Studies for the Technical, Economic-Financial, Environmental, Vulnerability & Social Feasibility for the Construction, Equipment, Test & Commissioning, Operation and Maintenance under Works Concession with Public Service of the Passenger Rapid Train in the Great Metropolitan Area

Second Report: Preliminary Environmental Study

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1 INTRODUCTION

1.1 Scope

This document contains the results of the Preliminary Environmental Study of the Rapid Passenger Train (TRP) Project, prepared on the basis of the terms of reference dictated by INCOFER in Section 3 of Annex 1 of the Tender for *Technical, Economic-Financial, Environmental, Social and Vulnerability Feasibility for Construction, Equipment, Commissioning, Operation and Maintenance under the Modality of Public Works Concession with Public Service, of the Rapid Train System of Passengers of the Greater Metropolitan Area.* This work focuses on analyzing the environmental and social feasibility of the TRP and therefore does not represent the definitive Environmental Impact Study (EsIA), which will be in charge of the future concessionaire and must be executed to obtain the Environmental Viability of the National Environmental Technical Secretariat (SETENA). Having said that, this study follows the guidelines of Resolution N^or^ 746-2018-SETENA, so that the Preliminary Environmental Study serves as a direct input for the eventual elaboration of the Environmental Impact Study.

It is important to bear in mind that the TRP project consists of the modernization and expansion of an existing rail transport service, therefore, the work to be carried out is on the same right of way, which is intended precisely to service could be expanded in the future, in line with the needs of cargo movement and people. Therefore, work will be carried out on a previously impacted area that is exposed day by day to the risks of impacts typical of a working train service. In this context, the TRP project is analyzed with respect to its interaction and interrelationship with the physical, biological and socio-economic environment. It also provides an analysis of potential threats of natural or anthropic origin in the project area. This analysis allows to predict the potential impacts that could be generated on each of these components, and identify possible prevention, mitigation and/or remediation actions.

Spatial scope is defined as the physical, biological and socioeconomic environment within which the Project will be developed. For the purposes of this study, three geographical spaces have been delimited for the assessment of potential impacts: the Project Area (PA), which corresponds to the current right-of-way area over the 84,85 kilometers covering the different TRP sections and where the construction phases will take place and operation; the Area of Direct Influence (ADI), which is defined as the area that will potentially receive biological, physical, and social impacts directly; and the Indirect Influence Area (AII), where they will be perceived impacts generated indirectly by the Project. As noted above, these areas have already been impacted by the construction and operation of the railway currently existing. This environmental assessment focuses mainly on what is known as additional or parallel impact, since what is proposed is an expansion, improvement and modernization of an existing service. Such a project generates fewer impacts than a train whose route was entirely new.

1.2 Objectives

The main objective of this environmental and social feasibility study is to predict the potential additional impacts that the TRP Project may generate on its biological, physical and socioeconomic environment; in addition to proposing prevention, mitigation and remediation actions, in order to harmonize the Project with its natural and social environment, thus trying, that promotes the development of the country from the concept of sustainability.

It must be based on the premise that any change in the natural or social environment, caused by the development of a project, constitutes an impact. However, not all impacts are necessarily negative, nor are all negative impacts necessarily unacceptable. But two situations that are unacceptable must be considered:

- Not attempting to predict, professionally, the possible negative interactions between a planned project and the physical, biological and social environment in the proposed area for the project and its buffers.
- Not responding to potential significant negative effects through the development and implementation of prevention, mitigation and/or compensation measures designed to reduce such effects to acceptable limits.

It is therefore the responsibility of the proponent, government regulators and civil society, to commit to sustainable economic growth and the need for environmental protection as part of that development. These studies allow managers to issue their criteria and make the necessary changes to the planning process, before impacts occur. In addition, the purpose of this environmental analysis serves as a tool for responsible parties to use it to formulate the necessary measures and changes to minimize the impacts detected.

This environmental and social feasibility study serves to identify the potential outcomes of future interactions between the TRP Project and the natural and social environment, as well as propose prevention, mitigation, and/or remediation measures for interactions that have negative impacts.

1.3 Methodology

This study is based in general terms of reference by SETENA in resolution No. 746-2018-SETENA, with the aim of serving as an input for the Environmental Impact Study that will eventually be presented to SETENA. It was also in compliance with the standards of good environmental and social protection practices of international bodies such as the World Bank and the Green Climate Fund. To this end, a multidisciplinary team of professionals was formed in order to carry out a comprehensive analysis of the interrelationships between the project and its natural and social environment.

In general, the methodology for conducting the study consists of the following stages:

- **Project Description**– Based on the information provided by the developer and technical team of the project, the works and activities to be carried out, demand for services, resources and labor are identified.
- **Environmental diagnosis:** evaluation of the physical, biological and socioeconomic environment of the project, with an emphasis on the areas of greatest relevance with respect to the works to be developed. The analysis is mainly carried out by reviewing bibliographic sources and publicly accessible databases, complemented by timely field work.
- **Identification of potential environmental impacts:** based on the characterization of the project and the information collected about the environment, the identification of the main environmental impacts potentially generated by the project is carried out.
- **Proposal for prevention, mitigation, and/or remediation measures:** the actions to be implemented are proposed to avoid or minimize the negative effects.

2 GENERAL INFORMATION

2.1 Information on legal persons.

The development of the TRP Project is the responsibility of the Costa Rican Institute of Railways (INCOFER), legal certificate number 3-007-071577-37. Mrs. Elizabeth Briceño Jiménez, bearer of the certificate 1-0721-0134, serves as Executive President of that institution.

2.2 Information on professional team that developed the Environmental Study

The Preliminary Environmental Study was conducted by CDG Environmental Advisors, a consulting firm with registration number at SETENA 008-2006.

The members of the multidisciplinary team that participated in the development of the study are listed in Table 1.

Professional	Specialty
José R. Dengo Garrón	**Environmental Impact Assessment, Coordinator**
Carlos A. Dengo Garrón	**Natural Resources Management, Coordinator**
Manuel B. Dengo Benavides	**Water Resource and Climate Change, Coordinator**
Marisol Hidalgo Prado	**Forestry Engineering and Environmental Management**
Alejandro Jiménez Fonseca	**Forestry Engineering**
José Castro Solís	**Geographic Information Systems**
Allan Astorga Gattgens	**Geology and Natural Threats**
Andreas Mende	**Geology and Natural Threats**
Silvia Camacho Prado	**Economic and Social Planning**
David Carvajal Rodríguez	**Agricultural Engineering and Community Development**
Sara Cognuck González	**Natural Resources Management and Gender Perspective**

Table 2.1. Professional team in charge of the environmental and social study, CDG Environmental Advisors.

2.3 Reference terms of the work done.

This study should evaluate what is requested in Section 3 of Annex 1 of the tender for the Technical, Economic-Financial, Environmental, Social and Vulnerability Studies for Construction, Equipment, Commissioning, Operation and Maintenance under the Public Works Concession Modality with Public Service, of the Rapid Passenger Train System of the Greater Metropolitan Area.

It is important to mention that, since the end of 2017, INCOFER processes the Environmental Impact Assessment before SETENA under file No. D1-21743-2017. The Terms of Reference issued by the Secretariat in resolution No. 746-2018-SETENA, lay down the specific requirements for the Environmental Impact Study (EsIA) of the Project. It was agreed with INCOFER that this feasibility work would generally follow the terms of reference dictated by SETENA, in order to provide a direct input for the development of the EsIA, which will be carried out by the future concessionaire when the TRP project at that stage of development.

3 PROJECT DESCRIPTION.

The "Fast Passenger Train" (TRP) Project aims to develop, build and operate an electric passenger rail transport system connecting the main urban centers of the Greater Metropolitan Area (GAM). The project to be developed will be carried out on the existing right of way of the National Railway Network, which currently connects the cities of San José, Alajuela, Cartago and Heredia, in a corridor with an extension of approximately 84,85 km. The TRP project then aims to transform the current intercity service of diesel trains and one-way, into a modern electrified mass transport system, with most of the sections in two-way dual track. The installation of the double track will be done taking advantage of the existing right of way.

The development of a modern passenger train system at GAM has been extensively studied over the past few years, with a series of diagnoses that have been evaluated and improved over time. For the current proposal, the following reference studies are available:

- Technical, Legal, Financial and Environmental Feasibility Study for Financing and Management for the Concession of the Project "Metro Electric Train of Costa Rica", prepared by Engevix.
- Feasibility Study for the Implementation of a Railway Transport System in the Metropolitan Area of San José, prepared by INECO.
- Prefeasibility Study of the GAM Passenger Fast Train System, prepared by LCR Logística S.A.
- Value Engineering Study of the GAM Rapid Passenger Train project, developed by IDOM.

The analysis of environmental and social feasibility takes as the basis of technical information of the project as determined in the IDOM Value Engineering Study, in which the best development scenario previously identified in the study of Prefeasibility is optimized.

<u>Project Features:</u>

- In general, the TRP consists of three main stretches:
  - Atlántico – Paraíso Station: 27,4 km
  - Atlántico – Alajuela Station: 21,6 km
  - Atlántico – Ciruelas Station: 25,4 km
  - In addition, the possibility of two sections is evaluated, connecting the

terminals of Alajuela and Ciruelas with a distance of approximately 7,8 km and Ciruelas- El Coyol with a distance close to 2,7 km.

- It is then estimated to have a layout of 84,85 of electrified two-way and bidirectional railway, taking advantage of the existing right-of-way space, distributed as follows:
    - Double track at plate level: 38,4 km, including structures.
    - Double track at ballast level: 46,5 km.
    - The layout will be carried out on the surface, with the exception of conflict crossings and areas where it is necessary to go uneven.

The above classification excludes the sections of Alajuela-Ciruelas and Ciruelas-El Coyol, although it is expected that they will be in ballast for the most part. The final railway path will be included in the Third Report.

- The existing right of way is governed by Decree No. 22483-MOPT. For the purposes of the TRP, the relevant road rights are:
    - Atlántico – Paraíso Station: 6.70 meters on both sides from the center of the track; in cut or filling terrain, 5 meters on both sides from the top of the cuts or from the foot of the slope. In the Cartago – Paraíso section, 10 meters on either side from the center of the track in flat condition; in cut or filling terrain, 5 meters on both sides from the top of the cuts or from the foot of the slope.
    - Atlántico – Alajuela Station: 6.70 meters on either side from the center of the track; in cut or filling terrain, 5 meters on either side from the top of the cuts or from the foot of the slope.
    - Atlántico – Ciruelas Station: 7.62 meters on both sides from the center of the track on flat ground; on cut or filled terrain, 5 meters on both sides from the top of the cuts or from the foot of the slope. On the stretch between the Atlantic Station and the Pacific Station, 5 meters on either side from the center of the track.
    - In some sectors, the right of way has been invaded by construction works, mainly housing. The design and planning of the TRP will be done by seeking the minimum possible impact to these residences, either with overpasses, via board level that allows sharing, or limiting the single-track layout to limit interactions. However, in some sectors it will be necessary to re-re-run people, which is discussed in the Social Chapter.
- The route crosses more than 50 channels in the public domain, which involves the

rehabilitation and extension of existing bridges to accommodate the expanded two-way service.

- A total of 47 stations are proposed, taking advantage, as the design parameters permit, the location of current stations (where they exist). Of the total stations, 10 will be intermodal, which will allow for greater articulation of the transport system.
- Complementary works such as a central workshop, 4 courtyards/garages, an administrative building, 24 substations, catenary system and power to stops, relocation of utilities (when necessary), drainage and road connectivity works.
- Since most of the works will take place within the existing right of way, the need to acquire terrain via expropriation is limited to isolated cases, such as areas for yards and stations, or specific sectors where the space is required due to engineering elements. Technical and design measures will be implemented to minimize expropriations in residential and commercial areas.

