distance to avoid material falling into nearby rivers and/or ravines. The collection area of the material must be selected before starting the excavation work to avoid that the mounds of accumulated material produce any impacts on the nearby rivers and/or ravines.
- Canalize rainwater on roads through ditches, sewers, sediment barriers and settlers, among other devices so as to reduce the entrainment of solids to rivers and/or ravines.
- In the outdoor parking and storage areas of machinery/equipment, suitable control systems such as hay bales should be placed to avoid contamination of the runoff water.
- Perform the management of domestic water during the construction phase using portable sanitary modules, as described in *Section 2.0 (Description of the Project and its Alternatives)*. Use at least one portable toilet for every 15 people and give daily treatment with detergents and biodegradable additives to these sanitary modules. The solid waste from these toilets will be extracted by the company that rents these devices, as well as their disposal.
- Comply with manufacturer's guidelines for machinery and equipment used to prevent fuel spills.
- Avoid vehicular traffic in riparian areas and avoid the use of machinery in the vicinity of watercourses.

- Have a prevention plan; control and response to risks of spills including emergency response, cleaning and recovery of contaminated soils *(see Section 7.0 - Environmental and Social Management Program).*
- Use sealed barrels with device for the transfer of fuel for power generators.

The implementation of these control measures to mitigate potential impacts on water quality will reduce the impact to *insignificant*.

5.2.4.3 Water Availability

According to *Section 2.0 (Project Description and Alternatives)* of this report, cement and concrete curing and cementing activities require the use of water to be taken from small cisterns mounted on trucks. The total water consumption during the tasks that comprise the construction phase (construction machinery, concrete processing, various mixtures, as well as compaction of terraces and others) of the Project is estimated at a total of 19,051 m3 which represents an estimated daily consumption of 38 m3 that will be obtained from the municipalities of Sonsonate or Acajutla. Non-potable water tank trucks will be used for works that require water to moisten the soil; while water for the consumption of workers will be treated drinking water. Other tasks that will require water consumption include drinking water, food preparation and sanitary facilities. During the construction phase, the construction of temporary or permanent camps for the accommodation of personnel is not contemplated due to the proximity of the Project area to urban centers. However, nine temporary sites will be built for the storage of tools and equipment. These establishments will include spaces for workers (approximately 200 workers at the peak of work spread across all work fronts) to change their clothes and clean them as well as portable toilets. The facilities will have the water supply that will also be supplied through cisterns mounted on trucks.

Considering the above and the fact that the use of water from rivers and/or ravines is not contemplated for the tasks of the construction phase, the impact on the availability of water is *insignificant*. On the other hand, during the operation of the Project, the supply requirements are minimal so no impacts on the availability of water are foreseen.

5.2.5 *Noise and Vibrations*

During the TL operation, noise generation is not envisioned above permitted limits and may affect neighboring properties and communities. According to the IFC (2007), there is often a buzzing or humming noise and the generation of ozone in the vicinity of transformers or high voltage cables that produce a corona effect. The noise caused by the corona effect is caused by the movement of ions and a crackling produced by the electric shocks. They are noises of small intensity, imperceptible in many cases. When the relative humidity is high, the effect increases resulting in a significant increase of audible noise. It is estimated that the corona effect can produce a rumble of 20 dB, although little noticeable, can cause alterations to the natural environment. However, this effect will be prevented by the design and proper thickness of the wiring used by the Project. This impact is considered *insignificant*.

Therefore, it is anticipated that impacts to noise levels will occur only during the construction phase of the Project. The noise will come from the use of mobile machinery such as excavators, cranes and mechanical excavation equipment with sound levels of approximately 89 dBA.

Construction activities, specifically the use of heavy machinery and trucks, the increase of human activity in the area, the preparation of the terrain and the lifting and installation of transmission lines will cause an increase in sound levels, thus creating a negative and direct impact. According to the Project Description (*see Section 2.0*), conventional construction techniques and equipment will be used and are presented in Table 5.2-2.

Conventional construction activities at the Project site will result in an increase in short-term and temporary environmental noise levels. The increase in noise levels will be experienced mainly in the proximity of the emitting sources. The magnitude of the noise will depend on factors such as the specific construction activity developed, the noise level emitted by various construction equipment, the duration of the construction phase and the distance between the noise source and the receptors.

The noise levels produced by typical construction equipment range from about 65 dBA to 95 dBA at a distance of 15.2 m from the source, with an average noise level of 89 dBA at that distance during the noisiest activities (HMMH, 2015) . Due to the intermittent nature of the construction work and to the topography of the route where the Project will be constructed, it is expected that the average noise level for an 8-hour working day will be less than 70 dBA at the residential receivers closest to the Proyect.

The Project will have nine facilities that will be installed for the storage of tools and equipment and that, among other things, will include spaces for workers to change clothes and clean up, besides to portable toilets. These facilities could be a source of noise according to the activities that are developed according to the movement of materials, machinery, equipment and the dynamics among the workers who access them. There will also be parking zones in areas near the campuses to house vehicles and other equipment that are used. It is anticipated that these activities will not contribute significantly to the total noise impacts generated by construction. This is due to the fact that the sites will be raised in areas distant from residences.

Access to TL construction areas will be via roads, paved streets or dirt roads. The workforce (approximately 200 people) required for construction will arrive at the Project site in private vehicles provided by EDP. Due to the high number of trucks currently traveling on this route, it is not considered that there will be an appreciable difference due to the noise generated by the vehicles used to transport the personnel who will work in the Project.

The Project has the potential to generate increases in the vibration transmission conditions and the attenuation of the waves will depend on the heterogeneous characteristics of the soil and subsoil and the type of material on which the construction works are carried out. The main activities that can produce changes in vibrations are also the movement of machinery and the transport of materials.

Considering the above and without the implementation of any mitigation measures, the significance of the impact due to contamination of noise and vibrations is *moderate*. This significance of the impact is based on the high sensitivity of social (human) and environmental receptors (species), because certain stretches of the proposed TL are close to population nuclei (*see Section 5.2*); and to the small magnitude of the impact because the effects on the environment will be temporary, direct and localized, since they would particularly affect the Project area and surrounding areas with a low intensity.

EDP will implement the following control and mitigation measures to minimize and, as far as possible, eliminate the impacts of noise pollution during the construction, operation and abandonment stages of the Project:

- Maintain maximum permitted noise levels within the values indicated by Salvadoran authorities or threshold levels of noise established by IFC (see Table 4.1-14).
- Indicate all sites where they emit noises above 85 dBA, to avoid exposure of persons without properly certified hearing protection equipment..
- Train all workers on techniques for the use and maintenance of hearing protection equipment (occupational safety) that must be required at all times during the exposure period.
- Set speed limits for vehicles traveling in populated areas (maximum speed of 25 km/h).
- Maintain in good condition the damping systems of all vehicles, machinery and equipment used during the Project phases.
- Design and implement a contingency plan and corrective measures to meet eventualities.
- Study and use noise barriers or acoustic noise suppression devices when necessary.

The implementation of these control measures to reduce noise pollution along the TL and proposed infrastructure will reduce the significance of impacts to *minor* and in some cases *insignificant*. The monitoring of noise levels during the construction and operation phases of the Project will allow the assessment of the correct functioning of the mitigation measures and determine if any additional measures are necessary to maintain the significance of the impact as *minor* or *insignificant*.

5.3 *IMPACTS ON THE BIOTETIC MEDIUM*

5.3.1 *Loss of Plant Cover*

As described in *Section 2.0 - Description of the Project and its Alternatives*, the available information on the design of the Project indicates that a total of 115 towers will be installed between the electrical Ahuachapán SE of the geothermal plant and the CA-12 and other 24 Towers between this route and the Acajutla SE. For each tower, an area of 10 m x 10 m will be used during construction and an area of 7.5 m x 7.5 m during the life of the Project, and a maximum area 35 m x 35 m around each tower to allow lifting maneuvers and tensioning of the cables during construction. For the construction and operation of the Ahuachapán SE it is planned to use a maximum area of 5,330 m2 and for the Acajutla SE a maximum area of 24,500 m2 (see Figures 2.2-1 and 2.2-2).

Using data from the topographic studies for the design of the Project, a total of 1,408 trees were counted within a radius of 24.75 m around the central point of each tower between the towers TP 1 and TP 128, with a global average of 11.93 trees per tower. This circle of 49.5 m in diameter covers the area of 35 m x 35 m of logging for each tower in a conservative way, given the uncertainty as to the orientation of each tower. Between the towers TP 129 and TP 151, the average value for towers TP 100 to TP 128 (2.96 trees per tower) was used, and a total of 71 additional trees is estimated, presuming a total of 24 towers in this segment.

Using satellite imagery from 2016, a total of 25 trees were counted in the expansion area of Ahuachapán SE and in the area of the new Acajutla SE a total of 65 trees.

The average tree density calculated for TP 1 and TP 128 is 0.00620 trees per square meter. For purposes of estimating tree density, the high coverage zone corresponds to towers TP 1 to TP 58, with a density of 0.010205 trees per m2 and the low coverage area corresponds to towers TP 59 to TP 128, with density of 0.001914 trees per m2.

In addition to the right of way, it will be necessary to construct a total of 64 new accesses with a total length of approximately 18.8 km and will rehabilitate approximately a total of 75.7 km of existing roads to allow temporary access of vehicles and machinery for the construction and lifting of the towers. The new accesses will have a width of 5 m and it was estimated a tree felling in a strip of one meter on each side of the accesses to be improved. Using the averages of the segments described in the previous paragraph, the number of trees to be felled for new and improved accesses was estimated in the following table (see Table 5.3-1).

Table 5.3-1 Estimated Number of Trees to be Felled for New and Improved Access

Type	*Coverage (%)*	*Length (Km)*	*Surface (ha)*	*Estimated Trees*
New accesses	High: 50-100	11.7	5.9	598.0
	Low: <50	8.0	3.4	68.0
	Total	***19.7***	***9.4***	***666.0***
Improved accesses	50-100	48.1	9.6	981.0
	<50	27.7	5.5	106.0
	Total	***75.8***	***15.2***	***1,087.0***

Key: km = Kilometers; ha = Hectare; % = Percentage.

Other areas will be temporarily converted to storage areas (facilities) during construction and dismantling of the Project. It is estimated a total of nine storage areas in towers TP 1 and TP 127, with measures of 100 m x 50 m, for a total approximate of 4.50 ha. It is estimated that it will be necessary to cut about 280 trees in total, applying the average density for towers TP 1 and TP 127.

In total, it is estimated that the Project will require the logging of some 3,599 trees (see Table 5.3-2).

Table 5.3-2 Estimated Number of Trees to be Felled by the Construction of the Project

Installation	*Approximate Number of Trees*
Foundations of towers and temporary areas for lifting and tensioning	1,476
Access	1,753
Storage áreas	280
Ahuachapán Substation	25
Acajutla Substation	65
Total	***3,599***

The significance of the impact on vegetation cover is classified as minor (minor magnitude, medium sensitivity).

EDP will implement the following control and mitigation measures to minimize and, as far as possible, eliminate impacts on plant cover:

- Optimize the design of the route to minimize impacts to natural forests.

- EDP will implement an environmental compensation program through the reforestation of trees (10 trees per cut tree) and shrubs (1 shrub per cut shrub).

According to the implementation of these measures, the significance of the impact on the vegetation cover is expected to be reduced to *insignificant* (insignificant magnitude, medium sensitivity).

In areas where trees and/or shrubs are felled, the following measures will be taken to manage the plant material generated:

- If trees whose timber is of commercial or utilitarian value are cut, it will be consulted with landowners to inquire if they are interested in retaining timber. The contractor will cut logs to segments of appropriate size.
- If the landowner is not interested in wood, the contractor may seek other ways to distribute the wood to entities that can use it.
- Other generated plant materials can be crushed on site and used to provide a layer of protection against erosion.

5.3.2 *Loss of Individuals Threatened or Endangered Species*

As described in *Section 4.2.1*, the Project will locally cause the logging of trees and shrubs within the right of way strip and other areas necessary for the construction and dismantling of the Project. Although the baseline of the biotic environment documented the presence of threatened or endangered species of flora, no details are available on how many individuals of such species are within the areas subject to felling or clearing by the Project. However, the numbers of individuals to be removed by the construction of the Project will be insignificant in the context of the global, regional and local populations of these species; therefore, the impact is considered *insignificant*.

EDP will implement the following control and mitigation measures for trees and shrubs categorized as threatened and endangered:

- Optimize the design of the route and substations to minimize impacts to natural forests.
- Prior to construction, count individuals of threatened and endangered species to be logged.

- Implement an environmental compensation program through reforestation of trees (10 trees x cut tree) and shrubs (1 shrub per shrub cut).

With the implementation of these measures, the impact on threatened and endangered species of trees and shrubs is expected to be positive because of the increase in populations of these species in reforestation areas.

5.3.3 *Pollution and Degradation of Aquatic Habitats*

Earth movements and loss of vegetation cover can cause soil erosion and the introduction of sediment and organic material into bodies of water. Besides, the crossing of ravines by vehicles and machinery can introduce contaminants. The two new access roads are adjacent to bodies of water and another crosses San Rafael river.

Three of the nine campuses or temporary storage areas are located within 100 m of a body of water and they also present a risk of pollution and degradation of aquatic habitats if adequate prevention and control measures are not implemented.

Without mitigation, the potential impact on aquatic habitats is considered moderate (medium magnitude, medium sensitivity).

Control and mitigation measures for aquatic habitats are presented in *Section 5.2.4.2 - Alterations in Water Quantity and Quality*. With the proper application of these measures, the Project's residual impact on aquatic habitats will be *insignificant* (insignificant magnitude, medium sensitivity).

5.3.4 *Disruption and Displacement of Fauna*

The infrastructure construction of the Project and maintenance of the lines and the right of way strip will generate noise, vibrations and movement that may cause the disturbance of movement of fauna outside the work areas. The good practices of maintenance of vehicles and machinery, the respect of work areas and the minimization of the felling of vegetation will contribute to minimize the impacts. These impacts will be of brief duration and limited in area, by which it is classified as of low magnitude and of low sensitivity in regard to the receiving species, resulting in an *insignificant* impact.

5.3.5 *Loss of Habitat and Individuals of the Black-eyed Frog*

Site preparation and construction work on wildlife habitats may lead to habitat loss and mortality of individuals from low mobility wildlife species, such as amphibians, reptiles, small mammals and bird chicks in their nests. The species of low mobility fauna of greatest concern for its state of conservation is the black-eyed frog (*Agalychnis moreletii*), which is classified as Critically Endangered according to the IUCN (2016) and Threatened according to MARN (2015). However, these habitats and individuals represent an insignificant fraction of their local population and will not affect the survival of the species. The impact is classified as *moderate* (low magnitude and high sensitivity because it is a Critically Endangered species according to the IUCN).

In order to avoid, minimize and compensate the impacts on the black-eyed frog and its habitat, EDP will strictly apply the following preventive and compensatory measures:

- Campaigns for the capture and relocation of frogs in habitats to be affected by the Project.
- Avoid impacts to its existing breeding sites.
- Construct two piles of water catchment in each area where the presence of the frog was documented to increase the availability of habitats for the reproduction of the species (Santa Rita and Tequendama farms). The "piles" are craft structures used by coffee producers in the region to store water. Frogs use these piles as shelters and breeding grounds. It should be installed four piles built according to local custom with the following dimensions and materials: approximate dimensions - 2.5 m long x 1.5 m wide x 1.6 m deep with, corrugated aluminum sheet roof with gutter and down tube; and materials - building bricks, cement, sand, corrugated aluminum sheets, nails and/or screws, with cement refining.
- Reforestation of forest habitats in the Biosphere Reserve.
- Educational conservation campaigns on the importance of the frog and the advantages of organic coffee cultivation without agrochemicals.

With the application of the measures detailed in *Section 7 - Project Environmental and Social Management Program*, the residual impact on the black-eyed frog will be *positive* because of the greater availability of habitats for its reproduction and the increase in forest cover in The Biosphere Reserve by the Ecological Compensation Program.

5.3.6 *Bird Collisions with Cables*

For big birds, such as raptors and waterfowl, there is a risk of collision with TL cables, mainly in guard cables because they are of smaller diameter and less visibility. This risk is greater in crossings of water bodies, high relief canyons and crosses of the peaks of the Apaneca mountain range within the Apaneca-Ilamatepec Biosphere Reserve. There are no major populations of raptors or waterfowl of high conservation importance (endangered species or species with significant concentrations during annual migrations) in the Project area. Nor are there areas of importance for the congregation of migratory species; according to Komar & Ibarra-Portillo (2009), there are no sites in El Salvador that meet the criteria A4 for Ramsar sites and Important Bird Areas ("IBAs").

Although the IBAs of El Imposible Forest and Los Volcanes Complex and San Marcelino, located to the west and east of the Project area, respectively, are of importance to boreal migrants, the Project area has not been identified as such. Small migratory birds are less likely to collide with transmission lines and in the particular case of the Project, the lines are oriented generally north-south, parallel to the migration route.

Although the last tower (TP 151) is located about 1.3 km from the Pacific coast, the transmission line is not located in areas frequented by seabirds or coastal birds and there is a separation by urbanized areas between the coast and the line.

Considering that the sensitivity of bird populations to collisions with the lines is considered average and that the magnitude of the impact is low, the impact is classified as *minor*.

Although the significance of impact without mitigation is classified as minor, EDP will implement the following control and mitigation measures to minimize the risk of bird collisions with transmission lines:

- Installation of bird flight deterrents throughout the section of the transmission line inside the IBA "Los Cóbanos."
- Installation of dissuasors in the main crossings of rivers and ravines.

With the application of the proposed measures, the residual impact on birds by collision with the lines is classified as *insignificant* (insignificant magnitude, medium sensitivity).

5.3.7 *Electrocution of Birds*

Although transmission lines may present high electrocution hazards for big birds such as raptors, this risk is minimal for transmission lines because the size of the structures because the distances between electrified elements and earth elements are large enough to be risk free of contact for birds (APLIC, 2006). This risk does not require mitigation because it is *insignificant* (insignificant magnitude, medium sensitivity) and does not require specific measures of control and mitigation.

5.3.8 *Impacts to the Apaneca-Ilamatepec Biosphere Reserve*

The Project will be built and operated, mostly within the Transition Zone:

- Buffer zone: TP 14 to TP 28 (11 towers).
- Transition Zone: TP 28 to TP 39 (16 towers) and TP 56 to TP 60 (1 tower in forest).

The construction of the towers and the laying of the lines require the felling of trees and shrubs in areas of 10 m x 10 m for the foundation of each towers and temporary areas of approximately 35 m x 35 m around each tower. According to the topographic studies carried out for the design of the Project, 194 trees will be felled in the Buffer Zone and 248 trees in the Transition Zone. Temporary areas will be rehabilitated and revegetated at the end of construction of the Project.

In addition, it is proposed to open new temporary access roads from existing roads. The accesses within the Buffer Zone will be rehabilitated and revegetated at the end of construction of the Project.

EDP will implement the following control and mitigation measures to minimize impacts on the Apaneca-Ilamatepec Biosphere Reserve:

- Installation of bird flight deterrents along the entire length of the transmission line within the IBA.
- Minimize felling of trees and shrubs by positioning towers outside areas of woody vegetation.
- Minimization of the opening of new accesses and their rehabilitation and revegetation to finalize the construction of the Project.

- Restoration of forests within the Reserve through the Environmental Compensation Program.
- Training of workers on the importance of the Reserve and its conservation objectives.
- Installation of information signals on public roads on the Reserve and its biodiversity values.

With the application of the measures detailed in *Section 7 - Project Environmental and Social Management Program*, the residual impact of the Project on the Apaneca - Ilamatepec Biosphere Reserve is rated as *positive.*

5.3.9 *Impacts to the Important Bird Area "Los Cóbanos"*

A section of approximately 2,890 m of transmission line crosses part of the northwest section of the IBA between towers TP 136 and TP 145.The construction of the towers and the laying of the lines require the felling of trees and shrubs in areas of 10 m x 10 m for the foundation of each towers and temporary areas of approximately 35 m x 35 m around each tower. Temporary areas will be rehabilitated and revegetated at the end of construction of the Project. In addition, it is proposed to open new temporary access roads from existing roads.

There is a risk of collision of birds with lines and the construction of towers that may result in the elimination of natural vegetation.

As part of the implementation of the Project's Environmental and Social Management Program (*see Section 7.0*), EDP will implement the following control and mitigation measures to minimize impacts on the IBA Los Cobanos:

- Installation of bird flight deterrents throughout the length of the transmission line within the IBA.
- Minimize felling of trees and shrubs by positioning towers outside areas of woody vegetation.
- Restoration of gallery forests within the IBA through the Environmental Compensation Program.
- Training of workers on the importance of birds and their habitats.
- Installation of informational signals about the IBA and its biodiversity values on Route 12.

With the application of the measures detailed in *Section 7 - Environmental and Social Management Program*, the residual impact of the Project on the Important Bird Area "Los Cóbanos" is rated as *positive.*

5.3.10 *Impacts to the Area between Los Cobanos - Apaneca-Ilamatepec Biosphere Reserve - El Imposible National Park*

The opening of a right-of-way strip, construction and operation of a linear project can cause adverse impacts on the ecological connectivity of the landscape and populations of sensitive organisms. The project traces mainly through areas of pasture and induced pastures, annual crops and coffee plantations, with short sections of natural forests. In its northern part, the trace also overlaps with a section of the Mesoamerican Biological Corridor and the Apaneca-Ilamatepec Biosphere Reserve. These areas are not a corridor of contiguous natural habitats, but include many areas of habitats modified between patches of natural habitats and most of the area is under coffee cultivation. The Impossible National Park is about 8-9 km west of the LDT and about 4-5 km from the western boundary of the Apaneca-Ilamatepec Biosphere Reserve.
At the southern end of the Project, the Area of Importance for Bird Conservation "Los Cobanos" lies on the Pacific coastal plain and is completely isolated from the protected areas of the volcanic mountain range by large tracts of grazing fields and crops. The construction and operation of the LDT will not result in impacts on the connectivity between the conservation areas, considering that, outside the areas around the towers, logging of the right of way strip will not normally be necessary and not Will create a gap of open habitats and also the LDT will not cause barrier effects for the species of flora and fauna of its area of influence. The LDT itself will not present a barrier to the terrestrial, aquatic or aerial fauna of the region, considering that there are no species of open habitats with aversion to high structures. The movements or migrations of fauna from north-south on the mountain and the coast would not be impacted either because the LDT runs parallel to these movements.

Without mitigation measures, the impact of the Project on biological connectivity in the area between Los Cobanos, Apaneca-Ilamatepec Biosphere Reserve, and El Imposible National Park is considered minor. With the application of the measures detailed in *Section 7 - Project Environmental and Social Management Plan*, the residual impact of the Project on this area is rated as *positive*.

5.4 *IMPACTS ON THE SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT*

In general, the impacts of the Project on the socio-economic environment will be positive, mainly due to the demand for labor and the requirement of other services (such as transport and food), especially during the construction phase. At the national level, the major contribution of the Project is the improvement of the reliability of the electricity supply in the national electricity system.

5.4.1 *Generation of Temporary and Permanent Employment*

For the construction and maintenance of TL and infrastructure, the Project will hire a labor force consisting mainly of workers from the towns and municipalities in the area of influence of the Project and national specialized workers. Although the final number of workers will be determined by the contractor, it is expected that at the peak of construction there will be approximately 200 people employed for the construction of TL and infrastructure, which will be divided into five work fronts (one for each section of line, plus substations). The Project will generate 30 indirect jobs, which will correspond to subcontracts and other services related to construction, such as materials transportation, food sales, water supply, among others.

Most of these workers will be hired from nearby hamlets or villages. Unemployment is high in the area of influence of the Project; as transmitted by the respondents during the completion of the baseline. Unemployment is clearly a significant problem in communities, as expressed by unemployed young adults during the participatory diagnosis. Therefore, these jobs will benefit the local economy. As a result, local expectations are high.

For the operation of the Project, it is estimated that the labor requirement will be approximately 3 to 5 people. Majority of the workforce will be used during this phase. Unskilled labor will be used for periodic maintenance of the right of way and support activities (eg pruning and vegetation control in right of way and maintenance of roads).

To be considered for the direct employment of unskilled jobs, individuals must be at least 18 years old and at least be able to read and write, present a record of criminal records and be in possession of the identity card. Positions such as truck driver supervisors and equipment operators require additional and specific requirements.

Depending on the type of work they do, some of the Project subcontractors may have other minimum requirements. Therefore, more unskilled workers could be hired through subcontractors. This impact has been rated as *positive*.

5.4.2 *Regional Economic Stimulus*

As a result of the Project, commercial, industrial and related services are expected to grow. This will be due to the increase in electricity supply, which will allow the growth of large and small companies; the local jobs generated by the Project will imply an influx of resources to be invested in the local economy; and the presence of the labor force for the construction and maintenance of the line will bring with it the demand for transportation, recreational services, meals among others. The economy of the public sector will also benefit from the presence of the Project since during its 20 years of useful life it will contribute its taxes for its operation, the jobs provided and taxes related to the importation of equipment. With the implementation of the TL and the expectations that in the near future improve the service of electricity supply it is possible that new economic actors at local and regional level that promote development appear. This impact has been rated as *positive*.

5.4.3 *Increased Power Supply*

The increase in power supply is one of the main impacts of the Project. It will not only respond to the regional demand for energy, but will also play an important role driving the development of the area within the framework of Government development projects. This impact has been rated as *positive*.

5.4.4 *Risk of Conflicts between the Local Population and the Project*

This risk exists in every project. The character of the relations between the community and the Project depends largely on the fair and respectful treatment of the local population by each member of the Project team and the presence of an open line of communication. This risk is especially sensitive in areas where the houses are closest to the transmission line, since the inhabitants will suffer the inconveniences generated by construction such as congestion or temporary interruption of access, increase of vehicular traffic, noise and dust.

The Project has designed a citizen participation plan that establishes recurrent meetings to inform the progress of the Project. It has also established a complaint mechanism to have an open line of communication with the communities. For more details, refer to *Section 7.0 Environmental and Social Management Program.*

Additionally, the contractors will have to be governed by the workers' code of conduct and all employees will be required an induction in community relations.

The magnitude of this impact for the construction phase has been considered small, and the vulnerability of the population low. With the application of mitigation measures, the impact has been rated as *insignificant*. In the operation stage, impact is considered *insignificant* because the interactions of Project staff with communities will be minimal. Only maintenance personnel will be moving to the area.

5.4.5 ***Risk of Traffic Accidents on Public Roads***

One of the main negative effects during the construction phase is the effect on the traffic routes. It is estimated that the vehicular flow will be about 10 trucks per day per sector and/or tower during the construction stage. During the maintenance stage, it will be 1 truck per month or 2 months. Increased traffic of heavy vehicles during construction can increase the possibility of traffic accidents. Likewise, the execution of improvement works on the access roads may temporarily affect the conditions of transitability.

In order to minimize interference with road users, the following mitigation measures will be implemented:

- The works will be programmed so as to always maintain the main communication channels enabled. The necessary precautions will be taken to avoid accidents, maintaining at all times adequate signage, both day and night, according to the rules of the competent authority complying with current regulations. It will be driven at a maximum speed of 25 km/h. At the end of the works to improve the roads, the clearance and cleaning work will be carried out.

- All personnel and Project contractors related to vehicle driving will undergo training for defensive driving (Smith System)[8]. It will ensure that the drivers have the Smith System certificate and if they do not have it, they will take a course.

- All Project staff and Project vehicles will give the right of passage to all local people (for example, inhabitants of communities that are moving on foot). Project employees as well as subcontractors will be responsible for the traffic of their vehicles and will have to comply with the measures proposed in the Environmental Management Plan and the Social Management Plan.

During the construction phase, the impact is estimated to be of medium magnitude due to increased traffic. The vulnerability of the population has also been considered medium, taking into account the greater probability of accidents that the vehicular flow could cause. The impact is categorized as *moderate* during construction and *insignificant* during operation and abandonment.

During the operation phase, activities that generate traffic impacts are not identified. During the abandonment phase, activities associated with the transportation of materials and machinery could temporarily alter the traffic conditions resulting from a greater flow of vehicles.

5.4.6 *Impacts Related to the Purchase of Right of Way*

The trace of the TL is projected with an approximate length of 44 km that will develop of aerial form in its entirety. The projection is developed from the port and city of Acajutla, passing through the municipality of Santo Domingo de Guzmán in the department of Sonsonate, and the municipalities of San Pedro Puxtla, Apaneca and Ahuachapán in the department of Ahuachapán. Along the route, 264 properties have been identified that represent 264 parcels of land.

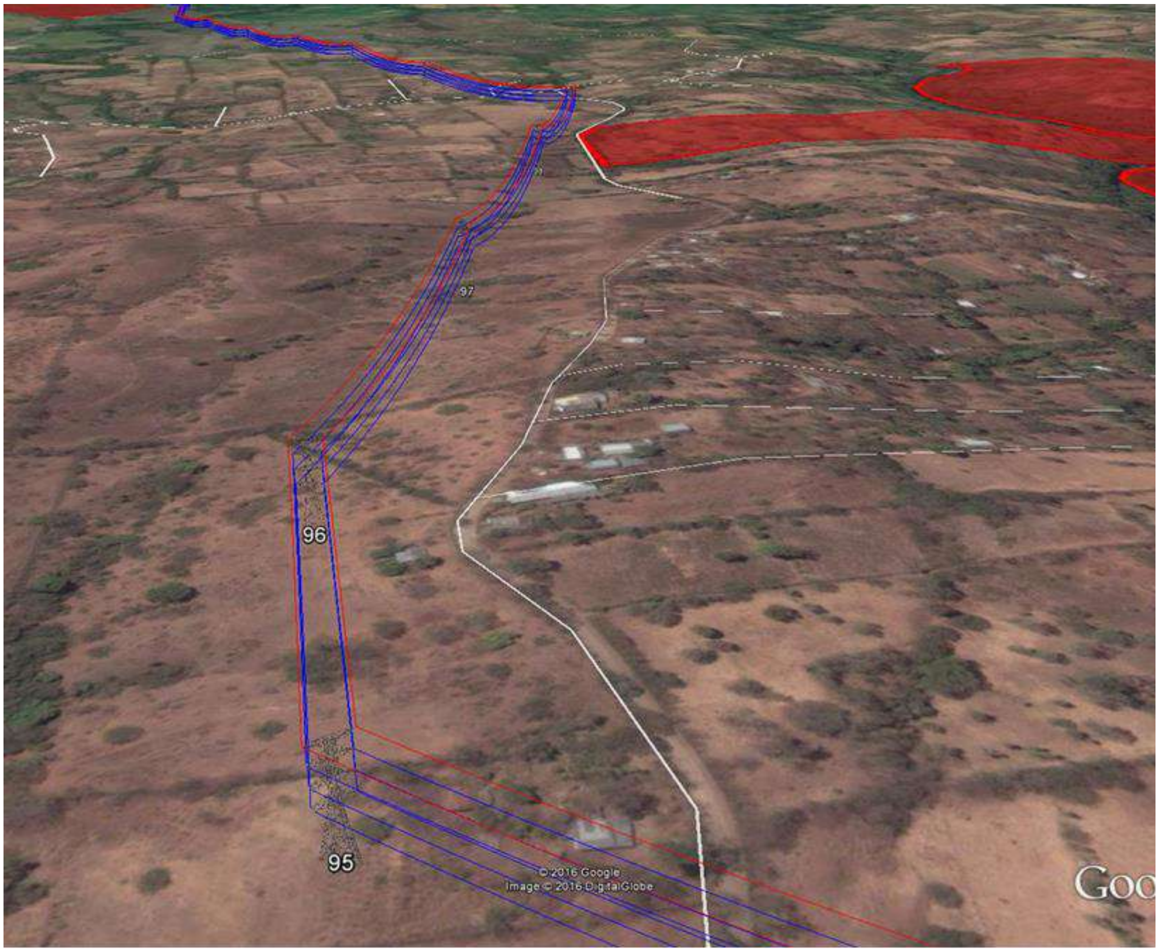
[8] https://www.drivedifferent.com/

For the management of right of way, the trace has been divided into three sections:

- Section A, comprises 77 parcels of land in 17 km within the coffee zone of Ahuachapán and Apaneca.
- Section B, comprises 132 parcels of land in 20 km.
- Section C, comprises 55 parcels of land in 7 km at the exit of Acajutla.

For the construction of the TL it is necessary to negociate the right of way in the estates that are being affected, which consists of the constitution of a tax legally known as right of way of electric conduit. The right of way of electric conduit is equivalent to a permit of passage and construction of the TL for an indefinite time, and by which the owners/possessors will be compensated justly and properly. The negotiation of the segments of land on which the transmission line would pass included an economic recognition by the company, which has been established by means of the current commercial valuation of the square vara in the Department of Ahuachapán and Sonsonate, for which a particular commercial negotiation with each of the owners was carried out or is being carried out. In cases where a price could not be agreed upon, the line had to be redesigned to land where negotiation was possible. Figure 5.4-1 below shows the design of the line avoiding those areas or parcels of land that showed no interest in negotiating with the Project or had land ownership problems.

It should be noted that there is no option of expropriation or other mandatory procedures in El Salvador, so in principle the negotiation is a free business between the representatives of the company and the owner or the representatives of the same. To date, there are 100% of the registry-cadastral verifications of real estate under the map. For more information on right of way management, see *Appendix G - Rights of Way Management Report.*



Source: EDP, 2016

Figure 5.4-1 Avoiding Project-Sensitive Buildings and Parcels of Land

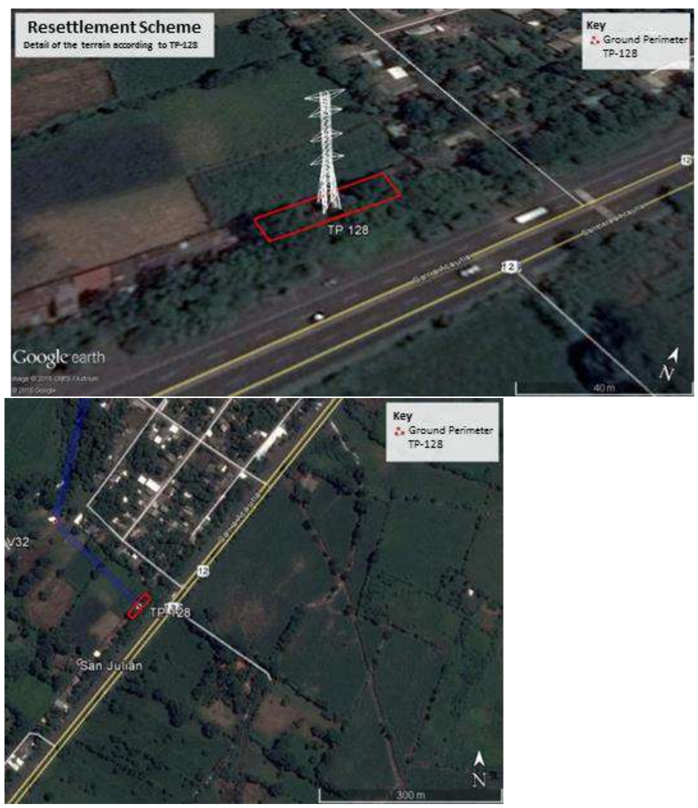
At all times, it was tried to avoid the displacement of families, that is to say, properties in which there were houses. Therefore, numerous alternative layout designs have been explored, as described in *Section 2.4 Considered Alternatives*. Therefore, the Project will only require the rehousing of a family in Acajutla, inside Santa Emilia Lotification. This case is located in parcel 246 where TP 128 is projected, between Section B and Section C, in the Acajutla Exit sector, identified as Rea-6 (see Table 5.4-1). The family data is listed below and in more detail in the socioeconomic data sheet collected during the socio-economic census (see Appendix H)

Table 5.4-1 Rea-6 Resettlement Case

Name	*Parcel according to Project*	*Vertex/ Parking lot*	*Name of Head of Family*	*Head according to Sex*	*No. of Structures (Housing)*	*No. de Grupos Familiares*
Rea-6		18/35+000	Julio Alberto Menéndez Ramírez	Male	1	1

Source: GRIS, 2016. Elaborated with data collected by EDP's Right of Way Management team

This family is made up of 6 members and has been living in the area for 9 years. The land will be bought and is located just in front of the road, having a dimension of approximately 45 m in front and 10 m in depth as shown in the pictures. The land will be used for the installation of one of the towers of the line (see Figure 5.4-2).



Source: EDP, 2016

Figure 5.4-2 Scheme for Property Resettlement in Acajutla

Control and mitigation measures include the following:

- Anticipate and avoid or, where this is not possible, minimize the adverse social and economic impacts arising from the acquisition or restrictions on land use: (i) compensating the loss of property at replacement cost

- The Project will make every effort to improve the living conditions of physically displaced persons by providing them with adequate housing with security of tenure in resettlement sites.
- Development of the document with the methodology for "Zoning of Land Uses, Determination of Securities Ranges for Land and Infrastructure Compensation, Definition of Valuation Parameters and Negotiation Criteria", which establishes the limits or boundaries of classification of ground uses in land, and the ranges of values for fair compensation for acquisitions or restriction of land use, arising from Project implementation.
- Resettlement activities will be carried out with appropriate dissemination of information, consultation and informed participation of the affected persons. The Project Social Management team will ensure that these aspects are met.
- An Office of Attention to Owners has been stablished since September of 2015 that has among its functions:
  - Attention to owners/holders of real estate located under the trace or any other person interested in obtaining project information.
  - Receipt of personal identification and property ownership documents.
  - Receipt of complaints and claims, not only by owners/holders of real property, but also by any person living in the area of influence of the trace, and who are directly involved who consider that they have suffered damage on their property by the work teams that perform in the field. This establishes a mechanism of complaints to file appeals and aims to resolve disputes in an impartial manner. As a reference, the complaints mechanism is centralized through an email (quejas@energiadelpacifico.com) which is located within the web page of Energía del Pacifico:
  - http://energiadelpacifico.com/html/contacto.html

During the construction phase, the impact is estimated to be of medium magnitude and low vulnerability. The impact is categorized as minor to *insignificant* in the stage of operation and abandonment.

5.4.7 *Restrictions on Land Use within the Right of Way*

The construction and operation of a transmission line entail, for safety, the restriction in the use of the ground for activities that are not compatible with the operation of the line. Thus, in the contracts signed between the landowners and EDP (see Appendix I), the following is specified:

- Excavations are prohibited "within 15 m of support structures, constructing buildings for any purpose or use, storing flammable or explosive materials, accumulating materials or other objects, opencast mining or pits, tunnel mining less than fifteen meters from the base of the support structures of the conductors";
- "Planting or permanence of waterlogged crops or vegetation that in their final development are closer to 5 m of cables" is also prohibited.
- Burns are not allowed regardless of their nature or reason.

In addition to these express limitations, other tacit ones are also codified in the agreement between EDP and each owner. In the field purchased, EDP reserves the right to:

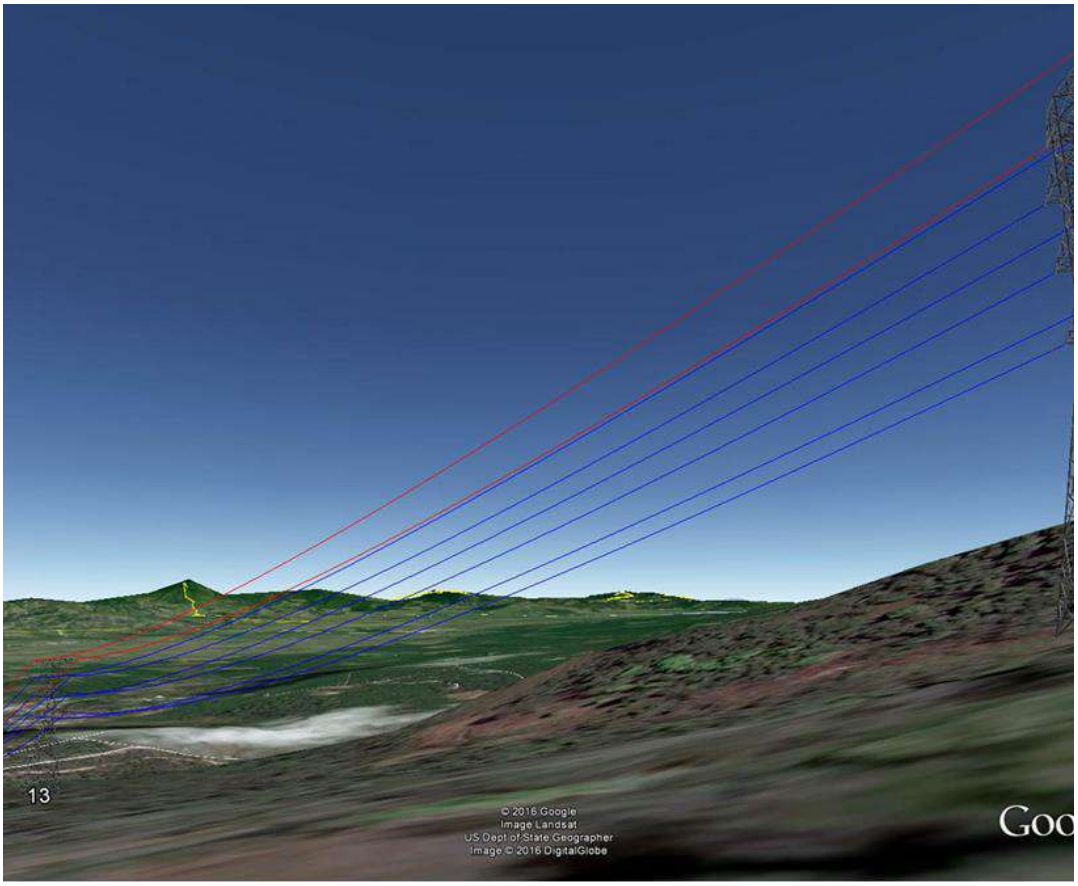
- Perform any installation of structures, such as towers or posts, and necessary construction;
- Authorizes to remove any obstacles within the respective path, including trees that approach the wires dangerously, in order to maintain a minimum distance of five meters, as long as this is necessary for the construction and optimal maintenance of the transmission lines;
- Approve or deny excavations that are carried out at a greater distance from the prohibited and the use of agricultural or construction machinery that guarantee a minimum distance of 5 m with the cables.

The magnitude of this impact is considered *insignificant* for all the stages, since it will start from a previous agreement, sealed through a legal contract, between the owners and the promoter of the Project.

5.4.8 *Alteration of Visual Quality and Fragility*

The clearance and weeding of vegetation, the extraction of stone material and soil, earth movements, associated with the rehabilitation and construction of access roads will produce a visual alteration of the landscape. The most important activities for visual perception will be the lifting of 139 towers and the laying of the conductors, as they introduce new elements that are foreign to the natural landscape.

Below is Figure 5.4-3 in three dimensions that capture the visual effect that the transmission line wil produce.



Source: EDP, 2016

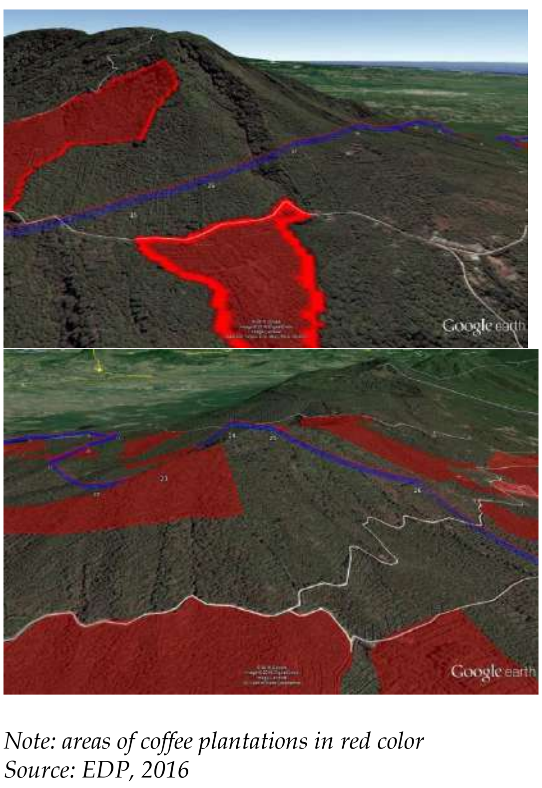
Figure 5.4-3 Transmission Line at its Pass through a Ravine

The layout of the line has avoided, as far as possible, passage through populated areas. For example, Figure 5.4-4 depicts how the Project has attempted to avoid populated areas in the approach to Ahuachapán.

Source: EDP, 2016

Figure 5.4-4 Transmission Line Avoiding Approach to Residential Zone in Ahuachapán

The line has avoided passage through sensitive areas, as shown in Figure 5.4-5 below.



Note: areas of coffee plantations in red color
Source: EDP, 2016

Figure 5.4-5 Transmission Line Avoiding Coffee Plantation Areas

The increase of anthropic components in the landscape reduces the visual quality of the area.

The line layout and the right of way corridor design have been optimized to minimize impact to the quality and visual fragility of the landscape and to preserve the visual quality of the natural environment. Elements of the natural environment (for example, points of tourist interest - especially in the northern part of the development of the Project - or natural observation, churches or buildings with historical and heritage value, peaks and mountains, etc.) have been taken into account to avoid intersection with them.

The line layout in the northern part of the Project is located in areas that are not visually sensitive and generally disturbed, moving away from populated centers, avoiding tourist areas (for example, Ahuachapán and the Ruta de las Flores, see Appendix S) and avoiding intersection with coffee growing areas.

Taking into account the mitigation measures integrated in the design of the line layout, the magnitude of the impact is considered medium and the vulnerability is low. Therefore, this impact is considered *minor*.

5.4.9 *Occupational Accident Risk*

During the construction phase, occupational accidents can be generated, as well as effects on the community, such as an increase in the incidence of traffic accidents. Control and mitigation measures include the following:

- The promoter will ensure that the working conditions in the Project comply with the occupational health and labor standards of El Salvador.
- The staff must be qualified to carry out the activities of the Project.
- All employees will receive training in Occupational Health and Safety.
- The contracting company will provide personal protective equipment and tools in good condition to all workers according to the activities they perform.
- Personnel shall wear appropriate personal protective equipment at all times and work at heights shall be carried out with appropriate safety

measures (safety harness, gloves and insulation clothing), in accordance with the applicable legal requirements in this area.

- The staff will have adequate and sufficient means to ensure a proper hydration and at least one hour of rest during the day.
- If torrential rains occur during the laying of the line, the work must be done with extreme caution or even suspended, while the rain lasts to avoid soil trapping and runoff.
- All workers should be made aware of the importance of complying with all the above measures in order to make an adequate waste management, have personal protective equipment and work tools in good condition and take care of and preserve the biological and environmental characteristics of the area.
- All access points to the Project sites will be clearly marked and will have security personnel.

After the application of the mitigation measures the magnitude of this impact is considered medium and the vulnerability is low, reason why the impact is categorized of *minor* significance in the construction stage. For the operation stage the impact is considered *insignificant*. During the abandonment phase, the impact would be reduced to *minor* again and mitigation measures would have to be the same as those detailed for the construction phase.

5.4.10 ***Potential Alteration of Community Health by Phenomena Associated with Transmission Line Magnetic, Electrical and Acoustic Fields***

5.4.10.1 Electrical Conduction - Electromagnetism

In some publications and media there have been talks of health effects by the electromagnetic fields of the electric conduction lines. However, recent research by the World Health Organization[9] concluded that there is no confirmation yet that exposure to low-intensity electromagnetic fields has

[9] http://www.who.int/peh-emf/about/WhatisEMF/es/index1.html Available in September 2016.

health consequences. However, this description is included to clarify the evaluation.

In general, two types of physical impacts must be considered regarding to the transmission of electrical energy by means of transmission lines:

1. The electric field that increases from the conuctor lines to the ground. In this case, the main variable is the electric field strength in kV/m, which is influenced by the electric current, the distance and the shield.

2. The magnetic flow density (colloquially referred to as the magnetic field strength), which is proportionally negative to the current and decreases with the square of the distance. The flow density is measured in microtesla (µT).

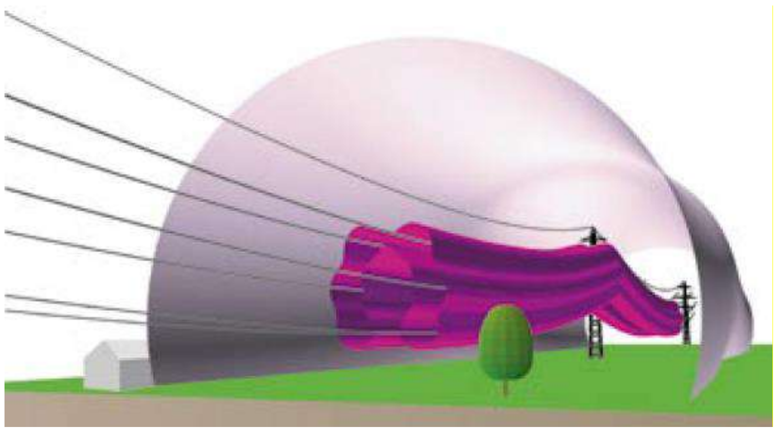
Both fields are of low-frequency oscillation with non-ionizing radiation at 50 Hertz (Hz).

Transmission of electricity by transmission lines can also be associated with noise emissions. These noises are caused by the electric discharges that result from an ionization of the air. This phenomenon is known as the "corona effect".

The noises caused by the wind and the "corona effect" are emitted mainly near the towers of high tension. The noises are perceptible as buzzing or small sparks. An increase in air humidity results in an increase in noise emission due to increased air conductivity.

5.4.10.2 *Magnetic Fields of High Voltage Lines*

The spatial extent of the magnetic field of a high voltage transmission line increases with the electric current and the distance between the conducting lines. The highest field strengths occur near the ground level midway between two high voltage towers, where the lines have the greatest collapse. The field strength decreases with increasing distance to the conductive lines (see Figure 5.4-6). The impact of the magnetic field can be minimized by optimizing the phase arrangement.



Source: ERM, 2016

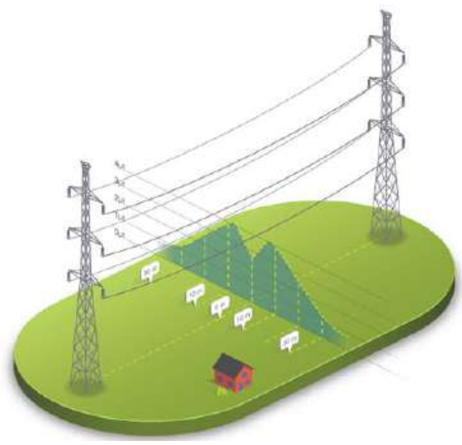
Figure 5.4-6 Representation (in Perspective) of the Magnetic Field of a High Voltage Air Line of 380 kV with Two Systems at Maximum Capacity

The highest flow density occurs in the vicinity of the six conductor lines. It equates to a value greater than 100 militesla (mT) inside the tubes of garnet color, but with only 1 mT in the mantle of the largest tunnel. The flow density decreases with increasing distance from the conductors and is not influenced by walls or trees.

After more than 30 years of research, scientists have yet to find formal evidence that exposure to magnetic fields poses a health risk. However, they have not been able to rule out any risk either. However, many scientists are still working to determine whether exposure to magnetic fields is harmful, whether in the short or long term.

Epidemiological studies have long suggested that there is a small statistical correlation between long-term exposure to low-voltage magnetic fields in the high voltage network and an increased risk of leukemia in children. Studies of cell and animal cultures since the 1980s have not been able to confirm this theory and, as such, no causal relationship has been established between exposure to magnetic fields and an increased risk of leukemia in children. However, in the absence of any explanation of the statistical relationship presented by epidemiological studies, there are no studies that have been able to rule out this fact.

Figure 5.4-7 represents the typical values for a magnetic field below the 380 kV high-voltage lines, superior to the proposed Project, and shows that the field strength is directly proportional to its distance from the line. The exposure value of the field varies by location and time depending on the voltage, the electricity passing through, and the height of the line. It is important to note that the levels of exposure anticipated as part of the Project are well below these levels.



Source: ERM, 2016

Figure 5.4-7 Typical Values of Magnetic Field of High Voltage Lines of 380 kV, Superior to the Proposal

Since the magnetic field is not determined by voltage, a high voltage connection with a higher voltage does not necessarily generate a stronger magnetic field. However, in practice, the strongest magnetic fields have been recorded in the vicinity of 380 kV lines. After all, the higher the voltage, the greater transmission capacity of the line and therefore the greater the volume of the electricity it conducts. Magnetic fields of high voltage lines below 380 kV, such as this Project, are usually no more than 4 mT and become increasingly weak the further away from the line are measured.

5.4.10.3 High Voltage Line Electrical Fields

The electric field of a high voltage line is proportional to its voltage. Below 380 kV, the electric field strength can be as high as 5 kV/m. The lower the voltage, the lower the electric field strength.

5.4.10.4 Acoustic Fields of High Voltage Lines

The "corona effect" is increased by:

- Unfavorable conductor geometries;

- Non-circular cross-section of conductive lines;
- Irregularities in the surface of conductive lines;
- Moisture deposits of insulator chains and conductive lines; and
- Wind noise and vibrations in steel beams of high voltage towers at wind speeds exceeding 15 meters per second (m/s).

Based on current scientific knowledge, noise emissions from overhead transmission lines are insignificant and do not pose a significant threat to human health.

5.4.10.5 *Anticipated Impacts of the Proposed Line*

No impacts related to electromagnetic fields are expected during the construction phase of the Project. It is anticipated that the impacts will be experienced during the stage of operation of the same.

Due to the lack of regulations in El Salvador for the TL design, the existing regulations and limits on electromagnetic fields imposed by the agencies in the United States of America are considered to be the most stringent in the world.

The electric field strength at the axis of the line and at the limits of the safety belt shall be limited to 8 kV/m and 2 kV/m, respectively. The strength of the magnetic field within the limits of the safety belt shall be limited to 150 miliGauss (mG). The safety belt is defined as 19 m on each side of the line axis. Table 5.4-2 only lists the standards of the US states that have some standards for regulating exposure to electromagnetic fields. Also, Table 5.4-3 shows the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines.

Electromagnetic fields are known to decrease rapidly as the distance from the source (in this case the transmission cables) is increased. Also, the height of the cables varies slightly due to the effect of several factors, for example, the temperature of the environment, the temperature of the cable (which in turn varies with the load), wind speed, etc. Therefore, the analysis of the possible impacts is done from a qualitative perspective.

For the analysis of impacts data were taken available in the technical literature. Figure 5.4-8 shows the typical exposure levels from 115 kV and 230 kv transmission lines as proposed, as measured in the USA by the Bonneville Power Administration in 1994. From Figure 5.4-8 it can be seen how the intensity of the fields decreases with distance. It is important to point out that, these levels are considerably below the levels required by the regulations in the US.