3.1 Political-administrative location.

The Greater Metropolitan (GAM) Area Rapid Passenger Train project is located, as the name implies, across 15 counties in the 4 provinces that make up the GAM:

- San José: San José, Goicoechea, Tibás, Montes de Oca, Curridabat
- Alajuela: Alajuela
- Cartago: Cartago, Paraíso, La Unión, Oreamuno
- Heredia: Heredia, Santo Domingo, Belén, Flores, San Pablo

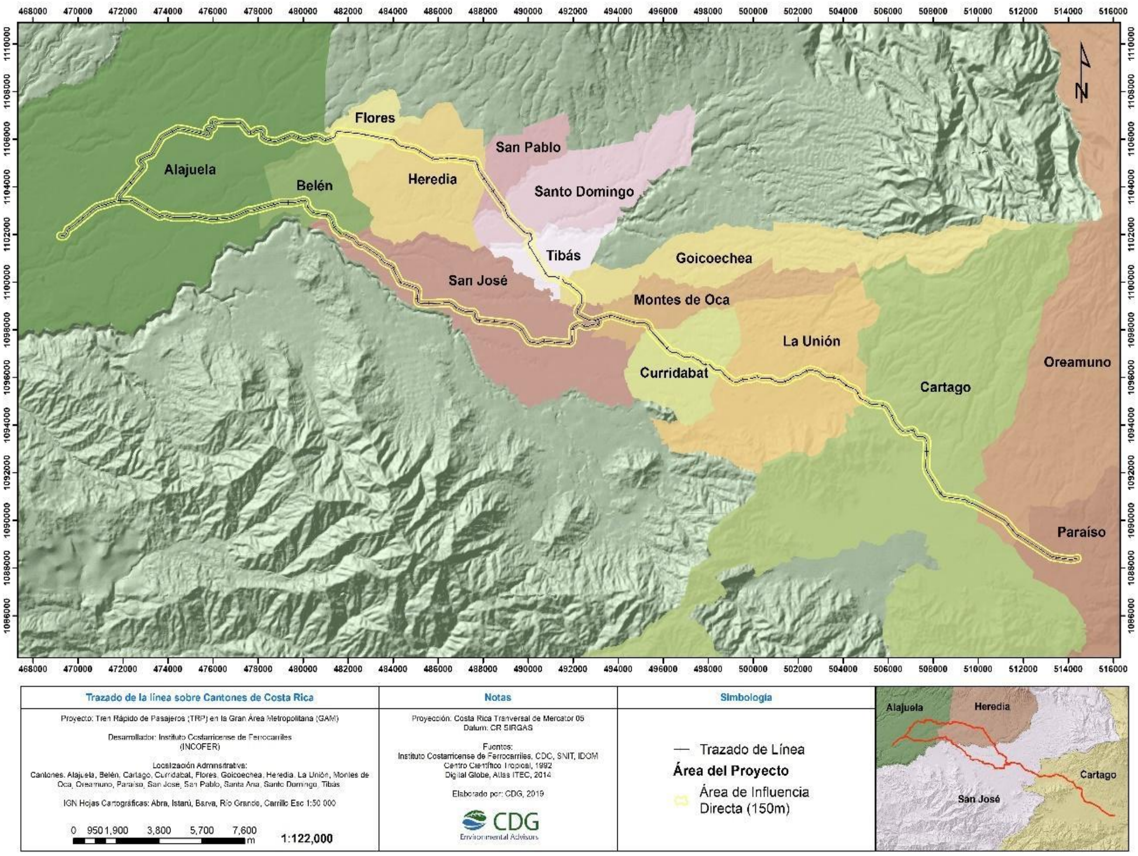


Figure 3.1. Political-administrative location of the Fast Passenger Train project.

4 TECHNICAL JUSTIFICATION OF THE PROJECT.

The Rapid Passenger Train project consists of the main mass transit initiative currently under development in Costa Rica. It is a priority project for the Government of the Republic, as a strategy to alleviate road congestion in the most populated areas of the country, which also implies an increase in the economic competitiveness of the environment, improvements in the quality of life of the population and a decrease in air pollution.

By moving from a diesel train and locomotive system to a state-of-the-art electrical system, a significant reduction in greenhouse gas emissions will also be achieved. It is for this reason that the TRP is one of the core projects of the National Decarbonization Plan 2018-2050.

The project is proposed as the spearhead for the modernization of transport in the country, moving from an inefficient and polluting system, based on private vehicles, to a modern, safe and sustainable system, focused on collective transport and transition to electric mobility. Of the 47 stops planned for the TRP, 10 will be intermodal stations, allowing a better connection with other public transport methods and incentivizing people to be less dependent on private vehicles.

4.1 Consistency with the land use plan.

The Project, being mainly located on an existing right of way (in some cases for more than 100 years), empowers INCOFER to execute the works once the environmental viability has been achieved. The Municipalities where the Project is located do not have jurisdiction over the right of way and therefore no municipal building permits or land use certification are required.

The legal justification for not obligatory presentation of the land use note issued by municipalities is based on Article N^{or} 75 of the Law on Constructions No. 833, which states that no institution of the State is obliged to obtain the municipal license for the execution of construction works, as well as the payment of respective municipal taxes on the value of those constructions.

It is located in a place where it is not affected by any Regulatory Plan, therefore, the construction project will adhere to the Urban Planning Law and its Regulations, General Health Law, Organic Law on the Environment, Forest Law and its Regulations , Law on the Use, Management and Conservation of Soil its Regulations, Mining Code and its

Regulations, as well as Resolution 2174-2010-SETENA and all environmental legislation in force.

On the other hand, there are certain complementary works to be developed on public streets and areas of municipal domain that do require the respective building permits. The same permits will be finalized once the final designs and the environmental viability of the project are obtained.

4.2 Project area and areas of influence.

4.2.1 Project Area.

The area where everything related to the project will be developed is the current right of route, along the 84,85 kilometers of the planned route, in the three sections described above (Atlántico – Paraíso, Atlántico – Alajuela, Atlántico – Ciruelas and the possible junction Ciruelas – Alajuela y Ciruelas-El Coyol).

4.2.2 Area of Influence.

According to Executive Decree No. 32966-MINAE and based on field visits by professionals in charge of the Environmental Impact Study, the Direct Influence Area (DIA) and the Indirect Influence Area (IIA) are identified:

1. **The Direct Influence Area (DIA)**; corresponds to an area immediately to the periphery of the project (right of way), where, due to the nature of the works to be developed, the physical, biological and social impacts will potentially be felt. For this Project, it is defined as the area surrounding the right of route at a distance of **150 meters** on both sides.
2. **The Indirect Influence Area (IIA);** is defined as the area that will receive the physical, social and biological impacts generated indirectly by the project. Given the nature of the project, considering the nature of the surrounding lands, and the permanence and magnitude of the work, the decision is taken not to establish a fixed IIA. This is a regional project, the development of which has an impact on the entire Central Valley, so it makes no sense to confine the IIA to a specific space.

4.3 Development phases.

The TRP project consists of several phases of development, which are described as follows:

- **Prefeasibility:** Already completed.
- **Feasibility:** Already completed.
- **Tender for Detailed Studies, Construction and Operation:**
  - Detailed studies: in this phase all technical engineering studies will be made to move towards a detailed design, which allows a fine calculation of the costs of the civil works. In this phase, the Environmental Impact Study (EsIA) is also completed to obtain the Environmental Viability, other permits related to the project are processed and expropriations are completed. The public tender will also define which company or consortium will be in charge of the civil works, equipment and operation of the TRP.
  - Construction: phase in which infrastructure works are developed, including the removal and demolition of existing structures, rehabilitation and recovery of the right of way, expansion and improvement of bridges, installation of new railways and acquisition of rolling equipment, layout configuration on plate, ballast or viaduct, construction of uneven steps for vehicles, relocation of homes and utilities, construction of the power supply system, configuration of courtyards and workshops.
  - Operation: consists of the start-up of the service in each section, as it ends its respective construction stage, for the period established in the contract of the concession. Includes all maintenance and renovation of roads and equipment, as well as other related TRP works.

5 DESCRIPTION OF LEGAL REGULATIONS.

5.1 Legal framework related to the EIA process.

Our country has as a general policy of development the protection and conservation of the environment. This policy is based as a first instance in the Political Constitution of Costa Rica and the Organic Law of the Environment, which seek the applicability of this policy in the development activities.

Legal Framework	Article
Political Constitution of Costa Rica	**Article 50.** The State will seek the greatest well-being to all the inhabitants of the country, organizing and stimulating production and the most appropriate distribution of wealth. Everyone has the right to a healthy and ecologically balanced environment. It is therefore entitled to denounce acts that infringe that right and to claim redress for the damage caused. The State shall guarantee, defend and preserve that right. The law shall determine the corresponding responsibilities and penalties. *(As amended by Law No. 7412 of June 3, 1994)*
Organic Law of the Environment	The EIA is a technical study that allows to identify and predict the effects on the environment that will be carried out by a particular activity, work or project, quantifying and weighing it to lead to an opinion of approving or rejecting the project, work or activity, as well as recommendations to mitigate the faults incurred. It will include specific effects, overall assessment, alternatives of greatest environmental benefit, a control and minimization of negative effects and a monitoring program.
	Article 17.- Environmental impact assessment Human activities that alter or destroy elements of the environment or generate waste, toxic or hazardous materials, will require an environmental impact assessment by the National Environmental Technical Secretariat created in this law. Its prior approval, on the part of this agency, will be an indispensable requirement to initiate activities, works or projects. Laws and regulations will indicate which activities, works or projects will require environmental impact assessment

Table 5.1. EIA-related legal framework.

The Organic Law on the Environment in article 2 also explicitly lists the principles of environmental law. It is on the basis that legal and legal provisions for environmental protection and specifically to environmental measures that were recommended for the development of works are interpreted and applied.

- The environment is a common heritage of all the inhabitants of the nation, with the exceptions established by the Political Constitution, international conventions and laws. The State and individuals must participate in their sustainable conservation and use, which are of public utility and social interest.
- Everyone has the right to enjoy a healthy and ecologically sustainable environment to develop, as well as the duty to preserve it, according to **article 50** of our Political Constitution.
- The State shall ensure the rational use of environmental elements in order to protect and improve the quality of life of the inhabitants of the national territory. It is also obliged to promote economic and environmentally sustainable development, understood as development that meets basic human needs, without compromising the choices of future generations.
- Anyone who pollutes the environment or causes harm will be liable, as required by the laws of the Republic and the international conventions in force.
- Damage to the environment is a social offence, as it affects the basis of society's existence; because it undermines the matters and resources indispensable for productive activities; culturally, as it jeopardizes the way of life of communities, and ethically, because it undermines the very existence of present and future generations.

The legal obligation to develop the EIA in the construction or operational activities arises with the publication in La Gaceta 215 of November 13, 1995, of Law No. 7554, known as organic law on the environment. This process strengthens compliance with all environmental protection environmental standards.

5.2 Environmental protection provisions set out in the administrative procurement law.

Law No. 7479, Law on Administrative Procurement, introduces the environmental variable in the procurement processes of the public administration by having in general terms the requirement to develop EIA, as a prerequisite for the execution of public works.

Consequently, the prerequisites for the initiation of the administrative procurement procedure referred to in the Law require the development of an EIA, which will measure the effects of the project on the environment. The EIA must provide information necessary to establish what impact mitigation measures should be followed by the project manager and those who will implement it. This is provided for **in article 59** of the Law on Administrative Procurement:

Legal framework	Article
Administrative Procurement Law	Article 59.- Environmental impact study: The commencement of the procurement procedure for a public work will always be preceded, in addition, by the requirements established in this law and its regulations, by an environmental impact study that defines the effects of the Work. Projects shall include the forecasts necessary to preserve or restore environmental conditions, when they may deteriorate. They shall also involve in the preceding the competent entities in the matter.
General Regulations on Administrative Procurement. Executive Decree No. 25038-H	67.4 Environmental impact study. 67.4.1. Any procedure for the procurement of a new public work shall be preceded, both by the requirements laid down by the Law on Administrative Procurement and its Regulations, and by an environmental impact study defining the effects of the work. 67.4.2. The respective projects shall include the forecasts necessary to preserve or restore environmental conditions, where they may be impaired by the execution of the work, all in accordance with the above-mentioned study. 67.4.3. The Authorities shall bring such a study to the attention of the competent bodies in this field so that, within the term conferred for that purpose, they rule on their quality and content. Where such a pronouncement is negative, the Administration shall seek a new study with the relevant corrections. 67.4.4. The competent bodies and entities shall participate in the safeguard of the environment in general or the environmental impact of the work in particular, in all procedures that seek to preserve or restore the environmental conditions affected for that work.

Table 5.2. Environmental protection provisions set out in the administrative procurement law.

6 DESCRIPTION OF THE GEOPHYSICAL ENVIRONMENT.

6.1 Introduction

As part of the prefeasibility studies of the Costa Rica Metropolitan Rapid Rail Project (TRP), the environmental and georisk component has been included. This in order to have technical information that allows to have in an appropriate detail the conditions of Geoaptitude of the terrain of the train stroke, as well as its area of direct influence, corresponding to 150 meters on both sides of the railway line. The results of this cartographic study carried out at 1:10,000 scale (which is attached in Annex 4 – Atlas of Geophysical Maps) are presented here.

In addition to giving the main data of the Geoaptitude of the Terrain of the project area and the area of direct influence of the TRP that we will define here as a study area, the so-called sectors of greatest sensitivity are established and that correspond to those areas where the TRP stroke passes through an area of high and very high environmental fragility. This, in order that, in the components of technical feasibility and final design, these sectors of greater environmental sensitivity (SEMSA) are considered in greater detail in order to ensure the appropriate resilience of the railway infrastructure to be developed.

Because of a matter of extension of the study area, and the scale of work performed, the mapping information is presented in three sectors from west to east. The CRTM 05 scale is used and SEMSAs are identified by their coordinates of the center point and the width or extent of the fragile area, to better facilitate identification.

6.2 Geology

6.2.1 Regional tectonic framework

Costa Rica is located on the western margin of the Caribbean Plate, forming part of the tectonic province called "Origin of South-Central America" which, in turn, is part of the Caribbean Plate.

The Origin of South-Central America, summit the Isthmus of Costa Rica and Panama and consists of an interoceanic insular magmatic arc originated during the Middle Cretaceous period (Dengo, 1985; Astorga, 1997). In this converging margin, the Cocos and Nazca ocean plates are subducted under the Caribbean plate with speeds of 5 - 9 cm/year (DeMets et al, 1990). It is important to highlight the fact that the northern part of the Orogen, where Costa Rica is located, is a site of high tectonic activity. As can be seen in the global tectonic map of Figure 6.1. and the regional one in Figure 6.2, due to the differential movement of plates and tectonic blocks in this regional of the planet, Costa Rica presents in the Pacific sector a subduction zone (Fosa Mesoamericana) where the Cocos Plate is subducted under the Caribbean Plate.

The particularity is presented that, in the southern part of the pit, off the coasts of the Central Pacific and partly of the South of Costa Rica, the Assimic Cocos Dorsal has been subducted, for several million years, which has serious repercussions on tectonics and neotectonics of the Costa Rica isthmus.

Meanwhile, in the Caribbean sector, the Isthmus of Costa Rica, also has important tectonic activity, since from the central part, from the Promontory of Limón, to the south, there is a Deformed Belt (from the North of Panama) that extends to that country and representing an area of strong intraplate tectonic compression, simulating a Type A Subduction, that is, without sinking one plate under the other, but only cortical shortening, revealed by a series of reverse faults of type of overrun and tectonic micro basins.

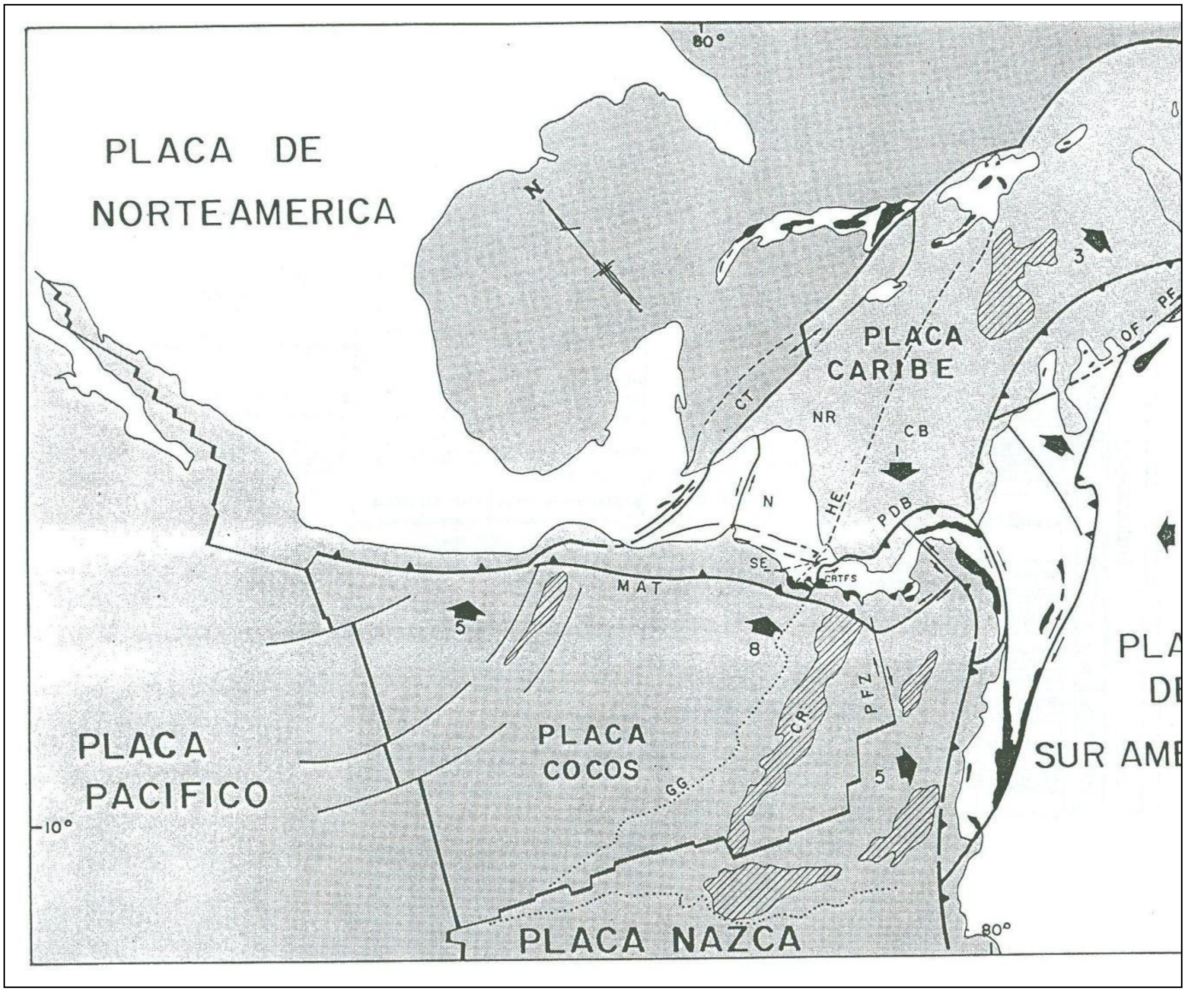


Figure 6.1. Regional geotechnical location of Costa Rica, as a southwest part of the Caribbean Plate. As can be seen, Costa Rica, occurs in an area affected by a significant tectonic compression. Taken from Astorga (1997).

The northern part of the Caribbean of Costa Rica has no tectonic deformation (see Astorga et al., 1989, 1991, 1995, and Brandes et al., 2008), thus simulating a tectonic context of a passive continental margin. This is because the Deformed Belt of Northern Panama, at the latitude of 10 ' North, enters the continent transforming into a system of transisthmic fault designated by Astorga et al. (1989) as Costa Rican's Transcurrent Fault System (see Figures 6.2 and 6.3).

This transisthmic fault system separates the isthmus of Costa Rica into two tectonic blocks with particular geological and tectonic differences.

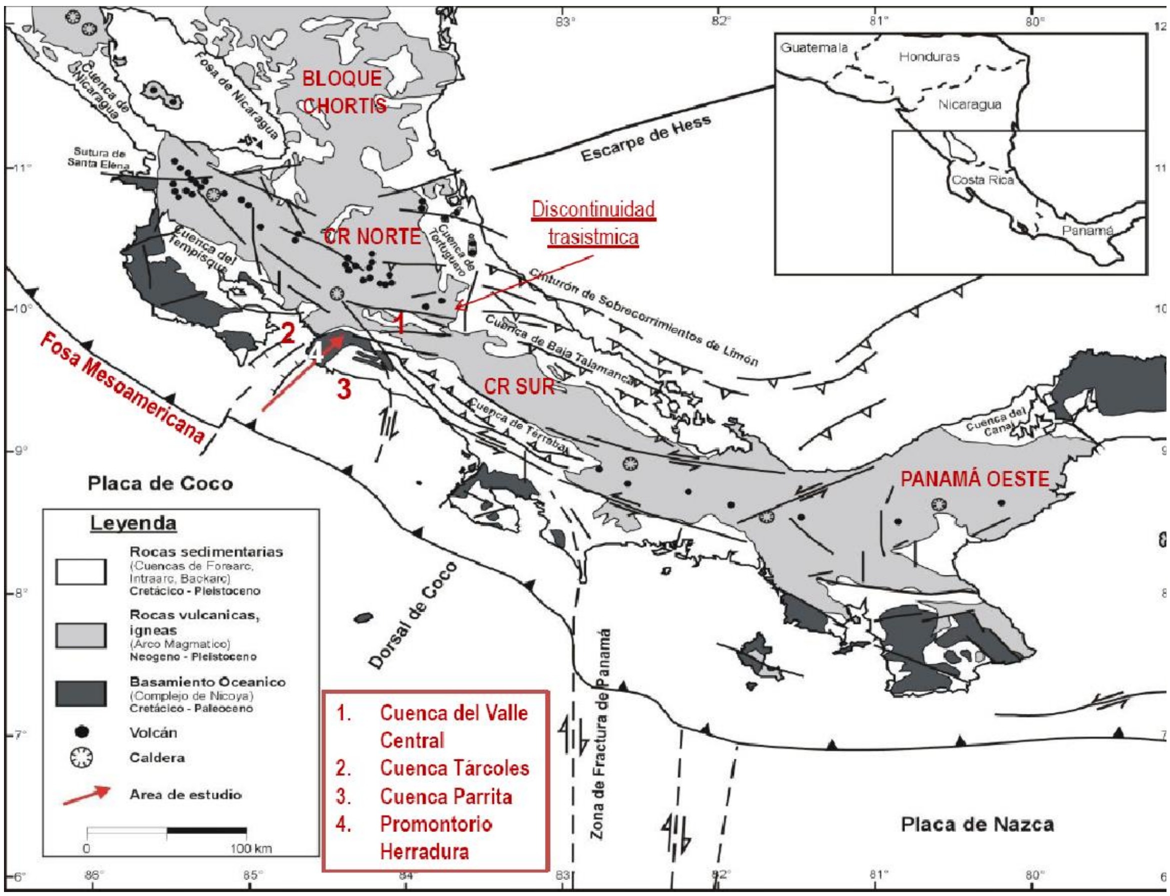


Figure 6.2. Tectonic map of part of the Orogen of South-Central America, with indication of the main tectonic and neotectonics elements related to the study area (red arrow). As can be seen the study area is presented in an area of double geological threshold, both in a north-south direction, and east-west orientation. This geotectonic situation gives it a feature of high neotectonic activity.