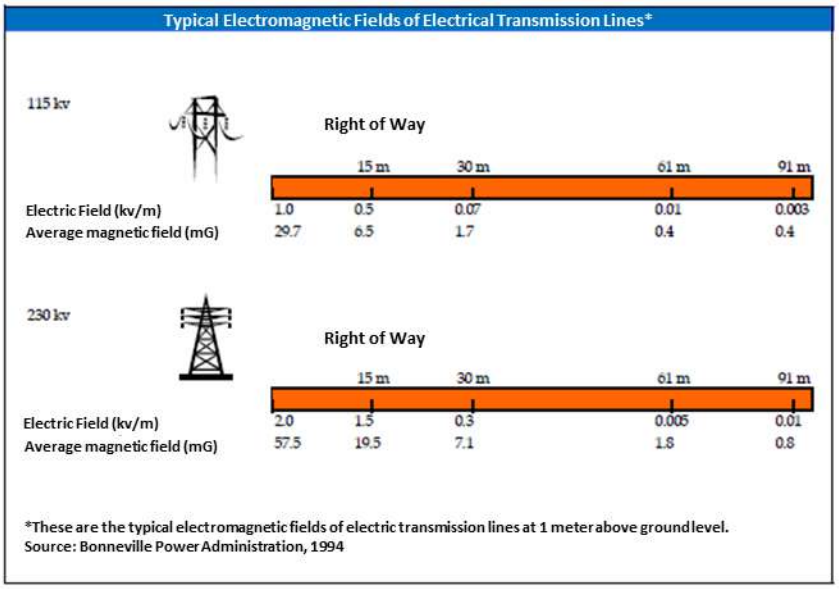


Figure 5.4-8 Typical Electromagnetic Fields of Electrical Transmission Lines

Table 5.4-2 US State Guidelines for Transmission Lines

State	*Electric Field*		*Magnetic Field*	
	In ROW (kV/m)	*ROW in Strip (kV/m)*	*In ROW (kV/m)*	*ROW in Corridor (mG)*
Florida	8[a]	2	–	150 [a] (maximum load)
	10[b]	–	–	200[b] (maximum load)
Minnesota	8[c]	–	–	–
Montana	7[d]	1	–	–
Oregon	9	–	–	–

Source: ICNIRP, 1998.
Key: ROW = Right Of Way; k/V = kilovolt; mG= milliGauss
[a] For lines of 69-230 kv.
[b] For lines of 500 kv.
[c] For lines of 500 kv in certain existing ROW.
[d] Maximum for crossings of avenues.

Table 5.4-3 Commission Guidelines on Non-Ionizing Radiation Protection

Exposure (60 Hz)	*Electric Field (kV/m)*	*Magnetic Field (mG)*
Occupational	8.3	4,200
General Public	4.2	833

Source: ICNIRP, 1998.
Key: k/V = kilovolt; mG= milliGauss

The anticipated exposure levels for the nearest residences are considered to be below the International standard (ICNIRP, 1998). Therefore, adverse health impacts as a consequence of the implementation of the Project are classified as *insignificant*.

Therefore, monitoring of the electromagnetic field is not proposed.

5.4.11 *Impacts on Cultural, Archaeological, Ceremonial and Historical Resources*

For the construction of the proposed Project, movement of land in the TL path will be required, in the area where the towers, substations and access roads to the Project will be installed. This will represent a potential risk of impacting archaeological resources. According to the design, for each tower it is necessary to install foundations six meters deep within an area of approximately 100 m2 (10 m x 10 m). After their construction, the towers will enjoy a regime of restricted access, under the control of EDP.

Even after having conducted a surface survey along the entire trace, complemented by cabinet studies and a paleontological survey, there is likelihood that cultural traces will be discovered during the excavation process. In the case of finding archaeological and/or cultural resources during the development of the Project, the necessary measures will be taken to minimize the impact on them. SECULTURA will be contacted to determine the course to follow in order to preserve and protect the resource. For this reason, this impact is classified as: *insignificant* to *minor*, direct, localized, low intensity, of permanent duration, irreversible, mitigable and of possible occurrence.

The restriction of access to the right of way of the Project will minimize the potential for looting of cultural heritage resources, facilitating the follow up and routine monitoring of sites reported during pre-survey, phase II and construction. Therefore, this impact is considered *positive*, indirect, generalized, of relative duration to the useful life of the project, reversible and of probable occurrence.

6.0 CITIZEN QUERY

6.1 *INFORMATIVE AND SOCIALIZATION ACTIVITIES*

6.1.1 *Information to Land Owners*

In September 2015, field activities were started to establish relations with the population of the Project area. Specifically, the first contacts with land owners were established as part of the negotiation process for the purchase and lease of land.

Approaches with owners/holders are numerous, since they include a constant approach and home visits to advance the agreements of use of the right of way with each owner affected.

The purpose of the visits is to generate an information channel and to facilitate participation in all processes and procedures, such as those mentioned below:

- ***Identification of owners/occupants.*** This visit is made once the residence and contact of the owner is identified, this is the first approach where they are informed about the project and all the stages that the right of way management entails.
- ***Collection of personal and property documents, measurement permit.*** This visit allows, once informed and with the approval of the owner, to collect personal documents and the property as: Unique Identity Document (DUI), Tax Identification Number (NIT) and deeds of the property, in turn the permission is requested to carry out the corresponding studies in the property to be affected by the trace.
- ***Follow-up visits.*** They are determined to inform the owner of how the processes are being developed, especially real estate profiled with legal problems, so it is necessary to be studied and according to complexity are determined constant visits to give a favorable resolution.
- ***Disclosure of information on management progress.*** Visit where owners/occupants are informed about each of the stages of the right of way management, allowing the participation and resolution of concerns in this regard.
- ***Cutoff Date Notification.*** After the study stages, in the settlement of cases, the eligibility is determined, so in written note the owner is

informed that he is considered to receive the compensatory measures by collaborating with the constitution of the right of way.

- ***Negotiation and acceptance of appraisal***. In this visit the appraisal of the area to be used is announced and the price for the land for the constitution of the right of way, counting with the agreement of both parties, is closed with the owner's signature.
- ***Signature of deed and payment***. Visit made after the negotiation, proceed to the signing of deed of right of way, the payment is made to the owner.

6.1.2 *Opening of the Project Offices in Sonzacate and Acajutla*

In the continuity of project execution, on September 23, 2015, the Project Office for the relationship with the owners was opened. This is located in Km. 63 ½ of Boulevard Las Palmeras, House No.3, 50 m south of Hotel Las Palmeras, Municipality of Sonzacate, Sonsonate.

The main objectives of the office are:

- Attention to owners/holders of real estate located under the trace or any other person interested in obtaining project information.
- Receipt of personal identification and property ownership documents.
- Receipt of complaints and claims, not only by owners/holders of estates, but also by any person living in the area of influence of the trace, and who are directly involved who consider that they have suffered damage on their property by the work teams who serve in the field.

Also, a job board was opened, where curriculums are received from the general public interested in participating in the project, the resumes received are shared with the Attention Office of Acajutla.

The attention of owners and general public is in charge of a social worker. The staff of the right of way management areas is of 14 people (see Table 6.1-1).

Table 6.1-1 Staff in the Office of Sonzacate

Area	*Number of Employees*
Management and coordination	2
Social	3
Technical	3
Legal	4
Administrative Staff	2
Total	14

Source: GRIS, 2016

Besides to this office, there is also another office in Acajutla. This office has been in operation since July 1, 2014, since it was opened to follow up on the project of the gas plant that EDP is developing in the city. Collaterally, it supports all TL activities. The functions of the office are those of technical, social and administrative coordination of the activities related to the Project. For this, a social manager is responsible for building positive relationships with communities, establishing a transparent dialogue and providing personalized information about the Project. Its activities include addressing the questions of communities and their leaders, visiting communities and monitoring their situation.

Another of the activities carried out by the staff of this office is the reception of resumes of those interested in working for the Project. In this way, the personal data or resumes are collected in the office and recorded in a database. This database focuses on the availability of human resources (qualified or unqualified personnel) in the area and willing to work for the Project, or for its contractors.

6.1.3 *Socialization Activities*

6.1.3.1 Activity with Local Authorities and Community Leaders

Since February 2016, a series of meetings have been held with local authorities and community leaders to present the Project, the process of developing the EIS and to collect information relevant to the baseline and the consideration of impacts. These meetings served the dual purpose of presenting the project formally to representatives of government institutions, while complementing the information necessary for the description of baseline characteristics.

The persons with whom meetings were held are presented in Table 6.1-2 below:

Table 6.1-2 Participating Authorities and Leaders

N°	Name	Institution / Position	Municipality	Date
1	Angélica Lopez de Dimas	Mayoralty of Acajutla. Unity of the Woman. Collaborator.	Acajutla	June 14, 2016
2	Vilma Noemí Santos	Mayoralty of Acajutla. Coordinator of the Women's Unit.	Acajutla	June 14, 2016
3	Vilma Noemí Santos	Mayoralty of Acajutla. Coordinator of the Women's Unit.	Acajutla	June 14, 2016
4	María Eugenia Araujo de Menjivar	Mayoralty of Acajutla. Municipal Unit of Tourism and Culture.	Acajutla	June 15, 2016
5	Yolanda del Carmen Garleto Madrid	Mayoralty of Acajutla. Municipal Unit of Tourism and Culture.	Acajutla	June 15, 2016
6	Sandra Elizabeth Abarca Rivera	Mayoralty of Acajutla. Municipal Unit of Tourism and Culture.	Acajutla	June 15, 2016
7	Amelia Cruz	Mayoralty of Acajutla. Social Projection.	Acajutla	June 15, 2016
8	Moises Bonilla	Mayoralty of Acajutla. Social Promotion.	Acajutla	February 29, 2016
9	Mardoqueo Flores	Mayoralty of Acajutla. Municipal Syndic.	Acajutla	February 29, 2016
10	Osmin Antonio Guzmán	Mayoralty of Apaneca. Municipal Mayor.	Apaneca	March 1, 2016
11	Lic. Walter Cardona	Mayoralty of Apaneca. Municipal Syndic.	Apaneca	March 1, 2016
12	Oswaldo Nájera	Mayoralty of Apaneca. Community Support.	Apaneca	March 1, 2016
13	Lic. Rodrigo Alfonso Nerio	Escuela General Francisco Menéndez. Sub Director.	Apaneca	March 1, 2016
14	Manuel de Jesús	School Center El Cafetal, Las Tablas. Principal.	Sonsonate	June 10, 2016
15	Lic. Jaqueline E. Pastore	Mayoralty of Sonsonate. Head of Social Projection and Community Development.	Sonsonate	June 10, 2016
16	Cristina García	Mayoralty of Sonsonate. Councilor and leader of Las Tablas Community.	Sonsonate	June 10, 2016
17	Estela Maritza	In charge of the Health Unit.	Sonsonate	June 10, 2016
18	Noé Genovéz	Pastor of the church of God. El Cafetal.	Sonsonate	June 11, 2016
19	Lic. José Roberto Jovel	Mayoralty of Sonsonate. Administrative Manager.	Sonsonate	June 11, 2016
20	Lic. Joaquín Cerna	Mayoralty of Sonsonate. Auditor	Sonsonate	June 11, 2016
21	Lic. Nelson Darío Magaña	Secretary of the Court of Peace.	Santo Domingo de Guzmán	April 12, 2016

N°	Name	Institution / Position	Municipality	Date
22	José Solís	Pastor	Santo Domingo de Guzmán	April 12, 2016
23	Francisca Vásquez	Mayoralty of Santo Domingo de Guzmán. Municipal Syndic.	Santo Domingo de Guzmán	April 12, 2016
24	Rodrigo Rivas	Mayoralty of San Pedro Putxla. Municipal Mayoralty Secretary.	San Pedro Putxla	April 15, 2016
25	Moises Bonilla	Mayoralty of San Pedro Putxla. Director of Infrastructure.	San Pedro Putxla	April 15, 2016
26	Jesús Romero	Mayoralty of San Pedro Putxla. Project Manager Environment Committee.	San Pedro Putxla	April 15, 2016
27	Claudia Azucena López	Mayoralty of Ahuachapán. Social Promotion.	Ahuachapán	March 1, 2016
28	Jonathan Méndez	Mayoralty of Ahuachapán. Tourism Leadership.	Ahuachapán	April 8, 2016
29	Luis Eduardo Menéndez	Mayoralty of Ahuachapán. In charge of Municipal Observatory	Ahuachapán	April 8, 2016
30	Luis Alfonso Castillo	Mayoralty of Ahuachapán. Responsible for the Environmental Unit.	Ahuachapán	April 8, 2016
31	Roxana Acosta de Rivas	Mayoralty of Ahuachapán. Coordinator of the committee for the prevention of violence and public safety.	Ahuachapán	April 8, 2016
32	Agente Rivera Rivas	Sub delegation Center of the PNC Public Safety	Ahuachapán	April 7, 2016
33	Pedro Armando Silva Castro	PNC Terrestrial Transit, Ahuachapán delegation. Sub head of Ahuachapán Terrestrial Transit PNC delegation.	Ahuachapán	April 7, 2016
34	Ismael Sambran	ASOTRA Association of Ahuachapanecan Transporters. Legal Representative	Ahuachapán	April 7, 2016
35	Luis Ernesto Muños Cañizales	Medical Unit Salvadoran Institute of Social Security. Medical Unit Director	Ahuachapán	April 7, 2016
36	Evelin Saz Madrid	ISDEMU. Departmental Coordinator	Ahuachapán	April 7, 2016
37	Ing. Rene Arnoldo Benavides Larin	ANDA. Western Region Manager	Ahuachapán	April 8, 2016
38	Ing. Héctor Sánchez	ANDA. Operations Department ROCC	Ahuachapán	April 8, 2016
39	Héctor Donald Aquino Pimentel	Ministry of Education (MINED). Departmental Director of Education	Ahuachapán	April 8, 2016
40	Luis Alfredo Gómez	Christian Mission ELIM. Pastor.	Ahuachapán	April 7, 2016
41	Carlos Álvarez M.J	Catholic Church Our Lady of the Assumption. Priest.	Ahuachapán	April 7, 2016
42	Néstor Zamora	Church of Jesus Christ of Latter-day Saints. Pastor.	Ahuachapán	April 7, 2016

N°	Name	Institution / Position	Municipality	Date
43	Ing. Santos Rafael Alemán Ortega	''Enrique Alvarez Córdova'' CENTA. Executive Director.	Ahuachapán	April 12, 2016
44	Dra. Cecilia Herrera	Health Unit Ahuachapán. Director	Ahuachapán	April 12, 2016
45	Lic. Beatriz de Contreras	Tours Universales. Gerente General	Ahuachapán	April 12, 2016
46	David Salvador Soles	Salvadoran Red Cross. Departmental Delegation President.	Ahuachapán	April 12, 2016
47	Walter Osmael Medoza Mendoza	Military Detachment Number 7	Ahuachapán	April 12, 2016

6.2 *QUERY ACTIVITIES WITH THE COMMUNITIES*

Consultation with communities is a two-way process that began at an early stage of the Project and included two moments: the presentation and discussion of the baseline and the presentation and discussion of impacts. Consultation activities with communities are described below.

6.2.1 *Participatory Quick Diagnosis*

During the baseline, the Participatory Quick Diagnosis (PQD) methodology was applied in the six municipalities of the Project's area of influence.

The PQD begins with the elaboration of an itinerary of visits to the communities to inform them of this intention. Then, taking into account the criteria of accessibility, closeness between communities, population size and working days, the work program and the dates of the meetings were defined. Subsequently, the participants were identified following the criteria of representativeness of the community, proximity to the layout of the Project and based on feedback from local authorities. Then the invitations were distributed personally a week in advance so that people could schedule their attendance.

The general objective of the PQD was to obtain primary information in the community, with a representative group of members, until a self-diagnosis of their socio-economic and ecological situation was obtained. In addition, it was intended with this activity to identify development opportunities in the communities, so that the Project could begin to define its social investment program.

From June 21 to June 23, 2016, three PQD workshops were held. The first one was developed in Agape Center, in the town of Sonsonate, in the municipality of the same name. In this workshop people from the municipalities of Sonsonate and Santo Domingo de Guzmán congregated. The second workshop was held in the same place mentioned above and people from the municipality of Acajutla were invited. The third workshop was held in El Jardín de Celeste, located on Ruta de las Flores, between the towns of Apaneca and Ataco in the municipality of Ahuachapán. This workshop was attended by guests from the municipalities of Apaneca and Ahuachapán.

On June 23, a focus group was held in the Municipality of San Pedro Puxtla. On August 22, a PQD workshop was held with the municipality, which was attended by 10 people.

6.2.1.1 Results of Participatory Quick Diagnosis

The workshops counted on 81 participants in the 5 municipalities congregated for the PQD and 3 participants in the case of the focal group realized in San Pedro Puxtla. The workshop with the largest number of attendees was the second, attended by 38 attendees of the municipality of Acajutla (see Table 6.2-1).

Table 6.2-1 Implementation of the Participatory Quick Diagnostic Workshops and Number of Participants in June 2016

Date	*Municipalities Served*	*Place of Realization*	*Place of Origin of the Participants*	*Number of Participants*	*Total Number of Participants*
Tuesday 21 June 2016	Workshop 1: Santo Domingo de Guzmán, Sonsonate	Ágape: Km. 63 Carretera Sonsonate San Salvador El Salvador	Sonsonate	8	29
			Santo Domingo de Guzmán (including Cantón Caulote)	8	
			El Cafetal	3	
			El Cellice	1	
			Hacienda La Pradera	1	
			Las Tablas	2	
			Santa Emilia	2	
			Santa Clara	1	
			Other	2	
			No Answer	1	
	Workshop 2: Acajutla		ADESCO Linda Vista	2	38
			Mayoralty of Acajutla	10	
			AMA	2	
			School / Education Center	3	
			C.E.B. El Campamento	1	
			Kilo 2	2	
			Kilo 5	2	
			Línea Férrea	4	
			Lt. El Puerto	2	
			Obelisco	1	
			U.A.M.	1	
			UMM- NA Acajutla	2	
			Other	4	
			No Answer	2	
Wednesday 22 June 2016	Workshop 3: Ahuachapán and Apaneca	Jardín de Celeste: Km. 94 Ruta de Las Flores El Salvador	Mayoralty of Ahuachapán	4	14
			Mayoralty of Apaneca	4	
			Civil National Police (PNC)	3	
			House of Culture Ahuachapán	1	
			Education Center	1	
			MINSDL	1	

Date	*Municipalities Served*	*Place of Realization*	*Place of Origin of the Participants*	*Number of Participants*	*Total Number of Participants*
Thursday 23 June 2016	Focus Groups: San Pedro Puxtla	Municipality of San Pedro Puxtla	Cantón Guachipilín	1	3
			Cantón Texispulco	1	
			El Durazno	1	
Total participants activities June 2016					**84**

Besides, on August 23, the activity of San Pedro Puxtla was complemented by a PQD workshop (see Table 6.2-2).

Table 6.2-2 Workshop on Participatory Quick Diagnosis San Pedro Puxtla, August 2016

Workshop Date	*Municipality*	*Participating Institution / Origin*	*Total*
Tuesday, August 22, 2016	San Pedro Puxtla	Catholic Church	2
		Nueva Esperanza	2
		ADESCO	3
		National Police	1
		Mayoralty	1
		House of Culture	1
		Total	**10**

Taking into account that the workshops were conducted during daytime and weekday, the high degree of attendance and participation of the population in the activity is valued positively. The workshops had an active participation, with opinions and questions mainly about the potential benefits of the Project as well as questions related to the potential impacts that could cause (see Figure 6.2-1).

<table>
<tr><th colspan="2">Participants in the Participatory Rural Diagnostic Workshops, June 2006</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Workshop of Acajutla</td><td>Workshop of Santo Domingo de Guzmán and Sonsonate</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Workshop of Apaneca</td></tr>
</table>

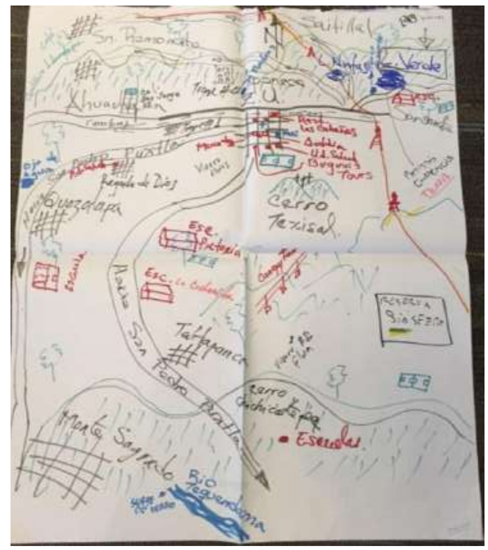
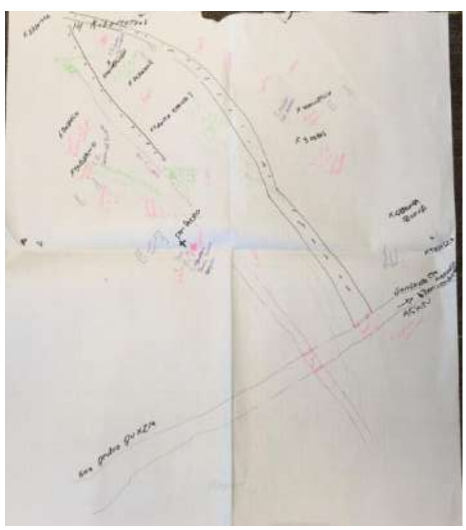
Figure 6.2-1 Participatory Rural Diagnostic Workshops

The PRD results are summarized below:

On the Knowledge and Perception that the Population of the Communities has of the Project

It was found that beyond the environmental authorities or landowners, the knowledge of the rest of the population about the Project was limited. In a way, the most relevant stakeholders of the project were aware of the project, while other relevant people in the community had a vague idea of the project. Therefore, this workshop served for an official presentation of the Project of the transmission line, as well as of the process that is being carried out to guarantee the participation of all those people involved in some way by the Project.

One of the first activities was the realization of ethnographic maps, to understand how the participants are located in the territory, their visions of the built and natural environment, and the location of the Project in the social imaginary. Figure 6.2-2 presents examples of maps made by workshop participants.

Maps Conducted by Participants in PRD Workshops, June 2016	
	
Ahuachapán	*Apaneca*
	
San Pedro Puxtla	*Acajutla*

Source: ERM, 2016

Figure 6.2-2 Ethnographic Maps

On the economic side, the expectations of both men and women of benefiting through the creation of sources of employment were verified. The hope that the Project will help the development of the area (for example, interceding with local authorities to improve their living conditions or carrying out small social investment projects in the communities) is also something that the workshop participants manifested homogeneously.

About Natural Resources

The general view is that natural resources are in degradation processes. The following are the results of the communities' perceptions of the most relevant natural resources. For more detail see Appendix L with workshop notes.

<u>Water Resource</u>

The participants expressed that the quality of the water varies and that the quantity is smaller than what they had in the past. The rivers bring less water, and it is believed that in the most populated areas along their courses there is pollution derived from industrial activities, the use of pesticides in agriculture and landfills. In rural areas the participants expressed that the water is of good quality and that it is derived from the care that the communities give to the eyes of water. They also mentioned the role of water boards and their coordination with the Community Social Development Association (ADESCOS) and the National Aqueduct and Sewerage Administration (ANDA). The water is treated and those areas where it is not drinkable for human consumption have identified, such as Laguna Del Espino in Ahuachapán.

<u>Forest Resource</u>

Illegal logging, burning and overexploitation have eliminated most of the forest. Reforestation, although numerous, is still insufficient. It is mentioned, for example, that more than 10,000 trees were donated for planting in June in Ahuachapán.

In some areas, as in Apaneca, participants mentioned that there are still much wooded areas in the mountain range but that shade trees such as coffee are still few.

On the Use of Environmental Goods and Services

Hunting, thermal tourism, mud or coconut handicrafts and the production of honey are some of the ways in which the participants identified to take advantage of the natural services of their environment. Ruta de Las Flores, hot springs and beaches in Acajutla are the biggest attractions in the area and those that receive more tourism.

Trend Lines

During the workshop, trend lines were also constructed that indicate changes in different aspects. Below is a summary of the most relevant topics.

Population

The migration from cities to the countryside, motivated in many cases by security and crime, has affected the increase of inhabitants in rural areas.

Health

Respiratory and diarrheal diseases were mentioned as prevalent in communities. Early pregnancy was identified as a serious health and social problem by all participants in the workshops. In the same way, there was consensus that the approach is preventive and that the figure of the health promoter has helped a lot in identifying and treating early symptoms of diseases.

Education

School dropout and lack of access to higher education motivated by the economic situation of the families were identified by the participants as critical issues in the educational field. The bureaucracy of the educational system, the neglect of teachers, lack of resources and government policies were mentioned as issues that directly affect the quality of education.

Agricultural and Livestock Production

Livestock farming has been declining over the years. Generally, it is for self consumption and double purpose, although if there is surplus it is commercialized locally. Crops for family supply are common and the largest scale production is the coffee growing area. It is mentioned that the cultivation of coffee has decreased in function of how the values of coffee in the international market are quoted.

Land Availability

The land tenure is particular although the figure of the settlers still exists, people who inhabit it with the consent of the owner. Illegal settlements were also mentioned, especially on the river banks.

Identifying Its Major Community Problems and Solution Alternatives

The main problems identified by the participants focus on economic, environmental and social aspects.

- Economic problems: unemployment and the situation of vulnerability and economic helplessness that generated was the main problem identified by all communities. Security and the proliferation of crime, especially among unemployed young people, were the other aspects mentioned above.
- Environmental problems: illegal logging, water pollution and air pollution were the problems identified by participants.
- Social problems: unemployment and its ramifications at the family and communal level, unwanted pregnancy, quality of education, child prostitution and dependence on remittances were highlighted by the participants.

Appendix O presents the following evidences: copy of invitations to the workshops, methodological approach, attendance lists, presentations, photographic memory and ethnographic maps.

6.3 *SOCIALIZATION OF THE ENVIRONMENTAL AND SOCIAL IMPACT STUDY*

After completing the studies that made up the EIS, EDP socialized with the communities the results of the same, as well as the methodology used to carry out the impact analysis. This activity was carried out in the communities of Sonsonate and Apaneca on September 7 and 8, 2016 with the participation of members of the following communities: Ahuachapán, Apaneca, Acajutla, Santo Domingo de Guzmán, San Pedro Puxtla, Sonsonate and Las Tablas.

The objectives of the activity were firstly to socialize the description of the Project; inform on the results of the studies carried out during the EIS process and the impacts identified during the construction, operation and closure phases; socialize the plans of environmental and social management and provide clarifications on doubts or concerns that the population has.

6.3.1 *Methodology*

In the process of planning this activity, the project's technical team agreed and developed a methodology called Socialization Workshops for Environmental Impact Assessment, which included the participation of EDP's technical and social team.

The methodology was developed with emphasis on a participatory approach where people had the opportunity and the space to raise questions and express their opinions and suggestions on the topics discussed.

With regard to the participants to the workshops, the participation of the following key people was prioritized: people with recognized leadership who live in communities close to the access works, transmission line and municipal authorities in charge of local development, environmental aspects or safety.

The participatory days were planned and executed considering the availability of time of the inhabitants of the different communities involved with the purpose of ensuring the greatest assistance to them. For this reason, it was determined to carry out the workshops in morning and afternoon sessions. Likewise, the methodological instrument established the participation of the specialists who form the technical team, who are responsible for the execution of the workshops (Table 6.3-1).

Table 6.3-1 Technical Team Participating in the Socialization of the Environmental Impact Study

Company	*Name*	*Position*
EDP	Ing. César Galdámez	Project Manager
	Brenda Lobato	Community Relations Officer
ERM/ Natural Capital	Isolina Sanchez	Social Specialist
	Odessa Bowen	Environmental Specialist
	Ing. Roberto Escalante	Environmental Specialist

6.3.2 *Results*

The participation of the participants in the development of the workshop was important as they had the opportunity to listen to the information that was provided and to comment on the points discussed. Table 6.3-2 shows workshop attendance for each community, by sex. The attendance lists and presentation are presented in Appendix N.

Table 6.3-2 Participant Assistance, by Community and According to Sex

Workshop Date	*Hour*	*Community where it was performed*	*Participating Communities*	*Total Participants / Community*	*Total Men*	*Total Women*
September 7, 2016	9:00 am	Sonsonate	Santo Domingo de Guzmán	7	3	4
			Las Tablas	9	5	4
			Sonsonate	6	5	1
			San Pedro Puxtla	5	2	3
	2:30 pm	Sonsonate	Acajutla	18	12	6
September 8, 2016	9:00 am	Apaneca	Apaneca	6	3	3
			Ahuachapán	4	4	-
Total				**55**	**34**	**21**

Concerning the environmental issue, the greatest number of questions on the part of the participants corresponded to the possible impacts on water resources (availability and quality of these), air pollution as a result of dust, long-term impacts to the flora and fauna in the area and the monitoring that will be given to the mitigation measures once the construction of the Project is completed. In the social issue, most of the questions were about the generation of employment of part of the Project, vehicular traffic, access roads and road safety.

Table 6.3-3 presents a summary table of the questions posed by the participants and the responses of the technical team.

Table 6.3-3 Workshop Assistant Questions and Answers

Participating Communities	*Questions*	*Answers*
Santo Domingo de Guzmán; Las Tablas; Sonsonate; San Pedro Puxtla	When you talk about that they are going to "divert water to avoid damaging the construction" how do you guarantee that water will get to the other farmers who sow nearby?	Additional gaps would be opened to ensure that water reaches these farmers. However, in this case the impact is "potential" and requires a conversation between the landowner and the builder to determine the specific situation.
	The development of all mitigation measures is based on	Isa Ramírez explained the process of acquisition of rights of way: "we are in the process of

Participating Communities	*Questions*	*Answers*
	the construction phase. I have not yet seen an assessment of a potential long-term impact. I do not know if they have taken into account the value of the properties and the cuts that these are going to take in the long run. What are the property restrictions due to the Project and how will they be remedied?	negotiating compensation for the transmission line. It has done a market study, with market values of all these properties and, an agreement has been reached with the owners. The characteristics of each land and property (eg type of land, type of properties) are being considered and the activities within the properties have been avoided. There has been a lot of collaboration with the property owners and there is direct communication with each one of them. The owners have knowledge [of the Project] and are collaborating in a harmonious way. [The Company] has permission to go with the line. If you want more information, we have social management offices and right of way procurement management. [This office] is 300 meters from where we are now and 100 meters from Hotel Las Palmeras."
	Are they going to open offices for comments and complaints from people living in the area?	Yes, the Project has developed a Social Management Plan that includes a mechanism of complaints and suggestions for communities. This mechanism will be managed from the social office that the Project will install and includes a specific process of how to receive and answer questions.
	Are the management plans for the construction or for the life of the Project? In another transmission line there are no schemes for proper pruning, they do not handle maintenance.	No, the plans are for the entire life of the Project. The management plan requires follow-up, [including] periodic monitoring reports and compliance with the actions detailed in the plans.
	What are the chances that the people living where the Project passes will be hired?	It will require 200 people for the Project. Qualified staff will be from everywhere. [For unskilled jobs] preference will be given to local labor. During the operation phase the labor force will be [mostly] qualified, but there will still be local staff hired for certain works such as pruning and maintenance, etc.
	I saw an announcement from the company that called the owners to a meeting and I realized that it was for this Project.	Right. Representatives of the owners - intermediaries - have led this management instead of the owners. Companies should make every effort to communicate directly with the owners to avoid encroachment and to ensure the full participation of property owners. In addition, companies must do everything possible to find landowners, records of mayors, etc. [The] right of way width has to do with safety, not with the current width of the transmission line.

Participating Communities	*Questions*	*Answers*
		[This is a] Project of public interest that although it is private management, will be administered by the government. Cultivation land will continue to be used for its original uses.
	How long is the assessment of right of way? 20 years?	The assassment of right of way is granted indefinitely.
	We are part of the community, but some are not owners; how have you ensured that all owners have been informed?	Review of [the] contracts by personal attorneys (owner) to eliminate uncertainties, complaints or [owners] feel defrauded. [It is recommended] that older owners be advised by children or trusted persons to explain the contracts. Work placements in offices where resumes are received to identify the sector in which the person lives before the start of construction work.
	What is the distance between towers?	Distances vary; in plane the distances can be greater and in mountains the distances can be smaller. We have places with 600 meters [between one tower and the other] and other places with 150m [between the towers] as a result of the topography of the Project. The biggest distance we have is 645 meters and the minimum distance is 150 meters.
	The Project is already adjudged, the plant and the construction line. What possibilities are there for me as representative of the area to take [the] resumes? Do they have to go individually?	Once the plant is built, there will be 30 permanent jobs. During the construction of the plant and the transmission line will require about 1000 people. In general people are hired locally. You can take resumes or go with people, all forms are welcome. The resumes have to carry all the necessary information to be able to contact the interested parties (telephone number, etc.). The construction phase is scheduled for next year.

Participating Communities	*Questions*	*Answers*
	Businesses have opportunities. It seems to me that when we are here, one or another company takes the opportunities and has to guarantee that people will benefit from the Project, either permanently or temporarily, but these people deserve it.	The project has the opportunity to give work to many people. When we award the builder we include a clause that ensures employment for the people of the area. That is our idea.
	Why is the assessment indefinite if the Project lasts for 20 years?	The bidding terms demanded 20 years, but in general the Project will last longer, it will not "die". Once the 20 years are over, [the assessment] will expand and you will have to ensure that this type of work can be maintained. In contracts and all approaches the process has been explained in a transparent way so as not to create inconvenience to any owner.
Acajutla	Where are the resumes given?	The resumes are delivered in the office of Acajutla or in the office of Sonsonate.
	Vibration on the ground: There was a vibration problem in the plant. We want to know if there is going to be a problem accumulated by the vibrations of the line.	[The Project] will maintain the maximum levels of Salvadoran legislation. [It will] use methods of hearing protection especially in those places where the noise will be greater than 85Db. [It will also] train workers on the use of auditory methods.
	What are mitigation measures to avoid dust?	Especially during the dry season there would be a wetting of access roads through an irrigation truck to minimize dust. Maximum speed limits of 25 km will be established and emission limits will be established along with air monitoring. The waste areas will have a tight canvas to prevent the wind from raising dust from debris.
	Development has to exist at the expense of whatever. Acajutla have [a problem] of air pollution. Where the plant is constructed there are other plants and there is a cumulative effect of contamination. [Besides,] we have an industrial safety problem and a lot of heat.	The environmental impact study is only of the transmission line and the LNG plant has not been taken into account. We agree that cumulative impact analysis is important. (Note: Having explained this aspect, attendees better understand the explanation of the impacts to air quality).
	Will the towers have restricted access or not?	During the construction phase the entrance to the work will be restricted to the public (people who are not Project workers or contractors). In some towers it may be necessary to establish some type of perimeter protection.

Participating Communities	*Questions*	*Answers*
	Do you already have the line defined and you already know where the transmission line will pass?	Yes, it has already been defined and all the owners of the lands through which the line passes have already been contacted.
	In the mitigation part, there is a section of "unforeseen events". For example, contingency in the event of the fall of a tower. What kind of preventive action would be taken? What are you going to do with company, in matters of prevention? There are always going to be accidents; What's the plan?	All risk prevention plans were explained to them. All [plans] must be endorsed by the national civil prevention commission. The prevention plan also needs to be reviewed at the local level.
	A few years ago a high voltage cable broke and fell on the street. It was a "mess" [problem] and thank God [nothing or nobody] was burned. What is the prevention regarding that? How is [such an incident] prevented? They are rare things but they could happen.	The design [of the Project] contemplates the installation of a special device [by means of which, in the event of a rupture], the system will shut down [automatically] and cut all the circuits in a matter of seconds. For transmission we are obliged to have this type of devices; by means of which the current through the cables is stopped. The cable is 13 meters [from the street] and if that cable falls, when it reaches down it will be off.
	Where do you go out in Acajutla?	By the railway, on the obelisk. We cross there and do not touch any house as we go the other way.
	What is going to happen under the lines with flora and fauna, in the short and long term? These projects always have benefits but there are also certain abnormalities, which often affect the population. For example, fish die, water becomes contaminated, etc.	The attendants are explained to the restrictions on the use of the land in the right of way, where it is mentioned that the major disturbances will be during the construction phase and not during the operation. It is also spoken of what are the studies of magnetism.
	The 38 meters of right of way is for the entire line, including urban areas?	Right of way is for the entire line, including non-urban areas.
	Are they going to give benefits just like they give us in Acajutla with the LNG plant?	The benefits you receive now are for the construction of the plant. For the transmission line, the environmental impact study will detail the compensations that are necessary.
	[The] power companies leave these areas very "wilted"; warning for children and adults.	[Areas] will not be affected by sludge. If necessary, protective measures will be implemented.

Participating Communities	*Questions*	*Answers*
Apaneca and Ahuachapán	I imagine the Project is sustainable; that the life of the Project is great; and that there will be exclusive teams, groups or areas to continue the mitigation measures. If there is going to be someone, or a team, after [the construction of the Project] that does the maintenance?	Yes, management plans identify: mitigation measures; the people responsible for implementing [the measures]; the reports that have to be generated along with their respective times; the [monitoring] indicators and the cost of the measures. When [a company] cuts a tree, a commitment is made that the tree will be planted and maintained and developed for a certain number of years. This is determined by law.
	How are they going to coordinate this monitoring of mitigation measures? Are they going to hire someone?	Yes, the Project will have an environmental and social management team. There will be activities that they implement directly and other activities that will be subcontracted to third parties.
	When you raise the impact that [the Project] will generate in the space you are going to use, do you determine whether "it could be done" or "should not be done"? I believe that many "assumptions of impacts" have been made and that, with the dioxide what is going to happen, it will burn fuel [in the same way that Nejapa Power does] and that [it will require] a huge quantity of water. I would like [to know] if this Project is going to generate these impacts and what are the compensations contemplated.	The construction of the transmission line has by its nature impacts less than those of a coal plant. The purpose of the environmental impact study is to identify these impacts. Once the study is delivered to MARN there will be a public consultation process.
	The presentation spoke of "rainwater runoff". In the area of San Pedro Puxtla and Apaneca, the water sources that leave the coast are born from that water. There are a lot of underground sources and at that height (the Guachipilín, etc.) the water is not deeper. I imagine that the tower is going to need a fairly wide depth and I consider that to some extent, they will affect many [water sources] since it is a fairly abundant area in springs. What proposals would you make to minimize this impact?	Geotechnical studies have been carried out to avoid these impacts. If this is not possible, there will be other mitigation measures such as the use of good building practices for projects of this nature. In the 44 kilometers of the track we have drilled approximately 15 meters [to understand] the quality of the soil, the groundwater levels that will determine the type of foundation design and to analyze the hole size. We have searched for soils where we will not [affect] the groundwater levels. Our towers will go to a depth between 3 and 5 meters, with the idea of not affecting the groundwater levels.

Participating Communities	*Questions*	*Answers*
	A few moments ago you mentioned the cutting of trees; "Trees are planted according to the environment where the tower is" and if the tower does not affect the water source, the trees will provide a higher level of humidity. [In the event of] lightning / thunder, the tower or line will have lightning rods?	Yes, the guard wire works as "lightning arrestor" (lightning / thunder protection). In addition, the towers will be isolated on the ground to avoid such situations.
	Have you done chemical analysis of water quality?	Yes they have been made as part of the baseline. In addition, water monitoring is part of the management plans.
	When the GEO was built, a canal was built where the wastewater (dirty) passed through different municipalities until reaching the sea. Are you going to make a canal to bring the wastewater to the sea? I have doubts, because I do not know. Do the engines need fossil fuel or not?	No, in our case this does not apply. During construction, water will only be used for concrete. The process of the environmental impact study of a plant is one and that of the transmission line is another. The transmission line is what corresponds to us.
	Are there people from Acajutla here? What are you going to generate the energy with? What are you going to burn?	Remember that all emissions are controlled by an air purification system and [we will] be audited by the Ministry of Environment, the World Bank, and so on. But that's for the plant. For the transmission line we will not burn anything. One advantage of the plant [in El Salvador] is that according to the unit of transactions the order of dispatch of Projects is: first hydrological and geothermal, then biomass plants and finally thermals (which are the most polluting). Our fuel is cleaner and [therefore] we take market from other projects.
	I heard that you (Odessa Bowen) are a marine biologist. We have heard talk about the impact on marine life, but only in relation to what will affect other places. We have also heard about spill prevention at the plant, specifically on the seabed, bearing in mind that there is one of the most important reefs in the Pacific. I am glad that a company dares to consult us.	It was explained to the attendees that EDP has carried out two environmental impact studies (plant and transmission line) and that ERM / Natural Capital is not qualified to respond on [the related impacts] to the plant since they did not work in that environmental impact study. However, ERM / Natural Capital is able to respond to the environmental impact study of the transmission line. However, we will take note of the question and consult with the people who carried out the environmental impact study of the plant.
	Really for us the Project is a single one. As a suggestion, for the next workshops, people form	We will take note of the suggestion.

Participating Communities	*Questions*	*Answers*
	the line and the plant should be here. Sometimes we leave with the restlessness and we have no answer on the plant. We would like to know more about that.	
	We also worry about where the laying comes and where it goes. We are interested in [understanding this].	The results of the workshops were shared and a "public consultation" meeting in which the Ministry of Environment invited people. Calls were made to the workshops and published in the newspaper [for related meetings] to the plant. In Acajutla more than 100 people arrived at [the meeting] of the plant. Also in the transmission line is going to make a public consultation. We (EDP) have an information office in Acajutla. We have been for more than two years and we invite you to come and access [related information] to the progress of the Project. It is a very large project and we cover different areas. The engineering department has two departments: 1. the transmission line and 2. the plant. On the website you can consult the environmental impact study of the plant and the results of this. It is important, even though you are withdrawn from the plant, and [we] are interested in being well informed.
	I [believe] that this Project is developmental but just as [this] is carried out we have to be transparent and protect ourselves from having misunderstandings. Let's try to be a bit more complete when it comes to sharing information about the plant and [the transmission line].	Thank you [for your attendance] at the workshop and these comments are taken into account for future activities.
	What are the sources of noise?	Heavy machinery is the main source of noise. This source is temporary and the Project avoids urban areas.

Participating Communities	*Questions*	*Answers*
	You have already analyzed the situation, it is assumed that [the Project] will cause (or is going to cause) impacts on the fauna. Why move the habitat frogs, why move them to another site?	Yes, we are proposing night shifts to catch these frogs and relocate them to another place. To protect the frog is best to move it, we think that is more beneficial than moving the transmission line to another side and possibly cause a greater impact.
	I do not know where the line will stop. I would have really like to [attend the meeting] in Ahuachapán to know what the impacts are. If the tower is going to fall on a mountain or in different places, all that would serve us [to develop] a more accurate opinion. We do not really have [this information].	Yes, we will explain that to you when we get to the end of the presentation. They are also going to explain the process that was carried out for the acquisition of right of way.
	How owners got paid?	Explanation from ISA.
	In this area we have a bird, a huge hawk that passes here. How would the impact [to this] be minimized?	Flight dissuasions, in spiral type, that are going to go on the crosses and ravines. Also included is the monitoring and maintenance of these "flight deterrents" in the management plan.
	I imagine that in all the planning and the layout of the transmission line have been contemplated the protection of millenary trees that are habitat of many species.	A forest inventory has been made throughout the route (44 kilometers and 38 meters of the right of way).
	Have you considered having a contingency plan in [case of] any emergency? Have you seen the need to have a contingency plan?	Yes, it is part of the environmental impact study and is a requirement of the government of El Salvador.
	You already have all this in mind, according to the [hostess]. It would be worth remembering what kind of birds are gone and can come back.	Your opinion will be taken into account and we will consider how it can be incorporated into the environmental management plans.
	How has the right of way been managed?	Other study teams have identified the different properties and their respective owners. [The Project] has dealt with almost 300 owners for the right of way tranches and [all of these] have been given full knowledge of the payment of compensation for bonded labor, legal requirements, values established by market valuation studies, etc. [This information is part of] a dialogue table that was initiated with the owners to reach an agreement, including owners in areas of high tourist value. The two offices where the [community] and [grievance] inquiries are received have not, to date, reported any mishaps. All the owners,

Participating Communities	*Questions*	*Answers*
		along the route, have contact with EDP, including large coffee producers who required that the agreements be transparent and friendly to the environment.
	[Is there] the possibility of employing people in the area?	Resumes will be received for the hiring of local labor during the construction phase.
	[The] biggest problem in the municipality is unemployment. [The Project] should take advantage of the opportunity to give work, especially the youngest, to prepare them according to the needs of the company. For example, make a small job fair to introduce young people to employees and EDP.	The resumes will be received at the offices, where EDP staff can also be contacted. A "job fair" is a good idea which was also presented during the workshop in Acajutla.
	How to control the speed [of vehicles]?	The vehicles have internal speed control; if it exceeds speed limits, the Project will fire the driver.
	How will you control the traffic of people?	It is going to coordinate with the traffic authorities in what signaling corresponds. In addition, there will be an approach in the municipalities to give information [related to this] and avoid the displacement of heavy machinery during the peak hours.
	Have mitigation measures been considered for possible damage to the road network?	The machinery is not so heavy as to damage the road network. Trucks will be like freight trucks that go through the roads normally and mules will be used to move the material wherever possible.
	When [the transmission line] arrives in Ahuachapán will it be connected to the substation to send energy to the GEO?	It will not connect to the GEO. An additional bay is to be built within a given section.
	Is [the Project] going to cover the whole country?	Yes.
	[The Project] is going to lower the cost of energy?	The forecasts say yes.
	It is expected to be so. Energy has ultimately doubled costs.	N/A
	How does the cost compare between fossil-generating plants versus gas plants?	Personally (César) it is considered that the cost decreases according to the moment of the analysis.

Participating Communities	*Questions*	*Answers*
	Do you have social projection projects?	Yes. [Communities] located around the plant have to benefit. [Projects are determined through] requests for donations. There is flexibility in the requests
	Could they generate education, health centers, etc.?	Yes.
	[Are these benefits] only for the municipality where the plant is located or for the communities where the line passes?	[In the communities where the line passes] certain works will be done, but where it is forced to compensate for the impacts is in the municipalities.
	Will there be [Project] offices in Ahuachapán?	It has not been contemplated to open offices in any other municipality.
	Explain the consortium with ETASAL?	ETESAL is a GEO distributor. They are in charge of distributing the energy.
	Does [Project] need permits from municipalities?	Yes.
	Concern that there are no social works for the municipalities through which the transmission line passes; there is a lot of need for social investment	N/A
	Will they give a better quality of life to the settlers? Have they looked for opportunities to see how it could be done?	In Acajutla there is a commitment [to invest in the community] but this does not exclude other sectors in which it is also being supported in development with, for example, the generation of employment in the area. EDP will sit down and review where the line goes to determine how to benefit those sectors. EDP will do its best to support social projects according to the priorities identified by the municipalities.
	GEO has collaborated in Apaneca and Ahuachapán, with schools. Schools need cooperation and it could be that EDP helps in that way in the future.	EDP agrees with that idea.
	Is there a possibility of expanding production or will it be set?	The production will be 20 years (on paper) but can be extended. Broadening the generation has not been seen as such, but it has been contemplated to sell natural gas directly to the public.
	Would the infrastructure have a margin to support expansion (eg wiring)?	The transmission line is designed with three tenders and three cables even though the EDP design is two-wire (and one will be empty). The Salvadoran government wants to make a "peripheral ring" from north to south.

As part of the workshop agenda, emphasis was placed on the impact table, detailing whether these were significant or not significant, positive or negative.

Regarding the environmental theme, the most relevant impacts were ranked and participants were explained that each stage of the Project is more susceptible to certain impacts. Participants perceived the satisfaction of the elaboration and content of the management plans (environmental and social), on which they posed questions related to the prevention of risks and the response to emergencies, which were attended by the technical team, who explained that the Management Plan contains actions and specific measures to mitigate each of the identified impacts.

The results presented as a result of the diagnoses carried out by the Project as part of the EIS were known to the workshop attendees, as they were informed about the type and content of the work carried out, as well as the usefulness of the information embodied as baseline. The participants were informed of the procedure followed in each of the activities carried out to date within the framework of the Project, and that the process required obtaining the environmental license.

6.3.3 *Conclusions*

- The objective of informing the inhabitants of the area of influence of the Project was fulfilled: the process of results of the environmental and socio-economic diagnosis, as well as of identified Impacts and of the Environmental Management Program (EMP) proposed in EIS, progress and activities that will carry out the Project in the immediate future.
- An answer was given to the questions, doubts and concerns raised by the participants regarding the socialized information in the workshops, in a clear and detailed manner.

7.0 *ENVIRONMENTAL AND SOCIAL MANAGEMENT PROGRAM OF THE PROJECT*

7.1 *INTRODUCTION*

This chapter presents the Environmental Management Program (EMP), which presents guidelines for the management and protection of environmental, social and health and safety of workers throughout the life of the Project. The EMP covers the phases of construction and operation of the Project and was prepared considering the impacts identified during the environmental assessment, EDP's environmental policy guidelines and compliance with the current legal framework. EDP is responsible for the implementation of the EMP.

EMP establishes environmental and social protection measures and contains a set of plans, specifications and guidelines aimed at preventing and controlling the environmental effects, impacts and risks that will be generated during the implementation of the Project, both in its direct and indirect area of influence.

7.2 *FUNCTIONAL ORGANIZATION AND POLICIES*

The main parties and their main functions of those responsible for the implementation of this EMP are:

- EDP, as the project proponent, is responsible for overall project oversight, ensuring compliance with environmental and social policies and obligations in the EMP, and ensuring that their commitments are met.
- Subcontractor is responsible for complying with the EMP and with the requirements established by EDP.

The implementation of the EMP will be carried out with the support of EDP's senior management, through the following organizational scheme:

- Project Director
- Field Manager
- Community Relations
- Construction Contractor
- Environmental Inspectors

This organizational scheme will be implemented very early in the process, since the responsibilities of its members begin from the construction phase of the Project. In the case of EDP employees, the responsibilities of each team member will be clearly defined. Also, in the case of external contractors, the description of their responsibilities will form part of the contractual agreement. The following is a brief description of each position within the organization:

Project Director: Is the highest-ranking position within the organization for the Project. It will be responsible for providing all necessary administrative and financial support to ensure the effective implementation of the EMP. He is ultimately responsible for the EMP.

Field Manager: Reports to the Project Director and will be responsible for coordinating day-to-day tasks during the implementation of the EMP. His responsibilities include coordinating monitoring tasks, reporting, and coordinating technical and managerial issues.

Community Relations Supervisor: reports directly to the Project Director or to the Project Manager. It is responsible for keeping the community informed and addressing their concerns in coordination with the Project Director.

Construction Contractor: Will be responsible for implementing all occupational safety and environmental protection measures described in this EMP during the construction phase. It will be responsible for identifying aspects of environmental interest that arise during construction and will direct them to the Project Manager for their relevant action.

Environmental Inspectors: Are reported to the Project Manager. They will be responsible for field monitoring and will report on EMP compliance status to the Project Manager.

7.2.1 *Environmental and Social Management System*

There is a strong need for companies to adopt environmental and social management systems for the implementation of their environmental management programs and other policies and procedures relevant to their projects. The environmental and social management system must be implemented and maintained as a process that achieves the objectives, institutional responsibilities and other policies, principles and associated commitments in relation to health, safety and compliance with established environmental regulations.

The process of implementing an environmental and social management system in line with industry best practices is to follow the general principles of the "Plan, Do, Verify and Review" cycle as described below and shown in the Figure 7.2-1.

7.2.1.1 Plan

- Define environmental and social performance policy and objectives.
- Identify the environmental and social impacts as well as the risks of operations.
- Develop mitigation measures and operational controls to address impacts and risks.
- Develop a management plan to achieve the above objectives.

7.2.1.2 Do

- Implement the management plan.
- Implement mitigation measures and operational controls.

7.2.1.3 Verify

- Monitor performance regarding to policies and objectives.
- Verify the effectiveness of mitigation measures and operational controls.

7.2.1.4 Review

- Make corrections to plans, mitigation measures and controls in response to performance monitoring and out-of-control events.

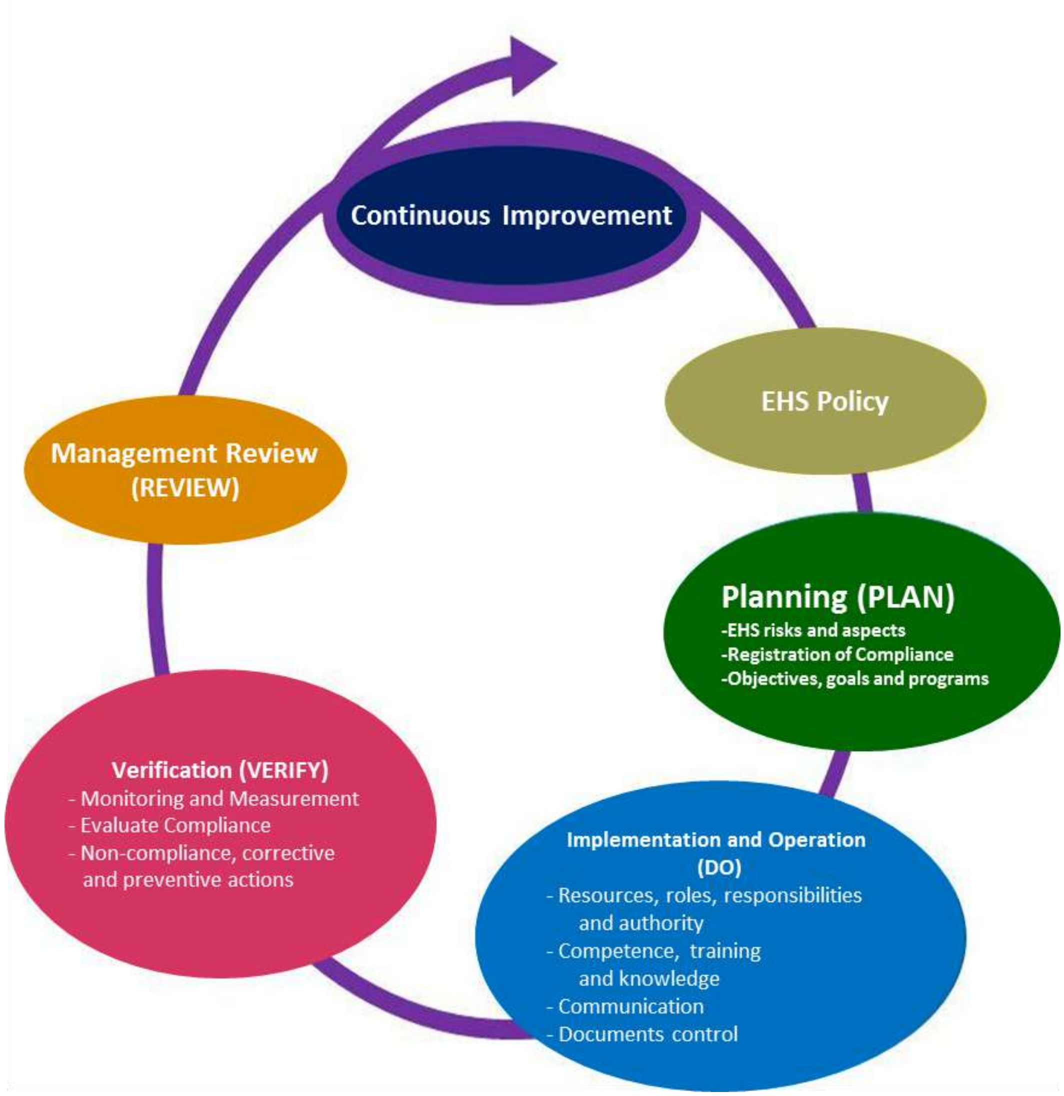


Figure 7.2-1 Plan, Do, Verify and Review

7.2.2 *Audit, Adjustment and Reporting Mechanisms*

Audit and adjustment procedures are an essential component of the successful implementation of EMP plans. Audit procedures include inspections, monitoring and audits to confirm the correct implementation of EMP plans, as well as the effectiveness of mitigation measures. Corrective actions include responses to out-of-control, non-compliance, and non-conformity situations. Actions also include those aimed at improving performance.

Environmental and social responsibility inspections will be carried out by representatives of the environment and social responsibility, as specified in the plans, to ensure that all staff (employees and subcontractors) meet their obligations. The Field Manager will be informed weekly of the results of the inspections, or as specified by the plan.