The Costa Rica North Block presents a less pronounced relief representing the volcanic mountain ranges of Guanacaste and Central, where important active stratovolcanoes and other non-active volcanic structures are presented. The rest of the territory are plains characterized by flat reliefs and fillers of volcanogenic material and alluvial deposits.

The Costa Rica South Block, on the other hand, presents a very conspicuous relief in almost the entire territory. The mountainous areas have heights of up to 3,800 meters above sea level, and are of tectonic and neotectonic origin, without active volcanism. The plain areas are also of tectonic origin, being of limited extension unlike those of the Costa Rica North Block.

There is no net limit between the two tectonic blocks, but a threshold zone that has a width ranging from kilometers to tens of kilometers.

The Central Valley, where the Great Metropolitan Area of Costa Rica is presented, is part of this technical threshold between the two blocks. Astorga et al. (1991) defines it as a second-generation basin originating in the Middle Tertiary as a product of the development and activity of the transisthmic fault.

In addition to the Central Valley, to the Pacific are presented other second-generation basins that are part of this tectonic threshold zone, such as the Tarcoles Basin and the Parrita Basin, both separated by the so-called Promontory of Herradura (see Figure 6.3).

Campos (2002) has completed the model of the geological evolution of that tectonic threshold zone, analyzing sedimentary fillings and tectonic evolution of the three basins indicated.

According to this work, it is verified that the Central Valley, together with the Reventazón River Valley and the Tárcoles River, forms the geographical discontinuity that represents this geological and tectonic accident.

As can be seen the area of study subject to this work, it is partially located within that tectonic threshold zone that separates the isthmus of Costa Rica into two blocks or segments.

This aspect is important, insofar as it explains, as will be seen below, the conspicuous relief presented, as well as the notable presence of active and potentially active geological fault, which, as expected, has important consequences in developing sources of natural threats.

Details about the local tectonics of the study area are described later in this same document.

6.2.1 Regional Geology

Figure 6.3 shows the location of the study area on the geological map of Costa Rica (cf. MINAE, 1995). As can be seen, from a geological point of view, the study area is located in a geological threshold area.

The entire study area is presented in the so-called Central Valley Basin, a second-generation basin opened at the end of the Eocene (Astorga et al., 1989, 1991, 1995), with a sedimentary and volcanic filling covering a period of approximately 40 million Years.

As mentioned in the previous section, from a structural point of view, the study area presents an overlay of tectonic structures.

On the one hand, it presents the typical structuring of an arch of islands, with axes of structures oriented parallel to the Mesoamerican pit, that is, in the northwest-southeast direction. On the other hand, a more modern structuring is overtaken, associated with the opening of the Central Valley Basin, which presents structures in main, east-west orientation.

From a stratigraphic point of view, the rock units present in the study area are sorted into four groups:

1. Volcanic Rocks
2. Sedimentary Rocks, and
3. Quaternary and recent surface formations.

The following are the main geological units of the study area according to their stratigraphic order.

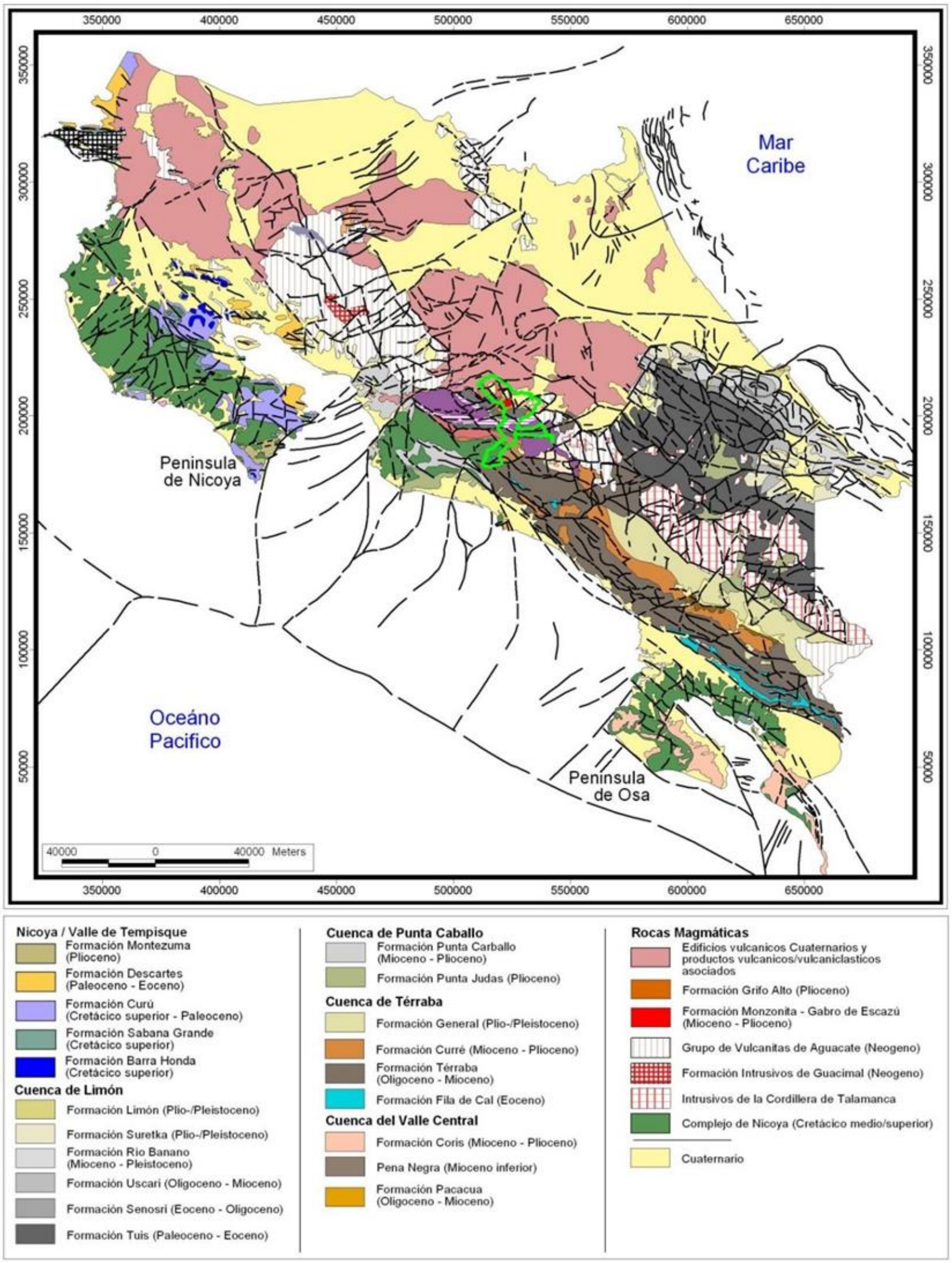


Figure 6.3. Location of the study area on Costa Rica's geological map (cf. MINAE, 1995).

6.2.2 Local Geology (Stratigraphy)

Annex 4 (MG 2.1-MG 2.3 of Map Atlas) accompanying this report present the geological maps of the study area. In the following, a brief geological description of the geological units presents in the area of study.

Aguacate Group (Miocene - Pliocene)

This stratigraphic unit has also been known as the "Aguacate Complex" (see Sprechmann, 1984). Included within this unit, basalts and andesite, agglomerates and tuffs, with a thickness of 800 meters and that emerge in the Mountains of the Aguacate, as well as the Cordillera de Tilarán, and the front of the Cordillera de Guanacaste (Cerros El Hacha, Cerros de Cañas Dulces) and the north of the Central Valley. In general, within this stratigraphic unit have included various formations or non-formal stratigraphic units of volcanic and miocene age origin – Pliocene, that is, prior to the volcanism of the Quaternary.

Several authors who have worked with the Aguacate Complex, have been able to divide it into stratigraphic units or have, failing that, separated formal geological formations from it. This has happened both in the Guanacaste region, particularly in the Cordillera de Tilarán, as well as in the Central Valley.

In the case of the Central Valley, the authors Denyer & Arias (1991) performed this task and defined new formations previously attached to the Aguacate Complex. However, it is important to note that this reordering is applicable, mainly to the area that was covered by the mapping work developed by the aforementioned authors.

Denyer et al. (1994) picks up the subject and clearly points to the La Cruz Formation as a stratigraphic unit separate from what they call the "Aguacate Group". These authors define this Group, for the Central Valley, as:

- In the western sector of the Central Valley, *by alkaline and augitic basalts, andesite, pyroclastic rocks and lahars attached to the Grifo Alto Formation* in the western sector of the Central Valley, *by alkaline and augitic basalts, andesite, pyroclastic rocks and lahars attached to the Grifo Alto Formation*(Denyer & Arias, 1991).
- In the eastern sector of the Central Valley, *by a sequence of several hundred meters thick of massive agglomerates, tuffs and ignimbrites with thin intercalations of andesitic lavas,* designated as Doan Formation (Escalante, 1966).

These authors further point out that this volcanic series corresponds to a more explosive volcanism than La Cruz, and that they were deposited after the swing and before the establishment of the magmatic arc in the position it currently occupies. They outstrain discordantly to the formations La Cruz, Coris and the sedimentary sequence of the Limón basin, and are over-waved by the Intracañón Lavas and the Burning Avalanche Deposits. The authors cited indicate that there are radiometric dating indicating ages between 4.4 and 1.9 million years (Pliocene).

In the case of the mapping work carried out for PRUGAM in this study, the stratigraphic guidelines indicated by Denyer et al have been followed. (1994) and by Denyer & Arias (1991). However, a small variant has been introduced, in the sense of differentiating according to the definition of the authors cited the Grifo Alto Formation as a separate element of the Central Valley Aguacate Group and restricting it to two units to six cartographic units matching:

- Aguacate Group no differentiation,
- Lahars and volcanoes with chaotic texture,
- Intercalations of lavas, scourges and lahars,
- Volcanic deposits,
- Massive volcanoes and
- Lava flows.

  In the case of the last 5 informal units, they are attached to the Doan Formation.

Burning Avalanche Formation (Pleistocene)

Its base consists of a layer of drooping pumice up to 3 meters thick, followed by ash flows rich in scoriaceous bombs, lapilli and lithic clasts. Locally there is well-welded facies (ignimbrite s.s.) of gray with very crushed black fiames and a vesicular andesitic lava cast. Fall deposits crown the sequence.

Pyroclastic flows have an average thickness of 45 m (maximum 150 m), cover an area of 500 km^2 and has a volume of 25 Km$^{3.}$ The thickness of pyroclastic flows, the diameter of the scoriaceous pumps and the frequency of the welded facies increases to the west, indicating that they cannot come from the volcanoes of the Cordillera Central.

This Formation undiscordantly over-controls the Intracañón, Pacacua, Peña Negra, Grifo Alto and La Cruz. It is over-acided by lahars and ash from the Cordillera Central and by alluvials. His age is Pleistocene, approximately 0.7 m.a.

It has a tabular geometry minting to the east. It emerges mainly in the NW sector of the central part of the study area. Its main outcrops are located in the vicinity of the Electriona Plant. The rocks of this Formation have also been designated by other authors as the Tiribí Formation (Echandi, 1981). For its characteristics, its rocks are used as a source of aggregates for construction in various sites of the Central Valley.

The pyroclastic rocks of this formation have high porosity and moderate permeability, while the ignimbrites have lower permeability and porosity, in such a way that they act as a regional aquitard. Further details on this training can be obtained in Denyer & Arias (1991) and Campos (2001).

Intracanon Lavas Formation (Pleistocene)

They comprise approximately 7 casts of andesitic lavas 10 to 30 meters thick, which emerge only in the lower valleys of the Virilla and Tiribí rivers but have been found in many of the drilling that took place in the Central Valley.

Locally it presents an intercalation of a tube of brechose flow (Mulas Bridge member), with a maximum thickness of 35 meters. The total thickness of the Formation is about 100 meters. They have been interpreted as the product of fissure-type eruptions or effusions, along NE-SW-direction fractures.

It discordantly overlies the formations La Cruz, Pacacua, Grifo Alto and Peña Negra, and is over-acided concordantly by the Deposits of Burning Avalanche. Its age is of Lower Pleistocene (the highest casting was radiometrically dated in 1 million years).

From the hydrogeological point of view, the lavas of this stratigraphic unit form a confined aquifer due to the development of porosity and high permeability, by fracturing (generated during rapid cooling of the lavas) or by brecciation.

The layer of tuffs that divide them works like a watering.

The upper lava layer forms the hanging aquifer (discontinuous) La Libertad, while the layers of lava below the tuffs make up the Upper Colima Aquifer.

Although they emerge only at the bottom of the canyons of the deepest rivers of the Central Valley, such as the Virilla and the Tiribí, it is very likely that their extent in the subsoil will be much greater. This is inferred from the data of groundwater extraction wells associated with the said Colima Superior aquifer. Within the study area it is considered that its extension covers a large part of the southern central area.

Further details on this geological formation can be obtained in Echandi (1981), Denyer & Arias (1991) and Campos (2001).

Bermudez Member of the Barva Formation (Quaternary)

The flowering base of the Barva Formation consists of a series of lava castings of andesitic to basaltic whose maximum thickness reaches 85 meters. The thickness of this unit shows considerable variations mainly due to fill structures.

In general, the lavas of the Bermudez member show an aphanitic texture with rare mainly feldspeatic phenocrystals, and porphyritic textures are rather rare. Abundant flow structures are observed in these lavas indicating low viscosity during their site.

This unit is located on the tubes and ignimbrites of the Tiribí Formation (Deposits of Burning Avalanche), where it is possible to observe fronts of casts mainly on the Bermudez River between the heights 1170 and 1190 meters above sea level, in the vicinity of the Water-eye spa, and on the Second River between the heights 860 and 900 meters above sea level. The south front of the Bermudez member's lavas is almost entirely covered by pyroclastic deposits; however, the geological map indicates its possible delimitation determined by the stratigraphic drilling data contained in the SENARA archives.

As seen in the geological map, the Bermudez member lavas emerge in the channels of the Porrosatí, Segundo, Mancarrón, Bermudez and Turales rivers due to the differential erosion of over-growing pyroclasts. The rivers mentioned have dug their channels through unconsolidated pyroclasts until they reach the upper levels of lavas.

They are classified as hard to very hard with a possible resistance to compression configured from strong to very strong. They are cracked, so they have a secondary porosity of moderate to high, which gives it important hydrogeological characteristics in the formation of open and fissured aquifers. These materials make up residue soils of the limo-clay type that vary from soft to firm, whose thickness is very variable from 0 to 2 meters.

This member includes the Tajo Mayo and Guararí units identified by Brenes (2003) for the southwest flank sector of the Barva Volcano.

Carbonal Member of the Barva Formation

This unit consists of lithic touches and unconsolidated ash touches whose maximum thickness reaches 20 meters.

The pyroclasts of the Carbonal member cover a large extent as shown in the geological map of the study area and are highly weathered forming high fertility soils.

In some places, however, the tobaceous nature of this unit is observed, particularly on the left bank of the Second River between the heights 1,200 and 1,240 meters above sea level, and in the vicinity of the town of Carbonal north of Heredia. In these sites emerges a lithic tub composed of vicenclated fragments of up to 5 cm., of heterogeneous composition, encompassed in a matrix of little welded pumytic ash.

Carbonal pyroclasts allow the lavas of the Bermudez member to be differentiated from the upper lavic units and are considered as a stratigraphic guide horizon whose most distinctive characteristic is precisely its high degree of meteority.

They are classified as soft to firm rocks. Because of their degree of alteration and relative high abundance of clay, they exhibit low permeabilities, forming aquitard and therefore little hydrogeological interest.

Los Angeles Member of the Barva Formation

The los Angeles member consists of an andesitic-basaltic lava cast that extends from Cerro Redondo or Monte de la Cruz (ancient volcanic emission focus) to the western part of the city of Barva.

This laundry was first mapped by SAENZ (1958). Its lavas show aphanitic texture, very rarely porphyritic inside the casting, and a slag vesicular texture on the outside.

Flow structures such as lava tubes, canoe topography (collapsed tunnels) and flow lines are common, which indicate low viscosity at the time of the site.

The thickness of this laundry does not seem to exceed 15 meters. On the surface of the terrain shows a slat texture although in the core of the laundry is presented as a dense and massive lava.

Good outcrops of this laundry are located in the quarries of Santa Lucia 2 km north of Heredia, and on the road San Rafael - Los Angeles at the level 1.480 meters above sea level where a burnt contact between this unit and the underlying pyroclasts of the Carbonal unit emerges.

About 1,600 meters above sea level the Laundry of Los Angeles overstretched the pyroclasts of Porrosatí, while at lower elevations it overstretches the Carbonal unit. It has been estimated that the total volume of lavas in the Laundry of the Angels ranges from 0.2 to 0.3 cubic km.

This volume of lava was expelled by the parasitic cone of the Barva volcano called Cerro Redondo or Monte de la Cruz and is considered to be the last lava emission associated with the volcanic activity of the Barva.

It is classified as a hard to moderately hard rock. It has a high porosity and permeability, so it has great hydrogeological importance. It has thin sandy and permeable residual soils. For its high permeability it is valued, from the point of view of hydrogeological potential as high type. It forms discontinuous, hung and short-spread aquifers (SENARA – BGS, 1985). They usually originate springs at the base of the unit.

Reventado Formation (Pleistocene)

SUPERIOR MEMBER

It emerges in the canyons of the rivers Reventado, Tiribí, Birrís, Chiquito, Durazno, and Birrisito among others.

According to Krushensky (1972) this member reaches about 600 m thick and consists of about 4 main flows with local development of a few more.

You can have columnar fracture. South of Quebrada Norberta presents lahars development, which also occur in the valleys of the Birrisito and Parrúas rivers.

The flows are in the order of 30 m thick interspersed with lahar horizons between 2 and 8m thick. The associated ash layers show a very variable thickness. The lower surfaces of lava flows are irregular, between 10 and 40 m apart, reflecting the underlying eroded surface, usually a lahar. The lavas are basaltic andesite, show fluid factory and are light grey to dark in texture.

They are rocks of generally high hardness, with good supporting capacity. They have rather high porosity and permeability, due to fractures. Which gives them good hydrogeological potential. Due to the presence of these fractures in exposed slopes may be susceptible to generate local rockslides.

MEMBER "ASH LAYER”

It consists of a thin layer of highly weathered ash brown –reddish brown orange, with no apparent stratification that extends between Caballo Blanco and Paraíso, southern Birrisito, Cervantes sur de Birrís and Naranjo. It overlies the Paradise Member and is over-acidized by the Higher Member both of the Trapped Formation. Its maximum thickness is 15 m.

From a geomechanical point of view they are rocks of low hardness (soft), with limited supporting capacity, low cohesion and susceptible to erosion processes. They have high porosity, but low permeability, which gives them limited aquifer potential.

Sub-Recent Ashes

This is called an extensive mapping unit covering an important extension of the central part of the study area. It comprises a package of variable thickness (meters to several tens of meters) of volcanic ash that commonly presents meteorists, forming thick cinecritic soils, and representing the final part of the volcano-sedimentary filling of the Central Valley basin.

Denyer & Arias (1991) and Denyer et al. (1994), they include the ashes along with the facies of lahars which is also part of the final filling of the basin, within a geological formation they designate as a "Lahars and Ashes".

From the point of view of the study documented here and given the difference in local morphology generated by the outcrop of the lahars from that of the ash packs, an effort has been made to differentiate them cartographically.

As Denyer et al points out. (1994) volcanic ash represents evidence of persistent volcanic eruptions in the stratovolcanoes of the Cordillera Central, as was the eruption of the Irazú volcano between 1963 – 1965. The fact that they represent the final part of the filling shows that many of these eruptions must have a historical record and have occurred over the past thousands of years.

From a geomechanical point of view they qualify as semi-hard to soft, clay and low permeability rocks. They produce clay-lime soils with plasticity, some porosity and low permeability (low to moderate hydrogeological potential). In addition, from low to regular resistance. Given its large extent and the fact that much of GAM's urban development is located on top of this unit, an example of its basic geotechnical parameters is provided:

a) consistency limits: liquid limit by 50%, 15% plastic limit and low-scallive scallin rating – high plasticity (ML-MH);

b) Permeability: 1.4 X 10-4m/s;

c) cut resistance: effective internal friction angles of 20 degrees.

Cohesive resistance is very low. This fact makes them sensitive to erosion on exposed surfaces, not protected by vegetation. In natural or artificial cutting slopes, greater than 20 degrees, they are susceptible to local collapses. Generally, geotechnical and slope stability studies in this geological unit do not recommend the development of slopes greater than 2:1 (H: V), and for sites with compacted fillers, slopes that meet the ratio 2.5:1.0 (H: V) can be recommended. seismic amplification phenomena (see Moya et al, 1994).

Recent deposits of recent gravity flows

It corresponds to recent deposits of material from the volcanic slope of the Irazú stratovolcano at the height of the City of Cartago, particularly in the sector between Taras and Cartago, where the Reventado River descends. It has been studied by several authors, including Krushensky (1972), Paniagua (1994) and Bergoing (1998).

It corresponds to deposit of recent sludge flows (lahars), which are composed of fragments of rocks, ash and sediments that contain enough water to flow quickly slope down. They can be produced by heavy rains or overflows of cuspidal lagoons on volcanic terrain.

They can also occur suddenly during volcanic eruptions, travel at speeds of between 30 and 100 km/h and can temporarily reach thicknesses of more than 10 meters while flowing within narrow channels (Paniagua, 1994).

In 1963, a Gravity Flow of the Resale River was identified that developed at the height of Taras during the eruption of the Irazú. This flow resulted in the deaths of 20 people and the destruction of 300 homes, according to the author quoted.

Volcanic slope fan deposits

For the study area, it mainly corresponds to the volcanic slope fan that is presented in the Cartago sector.

This type of fan has been deposited where the Reventado River enters the valley of Cartago. It is composed of an amalgam of lobes or flows, of which the Reventado River of 1963 is the most recent (see back). The oldest is Quircot (defined by Krushensky, 1972) north of Cartago, stretching from Quircot to San Rafael.

Erosion has removed most of the apex of the fan that extended to the southeast of Banderilla. The fan has been deeply dissected, so it forms canyoning channels up to 35 m deep, as it is easily eroded. It consists of meteorized detritus of the erosion of the Trap and Sapper formations.

The thickest detritus consists of metric blocks of the maximum order of the 3-4 m diameter of porphytic basaltic andesite that downstream rises to pebble sandstones and even clays. Both the selection and stratification of the deposit are poor. Some horizons correspond to deposits of mud currents.

The Cartago fan (defined by Krushensky, 1972) is located on the southern margin of the Quircot range and extends south under the city of Cartago, to the town of Guadalupe. Its western edge is bounded by the Taras River. It contains metric blocks up to 4 m in diameter of lavas from the Popped Formation from the apex to Campo Ayala. Stratification and selection are poor.

Compositionally both fans are similar to the lahars of the Sapper and Trapped formations, except in the clay content of the matrix, both originating from mud streams. The channel of the Reventado River has cut (incision) as 10 m in the Cartago fan.

Lahars

They consist of lava blocks, of various sizes and proportions, gravel and volcanic sands distributed in a clay matrix of dark brown to brown-yellow and reach great thicknesses (Castle, 1993).

They correspond to the most distant deposits from the volcanic activity of the emission centers of the Central Volcanic Range (Póas, Barva and Irazú, mainly).

The deposits are of two main types: proximal facies and distal facies, differentiated mainly by the size of the blocks.