Monitoring activities will be carried out to ensure compliance with the commitments set forth in the EIS, as well as to evaluate the effectiveness of operational controls and other measures aimed at mitigating potential impacts. Detailed information will be produced on the mitigation measures and the specific monitoring plans of the different aspects of the Project. The monitoring plans describe the effect to be measured and the frequency of its measurement, and are intended to confirm that the Project is meeting its obligations regarding environmental management and working practices. The monitoring will be carried out by EDP's environment and social responsibility staff; infrastructure personnel will also make contributions related to specific monitoring activities to ensure continued compliance with legal obligations and commitments.

7.3 *SUMMARY OF IDENTIFIED ENVIRONMENTAL, SOCIAL AND CULTURAL IMPACTS AND MEASURES OF MITIGATION*

The Project will have minor to moderate impacts. Most impacts to the physical environment will be adequately addressed through the implementation of typical construction measures and "best practices" typical of the industry. Most mitigation measures are already integrated into good construction practices (for example, erosion control) and others that are specific to the Project (for example, reforestation, frog piles, flight deterrents). Inevitable biological impacts, such as deforestation and damage to areas where black-eyed frogs reside, will be effectively offset by reforestation at a rate of 10 to 1 of trees and the construction of water piles that provide space for black-eyed frog breeding, resulting in a net positive effect. The project will have mostly positive social impacts, both direct (as local employment opportunities) and indirect (improving the availability of electricity), and negative impacts, such as the potential for traffic accidents or increased noise during construction, are moderate and will be effectively managed with the implementation of best practices. In its entirety, the Project is considered viable and positive for El Salvador.

While most management and mitigation measures include the implementation of good practices during construction, the EMP includes the following special measures to compensate for unavoidable impacts:

- Reforestation plan: following the requirements of El Salvador, the trees will be compensated in a proportion of 10 trees planted for each tree cut and one shrub planted for each shrub cut.

- Construction of water piles to provide areas for deposition of Black-eyed frog eggs.

- To mitigate potentially negative social impacts, the Project will implement a Complaint Management Plan, as well as a Community Participation Plan.

- To avoid or minimize potential impacts to archaeological resources, the EMP includes a Plan of Fortuitous Findings.

Table 7.3-1 summarizes the main potential impacts of the Project, the proposed mitigation measures and the significance of the impact after mitigation.

Table 7.3-1 Summary of Principal Project Potential Impacts and Proposed Mitigation Measures

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
Physical Environment				
Construction	Increased erosion and sedimentation	• Terrain leveling; construction of towers, substations, access roads and facilities.	• Especially in areas with steep slopes, the possibility of constructing the bases of the towers on the existing relief will be evaluated or they will be installed on piles, without leveling the area. This minimizes the amount of soil to be affected. • Implement measures to control soil erosion, rainwater management and sedimentation. These measures include the use of sediment fences, the installation of permanent and temporary drainage systems to manage runoff from construction sites and the use of sediment capture trenches; as well as the use of regulation dams to control water runoff, etc. • Use appropriate management practices during deforestation activities. For example, as far as possible, schedule construction activities during the dry season, especially in areas with steep slopes; limit deforestation and alteration only to the approved work area; minimize the area of vegetated soil within the approved work area as much as possible; and gradually stabilize and reforest the altered areas. • Revegetate slopes in areas where required. • Place surplus material in properly approved areas or reuse it as filler. • Properly compact all material at the end of activities. • Once the construction phase is completed, those access routes and service routes that are not necessary for the project operation stage will be closed and restored to their original or better conditions; and	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
			• Community requests to maintain an open service path or route will be evaluated jointly with the competent authorities.	
Construction / Operation	Pollution of soils	• The risk of pollution of soils by accidental spills of fuel and lubricants from equipment and machinery.	• The risk of pollution of soils by accidental spills of fuel and lubricants from equipment and machinery. • Maintenance of the equipment in good mechanical conditions, to avoid losses of fuel and lubricants that can contaminate the floors and be washed by rains; • Any major maintenance of the equipment should be carried out in specialized workshops and not at the project site; • Adequacy of a specific area, with waterproofing protection, to carry out minor maintenance activities; and • Implementation of the Contingency Plan in case of spills (see Section 7.0 - Environmental Management Program).	**Insignificant**
Construction / Operation	Natural Threats	• Volcanic eruptions, earthquakes, seisms and landslides	• Design and construction of all facilities associated with proposed TL considering high safety factors and under local and international seismic protection codes and standards. • EDP has located the path of the TL trace outside the trajectories of lava flows and lahars of the two volcanoes near the TL, • Revegetate slopes where excavation work has been done. If areas prone to landslides detected, which to date after several visual examinations have not been found, stabilizations would be made. • Implementation of a contingency plan (see Section 7.0 - Environmental Management Program).	**Minor**
Construction / Operation	Alteration of air quality	• Emissions of gases and particles from equipment, machinery and vehicles (mobile sources) using hydrocarbons as a fuel source.	• The dust generated by the construction and transit of material loading trucks will be mitigated by the irrigation of roads and access to the right of way and within the right of way. Such irrigation will be by means of water pipes. • The use of any machinery, equipment, or vehicles that have fuel leaks, ruptures in combustion and exhaust systems, or problems in catalyst systems shall not be permitted.	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
			• Concentrations of PM10, particulate matter less than 2.5 microns of aerodynamic diameter (PM2.5), volatile organic compounds, SO2, NO2 and CO will be monitored. • The box of vehicles transporting debris, dirt or construction material should be fitted with a tight canvas to prevent dust from escaping during its journey. Besides, the tires will be covered during loading and unloading of materials to prevent them from throwing material when spinning. • Any vehicle, whether for transportation, forklift or maneuvering equipment, shall be driven into previously opened roads, gaps and paths designated for that purpose. • Equipment that operates on diesel and gasoline, must have preventive maintenance to comply with applicable environmental regulations. • Gasoline equipment will have catalytic converters in good condition. Those that are maneuverable equipment (for example, forklifts and cranes) will adjust their operation to the guidelines of these measures. Catalytic converters or filters for diesel will be incorporated, as the case may be. • Establish speed limits for vehicles that circulate in populated areas as well as access to the project (maximum speed of 25 km/h). • Ensure that the vehicles and equipment to be used comply with the maintenance required by each equipment and will have: 1) specific maintenance requirements for each equipment, 2) inventory of equipment, spare parts and materials needed for maintenance; and 3) periodic lubrication. • Perform resistance testing of materials, galvanizing impregnation and other tests at the factory and not on site.	
Construction / Operation	Change in surface runoff	• Construction of towers, substations, access	• Proposed facilities should have roof drains that collect the runoff water and direct it to the ground where they can continue their normal course.	**Insignificant**

Phase	Impact	Source of Impact	Proposed Mitigation Measures	Residual Significance of Impact After Mitigation
		roads and facilities.	• Piping stormwater into roads through ditches, sewers, sediment barriers and settlers, among other devices to reduce the drag of solids to rivers and/or creeks. • • In the outdoor parking and storage areas of machinery/equipment, adequate control systems such as hay bales should be placed to avoid contamination of runoff water. • • If it is necessary to carry out ground leveling work for the foundation surface, these must be done in a way that does not alter the surface drainage conditions and do not leave areas that in future compromise the stability of the structure.	
Construction	Changes in the quantity and quality of wáter	• Construction of towers, substations, access roads and facilities; accidental spills of chemicals, lubricants and fuels. • Earth movement. • Crossing of ravines by vehicles and machinery can introduce contaminants. • Three of the nine storage facilities or temporary storage areas are located within 100 m of a body of water.	• The material generated from the excavation works will be removed from the excavation and deposited at a safe distance to avoid material falling into nearby rivers and/or ravines. The collection area of the material must be selected before starting the excavation work to prevent mounds of accumulated material from having any impacts on the nearby rivers and/or ravines. • Piping rainwater into roads through ditches and/or culverts, sediment barriers, and settlers, among other devices to reduce the flow of solids to rivers and/or ravines. • In outdoor parking and storage areas of machinery/equipment, suitable control systems such as hay bales should be placed to avoid contamination of runoff water. • Conduct domestic water management during the construction phase using portable sanitary modules, as described in Section 2.0 (Project Description). Use at least one portable toilet for every 15 people and give daily treatment with detergents and biodegradable additives to these sanitary modules. The solid waste from these toilets will be extracted by the company that rents these devices, as well as their disposal. • Comply with the manufacturer's guidelines for machinery and equipment used to prevent fuel spills.	**Insignificant**

Phase	Impact	Source of Impact	Proposed Mitigation Measures	Residual Significance of Impact After Mitigation
			• Avoid vehicular traffic in riparian areas and avoid the use of machinery in the vicinity of watercourses. • Have a prevention, control and response plan to risks of spills including emergency response, cleaning and recovery of contaminated soils (see Section 7.0 - Environmental Management Program). • Use sealed barrels with device for the transfer of fuel for the power generators.	
Construction / Operation	Increased environmental noise and vibration levels	• Increased traffic of vehicles and machinery (heavy machinery and trucks) and use of equipment and machinery.	• Maintain maximum permitted noise levels within the values indicated by Salvadoran authorities or threshold levels of noise established by IFC. • Indicate all sites where they emit noises above 85 dBA, to avoid exposure of persons without properly certified hearing protection equipment. • Train all workers on techniques for the use and maintenance of hearing protection equipment (occupational safety) that should be required at all times during the exposure period. • Establish speed limits for vehicles traveling in populated areas (maximum speed of 25 km/h). • Maintain in good condition the damping systems of all vehicles, machinery and equipment used during the Project phases. • Design and implement a contingency plan and corrective measures to meet eventualities. • Study and use noise barriers or acoustic noise suppression devices when necessary.	**Insignificant to minor**
Biotic Environment				
Construction	Loss of plant cover	• Tree felling during construction and installation of towers and substations; construction of access roads and	• Optimize the design of the TL route and infrastructure to minimize impacts to natural forests. • Implement an environmental compensation program through reforestation of trees (10 trees x felled tree) and shrubs (1 shrub per shrub felled). • If you cut trees whose timber is of commercial or utility value, you will consult with landowners to inquire if they are	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
		storage areas - campuses (towers and lifting cables).	interested in retaining timber. The contractor will cut the logs to segments of appropriate size. • If the landowner is not interested in wood, the contractor may seek other ways to distribute the wood to entities that can be put to good use. • Other generated plant materials can be crushed on site and used to provide a layer of protection against erosion.	
Construction	Loss of individuals from threatened or endangered species	• Tree felling during construction and installation of towers and substations; construction of access roads and storage areas - campuses (towers and lifting cables).	• Optimize the design of the TL route and infrastructure to minimize impacts to natural forests. • Prior to construction, count individuals of threatened and endangered species to be logged. • Implement an environmental compensation program through reforestation of trees (10 trees x felled tree) and shrubs (1 shrub er shrub felled).	**Insignificant to Positive**
Construction	Pollution and degradation of aquatic hábitats	• Tree cutting during construction and installation of towers and substations; Construction of access roads and storage areas - campuses. • Earth movement. • Crossing of ravines by vehicles and machinery can introduce contaminants.	• The material generated from the excavation works will be removed from the excavation and deposited at a safe distance to avoid material falling into nearby rivers and / or ravines. The collection area of the material must be selected before starting the excavation work to prevent mounds of accumulated material from having any impacts on the nearby rivers and / or ravines. • Piping rainwater into roads through ditches, sewers, sediment barriers and settlers, among other devices to reduce the drag of solids to rivers and / or ravines. • In outdoor parking and storage areas of machinery/equipment, suitable control systems such as hay bales should be placed to avoid contamination of runoff water. • Comply with the manufacturer's guidelines for machinery and equipment used to prevent fuel spills.	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
		• Three of the nine storage facilities or temporary storage areas are located within 100 m of a body of water.	• Avoid vehicular traffic in riparian areas and avoid the use of machinery in the vicinity of watercourses. • Have a prevention, control and response plan to risks of spills including emergency response, cleaning and recovery of contaminated soils (see Section 7.0 - Environmental Management Program). • Use hermetic barrels with device for transferring fuel for power generators.	
Construction	Loss of habitat and black-eyed frog individuals	• Loss of habitat and mortality of individuals during construction activities.	• Campaigns for the capture and relocation of frogs in habitats to be affected by the Project. • Avoid impacts to its existing breeding sites. • Construct two piles of water catchment in each area where the presence of the frog was documented to increase the availability of habitats for the reproduction of the species (Santa Rita and Tequendama farms). The "piles" are craft structures used by coffee producers in the region to store water. Frogs use these piles as shelters and breeding grounds. It should be installed four piles built according to local custom with the following dimensions and materials: approximate dimensions - 2.5 m long x 1.5 m wide x 1.6 m deep with, corrugated aluminum sheet roof with gutter and down tube; and materials - building bricks, cement, sand, corrugated aluminum sheets, nails and/or screws, with cement refining. • Reforestation of forest habitats in the Biosphere Reserve. • Educational conservation campaigns on the importance of the frog and the advantages of organic coffee cultivation without agrochemicals.	**Positive**
Operation	Collisions of birds with the transmission cables	• Collision with the TL cables, mainly in the cables of guard for being of smaller diameter and less visibility.	• Installation of bird flight deterrents throughout the section of the transmission line within the IBA "Los Cóbanos." • Installation of dissuasors in the main crossings of rivers and ravines.	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
Construction / Operation	Construction of TL in Apaneca-Ilamatepec Biosphere Reserve - Buffer zone and Transition zone.	• Felling of 194 trees in the Buffer Zone and 248 trees in the Transition Zone. • Installation of TL, partially, within the limits of the Apaneca Biosphere Reserve - Ilamatepec.	• Installation of bird flight deterrents throughout the length of the transmission line within the IBA. • Minimize felling of trees and shrubs by positioning the towers outside areas of woody vegetation. • Minimization of the opening of new accesses and their rehabilitation and revegetation to finalize the construction of the Project. • Restoration of forests within the Reserve through the Environmental Compensation Program. • Training of workers on the importance of the Reserve and its conservation objectives. • Installation of information signals on public roads on the Reserve and its biodiversity values.	**Positive**
Construction / Operation	Construction of TL in an important bird area "Los Cóbanos".	• Tree felling in the bird conservation area. • Risk of collision of birds with transmission cables.	• Installation of bird flight deterrents throughout the length of the transmission line within the IBA. • Minimize felling of trees and shrubs by positioning the towers outside areas of woody vegetation. • Restoration of gallery forests within the IBA through the Environmental Compensation Program. • Training of workers on the importance of birds and their habitats. • Installation of informative signage about the IBA and its biodiversity values on Route 12.	**Positive**
Socioeconomic Environment				
Construction / Operation	Generation of temporary and permanent jobs.	• Construction, operation and maintenance of TL and infrastructure.	• Recruitment of the labor force constituted mainly of workers of the towns and municipalities in the area of influence of the Project and national specialized workers.	**Positive**
Construction / Operation	Regional economic stimulus	• Construction, operation and maintenance of TL and infrastructure.	• The growth of commercial, industrial and related services is expected.	**Positive**

Phase	Impact	Source of Impact	Proposed Mitigation Measures	Residual Significance of Impact After Mitigation
Operation	Increased power supply	• Operation of the TL and infrastructure.	• Increased power supply.	**Positive**
Construction	Risk of conflicts between the local population and the Project	• Construction of the TL and infrastructure.	• The Project has designed a citizen participation plan that establishes recurrent meetings to inform the progress of the Project. It has also established a complaint mechanism to have an open line of communication with the communities. For more details, refer to Section 7.0 Environmental and Social Management Program. • In addition, contractors will have to abide by the workers' code of conduct and all employees will be required to induce community relations.	**Insignificant**
Construction / Operation	Risk of traffic accidents on public roads	• Traffic of vehicles and equipment during TL construction and infrastructure.	• The works will be programmed so as to always maintain the main communication channels enabled. The necessary precautions will be taken to avoid accidents, maintaining at all times adequate signage, both day and night, according to the rules of the competent authority complying with current regulations. It will be driven at a maximum speed of 25 km / h. At the end of the works to improve the roads, the clearance and cleaning work will be carried out. • All personnel and Project contractors related to vehicle driving will undergo training for defensive driving (Smith System). It will ensure that the drivers have the Smith System certificate and if they do not have it, they will take a course. • All Project staff and Project vehicles will give the right of passage to all local people (for example, inhabitants of communities that are moving on foot). Project employees as well as subcontractors will be responsible for the traffic of their vehicles and will have to comply with the measures proposed in the Environmental Management Plan and the Social Management Plan (see Section 7).	**Moderate — Construction. Insignificant — Operation.**
Construction	Purchase of right of way	• Resettlement of a house in Acajutla.	• Anticipate and avoid or, where this is not possible, minimize the adverse social and economic impacts arising from the	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
			acquisition or restrictions on land use: (i) compensating the loss of assets at replacement cost. • The Project will make every effort to improve the living conditions of physically displaced persons by providing them with adequate housing with security of tenure in resettlement sites. • Development of the document with the methodology for "Zoning of Land Uses, Determination of Securities Ranges for Land and Infrastructure Compensation, Definition of Valuation Parameters and Negotiation Criteria", which establishes the boundaries or limits of classification of land uses in the terrain, and value ranges for fair compensation for acquisitions or land use restriction arising from Project implementation. • Resettlement activities will be carried out with appropriate dissemination of information, consultation and informed participation of the affected persons. The Project Social Management team will ensure that these aspects are met. • It has an Office for Attention to Owners since September of 2015 that among its functions are: o Attention to owners / holders of real estate located under the trace or any other person interested in obtaining project information. o Receipt of personal identification and property ownership documents. o Receipt of complaints and claims, not only by owners / holders of properties, but also by any person living in the area of influence of the trace, and who are directly involved who consider that they have suffered damage on their property by the work teams that perform in the field. This establishes a complaint mechanism for appeals and for the resolution of disputes in an impartial manner.	
Construction / Operation	Alteration of visual quality and fragility	• Clearing and grubbing vegetation.	• The line layout and right of way corridor design have been optimized to minimize impact and preserve the visual quality of the natural environment. Elements of the natural	**Minor**

Phase	Impact	Source of Impact	Proposed Mitigation Measures	Residual Significance of Impact After Mitigation
		• Earth movement. • Rehabilitation and construction of access roads. • Rising the towers. • Laying of the conductors.	environment (for example, points of tourist interest or natural observation, churches or buildings with historical and heritage value, peaks and mountains, etc.) have been taken into account to avoid intersecting with them. • Design of TL route near the edge of agricultural or forest parcels of land in order to hide the lines in the dark background.	
Construction	Riesgo de accidentes laborales	• Construction of TL and infrastructure.	• EDP will ensure that the working conditions in the Project comply with the occupational health and labor standards of El Salvador. • The staff must be qualified to carry out the activities of the Project. • All employees will receive training in Occupational Health and Safety. • The contractor company will provide personal protection equipment and tools in good condition to all workers according to the activities they carry out. • Personnel shall wear appropriate personal protective equipment at all times and work at heights shall be carried out with appropriate safety measures (harness, gloves and insulation clothing), in accordance with the applicable legal requirements in this area. • The staff will have adequate and sufficient means to ensure adequate hydration and at least one hour of rest during the day. • If there are torrential rains during the removal work for the installation of the line, the work must be done with extreme caution or even suspended, while the rain lasts to avoid soil trapping and runoff. • All workers should be made aware of the importance of complying with all the above mentioned measures in order to ensure adequate waste management, personal protective equipment and work tools in good condition, and to safeguard	**Insignificant**

Phase	*Impact*	*Source of Impact*	*Proposed Mitigation Measures*	*Residual Significance of Impact After Mitigation*
			and preserve the biological and environmental aspects of the area. • All access points to the Project sites will be clearly marked and will have security personnel.	
Cultural, Archaeological, Ceremonial and Historical Resources (Cultural Heritage)				
Construction	Alteration of the context or state of resources of pre-hispanic cultural heritage	• Terrain leveling; excavation for bases and construction of the towers, access ways and facillities.	• The layout of the line and the design of the right of way corridor have been optimized to minimize the impact on the underground cultural heritage resources. The findings have been taken into account and a second phase of the survey will also be carried out with the participation of representatives of the Ministry of Culture. There will be monitoring for incidental findings and an awareness plan for workers during the construction process.	**Insignificant to moderate (depending of findings during phase II)**
Operation	Restriction of access to cultural heritage resources	• Access restricted to nearby of right of way.	• Communication channel will be established to ensure relevant research on the resources identified in the trace and restricted access will add an additional level of protection to documented resources.	**Positive**

7.4 *PROPOSED MANAGEMENT PLANS*

The PMP developed for the Project, which is presented in Appendix O, includes the environmental and social plans to be implemented by EDP and its contractors during the construction and operation stages of the Project to prevent, minimize, mitigate and/or compensate for negative environmental and social impacts resulting from the Project; and also to enhance the positive impacts that may result from Project activities. The individual management plans of the Project will:

- Potential impacts on environmental receptors and social values;
- Mitigation strategies;
- Performance monitoring;
- Indicators and performance criteria;
- Reporting requirements; and
- Appropriate corrective actions in the event of an undesirable impact or an unintended level of impact occur.

EDP is committed to providing the essential resources for the execution and control of the PMP.

The PMP includes actions that have been grouped by nature and objectives into specific plans, including the following:

- Air Quality Control Plan.
- Noise and Vibration Control Plan.
- Erosion and Sedimentation Control Plan.
- Contingency Program.
    - Seisms
    - Volcanic Threat
    - Leakage
- Terrestrial Flora and Fauna Protection Plan.

- Social Management Program.
    - Training Plan.
    - Community Involvement Plan.
    - Complaint Management Plan.
    - Community Health and Safety Plan.
    - Plan of Fortuitous Findings.

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Ahuachapán to Acajutla Transmission Line Project

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APPENDIX A

TERRESTRIAL FLORA REPORT FOR THE PROJECT: "ENERGÍA DEL PACÍFICO ELECTRICAL TRANSMISSION LINE" 2016

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July 2016.

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Biogeography

El Salvador lies in the neotropical region that comprises the American tropics, from the northern part of Mexico to the center of Argentina (Rapoport, 1968, Fittkau, 1969: Cabrera and Willink, 1973; Morrone, 1996b, 2001d.), and is one of the six main biogeographic regions and one of the most diverse, since one fourth of all plants and animal species are produced in South America and Central America, a Caribbean subregion which extends to the central and southern parts of Mexico, Mesoamerica, the Antilles, and the northwest of South America in Ecuador, Colombia, Venezuela, and Trinidad and Tobago (Morrone, 2001), Province of Chiapas which comprises the South of Mexico, Guatemala, Honduras, El Salvador, and Nicaragua; basically corresponds to the Sierra Madre of Chiapas, from 500 to 2,000 meters of altitude (Morrone, 2001). Conservation. The province of Chiapas is threatened by the conversion of its habitats for the production of sun coffee, firewood gathering, the conversion of natural habitats for agriculture, the clearing for the creation of pastures, overgrazing, man-made fires (Dinerstein et al., 1995, quoted by, Morrone, 2001), a situation very similar to that of El Salvador.

From the breakup of South America and Africa, basins (troughs) formed or high mountains rose. In one of these sinkings, a large trough accrued large amounts of sediment. Then it rose, deformed, and partially eroded, and the final rocks were to form the base of a new land: that of El Salvador, Honduras, and parts of Guatemala and Nicaragua.

In the beginning, the territory of El Salvador was nearly 1,500 kilometers north of its current location on the Pacific side across from the states of Guadalajara, Michoacán, and Guerrero, in Mexico, forming the south tip of a vast land strip that extended to Beringia (Alaska).

This had been its position since some 250 million years before, but gradually, the internal forces of the planet tore this land mass apart. First it got separated from the Mexican territory, then it was displaced towards the southeast, parallel to the coast. The southern sector of Nicaragua and Costa Rica had not been formed yet and South America was separated from North America by a vast sea.

During a long period of time, the land segment that would give birth to El Salvador moved across the Mexican territory, sliding south. However, once in front of Guatemala, its motion took a forward direction putting it on collision course. This movement took it some 20 million years to then slide back towards the southeast as it began to position itself where it now seats (Serrano, et al.1995.)

From about 20 million years to about 100,000 years ago, there was a transitional process between the volcanic events of the prior period and those of the present period. About 20 million years ago, violent eruptions took place that dispersed material north of the Lempa and Torola rivers. The volcanic activity later reached the central sector and south of the country. Towards the south, its limit was and still is the great fractures that were created in the past and that in turn share their boundary with the basin (Serrano, et al. 1995).

Some 100 thousand years ago, in the area of Coatepeque, the first eruptions took place of the volcanoes we now see. Still, none of the topographic features such as the Coatepeque lake, Santa Ana volcano or Izalco volcano existed.

Volcanic activity was also starting in the proximities of Ahuachapán, between San Lorenzo, Tacuba and Las Chinamas. Later, a marine plate in the Pacific, collided with the continental area. The earth's crust rose with the exerted pressures.

In the national territory, such deformation acquired significant proportions in the past hundred thousand years and has been of particular interest in terms of the forming of major morphologic traits of our country.

As the territory rose, a longitudinal strip, that runs through the central part of El Salvador, formed. There, the geological activity was intense (and continues to be), and changed the surface features of the country.

Approximately 50,000 years ago, the central part of that strip started to deform (as it started sinking). The northern sector of this formation has its limit in Chalatenango, north of the Lempa river; the southern part in Santa Tecla, south of the city. With the deformation basins were created and, within them, great lakes. To the north lied the basin of Metapán; in Chalatenango, that of the Lempa, which was the biggest; to the east, that of the Titihuapa and the Sisimico;

In these lakes there was abundance of life including fishes, frogs and shells. The climate was warm, humid, and favorable for a diversity of lifeforms. The vegetation was dense and its remains became coal of lignitic type 35,000 years ago.

Some 20,000 years ago, there was a small lake in a time of abundant rainfall and warm climate. Life was rich in the lake. Some organisms adapted to an agitated environment, with many suspended particles, others to a more tranquil environment. The process of deformation continued and the rock gave way. The first effect of this displacement of the superficial forests became noticeable in the lakes. Confined to small basins, they drained thus forming the modern fluvial system. The most important of them is that of the Lempa river, as it is known today.

Likewise, the great land blocks had vertical movements (very pronounced in some cases), that formed the mountains in the north of the country and tipped other blocks to the south, such as the Sierras del Bálsamo, Jucuarán, and Apaneca.

Between the blocks of the south and the mountains of the north, was (and still is) the central strip, a depression that, as it sank, became filled with volcanic materials. It is in that strip that seismic and volcanic phenomena currently take place.

Other volcanic massifs appeared more recently, in Apaneca (part of the Project site) and Chalchuapa, as well as in Laguna Verde (Serrano, et al. 1995).

Within the area of the Project the volcanic complex of Santa Ana stands out, of which the Santa Ana Volcano or Ilamatepec is the nucleus. This volcano originated in the Pleistocene (between 2 and 1 million years ago), before the explosive events of the caldera of Coatepeque (its most recent eruption was in 2005). The neighboring volcanoes of Izalco, Cerro Verde, San Marcelino and others are "parasitic" to the mother volcano. Studies conducted on the structure of the Santa Ana volcano reveal that it suffered a series of debris flows towards the east and south; the biggest of them covered some 300 km^2 of the coastal plain down to the sea shore, forming the peninsula of Acajutla, where the maritime port of El Salvador now lies (UNESCO, 2007).

According to the classification of Ecoregions of Dinerstein and the terrestrial and aquatic ecosystems of the classification available for the Mesoamerican region defined by the Central American Commission for the Environment and Development, CACED, in the year 2000, it is observed that there are two ecoregions present in the Apaneca-Ilamatepec Biosphere Reserve, which is the most important and most representative area from the standpoint of biodiversity that the Project runs through: the Central American Montane Forest, which is in a vulnerable state, and the Central American Dry Forest and the Central American Pine-Oak Forest, both in critical/vulnerable state. The ecoregions are the following (UNESCO, 2007):

- **Central American Montane Forest**
- **Moist Forest of the Sierra Madre of Chiapas**
- **Central American dry forest**
- **Central American pine-oak forest**
- **Northern Dry Pacific Coast mangroves**

Ecosystems and Life Zones

In the ecosystems defined for Mesoamerica by the CACED, El Salvador has the following regional ecosystems (UNESCO, 2007):

- Areas with sparse vegetation (over lava rock)
- Bodies of water
- Broadleaf shrubs
- Evergreen broadleaf forests
- Evergreen coniferous forests

- Mixed evergreen forests
- Marshes and wetlands

In Latin America, the description of land ecologic formations has been based primarily on the Holdridge et al Life Zone Classification System (1971) and of Holdridge (1978).

This method assumes that the vegetation classes vary based on certain climate and altitude gradients. Therefore, it is worth noting that the Holdridge system is predictive, rather than descriptive.

Holdridge et al (1971) state that a global system of life zones can be established over the basis of precipitation and temperature. Said classification system utilizes de concept of "biotemperature", which takes into account the gamut of optimal temperatures for plants. A second factor of temperature that is taken into account is the decrease in temperature as elevation increases. A third factor is evapotranspiration, for which he developed his own formula. Holdridge then associated a typical vegetation type with the various life zones he had identified based on precipitation, biotemperature, altitude, and evapotranspiration (Figure 1).

The design of the transmission line runs through different Holdridge life zones in the municipalities of Acajutla, Santo Domingo de Guzmán, San Pedro Puxtla, Apaneca, and Ahuachapán, which are:

- Warm subtropical moist forest bh-S (c)
- Subtropical moist forest, transition to tropical bh- S
- Tropical moist forest bh – T
- Tropical moist forest, transition to subtropical bh – T
- Subtropical very moist forest, transition to humid bmh – S
- Subtropical low montane very moist forest bmh –MBS
- Subtropical very moist forest bmh – S

EL SALVADOR
AREAS OF LIFE ACCORDING
TO DR. HOLDRIDGE

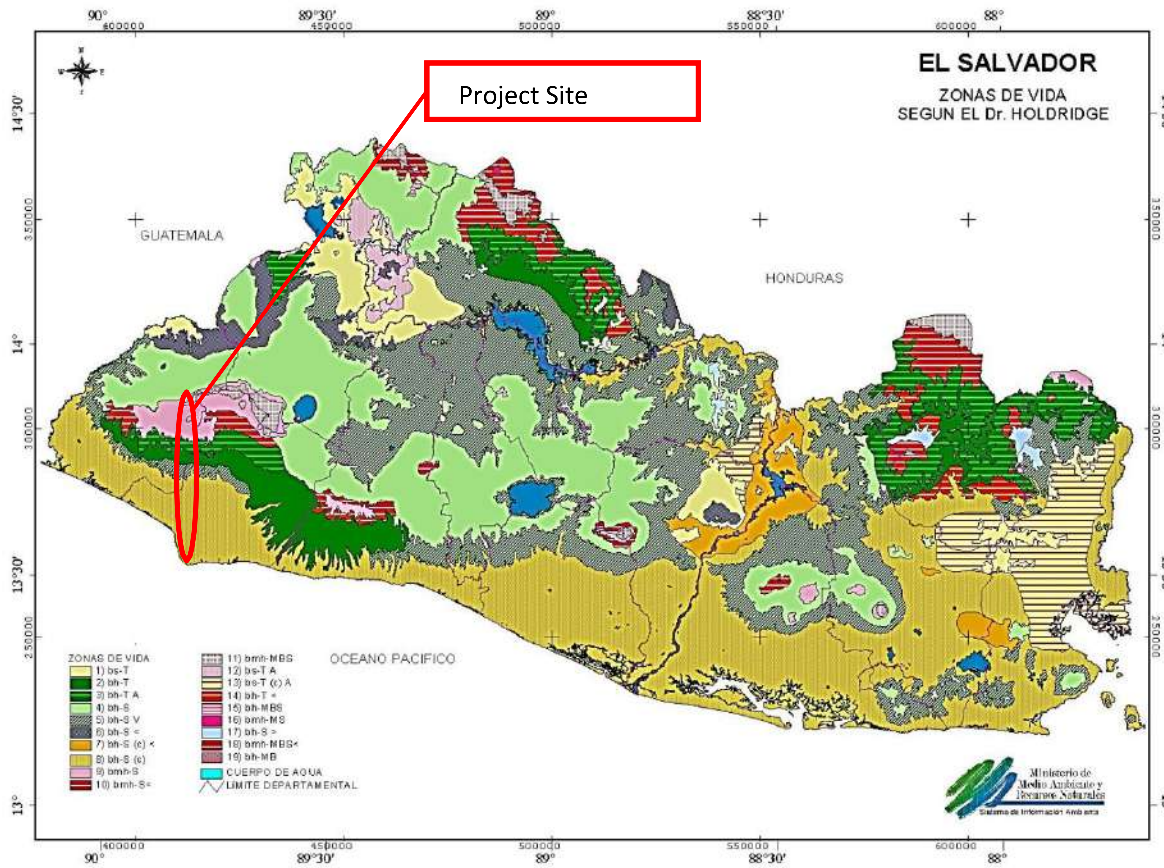

Figure 1. Life zones or vegetation formation according to Holdridge

Koeppen's Classification uses temperature and the yearly distribution of rainfall as criteria. In light of the relationship between temperature and altitude, the former can also be used as criterion for climate division.

Most of El Salvador is included in the warm tropical savanna climate type, with a dry season with average temperatures for the coldest month greater than 18°C and average temperatures for the warmest month above 22°C, which encompasses the coastal plains up to 200 meters and the interior valleys up to 800-900 meters.

In the mountains and valleys between 800 and 1,200 meters, the prevailing climate is that of warm tropical savannas, with average temperatures for the warmest month lower than 22°C, and above 1,200 meters the high tropical climate with average temperatures for the coldest month below 18°C. According to Sapper-Lauer, three levels can be identified, that is levels that show the same temperature conditions: warm land up to 900 meters, temperate land, and cold land above 1,800 meters.

Due to the special conditions caused by the presence of the ocean, with its buffer effect, the coastal zone up to 200 meters can be considered as a special climatic unit, which is differentiated by the attenuated temperature regime compared to the interior valleys.

Currently, the agricultural ecosystems or agroecosystems represent the main land use in El Salvador. Three quarters of the national territory are being used for agro-ecosystems (National Strategy of Biodiversity 2013).

Per the above, the design of the Project runs through the agroecosystems: Coffee, yearly crops tied to permanent cultivation, staple grains, cultivated pastures, sugar cane and scattered urban development (Figure 2).

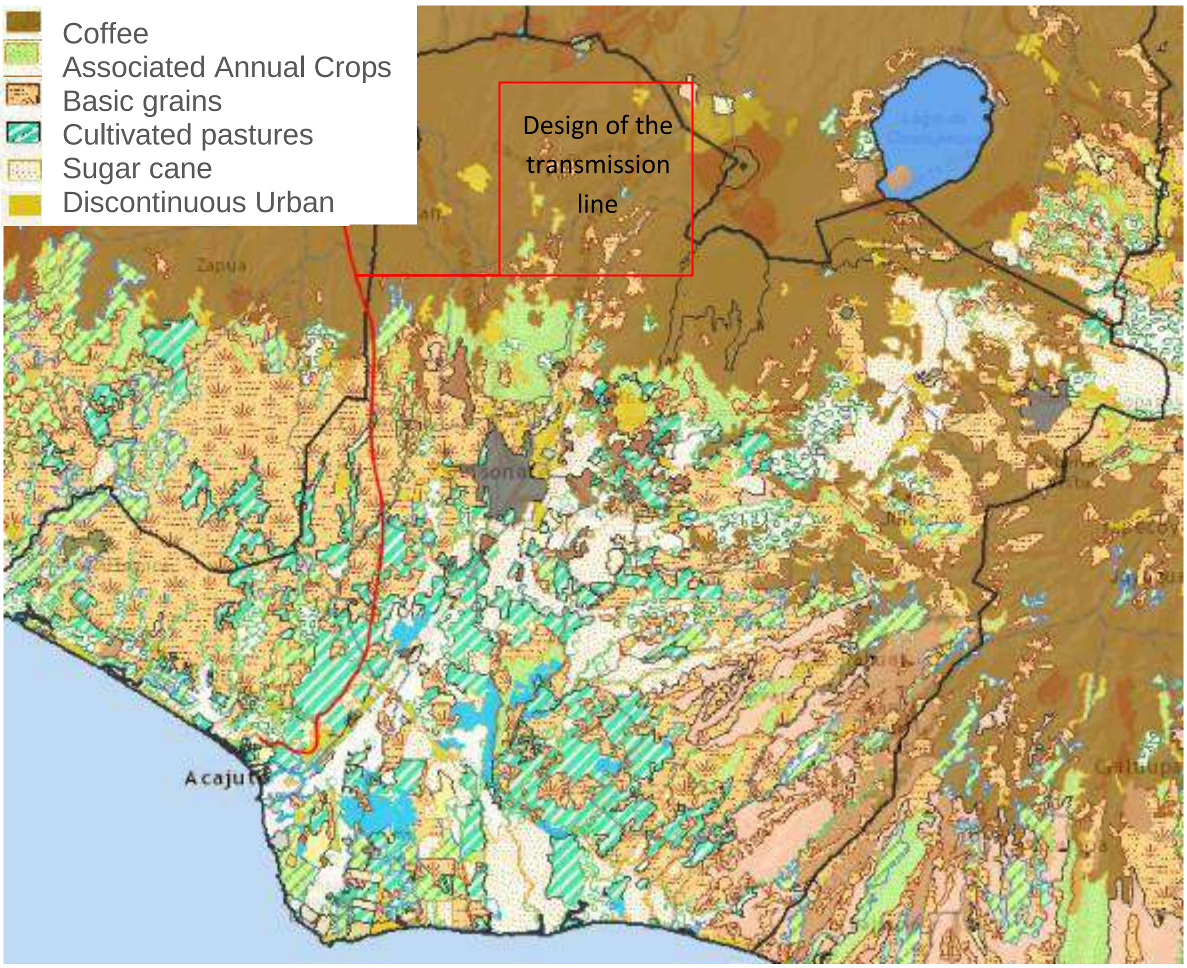

Figure 2. Land use in the zone of the transmission line. Source: Map made with base data of the Environmental Assessment Geographic Information Visualization program (VIGEA), MARN. JUNE/23/2016 .

The biosphere reserve shows four types of habitats:

Rockiness and lava, areas with sparse vegetation with a regional distribution.

Characteristic species:

This vegetation formation is the largest natural ecosystem in the Apaneca-Ilamatepec Biosphere Reserve and encompasses 5.54% of the total area (3,274 ha.). CACED (2000) describes it as areas with sparse vegetation (UNESCO VI code), the biosphere reserve would conserve some 30% of this type of habitat in El Salvador and some 0.5% of the total of this type of ecosystem in Mesoamerica. It is characterized for showing different successional stages of shrubs and forests, from the presence of bare rock, covered by crustose or fruticose lichens, with hepatics and mosses; with lower vasculars such as Selaginellas spp, several fern species, bromeliaceae and orchids. There are also areas with good coverage of gramineae, compounds and herbaceous leguminosae and even areas covered with shrubs and low trees. Most species in the shrub and tree stratum do not exceed average heights of 5 m, although some trees can be found of up to 7 m tall. The most representative vegetal species of this formation are: *Cochlospermun vitifolium, Bursera simaruba, Pentas lanceolata, Cnidosculus urens, Threma micrantha, Epiphyllum spp., Bauhinia ungulata, Omphalea oleifera, Pseudobombax ellipticum, Bursera bipinnata, Bursera graveolens, Lysiloma divaricatum, Clusia guatemalensis, Lonchocarpus salvadorensis, Lonchocarpus minimiflorus* and *Piscidia grandifolia* (MARN 2000). The special microclimate situations with great variations in temperature, exposure to dew, and good ventilation foster an abundant flora of orchids (*Pleurothallis sp., Stelis sp., Bletiasp., Corymborkis sp., Cranichis sp., Goodyera sp., Malaxis sp., Govenia sp., Spiranthes colorata*) that grow next to a variety of epifits and litofits (Asociación Salvadoreña de Orquideología 2007).

Evergreen forests with a regional distribution.

Characteristic species:

It is the second largest natural ecosystem in biosphere reserve, it comprises 4.35% of its surface. CACED (2000) describes it as evergreen and semi-evergreen broadleaf forests (code UNESCO IA1/2(1)). The characteristic plant species in these places are: *Quercus spp*., *Pinus spp*., *Cupressus lusitanica* and *Lyquidambar styraciflua*; although *Saurauia kegeliana, Styrax argenteus, Hirtella racemosa, Sapranthus violaceus* and *Matayba glaberrima* are also frequently present. A marked epifitsm can be observed in a variety of orchids, Bromeliads, Piperaceae, Cactaceae and ferns (MARN 2000).

Evergreen forests with a regional distribution.

Characteristic species:

This ecosystem extends to 1.09% of the Apaneca-Ilamatepec Biosphere Reserve, is the third most important natural ecosystem for its size. Lötschert (1955) described these pine forests as ecosystems consisting primarily of *Pinus oocarpa*, which was replaced by *Cupressus benthamii* plantations and with an abundance of malestomataceae with grass in the herbaceous layer, which agrees with Flores (1978). It must be stated that, in El Salvador, 27 years ago, several species of pine trees were naturally present in the national territory: *Pinus pseudostrobus, P. oocarpa, P. Tenuifolia and P. ayacahuite*, but slowly, these species were replaced by

Pinus caribea from Honduras. According to MARN 2000, there are currently few areas with a pure formation of pine trees; rather, the forest of conifers is a mixed forest with species of *Pinus caribaea, Quercus spp., Ternstroemia tepezapote, Lyquidambar styraciflua* and *Cupressus lusitanica*. A good cover of gramineae can be frequently observed with an abundance of *Hypharrhenia rufa*. Orchids, bromeliaceae, ferns and lower vasculars can also be seen.

Shade coffee plantations with a local distribution.

This agro-ecosystem is of fundamental importance in the Apaneca-Ilamatepec Biosphere Reserve, since it is the dominant landscape and encompasses 67% of the area (39,472 ha.). There are three types of agro-ecosystems: traditional coffee plantations where the forest understorey is replaced with coffee plants, diverse polyculture coffee plantations with considerable diversity of shade trees, and simplified polyculture coffee plantations less diverse in terms of shade species (PROCAFE 1998). The London Natural History Museum together with the University of el Salvador, published, in 2002, three fundamental studies on the species of these agro-ecosystems: an identification guide to the 239 spcies of trees found in the coffee plantations of El Salvador, 232 of which are native species (Monro et. al, 2001); an identification guide to ferns in the coffee plantations of El Salvador that describes 38 species ((Monro et. al, 2002); and an identification guide to the Pimplinidae of the shade coffee plantations (Gauld et. al 2002) describing 68 species of hymenopterous pimplinidae of which four are new to science: *Scambus monroi sp. n*., *Calliephialtes cafetalia sp*. *n*., *Anastelgis imposiblita sp. n.* and *Zatypota lagiralda sp*. n.

Of the habitats of the Biosphere Reserve, the only one the Project runs through is that of shade coffee plantations.

Land Flora

The study was developed in the coffee forest, patches of forest, and cultivation areas in the influence area of the design of the Project and the main objective is to gather information on the floristic species present in the area in order to promote adequate environmental measures.

Methodology

Description of the Study Area

The study area encompasses part of the western section of the Apaneca Range in the southwestern of El Salvador, in the departments of Sonsonate and Ahuachapán. This zone contains some important patches of natural forest located within the coffee plantations (see Figure 3).

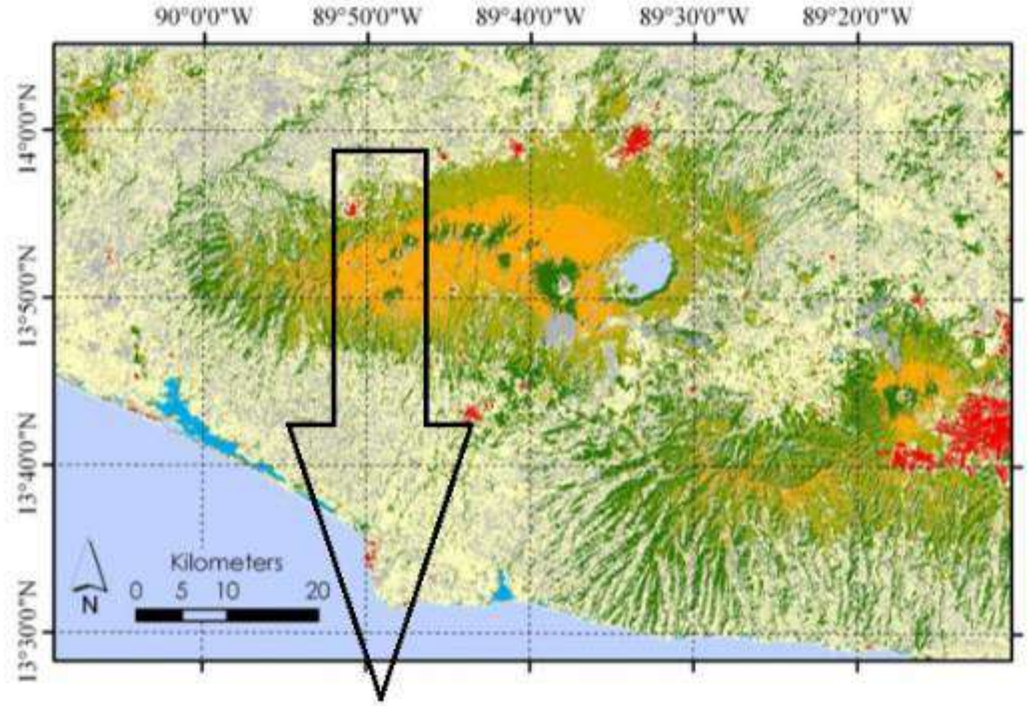

Figure 3. Classification of the Apaneca Range habitat (upper part of image) and of the study zone (lower part)

Color key:
Green=Forests
Yellow = Open canopy coffee plantations
Light green = Canopy coffee plantations
Gray = Lava flows or red bare soil
Red= urban areas
Blue = Bodies of water
Pale yellow = agricultural areas

The sampled sites, within the area of the study, belong to three different altitude zones: the low lands, up to 700 m above sea level, in Central America, are part of the Dry Forest Ecoregion; the medium elevations, up to approximately 1900 meters above sea level, are part of the Moist Forest Ecoregion; the highest peaks contain cloud forests and are part of the Montane Forest Ecoregion. Coffee is grown starting at 400 m and up to approximately 1700 m and over 90% of the surface within that altitude segment.

The area of the study is subject to a distinct dry season of 6 months, from December to May, in which the total amount of rainfall is lower than 100 mm. During the rest of the year, monsonic-type rains keep the soil moist. The yearly rainfall averages about 2000 mm, but in the wettest years they can reach 3000 mm in the highest elevations of the range.

Floristic composition

According to Harvey (2003), it is necessary to know the floristic wealth of the original vegetation through floristic inventory studies, since they are the basis to conduct more precise studies on ecology and biogeography and are indispensable in making policies for resource conservation and management.

Coffee Plantation Systems in the Study Area.

Mixed Farming.

This category is linked to vegetation structures of trees that are not so tall (8-10m), with a large number of young fruit, timber, and shade trees, which produces species-rich and diverse structures, that is, with a great variety of trees. However, they are not very complex in terms of their physiognomy and have many introduced species from out of the region (see Figure 4).

Simple Farming

In this type of coffee farm structure it is common to find planted trees of a same species to provide shade for the coffee plants. Most coffee farms use only one or two types of shade trees. These plantations show simpler structures with a density of 216 trees per hectare, with an average tree height of 4.8 meters and thin trunks of 17.7 centimeters in diameter as the average, no epifits and an average cover of 65% although the density of coffee plants per hectare is the greatest in farms it can reach (4,300) (see Figure 4).

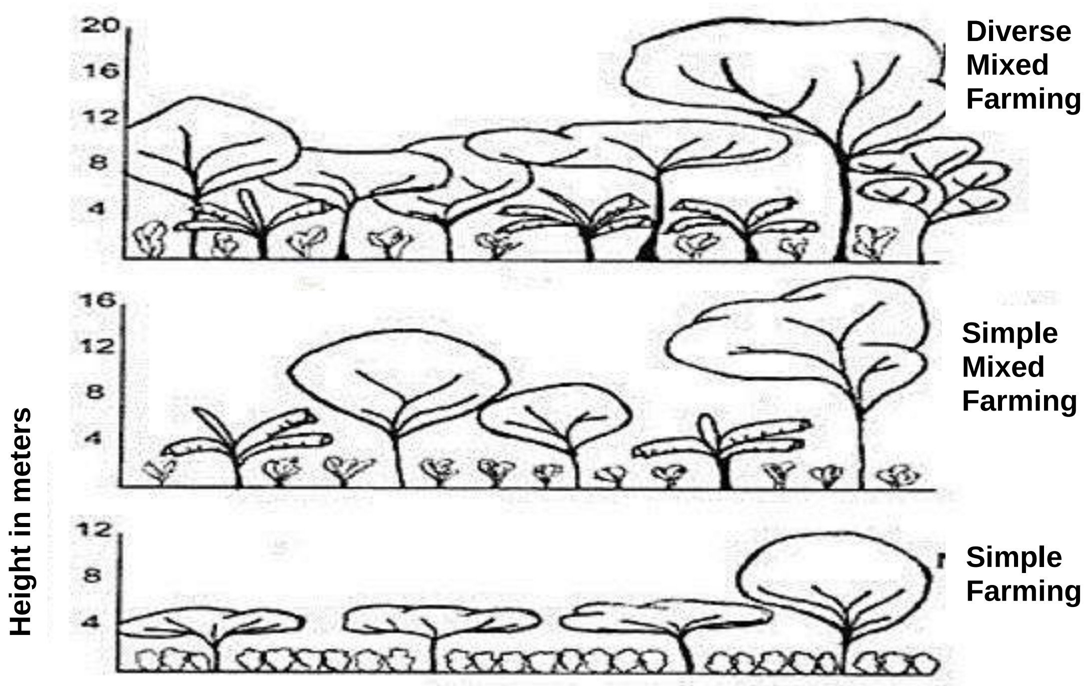

Figure 4. Coffee plantation structures in the influence area of the Project.

Structure and Diversity of the Grasslands

No representatives remain of the original forest. None of the original vegetation remains. These areas have been transformed into agro-ecosystems and currently are used as pastures and cultivation areas. The sites are dominated by herbaceous vegetation of the Poaceae, Euphorbiaceae and Asteraceae families and some tree species.

The sample herbaceous of the Poaceae, Euphorbiaceae and Asteraceae families include species that are ideal for warm climates. They do not tolerate the shade, grow very well under the sun and with the traditional cattle management after producing dry seeds. These are some of the first species to produce new shoots when the rains arrive.

The tree species found, for the most part, in living fences are well adapted to an ample range of soils in moist to submoist climates, including moderately acid and infertile sites. They have been favored by human disturbance and have colonized large areas following the destruction of native forests.

They are a main component of falow lands that follow the slash-and-burn agriculture probably because of their tolerance to fire (they break out again vigorously after a fire with the arrival of the rainy season).

Estimates of the vegetation population

Calculations

The abundance, the richness, and the diversity value index will be determined with the information recorded through the sampling. The data will be processed in Excel spreadsheets. For alpha diversity, the Shannon-Weiner indices are used. The absolute abundance **(n)** and relative abundance **(%)** of aquatic organisms recorded in the study will be determined.

Relative abundance.

$A_{r.} = \frac{A_i}{A_{total}} X\ 100$

Where:

A_r = relative abundance of the family or species

A_i = total number of individuals of the family or species

A_{total} = Total number of individuals of all registered families or species

Relative density:

$$D_r = \quad \frac{D_x}{D_{total}} X\ 100$$

Where:

D_r = relative density

D_x = total number of individuals of the species x D

$_{total}$ = Total number of individuals of all species.

Relative basal area

$$AB_r = \frac{AB_x}{AB_{total}} X\ 100$$

Where:

AB_r = relative basal area

AB_x = absolute basal area of species x

AB_{total} = sum of the absolute basal areas of all species.

Relative frequency:

$$Fr = \frac{Fx}{\sum Fx\ total} x100$$

Where:

F_r = relative frequency

F_x = number of times that species x appears

$\sum F_{x\ total}$= sum of the frequencies of all species

Importance value index:

$$IVI = Dr + ABr + Fr$$

Where:

IVI = importance value index

Dr = relative density, ABr = relative basal area and Fr = relative frequency

Additionally, in order to measure the diversity of species within a community (α diversity), the Shannon-Wiener index is utilized. This index is based on that all species have the same probability of occurrence in the sample. It shows values between 0 and 6 and is calculated according to the following formula:

Shannon Wiener Index.

$$H' = -\sum_{i-1}^{n} pi\ (lnpi))$$

Where:

H´ = Shannon-Wiener species diversity index

P_i = proportion of the species (n_i) in the total sample (N) ($p_i = n_i$/ N).

Simpson Index

Known also as the index of diversity of the species or dominance index. This is one of the parameters that allowed to measure the wealth of organisms. In ecology, it is also used to quantify the biodiversity of a habitat. It takes a given number of species present in the habitat and their relative abundance. The Simpson index represents the probability of two randomly selected individuals, within a habitat, belonging to the same species.

Simpson dominance index

$$D = \frac{\sum_{i=1}^{S} n_i(n_i - 1)}{N(N-1)}$$

Where:

S =is the number of species

N = is the total of organisms present (or square units)

n =is the number of specimens per species

Simpson diversity index

$$D = 1 - \sum_{i=1}^{S} Pi$$

Where:

D = Simpson diversity index

Pi = Proportion of individuals of the species in the community

Geographic Description of the Study Area

For the flora study, all crop areas, coffee plantations, and forest patches within the range of influence of the Project were sampled. These sites are shown in Figure 5. In all, 30 sampling sites were established, 10 for each experimental treatment. The experimental treatments are: Forest fragments, coffee plantations and extension zones, that are used for pasture or for the production of staple grains.

Site Selection

In all, 30 sampling sites were established, 10 for each experimental treatment. The experimental treatments are: Forest fragments (Figure 6), located and divided for this investigation into north (Figure 7a) and south of the range (Figure 7b); coffee plantations (Figure 8); and extension zones that are used for pasture or for the production of staple grains (Figure 9). Each treatment with 10 repetitions.

The vegetation data were obtained from a total of 30 parcels of 0.1 hectares (10 m x 100 m) placed randomly. One parcel was established for each site of the study.

Vegetation Population Estimates

During the research, the efforts were focused on extensive sampling in the area of influence of the Project design and writing down all tree species with a chest-height circumference greater or equal to 16 cm, the scientific name was recorded for each species and, whenever possible, the common name. Whenever it was impossible to identify the name of the plant, pictures were taken and some of the main traits of the plant written down for immediate identification through keys and specialized literature.

In order to calculate the structure and floristic composition of the patches of forest, coffee plantations and cultivation areas, data was gathered from 10 parcels per type of habitat; these parcels measured 100 x 10 m similar to an area of 1000 m^2 per parcel, Yielding a total of 10,000 m^2 = one hectare per habitat.In all, from all habitats, 30 sites totalling 30,000 m^2 were processed, which is equivalent to 3 hectares of the area of influence of the Project. For each tree, the chest-high circunference was measured greater or equal to 16 cm. The Importance Value Index (IVI) was calculated, based on this information, for the main woody plant species. The sampling was also carried out for the coffee bushes in the 10 parcels corresponding to the habitat of the coffee plantations (10,000 m^2 = one hectare) in order to obtain densities per hectare, basal area per hectare and number of bushes.