Locally you can also find small lacustrine deposits deposited in the temporary lakes that formed as a result of the dam produced by the lahars and ash.

The lahars are approximately 60 meters thick, they are heterogeneous, with sub-angular andesitic fragments with sizes reaching more than the meter. The matrix is clay-sandy and very poorly cemented.

These materials emerge in various areas of the Central Valley, including in the Valley of the Rio María Aguilar from the crossing of the Curridabat-San Pedro highway to its confluence with the Tiribí River. They also emerge on the middle slopes of the Volcanoes Póas (see Campos et al, 2004) and Barva (see Brenes, 2003).

Possibly interstratified are volcanic avalanches and floods (Denyer & Arias, 1990). Madrigal (1966) called it lavina and assigned it a thickness of 53 meters.

In many places the lahars are over-acided in a concordant way by the layer of subjacent ash.

Its age is Pleistocene – Holocene, possibly originated during the last 50 thousand years.

From a hydrogeological point of view, the lahars, due to their presence of fine loins and sand granulometries, exhibit a behavior of an aquitard type, that is, that they store a certain amount of water but have difficulty transmitting it. Locally within the lahars can be found sandy lenses that make up small average flow aquifers of less than 1l/s, and eventually up to 3l/s.

Further details on this formation can be obtained in Denyer & Arias (1991) and Campos (2001).

Alluvial deposits

It includes deposits of gravel and sand accumulated as a product of river transport within active and inactive channels. They are a few meters thick and widths of meters up to tens of meters. They are highly mobile depending on the flow of the river.

6.2.3 Structural Geology

The structural geology of the study area is characterized by a relatively simple structure: the deepest subsoil is formed by the oldest sedimentary rocks of the Oligocene - Miocene, possibly over-lying Eocene rocks, and these to their a Cretaceous ocean crust base regionally designated as a Higher Nicoya Complex (Astorga, 1997, Denyer et al, 1994).

These sedimentary rocks are structurally deformed forming folds and homoclinals, with a tendency of inclination (buzine) of the layers in the N-NE direction (see Figure 6.4).

In turn these sedimentary rocks are intruded by igneous rocks of intermediate to acidic composition in whose contacts present metamorphic rocks of the cornubian type.

In a coalescing way with the sedimentation that was filling the Central Valley basin, as is natural in a volcanic intraarchal basin, there were various volcanic events, which greatly influenced, until they completely dominated the final phases sedimentary filling (see Astorga et al, 1989, 1991, 1995, Denyer & Arias, 1991, Denyer et al., 1994, Campos, 2001).

In the final phase of volcanic filling and as a result of the presence of pronounced relief in the territory under study, intense erosion processes were developed that result in the development of alluvial fans and other types of associated deposits.

Recent evidence that this erosive activity still prevails is represented by Holocene landslide deposits, as well as any deposits of ash layers from volcanic activity, as was the case in the cycle of eruptions of the Irazú volcano between 1963 and 1965.

It is important to note that the entire sector of the Central Valley, to which it is geologically attached, the study area has an emerging tectonic condition, since it is a system under geological survey. This fact explains the geological situation of high activity of erosion and sedimentation processes present in the area.

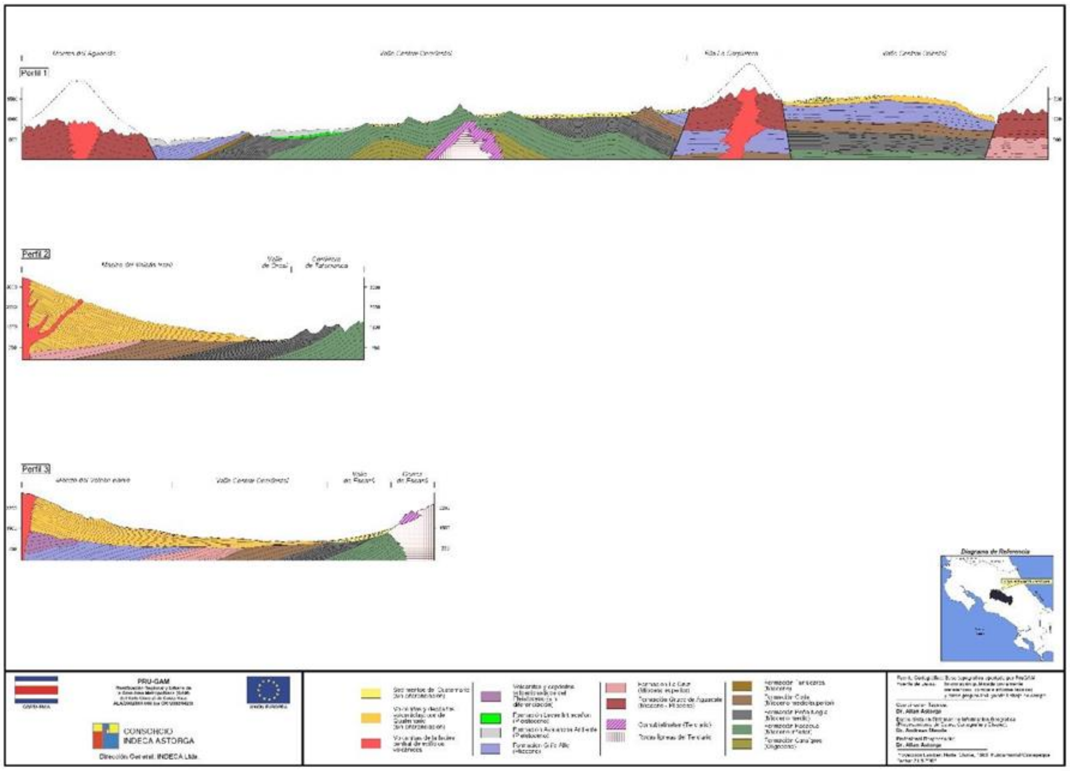


Figure 6.4. General geological profiles along Costa Rica's Central Valley (cf. Astorga et al., 2008).

6.2.5 Geological faults

Procedure for identification

The analysis of the existence or not of geological faults in the area of study and its area of influence follows a two-step procedure.

First, a verification of the geological technical information available for the area, in particular the geological maps previously published, by various authors (see references) is carried out and among them is the map of Montero (1994) and more recently by data from the Costa Rican Neotectonic Atlas (Denyer et al., 2003), as well as from threat maps issued by the National Commission for Risk Prevention and Disaster Care (CNE).

Secondly, the geological and geomorphological information processed by the authors during the field and photointerpretation work carried out as part of the environmental fragility study, in particular, in the Geoaptitude component, is analyzed.

The results of both lines of work are compared and finally a geological map is derived that synthesizes said processing and integration of information (see Figure 6.5). It is important to note that because some of the maps generated as a product of previous work, have been made at scale greater than 1:10,000, not in a few cases, the location of the faults that is presented in them, has a high degree of error and printing , sometimes in the order of hundreds of meters or more than one kilometer. In view of this, and as part of the work covered by this study, the corresponding adjustment has been carried out according to the data of field geology and photointerpretation, as well as the analysis of the digital model of the field.

From a regional geological point of view, the Tectonic Atlas of Costa Rica (Denyer et al., 2003) indicates the existence of a series of geological faults, most of them classified as quaternary faults, that is, for which there is evidence that they have been active for the past two million years. The authors of the referred atlas warn that it does not make any difference between active and quaternary faults, so it should not be used for seismic threat studies. They also point out that the scale of the atlas does not allow it to be used to determine the location of civil works with respect to the faults presented.

Accordingly, and due to the scale at which the map of said Atlas (1:200,000) is presented, this information is considered as a reference to take into account as part of the more detailed geology performed in this work.

Procedure for its practical classification for territorial planning

The technical procedure established by Executive Decree No. 32967 – MINAE includes in Annex 2, the so-called "***Protocol for the zoning of land use on and near active geological faults".*** As part of the recitals in that document, it is indicated that:

> *"Costa Rica is a geologically young country, characterized by numerous geological faults along its continental and marine territory. Many of these geological faults are a source of seismic and neotectonic activity, and sources of a type of geological threat called "surface rupture potential" that, has meant and can continue to represent the generation of significant damage to works of infrastructure and human occupation that*

are located on or in areas immediately adjacent to fault traces or deformation zones that may occur on the ground".

"Not all geological faults that can be identified in a given geographic area qualify as active geological faults, that is, capable of producing, with some degree of probability, and according to concrete geological evidence, potential for rupture in surface and therefore conform as a natural threat to human occupation works"

As part of the Protocol, three concepts are defined that are key to geological mapping work for territorial planning, which are:

Fault: *Defined as a fracture or area of nearly spaced fractures along which rocks* on one side have been displaced from the rocks on the other side.

Potentially Active Fault: *Faults showing evidence of surface displacement during the Quaternary (last 1.6 million years), also known as Neotectonic Fault.*

Active fault: *Fault (geological) that has had surface displacements during the Holocene (last 11,000 years) and that has potential for future displacements along one or more of its segments, constituting a potential threat to structures located on their trace. Displacements can be observed directly or inferred along or in part of the fault line.*

According to the above, the quaternary faults identified in the Tectonic Atlas of Costa Rica, would qualify as Potentially Active Geological Faults. However, with the exception indicated above on its scale.

In this respect, given the complementarity of the information and the fact that the map of Montero (1994) presents greater detail than the Atlas, it has been used as a source of basic information to support the work that is documented here.

The above-mentioned Protocol procedure indicates that the task of the advisory team with regard to geological faults is to separate those that are pre-quaternary faults or are inactive faults from potentially active faults.

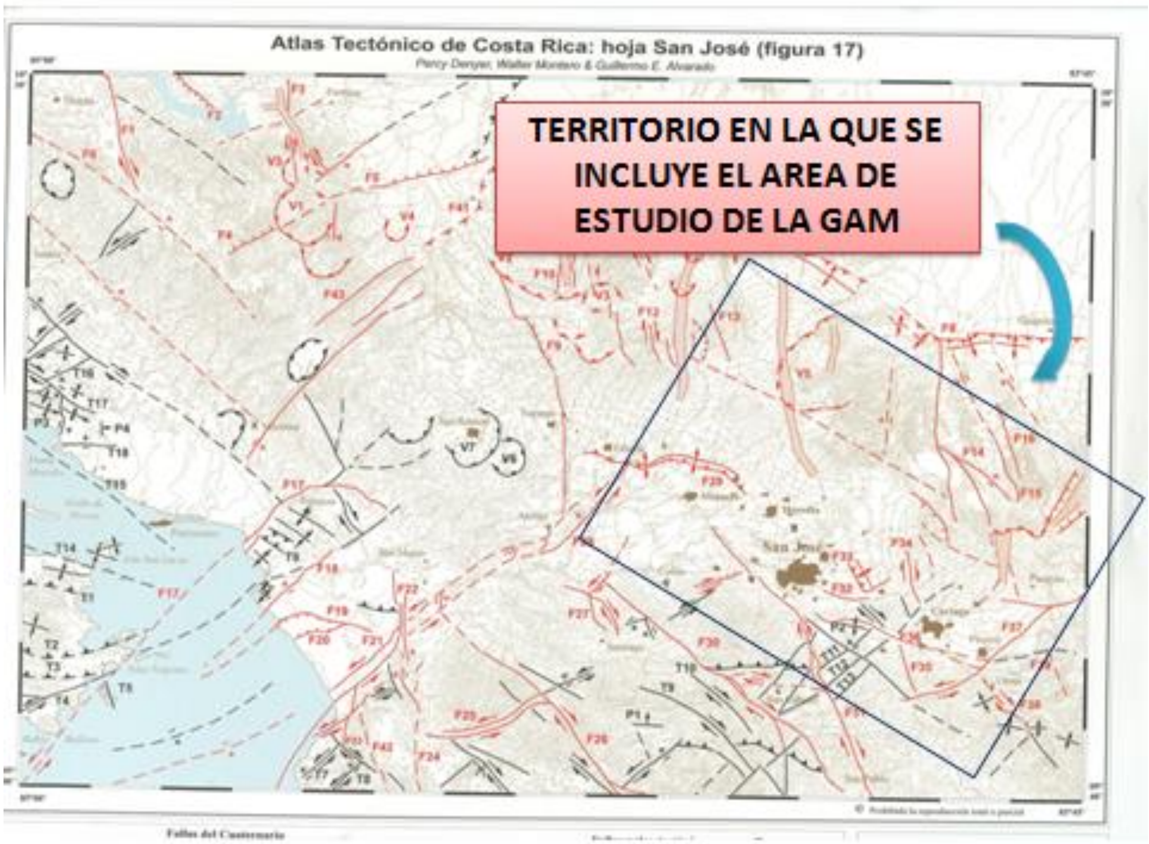


Figure 6.5. Map of the leaf San José, according to the Tectonic Atlas of Costa Rica (cf. Denyer et al., 2003). The faults in red are Quaternary faults. Faults in black are Pre-Quaternary faults.