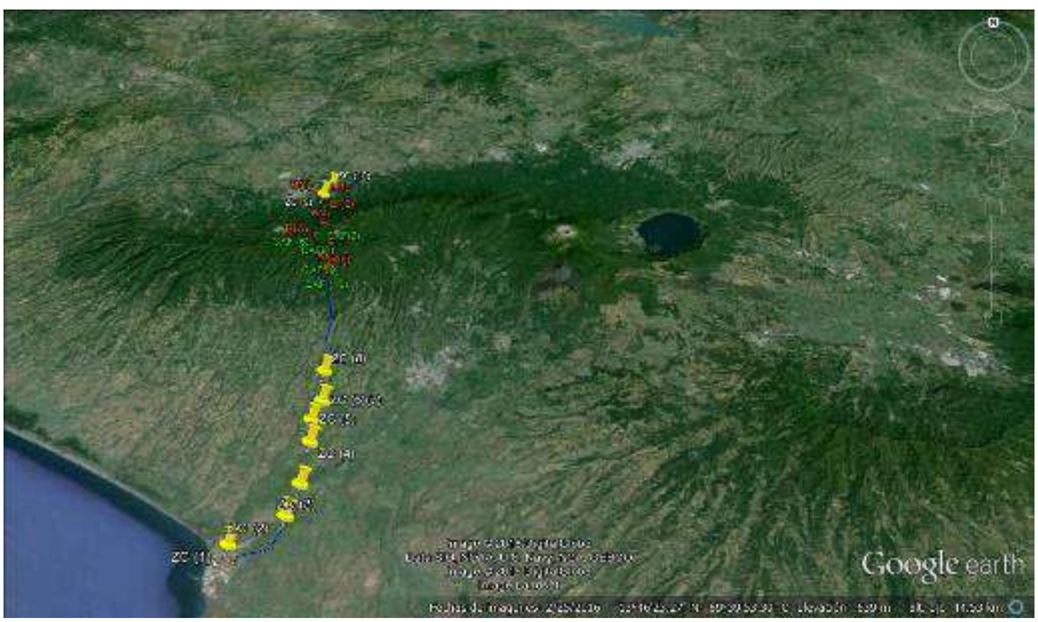

Figure 5. Image showing the 30 sampling sites for the assessment of the flora found in the coffee plantations within the influence area of the designs of the Project.

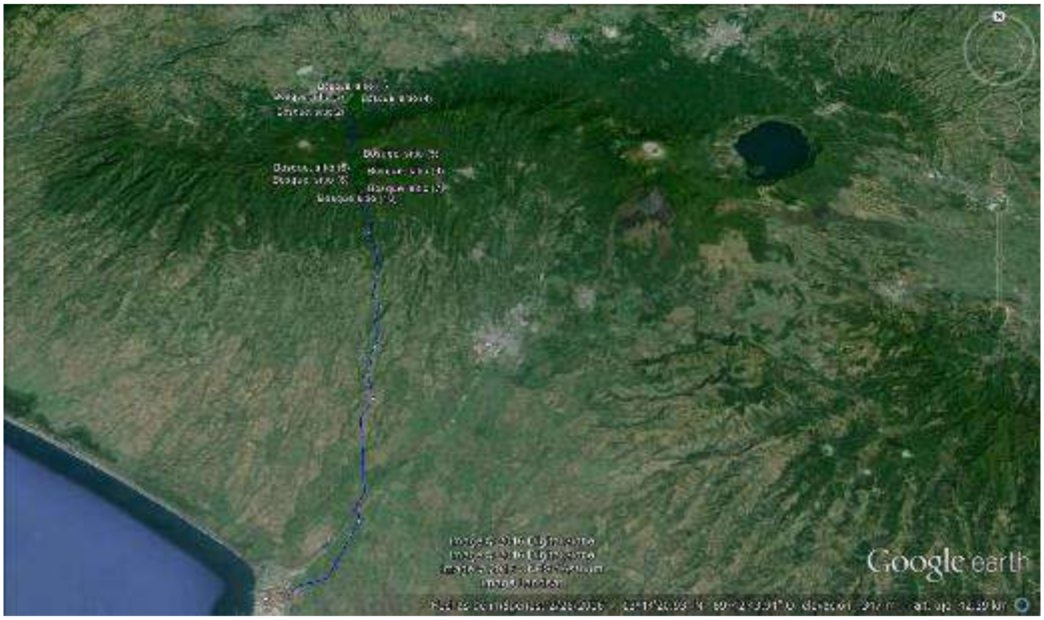

Figure 6. Image showing the 10 sampling sites for the assessment of the flora found in the patches of forest within the area of design of the Project.

Figure 7. 7a: Segments of forest located north of the range and 7b segments of forest located south of the range.

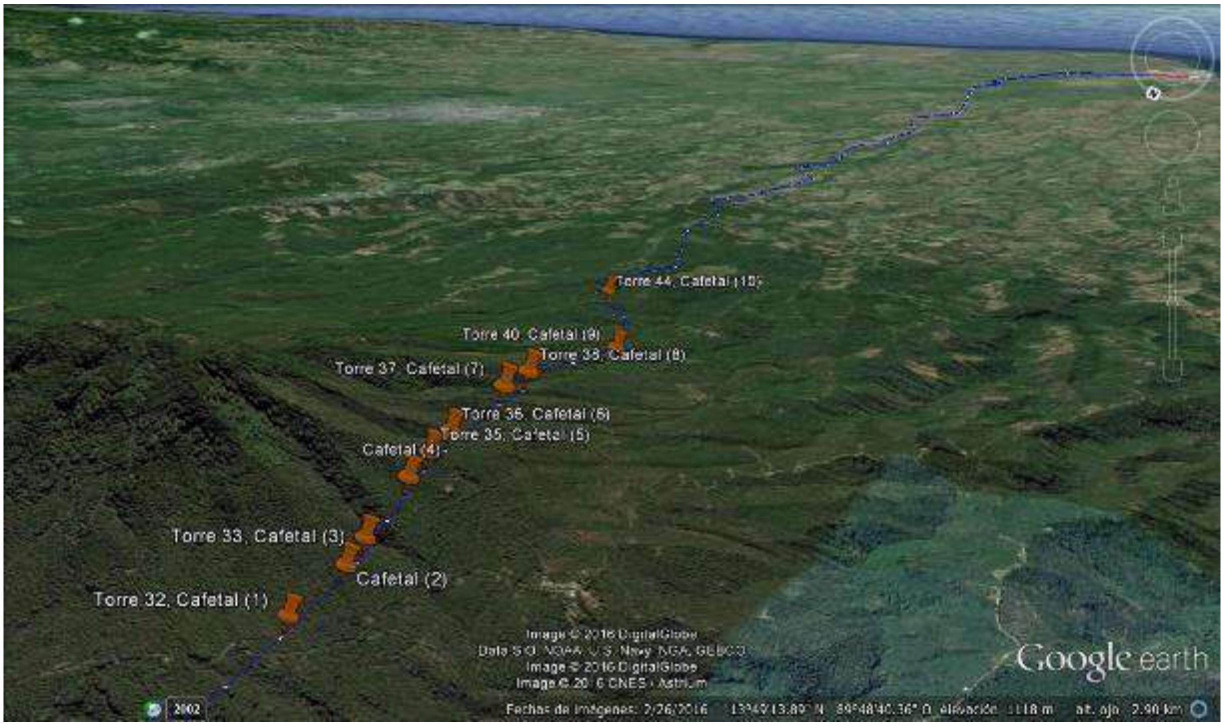

Figure 8. Image showing the 10 sampling sites for the assessment of the flora found in the coffee plantations within the area of design of the Project.

Figure 9. Image showing the 10 sampling sites for the assessment of the flora found in the extension zones utilized for the production of staple grains found in the area of the Project.

Calculations and Results

In progress

This study records a total of 123 families, 384 genders, 536 species (including subspecies, varieties and forms) of vascular plants, that is, those that posses conducting vessel systems, including ferns (and like plants, as well as plants that produce seeds. Of the 536 species, 411 are native and 125 are exotic.

Of the total number of species, 156 are trees (118 native and 38 exotic), 65 are bushes (34 native and 31 exotic), 75 are vines (67 native and 8 exotic), 29 are ferns (28 native and 1 exotic), 209 herbs (164 native and 45 exotic).

There is a striking diversity of tree species owed, to a large extent, to various intermittent gullies in the area sufficiently large to allow the survival of trees native to the type of forest that must have existed several years ago in the area.

Many of the trees are relatively large and appear to be very old, which makes it likely that they were there since the time the area was a forest. These trees produce recalcitrant seeds that do not germinate in dry, open or sunny places and they also seem to be in the upper boundary of their altitude distribution growing in places away from the gullies, which makes it difficult to assume they may have been carried there by the water path.

Some species like the wattle (*Acacia polyphylla*) and the laurel (*Cordia alliodora*) are typical or regenerations. The Quickstick (*Gliricidia sepium*), pepeto and paterna (*Inga spp*.), are native to the country, but grown in the area for their properties in enhancing the soils through the fixation of nitrogen and because of their edible fruits. Some trees such as the amate (*Ficus spp*.), although dispersed by birds and with relatively fleshy infructescence, are also native to the first stages of regeneration of a forest.

Many of the trees detected in the inventory were found only in the gullies. Trees such as *Annona muricata*, *chaperno* (*Lonchocarpus rugosus*), Bastard Hogberry (*Margaritaria nobilis*), Wild Sugar-apple (*Rollinia mucosa*), *palanco* (*Sapranthus palanga*) were only found growing in the path of gullies or close to them. Others, such as *Crudia acuminata*, although they grow in other places, are more common in gullies; also, vines such as *Aristolochia grandiflora* were seen only in those places. This highlights the importance of gullies as microhabitats of great importance for conservation and restoration of the forests.

Exotic and invasive species

In all, 123 species of exotic plants were identified (Table 1). Some of these species propagate vegetatively through cuttings and rhizomes, since, here, they do not have adequate pollinizers. Some that propagate vegetatively are Angel's Trumpets (*Brugmansia candida* and *B.suaveolens*), *izote* (*Yucca guatemalensis*) and bougainvillea (*Bougainvil aea* spp.), which although can persist a long time in forests and neglected horchards, do not propagate in any other form than vegetatively, therefore, they do not pose a danger to the native biodiversity. Nonetheless, a total of 39 species were identified and recorded as dangerous invasive according to the list of invasive plants of the UICN; available at http://www.issg.org/database/welcome/ and detailed in Table 1.

Table 1. List of all native or exotic species with potential to become invasive

Species	Family	Habit	Origin	State of Conservation
Acalypha wilkesiana fo. *circinata* Müll. Arg.	Euphorbiaceae	Ab	E	
Acalypha wilkesiana Tahiti	Euphorbiaceae	Ab	E	
Aechmea gamosepala Wittm.	Bromeliaceae	Hi	E	
Agave angustifolia var. *marginata* hort. ex Gentry	Agavaceae	Ro	E	
Ageratum conyzoides L.	Asteraceae	Hi	N	UICN, Invasive
Allamanda cathartica L.	Apocynaceae	Ab	E	
Allamanda Compacta Hendersonii	Apocynaceae	Ab	E	
Alocasia cucullata (Lour.) G. Don	Araceae	Hi	E	
Aloe vera (L.) Burm. f.	Aloaceae	Ro	E	
Alpinia speciosa (Blume) D. Dietr.	Zingiberaceae	Hi	E	
Anacardium occidentale L.	Anacardiaceae	A	E	
Aptenia cordifolia (L. f.) Schwantes	Basellaceae	B	E	UICN invasive, such as Anredera cordifolia (vine, climber).
Arachis pintoi Krapov. & W.C. Greg.	Leguminosae-Papilionoideae	Hi	E	
Asparagus plumosus Baker	Asparagaceae	B	E	
Asystasia gangetica (L.) T. Anderson	Acanthaceae	Ab	E	UICN, Invasive
Bambusa vulgaris Schrad. ex J.C. Wendl.	Poaceae	Ab	E	UICN, invasive, already out of houses, invasive aggressive
Barleria cristata L.	Acanthaceae	Hi	E	Already out of houses
Bauhinia monandra Kurz	Leguminosae-Caesalpinoideae	A	E	
Bougainvillea × buttiana Holttum & Standl.	Nyctaginaceae	B	E	
Bougainvillea glabra Choisy	Nyctaginaceae	B	E	
Brasiliopuntia brasiliensis (Willd.) A. Berger	Cactaceae	A	E	
Brugmansia × candida Pers.	Solanaceae	A	E	Already out of houses
Brugmansia suaveolens (Humb. & Bonpl. ex Willd.) Bercht. & C. Presl	Solanaceae	A	E	Already out of houses, but does not reproduce through seeds.
Brunfelsia latifolia Benth.	Solanaceae	Ab	E	
Callisia fragrans (Lindl.) Woodson	Commelinaceae	Hi	E	Aggressive invasive
Callitropsis lusitanica (Mill.) D.P. Little	Cupressaceae	A	E	
Canna indica L.	Cannaceae	Hi	E	UICN, Invasive
Castilla elastica Sessé ex Cerv.	Moraceae	A	N	UICN, Invasive
Casuarina equisetifolia L.	Casuarinaceae	A	E	UICN, invasive, already out of houses
Catharanthus roseus (L.) G. Don	Apocynaceae	Hi	E	
Cedrela odorata L.	Meliaceae	A	N	UICN, Invasive

Species	Family	Habit	Origin	State of Conservation
Cestrum nocturnum L.	Solanaceae	A	N	UICN, Invasive
Chlorophytum comosum (Thunb.) Jacques	Anthericaceae	Hi	E	
Chrysothemis pulchella (Donn) Decne.	Gesneriaceae	Hi	E	
Citrus × *aurantiifolia* (Christm.) Swingle	Rutaceae	A	E	Already out of houses
Citrus × *sinensis* (L.) Osbeck	Rutaceae	A	E	
Citrus aurantium L.	Rutaceae	A	E	
Citrus nobilis var. *deliciosa* (Ten.) Swingle	Rutaceae	A	E	
Cleome rutidosperma DC.	Capparaceae	Hi	E	Already out of houses
Codiaeum variegatum (L.) Rumph. ex A. Juss.	Euphorbiaceae	A	E	
Coffea arabica L.	Rubiaceae	Ab	E	
Coleus Beckswith's Gem	Lamiaceae	Hi	E	Already out of houses
Coleus Grape Expectations	Lamiaceae	Hi	E	
Cordyline fruticosa (L.) A. Chev.	Agavaceae	Ab	E	
Crinum jagus (Thompson) Dandy	Amaryllidaceae	Hi	E	
Crossandra infundibuliformis (L.) Nees	Acanthaceae	Hi	E	
Croton reflexifolius Kunth	Euphorbiaceae	A	E	
Cynodon dactylon (L.) Pers.	Poaceae	Hi	E	UICN, Invasive
Cyperus rotundus L.	Cyperaceae	Hi	N	UICN, Invasive
Dahlia hybrida	Asteraceae	Ab	E	
Dieffenbachia seguine (Jacq.) Schott	Araceae	Hi	E	
Dombeya wallichii (Lindl.) Benth & Hook. ex B.D. Jackson	Sterculiaceae	A	E	
Dracaena fragrans var. *massangeana* (Rodigas) E. Morren	Dracaenaceae	A	E	
Dypsis lutescens (H. Wendl.) Beentje & J. Dransf.	Arecaceae	A	E	
Eleusine indica (L.) Gaertn.	Poaceae	Hi	E	Already out of houses, invasive aggressive
Emilia fosbergii Nicolson	Asteraceae	Hi	E	Already out of houses, invasive aggressive
Epiphyllum pumilum Britton & Rose	Cactaceae	Hi	E	
Eriobotrya japonica (Thunb.) Lindl.	Rosaceae	A	E	UICN, Invasive
Erythrina poeppigiana (Walp.) O.F. Cook	Leguminosae-Papilionoideae	A	E	Already out of houses, invasive aggressive
Eucalyptus camaldulensis Dehnh.	Myrtaceae	A	E	Already out of houses
Eucalyptus deglupta Blume	Myrtaceae	A	E	Already out of houses
Ficus microcarpa L. f.	Moraceae	A	E	UICN, Invasive
Gardenia jasminoides J. Ellis	Rubiaceae	Ab	E	
Grevillea robusta A. Cunn. ex R. Br.	Proteaceae	A	E	UICN, invasive, already out of houses
Heliconia rostrata Ruiz & Pav.	Heliconiaceae	Hi	E	
Hibiscus rosa-sinensis L.	Malvaceae	Ab	E	
Hippobroma longiflora (L.) G. Don	Campanulaceae	Hi	E	
Hydrangea macrophylla (Thunb.) Ser.	Hydrangeaceae	Ab	E	
Impatiens balsamina L.	Balsaminaceae	Hi	E	
Impatiens walleriana Hook. f.	Balsaminaceae	Hi	E	UICN, invasive, already out of houses, invasive aggressive
Ixora coccinea L.	Rubiaceae	Ab	E	
Jacaranda mimosifolia D. Don	Bignoniaceae	A	E	

Species	Family	Habit	Origin	State of Conservation
Justicia aurea Schltdl.	Acanthaceae	Ab	E	
Justicia betonica L.	Acanthaceae	Ab	E	
Kaempferia rotunda L.	Zingiberaceae	Hi	E	
Kalanchoe blossfeldiana Poelln.	Crassulaceae	Hi	E	
Kalanchoe pinnata (Lam.) Pers.	Crassulaceae	Hi	E	UICN, Invasive
Lantana camara L.	Verbenaceae	Ab	N	UICN, Invasive
Lepidium virginicum L.	Brassicaceae	Hi	N	UICN, Invasive
Lycianthes rantonnei (Carrière) Bitter	Solanaceae	Ab	E	
Lycopersicon esculentum Mill.	Solanaceae	Hi	E	
Macfadyena unguis-cati (L.) A.H. Gentry	Bignoniaceae	B	N	UICN, Invasive
Mangifera indica L.	Anacadiaceae	A	E	Already out of houses
Manihot esculenta Crantz	Euphorbiaceae	Ab	E	
Megaskepasma erythrochlamys Lindau	Acanthaceae	A	E	
Melicoccus bijugatus Jacq.	Sapindaceae	A	E	
Mikania micrantha Kunth	Asteraceae	B	N	UICN, Invasive, aggressive
Mimosa pigra L.	Leguminosae-Mimosoideae	Ab	N	UICN, Invasive
Mimosa pudica L.	Leguminosae-Mimosoideae	Hi	N	UICN, Invasive
Morinda citrifolia L.	Rubiaceae	A	E	
Mussaenda erythrophylla Schumach. & Thonn.	Rubiaceae	Ab	E	
Nerium oleander L.	Apocynaceae	Ab	E	
Odontonema callistachyum (Schltdl. & Cham.) Kuntze	Acanthaceae	Ab	E	
Oeceoclades maculata (Lindl.) Lindl.	Orchidaceae	Hi	E	UICN, invasive, already out of houses, invasive aggressive
Oxalis latifolia Kunth	Oxalidaceae	Hi	N	UICN, Invasive
Pachystachys lutea Nees	Acanthaceae	Hi	E	
Panicum maximum Jacq.	Poaceae	Hi	E	Already out of houses
Pentas lanceolata (Forssk.) Deflers	Rubiaceae	Ab	E	
Phyllanthus disticha fo. *nivosa* Croizat	Euphorbiaceae	Ab	E	
Pinus caribaea var. *hondurensis* (Sénécl.) W.H.G. Barrett & Golfari	Pinaceae	A	E	Already out of houses
Piper aduncum L.	Piperaceae	A	N	UICN, Invasive
Plantago major L.	Plantaginaceae	Hi	E	UICN, Invasive
Platycerium bifurcatum (Cav.) C. Chr.	Polypodiaceae	Hh	E	
Plectranthus amboinicus (Lour.) Spreng.	Lamiaceae	Hi	E	
Pluchea carolinensis (Jacq.) G. Don	Asteraceae	A	N	UICN, Invasive
Plumbago capensis Thunb.	Plumbaginaceae	Ab	E	
Polyscias balfouriana Bailey	Araliaceae	Ab	E	
Polyscias guilfoylei var. *victoriae* Bailey	Araliaceae	Ab	E	
Portulaca grandiflora Hook.	Portulacaceae	Hi	E	
Psidium guajava L.	Myrtaceae	A	N	UICN, Invasive
Punica granatum L.	Punicaceae	A	E	
Pyrostegia venusta (Ker Gawl.) Miers	Bignoniaceae	B	E	
Rhynchelytrum repens (Willd.) C.E. Hubb.	Poaceae	Hi	E	Already out of houses, invasive aggressive
Ricinus communis L.	Euphorbiaceae	A	E	UICN, Invasive

Species	Family	Habit	Origin	State of Conservation
Rubus niveus Thunb.	Rosaceae	Ab	E	UICN, invasive, already out of houses
Salvia vista red	Lamiaceae	Hi	E	
Samanea saman (Jacq.) Merr.	Leguminosae-Mimosoideae	A	N	UICN, Invasive
Sansevieria trifasciata Prain var. *trisfasciata*	Dracaenaceae	Hi	E	Already out of houses, invasive aggressive
Sechium edule (Jacq.) Sw.	Cucurbitaceae	B	N	UICN, Invasive
Solanum pseudocapsicum L.	Solanaceae	B	E	
Solanum torvum Sw.	Solanaceae	Hi	N	UICN, Invasive
Solanum wendlandii Hook. f.	Solanaceae	Hi	E	
Spathiphyllum wallisii Regel	Araceae	Hi	E	
Spathodea campanulata P. Beauv.	Bignoniaceae	A	E	UICN, Invasive
Sphagneticola trilobata (L.) Pruski	Asteraceae	Hi	E	UICN, invasive, already out of houses, invasive aggressive
Synadenium grantii Hook. F.	Euphorbiaceae	A	E	
Syzygium cumini (L.) Skeels	Myrtaceae	A	E	UICN, invasive, already out of houses
Syzygium jambos (L.) Alston	Myrtaceae	A	E	UICN, invasive, already out of houses, invasive aggressive
Syzygium malaccense (L.) Merr. & L.M. Perry	Myrtaceae	A	E	
Tecoma stans L.	Bignoniaceae	A	N	UICN, Invasive
Tectona grandis L. f.	Lamiaceae	A	E	
Terminalia catappa L.	Combretaceae	A	E	UICN, Invasive
Thunbergia alata Bojer ex Sims	Acanthaceae	B	E	Already out of houses
Thunbergia fragrans Roxb.	Acanthaceae	B	E	Already out of houses
Thunbergia grandiflora Roxb.	Acanthaceae	B	E	UICN, Invasive
Urochloa decumbens (Stapf) R.D. Webster	Poaceae	Hi	E	
Veitchia merrillii (Becc.) H.E. Moore	Arecaceae	Ab	E	
Xanthosoma violaceum Schott	Araceae	Hi	E	
Yucca guatemalensis Baker	Agavaceae	A	E	
Zea mays L.	Poaceae	Hi	E	
Zingiber officinale Roscoe	Zingiberaceae	Hi	E	

Habit: A = Tree, Ab = Shrub, B = Vine, Hh = Fern, Hi = Herb Origin: E = Exotic, N = Native

MAIN INVASIVE SPECIES

The total of all exotic and invasive species is summarized in Table 2.

Most of the tree species or exotic origin grown in the area do not become an ecologic problem in commercially exploited coffee plantations, since they are subject to periodic trimming or eradication of unneeded trees or their offshoot are eliminated during routine weeding.

Table 2. List of exotic and invasive species.

Species	Family	Habit	Origin	State of Conservation
Ficus microcarpa L. f.	Moraceae	A	E	Is not in UICN. Invasive aggressive
Eriobotrya japonica (Thunb.) Lindl.	Rosaceae	A	E	UICN
Ricinus communis L.	Euphorbiaceae	A	E	UICN
Spathodea campanulata P. Beauv.	Bignoniaceae	A	E	UICN
Terminalia catappa L.	Combretaceae	A	E	UICN
Castilla elastica Sessé ex Cerv.	Moraceae	A	N	UICN
Cedrela odorata L.	Meliaceae	A	N	UICN
Cestrum nocturnum L.	Solanaceae	A	N	UICN
Piper aduncum L.	Piperaceae	A	N	UICN
Pluchea carolinensis (Jacq.) G. Don	Asteraceae	A	N	UICN
Psidium guajava L.	Myrtaceae	A	N	UICN
Samanea saman (Jacq.) Merr.	Leguminosae-Mimosoideae	A	N	UICN
Tecoma stans L.	Bignoniaceae	A	N	UICN
Casuarina equisetifolia L.	Casuarinaceae	A	E	UICN, already out of houses
Grevillea robusta A. Cunn. ex R. Br.	Proteaceae	A	E	UICN, already out of houses
Syzygium cumini (L.) Skeels	Myrtaceae	A	E	UICN, already out of houses
Syzygium jambos (L.) Alston	Myrtaceae	A	E	UICN, already out of houses, invasive aggressive
Brugmansia × candida Pers.	Solanaceae	A	E	Is not in UICN. Already out of houses
Citrus × aurantiifolia (Christm.) Swingle	Rutaceae	A	E	Is not in UICN. Already out of houses
Eucalyptus camaldulensis Dehnh.	Myrtaceae	A	E	Is not in UICN. Already out of houses
Eucalyptus deglupta Blume	Myrtaceae	A	E	Is not in UICN. Already out of houses
Mangifera indica L.	Anacadiaceae	A	E	Is not in UICN. Already out of houses
Pinus caribaea var. *hondurensis* (Sénécl.) W.H.G. Barrett & Golfari	Pinaceae	A	E	Is not in UICN. Already out of houses
Erythrina poeppigiana (Walp.) O.F. Cook	Leguminosae-Papilionoideae	A	E	Is not in UICN. Already out of houses. Invasive aggressive
Brugmansia suaveolens (Humb. & Bonpl. ex Willd.) Bercht. & C. Presl	Solanaceae	A	E	Is not in UICN. Already out of houses, but does not reproduce through seeds.
Asystasia gangetica (L.) T. Anderson	Acanthaceae	Ab	E	UICN
Lantana camara L.	Verbenaceae	Ab	N	UICN
Mimosa pigra L.	Leguminosae-Mimosoideae	Ab	N	UICN
Rubus niveus Thunb.	Rosaceae	Ab	E	UICN, already out of houses
Bambusa vulgaris Schrad. ex J.C. Wendl.	Poaceae	Ab	E	UICN, already out of houses, invasive aggressive
Aptenia cordifolia (L. f.) Schwantes	Basellaceae	B	E	UICN [like Anredera cordifolia]

Species	Family	Habit	Origin	State of Conservation
Thunbergia grandiflora Roxb.	Acanthaceae	B	E	UICN
Macfadyena unguis-cati (L.) A.H. Gentry	Bignoniaceae	B	N	UICN
Sechium edule (Jacq.) Sw.	Cucurbitaceae	B	N	UICN
Mikania micrantha Kunth	Asteraceae	B	N	UICN, aggressive invasive
Thunbergia alata Bojer ex Sims	Acanthaceae	B	E	Is not in UICN. Already out of houses
Thunbergia fragrans Roxb.	Acanthaceae	B	E	Is not in UICN. Already out of houses
Callisia fragrans (Lindl.) Woodson	Commelinaceae	Hi	E	Is not in UICN. Invasive aggressive
Canna indica L.	Cannaceae	Hi	E	UICN
Cynodon dactylon (L.) Pers.	Poaceae	Hi	E	UICN
Kalanchoe pinnata (Lam.) Pers.	Crassulaceae	Hi	E	UICN
Plantago major L.	Plantaginaceae	Hi	E	UICN
Ageratum conyzoides L.	Asteraceae	Hi	N	UICN
Cyperus rotundus L.	Cyperaceae	Hi	N	UICN
Lepidium virginicum L.	Brassicaceae	Hi	N	UICN
Mimosa pudica L.	Leguminosae-Mimosoideae	Hi	N	UICN
Oxalis latifolia Kunth	Oxalidaceae	Hi	N	UICN
Solanum torvum Sw.	Solanaceae	Hi	N	UICN
Impatiens walleriana Hook. f.	Balsaminaceae	Hi	E	UICN, already out of houses, invasive aggressive
Oeceoclades maculata (Lindl.) Lindl.	Orchidaceae	Hi	E	UICN, already out of houses, invasive aggressive
Sphagneticola trilobata (L.) Pruski	Asteraceae	Hi	E	UICN, already out of houses, invasive aggressive
Barleria cristata L.	Acanthaceae	Hi	E	Is not in UICN. Already out of houses
Cleome rutidosperma DC.	Capparaceae	Hi	E	Is not in UICN. Already out of houses
Coleus Beckswith's Gem	Lamiaceae	Hi	E	Is not in UICN. Already out of houses
Panicum maximum Jacq.	Poaceae	Hi	E	Is not in UICN. Already out of houses
Eleusine indica (L.) Gaertn.	Poaceae	Hi	E	Is not in UICN. Already out of houses. Invasive aggressive
Emilia fosbergii Nicolson	Asteraceae	Hi	E	Is not in UICN. Already out of houses. Invasive aggressive
Rhynchelytrum repens (Willd.) C.E. Hubb.	Poaceae	Hi	E	Is not in UICN. Already out of houses. Invasive aggressive
Sansevieria trifasciata Prain var. *trisfasciata*	Dracaenaceae	Hi	E	Is not in UICN. Already out of houses. Invasive aggressive

Habit: A = Tree, Ab = Shrub, B = Vine, Hh = Fern, Hi = Herb Origin: E = Exotic, N = Native

The following is a brief description of the main invasive plants. The list shows plants listed as invasive in the UICN list:

Ageratum conyzoides L.

Ageratum conyzoides is a weed distributed in many tropical and subtropical countries and is often difficult to control. It is an established weed in the Himalayas where several invasion research studies have been conducted in the Shiwalik Ranges. It has been found that Ageratum significantly reduces total biomass and species number, that is, biodiversity. It also changes vegetation community structure and modifies the soil regime. El Salvador is within its range of natural distribution and the aforementioned effect has not been observed.

Aptenia cordifolia (L. f.) Schwantes

Cited as *Anredera cordifolia*, in the UICN listing, commonly known as Madeira vine is a succulent climbing vine. The combination of fleshy leaves and thick aerial tubers makes this a very heavy vine. It smothers trees and other vegetation on wich it grows and can easily can break branches and bring down entire trees on its own. A. cordifolia is notoriously difficult to control.

Asystasia gangetica (L.) T. Anderson

Asystasia gangetica is an ornamental herb native to India, Malaysia and Africa. With its ability to reproduce by vegetative propagation and form dense vegetation mats, this species can be highly invasive. It can smother any vegetation with its herbaceous layer. Its introduction to the Pacific Islands has caused major disruptions in native ecosystems.

Bambusa vulgaris Schrad. ex J.C. Wendl.

Bambusa vulgaris is the most widespread member of its genus, and has long been cultivated across the tropics and subtropics. It prefers lowland humid habitats, but tolerates a wide range of climatic conditions and soil types. It commonly naturalises, forming monospecific stands along river banks, roadsides and open ground.

Canna indica L.

Is a native of tropical America and is a very popular ornamental plant throughout the tropical world. This plant has become invasive in the Pitcairn Islands and New Zealand, where it grows in thickets, crowding out other plants. It is spread by rhizomes making it difficult to remove.

Castilla elastica Sessé ex Cerv.

Castilla elastica is a native Central American tree which may reach 5 to 10m high. Rubber can be extracted from the tree. It is invasive in several islands, notably in the Pacific (French Polynesia and Samoa).

Casuarina equisetifolia L.

Casuarina equisetifolia is an evergreen conifer-like angiosperm. It has been introduced to new locations for coastal landscaping and erosion control. It has become invasive in Florida (USA) and other parts. It interferes with prime reptile (turtle) nesting sites in USA and forms monocultures that degrade the native habitats in the Cayman Islands, where it is also usurping protected areas.

Cedrela odorata L.

Cedrela odorata is native to the West Indies, Central America and South America, including the atlantic forests and rainforests of Brazil. It has been introduced to many Pacific Islands and South Africa. This fast growing timber tree has become invasive in some areas, especially those disturbed by cutting.

Cestrum nocturnum L.

Cestrum nocturnum is a perennial woody shrub that can reach up to 4 m. Native to the American tropics, it was introduced as ornamental in many tropical and subtropical regions of the world. It has become widely naturalized and is at times invasive in places where it forms dense, impenetrable thickets that limit the regeneration of native species. All parts of this plant are poisonous.

Cynodon dactylon (L.) Pers.

This plant is a pasture or grass adapted to survive both extended dry periods and flooding conditions. It is a potential agricultural weed and a commonly used as a lawn grass.

Cyperus rotundus L.

Cyperus rotundus (purple nutsedge) is a weed in over 90 countries and the world's worst invasive weed based on its distribution and effect on crops. Its complex underground network of tubers, basal bulbs, roots and rhizomes ensure its ability to survive and reproduce during adverse conditions. Further biological features, such as its adaptation to high temperatures, solar radiation and humidity, have turned this weed into a serious problem in subtropical and even arid regions.

Eleusine indica (L.) Gaertn.

Is native to Asia, but has dispersed all over the world. Commonly known as crowfootgrass is a very invasive species. It is of yearly growth, but due to its high production of seeds and the fact that birds eat them and disperse them, it can become a problem especially in open areas such as roads and edges of forests. It is a common weed in many places of the country.

Emilia fosbergii Nicolson

The common name in the U.S. is Florida Tasselflower. It is a relatively striking flower and very abundant in sunny places such as edges of plantations, pastures, roads, and disturbed sites in general. It is native to Asia, from where it was introduced to the tropics and subtropics of the world. In the influence area of the Project it has been seen only by the side of roads. As all species of the Asteraceae family, it produces large quantities of seeds that are dispersed by the wind.

Eriobotrya japonica (Thunb.) Lindl.

Has been introduced to warm regions as a fruit or ornamental tree. In various Pacific islands and La Réunion, it can be very invasive in natural environments.

Erythrina poeppigiana (Walp.) O.F. Cook

Erythrina poeppigiana is a native tree of Venezuela and Bolivia. Because of its intense flowering and capacity to enhance the soils through the fixation of nitrogen, it has been very popular as a shade tree in coffee plantations and others. Nevertheless, in the case of the Project area it has been seen growing unchecked, especially in open areas filled with rocks or construction material debris. In coffee plantations it is present in open areas.

Ficus microcarpa L. f.

Ficus microcarpa is a woody plant species that occasionally becomes a tree. It is native to the Asia-Pacific region. Commonly known as Chinese banyan and the curtain fig, it is a popular ornamental tree that grows in tropical and temperate regions of the world. *F. microcarpa* has small, tiny seeds that are easily spread by birds, bats and rodents, and which are capable of germinating almost anywhere they land - even in cracks in concrete. *F. microcarpa* is considered to be a major invasive species in Hawaii, the Bonin (Ogasawara) Islands, Florida, Bermuda and Central down to South America.

Grevillea robusta A. Cunn. ex R. Br.

Grevillea robusta is a tree that can reach 12 metres in height. It adapts to different ecological conditions and is found between 500 and 2000m altitude where annual rainfall ranges from 800 to 1500mm. Widely planted in warm temperate, subtropical or tropical regions for shade or agroforestry, Grevillea robusta has naturalised and become invasive in several countries (Hawaii, Australia, Mauritius, the Caribbean, Brazil and French Polynesia). Its leaves produce an allelopathic substance which inhibits the establishment and development of other species.

Impatiens walleriana Hook. f.

Impatiens walleriana is a herb from Africa. It has been introduced to many countries as an ornamental but has escaped from gardens and naturalised. *Impatiens walleriana* can be very invasive where it is dominant or co-dominant in natural or semi-natural environments.

Kalanchoe pinnata (Lam.) Pers.

Is a succulent plant which has been introduced to many temperate and tropical regions of the world as ornamental. In several of these regions, the species is widely naturalised and regarded as invasive. It forms dense stands in dry and disturbed areas. In French Polynesia, *Kalanchoe pinnata* has been declared a threat to biodiversity.

Lantana camara L.

Lantana camara is a significant weed of which there are some 650 varieties in over 60 countries. It is established and expanding in many regions of the world, often as a result of clearing of forest for timber or agriculture. It impacts severely on agriculture as well as on natural ecosystems. The plants can grow individually in clumps or as dense thickets, crowding out more desirable species. In disturbed native forests it can become the dominant understorey species, disrupting succession and decreasing biodiversity. At some sites, infestations have been so persistent that they have completely stalled the regeneration of rainforest for three decades. Its allelopathic qualities can reduce vigour of nearby plant species and reduce productivity in orchards. *Lantana camara* has been the focus of biological control attempts for a century, yet still poses major problems in many regions.

Lepidium virginicum L.

Lepidium virginicum is a weed of agronomic, vegetable, orchard, and nursery crops. It is reported to have naturalised on disturbed sites in Hawaii and the western United States, and spreading rapidly on Grand Cayman.

Macfadyena unguis-cati (L.) A.H. Gentry

Macfadyena unguis-cati is a perennial, climbing liana found primarily in tropical forests. It is native to Central America and the West Indies, but is now present on all continents except Antarctica. It is an invasive species in much of its range and is said to be “one of the most destructive exotic vines”. *Macfadyena unguis-cati* affects all layers of infected forest ecosystems by rapidly spreading both vertically and horizontally across everything with which it makes contact, overwhelming both the understorey plants and the canopy trees. *Macfadyena unguis-cati* species becomes established quickly and is difficult to eliminate due to its rapid growth, extensive root system, and prolific seed production.

Mikania micrantha Kunth

Mikania micrantha is a perennial creeping climber known for its vigorous and rampant growth. It grows best where fertility, organic matter, soil moisture and humidity are all high. It damages or kills other plants by cutting out the light and smothering them. A native of Central and South America, *Mikania micrantha* was introduced to India after the Second World War to camouflage airfields and is now a major weed. It is also one of the most widespread and problematic weeds in the Pacific region. Its seeds are dispersed by wind and also on clothing or hair.

Mimosa pigra L.

Mimosa pigra is invasive, especially in parts of South East Asia and Australia. It reproduces via buoyant seed pods that can be spread long distances in flood waters. *Mimosa pigra* has the potential to spread through natural grassland floodplain ecosystems and pastures, converting them into unproductive scrubland which are only able to sustain lower levels of biodiversity. In Thailand *Mimosa pigra* blocks irrigation systems that supply rice fields, reducing crop yield and harming farming livelihoods. In Vietnam it has invaded unique ecosystems in protected areas, threatening the biodiversity of seasonally inundated grasslands.

Mimosa pudica L.

Mimosa pudica is native to South America, but has become a pan-tropical weed. It was introduced to many countries as an ornamental plant and is still widely available for sale. *Mimosa pudica* has become a pest in forest plantations, cropland, orchards and pasture. *Mimosa pudica* is used as a medicinal plant in many regions.

Oeceoclades maculata (Lindl.) Lindl.

Oeceoclades maculata is a terrestrial orchid which probably originated in Africa. Of recent introduction to the French Antilles and Florida, it is a species with invasive behaviour. *Oeceoclades maculata* self-fertilising mode of reproduction is a factor that assists its spread.

Oxalis latifolia Kunth

Oxalis latifolia is a perennial herb native to North, Central and South America. It mainly reproduces vegetatively, via bulbils and bulbs, and commonly grows in gardens, cultivated areas, orchards, crop fields and nurseries. *Oxalis latifolia* is now found worldwide and is known to be invasive in the following areas: Australia, Galapagos Islands, Indonesia, Kermadec Islands, Mauritius, New Caledonia, New Zealand and Papua New Guinea. Despite its native status, it is also considered to be a weed in Guadeloupe, Mexico, Puerto Rico and the United States.

Piper aduncum L.

Piper aduncum is a shrub or small tree that is a native of the West Indies and mainland tropical America from Mexico to northern Argentina. It is an invader of disturbed areas, where it is able to form thickets and spreads by sprouts and suckers. *Piper aduncum* is a problem in some Pacific Islands, where it can interfere with the harvesting of the related kava plant (*Piper methysticum* G. Forst.). *Piper aduncum* has a number of uses, including traditional medicines and agroforestry.

Pluchea carolinensis (Jacq.) G. Don

Pluchea carolinensis is a shrub or small tree. It usually occurs in open and disturbed areas, such as roadsides and pastures. This fast-growing shrub can form dense stands in dry habitats. It can compete with fodder plants in pasture and with native plants in natural areas. It can be very invasive in coastal areas on limestone substrates as is the case in French Polynesia. This shrub is now widespread in many Pacific islands where it is regarded as an aggressive weed.

Psidium guajava L.

Psidium guajava is a tropical tree or shrub. It is native to Central America from Mexico to northern South America. It has been introduced to most tropical and sub-tropical locations around the world for its edible fruit. In some countries the harvesting, processing and export of the fruit forms the basis of a sizeable industry. Due in part to its ability to grow on a variety of soils and across a range of climates, *P. guajava* has become invasive . Pastures and fields are overrun and native plants are outcompeted by this species, which has the ability to form dense thickets. This has led to its designation in many areas as a noxious weed to be controlled or eradicated. It is ranked by some authorities amongst the highest invasive categories.

Rhynchelytrum repens (Willd.) C.E. Hubb.

Rhynchelytrum repens is a pasture native of South Africa, but widely distributed in the tropical and subtropical regions. It was initially imported as fodder, but it lacks the nutritional qualities of other forms of pasture, and it soon became an aggressive weed in many places. It thrives in dry conditions and is abundant in unused land or neglected pastures and, in some places, it can displace the native vegetation and prevent its regeneration.

Ricinus communis L.

Ricinus communis is a perennial shrub that can assume tree-like status if it establishes in a suitable climate. It is frequently found invading riparian areas where it displaces native vegetation. The seed of this species is toxic to variety of species including humans. Consuming only a few seeds can be fatal. In January of 2003, people tied to Al Qaeda were arrested in London accused of making ricin (ricinus compound) and in February of 2008, a man was poisoned in Las Vegas. Given the growing threat of mass destruction weapons in the United States, doctos have been familiarizing themselves with the treatment of poisoning with substances such as ricin.

Rubus niveus Thunb.

Rubus niveus is a shrub native to Asia that may form dense, impenetrable, thorny thickets that can displace native species. It produces sweet, palatable fruit enjoyed by birds, rodents, reptiles and humans and has been cultivated in many regions throughout the world for this reason. It is also used as a living fence. Mechanical management of the species is difficult due to its growth form and persistent seedbank, but chemical methods have been developed and biological means of management are being explored.

Samanea saman (Jacq.) Merr.

Samanea saman is a leguminous tree which can easily reach a height of 25 metres. It has been distributed around the world, mostly in tropical climates and has become naturalised in many countries. *Samanea saman* is valued for its many uses, the primary ones being shade, timber and animal fodder. *Samanea saman* has become invasive in Fiji, where it can dominate areas of vegetation and is able to invade native forest ecosystems, as found in Hawaii.

Sansevieria trifasciata Prain var. *trifasciata*

It is native to Africa, where it was introduced to control erosion, as a live fence in coffee plantations. It is also used as an ornamental indoor plant and hedging.

Sechium edule (Jacq.) Sw.

Sechium edule is a perennial from the Cucurbitaceae family. It is cultivated in the tropics for its fruit which are edible when ripe. The plant has climbing stems several metres in length. It can escape from gardens and become naturalized. It is considered invasive in New Caledonia.

Solanum torvum Sw. Solanaceae

Solanum torvum is considered a weed in the tropics. Often found in disturbed areas, it can form dense impenetrable stands. *Solanum torvum* is considered to be a serious threat to the productivity and sustainability of pasture. Besides its economic impacts, it competes with native species.

Spathodea campanulata P. Beauv.

The African tulip tree (*Spathodea campanulata*) is an evergreen tree native to West Africa. It has been introduced throughout the tropics and has naturalized in many parts of the Pacific. It favors moist habitats and will grow best in sheltered tropical areas. It is invasive in Hawaii, Fiji, Guam, Vanuatu, the Cook Islands and Samoa, and is a potential invader in several other tropical locations. The author has already seen it propagating in forests in the western part of the country and it as been noticed that it aggressively grows in the park.

Sphagneticola trilobata (L.) Pruski

This species is widely known as Wedelia trilobata, its former name and now botanical synonym. In fact, in some places its common name is Wedelia. In some places it is cultivated as coverage since it forms very dense ground cover. Its leaves are dark-green and contrast with the yellow of the inflorescences. It readily escapes from gardens and because of its dense growth, it can impede the growth of many species.

Syzygium cumini (L.) Skeels

Syzygium cumini has been introduced in many different places to populate plazas, parks, gardens, and avenues. It is important as an ornamental plant and it can be used as timber. Some people eat its fruits as well, but some are very astringent. Nonetheless, it can form very dense stands that prevent the development of other species. Because of this, it has been reported as invasive in Hawaii, where it is said that it has prevented the natural repopulation or regeneration of the forests (UICN 2010).

Syzygium jambos (L.) Alston

Is indigenous to the Malay Archipelago and has been introduced in the tropics of the entire world. Given its ample presence since a long time ago, it is difficult to convince people in the area about the origin of this plant. It is likely that its growth will hinder the development of the native flora.

Tecoma stans L.

Tecoma stans is a South American tree which has been introduced to other tropical and subtropical regions (Indian Ocean, Pacific, Australia) as an ornamental. Tecoma stans prefers dry and disturbed areas such as roadsides but it can also be found in relatively undisturbed forests. It can develop dense, almost monospecific thickets and restrict the regeneration of native species.

Terminalia catappa L.

Terminalia catappa is a native plant of Asia that has escaped from cultivation. Due to its ability to cope with sandy, well draining soil, and salt spray it is often found on coastal regions. It is considered invasive in Florida, United States, and several Caribbean Islands, including Montserrat, Puerto Rico and the Cayman Islands. Its seeds are highly bouyant which allows it disperse vast distances however they are highly edible so are eaten by bats, crabs and humans. However despite its potential as being an invasive species it is being considered for multiple applications. Due to its extensive and deep-rooting structure it is considered a possible species to use as a dune retention species against proposed climate change and sea-level rise, and in Brazil it is also being considered a potential cultivar to use in bio-fuel creation.

Thunbergia grandiflora Roxb.

Thunbergia grandiflora is a climbing vine native to Asia which is able to smother native vegetation. Introduced and cultivated in many regions as an ornamental, it has become a widespread invasive plant. It invades pastures and roadsides forming impenetrable stands and is a major threat to remnants of tropical forests fragmented by agriculture and urbanisation. It is one of the most problematic invasive plants in Australia. It can cover 100% of the ground over several hectares, excluding all native plants.

Threatened species

Although the access right of way strip is used up almost entirely by a coffee plantation in which most usual practices are no longer being applied, it still conserves some significant biodiversity, most notably, a considerable number of tree and shrub species. The total number of tree species reaches 151, of which 113 are native and 38 exotic. Of this total, at least four species (Table 3) are classified as globally threatened, according to UICN (2016).

Table 3. Species of importance for conservation found in the design path of the Project.

Species	Category	Family	Habit
Eugenia salamensis var. *rensoniana* (Standl.) McVaugh	EN	Myrtaceae	Tree
Juglans olanchana Standl. & L.O. Williams	EN	Juglandaceae	Tree
Quercus skinneri Benth.	VU	Fagaceae	Tree
Cedrela odorata L.	VU	Meliaceae	Tree

The abbreviation for each category corresponds to the Enlish nomenclature. **EN**: (endangered); **VU:** (vulnerable), According to: **(UICN)**

Floristic-structural analysis Methods of

Analysis

After the field work, with the circumference measurements, the structural analysis was conducted to obtain the Importance Value Indices (IVI’s) for all of the

Species of the four transects. The following values were calculated for the IVI's: Dominance, abundance, and frequency.

Importance value index (IVI)

It is a parameter that estimates the ecological contribution or significance of each species in the community. The maximum value is 300%. The closest a species gets to this value, the greater its ecological importance and floristic dominance will be over the other species present and it is equal to the sum of dominance, abundance, and frequency.

The IVI data for all species found in the parcels are summarized in Table 4.

Table 4. Importance Value Indices of the most representative tree species (according to IVI results) present in the structural flosristic analysis parcels.

Species	Family	Circumference (cm)	Total basal area	Relative basal area	Abundance	Relative abundance	Frequency	Relative frequency	IVI
Inga vera	Leguminosae-Mimosoideae	63	27057.30	30.73	33.00	27.73	0.75	18.99	77.45
Inga punctata	Leguminosae-Mimosoideae	107	14659.64	16.65	20.00	16.81	0.50	12.66	46.12
Inga oerstediana	Leguminosae-Mimosoideae	91	9506.90	10.80	11.00	9.24	0.35	8.86	28.90
Persea americana	Lauraceae	159	6615.35	7.51	3.00	2.52	0.15	3.80	13.83
Trophis racemosa	Moraceae	44	1754.07	1.99	7.00	5.88	0.20	5.06	12.94
Dendropanax arboreus	Araliaceae	245	5713.44	6.49	2.00	1.68	0.10	2.53	10.70
Crudia acuminata Benth.	Leguminosae-Caesalpinoideae	182	5045.21	5.73	2.00	1.68	0.10	2.53	9.94
Syzygium jambos	Myrtaceae	32	2348.21	2.67	4.00	3.36	0.15	3.80	9.83
Gliricidia sepium	Leguminosae-Papilionoideae	115	3675.70	4.17	3.00	2.52	0.10	2.53	9.23
Trichilia havanensis	Meliaceae	40	648.40	0.74	4.00	3.36	0.15	3.80	7.90
Zanthoxylum kellermanii	Rutaceae	161	2866.48	3.26	2.00	1.68	0.10	2.53	7.47
Nectandra martinicensis	Lauraceae	95	945.08	1.07	3.00	2.52	0.15	3.80	7.39
Psidium guajava	Myrtaceae	54	698.37	0.79	3.00	2.52	0.15	3.80	7.11
Mangifera indica	Anacardiaceae	61	668.87	0.76	3.00	2.52	0.15	3.80	7.08

Species	Family	Circumference (cm)	Total basal area	Basa l area	Abundance	Relative abundanc	Frequency	Relative frequenc	IVI
Tabebuia rosea	Bignoniaceae	32	530.34	0.60	3.00	2.52	0.10	2.53	5.66
Eremosis triflosculosa subsp. Triflosculosa	Asteraceae	32	387.38	0.44	2.00	1.68	0.10	2.53	4.65
Sideroxylon capiri subsp. tempisque	Sapotaceae	141	1582.08	1.80	1.00	0.84	0.05	1.27	3.90
Spondias purpurea	Anacardiaceae	36	181.77	0.21	2.00	1.68	0.05	1.27	3.15
Cecropia obtusifolia.	Cecropiaceae	101	811.77	0.92	1.00	0.84	0.05	1.27	3.03
Licania platypus	Chrysobalanaceae	100	795.77	0.90	1.00	0.84	0.05	1.27	3.01
Vernonia patens	Asteraceae	69	378.87	0.43	1.00	0.84	0.05	1.27	2.54
Sapindus saponaria	Sapindaceae	65	336.21	0.38	1.00	0.84	0.05	1.27	2.49
Calophyllum brasiliense var. rekoi	Clusiaceae	51	206.98	0.24	1.00	0.84	0.05	1.27	2.34
Quercus skinneri	Fagaceae	45	157.58	0.18	1.00	0.84	0.05	1.27	2.29
Cedrela odorata	Meliaceae	38	111.91	0.13	1.00	0.84	0.05	1.27	2.23
Castilla elastica	Moraceae	37	108.94	0.12	1.00	0.84	0.05	1.27	2.23
Cordia alliodora	Boraginaceae	33	86.66	0.10	1.00	0.84	0.05	1.27	2.20
Croton reflexifolius	Euphorbiaceae	33	84.05	0.10	1.00	0.84	0.05	1.27	2.20
Lycianthes heteroclita	Solanaceae	32	81.49	0.09	1.00	0.84	0.05	1.27	2.20
			88044.85	100.00	119.00	100.00	3.95	100.00	300.00

As can be observed in the above table, over half of the IVI, that is the ecologic weight of the species, is represented only by three species: *pepeto* (*Inga vera*), *cuje* or *Guamito* (*Inga punctata*), and *cujinicuil* (*Inga oerstediana*). Although all three are native to the country, they are grown in the area with the purpose of providing shade for the coffee plants and to contribute to the improvement of the soil through the fixation of nitrogen.

Table 5. Estimated number of trees to be felled, by species.

Specie	Family	IUCN status *	El Salvador status**	Number of trees
Inga vera	Leguminosae-Mimosoideae			998
Inga punctata	Leguminosae-Mimosoideae			604
Inga oerstediana	Leguminosae-Mimosoideae			333
Trophis racemosa	Moraceae			212
Trichilia havanensis	Meliaceae			123
Syzygium jambos	Myrtaceae			119
Mangifera indica	Anacardiaceae			94
Tabebuia rosea	Bignoniaceae			94
Persea americana	Lauraceae			91
Nectandra martinicensis	Lauraceae			90
Gliricidia sepium	Leguminosae-Papilionoideae			88
Psidium guajava	Myrtaceae			87
Spondias purpurea	Anacardiaceae			67
Dendropanax arboreus	Araliaceae			64
Eremosis triflosculosa	Asteraceae			61
Crudia acuminata Benth.	Leguminosae-Caesalpinoideae			58
Zanthoxylum kellermanii	Rutaceae			53
Sideroxylon capiri	Sapotaceae			41
Sapindus saponaria	Sapindaceae			40
Vernonia patens	Asteraceae			38
Cordia alliodora	Boraginaceae			36
Cecropia obtusifolia.	Cecropiaceae			33
Licania platypus	Chrysobalanaceae			31
Calophyllum brasiliense	Clusiaceae			30
Croton reflexifolius	Euphorbiaceae			28
Castilla elastica	Moraceae			25
Lycianthes heteroclita	Solanaceae			20
Cedrela odorata	Meliaceae	VU	A	16
Quercus skinneri	Fagaceae	VU	A	15
Juglans olanchana	Juglandaceae	EN	EP	5
Eugenia salamensis	Myrtaceae	EN		5
			Total:	**3599**

** VU: vulnerable; EP: in danger*

*** A: Threatened; EP: In danger (according to the list of Agreement No. 74 of March 23, 2015)*

Table 5, after an overestimation of the area of logging affected by each of the towers, details the breakdown of trees to be cut by species. This is based on the counting and inventory of trees made by the surveying team. The table also details protected species based on IUCN Status and El Salvador Status.

Condition of the Coffee Plantation

As a result of the floristic analysis it was found that in 10 parcels that added up to 10,000 m^2 each (a total area of 1,000 m^2) the following parameters were found:

Number of coffee bushes per 1,000 m^2: 298
Number of coffee bushes per ha: 2979
Average diameter of the bushes (in cm): 7.96
Basal area in 1,000 m^2 (in m^2): 1.72189
Basal area in 1 ha (in m^2): 17.2189

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Appendix B

Land Fauna Report, Transmission Line Energía del Pacifico S.A. de C.V.