According to the procedure, geological faults classified as "potentially active" must have a 50-meter-wide preliminary safety zone on both sides of the trace. A subsequent neotectonic study, involving paleosismicity studies, should confirm, eliminate or reduce that safety zone.

In the case of this study, since its general nature does not contemplate the conduct of neotectonic studies for each fault. This is because it is a feasibility study and since the cost of that work would exceed, by the number of faults identified, the individual value of the work of the total consultancy.

This work is recommended to be done as part of the detailed studies phase.

It should be noted that given some of the geological faults identified for the study area, these neotectonic analyses involve significant investment, both in time and cost.

6.2.6 IFA Geoaptitude Litopetrophysics

The Lytopetrophysical factor of the IFA Geoaptitude represents the stability of the land for buildings such as buildings or infrastructure based on the spatial distribution of geological formations, the properties of soil cover and the characteristics related geotechnicals.

The most important basis for evaluation of the Physical Lytopetrophysical factor of the IFA Geoaptitude is a detailed study of the geology of the area in question.

The information Litopetrophysics, by its scale, is not a substitute for the specific geotechnical reports that may be given on specific farms or geographical spaces on a smaller scale than that used in the IFA study.

However, the IFA study can guide, given a more inclusive and general view it contains, on the geographical spaces in which such studies require a deeper and more detailed approach, prior to the development of projects, works or activities.

The *Litopetrophysics Geoaptitude Factor* represents the stability of the land for buildings such as buildings or infrastructure based on the spatial distribution of geological formations, the properties of soil cover and related geotechnical features.

As previously mentioned, the *Terrain Geoaptitude* methodology is based on a 5-level I-V categorization with increasing value for human use.

Depending on the characteristics of the geological units of the study area, as mentioned earlier in this document, the result of the application of the parameters of Executive Decree No. 32967 – MIANE, is presented on the *Geoaptitude Factor Map Lithopetrophysicist* (see Annex 4 MG 3.1 to MG 3.3).

As can be seen, much of the TRP stroke path is located in areas of High IFA Geoaptitude Lithopetrophysics, which implies that there are certain geomechanical limitations in rock units, particularly in the issue of supporting capacity, why it is necessary to carry out geotechnical studies of detail to establish appropriate support conditions in particular for those tranches of the TRP that are not available at the surface level.

6.3 Geomorphology

6.3.1 Regional geomorphology

Figure 6.6 shows the regional location of the study area on the map of Costa Rica's digital model. As can be seen, the study area is presented in the southern part of the Central Valley and, mostly, in the so-called Pre- Cordillera de Talamanca.

From a regional point of view, the study region has several regional geomorphological units. Here's a brief summary of them:

Astorga et al. (1989, 1991, 1995) defines the Central Valley as a "second generation" basin, of tectonic origin associated with a transcurrent-type regional geological fault system called Costa Rica's Transcurrent Fault System.

According to these authors, this system of geological fault, active from the Upper Tertiary (Middle Eocene – Superior, approximately 40 million years ago), separated the arch of islands of Costa Rica, into two segments designated as Costa Rica North and Costa Rica South.

The movement of the Transcentive type transcurrent system developed a phenomenon of tectonic depression predominantly facing East – West that originated the Central Valley Sedimentary Basin.

According to the above-mentioned authors, the sedimentary basin functioned as a depression zone with a natural channel linking the Caribbean Sea with the Pacific Ocean.

This sedimentary basin was gradually filled (see Campos, 2001) until the natural canal was closed during the Upper Pliocene (about 2 to 3 million years ago).

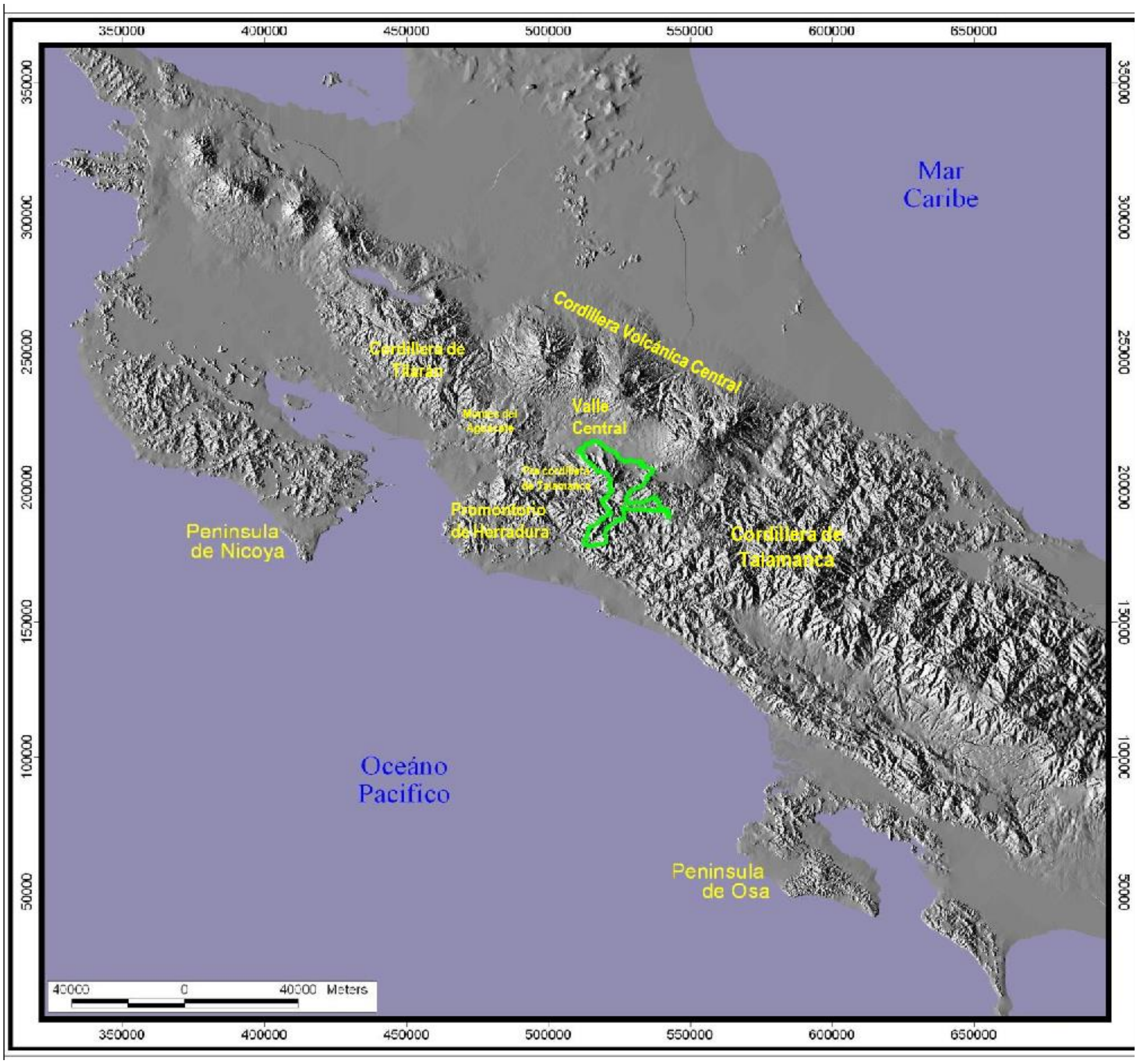


Figure 6.6. *Regional geomorphological context of the study area (green line) on the Costa Rica Digital Model Map. As can be seen, the study area is presented in the southern part of the Central Valley and, mainly, in the so-called Pre Cordillera de Talamanca (Bergoing, 2007).*

From that time, the basin was filled and filled by volcanic products from the volcanoes that preceded the current volcanoes of the Central Volcanic Range and later by them. In this way, the Central Valley took the configuration that it currently has.

Jean Pierre Bergoing (1998), points out that the Central Valley has a total area of 3,246 Km 2,and presents itself as an East–West depression that separates the Central Volcanic Mountain Range (to the north) from the Cordillera de Talamanca (to the south), thus becoming, at the natural northern boundary of the latter.

The Central Valley is divided into two distinct aspects, separated by the small volcanic – sedimentary mountain range of the Northeast-facing Carpintera Hills. The Eastern Central Valley, where the Reventazón River is inscribed that drains its waters into the Caribbean and the Western Central Valley traveled by the Virilla – Tárcoles River, whose waters will give to the Pacific Ocean.

According to Bergoing (1998) the Western Central Valley is divided into three main morphological units: the northern slope composed of the Central Volcanic Range, the volcanic plateau that forms the area of flat topography in which it is presented mainly the Great Metropolitan Area (San José, Alajuela and Heredia), and the southern slope comprising the mountain range of the Talamanca pre-mountain range and the mountain-foot ending deposits that are associated with it.

The Talamanca Precordillera, from a geological point of view, as explained in the preceding chapter has a genetic link with the Central Valley, because they are collectively part of the same sedimentary basin. The difference between the two units is that the southern sector of the basin, which now corresponds to the Talamanca Precordillera, has been affected by a strong tectonic uprising since the late Miocene (approximately 10 million years ago).

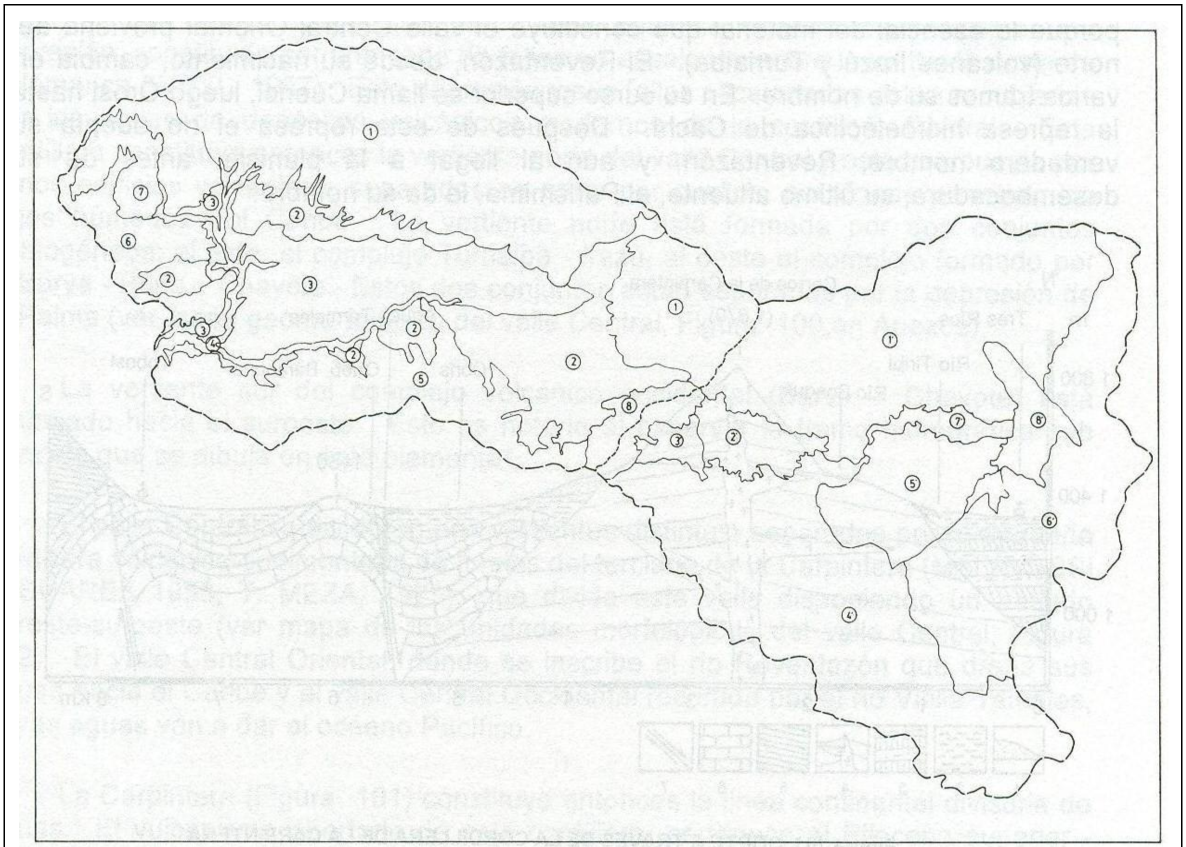
Tectonic lift that has not yet ceased and is primarily responsible for the pronounced highlight conditions that are presented in the study area.