Presented by:
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MAY, 2016

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superciliosa; Cham: Chloroceryle americana; Aupr: Aulacorhynchus prasinus; Ptto: Pteroglossus torquatus; Meau: Melanerpes aurifrons; Chli: Melanerpes aurifrons; Pisu: Pitangus sulphuratus; Cafo: Calocitta Formosa; Riri: Riparia riparia; Caru: Campylorhynchus rufinucha; Tugr: Turdus grayi; Sepe: Setophaga petechia xantholora; Sema: Setophaga magnolia; Cycy: Cyanerpes cyaneus; Thab: Thraupis Abbas; Voja: Volatinia jacarina; Spto: Sporophila torqueola; Didi: Dives dives; Qume: Quiscalus mexicanus; Icgu: Icterus gularis; Euhi:Euphonia hirundinacea. 45
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SUMMARY

An inventory of the terrestrial fauna (amphibians, reptiles, mammals and birds) was carried out in the Area of influence of the project of Line of Transmission of Energia del Pacifico S.A. de C.V., located in the western zone of the country, in the departments of Ahuachapán and Sonsonate that comprised the months of May and June of 2016, corresponding to the rainy season. Samplings were carried out in the three habitats identified in the area of influence: agricultural areas in the lower zone, natural forest patches and the main shade coffee plantation. We worked on sampling transects in which an intensive search of amphibians and reptiles was carried out, these were used for the registration of mammalian species and for the case of birds were mounted observation points. A total of 15 species of herpetofauna, 14 species of mammals and 39 species of birds were registered. During the study, no new species were recorded for the departments of Ahuachapán and Sonsonate. It is estimated the occurrence of between 15 and 18 of additional species to those found, which have been recorded in similar habitats outside the study area or are widely distributed in the country. The fauna inventory in the Area is considered 60% to be completed. Of the species registered in the Area, six are of particular interest for conservation: the Black-Eyed Tree Frog *Agalychnis moreletii*, critically Endangered species worldwide; Gavilan zancudo *Geranospiza caerulescens,* Endangered species at national level; Parakeet chocoyo *Eupsittula canicularis;* Parakeet catalnica *Brotogeris jugularis*; Toledo *chiroxiphia linearis* and the Tucaneta green *Aulacorhynchus prasinus*. The last four species in threatened status at the national level.

INTRODUCTION

The study focused on evaluating the species of fauna occurring along the trace of the Energia del Pacífico transmission line. Therefore, the areas of major importance for biodiversity were identified and the impact will be greater.

So, our effort was focused on the mountain range of Apaneca because it is a coffee area presents good conditions to accommodate a large diversity of species important for conservation.

The area is mostly occupied by coffee plantations, and there are several publications documenting the importance of these agroforestry systems in Latin America. Although the group most studied has been that of birds, studies have also been carried out of other taxonomic groups in coffee plantations in the western zone of the country.

Due to the aforementioned, this study is of vital importance to know the current state of the faunal species present in the area of influence of the project since the information collected will support the development of priority activities for the conservation, protection, monitoring and maintenance of the Area, and thus minimize the impact.

OBJECTIVES

General objective

To determine the species of terrestrial fauna (amphibians, reptiles, mammals and birds) occurring in the area of influence of the *Transmission Line Project of Energía del Pacífico S.A. de C.V.*

Specific objectives

- Identify and quantify terrestrial fauna species in the different habitats in the area of influence of the *Transmission Line Project of Energía del Pacífico S.A. de C.V.*

- To analyze the diversity and richness of the different groups of terrestrial fauna evaluated in the present study.

- Detail the threatened and endangered species at national and international level.

- Define sites of importance for the conservation of threatened and endangered species.

MATERIALS AND METHODS

DESCRIPTION OF THE STUDY AREA

The study area comprises part of the western section of the Sierra de Apaneca in southwest of El Salvador, within the departments of Sonsonate, Ahuachapán. This area houses the largest coffee growing landscape in El Salvador, and contains some important patches of natural forest located between coffee plantations. See (Figure 1).

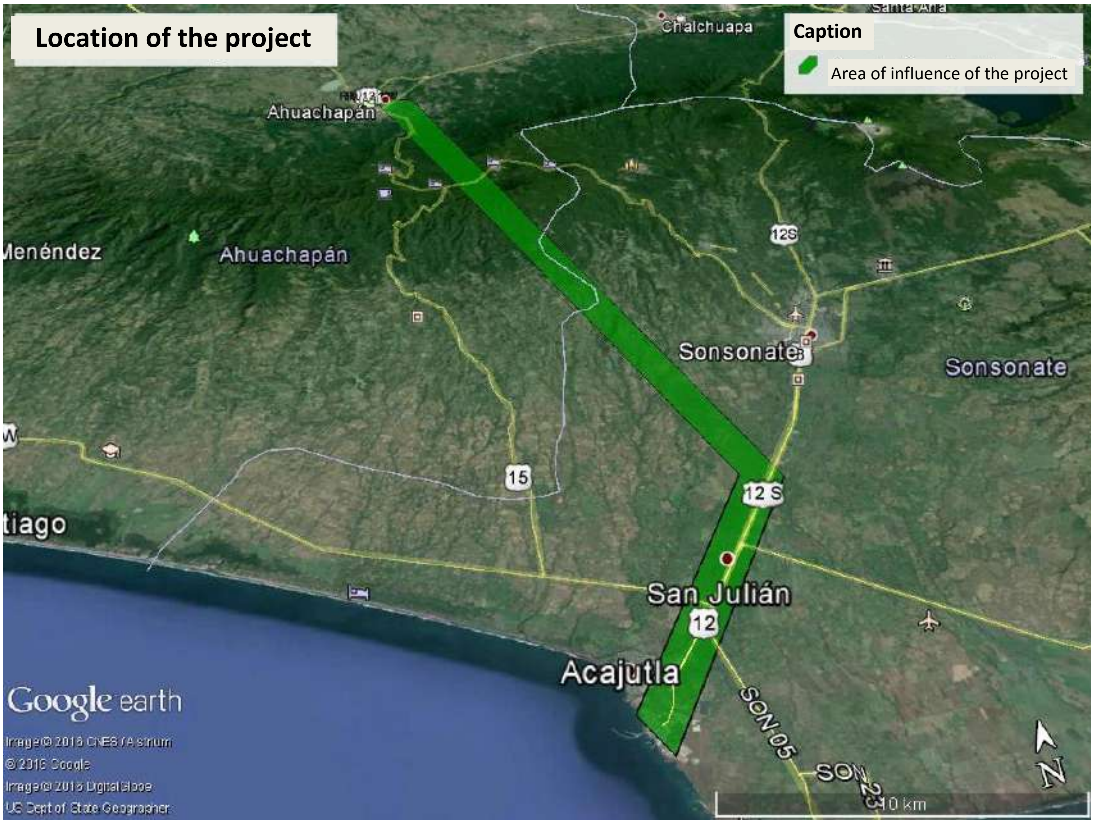

Figure 1. Gap of the area of influence of the Transmission Line Project of Energia del Pacifico. May-June 2016,

METHODOLOGY

For the accomplishment of the investigation standardized samplings were realized in the different identified habitats. In the case of faunal species, samples were taken in the following habitats.

- Patches of Natural Forests.
- Forest of coffee plantation.
- Open areas with crops.

Depending on each taxon, the types of sample units were designed in the same way, the samplings of each group were made according to their schedule of activity. In order to achieve an inventory of as many species as possible.

Materials and equipment.

- **Amphibian and reptile field guides**
- **Mammals Field Guide**
- **Field Guides for Birds**
- **Binoculars**
- **Camera traps**
- **Sherman Traps**
- **Serpentine hook**
- **Field notebook**
- **Photographic camera**
- **Taxonomic keys**

Sampling design.

Herpetofauna

Members of these groups are sensitive to environmental conditions and are closely tied to a particular habitat, making them more vulnerable than other vertebrate groups to changes in habitat, pollution, and human pressure.

We performed intensive searches on transects, one hour of, without repeating transects. The field work was carried out during 5 days between May and June 2016, covering the rainy season, with sampling times from 8:00 a.m. to 1:00 p.m. in the morning and 8:00 p.m. At 10:00 pm at night. Sampling sites were selected depending on the conditions for a greater probability of finding amphibians and reptiles. In the case of reptiles, sunny sites were selected, with trunks and shrubs usually used as hiding places; In the case of amphibians, places with sufficient humidity, as well as small pools present in ravines and in the main roads of the area.

Figure 2. Transects Established for the Sampling of Herpetofauna in the Sector of Apaneca to San Pedro Puxtla for the Transmission Line Project of Energía del Pacifico. May-June 2016.

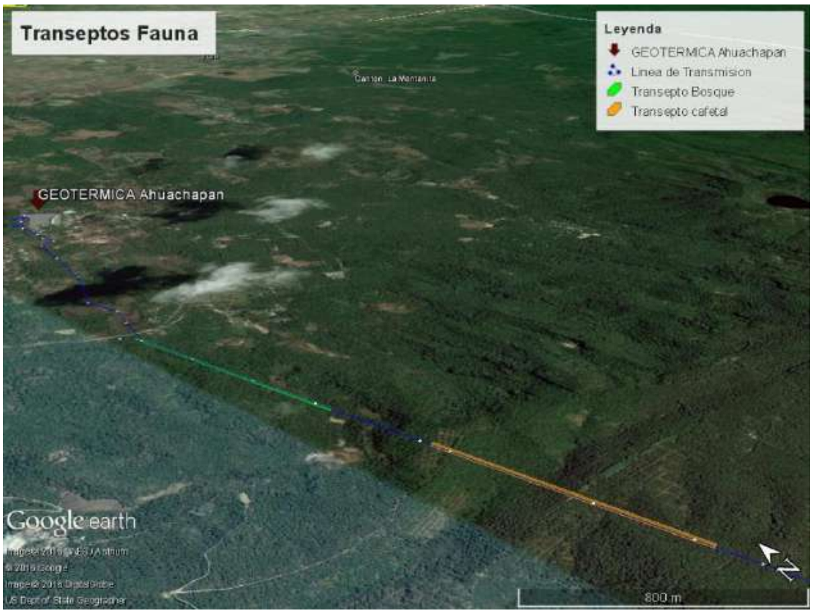

Figure 3. Transects Established for Herpetofauna Sampling in the Ahuachapán Sector for the Transmission Line Project of Energía del Pacifico. May-June 2016.

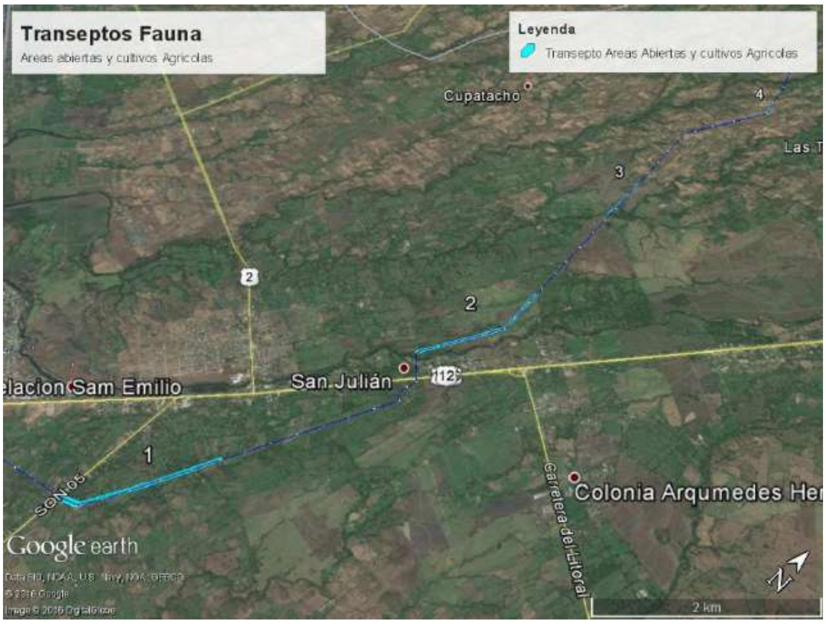

Figure 4. Transects Established for Herpetofauna Sampling in the Acajutla Sector towards Santo Domingo de Guzmán for the Transmission Line Project of Energía del Pacífico. May-June 2016.

Figure 5. Transects Established for Herpetofauna Sampling in the Ahuachapán Sector for the Transmission Line Project of Energía del Pacífico. May-june 2016.

Mastofauna

Linear transepts were established for the census of these species. In which the species of mammals present were recorded by sightings and indirectly from traces, excreta or other traces indicating the occurrence of these species, The same transects destined for herpetofauna were used. (See figures 2,3 and 4). However, camera traps were also used that were placed at strategic sites such as animal tracks or evidence of animal passage, in order to increase the probability of species registration.

Sampling schedules for the mastofauna were performed during the day from 8:00 a.m. to 12:00 p.m. and 2:00 p.m. to 4:00 p.m., mostly looking for traces and night sampling from 10:00 p.m. to 2:00 a.m. to try to make sightings of species with nocturnal habits.

Figure 6. Trap camera that was used for the registration of mammal species in the Transmission Line Project of Energía del Pacífico. May-june 2016.

Birds

In the case of the group of birds will be established observation points in which stops were made of 15 minutes per point and the identified species will be recorded either by their morphological characteristics or by their song. The points have been mounted on the transects previously established for the other groups since at these points a high incidence of birds has been determined. (See figures 7, 8, 9 and 10).

The tours were made during the hours when the weather conditions were favorable, performing a sampling at dawn from 5:00 am to 8:00 am and in the afternoon from 4:00 pm to 6:00 pm.

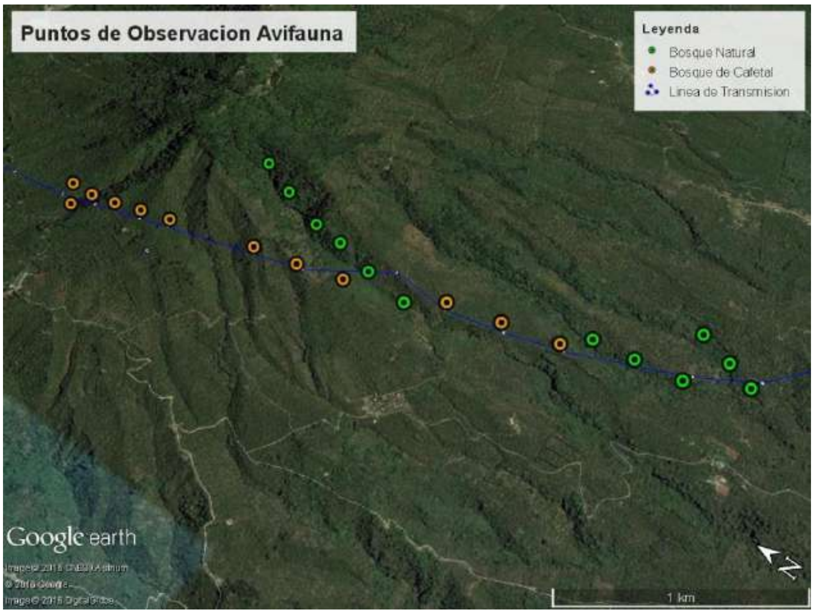

Figura 7. Observation Points Established for Avifauna Sampling in the Sector of Apaneca to San Pedro Puxtla for the Transmission Line Project of Energía del Pacífico. May-june 2016.

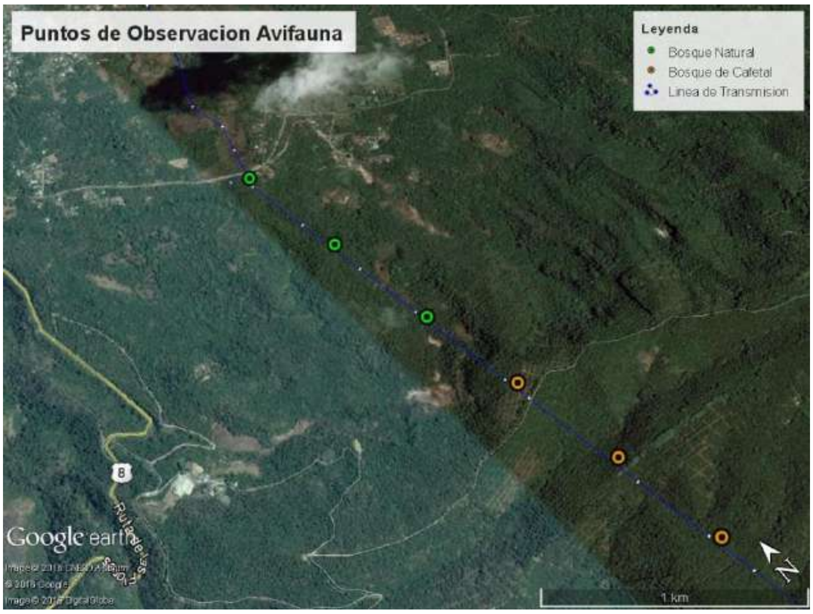

Figura 8. Observation Points Established for Avifauna Sampling in the Ahuachapán Sector for the Transmission Line Project of Energía del Pacífico. May-june 2016.

Figure 9. Observation Points Established for Avifauna Sampling in the Ahuachapán Sector for the Transmission Line Project of Energía del Pacífico. May-june 2016.

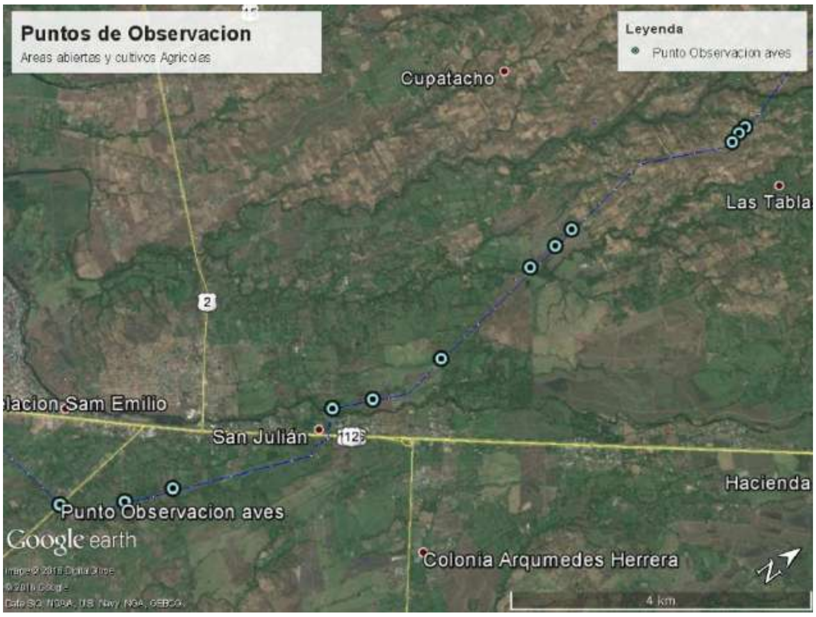

Figura 10. Observation Points Established for Avifauna Sampling in the Acajutla Sector to Santo Domingo de Guzmán for the Transmission Line Project of Energía del Pacífico. May-june 2016.

Calculations

The information recorded in the samples will determine the abundance, wealth and diversity value index, these will be processed in Excel spreadsheets; For alpha diversity the Shannon-Wiener indexes will be used. The absolute **(n)** and relative **(%)** abundance of aquatic organisms recorded in the study.

Relative Abundance.

$$A_{r.} = \frac{A_i}{A_{total}}\ X\ 100$$

Where:
A_r = Relative abundance of family or species
A_i = Total number of individuals in the family or species
A_{total} = Total number of individuals of all families or species registered

In addition to measuring the diversity of species within a community (diversity α), the Shannon-Wiener index is used. This is based on the fact that all species have the same probability of occurrence in the sample. It has values between 0 and 6 and is calculated according to the following formula:

Shannon Wiener Index.

$$\boldsymbol{H' = -\sum_{i-1}^{n} pi(lnpi)}$$

Where:
H´ = species diversity index Shannon-Wiener
P_i = proportion of species (n_i) in the total sample (N) ($p_i = n_i$/ N).

Simpson Index

Also known as the index of species diversity or dominance index. It is one of the parameters that allowed to measure the wealth of organisms. In ecology, it is also used to quantify the biodiversity of a habitat. It takes a certain number of species present in the habitat and their relative abundance. The Simpson index represents the probability that two randomly selected individuals within a given habitat belong to the same species.

Simpson Dominance Index

$$D = \frac{\sum_{i=1}^{S} n_i(n_i - 1)}{N(N-1)}$$

Where:
S = is the number of species
N = is the total of organisms present (or square units)
n = is the number of specimens per species

Simpson Diversity Index

$$D = 1 - \sum_{i=1}^{S} Pi$$

Where:

D = Simpson Diversity Index

Pi = Proportion of individuals of species i in the community

Accumulation curve and indexes of wealth.

To determine the degree of completion of the inventory the species accumulation curve was used as well as the wealth indexes of ACE (Abundance-based Coverage Estimator), ICE (Incidence-based Coverage Estimator), Chao 1, Chao 2, Jack-Knife 1 and Jack-Knife 2, calculated with the program EstimateS version 7.51 (Colwell 2006).

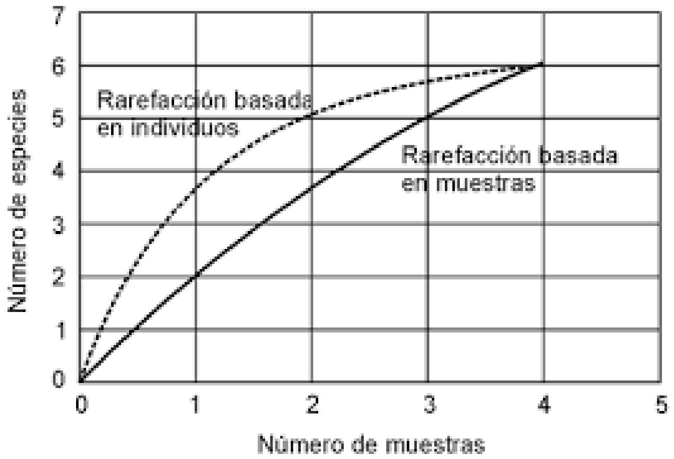

Figure 11. Example species accumulation curves for the Transmission Line Project of Energía del Pacífico. May-june 2016.

RESULTS

For the study area, the presence of 68 species belonging to the amphibian, reptile, mammal and bird groups has been evidenced in ten species of amphibians, five reptiles, 14 species of mammals and 39 species of birds.

The abundances are detailed below the results and analyzes obtained for each group evaluated.

Herpetofauna

A total of 15 species of amphibians and reptiles were recorded in 8 families and 14 genders. Most of the species recorded are common, with wide distribution at national level and high adaptability to areas disturbed by anthropogenic activity. However, the second most abundant species was the black-eyed tree frog (*Agalychnis moreletii*). A nationally threatened species that is on the IUCN's red list as a critically endangered species. See table 1.

Table 1. Herpetofauna Species Registered During the Study Completed for the Transmission Line Project of Energía del Pacífico. May 2016. E.N: National conservation status; IUCN: Conservation status according to IUCN; C: Coffee plantation; P.B: Patch of natural forest; A.A: Agricultural Areas.

Family	Specie	Common Name	E.N	IUCN	C	P.B	A.A	Total
Bufonidae	*Incilius coccifer*	Toad Enano	NA	MP	0	2	0	2
	Rhinella marina	Toad Sabanero	NA	MP	4	0	24	28
Craugastoridae	*Craugastor loki*	Little Frog of forest	NA	MP	45	85	0	130
Hylidae	*Agalychnis moreletii*	Black-Eyed Tree Frog	A	CR	25	40	0	65
	Scinax staufferi	Swamp Frog	NA	MP	0	0	14	14
	Smilisca baudinii	Frog	NA	MP	0	0	32	32
Leptodactylidae	*Leptodactylus melanonotus*	Frog de Charca	NA	MP	0	0	32	32
Leiuperidae	*Engystomops pustulosus*	Little Toad Túngara	NA	MP	0	7	30	37
Ranidae	*Lithobates maculatus*	Frog	NA	MP	4	0	0	4
	Lithobates forreri	Frog Leopard	NA	MP	0	0	12	12
Iguanidae	*Ctenosaura similis*	Garrobo	NA	MP	0	0	6	6
	Basiliscus vittatus	Tenguereche	NA	MP	1	0	22	23
	Anolis sericeus	Bebeleche	NA	MP	0	2	1	3
	Sceloporus malachiticus	Talconete	NA	MP	2	0	0	2
Teidae	*Ameiva undulata*	Corredor Pintado	NA	MP	0	0	6	6
				TOTAL OF INDIVIDUALS	81	136	179	396
				SP	6	6	10	15

Herpetofauna populations in different sampled habitats.

For this study, three different habitats were classified: *coffee forest, natural forest and agricultural areas*. The highest number of species and individuals was recorded in the areas of agricultural crops with a high degree of anthropic activity and contaminants. (See Figure 12). However, the most important species as environmental indicators occur both in patches of natural forest and in coffee plantations.

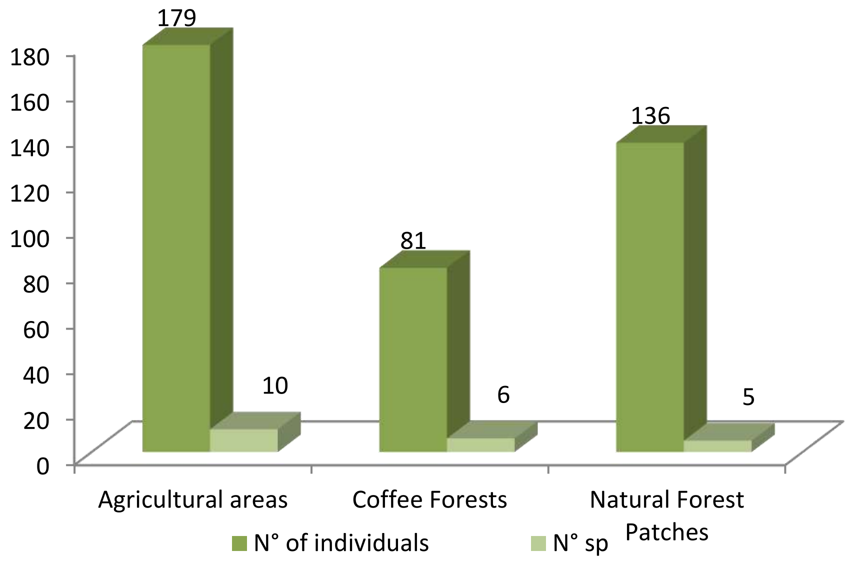

Figure 12. Numbers of Individuals and Herpetofauna Species Registered in the Various Sampling Habitats During the study conducted for the Transmission Line Project of Energía del Pacífico, May-june 2016.

Coffee plantation

For this habitat were reported a total of six species of which four belong to the amphibian case and the other two are two species of lacertilios of common and widely distributed. (See figure 13).

The most abundant amphibian species were Craugastor *loki and Agalychnis moreletii,* respectively but only the latter is in nationally threatened status and in critical danger according to IUCN.

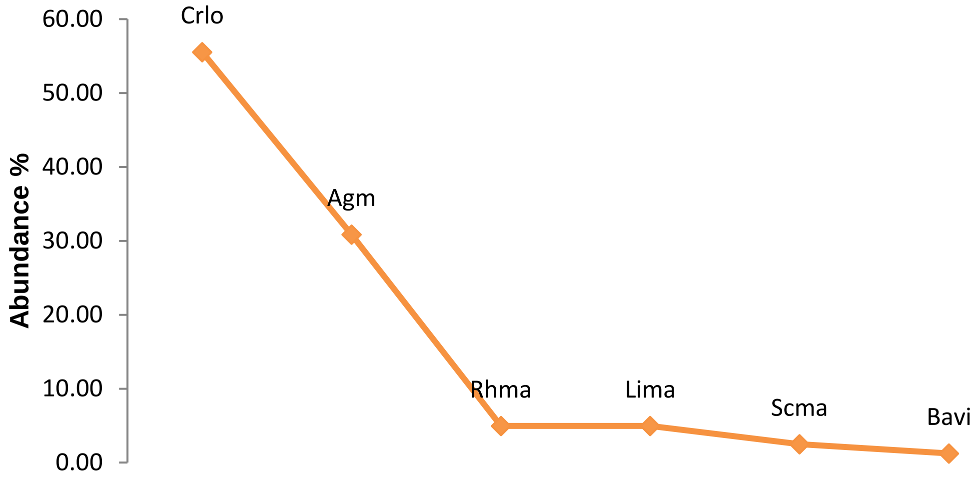

Figure 13. Range-abundance plot of the herpetofauna species in coffee forest in the location areas of towers of Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016). Rhma; Rhinella marina; Crlo; Craugastor loki; Agmo; Agalychnis moreletiis; Lima; Lithobates maculatus; Bavi; Basiliscus vittatus; Scma; Sceloporus malachiticus.

Natural Forest Patches

Only five species were recorded for this habitat, and just as in the forest of coffee the predominant species and of greater ecological importance were the frogs *Craugastor loki and Agalychnis moreletii,* (See figure 14).

The frog *Agalychnis moreletii* was mostly recorded by auditory means and was located in the forest canopy and also direct observations were made in pools of rainwater and leaves of shrubs.

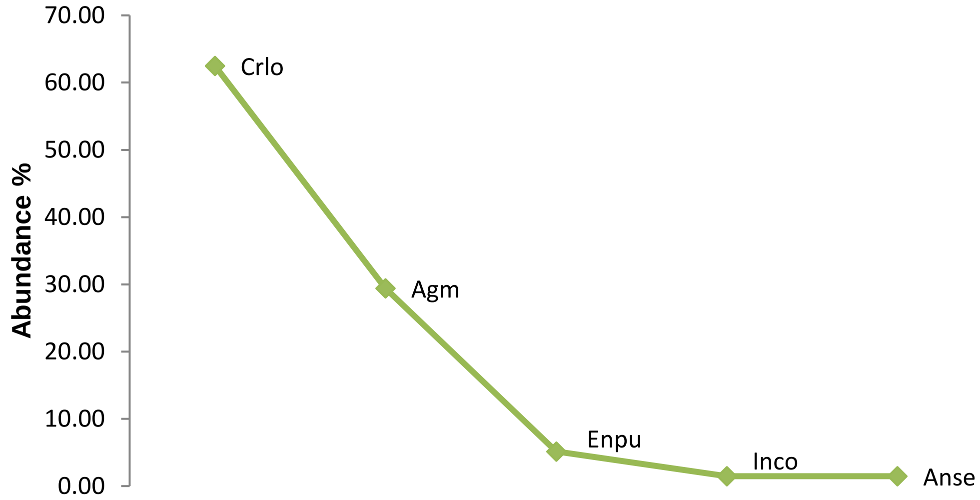

Figure 14. Range-abundance plot of the species of herpetofauna in the zones of location of towers of the Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016). Inco:Incilius coccifer; Crlo; Craugastor loki; Agmo; Agalychnis moreletii; Enpu; Engystomops pustulosus; Anse; Anolis sericeus.

Agricultural Areas.

These areas had a high degree of disturbance, however, most species were recorded for the study. The most abundant species were *Smilisca baudinii*, *Leptodactylus melanonotus* and *Engystomops pustulosus*. All species registered for this area are not in any conservation status either nationally or internationally. (See Figure 15).

Most amphibian species were found in pools of water with a high degree of contamination.

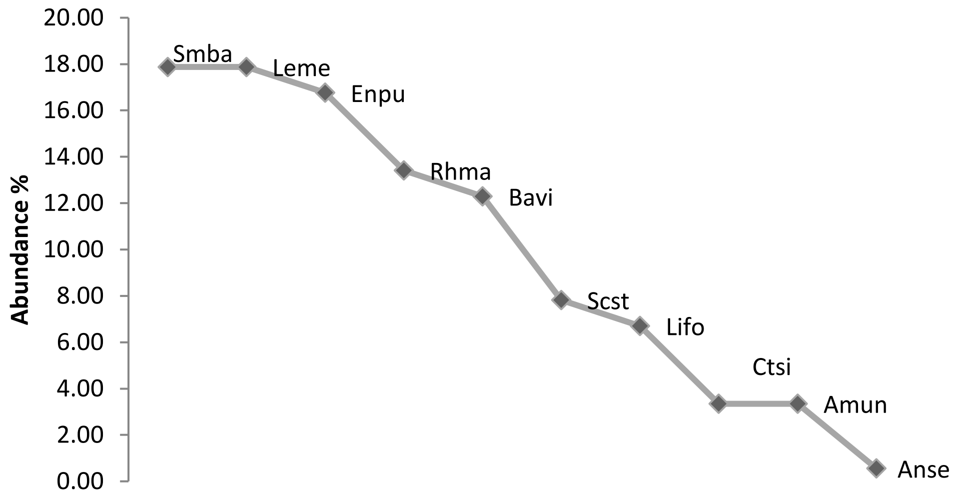

Figure 15. Range-abundance plot of the species of herpetofauna in the zones of location of towers of the Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016). ***Rhma; Rhinella marina; Scst; Scinax staufferi; Smba; Smilisca baudinii; Leme; Leptodactylus melanonotus; Enpu; Engystomops pustulosus; Lifo; Lithobates forreri; Bavi; Basiliscus vittatus; Anse; Anolis sericeus; Amun; Ameiva undulata.***

Abundance of species of herpetofauna in area of influence of the project

As shown below, the species *Craugastor loki* and *Agalychnis moreletii*. They are the most abundant during the evaluation carried out in the strip of forest, coffee and agricultural areas where the Transmission Line Project of Energía del Pacífico S.A de C.V.

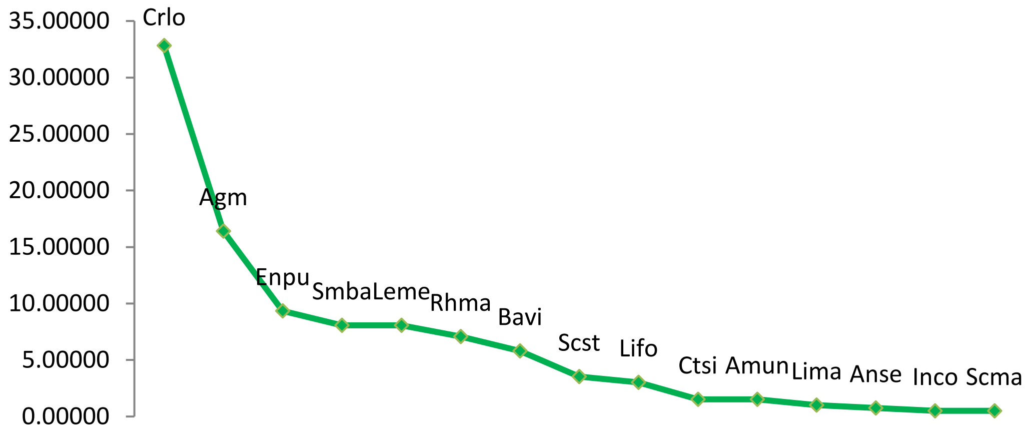

Figure 16. Range-abundance plot of the species of herpetofauna in the zones of location of towers of the Transmission Line Project of Energía del Pacífico S.A. de C.V. (may-june 2016). ***Inco: Incilius coccifer; Rhma; Rhinella marina; Crlo; Craugastor loki; Agmo; Agalychnis moreletii; Scst; Scinax staufferi; Smba; Smilisca baudinii; Leme; Leptodactylus melanonotus; Enpu; Engystomops pustulosus; Lima; Lithobates maculatus; Lifo; Lithobates forreri; Bavi; Basiliscus vittatus; Anse; Anolis sericeus; Scma; Sceloporus malachiticus; Amun; Ameiva undulata.***

Figura 17. Individual of *Agalychnis moreletii* Captured in the coffee plantation during the study carried out for the project of the Transmission Line of Energía del Pacífico, May-June 2016.

Figura 18. Individual of *Craugastor loki* in litter of coffee during the study carried out for the project of the Transmission Line of Energía del Pacífico, May 2016.

Curve of accumulation of herpetofauna species

The review of the species accumulation curve recorded during the study indicates that more field effort is required to complete the inventory (Figure 19), Since not all of the expected species were recorded. Through the study were recorded 15 species in total and several species that were expected to occur in the area could not be census.

The following figure shows a comparison between the species recorded during the present study versus the species that throw the wealth estimators for the group of amphibians and reptiles.

In the table 2 also reflects the number of species that can occur in the area according to wealth estimators.

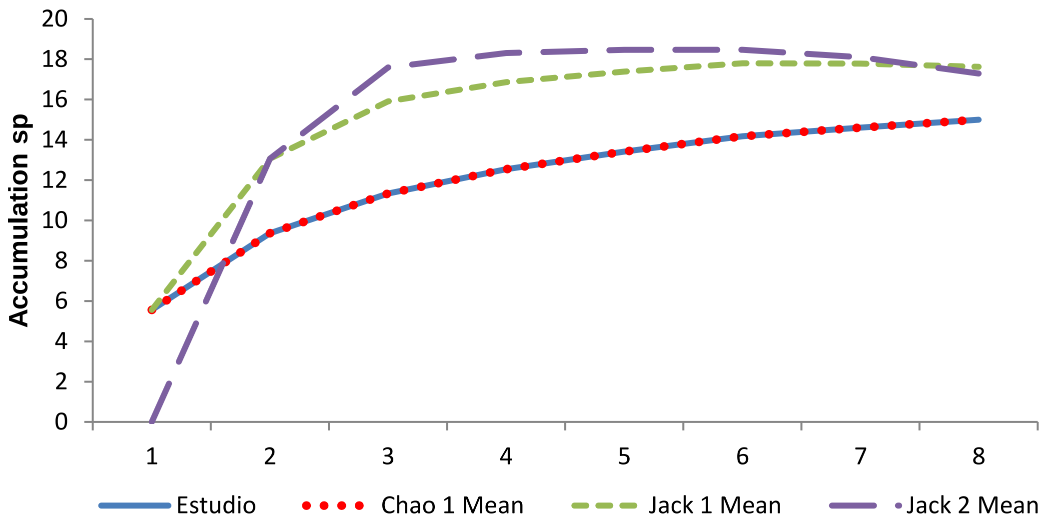

Figure 19. Accumulation curve of herpetofauna species recorded during the study and estimates of wealth realized for theTransmission Line Project of Energía del Pacífico May and June 2016.

Table 2. Estimators of species richness of herpetofauna for the Transmission Line Project of Energía del Pacífico, May and June 2016.

Estimator	Species richness
Estudio	15
ACE	15
ICE	16,44
Chao 1	15
Chao 2	15,53
Jack-Knife	17,63
Jack-Knife 2	17,3

__Amphibian and reptile species accumulation curves__

The accumulation curves of species for amphibians and reptiles indicate that in this group their curve shows a tendency to stabilize (Figure 20).

As for the indicators of wealth for the amphibian group, these indicate that the estimated amphibian wealth for the area is 10 to 12 species, (see table 3) So the inventory for this group would be almost complete and likewise in the case of reptiles the inventory is almost complete, which can be observed through the curve and with the indicators of wealth. These last ones indicate that in the zone could inhabit between 5 and 7 species reason why greater effort of sampling could lead in the registry of new species. (Table 3)

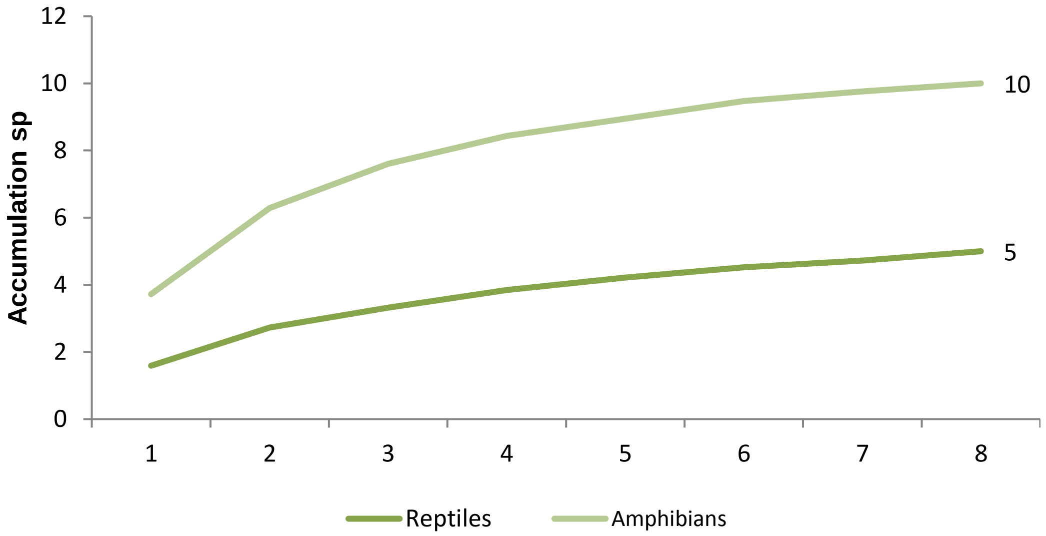

Figure 20. Comparative species accumulation curve of both groups recorded during the study conducted for the Transmission Line Project of Energía del Pacífico, May and June 2016

Table 3. Wealth estimators of both groups for the Transmission Line Project of Energía del Pacífico, May and June 2016.

Estimator	Reptiles	Amphibians
Estudio	5	10
ACE	5	10
ICE	7.06	10.91
Chao 1	5	10
Chao 2	5.44	10.29
Jack-knife 1	6.75	11.75
Jack-knife 2	7..61	11.6

Diversity of amphibians and reptiles

The diversity of species was analyzed through two indexes (Shannon and Simpson). According to the Shannon index, the diversity value is 2.13 (from a scale of 1 to 6), which is interpreted as a range of low-value herpetofauna diversity in the Area; With this data, should not be interpreted that the site is not important. It must be taken into account that the area currently for the most part is a coffee plantation, which could explain the low diversity of species. It is significant that the area presents species of importance for conservation. The Simpson index gave a result of 0.83, which indicates that there is a high probability that the first two species chosen at random are the same. This is due to the dominance of some species found in this site. In reviewing figure 21 of general abundances for the site it can be corroborated that there are two species of amphibians that are the most abundant and dominant for the area.

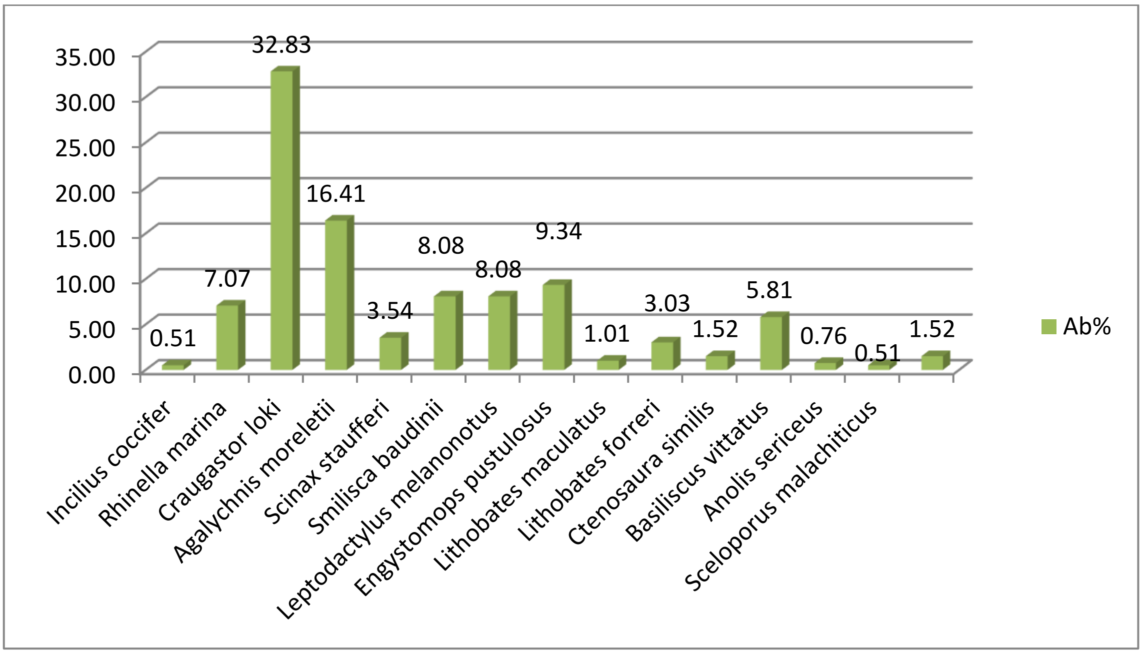

Figure 21. General abundances in% of herpetofauna species at the project site. May –june 2016.

Diversity indexes by habitat

Table 4. Diversity indexes of the herpetofauna species recorded in the different habitats for the Transmission Line Project of Energía del Pacífico, May and June 2016

Indexes	Coffee plantation	Natural Forest	Agricultural Areas
Shannon	1.13	0.93	2.07
Simpson	0.59	0.51	0.86

In the previous table, it is observed that all the sampled habitats present similar values of both species diversity and dominance.

The diversities in the three habitats are considered low, however, the level of completion of the inventory that does not finish stabilizing according to the curve of accumulation of species and wealth estimators must be taken into account. The agricultural areas are those that present a greater diversity and dominance.

Species of amphibians and reptiles of importance in the area.

Species of importance for conservation

The majority of species that were recorded during the present study are not in the official listings of endangered species, except for the Black-Eyed Tree Frog (*Agalychnnis moreletii*), which presents Critically Endangered species status at a global level (IUCN 2011) and Threatened at national level (MARN 2015). The remaining species are widely distributed or habitat generalists, and are not listed in species threatened with extinction.

Agalychnis moreletii (Black-Eyed Tree Frog). Critically Endangered Species worldwide due to Quitridiomycosis (Santos–Barrera et al. 2004), disease that has caused the extinction of several species of amphibians worldwide. It was recorded at two sites where the transmission line passes on the Santa Rita and Tequendama farms where both sites were found in reservoir tanks with several adult individuals as well as tadpoles and several oviposts on the leaves of the trees surrounding that pool. Photos by: Rene Arturo Vaquerano Gómez.

Figura 22. Adult frog *Agalychnis moreletii* recorded during the study for the Transmission Line Project of Energía del Pacífico, May and June 2016

Figura 23. Ovipostura *Agalychnis moreletii* found in reservoir tank during the study for the Transmission Line Project of Energía del Pacífico, May and June 2016

Species of importance for ecotourism

Groups of amphibians and reptiles are generally not attractive to the general public, however, the Black-Eyed Tree Frog (*Agalychnis moreletii*), with its striking green color and reddish legs, could be of interest to ecotourers who are fond of the amphibians, as it is easily observed during the nights, in the breeding ponds.

Indicating Species

Amphibians are good environmental indicators of ecosystem health, as their permeable skin makes them sensitive to pollution or the presence of diseases. In this way, a site with high levels of contamination will present diminished populations of these species. Reptiles are among the species most misunderstood by humanity, mainly snakes, which by their appearance or by the belief that they are all poisonous are killed by the villagers, so that the human presence within ecosystems greatly harms this group. The species that can be used as indicators are the following: ***Agalychnis moreletii* (Black-Eyed Tree Frog):** This species is Critically Endangered worldwide due to the disease Quitridiomycosis. Within the Area, only two Artificial Piles were found in the coffee plantations that met the conditions for the normal development of the tadpoles of the species. Therefore, it is very important to monitor this population and its behavior over the years. The species is sensitive to contamination in the water so it is necessary to implement measures to prevent the washing of agricultural implements in these structures.

***Craugastor loki* (Little Frog of forest):** This little frog has a very peculiar call, which resembles the song of a small chicken. Many people confuse this song with the call of a coral, which is false, because snakes do not make sounds like that. This frog has the characteristic of not depending much of the water, since it does not realize the phase of aquatic larva (tadpole), developing inside the egg. This species places the eggs in moist soil, making it a species that may be sensitive to soil contamination.

Sites of importance for the conservation of amphibians and reptiles within the area of influence of the project.

The stacks located on the Santa Rita and Tequendama farms are the only spaces where a reproduction site of the Black-Eyed Tree Frog (*Agalychnis moreletii*) in the area. Many zones of the Area are refuge for these groups as they have abundant litter and decomposing logs, so to determine other specific sites of importance becomes difficult since the whole Area is a shelter for the amphibians and reptiles.

Figure 24. Frog adulta de *Agalychnis moreletii* extracted from reservoir pile in Finca Santa Rita during the study for the Transmission Line Project of Energía del Pacífico, May and June 2016.

Mastofauna.

For the mammal group, a total of 14 species belonging to ten families were recorded, none of which are either threatened or threatened with extinction. See table 5.

Table 5. Species of registered mammals during the study for the Transmission Line Project of Energía del Pacífico, May 2016

Family	Specie	Comun name	E.N	IUCN	C	P.B	A.A	Total
Canidae	***Urocyon cinereoargenteus***	Zorrita / Cervantes cat	NA	MP	0	0	5	5
Dasypodidae	***Dasypus novemcinctus***	Cusuco	NA	MP	7	9	6	22
Dasyproctidae	***Dasyprocta punctata***	Cotuza	NA	MP	0	4	0	4
Didelphidae	***Didelphis marsupialis***	Black Tacuacín	NA	MP	3	1	8	12
	Philander opossum	Four eyes	NA	MP	0	0	5	5
Felidae	***Puma yagouaroundi***	Zonte cat	NA	MP	0	1	0	1
Geomidae	***orthogeomys sp***	Taltuza	NA	MP	6	4	0	10
Leporidae	***Sylvilagus floridanus***	Mount Rabbit	NA	MP	3	1	5	9
Mephitidae	***Spilogale putorius***	Common Skunk	NA	MP	0	2	1	3
Mephitidae	***Mephitis macroura***	Striped skunk	NA	MP	0	0	1	1
Procionidae	***Procyon lotor***	Raccoon	NA	MP	0	0	11	11
Procyonidae	***Nasua narica***	Pezote	NA	MP	0	6	0	6
Procyonidae	***Potus flavus***	Micoleón	NA	MP	0	1	0	1
Sciuridae	***Sciurus variegatoides***	Gray squirrel	NA	MP	1	1	1	3
		TOTALS			20	30	43	93
		sp			5	10	9	14

E.N: National conservation status; IUCN: IUCN conservation status; C: Coffee plantation; P.B: Patch of natural forest; A.A: Agricultural Areas.

Populations of mammals in the different habitats sampled.

For the three different habitats, the largest number of species was located in the areas of natural forest, but a greater number of individuals were obtained in the sampled agricultural areas. (See Figure 25). These areas in general registered a high number of individuals due to being adjacent to small rivers and broken where the species of this group find good conditions for their subsistence.

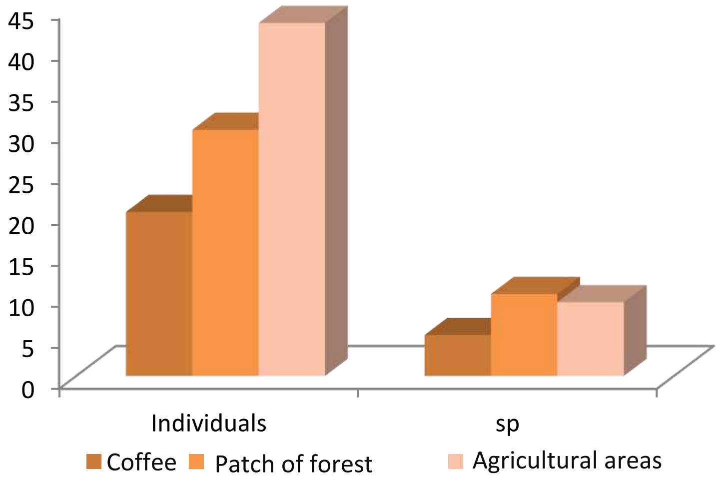

Figure 25. Numbers of individuals and species of mammals recorded in the different sampled habitats during the study for the Transmission Line Project of Energía del Pacífico, May-June 2016.

Coffee plantation.

Coffee plantations are often ideal sites for the occurrence of various species of mammals. For the present study were recorded in total five species of which the most abundant for the site were *Dasypus novemcinctus* and *Orthogeomys sp*. most of these individuals were reported from traces.

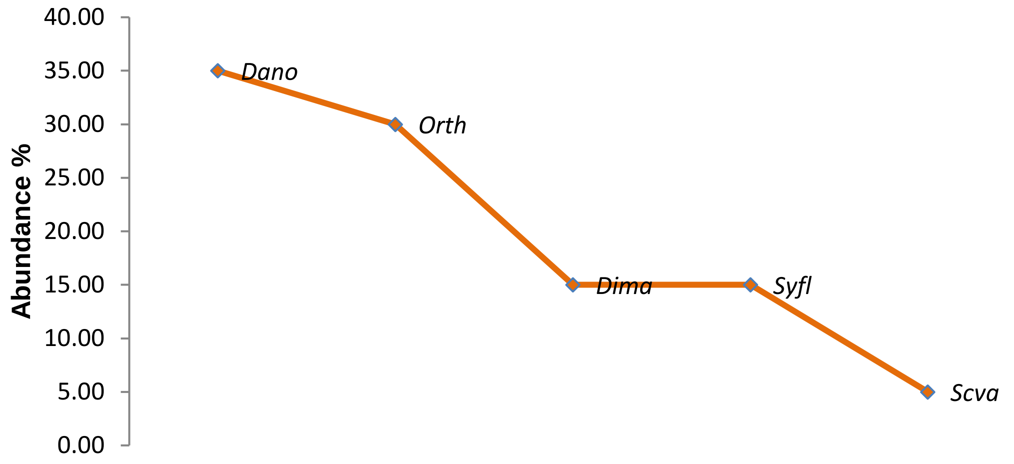

Figure 26. Range-abundance plot of mammal species in coffee forest of Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016). ***Dano: Dasypus novemcinctus;Dima: Didelphis marsupialis; Orth: Orthogeomys sp; Syfl: Sylvilagus floridanus; Scva: Sciurus variegatoides.***

Natural Forest.

This was the habitat that registered the majority of species ten in total and as in the areas of coffee the most abundant species was the *Dasypus novemcinctus* species quite common in the area.

Another fairly abundant species was *nasua narica* (pezote) this species was recorded in the patch of forest located in the farm El Naranjo. In this same area was found one more species of the same family (Procyonidae), *potus flavus* known as micoleón. (See figure 27).

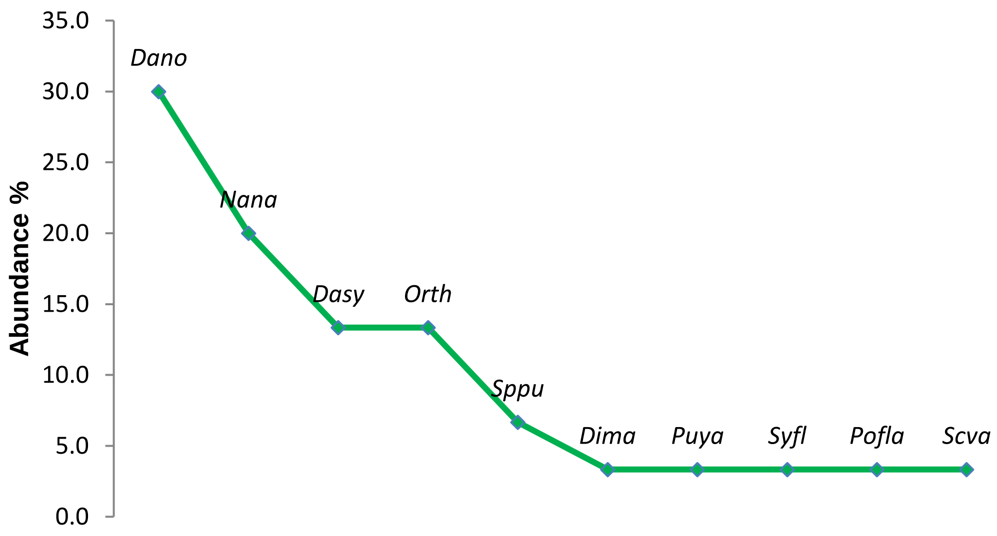

Figure 27. Range-abundance plot of mammal species in natural forest patches of the Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016). ***Dano: Dasypus novemcinctus; Dasy: Dasyprocta punctata; Dima: Didelphis marsupialis; Puya: Puma yagouaroundi; Orth: Orthogeomys sp; Syfl: Sylvilagus floridanus; Sppu: Spilogale putorius; Nana: Nasua narica; Pofla: Potus flavus; Scva: Sciurus variegatoides***

Agricultural Areas.

Agricultural areas are usually areas that due to the food layout generates the conditions of occurrence of many species of mammals however. These can become a problem because of the damage they cause to crops.

For the area, the species with the greatest abundance is *Procyon lotor* which is a species normally associated with habitats with high water availability. In the following figure, it is observed that the species with lower abundance are *Mephitis macroura* and *Spilogales putorius*, both species of skunks common in these types of habitats.

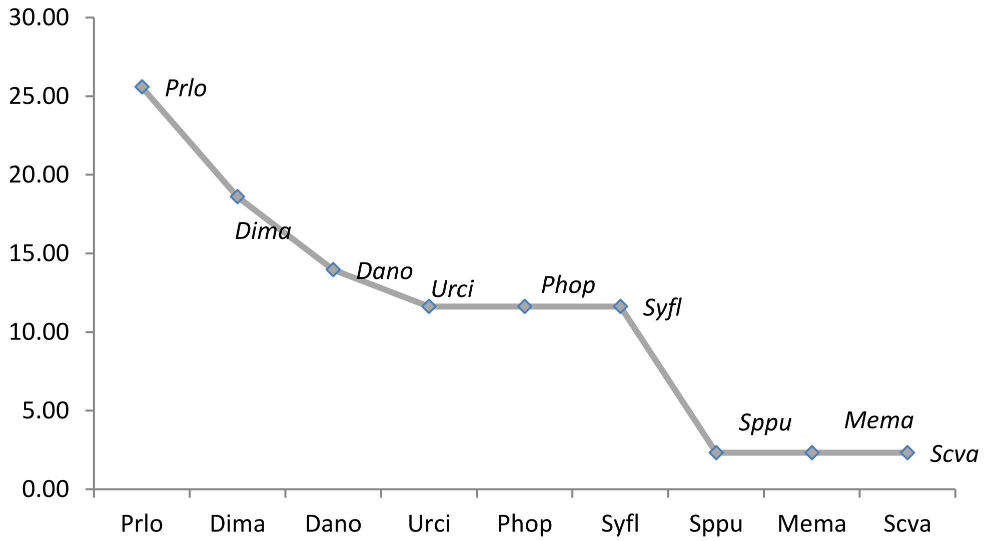

Figure 28. Rank-abundance chart of mammal species in agricultural areas of the Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016). ***Urci: Urocyon cinereoargenteus; Dano: Dasypus novemcinctus; Dasy: Dasyprocta punctata; Dima: Didelphis marsupialis; Phop: Philander opossum; Puya: Puma yagouaroundi; Orth: Orthogeomys sp; Syfl: Sylvilagus floridanus; Sppu: Spilogale putorius; Mema: Mephitis macroura; Prlo: Procyon lotor; Nana: Nasua narica; Pofla: Potus flavus; Scva: Sciurus variegatoides***

Abundance of species of Mastofauna in area of influence of the project.

In total, 14 species of mammals were registered for the area of influence of the project, being the most abundant the *Dasypus novemcinctus* (Cuzuco), *Didelphis marsupialis* (tacuazin) and *Procyon lotor* (raccoon). On the other hand the three species less abundant during this investigation were *Puma yagouroundi,* (zonto cat), *Mephitis macroura* (Skunk) and *Potus flavus (*micoleón). The following figure details the abundance of all mammalian species recorded during the present study.

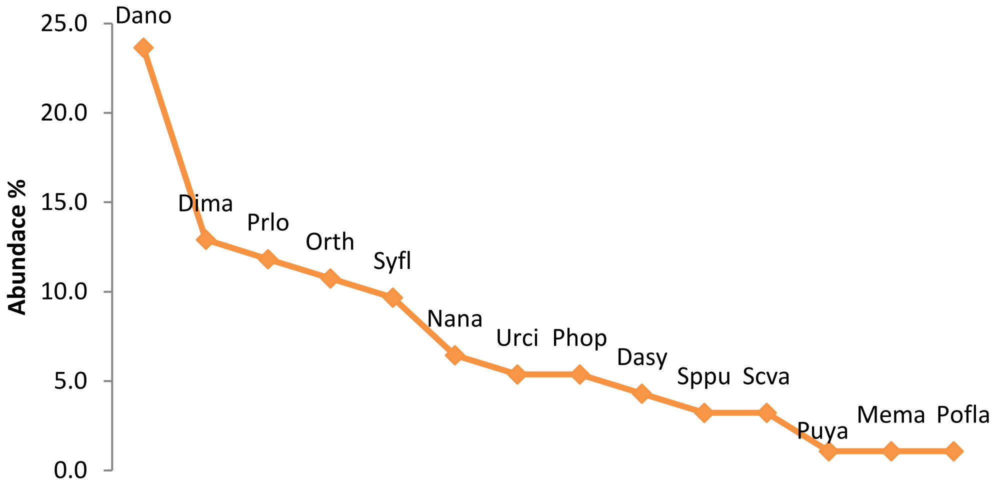

Figure 29. Rank-abundance chart of mammal species in the project's areas of influence for el Transmission Line Project of Energía del Pacífico S.A. de C.V. (may-june 2016). Urci: Urocyon cinereoargenteus; Dano: Dasypus novemcinctus; Dasy: Dasyprocta punctata; Dima: Didelphis marsupialis; Phop: Philander opossum; Puya: Puma yagouaroundi; Orth: Orthogeomys sp; Syfl: Sylvilagus floridanus; Sppu: Spilogale putorius; Mema: Mephitis macroura; Prlo: Procyon lotor; Nana: Nasua narica; Pofla: Potus flavus; Scva: Sciurus variegatoides

Species accumulation curve

The accumulation curve of species recorded during the study indicates that (Figure 30) not all predicted species were recorded. Through the study were recorded 14 species in total and several species that were expected to occur in the area could not be census

The following figure shows a comparison between the species recorded during the present study versus the species that the wealth estimators show. As can be observed, the indexes show a richness between 17 and 18.57, so that for the site one could expect the occurrence of three to five more species.

Table 6 also reflects the number of species that can occur in the area according to the wealth estimators.

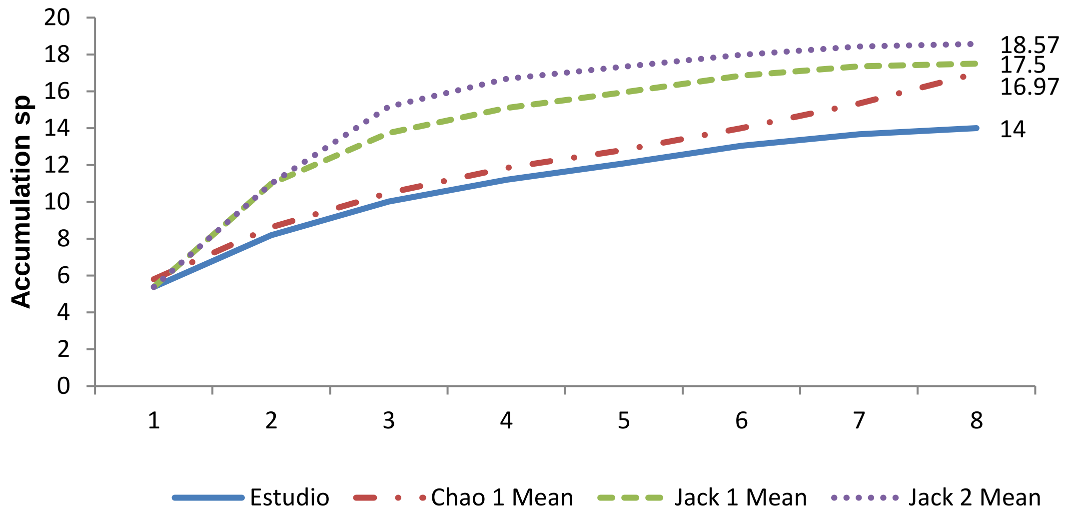

Figure 30. Curve of accumulation of mammal species for the Transmission Line Project of Energía del Pacífico, May and June 2016.

Table 6. Wealth estimators of mammal species for the Transmission Line Project of Energía del Pacífico, May and June 2016.

Estimator	Species richness
Estudio	14
ACE	15,79
ICE	17,35
Chao 1	16,97
Chao 2	15,31
Jack-Knife 1	15,5
Jack- Knife 2	18,57

Diversity of mammals

The diversity of species was analyzed through two indexes (Shannon and Simpson). According to the Shannon index, the diversity value is 2.31 (from a scale of 1 to 6), which is interpreted as a range of mammal diversity with low value.

The Simpson index resulted in a value of 0.87 which indicates that for the area in general there is a high dominance of some species over the general population.

Diversity indexes by habitat.

Table 7. Indexes of diversity of mammal species recorded in the Transmission Line Project of Energía del Pacífico, May and June 2016

Indexes	Coffee plantation	Natural Forest	Agricultural Areas
Shannon	1.44	1.96	1.69
Simpson	0.74	0.82	0.83

In the previous table, it is observed that all the sampled habitats present similar values of both species diversity and dominance.

Diversities in all three habitats are considered low, however, we must take into account the level of finalization of the inventory that does not finish stabilizing according to the curve of accumulation of species and wealth estimators. Therefore, by carrying out more sampling effort, we could increase the number of occurring species.

Avifauna

A total of 39 bird species were recorded during 26 families. Only four species with nationally threatened status are recorded according to MARN. See table 8.

Table 8. Species of birds recorded during the study conducted for the Transmission Line Project of Energía del Pacífico, May and June 2016

Family	Specie	Common name	E.N	IUCN	C	P.B	A.A	Total
Ardeidae	***Bubulcus ibis***	Heron livestock (Garrapatera)	NA	MP	0	0	6	**6**
Cathartidae	***Cathartes aura***	Aura Cabecirroja	NA	MP	0	0	55	**55**
Accipitridae	***Buteo magnirostris***	Pollero sparrowhawk	NA	MP	0	1	9	**10**
	Geranospiza caerulescens	Mosquito sparrowhawk	NA	MP	0	0	**1**	**1**
Falconidae	***Herpetotheres cachinnans***	Guaco Hawk (Guas)	NA	MP	3	0	0	**3**
Jacanidae	***Jacana spinosa***	Jacana Mesoamerican	NA	MP	0	0	8	**8**
Columbidae	***Zenaida asiatica***	White-winged dove	NA	MP	9	17	94	**120**
	Patagioenas flavirostris	Purple dove	NA	MP	6	5	1	**12**
	Columbina inca	Turtledove Colilarga	NA	MP	0	0	12	**12**
	Columbina talpacoti	Turtledove Reddish	NA	MP	0	0	23	**23**
Psittacidae	***Brotogeris jugularis***	catalnica	A	MP	**30**	0	0	**30**
	Eupsittula canicularis	Chocoyo	A	MP	0	0	**7**	**7**
Cuculidae	***Piaya cayana***	Chocolatero, Piscoy	NA	MP	2	1	0	**3**
	Crotophaga sulcirostris	Pijuyo	NA	MP	0	0	16	**16**
Tytonidae	***Tyto alba***	Barn Owl from Campanario	NA	MP	0	0	1	**1**
Caprimulgidae	***Nyctidromus albicollis***	Tapacaminos Pucuyo (Caballero)	NA	MP	0	0	2	**2**
Trochilidae	***Amazilia rutila***	Cinnamon Hummingbird	NA	MP	0	3	0	**3**
Trogonidae	***Trogon elegans***	Trogón Elegant (Coa Pechirroja)	NA	MP	6	3	0	**9**
Momotidae	***Eumomota superciliosa***	Momoto Cejiturqueza (Torogoz)	NA	MP	5	2	7	**14**
Alcedinidae	***Chloroceryle americana***	Martin-fisherman Green	NA	MP	0	0	3	**3**
Ramphastidae	***Aulacorhynchus prasinus***	Green Tucaneta (Green Toucan)	A	MP	0	**3**	0	**3**
	Pteroglossus torquatus	Tucancillo Collarejo (Razor Peak)	NA	MP	0	5	0	**5**
Picidae	***Melanerpes aurifrons***	cheje	NA	MP	3	2	7	**12**
Pipridae	***Chiroxiphia linearis***	Saltarín Colilargo (Toledo)	A	MP	0	**20**	0	**20**
Tyrannidae	***Pitangus sulphuratus***	Luis Grande (Cristo Fue)	NA	MP	3	4	12	**19**
Corvidae	***Calocitta formosa***	Urraca-hermosa Cariblanca (Urraca)	NA	MP	15	3	6	**24**
Hirundinidae	***Riparia riparia***	Riverena Swallow	NA	MP	0	0	7	**7**
Troglodytidae	***Campylorhynchus rufinucha***	guacalchia	NA	MP	5	0	12	**17**
Turdidae	***Turdus grayi***	Zorzal pardo	NA	MP	5	3	20	**28**
Parulidae	***Setophaga petechia xantholora***	Chipe de Manglar	NA	MP	8	2	4	**14**
	Setophaga magnolia	Chipe de Magnolia	NA	MP	0	10	0	**10**
	Cyanerpes cyaneus	Mielero Patirrojo	NA	MP	4	0	0	**4**

Family	Specie	Common name	E.N	IUCN	C	P.B	A.A	Total
	Thraupis abbas	Tángara Aliamarilla	NA	MP	2	0	0	**2**
Emberizidae	**Volatinia jacarina**	Semillero Brincador	NA	MP	0	0	11	**11**
	Sporophila torqueola	Semillero Collarejo	NA	MP	0	0	4	**4**
Icteridae	***Dives dives***	Tordo cantor	NA	MP	2	3	4	**9**
	Quiscalus mexicanus	clarinero	NA	MP	7	3	25	**35**
	Icterus gularis	Bolsero de Altamira	NA	MP	5	4	14	**23**
Fringillidae	***Euphonia hirundinacea***	Eufonia Gorjiamarillo	NA	MP	8	17	0	**25**
		Total Individuos			**128**	**111**	**371**	
		sp			*20*	*21*	*28*	

E.N: National status, NA not threatened, A: threatened, EP in danger; IUCN: International Union for the Conservation of Nature, MP less concern; C coffee plantation; P.B forest patch; A.A Agricultural Areas.

Populations of avifauna in the different habitats sampled.

Three different habitats were sampled. The highest number of species and individuals was recorded in areas of agricultural crops with a high degree of anthropic activity. (See Figure 31). The number of individuals quite high because it is these areas were located large populations of Columbidos.

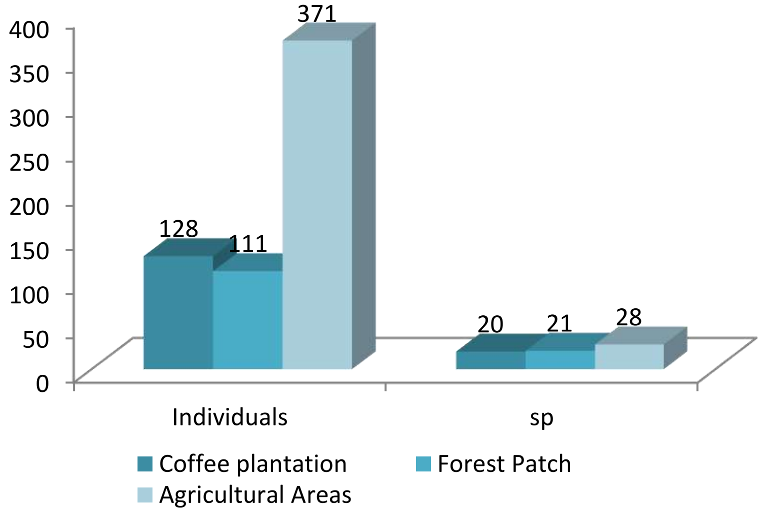

Figure 31. Numbers of individuals and species of birds recorded in different habitats during the study conducted for the Transmission Line Project of Energía del Pacífico, May and June 2016

Coffee plantation

After the evaluation of this habitat it is observed that the species *Brotogeris jugularis* is the predominant species followed by *Calocitta Formosa.* (See figure 32). The first is the only species that was registered in coffee plantation with threatened status at the national level. However since for the coffee crop it is necessary to have tree species, to provide the necessary shade for a good development of the crop. In turn these trees provide shelter, food and nesting areas and resting for both resident and migratory species.

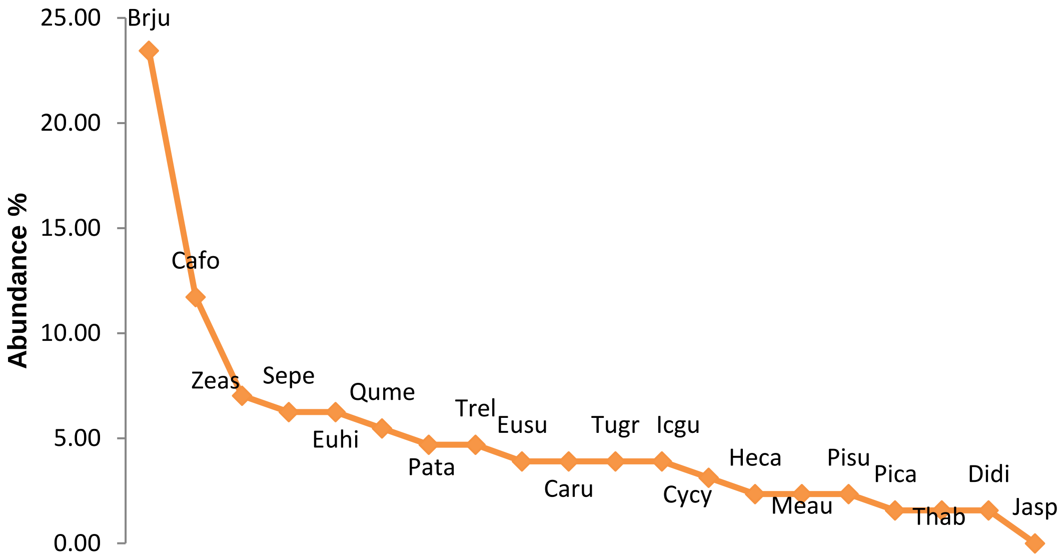

Figure 32. Range-abundance plot of bird species in coffee forests for the Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016). ***Heca: Herpetotheres cachinnans; Zeas: Zenaida asiática; Pata: Patagioenas flavirostris; Brju: Brotogeris jugularis; Pica: Piaya cayana; Trel: Trogon elegans; Eusu: Eumomota superciliosa; Meau: Melanerpes aurifrons; Pisu: Pitangus sulphuratus; Cafo: Calocitta Formosa; Caru: Campylorhynchus rufinucha; Tugr: Turdus grayi; Sepe: Setophaga petechia xantholora; Cycy: Cyanerpes cyaneus; Thab: Thraupis Abbas; Didi: Dives dives; Qume: Quiscalus mexicanus; Icgu: Icterus gularis; Euhi:Euphonia hirundinacea.***

Natural Forest

For the patches of natural forest sampled, a total of 21 species of birds were obtained within these two that are in state of threatened at the national level are:
Aulacorhynchus prasinus (Green Tucaneta) and
Chiroxiphia linearis (Saltarin collajero or Toledo).

The most abundant species were *Chiroxiphia lineari, Zenaida asiática* and *Euphonia hirundinacea* respectively. (See figure 33).

These relics of forests known as machorras in the coffee plantations, are very scarce since for being a purely coffee area the greater extension is cultivated. However, these spaces that do not meet the requirements for planting the crop. They are of vital importance for specialist species of forest since there is a greater floristic diversity providing the conditions to a great number of species important for the conservation.

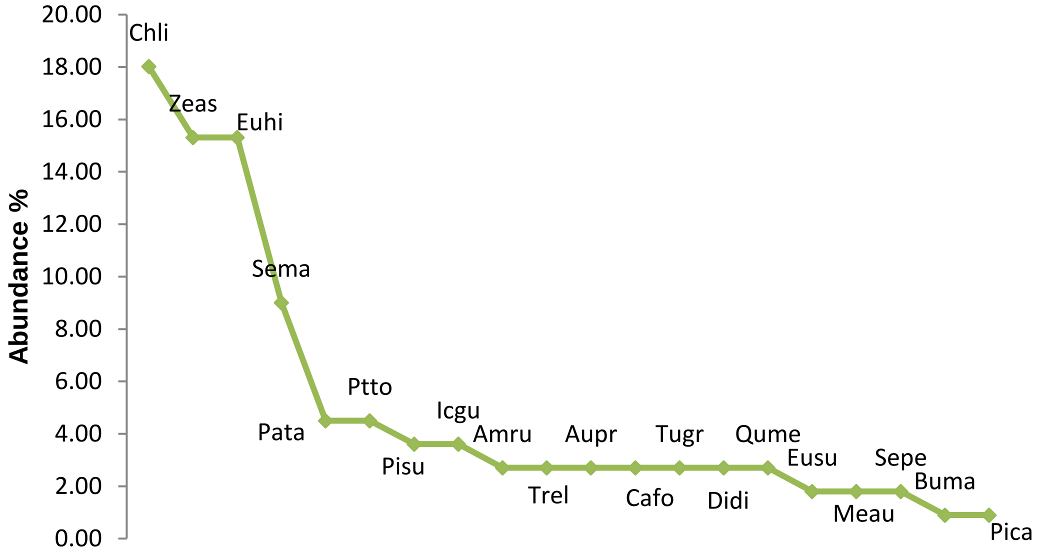

Figure 33. Range-abundance plot of bird species in natural forests for the Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016). ***Buma: Buteo magnirostris ; Zeas: Zenaida asiática; Pata: Patagioenas flavirostris; Pica: Piaya cayana; Amru: Amazilia rutila; Trel: Trogon elegans; Eusu: Eumomota superciliosa; Aupr: Aulacorhynchus prasinus; Ptto: Pteroglossus torquatus; Meau: Melanerpes aurifrons; Chli: Melanerpes aurifrons; Pisu: Pitangus sulphuratus; Cafo: Calocitta Formosa; Tugr: Turdus grayi; Sepe: Setophaga petechia xantholora; Sema: Setophaga magnolia; Didi: Dives dives; Qume: Quiscalus mexicanus; Icgu: Icterus gularis; Euhi:Euphonia hirundinacea.***

Agricultural Areas

This habitat recorded the largest number of species a total of 28 of which could be verified the presence of a species in danger at the national level (*Geranospiza caerulescens*). It is a predatory species known as: hawk-mosquito and also recorded a threatened species the species of parakeet *Eupsittula canicularis.*

The most abundant species for this habitat were *Zenaida asiática* (White-winged dove) and *Catharte aura* (aura cabeciroja or zunche). See Figure 34.

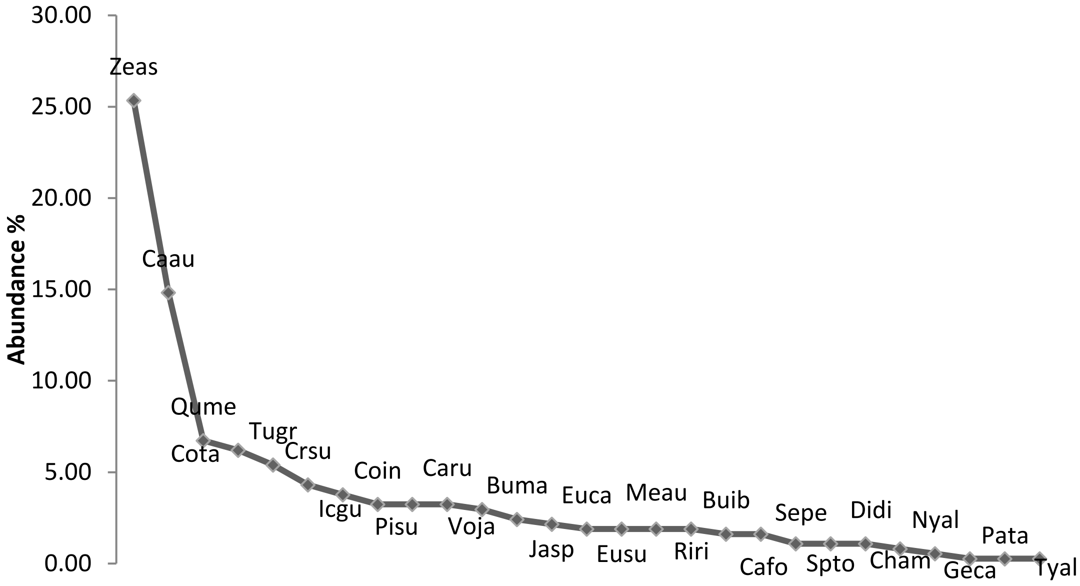

Figure 34. Rank Chart-abundance of bird species Agricultural Areas for the Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016). ***Buib: Bubulcus ibis; Caau: Cathartes aura; Buma: Buteo magnirostris; Geca: Geranospiza caerulescens; Jasp: Jacana spinosa; Zeas: Zenaida asiática; Pata: Patagioenas flavirostris; Coin: Columbina inca; Cota: Columbina talpacoti; Euca: Eupsittula canicularis; Crsu: Crotophaga sulcirostris; Tyal: Tyto alba; Nyal: Nyctidromus albicollis; Eusu: Eumomota superciliosa; Cham: Chloroceryle americana; Meau: Melanerpes aurifrons; Pisu: Pitangus sulphuratus; Cafo: Calocitta Formosa; Tugr: Turdus grayi; Sepe: Setophaga petechia xantholora; Didi: Dives dives; Qume: Quiscalus mexicanus; Icgu: Icterus gularis***

Abundance of bird species in project area of influence.

The most abundant species during this study were *Zenaida asiática, Catarthes aura, Quiscalus mexicanus* and *Brotogeris jugularis.* The majority of species had an intermediate abundance and some that were of a single observation.

The other endangered species at the national level had a significant abundance. (See figure 35).

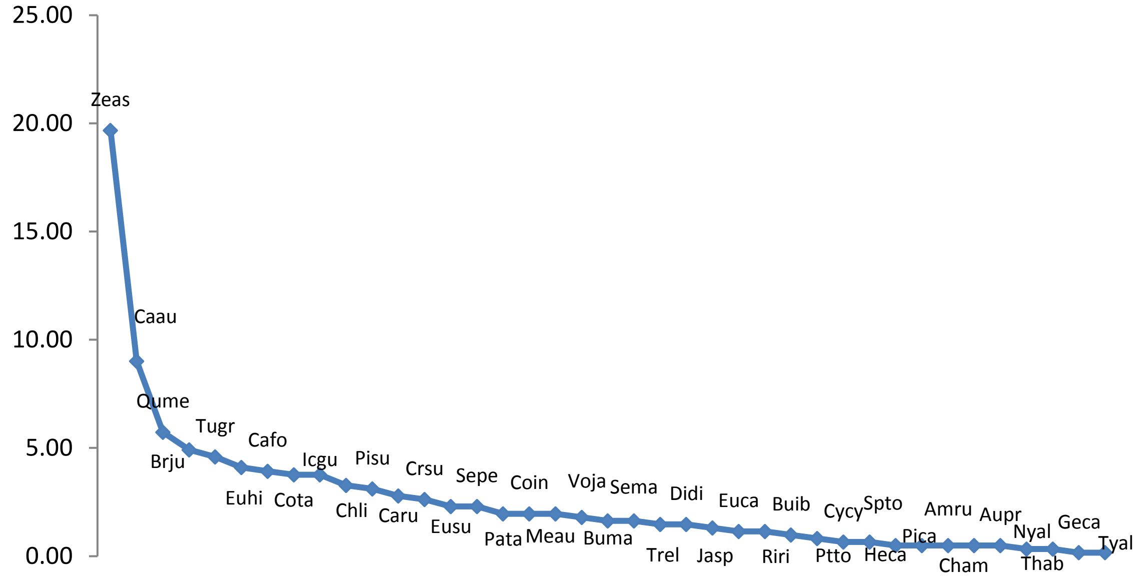

Figure 35. Range-abundance plot of bird species in the areas of influence of the Transmission Line Project of Energía del Pacífico S.A. de C.V. (may 2016).*Buib: Bubulcus ibis; Caau: Cathartes aura; Buma: Buteo magnirostris; Geca: Geranospiza caerulescens; Heca: Herpetotheres cachinnans; Jasp: Jacana spinosa; Zeas: Zenaida asiática; Pata: Patagioenas flavirostris; Coin: Columbina inca; Cota: Columbina talpacoti; Brju: Brotogeris jugularis; Euca: Eupsittula canicularis; Pica: Piaya cayana; Crsu: Crotophaga sulcirostris; Tyal: Tyto alba; Nyal: Nyctidromus albicollis; Amru: Amazilia rutila; Trel: Trogon elegans; Eusu: Eumomota superciliosa; Cham: Chloroceryle americana; Aupr: Aulacorhynchus prasinus; Ptto: Pteroglossus torquatus; Meau: Melanerpes aurifrons; Chli: Melanerpes aurifrons; Pisu: Pitangus sulphuratus; Cafo: Calocitta Formosa; Riri: Riparia riparia; Caru: Campylorhynchus rufinucha; Tugr: Turdus grayi; Sepe: Setophaga petechia xantholora; Sema: Setophaga magnolia; Cycy: Cyanerpes cyaneus; Thab: Thraupis Abbas; Voja: Volatinia jacarina; Spto: Sporophila torqueola; Didi: Dives dives; Qume: Quiscalus mexicanus; Icgu: Icterus gularis; Euhi:Euphonia hirundinacea.*

Species accumulation curve

The review of the accumulation curve of species recorded during the study indicates (Figure 36) that not all predicted species were recorded. Through the study were 39 species in total and several species that were expected to occur in the area could not be census.

The following figure shows a comparison between the species recorded during the present study versus the species that show the wealth estimators.

Table 9 also shows the number of species that can occur in the area according to the wealth estimators.

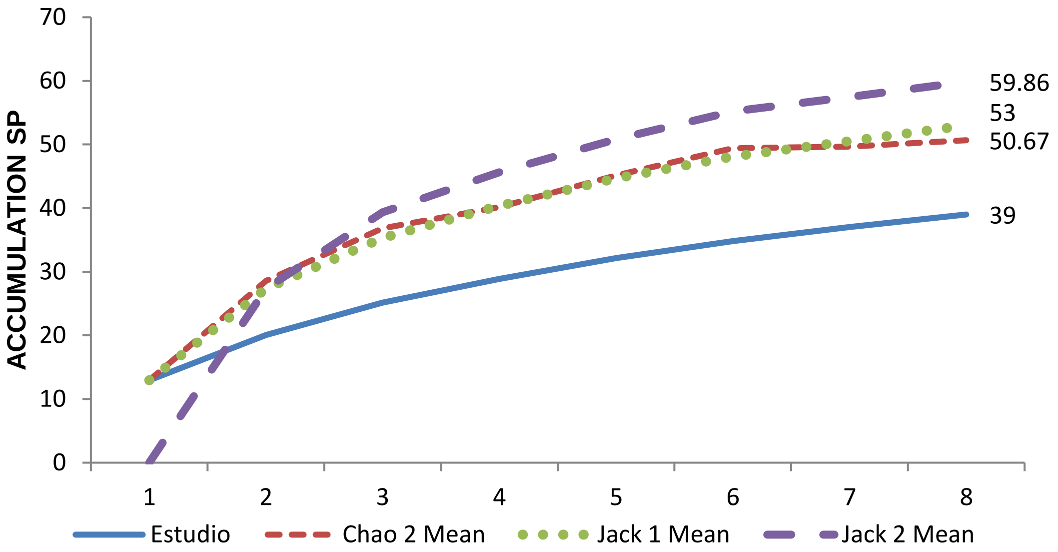

Figure 36. Curve of accumulation of bird species for the Transmission Line Project of Energía del Pacífico, May and June 2016.

Table 9 Wealth estimators of bird species for the Transmission Line Project of Energía del Pacífico, May and June 2016.

Estimator	Species richness
Estudio	39
ACE	39,77
ICE	56,81
Chao 1	39,33
Chao 2	50,67
Jack-Knife 1	53
Jack- Knife 2	59,86

Diversity of birds

The species diversity was analyzed through two indexes (Shannon and Simpson). According to the Shannon index, the diversity value is 3.14 (from a scale of 1 to 6), which is interpreted as a range of diversity of birds with mean value in the Area. However, it must be taken into account that according to the Wealth estimators inventory is not complete and it is necessary to increase sampling effort to record and monitor bird populations. It must be taken into account that the area has species of importance for conservation.

The Simpson index yielded a value of 0.83, indicating that there is a high probability that the first two randomly selected species will be the same. This is due to the dominance of some species found in this site. When reviewing the figure x of general abundances for the site it is possible to corroborate that there are two species of birds with greater presence in the area reason why one has this value of Simpson.

Diversity indexes by habitat.

Table 10. Index of diversity of bird species recorded in different habitats for the Transmission Line Project of Energía del Pacífico, May and June 2016

Indexes	Coffee plantation	Natural Forest	Agricultural Areas
Shannon	2,64417421	2,60426691	2,706411046
Simpson	0,9017334	0,89960231	0,891769168

In the previous table, it is observed that all the sampled habitats present similar values of both species diversity and dominance.

Diversities in the three habitats are considered low by half, however, we must take into account the level of completion of the inventory that does not finish stabilizing according to the curve of accumulation of species and wealth estimators.

SPECIES OF BIRDS OF IMPORTANCE IN THE AREA

Species of importance for conservation

The majority of species that were recorded during the present study are not in the official lists of species with conservation status, with the exception of four species that are reported with status of threatened at national level.

The remaining species are widely distributed or habitat generalists, and are not listed in species threatened with extinction.

Brotogeris jugularis:

Specie of perico known as "catalnica" (figure 37) that register a good population in the area. It is a threatened species at the national level. Its main risks for its conservation are the destruction of habitat and human predation since this species is usually captured at an early age in their nests (talchinol), and then marketed in order to be restricted to captivity.

Figure 37. Brotogeris jugularis; Species evaluated with minor LC concern by IUCN but found in CITES Appendix II and Threatened by MARN 2015 photographed in the area of Transmission Line Project of Energía del Pacífico S.A. de C.V. (may-june 2016).

Eupsittula canicularis

Another species of parakeet popularly known as chocoyo, like the previous species, its main risks are the predation for illegal commercialization and the loss of habitat. (Specie threatened MARN).

Figura 38. Eupsittula canicularis; Species evaluated with minor LC concern by IUCN but found in CITES Appendix II and Threatened by MARN 2015 photographed in the area of *Transmission Line Project of Energía del Pacífico S.A. de C.V. (may-june 2016).*

***Geranospiza caerulescens*.**

It is a bird of prey of approximately 46 cm of length, confident, that jumps between the branches of the trees. Make short flights. It has a light gray coloration. Long and narrow tails, black barrel of cinnamon and white. Known as hawk mosquito is a species with endangered status at the national level until 2009 however in the recent listing with the input of several observers and specialist has been removed from the list of threatened or endangered species of El Salvador (figure 39).

Figura 39. ***Geranospiza caerulescens*** **Species evaluated with minor LC concern by IUCN but found in CITES Appendix II and Threatened by MARN 2015 photographed in the area of** ***Transmission Line Project of Energía del Pacífico S.A. de C.V. (may-june 2016).***

CONCLUSIONS AND RECOMMENDATIONS

Herpetofauna.

The diversity of amphibians and reptiles in the Area is considered low (according to Shannon), with a dominance of one or two species in the area (Simpson). A total of 15 species were recorded during 6 days of research, representing 11% of the total amphibians and reptiles registered in the country (133). All species recorded in the area can be found in similar habitats in the country (coffee plantation under shade), ranging in height from 800 to 1.300 meters above sea level.
The inventory of amphibians and reptiles 40% since there are still several species that have been reported in other studies in similar habitat type.

Two significant populations of the Black-Eyed Tree Frog were recorded (*Agalychnis moreletii*) In the fincas santa Rita and Tequendama. Which are in the lists of species threatened of extinction at world and national level.

<u>It is recommended</u>:

- That future inventory efforts are made especially with the reptile group, since a greater effort of sampling could lead to the registration of a greater number of species and the obtaining of more data that allow a better analysis of the real wealth of this group in the area.

- Create monitoring protocols for threatened species at the global and national levels that have been registered in the area to determine the behavior of the species over the years.

- To establish measures of protection in the surroundings of the reservoir piles of the farms was found population of the Black-Eyed Tree Frog (*Agalychnis moreletii*).

- The construction of exclusive water collection cells for the reproduction of such an important species.

- And, in turn, promote conservation educational campaigns to owners and inhabitants of the area as well as encourage owners to move to an organic coffee crop without agrochemicals in the area of influence of the project where they found the largest populations of this amphibian.

- Hire a specialized institution or technicians who present and execute a Capture and Release Plan for specimens of the different species of reptiles and amphibians, prior to the opening of access roads and construction works in the maneuvering areas and places where the towers will be built in agreement with the authorities of the Ministry of Environment and Natural Resources MARN.

Mastofauna.

The diversity of mammals is considered low (according to Shannon), with a dominance of one to three species in the area (Simpson). A total of 14 species were recorded during 6 days of research. All species registered in the Area can be found in similar habitats in the country (coffee plantation under shade), in a height range of 800 to 1,300 meters above sea level.

However, it is necessary to emphasize that to have a more accurate inventory of this group it is necessary to have a greater effort of sampling since the methods like photographic traps, traditional traps or trail tracks are methods that obtain good results must be exercised for periods of weeks or months in the field. Since these species are very sensitive to odors or human intrusion.

<u>It is recommended</u>:

- For the development of this project, the capture and mobilization of mammal species should be considered in another safe area and away from the development of the project.

Avifauna.

For the present study, we recorded a total of 39 species of birds, the diversity indexes yielded an average value and a high dominance since the indexes were 3.14 for Shannon (range from 1 to 6) and 0.84 for Simpson. To emphasize that according to the curve of accumulation and the indexes of wealth would lack the registration of more species to complete the inventory.

On the other hand, the climatic conditions during the realization of the present study were not the ideal ones to census the majority of occurring species.

<u>It is recommended</u>:

- The birds found in the region are transient, temporary or permanent in the area where the construction works of the transmission line were carried out; For which the personnel of the work must refrain from disturbing, buying and / or hunting, any type of wild bird that is located in the work areas.

- For the verification of nests is convenient the use of binoculars, since they would facilitate the location of these, prior to the activities of opening of access roads, depopulation of the area of the tower and one of the most important that is the opening of the gap Forest, where the demolition of a large number of trees of good size is carried out, which can sometimes present clutches or nests of different species.

- When nests located in very high trees are located, every effort will be made to lower the nests to avoid damage to the birds that are there, as long as the nests are occupied.

- If it is possible to detect the presence of chicks, pups or eggs in nests found it is recommended not to touch or manipulate these with bare hands, because by having direct contact with them we can damage them. In this case it is necessary to relocate the nests in areas near the place where they were found, in order to facilitate the localization by the parents of the offspring or eggs so that they can continue to be fed or where appropriate incubated by the birds. If a wild bird is to be completely relocated and is injured and unable to fly, the security personnel and environment of the project should be advised to perform the rescue. Likewise, the corresponding authorities (MARN) will be notified so that they designate the place or zone where they will be taken to provide them with the necessary attention.

- All previous recommendations must be made by specialized institution or technicians contracted within a species capture and release plan.

- Once the towers have been constructed, bird-saving devices should be placed (Figure 40) every 10 or 15 meters on the guard wire between spans that attract the Apaneca mountain range and those near the coast where pelicans and other birds occur.

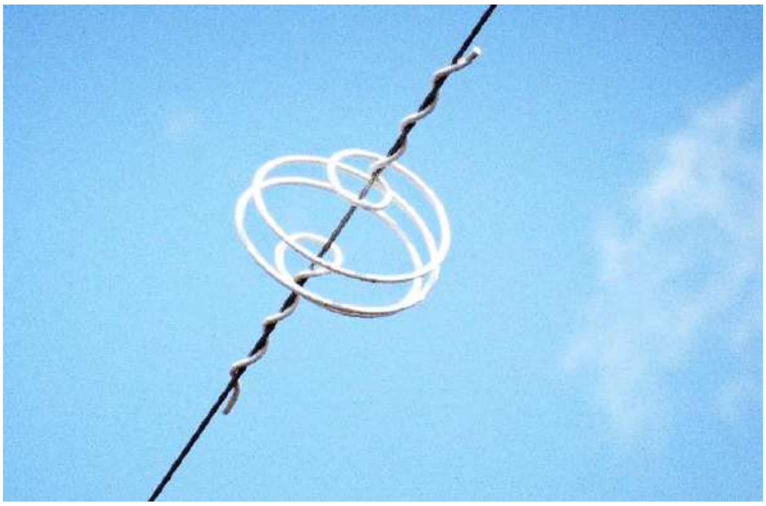

Figura 40. Bird-saving devices Spiral type used to prevent birds from colliding with high voltage cables.

- El Salvador is a territory of passage of migrations of birds, there are two periods in the year in which migrations from north to south and vice versa, during the months of October to November and April to May, so it is recommended to carry out Monitoring of the effectiveness of the bird-saving devices at least once a year preferably in the month of October.

ANNEXES

Annex 2: Coordinates established for the study of Transmission Line Project of Energía del Pacífico S.A. de C.V. May 2016.

GEOGRAPHICAL COORDINATES OF THE SAMPLING UNITS DEFINED FOR THE STUDY OF FAUNA																				
				Transect			Habitat			P.observation		LATITUDE			LENGTH					
Nª	Canton	Municipality	TP or span	Start	End	Nª	A	b	c		Nª	º	mm'	ss"	º	mm'	ss"	Lambert E	Lambert N	Observations
1	San Julian	Acajutla	TP 145	X		1	X			X	1	13	35	23,13	89	48	18,1	412878,987	274540,45	Presa El Venado
2	San Julian	Acajutla	TP141			1	X			X	2	13	35	47,05	89	48	1,41	413383,157	275273,821	RIO EL VENADO
3	San Julian	Acajutla	TP 139		X	1	X			X	3	13	36	7,10	89	47	53,2	413631,998	275889,124	RIO EL VENADO
4	San Julian	Acajutla	TP 126	X		2	X			X	4	13	37	23,54	89	47	38,98	414067,205	278236,66	Río Sensunapán
5	San Julian	Acajutla	TP 124			2	X			X	5	13	37	40,32	89	47	31,3	414299,741	278751,538	Río Sensunapán
6	San Julian	Acajutla	TP119-TP118		X	2	X			X	6	13	38	15,52	89	47	27,42	414419,918	279832,828	Río Sensunapán
7	Santa Emilia	Sonsonate	TP112-TP113	X		3	X			X	7	13	39	12,80	89	47	36,5	414152,824	281593,906	Río La Arrocera, El Coyol
8	Santa Emilia	Sonsonate	TP111-TP112			3	X			X	8	13	39	28,07	89	47	37,4	414127,325	282063,233	Río La Arrocera, El Coyol
9	Santa Emilia	Sonsonate	TP110-TP111		X	3	X			X	9	13	39	38,81	89	47	39,17	414075,222	282393,442	Río La Arrocera, El Coyol
10	Las Tablas	Sonsonate	TP 100	X		4	X			X	10	13	41	2,68	89	47	26,32	414469,867	284969,447	Crossing line over street
11	Las Tablas	Sonsonate	TP99			4	X			X	11	13	41	7,61	89	47	27,44	414436,71	285121,053	Crossing line over street
12	Las Tablas	Sonsonate	TP98		X	4	X			x	12	13	41	13,28	89	47	28,71	414399,121	285295,415	Crossing line over street
13	Talp	Apaneca	TP 44-TP44a	X		5		X		X	13	13	48	38,48	89	48	26,07	412721,44	298981,944	forest patch
14	Tapaneca	Apaneca	TP 44-TP44a			5		X		X	14	13	48	42,90	89	48	23,8	412790,07	299117,541	forest patch
15	Tapaneca	Apaneca	TP 44-TP44a		X	5		X		X	15	13	48	48,05	89	48	21,43	412861,779	299275,56	forest patch

GEOGRAPHICAL COORDINATES OF THE SAMPLING UNITS DEFINED FOR THE STUDY OF FAUNA																				
				Transect			Habitat			P.observation		LATITUDE			LENGTH					
Nª	Canton	Municipality	TP or span	Start	End	Nª	A	b	c		Nª	º	mm'	ss"	º	mm'	ss"	Lambert E	Lambert N	Observations
16	Tapaneca	Apaneca	TP44	X		6		X		X	16	13	48	47,28	89	48	30,35	412593,807	299252,798	forest patch
17	Tapaneca	Apaneca	TP42-TP44			6		X		X	17	13	48	54,54	89	48	31,16	412570,231	299475,977	forest patch
18	Quezalapa	Apaneca	TP42-TP45		X	6		X		X	18	13	49	1,12	89	48	31,62	412557,096	299678,225	forest patch
19	Quezalapa	Apaneca	TP42	X		7			X	X	19	13	49	4,72	89	48	35,09	412453,256	299789,203	private farm
20	Quezalapa	Apaneca	TP 41			7			X	X	20	13	49	13,69	89	48	36,82	412402,229	300065,024	private farm
21	Quezalapa	Apaneca	TP 40		X	7			X	X	21	13	49	22,30	89	48	38,5	412352,668	300329,777	private farm
22	Quezalapa	Apaneca	TP 39	X		8		X		X	22	13	49	27,59	89	48	42,21	412241,800	300492,713	forest patch
23	Quezalapa	Apaneca	TP 39-TP38			8		X		X	23	13	49	35,25	89	48	40,64	412289,743	300727,944	forest patch
24	Quezalapa	Apaneca	TP 38		X	8		X		X	24	13	49	42,02	89	48	38,67	412349,606	300935,785	forest patch
25	Quezalapa	Apaneca	TP 38	X		9		X		X	25	13	49	47,28	89	48	37,88	412373,875	301097,343	forest patch
26	Quezalapa	Apaneca	TP 38			9		X		X	26	13	49	54,87	89	48	35,07	412459,046	301330,298	forest patch
27	Quezalapa	Apaneca	TP 38		X	9		X		X	27	13	50	1,33	89	48	32,13	412548,003	301528,515	forest patch
28	Quezalapa	Apaneca	TP39-TP38	X		10			X	X	28	13	49	37,60	89	48	44,08	412186,68	300800,507	private farm
29	Quezalapa	Apaneca	TP 38			10			X	X	29	13	49	45,22	89	48	45,86	412134,016	301034,849	private farm
30	Quezalapa	Apaneca	TP37		X	10			X	X	30	13	49	52,70	89	48	47,1	412097,555	301264,833	private farm
31	Quezalapa	Apaneca	TP 36	X		11			X	X	31	13	50	7,10	89	48	50,6	411993,947	301707,697	private farm
32	Quezalapa	Apaneca	TP 35			11			X	X	32	13	50	12,19	89	48	51,83	411957,54	301864,237	private farm

GEOGRAPHICAL COORDINATES OF THE SAMPLING UNITS DEFINED FOR THE STUDY OF FAUNA																				
				Transect			Habitat			P.observation		LATITUDE			LENGTH					
Nª	Canton	Municipality	TP or span	Start	End	Nª	A	b	c		Nª	º	mm '	ss"	º	mm '	ss"	Lambert E	Lambert N	Observations
33	Quezalapa	Apaneca	TP35-TP34		X	11			X	X	33	13	50	16,70	89	48	53,1	411919,871	302002,958	private farm
34	Quezalapa	Apaneca	TP 34	X		12			X	X	34	13	50	20,90	89	48	54	411893,282	302132,114	private farm
35	Quezalapa	Apaneca	TP34-TP33			12			X	X	35	13	50	22,37	89	48	57,35	411792,837	302177,628	private farm
36	Quezalapa	Apaneca	TP33		X	12			X	X	36	13	50	25,10	89	48	54	411893,72	302261,179	private farm
37	El Saltillal	Ahuachapán	TP 18	X		13			X	X	37	13	52	53,20	89	49	13,45	411325,176	306814,257	private farm
38	El Saltillal	Ahuachapán	TP 17			13			X	X	38	13	53	8,68	89	49	15,21	411273,957	307290,137	private farm
39	El Saltillal	Ahuachapán	TP 15- TP 16		X	13			X	X	39	13	53	24,63	89	49	17,42	411209,28	307780,506	private farm
40	El Saltillal	Ahuachapán	TP 14	X		14		X		X	40	13	53	39,90	89	49	19,71	411142,131	308249,987	forest patch
41	El Saltillal	Ahuachapán	TP 13- TP 12			14		X		X	41	13	53	57,24	89	49	21,58	411087,812	308783,037	forest patch
42	El Barro	Ahuachapán	TP 11		X	14		X		X	42	13	54	14,36	89	49	23,54	411030,771	309309,336	forest patch
43	Los Magueyes	Ahuachapán	TP 4	X		15	X			X	43	13	55	3,63	89	49	9,2	411466,432	310821,935	GEO
44	Los Magueyes	Ahuachapán	TP 3			15	X			X	44	13	55	7,57	89	49	9,37	411461,741	310943,028	GEO
45	Los Magueyes	Ahuachapán	TP 3- TP 2		X	15	X			X	45	13	55	13,30	89	49	9,73	411451,534	311119,148	GEO

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APPENDIX C

REPORT OF BATS IN PROJECT TRANSMISSION LINE OF ENERGÍA DEL PACIFICO, S.A. DE C.V.

Technical Manager:

Kevyn Jeasson Junior Quijano Vásquez

May 2016

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1. Introduction

El Salvador is one of the Latin American countries with the lowest forest cover; Which in relation to its total area of its territory mean 362,700 ha; Only 17.5%; Of this area 3.7% is coniferous forest, 3.7% broadleaf forest, 2.0% mangrove forest; 0.3% forest plantations and the coffee forest 7.8%, equivalent to almost 50% of the country's forest cover (PROCAFE, 2009).

Shade coffee plantations are considered as agro ecosystems of great importance for the conservation of biodiversity, which is mainly associated with the existence of an arboreal stratum that conserves many of the functions and resources of forests transformed into coffee plantations, such as retention Humidity, shade, availability of nesting sites, shelter, fruit food, flowers and insects, etc. (Aguilar-Ortiz, 1982, Gallina *et al.*, 1996, Greenberg *et al.*, 1997, Calvo and Blake, 1998; Moguel and Toledo, 1999; Perfecto *et al.*, 2003).

Among the animals that use shade-grown coffee areas as habitat are bats that are considered as one of the most diverse and species richest groups in neotropical ecosystems, accounting for approximately 20% of the world's mammal species (Estrada-Villegas *et al*., 2010). In addition, they have a large number of ecosystem services to the environment such as: seed dispersal, insect pest control and pollination. In El Salvador, seven families have been registered, with 37 genera and 65 species (Owen *et al.*, 1991; Miller and Miller, 2001; Girón, 2005; Girón, 2011), so the conservation of areas that can provide shelter and food for this group of mammals is crucial for their protection.

2. Methodology

2.1 Capturing bats

In the places around the points of the towers TP2-3, TP33-34, TP36 and TP44-44a two mist nets were installed (one of 9m x 2.6m and one of 12m x 2.6m) which were located at ground level. The distance between each net was at least 150 m and were located in places with a reasonable amount of vegetation and / or on roads that could possibly serve as passage tunnels for bats. Sampling was carried out from 6:30 p.m. to 11:00 p.m., checking each net at 30 minute intervals, removing them from sites at the end of catches.

From each captured bat, measurements of forearm, weight, sex and reproductive condition were recorded using standard methodologies (Annex 1, b, c, d, e) (Kunz, 1988; Jones *et al.*, 1996), Photographs of their characteristic features were taken and were identified using the field guide of Medellín, Arita and Sánchez (2007), Later they were released in the vicinity of where they were captured. In addition, at each sampling site the geographic references of each point were taken with a GPS Garmin e Trex 20 Worlwide Handheld Navigator.

Figure 1. Laying of mist nets at sampling points near TP2-3.

2.2 Acoustic record of bats

In the vicinity of TP 139 tower in the Acajutla area an ultrasound recorder for monitoring of Song Meter SM3 bats was used (figure 2). The active ultrasound recorder (Echo Meter EM3+), Was not placed, because it presented configuration flaws.

The equipment was located in an open area and was programmed using monitoring methodologies (Víquez and Arias, 2015) (Figure 3), The recordings were made from 6:00 pm to 5:00 am, removing the equipment from the place the next day and georeferenced the sampling point with a GPS Garmin e Trex 20 Worlwide Handheld Navigator.

The acoustic recordings were analyzed by the program Analook (figure 2), to obtain sonograms that were used for the identification of species of insectivorous bats by the document Miller (2003).

Figure 2. Installation of Acoustic Equipment SME3 and Analysis of Sonograms.

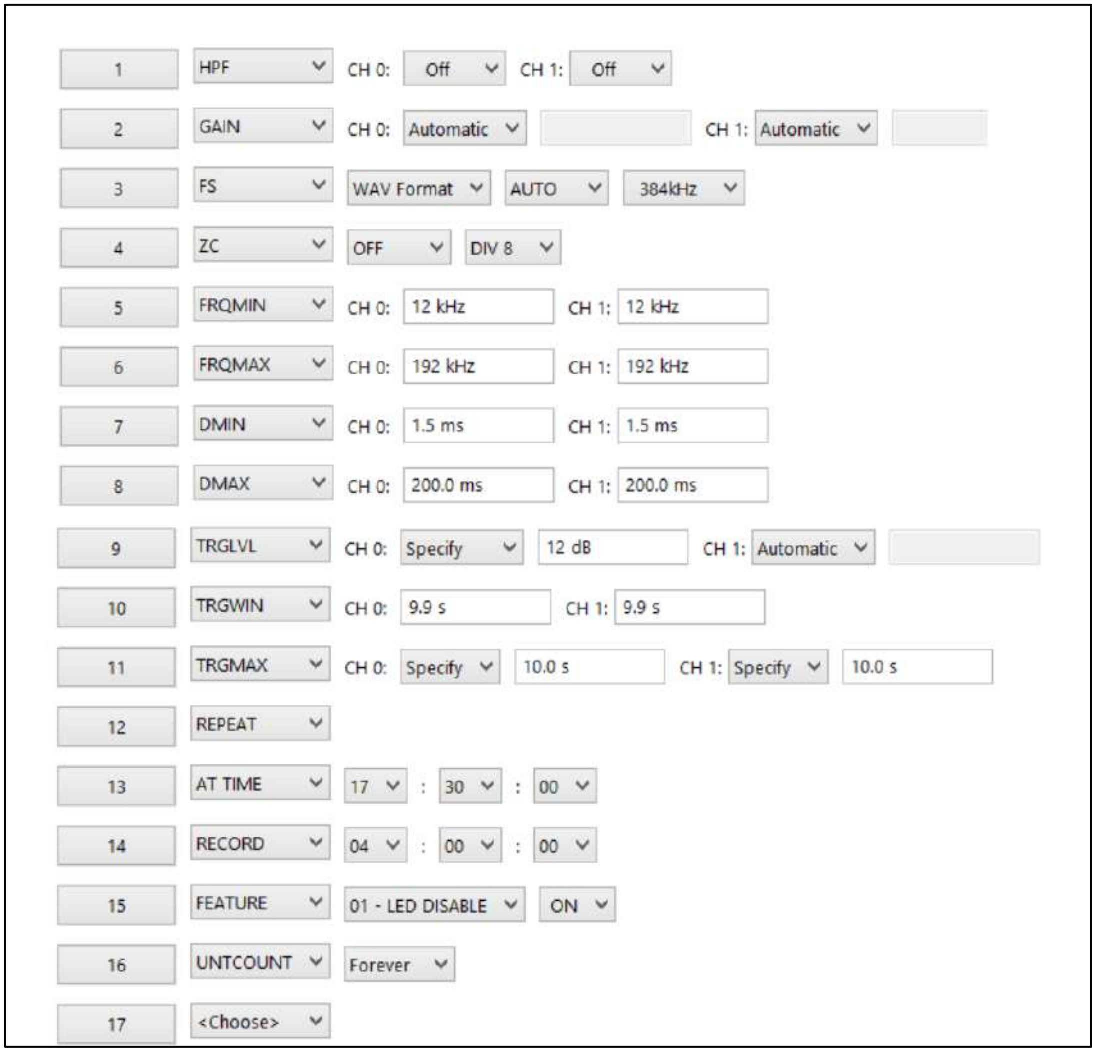

Figure 3. Programming the Song Meter SM3 Recording Equipment

2.3 Analysis of data

For the community analysis of bats we used the range-abundance curves (Feinsinger, 2003), species accumulation curves to compare the species acquired with respect to non-parametric wealth estimators Jacknife 1, Jacknife 2 and Chao 2 (González–Oreja *et al.*, 2010), Simpson's dominance index and Shannon-Weiner equitability.

Range-abundance curves are an important tool to visualize aspects of the assemblage as species richness, similarity, number of rare species and relative abundance of each species, curves have been suggested as an alternative way to compare the communities in different habitats (Feinsinger 2003).

A species accumulation curve is the graph of the number of species observed as a function of some measure of the sampling effort required to observe them (Colwell, Mao & Chang, 2004). These curves show the number of species accumulated as the harvesting effort increases in a site, so that the richness will increase until a time in which, although collected, the number of species will reach a maximum and will stabilize in one asymptote (Escalante, 2003).

Non-parametric wealth estimators, statistically speaking, do not assume the type of distribution of the data set and do not fit them into a given model, so only presence-absence data are required; based on the data, estimators can generate a range of possible species or rare species that need to be found in an inventory (Colwell, Mao & Chang, 2004).

3. Results

3.1 Sampling points

A total of 8 sampling points were obtained during the development of the field phase, the first sampling points were located around the span of towers 2-3 at an approximate height of 780 masl, the second sampling was performed in the span between tower 33-34 at an approximate height of 1440 masl, the third sampling in the vicinity of tower 36 at an approximate height of 1179 masl, the fourth tower sampling 44 (figure 4).

The remaining points proposed in the work plan for the capture of bats, TP 34, TP 40 and acoustic monitoring TP 35 TP 32 and TP 40; Were not taken into account due to security measures, since working at night and leaving equipment for so long, there is a high risk of theft in those areas.

Table 1. Geographical location of the sampling points of the Project Transmission Line of Energía del Pacifico, S.A. de C.V. (May 2016).

Date	Sampling Point	Sampling Point	Coordinate N	Coordinate W	Height (m)
28/05/2016	Span Tower 2-3	PLT 1	13°55'06.4"	89°49'09.9"	771
28/05/2016	Span Tower 2-4	PLT 2	13°55'07.6"	89°49'10.1"	767
28/05/2016	Span Tower 2-3	PLT 3	13°55'04.8"	89°49'08.9'	777
29/05/2016	Span Tower 33-34	PLT 4	13°50'21.0"	89°48'53.7"	1436
29/05/2016	Span Tower 33-34	PLT 5	13°50'20.0"	89°48'54.8"	1435
30/05/2016	Tower 36	PLT 6	13°49'26.8"	89°48'42.0"	1179
31/05/2016	Span Tower 44-44ª	PLT 7	13°48'32.4"	89°48'15.6"	966
01/06/2016	Tower 139	PLT 8	13°36'04.6"	89°47'49.6"	58

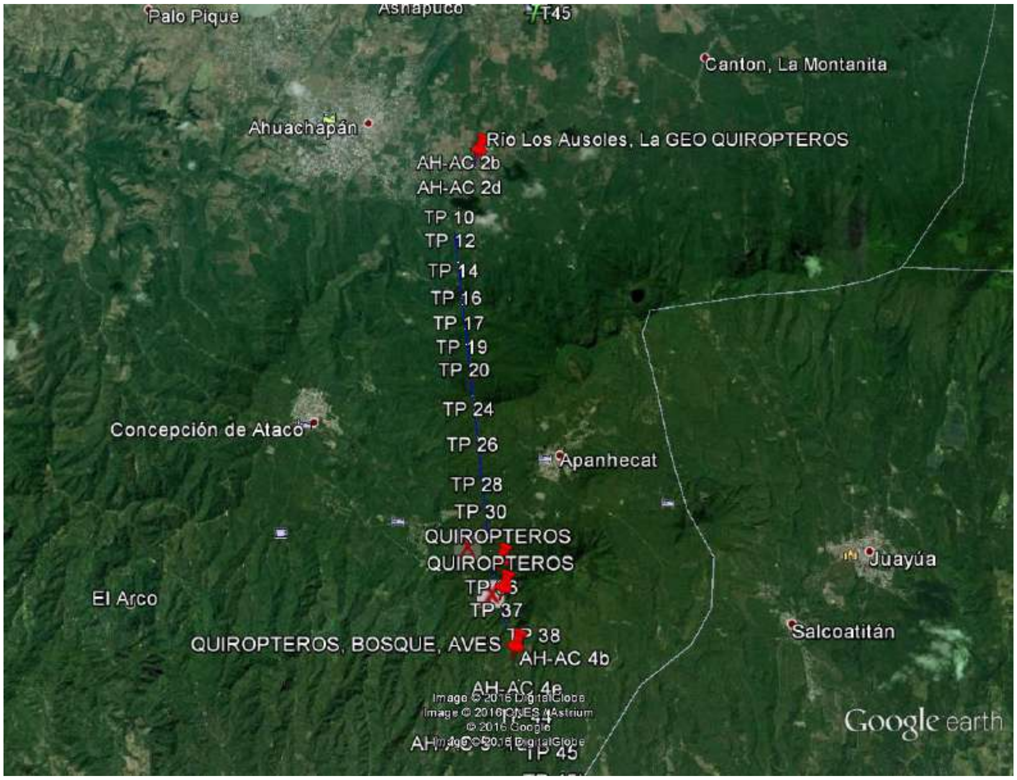

Figure 4. Georeferenced map of the points sampled (in red, points of bats).

3.2 Registered species

A total of 63 individuals belonging to 12 species of bats, eight genera and two families were captured by the mist net method. Using the acoustic monitoring method, 636 recordings were obtained from 9 species of insectivorous bats, 6 genera and 4 families.

Nine species were recorded for points VT2-3, VT33-34 and T139, being the most diverse among those sampled during the development of the work, however, it should be considered that for points T36 (N: 2) and T44- 44a (N: 5), was macerated with weather conditions so that sampling had to be completed ahead of time for the safety of both the team and the bats.

A large number of species of insectivorous (N: 10) and frugivorous (N: 9) habitats were obtained, so the environments around the sampling points should be considered healthy and could harbor tree species that may be Used by all species, as well as, fruit trees from which the fruiting species are being fed.

Although it was only possible to capture *P. discolor* In the vicinity of VT44-44a the points between them do not have so much difference in their altitudes and less still in their proximity; So that its distribution in the surroundings could also be considered of the other zones sampled.

Figure 5. *Glossophaga commissarisi*

Figure 6. *Artibeus inopinatus*

Table 2. List of species of bats by points of placement of towers in the Project Transmission Line of Energía del Pacifico, S.A. de C.V. (May 2016). MRN: Method of mist nets; MA: Acoustic monitoring; OM: Omnivore; NE: Nectariferous; FR: Frugivore; IN: Insectivorous; VT2-3: Tower span 2-3; VT33-34: Tower Span 33-34; T36: Tower 36.

Family	Specie	Common name	Habitat	MRN				MA
				VT3-2	VT33-34	T36	VT44-44a	T139
Phyllostomidae	*Phyllostomus discolor*	Pale spear-nosed bat	OM				X	
	Glossophaga commissarisi	Commissaris's long-tongued bat	NE	X	X			
	Glossophaga soricina	Pallas's long-tongued bat	NE	X				
	Artibeus inopinatus	Honduran fruit-eating bat	FR	X				
	Artibeus jamaicensis	Jamaican fruit bat	FR	X	X	X	X	
	Artibeus lituratus	Great fruit-eating bat	FR	X	X		X	
	Chiroderma salvini	Salvin's big-eyed bat	FR	X	X			
	Dermanura aztecus	Aztec fruit-eating bat	FR				X	
	Dermanura toltecus	Toltec fruit-eating bat	FR		X			
	Platyrrhinus helleri	Heller's broad-nosed bat	FR	X	X			
	Sturnira hondurensis	Honduras yellow-shouldered bat	FR		X	X		
	Sturnira parvidens	Northern yellow-shouldered bat	FR	X	X		X	
Mormoopidae	*Pteronotus davyi*	Davy's naked-backed bat	IN					X
	Pteronotus gymnonotus	Big naked-backed bat	IN					X
	Pteronotus personatus	Wagner's mustached bat	IN					X
Emballonuridae	*Saccopteryx bilineata*	Greater sac-winged bat	IN					X
Molossidae	*Molossus molossus*	Velvety free-tailed bat	IN					X
	Molossus sinaloe	Sinaloan mastiff bat	IN					X
Vespertilionidae	*Myotis nigricans*	Black myotis	IN					X
	Myotis keaysi	Hairy-legged myotis	IN	X				
	Lasiurus intermedius	Northern yellow bat	IN					X
	Rhoggessa bickhami	Beckhams Little Yellow Bat	IN		X			X
Total				9	9	2	5	9

3.3 Species per tower point

For VT3-4 a greater abundance was found in the specie *G. commissarisi* (N:19) which has nectariferous habits mainly, followed by *A. jamaicensis* (N: 6), *A. lituratus* (N:4), *C. salvini* (N:4), *G. soricina* (N:4), and in lower abundance *M. keaysi, P. helleri, S. hondurensis* and *A. inopinatus*; although the area is located in a river that in its borders owns vegetation constituted mainly by bamboo, the zone is used by several species of bats possibly as zone of transit between areas.

For VT 33-34, a higher abundance was reported in the species *G. commissarisi* (N:6), s followed by *A. lituratus* (N:5), *A. jamaicensis* (N:4), and in lower abundance *C. salvini, D. toltecus, P. helleri, R. tumida, S. hondurensis* and *S. parvidens*. For being a forested area considered as coffee plantation under shade, has a large number of fruit trees in its surroundings, which could explain the diversity of species with frugivorous habits, so it is possibly a feeding zone for these species, and the presence of other species in the area is not ruled out.

For the point T36 only two species of bats were reported, however, the climatic conditions made it difficult to catch them, but due to the similarity of the area with the point VT 33-34, the same species can be considered for this zone. Of even greater importance since it has a forest area greater than that of VT 33-34.

In the point VT44-44ª Species of frugivorous and some omnivorous habits were reported (*P. discolo*r), which can be fed with insects, fruits, pollen, nectar, even frogs, being a species with a great variety of eating habits.

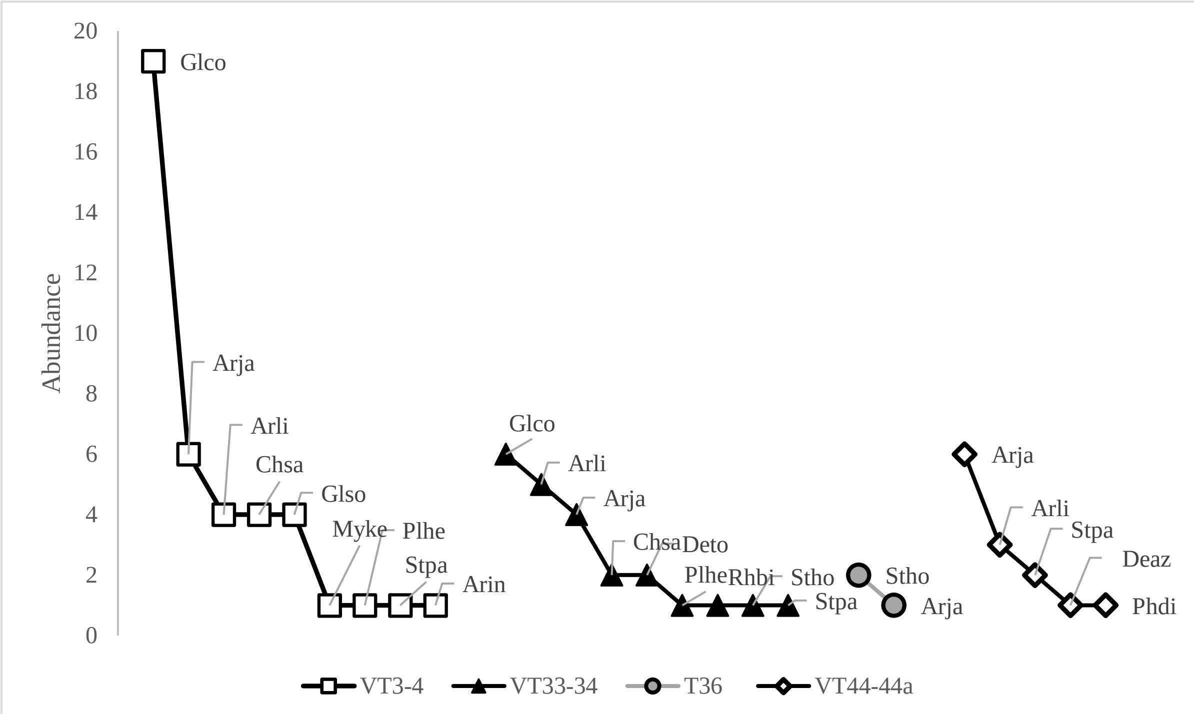

Figure 7. Range-abundance plot of bat species captured by tower point zone of Project Transmission Line of Energía del Pacifico, S.A. de C.V. (may 2016). Glco: *Glossophaga commissarisi;* Arja: *Artibeus jamaicensis*; Arli: *Artibeus lituratus*; Chsa: *Chiroderma salvini*; Glso: *Glossophaga soricina*; Myke: *Myotis keaysi*; Plhe: *Platyrrhinus helleri*; Stpa: *Sturnira parvidens*; Arin: *Artibeus inopinatus*; Deto: *Dermanura toltecus*; Deaz: *Dermanura aztecus*; Rhbi: *Rhoggessa bickhami*; Stho: *Sturnira hondurensis*; Phdi: *Phyllostomus discolor*.

3.4 Total species

During the course of the work, 14 species of bats were recorded (figure 8), from which a greater total abundance of *G. commissarisi* (N: 25) species of nectariferous habits, so it is considered that there is an abundance of trees that can be pollinated by it, can also indicate a flowering of most plants in the area.

A total of 9 species of frugivorous habits were obtained, among them (*Artibeus, Dermanura and Sturnira*) species considered tolerant or adaptable to disturbed environments (Fleming, 1986; Galindo-González, 2004; Sosa et al., 2008), So it is considered that the areas could house shrubs (genders *Solanum, Piper, Cestrum*) or trees (genders *Ficus, Inga, Cecropia, Psidium, Spondias, Persea* among others) Which can provide food to frugivorous species (Sosa et al., 2008).

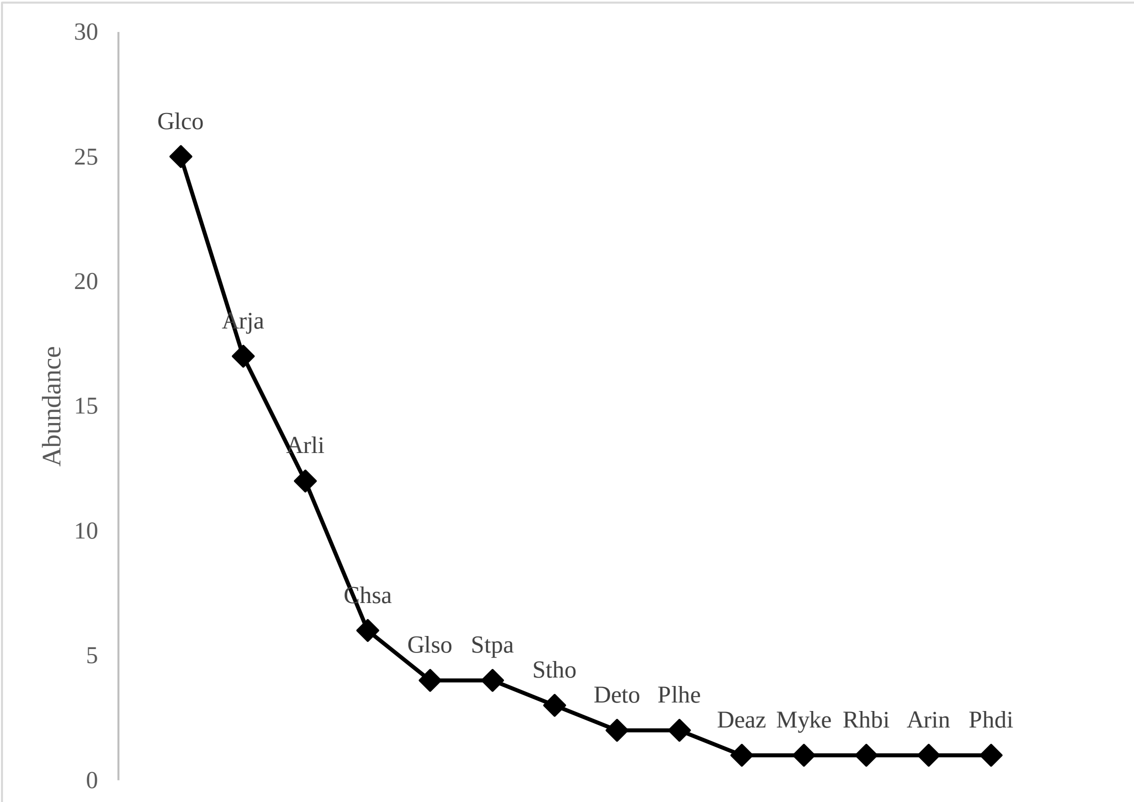

Figure 8. Range-abundance plot of species of bats captured in the towers location areas of the Project Transmission Line of Energía del Pacifico, S.A. de C.V. (may 2016). Glco: *Glossophaga commissarisi;* Arja: *Artibeus jamaicensis*; Arli: *Artibeus lituratus*; Chsa: *Chiroderma salvini*; Glso: *Glossophaga soricina*; Myke: *Myotis keaysi*; Plhe: *Platyrrhinus helleri*; Stpa: *Sturnira parvidens*; Arin: *Artibeus inopinatus*; Deto: *Dermanura toltecus*; Rhbi: *Rhoggessa bickhami*; Stho: *Sturnira hondurensis*.

3.5 Sampling Effort

Wealth estimators suggest a presence of 17 to 21 species of bats in the area, compared to this study of which only 12 have been recorded (Table 3 and figure 9).

Table 3. Expected bat wealth estimators.

Indexes	Value
Jack 1 Mean	17
Jack 2 Mean	19
Chao 2 Mean	21

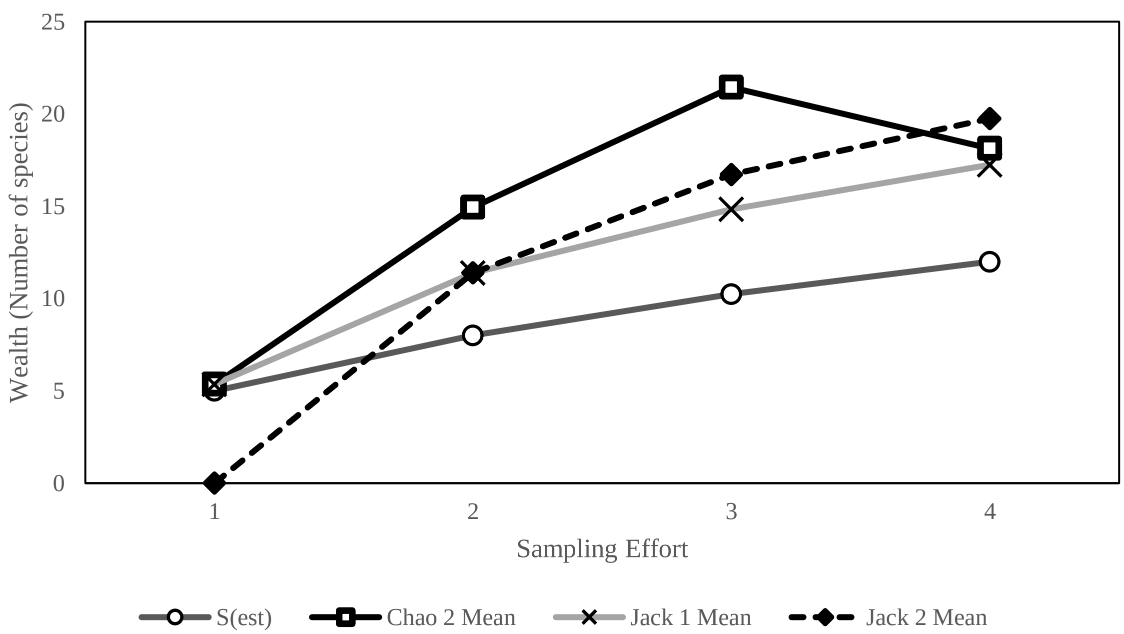

Figure 9. Curve of species accumulation for the Project Transmission Line of Energía del Pacifico, S.A. de C.V. (May 2016).

4. Conclusions

Throughout the different sampling points, a great variety of species of bats of frugivorous habit could be observed so that all the points can be considered areas of feeding and shelter. This can be attributed to the fact that the entire Apaneca-Ilamatepec mountain range consists mainly of shade-grown coffee areas, with remnants of forest in certain areas, and with the presence of fruit trees, this set of factors could be influencing the species to feed in the vicinity of coffee plantations and to use trees in areas that have not been so disturbed.

For the area of Acajutla, only one point of acoustic monitoring was realized, located in a cattle zone, with little vegetation and bordering to a river; Where records of 9 species of insectivorous bats, and although the area has a great alteration by the use of soil for livestock pastures, the site is possibly used by bats as a way of passage between their refuges and their feeding areas.

The line of tower placement that crosses the Apaneca-Ilamatepec mountain range towards the Acajutla zone has a high diversity of bats, so it should be considered as a complete trail of the species, since certain frugivorous species can fly distances of 3-5 km from their shelter sites (Galindo, 1998) so that the mountain range could be used as a refuge and feeding zone.

5. Proposed intervention

Among the measures that must be taken to mitigate damages to the bat community are:

- Planting trees gender *Cecropia* (Guarumo), *Ficus* (Rubber stick), *Inga* (paterna, pepeto), *Persea* (Avocado) *Spondia* (Jocote) Or gender shrubs *Piper* (Piper), *Solanum* (Wild tomatoes), these are plants from which fruit bats feed on disturbed or secondary forests (Lobova *et al.*, 2009; Sosa *et al.*, 2008).

- Reduce the area of placing of towers of the stipulated of 20m to each side to 10m, this with the objective of avoiding the unnecessary clearing of trees that can be being used by the bats and other species of mammals, like refuge and food.

No action is recommended on the effects of magnetic fields, collisions or electrocutions that the towers may cause to bats, since there are no records to date of such an effect (Riviera *et al.*, 2014).

Other documents have recorded as the only interaction between the chiroptera and the electronic lines the location of structures (towers) that physically obstruct and / or destroy places of refuge, sleeping or feeding. However, this is not exclusive of electrical structures but common to any structure of anthropic origin (Buildings, antennas, etc..) (Cris Hein, com. pers. Taller de expertos. Santiago, Julio 2014; Riviera *et al.*, 2014).

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7. Annexes

Annex 1. Capture and take of biometric data of bats; (A) capture of bats; (B) Weight; (C) Forearm measurement; (D) Species identification; (E and f) Reproductive status.

Annex 1 b. List of species of bats with their biometric data of VT3-4; Correlate, Date, Family, Species, Weight, Forearm, Sex and Reproductive Stage (Scrounged; Lactating; Pregnant; N= normal).

Correlative	Date	Family	Specie	Weight each bat (gr)	Weight Bag (gr)	Total weight (gr)	Forearm (mm)	Sex	Reproductive stage
1	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	40	5	35	male	Scrounged
2	28/5/2016	Vespertilionidae	*Myotis keaysi*	46	40	6	33	male	N
3	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	50	43	7	35	male	Scrounged
4	28/5/2016	Stenodermatinae	Artibeus jamaicensis	80	40	40	59	female	Lactating
5	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	48	40	8	33	male	N
6	28/5/2016	Glossophaginae	*Glossophaga soricina*	49	41	8	32	female	N
7	28/5/2016	Stenodermatinae	*Artibeus lituratus*	89	41	48	69	female	N
8	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	49	43	6	36	female	Pregnant
9	28/5/2016	Stenodermatinae	*Artibeus jamaicensis*	90	41	49	62	male	N
10	28/5/2016	Glossophaginae	*Glossophaga soricina*	50	41	9	35	male	Scrounged
11	28/5/2016	Stenodermatinae	*Sturnira parvidens*	53	40	13	40	female	N
12	28/5/2016	Stenodermatinae	*Artibeus jamaicensis*	100	41	59	57	female	Pregnant
13	28/5/2016	Stenodermatinae	*Artibeus jamaicensis*	88	40	48	56	male	Scrounged
14	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	40	5	38	male	N
15	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	48	40	8	35	male	Scrounged
16	28/5/2016	Stenodermatinae	*Artibeus lituratus*	98	40	58	70	female	N
17	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	41	4	35	male	Scrounged
18	28/5/2016	Glossophaginae	*Glossophaga soricina*	48	40	8	34	male	N
19	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	43	40	3	36	female	Lactating
20	28/5/2016	Stenodermatinae	*Platyrhinus helleri*	60	43	17	46	male	N
21	28/5/2016	Glossophaginae	*Glossophaga soricina*	49	40	9	35	male	Scrounged
22	28/5/2016	Stenodermatinae	*Artibeus lituratus*	100	40	60	73	female	N
23	28/5/2016	Stenodermatinae	*Chiroderma salvinii*	54	40	14	45	male	Scrounged
24	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	44	40	4	34	female	N

25	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	46	40	6	36	female	N
26	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	49	41	8	36	female	N
27	28/5/2016	Stenodermatinae	*Artibeus jamaicensis*	98	43	55	62	female	N
28	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	40	5	35	female	N
29	28/5/2016	Phillostominae	*Artibeus inopinatus*	100	40	60	76	male	N
30	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	48	40	8	33	male	N
31	28/5/2016	Stenodermatinae	*Artibeus lituratus*	85	43	42	70	male	N
32	28/5/2016	Stenodermatinae	*Chiroderma salvinii*	55	40	15	48	female	N
33	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	49	40	9	35	male	Scrounged
34	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	47	40	7	32	male	Scrounged
35	28/5/2016	Stenodermatinae	*Artibeus jamaicensis*	89	41	48	58	male	Scrounged
36	28/5/2016	Stenodermatinae	*Chiroderma salvinii*	55	43	12	50	male	N
37	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	52	43	9	34	male	N
38	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	41	4	36	male	N
39	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	40	5	35	male	Scrounged
40	28/5/2016	Stenodermatinae	*Chiroderma salvinii*	59	40	19	50	female	N
41	28/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	40	5	35	female	Pregnant

Annex 1 c. List of species of bats with their biometric data of VT33-34; Correlate, Date, Family, Species, Weight, Forearm, Sex and Reproductive Stage (Scrounged; Lactating; Pregnant; N= normal).

Correlative	Date	Family	Specie	Weight each bat (gr)	Weight Bag (gr)	Total weight (gr)	Forearm (mm)	Sex	Reproductive stage
1	29/5/2016	Stenodermatinae	*Artibeus jamaicensis*	98	43	55	62	female	N
2	29/5/2016	Glossophaginae	*Glossophaga comissarisi*	49	40	9	35	male	Scrounged
3	29/5/2016	Stenodermatinae	*Sturnira hondurensis*	54	40	14	39	male	N
4	29/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	41	4	35	male	Scrounged
5	29/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	40	5	36	female	N
6	29/5/2016	Stenodermatinae	*Platyrhinus helleri*	60	43	17	46	male	N
7	29/5/2016	Stenodermatinae	*Chiroderma salvinii*	54	40	14	45	male	N
8	29/5/2016	Glossophaginae	*Glossophaga comissarisi*	44	40	4	34	female	N
9	29/5/2016	Stenodermatinae	*Artibeus lituratus*	89	41	48	68	female	Pregnant
10	29/5/2016	Stenodermatinae	*Artibeus lituratus*	98	40	58	71	male	N
11	29/5/2016	Stenodermatinae	*Chiroderma salvinii*	55	40	15	48	male	N
12	29/5/2016	Stenodermatinae	*Sturnira parvidens*	54	40	14	39	male	N
13	29/5/2016	Glossophaginae	*Glossophaga comissarisi*	46	40	6	36	female	Pregnant
14	29/5/2016	Glossophaginae	*Glossophaga comissarisi*	48	41	7	36	male	N
15	29/5/2016	Glossophaginae	*Glossophaga comissarisi*	45	40	5	35	male	Scrounged
16	29/5/2016	Stenodermatinae	*Artibeus lituratus*	100	40	60	73	male	N
17	29/5/2016	Stenodermatinae	*Artibeus jamaicensis*	88	40	48	56	male	Scrounged
18	29/5/2016	Stenodermatinae	*Artibeus lituratus*	100	40	60	73	female	N
19	29/5/2016	Stenodermatinae	*Artibeus lituratus*	85	43	42	70	male	N
20	29/5/2016	Stenodermatinae	*Dermanura toltecus*	55	40	15	37	male	N
21	29/5/2016	Stenodermatinae	*Artibeus jamaicensis*	90	41	49	62	male	N
22	29/5/2016	Stenodermatinae	*Artibeus jamaicensis*	100	41	59	57	male	N
23	29/5/2016	Stenodermatinae	*Dermanura toltecus*	58	40	18	38	male	N
24	29/5/2016	Vespertilionidae	*Rhogeessa tumida*	54	40	14	26	male	N

Annex 1 d. List of species of bats with their biometric data of T36; Correlate, Date, Family, Species, Weight, Forearm, Sex and Reproductive Stage (Scrounged; Lactating; Pregnant; N= normal).

Correlative	Date	Family	Specie	Weight each bat (gr)	Weight Bag (gr)	Total weight (gr)	Forearm (mm)	Sex	Reproductive stage
1	30/5/2016	Stenodermatinae	*Sturnira hondurensis*	53	41	12	39	male	N
2	30/5/2016	Stenodermatinae	*Artibeus jamaicensis*	88	43	45	57	female	N

Annex 1 e. List of species of bats with their biometric data of VT44-44a; Correlate, Date, Family, Species, Weight, Forearm, Sex and Reproductive Stage (Scrounged; Lactating; Pregnant; N= normal).

Correlative	Date	Family	Specie	Weight each bat (gr)	Weight Bag (gr)	Total weight (gr)	Forearm (mm)	Sex	Reproductive stage
1	31/5/2015	Stenodermatinae	Artibeus jamaicensis	90	40	50	59	male	N
2	31/5/2015	Stenodermatinae	*Dermanura aztecus*	57	43	14	48	female	N
3	31/5/2015	Stenodermatinae	*Artibeus jamaicensis*	90	41	49	62	male	Scrounged
4	31/5/2015	Stenodermatinae	*Artibeus liturarus*	100	41	59	74	male	N
5	31/5/2015	Stenodermatinae	*Artibeus jamaicensis*	100	41	59	57	female	N
6	31/5/2015	Stenodermatinae	*Artibeus jamaicensis*	99	40	59	56	female	Lactating
7	31/5/2015	Stenodermatinae	*Artibeus liturarus*	88	41	47	70	female	N
8	31/5/2015	Stenodermatinae	*Artibeus liturarus*	94	41	53	70	female	N
9	31/5/2015	Stenodermatinae	*Artibeus jamaicensis*	98	43	55	62	male	N
10	31/5/2015	Stenodermatinae	*Artibeus jamaicensis*	100	41	59	58	male	Scrounged
11	31/5/2015	Stenodermatinae	*Sturnira parvidens*	56	40	16	39	female	Lactating
12	31/5/2015	Stenodermatinae	*Sturnira parvidens*	57	45	12	41	male	N
13	31/5/2015	Phillostominae	*Phillostomus discolor*	100	40	60	67	male	N

Annex 2. Species of captured bats.

Artibeo jamaiquino (Artibeus jamaicensis)

Artibeo correcto (*Artibeus lituratus*)

Quiroderma de salvini(*Chiroderma salvinii*)

Artibeo tolteca (*Dermanura toltecus)*

Bat of helleri (*Platyrhinus helleri*)

Mioto de keaysi (*Myotis keaysi*)

Esturnira ludovisio (*Sturnira parvidens*)

White Esturnira(*Sturnira hondurensis*)

APPENDIX D

BIOTA AQUATIC REPORT – EVALUATION OF AQUATIC VEGETATION, FISH AND AQUATIC MACRO-INVERTEBRATES OF THE RIVERS IN THE AREA OF INFLUENCE OF THE TRANSMISSION LINE PROJECT OF ENERGIA DEL PACIFICO, SONSONATE, AHUACHAPAN, EL SALVADOR.

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INTRODUCTION

Nature provides human resources, which must be exploited in a sustainable manner with clarity to keep and preserve them for future generations. Conserving the goods and services provided by nature for human populations is basically maintained by ecological processes. The alteration of these processes can lead to the degradation of the ecosystems and the corresponding reduction of the quality of life, with high economic and social costs (Turner, 2000; Levy *et al*. 2006, cited by Muniz *et al*. s.f.). Characterization, impact assessment and environmental monitoring programs also contribute to reverse this type of degradation and ensure that human health and the integrity of ecosystems and their resources are not irreversibly affected. This is achieved by providing decision-makers with adequate management tools, effective and supported by the best existing scientific knowledge. In this sense, impact assessments and monitoring programs should be seen as the basic tools for determining the nature, magnitude, spatial extent and temporal distribution of environmental impacts derived from human activities (Muniz s.f.). In order to know the state of health and provide the necessary information to the decision makers, the present study is being carried out in the rivers of the area of influence of the Transmission Line Project of Energia del Pacifico, which is located in the departments of Sonsonate and Ahuachapán and has a length of approximately 40 kilometers. The objective of this work is to estimate the populations of aquatic plants, fish and aquatic invertebrates in the different rivers of the area of influence of the project. The study was carried out during the months of May and June of 2016, this is the final report of this investigation.

THEORETICAL FRAMEWORK

Aquatic plants

The use of aquatic plants for the study of the state of aquatic systems has become more and more important.

Aquatic plants basically have the same nutritional requirements as terrestrial plants. They can be classified into floating, submerged and emergent, facilitate the integration of landscape systems and recreate complex ecosystems involving other organisms such as aquatic insects, amphibians and waterfowl, regulating the system. In addition, they offer the possibility of obtaining recoverable products for various purposes. Among the possible uses are ornamental uses, bed for livestock, production of compost, forage production, obtaining fibers for crafts, etc. (García-Trujillo 2012).

Macrophytes comprise all multicellular aquatic plants, including mosses, hepatics and phanerogams, are natural components of most aquatic ecosystems. Qualitative sampling of these organisms includes a visual observation and collection of the most representative types of the study area. The community of macrophytes are influenced by climate, geology and substrate type (Arce *et al*. 2006).

Fishes

This group is the only one that is easily monitored by the public or interested groups such as fishermen. Being the apex of the food chain, the fish reflect the effects of direct and indirect contamination, the latter by the food of other contaminated fish. However, fish have great mobility within the aquatic environment and can escape pollution and return when conditions have improved. Fish have been widely used to assess biotic integrity in streams and rivers (Arce *et al*. 2006).

In general, fish are considered good indicators of the quality of the environment, so a great diversity and abundance of fish in rivers, lakes and lagoons indicate that it is a healthy environment for all other forms of life. On the contrary, a high mortality or a high percentage of diseased fish could be caused directly or indirectly by considerable levels of pollutants (Huidobro 2000, in Vásquez *et al*. cited by Arce *et al*. 2006).

Aquatic macroinvertebrates

Macroinvertebrates are generally abundant, relatively easy to collect and of sufficient size to be observed with the naked eye, are universal, sedentary, extremely sensitive to disturbances, have relatively long life cycles, show an immediate response to an impact, their taxonomic identification is well known and does not require specialized personnel for sampling (Toro *et al*. 2003, cited by Vásquez-Silva *et al*. 2006).

Macroinvertebrates are found in almost all habitats, so they are affected in different strata of the system, have a wide range of response to pollution, their sedentary habits and their relatively long life cycles allow to establish considerations of the state of health in an aquatic system (Sandoval and Molina 2000, cited by Vásquez-Silva *et al*. 2006).

MATERIALS AND METHODS

Description of the study area

The study area is located the Departments of Sonsonate and Ahuachapán (Figure 1) that crosses vertically the western part of the Apaneca-Ilamatepeque mountain range and its length is approximately 40 km with an average width of 20 m.

Figure 1. Location of the study area for the evaluation of the diversity of aquatic plants, fish and macroinvertebrates

Methodology used to conduct the study

First, we proceeded to carry out a tour of the sites where this proposal establishes the electric transmission line in order to identify possible areas of influence. Finally it was considered to sample five rivers, (Figure 2).

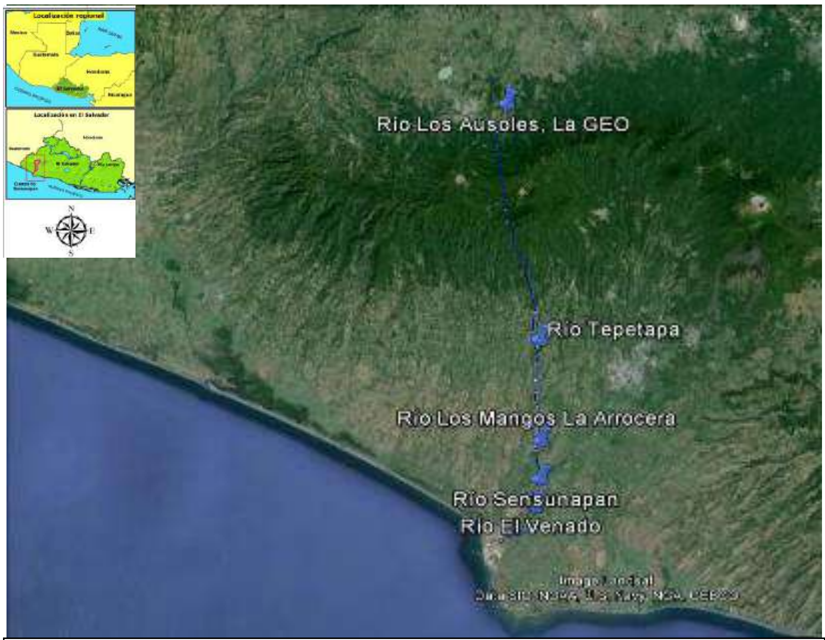


Figure 2. Sites selected for the evaluation of the diversity of aquatic plants, fish and macroinvertebrates, within the area of influence of the project

Geographical description of the study area
For the study of aquatic plants, fish and aquatic macroinvertebrates. Five rivers were considered for sampling (Figure 2), according to the following detail:

Site 1: Los Ausoles River: 753 meters above sea level (masl) ,13^ 43’0.7”; 89^49’10.2”
Site 2: Tepetapa River: 233 meters above sea level (masl) ,13^ 44’01.2”; 89^47’40.4”
Site 3: El Mango River – La Arrocera: 77 meters above sea level (masl) ,13^ 39’12.8”; 89^47’36.2”
Site 4: Sensunapan River: 73 meters above sea level (masl) ,13^ 37’23.2”; 89^47’37.6”
Site 5: El Venado River: 58 meters above sea level (masl) ,13^ 36’04.2”; 89^47’51.2”

Description of each of the sampled sites

Site 1: Los Ausoles River

The sampled site is located in the department of Ahuachapán, bordering the geothermal station (Figure 3).

The elevation is of 753 masl and the section of the sampled river measures a maximum of 7 meters of width and a depth that can reach approximately of 1 meter in rainy season and 15 cm in dry season, the speed of the water is moderate, The substrate of the river is made up of stones of different size and coarse sand, the riverbed and the surrounding river is populated by rocks of different sizes from small to medium, some of which are covered with growth of Periphyton (algae) and moss, Although rocks with a clean surface also exist (Figure 3). In the first sampling, the riverbed presented leaf litter and the color of the water was clear. The riparian vegetation forms a gallery more conformed by bamboo, ingas, guarumo, Mango, acacias and other variety of species, which generated a shady environment. The site is apparently used mostly for tourism, fishing and irrigation crops.

Figure 3. Site Overview 1, Los Ausoles River

Site 2. Tepetapa River

The sampled site is located in the department of Ahuachapán, municipality of Santo Domingo de Guzmán. The elevation is 233 masl and the section of the sampled river measures a maximum of 12.0 meters wide and an approximate depth of 25 to 160 cm, the speed of the water is moderate, the substrate of the river is conformed by stones of different size and sand gross, The riverbed and surrounding area of the river is populated by rocks of different sizes from small to very large, some of which are covered with growth of Periphyton (algae) and moss, although there are also rocks with a clean surface (figure 4). The riverbed presents litter and some parts of the margin of the river was observed the presence of grassy vegetation and the color of the water was clear. In general, the presence of organic wastes derived from the decomposition of litter was observed.

Figure 4. Site Overview 2, Tepetapa River

Site 3. El Mango River – La Arrocera

The sampled site is located in the Cantón Santa Emilia, Department of Sonsonate. The elevation is 77 masl and the section of the sampled river measures a maximum of 7 meters wide and an approximate depth of 50 to 130 cm, the speed of the water is slow, the substrate of the river is made up of coarse sand. The riverbed has abundant litter, logs and submerged branches, the color of the water was turbid. In general, the presence of organic wastes was observed. The most predominant gallery vegetation is made up of ingas, guarumo, Mango, jiote, flying, chilamate, guiscoyol and other species, which provides a shady environment with windows, typical of a gallery forest (figure 5).

Figure 5. Site Overview 3, El Mango River – La Arrocera

Site 4. Sensunapan River

Located in the canton San Julián, municipality and department of Sonsonate, at an elevation of 73m.s.n.m., south of the city of Sonsonate. The area is completely sub urban, almost inaccessible to be found in a canyon with walls of approximately 10 meters of height, the area surrounding the river is surrounded by canals, pastures and dispersed fruit trees. The river has a remarkable load of municipal wastes mainly of the Municipality of Sonsonate; The water is used for irrigation of canals. The bed of the river is a substrate of coarse sand the velocity of the water is moderate to strong and the channel measures 12.5m wide. See figure 6.

Figure 6. Site Overview 4, Sensunapan River

Site 5. El Venado River

Located in the cantón San Julián, Municipality of Acajutla, department of Sonsonate; Site known as El Venado. The elevation is 58 m.s.n.m. The topography at this point lacks marked slopes. Its bed is covered with stones of different size, with growth; border the site of paddocks for the foraging and breeding of cattle. Water velocity is moderate to strong. The width is 600 centimeters with a minimum depth of 20 and maximum of 150 centimeters. This river is populated in its borders by abundant riparia and emergent aquatic vegetation. See figure 7

Figure 7. Site Overview 5, El Venado River.

General aspects of the different sites sampled
Sampling methodologies used
Sampling of aquatic plants

The procedure for the sampling of aquatic plants began with the selection of five sampling sites along the area of influence of the project, identifying for each sampling site a representative location of the conditions of the section of the river to be sampled. This section had a length of 50 meters that adequately reflected the floristic composition and abundance of species characteristic of the aquatic environment in waters of moderate rapids, backwaters, pools and riverside conditions that generate areas, both shade and light (Herrera 2013).

For this purpose, non-destructive quantitative sampling was performed with the aid of a PVC tube quadrant of 50 centimeters per side with twelve replicates (Lot & Chiang 1986); Placing the quadrant on the aquatic vegetation at each sampling site (Figure 8). The aquatic plants contained in each quadrant were reviewed and they were taken to a procedure of identification of species for later statistical analysis and in this way to be able to estimate the populations through their frequency and percentage of abundance. Identification of the material was performed through the use of identification guides (Figure 9).

Figure 8. Quadrant used to measure the coverage of aquatic vegetation at each sampling site.

Figure 9. Use of aquatic plant identification guides.

Fish Sampling

For the fish sampling, a medium proportion pellet was used. The sampling of fish was developed in a non-destructive way or that the majority of fish after being identified were returned to the river; Fish caught in the "D" network used for the sampling of aquatic macroinvertebrates. Firstly, we identified sections of the river representative of approximately 50 linear meters with the typical features, considering waters of rapid, moderate displacement, remansos and puddles, in the same way we considered both shady and luminous environments (Herrera, 2013). For the sampling of the different species of fish, two sampling techniques were combined: 1) a total of 12 effective sets were carried out in each section with a 2.6 x 4.5 meter spanning net with a monofilament wire gauge of 0.3 mm, and 1/4 "mesh light (Figure 10). The captured fish were deposited in buckets with water for identification; 2) the other sampling methodology was carried out with the use of the "D" network, sampling for five minutes with three replications to cover all the micro habitats of the river section. The identifications of the fish species were made with the help of specialized literature. After the fish were identified and photographed, they were returned to the aquatic ecosystem.

Figure 10. Atarraya hauls for sampling fish

Sampling of macro-aquatic invertebrates

We proceeded to select a section of river not exceeding 50 m in length, then recorded the necessary information of the place in a previously structured form. The following information was taken: depths and maximum width of the river in the sampled section (Annex 1) and depth of the river, as well as aspects related to the arboreal vegetation in the vicinity of the river section, uses of the riverbed, and any other Information that was deemed relevant, including relevant photographs.

The selected section was aimed at presenting the greatest diversity of habitats possible, such as: areas with soft current, strong current, hard substrate, soft substrate, emerged aquatic vegetation, both within the river and on its banks, presence of decaying organic matter (Litter, wood, etc.), Content of mud and / or sand, evidence of algae (periphyton) or other conditions that tend to favor the biodiversity of organisms present in the selected section. We tried to take into account the greatest number of habitats, considering that the depths sampled oscillated between 20 and 50 cm. First, we proceeded to identify and observe the different habitats present in the selected stretch of river. During the sampling the route was made taking into account the different identified habitats, trying to collect the greatest possible biodiversity.

The river section of the selected site was divided into three parts as closely as possible and each of these parts was intensively sampled for a period of five minutes per sub-sample, for a total of 15 minutes for the three subsamples. After entering the river with the "D" net in hand and start the sampling process by timing the five-minute countdown, placing the "D" net in an upright position by taking it through the top of the handle and placing it Countercurrent in contact with the bottom of the river surface to be sampled (Figure 11). For the micro-habitat of strong current or slow and hard or soft substrate, it was cleaned by hand or rubbed with the feet the substrate, ensuring that the residue removed would be trapped inside the net "D". The network was constantly relocated, placing it in such a way that the material removed was trapped in it. For the microhabitat corresponding to emerged aquatic vegetation or terrestrial vegetation in contact with the water of the river banks, and that of macrophytes, the net was passed through the vegetation and the submerged roots.

Figure 11. Multihabitat sampling of aquatic macroinvertebrates through the use of net "D"

For the micro-habitat of sand, gravel or mud, the bottom was removed with the feet and the floating material was tried to be dragged by the stream to be trapped in the "D" net. In microhabitats with leaf litter the net was introduced with the leaf litter in the water and the material was carefully washed trying to keep the insects inside and in this way the most of material was removed with the hand, without losing the living organisms accumulated in it. Once the five minutes had been completed in each of the groups of microhabitats identified, the material adhered to the walls of the "D" net was moved towards the bottom of the "D" netting with some force of water, so that The organisms adhered to the walls were deposited in the bottom of the same. Then the material contained in the net was deposited in a plastic tray for inspection and the network "D" was carefully inspected to catch the insects or arthropods attached to the net and to be able to consider them in the count.

After placing the sample in the tray and rinsing the net "D", proceeded to continue with the taking of the second and third sub-sample and the rest of collaborators to separate the macroinvertebrates contained in the tray, through an exhaustive observation of the biological material. At the end of the three sub-samples, we proceeded to wash the net with enough clean water and check it well to avoid overlapping organisms from a sampling Site with another Site.

The macronivertebrates found were identified at the field level however for the taxonomic identification of some aquatic organisms it was necessary to use microscope stereoscope, for which, it was supported by illustrated guides for the ecological and taxonomic study of the immature aquatic insects of El Salvador (Sermeño Chicas, J.M., Pérez D. & P.E. Gutiérrez Fonseca. 2010; Gutiérrez Fonseca, P.E., Sermeño Chicas, J.M. & J.M. Chávez Sifontes. 2010; López Sorto, R.E., Sermeño Chicas, J.M. & D. Pérez. 2010; Hernandez Martínez, M.A., Pérez, D., Serrano Cervantes, L., Sermeño Chicas, J.M., Paniagua Cienfuegos, M.R., Springer, M. & A..J. Monterrosa Urias. 2010; Pérez, D., Serrano Servantes, L., Sermeño Chicas, J.M., Monika Springer, *et. al.* 2010; Gutiérrez Fonseca, P. E. 2010; Pacheco-Chaves, B. 2010; Serrano Cervantes, L. & A.

Zepeda Aguilar. 2010; Menjìvar Rosa, R.A. 2010; Serrano Cervantes, L. & A. Zepada Aguilar. 2010; Springer, M. Serrano Cervantes, L. & A. Zepeda Aguilar. 2010). See figure 12

Figure 12. Identification guides for aquatic macroinvertebrates from El Salvador.

Sorting and processing of data obtained in field

All information obtained at the field level was duly ordered in Excel databases for analysis and interpretation. With the information recorded in the samplings, it was possible to determine the abundance, wealth and diversity value index, which were processed in Excel spreadsheets. For alpha diversity, the Shannon-Wiener and Simpson indices were used, depending on the data obtained. Absolute (n) and relative (%) abundance of aquatic organisms recorded in the study.

Relative abundance of aquatic organisms

$$A_{r.} = \frac{A_i}{A_{total}} \; X \; 100$$

Where:

Ar = Relative abundance of family or species

Ai = Total number of individuals in the family or species

Atotal = Total number of individuals of all families or species registered

In addition to measuring the diversity of species within a community (diversity α), the Shannon-Wiener index is used. This is based on the fact that all species have the same probability of occurrence in the sample. It has values between 0 and 6 and is calculated according to the following formula:

Shannon-Wiener Biodiversity Index.

$$H' = -\sum_{i-1}^{n} pi(lnpi)$$

Where:
H´ = biodiversity species diversity index Shannon-Wiener
Pi = proportion of species (ni) in the total sample (N) (pi = ni/ N).

Simpson Index

Also known as the index of species diversity or dominance index. It is one of the parameters that allowed to measure the wealth of organisms. In ecology, it is also used to quantify the biodiversity of a habitat. It takes a certain number of species present in the habitat and their relative abundance. The Simpson index represents the probability that two randomly selected individuals within a given habitat belong to the same species.

Simpson Dominance Index

$$D = \frac{\sum_{i=1}^{S} n_i(n_i - 1)}{N(N-1)}$$

Where:
S = is the number of species
N = is the total of organisms present (or square units)
n = is the number of specimens per species

Simpson Diversity Index

$$D = 1 - \sum_{i=1}^{S} Pi$$

Where:
D = Simpson Diversity Index
Pi = Proportion of individuals of species i in the community

RESULTS AND DISCUSSION

ESTIMATED OF AQUATIC VEGETATION POPULATIONS

After sampling the aquatic plants of the different rivers, the information reflects that there is little variability between each of them, either in the number of species or the number of plants found. However, at the site corresponding to the Quebrada El Venado (Site 5), the largest number of species with more plants (Table 1) was found, this is possibly due to abundant sunlight and vegetation exists in the sampling site near the river (Figure 7), Which causes a very different environment to the other sampled sites, which are generally totally shaded, this shade is usually limiting for the growth of some aquatic plants.

Site 5, (Quebrada El Venado), showed the highest diversity of genders of plants and aquatic algae with a total of 12, and in second place is located Site 2, (Tepetapa River), with a total of ten species Sites 1 and 3, (Los Ausoles River and El Mango River – La Arrocera), presented 7 species each. Site 4, (Sensunapan River) recorded only 4 species. (Table 1).

Table 1. Quantity and percentage of dominance of aquatic plants found in each of the sample sites of the project area of influence

Specie	**Quantity and percentage of plant dominance by species**									
	S1		**S2**		**S3**		**S4**		**S5**	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Aeschynomene sensitiva (dormilona)	0	0	0	0	5	18	0	0	7	14
Cupea carthagenensis	0	0	4	8	0	0	2	17	0	0
Fontinalis bogotensis	0	0	1	2	9	32	3	25	2	4
Heteranthera reniformis	0	0	0	0	0	0	0	0	3	6
Lemna aequinoctialis	0	0	1	2	2	7	5	42	2	4
Eclipta prostrata	2	6	4	8	0	0	0	0	3	6
Ludwigia erecta	2	6	5	10	0	0	0	0	2	4
Cyperus alternifolius	3	9	4	8	1	4	0	0	2	4
Paspalum repens	4	12	4	8	3	11	2	17	8	16
Spirogyra sp and *Cladophora* sp (lama)	6	18	8	17	1	4	0	0	5	10
Spirogyra sp (Alga)	7	21	9	19	0	0	0	0	6	12
Cladophora sp (Alga)	10	29	8	17	7	25	0	0	10	20
Number of species per site	**7**		**10**		**7**		**4**		**12**	
Total plants per site	**34**		**48**		**28**		**12**		**50**	

S= Sampling site.

The plants and / or algae most abundant in each of the sites sampled with their respective percentage of predominance among plant organisms found (Figura13), were: in the Site 1: *Cladophora* sp. (29%) and *Spirogyra* sp. (21%); Site 2: *Spirogyra* sp. (19%) and *Cladophora* sp. (17%); Site 3: *Cladophora* sp (25%); and *Aeschynomene sensitiva* (18%); Site 4: *Lemna aequinoctialis* (42%) *Fontinalis bogotensis* (25%), *Paspalum repens* (17%) and the site 5: *Cladophora* sp. (20%) and *Paspalum repens* (16%); As can be seen, there is a great deal of variability between each of the sites sampled as to the dominance of the plants found at each sampling site. Table 2 details the species with their respective families.

Figure 13. Different genera of plants and aquatic algae found in the samples of the 5 rivers within the area of influence of the project: a) *Spirogyra* sp and *Cladophora* sp (lama), b) *Paspalum repens*, c) *Ludwigia erecta*, d) *Lemna aequinoctialis*, e) *Heteranthera reniformis*, f) *Fontinalis bogotensis*, g) *Eclipta prostrata*, h) *Cyperus alternifolius*, i) *Cupea carthagenensis*, j) *Spirogira* sp (alga), k) *Cladophora* sp (alga), l) *Aeschynomene sensitiva.*

Table 2. Species and families of aquatic flora of the rivers sampled in the areas of influence of the project

Species	Families
Aeschynomene sensitiva (dormilona)	Fabaceae
Cladophora sp. (Algas)	Cladophoraceae
Spirogyra sp. (Algas)	Zygnemataceae
Cupea carthagenensis	Lythraceae
Cyperus alternifolius	Cyperaceae
Eclipta prostrata	Asteraceae
Fontinalis bogotensis	Fontinalaceae
Heteranthera reniformis	Pontederiaceae
Lemna aequinoctialis	Lemnaceae
Ludwigia erecta	Onagraceae
Paspalum repens	Poaceae
Spirogyra sp and Cladophora sp (lama)	Cladophoraceae and Zygnemataceae

In Table 3, we detail the dominance data in terms of percentage for each of the species reported for Site 1, the most representative being algae *Cladophora sp*. and *Spirogyra sp*.

Table 3. Dominance in percentage for the aquatic flora of the Site 1: Los Ausoles River

	Species	n	%
Site 1	*Aeschynomene sensitiva* (dormilona)	0	0
	Cupea carthagenensis	0	0
	Fontinalis bogotensis	0	0
	Heteranthera reniformis	0	0
	Lemna aequinoctialis	0	0
	Eclipta prostrata	2	6
	Ludwigia erecta	2	6
	Cyperus alternifolius	3	9
	Paspalum repens	4	12
	Spirogyra sp and Cladophora sp (lama)	6	18
	Algas Spirogyra	7	21
	Algas Cladophora sp	10	29
		34	**100**

The algae *Spirogyra sp. and Cladophora sp.* they reached the highest percentage of coverage with 68% over the rest of the species. Of the superior vascular plants were the pastures *Paspalum repens*, the ones that obtained the greatest registry of coverage on the other species with 12% (Figure 14).

Figure 14. Algae A)*Spirogyra sp. and* B) *Cladophora sp.*; Pastures C) *Paspalum repens*.

Ecology of predominant species based on Garrett 2002 and Posada García & López Muñoz 2011.

Spirogyra sp: It lives in fresh water, like rivers and streams. Also in stagnant waters, such as puddles and lagoons.
Cladophora sp: They live in both inland and estuarine waters, are observed in ponds, lagoons, backwaters and water courses with pH values above 7.
Paspalum repens: It inhabits marshes, marshes and stagnant waters.

In Table 4, we detail the dominance data in terms of percentage for each of the species reported for Site 2: Tepetapa River, being the most representative algae *Spirogyra sp and Cladophora sp,* as well as *Cupea carthagenensis, Cyperus alternifolius, Eclipta prostrata, Paspalum repens, Ludwigia erecta*

Table 4. Dominance as a percentage for the aquatic flora of site 2: Tepetapa River

	Specie	Total	%
Site 2	*Aeschynomene sensitiva (dormilona)*	0	0
	Heteranthera reniformis	0	0
	Fontinalis bogotensis	1	2
	Lemna aequinoctialis	1	2
	Cupea carthagenensis	4	8
	Cyperus alternifolius	4	8
	Eclipta prostrata	4	8
	Paspalum repens	4	8
	Ludwigia erecta	5	10
	Algas Cladophora sp	8	17
	Spirogyra sp and Cladophora sp (lama)	8	17
	Algas Spirogyra	9	19
		48	**100**

These algae *Spirogyra sp and Cladophora sp* Which also form what is known as Lama, reached the highest percentage with a 52% coverage over the rest of the species, *Cupea carthagenensis, Cyperus alternifolius, Eclipta prostrata, Paspalum repens, Ludwigia erecta* together account for 44% coverage (Figure 15).

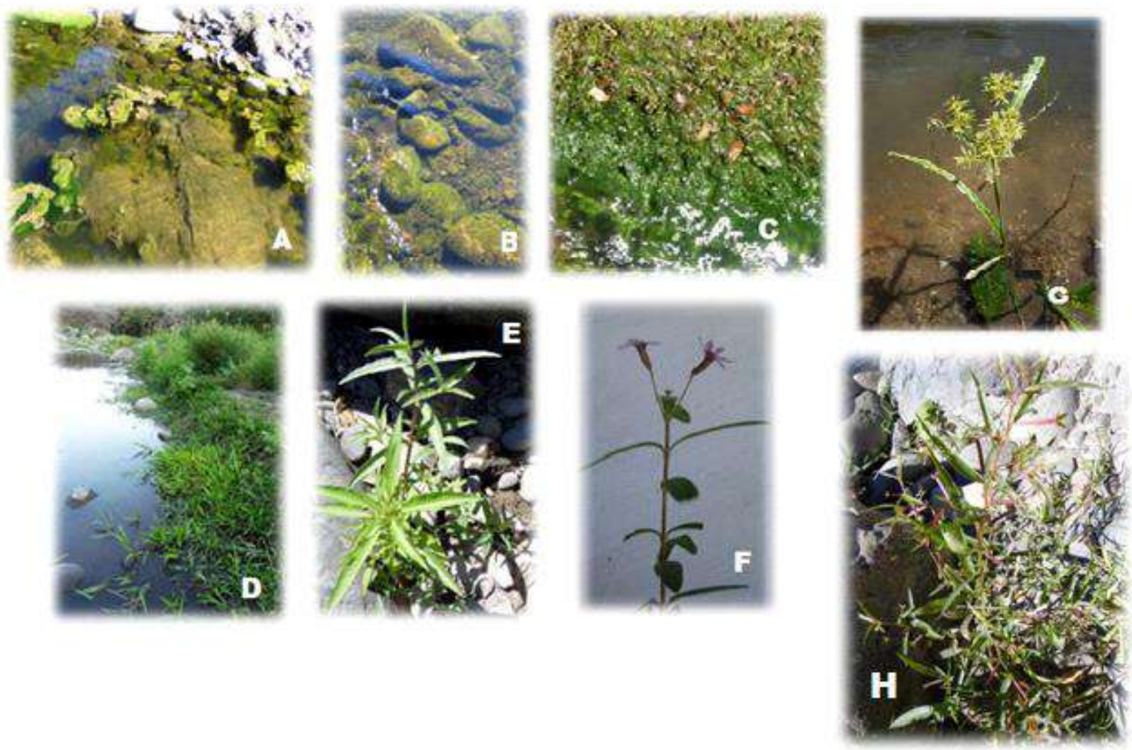


Figure 15. A) *Spirogyra sp* **B)***Cladophora sp* **C)** Lama (*Spirogyra sp* and *Cladophora sp)* **D)** *Paspalum repens* **E)** *Eclipta prostrata* **F)** *Cupea carthagenensis* **G)** *Cyperus alternifolius* **H)** *Ludwigia erecta*.

Ecology of predominant species based on Garrett 2002 and Posada García & López Muñoz 2011.

Spirogyra sp: It lives in fresh water, like rivers and streams. Also in stagnant waters, such as puddles and lagoons.
Cladophora sp: They live in both inland and estuarine waters, are observed in ponds, lagoons, backwaters and water courses with pH values above 7.
Lama (*Spirogyra sp* and *Cladophora sp*): Indicator of excess ammonia and eutrophication
Paspalum repens: It inhabits marshes, marshes and stagnant waters.
Eclipta prostrata: Inhabits disturbed and moist open areas
Cupea carthagenensis: It is frequently found on edges of streams and broken streams of disturbed areas
Cyperus alternifolius: Most of them are wet and swampy environments, preferably in fresh waters (ponds, torrents, ponds, ditches, etc.)
Ludwigia erecta: It inhabits disturbed and humid open areas, flooded savannahs and ditches.

In Table 5, we detail the dominance data in terms of percentage for each of the species reported for Site 3, being the most representative *Fontinalis bogotensis*, the algae *Cladophora sp* and *Aeschynomene sensitiva*.

Table 5. Dominance as a percentage for the aquatic flora of site 3: El Mango River – La Arrocera

	Specie	**n**	**%**
Site 3	*Algas Spirogyra*	0	0
	Cupea carthagenensis	0	0
	Eclipta prostrata	0	0
	Heteranthera reniformis	0	0
	Ludwigia erecta	0	0
	Cyperus alternifolius	1	4
	Spirogyra sp and Cladophora sp (lama)	1	4
	Lemna aequinoctialis	2	7
	Paspalum repens	3	11
	Aeschynomene sensitiva (dormilona)	5	18
	Algas Cladophora sp	7	25
	Fontinalis bogotensis	9	32
		28	**100**

The specie *Fontinalis bogotensis* reached the highest percentage with a 32% coverage over the rest of the species, followed by Algae *Cladophora sp* with 25% and later *Aeschynomene sensitiva* (dormilona) with 18% of the total coverage over other species (Figure 16).

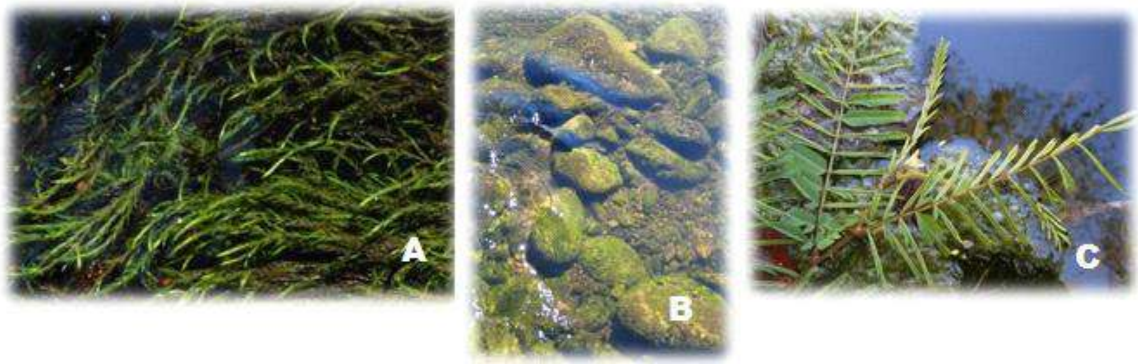


Figure 16. A) *Fontinalis bogotensis* B) *Cladophora sp.* C) *Aeschynomene sensitiva*.

In Table 6, include detailed dominance in percentage terms for each of the species reported for Site 4: Sensunapan River, being the most representative *Lemna aequinoctialis*, *Fontinalis bogotensis*, *Paspalum repens* and *Cupea carthagenensis*.

Table 6. Dominance as a percentage for the aquatic flora of the site 4: Sensunapan River

	Specie	**n**	**%**
Site 4	*Aeschynomene sensitiva* (dormilona)	0	0
	Algas Cladophora sp	0	0
	Algas Spirogyra	0	0
	Cyperus alternifolius	0	0
	Eclipta prostrata	0	0
	Heteranthera reniformis	0	0
	Ludwigia erecta	0	0
	Spirogyra sp and Cladophora sp (lama)	0	0
	Cupea carthagenensis	2	17
	Paspalum repens	2	17
	Fontinalis bogotensis	3	25
	Lemna aequinoctialis	5	42
		12	**100**

The specie *Lemna aequinoctialis*, reached the highest percentage of coverage with 42% over the rest of the species, followed by *Fontinalis bogotensis* with 25% and later *Cupea carthagenensis and Paspalum repens* with 17% each. Of the total coverage over the other species, they are shown in Figure 17.

Figure 17. A) *Lemna aequinoctialis* B) *Fontinalis bogotensis* C) *Paspalum repens* D) *Cupea carthagenensis*.

Ecology of predominant species based on Garrett 2002 and Posada García & López Muñoz 2011.
Lemna aequinoctialis: Plants that float freely through canals, ravines, lagoons and ditches.
Fontinalis bogotensis: It grows on rock, either totally submerged or at the interface air water, in oxygenated waters to medium contaminated.
Paspalum repens: It inhabits marshes and standing waters.
Cupea carthagenensis: It is frequently found on edges of streams and broken streams of disturbed areas.

In Table 7, we detail the dominance data in terms of percentage for each of the species reported for Site 5: El Venado River, being the most representative algae *Spirogyra sp and Cladophora sp,* as well as *Aeschynomene sensitiva (dormilona)* and *Paspalum repens*

Table 7. Dominance as a percentage for the aquatic flora of the site 5: El Venado River

	Specie	**Total**	**%**
Site 5	*Cupea carthagenensis*	0	0
	Cyperus alternifolius	2	4
	Fontinalis bogotensis	2	4
	Lemna aequinoctialis	2	4
	Ludwigia erecta	2	4
	Eclipta prostrata	3	6
	Heteranthera reniformis	3	6
	Spirogyra sp and Cladophora sp (lama)	5	10
	Algas Spirogyra	6	12
	Aeschynomene sensitiva (dormilona)	7	14
	Paspalum repens	8	16
	Algas Cladophora sp	10	20
		50	**100**

These algae *Spirogyra sp and Cladophora sp* which also form what is known as lama reached the highest percentage of coverage with a 42% coverage over the rest of the species, followed by Pastures *Paspalum repens* those who obtained the registration of 16% and Aeschynomene sensitive with 12% coverage over the others (Figure 18).

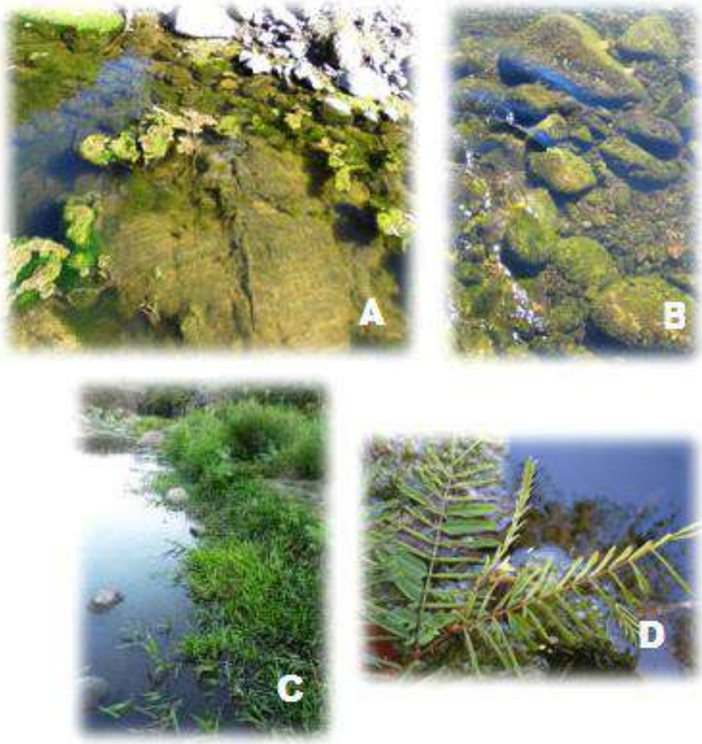


Figure 18. A) *Spirogyra sp* **B)** *Cladophora sp* **C)** *Paspalum repens* **D)** *Aeschynomene sensitiva*.

Ecology of predominant species based on Garrett 2002 and Posada García & López Muñoz 2011.

Spirogyra sp: It lives in fresh water, like rivers and streams. Also in stagnant waters, such as puddles and lagoons.

Cladophora sp: They live in both inland and estuarine waters, are observed in ponds, lagoons, backwaters and water courses with pH values above 7.

Paspalum repens: It inhabits marshes and standing waters.

Aeschynomene sensitiva: Lives on the banks of swampy places.

ESTIMATES OF FISH POPULATIONS

In the different sites sampled from the five rivers of the project's area of influence, there was no greater variability in the number of fish species found, being 32, 20, 69, 3, and 52 respectively, from Site 1 to Site 5. Site 3 presented the largest number of species (6), followed by Site 3 with six species (Table 8).

Table 8. Quantity and percentage value of fish species found at each sampling site in the project's area of influence

Specie	Quantity and percentage value of fish species									
	Site 1		Site 2		Site 3		Site 4		Site 5	
	No	%	No	%	No	%	No	%	No	%
Amphilophus macracanthus (Black Mojarra)	0	0	0	0	1	1	0	0	0	0
Ariopsis guatemalensis (Juilin)	0	0	0	0	0	0	0	0	0	0
Cryptoheros cutteri (Conguito)	0	0	0	0	0	0	0	0	9	17
Poecilia gillii (Olomina)	0	0	1	5	0	0	0	0	2	4
Poeciliopsis pleurospilus (Guatopote)	0	0	10	50	11	16	0	0	16	31
Amatitlania nigrofacsiata (Burrita)	6	19	1	5	22	32	0	0	20	38
Heterandria anzuetoi (Chimbolo)	10	31	8	40	33	48	2	67	3	6
Astyanax aeneus (Silvery)	16	50	0	0	2	3	1	33	2	4
Number of species per site	**3**		**4**		**5**		**2**		**6**	
Total fish sampled per site	**32**		**20**		**69**		**3**		**52**	

Likewise, the total number of fish caught during the sampling was 32, 20, 69, 3 and 52. Corresponding to the sites sampled. At the site 4 Sensunapan River, we found the lowest fish numbers, corresponding to 3 individuals, unlike Sites 3 and 5 corresponding to El Mango River – La Arrocera and the El Venado River presented 69 and 52 fish caught, where the species *Poeciliopsis pleurospilus* (Guatopote) (Figure 19). *Amatitlania nigrofacsiata (Burrita)* (Figure 20). *Heterandria anzuetoi (Chimbolo)* (Figure 21) *and Astyanax aeneus* (Silverly) (Figure 22).

Figure 19. *Poeciliopsis pleurospilus*

Figure 20. *Amatitlania nigrofacsiata*

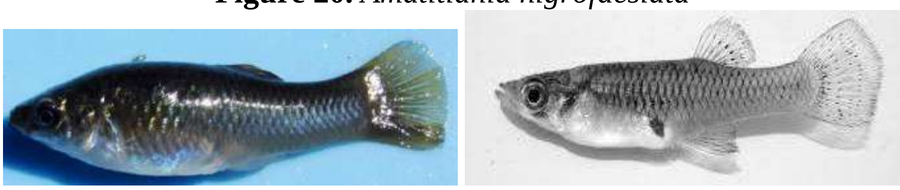


Figure 21. *Heterandria anzuetoi*

Figure 22. *Astyanax aeneus*

Table 9. Species and families of fish caught from rivers sampled in the sections of influence.

Specie	Family
Ariopsis guatemalensis (juilin)	Ariidae
Astyanax aeneus (silverly)	Characidae
Amatitlania nigrofasciata (burrita)	Cichlidae
Amphilophus macracanthus (black mojarra)	Cichlidae
Cryptoheros cutteri (conguito)	Cichlidae
Heterandria anzuetoi (chimbolo)	Poeciliidae
Poecilia gillii (olomina)	Poeciliidae
Poeciliopsis pleurospilus (Guatopote)	Poeciliidae

These results are reflected in the analysis of the diversity-dominance index of Simpson reflects Site 5 with a greater diversity (0.73) and of course a lower dominance (0.27) (Table 14), en segundo lugar the Site 3 with a fairly large diversity of 0.64 and a dominance of 0.36 (Table 12). Third is site 1 with a diversity of 0.62 and a dominance of 0.38 (Table 10). Fourth, site 2 with a diversity of 0.59 and a dominance of 0.41 (Table 11) and finally in scale of diversity the site 4 with a calculation of diversity of 0.44 and a dominance of 0.56 (Table 13).

Table 10. Simpson DIVERSITY-DOMINANCE Index Calculation for Site 1: Los Ausoles River: Third highest calculation of diversity

Index Calculation Simpson DIVERSITY-DOMINANCE:				
Specie	Total	AB Relative	Simpson	
Amphilophus macracanthus (black mojarra)	0	0	0	
Ariopsis guatemalensis (juilin)	0	0	0	
Cryptoheros cutteri (conguito)	0	0	0	
Poecilia gillii (olomina)	0	0	0	
Poeciliopsis pleurospilus (Guatopote)	0	0	0	
Amatitlania nigrofasciata (burrita)	6	0.1875	0.0351	
Heterandria anzuetoi (chimbolo)	10	0.3125	0.0976	
Astyanax aeneus (silverly)	16	0.5	0.25	
	32	D	**0.38**	**Dominance**
		1-D	**0.62**	**Diversity**

Table 11. Simpson DIVERSITY-DOMINANCE Index Calculation for Site 2: Tepetapa River: Fourth highest calculation of diversity

Index Calculation Simpson DIVERSITY-DOMINANCE				
Specie	Total	AB Relative	Simpson	
Amphilophus macracanthus (black mojarra)	0	0	0	
Ariopsis guatemalensis (juilin)	0	0	0	
Astyanax aeneus (silverly)	0	0	0	
Cryptoheros cutteri (conguito)	0	0	0	
Amatitlania nigrofasciata (burrita)	1	0.05	0.0025	
Poecilia gillii (olomina)	1	0.05	0.0025	
Heterandria anzuetoi (chimbolo)	8	0.4	0.16	
Poeciliopsis pleurospilus (Guatopote)	10	0.5	0.25	
	20	D	**0.41**	**Dominance**
		1-D	**0.59**	**Diversity**

Table 12. Simpson DIVERSITY-DOMINANCE Index Calculation for Site 3: El Mango River – La Arrocera: Second highest calculation of diversity

Index Calculation Simpson DIVERSITY-DOMINANCE				
Specie	Total	AB Relative	Simpson	
Ariopsis guatemalensis (juilin)		0	0	
Poecilia gillii (olomina)		0	0	
Cryptoheros cutteri (conguito)	0	0	0	
Amatitlania nigrofasciata (burrita)	1	0.01449275	0.0002	
Amphilophus macracanthus (black mojarra)	2	0.02898551	0.0008	
Astyanax aeneus (silverly)	11	0.15942029	0.0254	
Poeciliopsis pleurospilus (Guatopote)	22	0.31884058	0.1017	
Heterandria anzuetoi (chimbolo)	33	0.47826087	0.2287	
Total	69	D	**0.36**	**Dominance**
		1-D	**0.64**	**Diversity**

Table 13. Simpson DIVERSITY-DOMINANCE Index Calculation for Site 4: Sensunapan River: The worst record in calculation diversity

Index Calculation Simpson DIVERSITY-DOMINANCE				
Specie	Total	AB Relative	Simpson	
Amatitlania nigrofasciata (burrita)		0	0	
Amphilophus macracanthus (black mojarra)		0	0	
Ariopsis guatemalensis (juilin)		0	0	
Cryptoheros cutteri (conguito)		0	0	
Poecilia gillii (olomina)		0	0	
Poeciliopsis pleurospilus (Guatopote)		0	0	
Astyanax aeneus (silverly)	1	0.3333	0.1111	
Heterandria anzuetoi (chimbolo)	2	0.6667	0.4444	
Total	3	D	**0.56**	**Dominance**
		1-D	**0.44**	**Diversity**

Table 14. Simpson DIVERSITY-DOMINANCE Index Calculation for Site 5: El Venado River: Highest calculation of diversity

Index Calculation Simpson DIVERSITY-DOMINANCE				
Specie	Total	AB Relative	Simpson	
Amphilophus macracanthus (black mojarra)		0.00	0.0000	
Ariopsis guatemalensis (juilin)		0.00	0.0000	
Astyanax aeneus (silverly)	2	0.04	0.0015	
Cryptoheros cutteri (conguito)	2	0.04	0.0015	
Amatitlania nigrofasciata (burrita)	3	0.06	0.0033	
Poecilia gillii (olomina)	9	0.17	0.0300	
Heterandria anzuetoi (chimbolo)	16	0.31	0.0947	
Poeciliopsis pleurospilus (Guatopote)	20	0.38	0.1479	
	52	D	**0.27**	**Dominance**
		1-D	**0.73**	**Diversity**

The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1.

The abundance and diversity calculations can be compared in the SHANOON indexes and the SIMPSON DIVERSITY-DOMINANCE Index in Table 15.

Table 15. Comparison between the 5 sampling sites and their abundance values, as well as the calculations for the different indices of diversity and Dominance

Site	1	2	3	4	6
# of individuals	32	20	69	3	52
Simsonp Dominance	0.38	0.41	0.36	0.56	0.27
Simsonp Diversity	0.62	0.59	0.64	0.44	0.73
Shanoon Diversity	1.02	1.01	1.17	0.64	1.20

Bioindicators

The dominant species were used as indicators of the water quality of the rivers sampled, using the work of Guadalupe de la Lanza Espino, Salvador Hernández Pulido and José Luis Carbajal Pérez: Indicators of water quality and pollution (bioindicators).

Poeciliopsis pleurospilus (Guatopote) (figure 19),
Family Poecilidae
It presents the following information:

Characteristics: Fish of tall body and short size. The origin of the dorsal fin is located behind the anal fin. They present sexual dimorphism, in the male the anal fin is transformed into an intromiting organ in the form of a stick or oar; The pectoral and pelvic fins are smaller in females (figure 19).
Coloration: The body is golden yellow in the part of the abdomen, less in a quarter of the caudal peduncle and the ventral part of the head is metallic blue, in the sides they have 6 to 16 spots.
Size: They are small fish that do not exceed 4 cm in total length.
Habitat: These fish are abundant in small streams, clear waters, with little current and depth of 0.5 to one meter, live near the submerged vegetation.
Food Type: Insectivorous

Bioindicator: **Tolerant to high turbidity caused by erosion and to agricultural fertilizers.**

Amatitlania nigrofacsiata (Burrita) (figure 20):
Family:Cichlidae
It presents the following information:

Characteristics: High body small and terminal mouth. Pelvic fins, dorsal and anal pointed at the posterior end, the latter two extend beyond the end of the caudal fin. Short caudal peduncle. Round caudal fin. With 18 to 19 spines and seven to nine spokes in the dorsal fin. The anal fin has nine to 11 spines and six to eight bone spokes (figure 20).
Coloration: Usually six to seven dark vertical bars on the sides; The first bar of the body on the nape, Y-shaped, and the last bar at the base of the caudal fin, the color is lost at the tips of the fins, bright yellow belly with tiny brown spots
Size: The average size reached by these fish is 8 to 9 cm, being the maximum 12 cm.
Habitat: Shallow areas of rivers and their tributaries, in rocky areas with submerged vegetation.
Food Type: Omnivorous

Bioindicator: **Tolerant to contaminants of urban and industrial origin.**

Heterandria anzuetoi (Chimbolo) (figure 21):
Family: Poecilidae
It presents the following information:

Characteristics: Body elongated, somewhat robust, not very compressed, flattened head on back, gonopodium and base of dorsal fin very long, short and broad pectorals, caudal fin, round caudal, high caudal peduncle (figure 21).

Coloration: The body with golden tones, mauve-blue, with spots on the operculum and caudal peduncle; The edges of the scales on the sides, sometimes obscured by metallic tones on the sides of the body.

Size: They are small fish that do not exceed 9 cm in total length.

Habitat: It is a kind of warm fresh water, it lives in lentic and lotic environments, with abundant vegetation submerged to the borders.

Food Type: Insectivorous mainly, but in your diet, may include plants and benthic crustaceans.

Bioindicator: Tolerant to contaminants of urban and industrial origin.

Astyanax aeneus (Silverly) (figure 21):
Family: Characidae
It presents the following information:

Characteristics: Fusiform and compressed body, sturdy head, small oblique and non-protráctil mouth, with small teeth, dorsal fin with nine to twelve spokes followed by a fatty adipose. The anal fin with 18 to 23 spokes is longer than the dorsal, the dorsal is bilobed, the pecs are short and are inserted in the lower part of the sides. Body covered by small scales.

Coloration: Body of silver color, in the sides with a dark band that goes from the operculum to the caudal base, dark spot in the caudal base and another in the anterior part of the body (figure 22).

Size: Varies between 6 and 15 cm total length.

Habitat: Freshwater It lives near the surface of the water column of rivers, streams, ponds and ponds, with slow current, rocky and sandy bottom, on banks of vegetation.

Food Type: Omnivorous, while young people prefer plankton, adults are mostly carnivorous.

Bioindicator: Tolerant. Supports water with high concentrations of heavy metals, urban, agricultural and industrial waste.

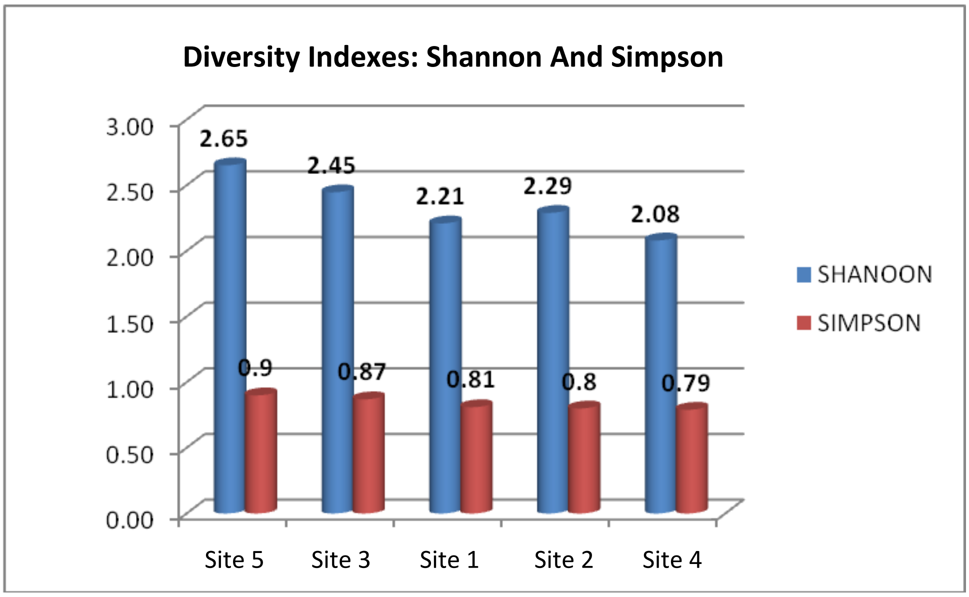
Estimates of aquatic macroinvertebrate populations

To better understand the relationship between diversity at sampling sites Table 16 shows comparisons of results across diversity indexes. As we can see in figure 23, the sites where the greatest diversity calculations were obtained are (Site 5 and 3) (El Venado River and El Mango River – La Arrocera) Also in Figure 23 it is shown that site 4 obtains the poorest values in terms of the diversity of aquatic macroinvertebrates.

Table 16. Determination of Biodiversity Indexes at Sampling Sites

DIVERSITY INDEXES: SHANNON AND SIMPSON						
Indexes	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Promedio**
SHANOON	2.21	2.29	2.45	2.08	2.65	**2.4**
SIMPSON	0.81	0.8	0.87	0.79	0.9	**0.825**

Shannon H 'Index: The value of the index is normally represented as H "and in natural ecosystems varies between 0 and 6.
The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1.



Shannon H 'Index: The value of the index is normally represented as H "and in natural ecosystems varies between 0 and 6.
The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1.

Figure 23. Behavior of biodiversity index results for the five sampling sites.

The Site 1 of sampling (Los Ausoles River), Presented a total of 22 families of aquatic macroinvertebrates with a total abundance of 234 individuals dominated by families: Staphylinidae (37.18%), Leptohyphidae (17.52%), Hydropsychidae (11.54%) (Table 19 and 20). Coleoptera of the Staphylinidae family that represent the largest number of individuals (37.18% of the total population) are characterized by three larval stages; Both larvae and adults are mainly insect larvae predators of the Order Diptera and other invertebrates, also reported eating habits including mycophagia, saprophagia and phytophagy (Archangelsky *et al*. 2009). The Staphylinidae family, their sensitivity to water pollution is six (6) on a scale of zero to ten (0-10), therefore they are insects with average tolerance to water contaminated by domestic use, waste Industrial and farming.

Of the total aquatic invertebrates found in the five sampling sites (see Annex 2) and (Table 19), the highest abundance was reported in the **Site 3** (El Mango River – La Arrocera) With 672 individuals (Table 19 and 22), compared to the **Site 2** (Tepetapa River) which recorded the lowest number of individuals reported for the five sampling sites (Table 19 and 21). In the sampling performed in the **Site 3**, the following macroinvertebrate families predominate: Hydropsychidae (27.98%), Gerridae (12.05%), Philopotamidae (10.12%), Leptohyphidae (9.97%), Dryopidae

(8.78%), Baetidae (5.65%), Elmidae (5.51%) Of a total of 24 families of aquatic invertebrates found, compared to (Site 2) Tepetapa River in which aquatic macroinvertebrate families predominate: Dryopidae (40.52%), Coenagrinidae (8.62%), Leptophlebiidae (7.76%), Hebridae (6.90%) Of a total of 23 families with a total abundance of 122 aquatic invertebrate families (Table 19 and 22). The Coleoptera of the Dryopida family (measured 2-5 millimeters long) and had the highest predominance of individuals (40.52% of the total macroinvertebrate population) of the Tepetapa River, which are characterized by organisms that have life cycles ranging from a few months to a couple of years, depending on the species of insect and the temperature of the site where they live.

Drypidae, like the Elmidae, have plastron respiration and feed mainly on algae (Archangelsky *et al*. 2009). Insects of the Dryopidae family have a degree of sensitivity to water contamination of four (4) on a scale of zero to ten (0-10), therefore they are insects that do not tolerate water heavily contaminated by industrial wastes and Farming. In the Tepetapa River the organic contamination is quite substantial, probably because the Site of sampling contained a lot of litter in decomposition coming from the trees that form the gallery forest that surrounds it.

In the **Site 4** of sampling (Sensunapan River), 24 families of aquatic macroinvertebrates were recorded with an abundance of 195 individuals, of which dominate families: Veliidae (36.92%), Caenidae (22.05%), Leptohyphidae (10.77%), Baetidae (7.69%), Coenagrionidae (3.08%) (Table 19 and 23). The most abundant group represented by aquatic bugs in the Veliidae family is characterized by living on the surface of water, floating aquatic plants and algae or on trunks, roots and plants of the banks that hang and penetrate the water. These bedbugs are predators and scavengers that feed on dead or dying insects that get trapped in the surface film of water; In addition, can feed on aquatic insects and microcrustaceans, such as cladocerans, eggs and larvae of mosquitoes, collémbolas, among others (Pacheco Chaves, 2010). The family Veliidae, their sensitivity to water pollution is five (5) on a scale of zero to ten (0-10); therefore, they are insects with average tolerance to water contaminated by domestic use, industrial and agricultural wastes (Sermeño Chicas, *et al*. 2010). In this **Site 4** of sampling, the second group of aquatic macroinvertebrates more abundant, is represented by Ephemeroptera of the Caenidae family that prefer muddy areas and vegetation with little or no water flow. The gender *Caenis* Can withstand a wide range of environmental conditions and live in polluted and eutrophic waters (Flowers, 2010). Insects of the Caenidae family found in the **Site 4** of sampling (Sensunapan River), show sensitivity to water contamination of seven (7) on a scale of zero to ten (0-10), therefore, they are insects that tolerate contaminated water from domestic use, industrial and agricultural wastes (Sermeño Chicas, *et al*. 2010).

The Site 5 of sampling (El Venado River), presented a total of 24 families of aquatic macroinvertebrates with a total abundance of 290 individuals of whom the families dominate: Veliidae (20.00%), Hydropsychidae (15.17%), Calopterygidae (10.69%), Gomphidae (6.55%), Leptophlebiidae (6.55%) (Table 17 and 22).

Table 17. Aquatic macroinvertebrates of the rivers of the area of influence of the project.

Ratings		Places of sampling				
		Site 1	**Site 2**	**Site 3**	**Site 4**	**Site 5**
		Los Ausoles River	Tepetapa River	El Mango River – La Arrocera	Sensunapan River	El Venado River
Total families of aquatic macroinvertebrates		22	23	24	24	24
Total abundance of aquatic macroinvertebrate individuals		234	122	672	195	290
Relative abundance of aquatic macroinvertebrate individuals		0.88	1.05	1	0.95	1
Families of dominant aquatic macroinvertebrates		Staphylinidae (37.18%), Leptohyphidae (17.52%), Hydropsychidae (11.54%)	Dryopidae (40.52%), Coenagrinidae (8.62%), Leptophlebiidae (7.76%), Hebridae (6.90%)	Hydropsychidae (27.98%), Gerridae (12.05%), Philopotamidae (10.12%), Leptohyphidae (9.97%), Dryopidae (8.78%), Baetidae (5.65%), Elmidae (5.51%)	Veliidae (36.92%), Caenidae (22.05%), Leptohyphidae (10.77%), Baetidae (7.69%), Coenagrionidae (3.08%)	Veliidae (20.00%), Hydropsychidae (15.17%), Calopterygidae (10.69%), Gomphidae (6.55%), Leptophlebiidae (6.55%)
Shannon index H '		2.21	2.29	2.45	2.08	2.65
Simpson Index	Dominance	0.19	0.2	0.13	0.21	0.1
	Diversity	0.81	0.8	0.87	0.79	0.9

Shannon H ‘Index: The value of the index is normally represented as H “and in natural ecosystems varies between 0 and 6.
The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1.

Table 18. Aquatic macroinvertebrates found in the Site 1 Los Ausoles River					
Taxonomic group					
Order	Family	Abundance	AB Relative	Shannon index H ‘	Simpson
Coleoptera	Dryopidae	6	0.0256	0.0939	0.0007
Coleoptera	Elmidae	8	0.0342	0.1154	0.0012
Coleoptera	Staphylinidae	87	0.3718	0.3679	0.1382
Diptera	Chironomidae	6	0.0256	0.0939	0.0007
Ephemeroptera	Leptophlebiidae	8	0.0342	0.1154	0.0012
Ephemeroptera	Leptohyphidae	41	0.1752	0.3052	0.0307
Ephemeroptera	Caenidae	3	0.0128	0.0559	0.0002
Gastropoda	Physidae	1	0.0043	0.0233	0.0000
Hemiptera	Mesoveliidae	3	0.0128	0.0559	0.0002
Hemiptera	Gerridae	1	0.0043	0.0233	0.0000
Hemiptera	Hebridae	6	0.0256	0.0939	0.0007
Hemiptera	Belostomatidae	2	0.0085	0.0407	0.0001
Lepidoptera	Crambidae (Pyralidae)	8	0.0342	0.1154	0.0012
Megaloptera	Corydalidae	9	0.0385	0.1253	0.0015
Odonata	Calopterygidae	2	0.0085	0.0407	0.0001
Odonata	Gomphidae	1	0.0043	0.0233	0.0000
Odonata	Libellulidae	2	0.0085	0.0407	0.0001
Odonata	Coenagrionidae	4	0.0171	0.0696	0.0003
Plecoptera	Perlidae	6	0.0256	0.0939	0.0007
Trichoptera	Calamoceratidae	1	0.0043	0.0233	0.0000
Trichoptera	Hydropsychidae	27	0.1154	0.2492	0.0133
Trichoptera	Philopotamidae	2	0.0085	0.0407	0.0001
	Totals	**234**	**0.88**	**2.21**	**0.19 (Dominance)**
					0.81 (Diversity)

Shannon H ‘Index: The value of the index is normally represented as H “and in natural ecosystems varies between 0 and 6.
The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1.

Table 19. Aquatic macroinvertebrates found in the Site 2 Tepetapa River					
Taxonomic group					
Order	Family	Abundance	AB Relative	Shannon index H ‘	Simpson
Blattodea		1	0.0086	0.0410	0.0001
Coleoptera	Dryopidae	47	0.4052	0.3661	0.1642
Coleoptera	Hydroscaphidae	1	0.0086	0.0410	0.0001
Coleoptera	Limnichidae	1	0.0086	0.0410	0.0001
Coleoptera	Scirtidae	1	0.0086	0.0410	0.0001
Coleoptera	Staphylinidae	1	0.0086	0.0410	0.0001
Coleoptera	Dytiscidae	1	0.0086	0.0410	0.0001
Diptera	Tipulidae	3	0.0259	0.0945	0.0007
Diptera	Tabanidae	1	0.0086	0.0410	0.0001
Diptera	Psychodidae	1	0.0086	0.0410	0.0001
Diptera	Chironomidae	2	0.0172	0.0700	0.0003
Ephemeroptera	Leptophlebiidae	9	0.0776	0.1983	0.0060
Hemiptera	Gerridae	3	0.0259	0.0945	0.0007
Hemiptera	Hebridae	8	0.0690	0.1844	0.0048
Hemiptera	Belostomatidae	1	0.0086	0.0410	0.0001
Megaloptera	Corydalidae	2	0.0172	0.0700	0.0003
Odonata	Gomphidae	1	0.0086	0.0410	0.0001
Odonata	Libellulidae	7	0.0603	0.1694	0.0036
Odonata	Coenagrionidae	10	0.0862	0.2113	0.0074
Plecoptera	Perlidae	3	0.0259	0.0945	0.0007
Trichoptera	Calamoceratidae	3	0.0259	0.0945	0.0007
Trichoptera	Hydropsychidae	12	0.1034	0.2347	0.0107
Trichoptera	Philopotamidae	3	0.0259	0.0945	0.0007
	Totals	**122**	**1.05**	**2.39**	**0.20 (Dominance)**
					0.80 (Diversity)

Shannon H ‘Index: The value of the index is normally represented as H “and in natural ecosystems varies between 0 and 6.
The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1.

Table 20. Aquatic macroinvertebrates found in the Site 3 El Mango River – La Arrocera					
Taxonomic group					
Order	Family	Abundance	AB Relative	Shannon index H ‘	Simpson
Plecoptera	Perlidae	9	0.0134	0.0578	0.0002
Coleoptera	Dryopidae	59	0.0878	0.2136	0.0077
Coleoptera	Elmidae	37	0.0551	0.1596	0.0030
Coleoptera	Psephenidae	4	0.0060	0.0305	0.0000
Coleoptera	Staphylinidae	2	0.0030	0.0173	0.0000
Diptera	Simuliidae	7	0.0104	0.0475	0.0001
Diptera	Tabanidae	4	0.0060	0.0305	0.0000
Diptera	Chironomidae	12	0.0179	0.0719	0.0003
Ephemeroptera	Leptophlebiidae	14	0.0208	0.0807	0.0004
Ephemeroptera	Baetidae	38	0.0565	0.1624	0.0032
Ephemeroptera	Leptohyphidae	67	0.0997	0.2299	0.0099
Hemiptera	Mesoveliidae	1	0.0015	0.0097	0.0000
Hemiptera	Veliidae	10	0.0149	0.0626	0.0002
Hemiptera	Gerridae	81	0.1205	0.2550	0.0145
Hemiptera	Hebridae	2	0.0030	0.0173	0.0000
Hemiptera	Naucoridae	5	0.0074	0.0365	0.0001
Hemiptera	Belostomatidae	9	0.0134	0.0578	0.0002
Lepidoptera	Crambidae (Pyralidae)	3	0.0045	0.0242	0.0000
Megaloptera	Corydalidae	3	0.0045	0.0242	0.0000
Odonata	Gomphidae	13	0.0193	0.0763	0.0004
Odonata	Libellulidae	16	0.0238	0.0890	0.0006
Odonata	Coenagrionidae	20	0.0298	0.1046	0.0009
Trichoptera	Hydropsychidae	188	0.2798	0.3564	0.0783
Trichoptera	Philopotamidae	68	0.1012	0.2318	0.0102
	Totals	**672**	**1.00**	**2.45**	**0.13 (Dominance)**
					0.87 (Diversity)

Shannon H ‘Index: The value of the index is normally represented as H “and in natural ecosystems varies between 0 and 6.
The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1.

Table 21. Aquatic macroinvertebrates found in the Site 4 Sensunapan River					
Taxonomic group					
Order	Family	Abundance	AB Relative	Shannon index H ‘	Simpson
Coleoptera	Dryopidae	1	0.0051	0.0270	0.0000
Coleoptera	Elmidae	1	0.0051	0.0270	0.0000
Coleoptera	Psephenidae	1	0.0051	0.0270	0.0000
Coleoptera	Hydriphilidae	1	0.0051	0.0270	0.0000
Coleoptera	Staphylinidae	1	0.0051	0.0270	0.0000
Diptera	Tabanidae	1	0.0051	0.0270	0.0000
Diptera	Stratiomidae	1	0.0051	0.0270	0.0000
Diptera	Ceratopogonidae	2	0.0103	0.0470	0.0001
Ephemeroptera	Leptophlebiidae	8	0.0410	0.1310	0.0017
Ephemeroptera	Veliidae	72	0.3692	0.3679	0.1363
Ephemeroptera	Baetidae	15	0.0769	0.1973	0.0059
Ephemeroptera	Leptohyphidae	21	0.1077	0.2400	0.0116
Ephemeroptera	Caenidae	43	0.2205	0.3334	0.0486
Hemiptera	Gerridae	2	0.0103	0.0470	0.0001
Hemiptera	Hebridae	1	0.0051	0.0270	0.0000
Hemiptera	Naucoridae	1	0.0051	0.0270	0.0000
Hemiptera	Belostomatidae	1	0.0051	0.0270	0.0000
Odonata	Calopterygidae	2	0.0103	0.0470	0.0001
Odonata	Gomphidae	5	0.0256	0.0939	0.0007
Odonata	Libellulidae	5	0.0256	0.0939	0.0007
Odonata	Coenagrionidae	6	0.0308	0.1071	0.0009
Trichoptera	Calamoceratidae	1	0.0051	0.0270	0.0000
Trichoptera	Hydropsychidae	1	0.0051	0.0270	0.0000
Trichoptera	Philopotamidae	2	0.0103	0.0470	0.0001
	Totals	**195**	**0.95**	**2.08**	**0.21 (Dominance)**
					0.79 (Diversity)

Shannon H ‘Index: The value of the index is normally represented as H “and in natural ecosystems varies between 0 and 6.
The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1.

Table 22. Aquatic macroinvertebrates found in the Site 5 El Venado River					
Taxonomic group					
Order	Family	Abundance	AB Relative	Shannon index H ‘	Simpson
Plecoptera	Perlidae	16	0.0552	0.1599	0.0030
Coleoptera	Elmidae	11	0.0379	0.1241	0.0014
Coleoptera	Psephenidae	2	0.0069	0.0343	0.0000
Coleoptera	Staphylinidae	4	0.0138	0.0591	0.0002
Diptera	Tabanidae	3	0.0103	0.0473	0.0001
Diptera	Stratiomidae	1	0.0034	0.0196	0.0000
Diptera	Chironomidae	12	0.0414	0.1318	0.0017
Ephemeroptera	Leptophlebiidae	19	0.0655	0.1786	0.0043
Ephemeroptera	Baetidae	6	0.0207	0.0802	0.0004
Ephemeroptera	Leptohyphidae	9	0.0310	0.1078	0.0010
Ephemeroptera	Caenidae	8	0.0276	0.0990	0.0008
Gastropoda	Hydrobiidae	1	0.0034	0.0196	0.0000
Hemiptera	Veliidae	58	0.2000	0.3219	0.0400
Hemiptera	Gerridae	3	0.0103	0.0473	0.0001
Hemiptera	Naucoridae	1	0.0034	0.0196	0.0000
Lepidoptera	Crambidae (Pyralidae)	2	0.0069	0.0343	0.0000
Megaloptera	Corydalidae	16	0.0552	0.1599	0.0030
Odonata	Calopterygidae	31	0.1069	0.2390	0.0114
Odonata	Gomphidae	19	0.0655	0.1786	0.0043
Odonata	Libellulidae	5	0.0172	0.0700	0.0003
Odonata	Coenagrionidae	10	0.0345	0.1161	0.0012
Trichoptera	Hydropsychidae	44	0.1517	0.2861	0.0230
Trichoptera	Philopotamidae	8	0.0276	0.0990	0.0008
Trichoptera	Glossosomatidae	1	0.0034	0.0196	0.0000
	Totals	290	1.00	**2.65**	**0.10 (Dominance)**
					0.90 (Diversity)

Shannon H ‘Index: The value of the index is normally represented as H “and in natural ecosystems varies between 0 and 6.
The value of the Simpson index, dominance (D) and diversity (1-D) in natural ecosystems varies between 0 and 1

CONCLUSIONS

Aquatic Flora

Samplings conducted in May and June of 2016 in the rivers: Los Ausoles, Tepetapa, El Mango – La Arrocera, Sensunapan and El Venado. Reported, 11 species between algae and aquatic plants, distributed in 11 families.

In general, the species of plants and / or algae reported as most abundant in sampling conducted in May and June are algae *Spirogyra sp.* and *Cladophora sp.,* Which also form what is known as lama.

During sampling the Chlorophyta: *Spirogyra* and *Cladophora*, Were abundant in areas with high to moderate eutrophication, and can be used as indicators of high organic matter concentration. They were particularly abundant in the Site 1 (Los Ausoles River) with a sampling register of 68% of the total aquatic plants and in the Site 2 (Tepetapa river) with a sampling register of 52% of the total aquatic plants.

Fishes

The five sampling sites in the project area identified 680 individuals from 8 genera and 8 species corresponding to five fish families.

The most abundant fish species were *Poeciliopsis pleurospilus* (guatopote), *Amatitlania nigrofasciata* (burrita), *Heterandria anzuetoy* (chimbolo) and *Astyanax aeneus* (Silverly).

The families of Cichlidae and Poeciliidae fish are reported in the five sampling sites. Both species are tolerant to pollution of urban and industrial type, that is why they were found in greater abundance.

Simpson's Diversity and Dominance Index showed that sites five, three and one are the ones with the highest fish diversity with scores of 0.73, 0.64 and 0.62 respectively. The Simpson Index reflected that sites two and four are the ones with the lowest fish diversity with results of 0.59 and 0.44 respectively.

Macroinvertebrates

The largest number of individuals of the aquatic macroinvertebrates found in the study were the order Ephemeroptera (Baetidae, Leptohyphidae, Leptophlebiidae) Hemiptera (Veliidae, Hebridae,Guerridae) and Odonata (Coenagrionidae).

Regarding the diversity of aquatic macroinvertebrates found in the study. Observing the results of the **table 17**, Which will buy the results obtained among the five sites of sampling, it can be concluded that Site 5 (El Venado River) obtained the largest diversity calculation, in addition, that point 4 (Sensunapan River) obtained the lowest diversity values.

Considering the macro invertebrates as a bioindicator, it is necessary to emphasize the presence of Plecoptera: Perlidae in the Site 3 (El Mango River - La Arrocera) and in the Site 5 (El Venado River), since the members of this family of Aquatic insects are sensitive to changes produced by any effect or change in their habitat and are considered clean water indicators.

General Conclusion

The study is used to create an inventory of the diversity of macroinvertebrates in the lotic systems of the project area establishing an electric transmission line in the stretch comprising the municipalities of Acajutla, Santo Domingo de Guzmán, San Pedro Puxtla, Apaneca And Ahuachapán of the Department of Sonsonate and Ahuachapán, El Salvador. At the same time, it provides very important data on the communities of aquatic flora, macroinvertebrates and fish in these types of systems for a future monitoring of the diversity and quality of the water.

RECOMMENDATIONS

Promote research on the communities of macroinvertebrates and fish to learn more about their diversity, behavior, tolerance and sensitivity, according to levels of pollution and disturbance within the project area.

Carry out longer studies and with a greater effort of sampling to analyze macroinvertebrate and fish communities throughout the year to observe, identify or evaluate behavior and potential causes that could affect or benefit the development of these groups within the area of the project.

Carry out studies in other lentic systems near the project area to observe biodiversity and at the same time use the communities of macroinvertebrates as monitoring tools for environmental quality and benefit from this information to the inhabitants of the area.

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Annex 1. Field protocol for sampled sites.

ANEXO 1

Registration Number 1

Field Protocol

General data

Name of River/Quebrada/Lake: Rio Los Ausoles

Location (Department, Municipality, Canton, Village, Place): contiguo a GEO Ahuachapan + N: 13° 43' 0.7" – O: 89° 44' 10.2" + 753 msnm

Use of the course of water: E – oeste

Date (DD/MM/YY): 28 – 5 – 2016

Sampling Time: 10:30 am

Company/Industry/Organization, which hires: Energia del Pacifico

Purpose of Sampling: Diversidad Macroinvertebrados, peces y flora acuatica

Gatherers: Ruben Sorto – Arturo Vaquerano

Project Stage: ___ Start ✓ Development ___ Closing

Duration of sampling: 25 min Number of Sites Sampled: 1 muestra de 3 submuestras

Sampling Technique: ___ Colander _ Net D ✓ ___ Others

Other Samplings: ✓ Yes __ No. Responsible Ruben Sorto Other Peces Macrofitos. Vegetacion cercas

Comments or Observations

cielo nublado, Rio con poca agua, Dominado por Burbujas, pocos peces.

Signature: [signature]

Registration Number 2

Field Protocol

General data

Name of River/Quebrada/Lake: TEPETAPA

Location (Department, Municipality, Canton, Village, Place): AHUACHAPAN 233 MSNM N: 13° 44' 01.2" – O: 89° 47' 40.4

Use of the course of water: orte - este hacia el Sur

Date (DD/MM/YY): 3 - Jun - 2016

Sampling Time: 2:00 pm

Company/Industry/Organization, which hires: Energia del Pacifico

Purpose of Sampling: Diversidad de Peces, flora acuatica y Macroinvertebrados

Gatherers: Rubén Soto y Arturo Vaquerano

Project Stage: ___Start ✓Development ___ Closing

Duration of sampling: 40 minutos Number of Sites Sampled: 1 muestra de 3 submuestras

Sampling Technique: ___Colander __Net D ✓ ___Others

Other Samplings: ___Yes ✓No. Responsible ___ Other___

Comments or Observations

Se observan árboles altos y buena cobertura vegetal en los alrededores

Signature: [signature]

Registration Number: 3

Field Protocol

General data

Name of River/Quebrada/Lake: El Mango – La Arrocera

Location (Department, Municipality, Canton, Village, Place): Sonsonate
77 msnm + N 13° 39' 12.8"; O: 89° 47' 36.2"

Use of the course of water: Ste – Suroeste

Date (DD/MM/YY): 2 de Junio del 2016

Sampling Time: 10:00 am

Company/Industry/Organization, which hires: Energía del Pacífico

Purpose of Sampling: Macroinvertebrates – peces y plantas acuáticas

Gatherers: Rubén Soto y Arturo Vaquerano

Project Stage: ___ Start ✓ Development ___ Closing

Duration of sampling: 45 min Number of Sites Sampled: 1 muestra de 3 submuestras

Sampling Technique: ___ Colander ___ Net D ✓ ___ Others

Other Samplings: ___ Yes ✓ No. Responsible ___ Other ___

Comments or Observations

Rodeado por cañales y una porqueriza en las cercanías,

Signature: [signature]

Registration Number 4

Field Protocol

General data

Name of River/Quebrada/Lake: Sensunapan

Location (Department, Municipality, Canton, Village, Place): Sonsonate
73 Msnm

Use of the course of water: Norte – Sur

Date (DD/MM/YY): 2 de junio 2016

Sampling Time: 2:00 PM

Company/Industry/Organization, which hires: Energia del pacifico

Purpose of Sampling: Diversidad de flora – macroinvertebrados y peces

Gatherers: Rubén Sorto y Arturo Vaquerano

Project Stage: ___ Start ✓ Development ___ Closing

Duration of sampling: 1:00 Hora Number of Sites Sampled: 1 muestra de 3 submuestras

Sampling Technique: ___ Colander ✓ Net D ___ Others

Other Samplings: ___ Yes ✓ No. Responsible ___ Other ___

Comments or Observations

Ubicado en un cañon profundo y se observa mucha contaminación de tipo Urbano y mal olor. Rodeado de canales y cultivos de mora.

Signature: [illegible]

Registration Number 5

Field Protocol

General data

Name of River/Quebrada/Lake: El Venado

Location (Department, Municipality, Canton, Village, Place): Sonsonate
58 msnm N: 13° 36' 04.2" ; O: 89° 47' 51.2"

Use of the course of water: orte - este - Sur

Date (DD/MM/YY): 3 de junio

Sampling Time: 10:30 am

Company/Industry/Organization, which hires: Energía del pacífico

Purpose of Sampling: Macroinvertebrados - peces y flora acuática

Gatherers: Ruben Sorto y Arturo Vaquerano

Project Stage: ____ Start ✓ Development ____ Closing

Duration of sampling: 1:00 Hora Number of Sites Sampled: 1 muestra de 3 submuestras

Sampling Technique: ____ Colander ✓ Net D ________________ Others

Other Samplings: ____ Yes ✓ No. Responsible ____________ Other ____________

Comments or Observations

Diversidad de flora acuática y [illegible].

Signature: [illegible signature]

Annex 2. Stereoscopic photographs showing the diversity of macroinvertebrates in the project rivers

Trichoptera: Hydropsychidae

Plecoptera:Perlidae

Diptera: Chironomidae

Ephemeroptera: Leptophlebiidae

Odonata: Coenagrionidae

Hemiptera: Vellidae

Hemiptera: Belostomatidae

Hemiptera: Guerridae

Diptera: Psichodidae

Trichoptera: Hydropsychidae

Coleoptera: Dytiscidae

Appendix E - Minutes Focus Groups and Key Informant Interviews