Figure 6.7 presents the Geomorphological Map of the Great Metropolitan Area. In total, 110 local geomorphological units are distinguished.

As for the geological map, the development of the geomorphological map of the study area was based on an assessment of the information previously published on the subject (Bergoeing & Malavassi, 1981), the photointerpretation of the images of CARTA 2005, the possibility of working with a high-detail topographic base and direct observation in the field.

Due to the practical impossibility of describing each of the 110 distinct geomorphological units, they have been grouped into a number of geomorphological domains, namely:

- Volcanic Slope Domain,
- Domain of the Volcanic Plateau, and
- Mountain domain.



A) Valle Central Occidental
1) Cordillera Volcánica Central. 2) Fondo del valle con coladas* laháricas de San José. 3) Meseta vulcano ignimbrítica occidental. 4) Cañones de los ríos Grande y Virilla. 5) Piemonte* vulcano sedimentario sur. 6) Depósitos volcánicos plio-cuaternarios de los montes del Aguacate. 7) Caldera de Palmares con depósitos ignimbríticos y lacustres. 8) pequeña cordillera volcánico-sedimentaria en parte plegada de La Carpintera.

B) Valle Central Oriental
1) Piemonte* de la cordillera Volcánica Central. 2) Conos laháricos y depósitos torrenciales de Cartago. 3) Depresión tectónica de Coris. 4) piemonte* Noreste (cordillera de Talamanca) 5) Horst* de Doán con relieves de calderas. 6) Piemonte* Este vulcano-sedimentario (Neógeno) 7) Cañón del río Reventazón con terrazas fluviales enconadas. 8) Depresión tectónica de Turrialba de rellenos laháricos.

Figure 6.7. Regional geomorphological units according to Bergoeing (1998).

As part of the ***Volcanic Slope*** are included all geomorphological units identified and directly related, with the southern slope of the volcanoes Póas, Barva, Irazú and Turrialba. For the various geological units mapped in this domain, local geomorphological units have been distinguished, depending on the degree of slope and the geodynamic processes in force in them.

The Domain of the ***Volcanic Plateau*** corresponds to the part of flat slope to moderate and distributed by various water channels, which is presented between the Volcanic Slope and the Precordillera. It has an NW – SE direction and is interrupted by the small sierra de La Carpintera. Also, here the morphological units identified are related to the geological units and are separated according to the slope, or in their defect from the erosion or sedimentation processes that prevail. The study area analyzed here is located within this unit.

The ***Mountain Domain*** corresponds to the entire area of pronounced relief that extends from the Avocado Mountains to the west to the Pre Cordillera in the central part and the Cordillera de Talamanca in the eastern part of the entire southern sector of the Central Valley. Within this area is presented the system of Cerros Denudados. Also, here the different geological units mapped, are separated according to their relief, including the presence of ravines and their degree of dissection.

6.3.1 Local Geomorphology

Annex 4 (MG 4.1 to MG 4.3) presents the geomorphological maps of the study area. As can be seen, 26 local geomorphological units were identified.

The following describes some of the key morphological elements considered to differentiate the various geomorphological units, according to geological units.

In the event that some of them have been described in the Geology Section of this document, their characterization is not repeated in this section.

High relief

In the case of **"high relief**" units, erosion and denudation processes are considered as high to very important. An aspect that represents a significant limitation the use of these lands in the development of activities involving the development of human occupation infrastructure. It is important to note that, at present, some of these lands are presented in an environmental equilibrium condition because they have a residual soil coated with wood cover.

However, a significant percentage of these lands also have no forest cover. The initiation of an imbalance process in these units, due to the development of anthropic infrastructure activities, would most likely initiate an erosion process whose brake, once initiated, is extremely difficult. Hence the importance of keeping this geomorphological unit as unchanged as possible and strengthening the existing equilibrium situation, where forest cover is still already covered.

Moderate relief

In the case of the "moderate relief" subunit, erosion and nudity processes are of significant importance, a fact that should be taken into account in the technical design construction projects. In these subunits the slopes are relatively steep, and erosive processes can be increased in case of fracture of the rocks or subflares or fractures in the same direction of the slope.

Low relief

The lands of the “low relief" subunit are more limited to erosion and nudity processes. From this point of view, they have better potential for the development of urban infrastructure activities, provided that the geological and geotechnical conditions arising from local studies are respected.

Barrancas

The "ravines" subunit corresponds to pronounced relief terrain associated with a rapid process of river erosion and the deepening of the relief to form a gorge, usually very inclined walls, sometimes vertical in which a river runs. Usually, as a result of an intense erosive process of the river current.

Recent Floodplains

It corresponds to areas of river flood valley associated with riverbeds. Flooding occurs when the flow of the river grows significantly as a result of heavy rain processes or, failing that, a combination of high flow rates and high sedimentary load caused by landslides at the top of the basin or failing volcanic material from the activity of a volcano. These areas have significant constraints for the development of human activities and for the development of strategic infrastructure.

Recent gravity flows

In the case of the study area corresponds to areas where events of passage of a flow of gravity of volcanic origin (lahar) related to the activity of the Irazú Volcano in 1963 have occurred. It is a flow of high energy and high sedimentary load, with enormous destructive power.

Alluvial plains

They are areas of flat topography originated as a product of river sedimentation.

6.3.1 IFA External Geodynamics

The External Geodynamics factor of the IFA Geoaptitude represents the suitability of land for human use based on surface characteristics and related geodynamic processes.

A detailed study of geomorphology forms the basis for the evaluation of this factor including the digital interpretation of aerial photographs, the interpretation of digital topographical data such as the digital terrain model, as well as fieldwork.

Applying the same methodology as in Geology, the following map of IFA Geoaptitude is that of Geomorphology, from which the map of IFA Geoaptitude is derived by external dynamics.

The arrangement of high-resolution aerial photographs, digital terrain model and field verification, allows to recognize and characterize various geomorphological units in the study area, and even confirm geological structures such as faults already identified on the geological map.

As previously mentioned, one of the most useful by-products of the geomorphological map is the recognition and individualization of the immediate flood valleys of river and ravines (see Figure 6.8).

Its recognition is very useful, because it is based on a simple criterion, the individualization of the first river terrace. With this geometric criterion, it is possible to separate the area most likely to be flooded during a river flood or ravine. Then with the field check, this area is checked.

Unfortunately, it is generally wider than the protection zone established by the Forest Law, making it an area where building permits are granted, making it a flood risk zone (see below).

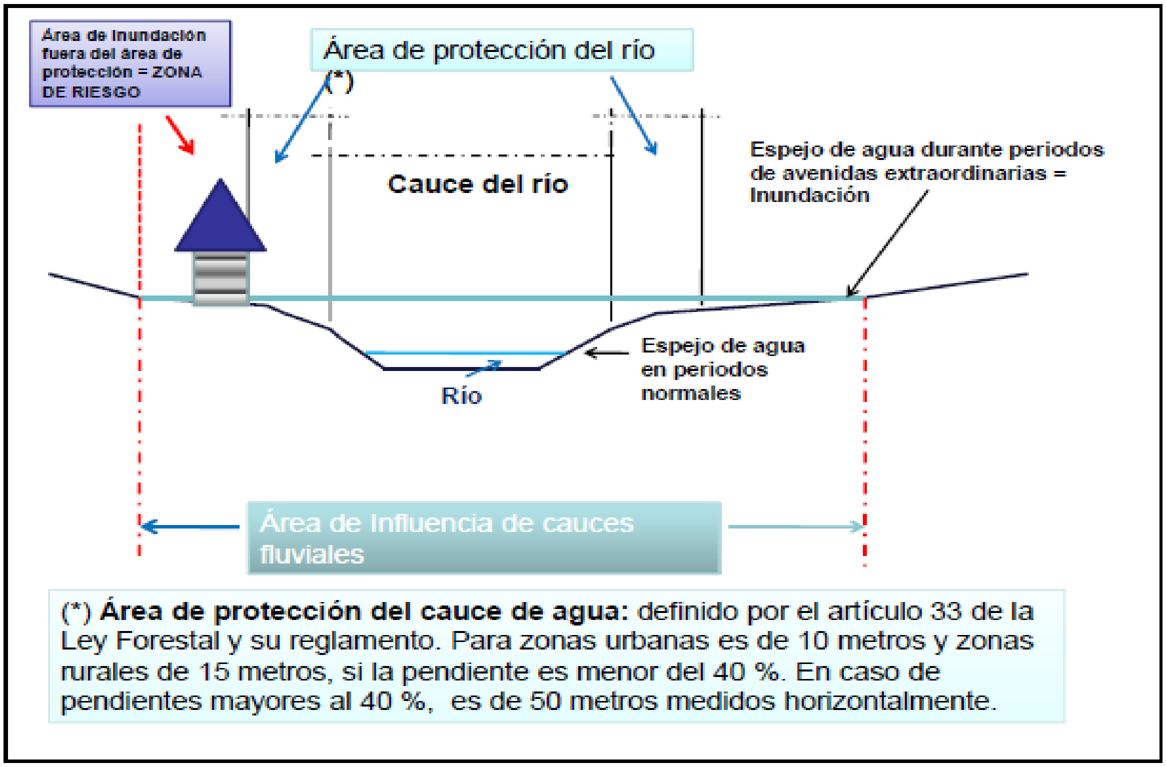


Figure 6.8. Schematic model of the immediate flood valley of a watercourse based on the geometry of its first terrace, for low to moderate relief terrain.

Geomorphological map data is combined with variables already measured for geology in GIS. In addition, ratings are added for other new variables such as slope, which uses the same grade ranges set for land-use capacity studies, relative relief, drainage density, the importance of erosion processes and the importance of sedimentation processes.

With all this it is possible to generate the Map of IFA – Geoaptitudofe of External Geodynamics that, in five colors, establishes the most fragile areas because active erosion or sedimentation processes predominate, or less fragile areas, because there is a good balance between both processes. Although this map is not a product requested in this study, it plays a key role in the development of the vulnerability map to slippages, in obedience to the application of the methodology of Executive Decree No. 32967 – MINAE.

Annex 4 (MG 5.1 to MG 5.3) presents the External Geodynamic IFA maps for the study area. As can be seen most areas are of moderate fragility, however, there are some areas of high and very high external geodynamics, in relation to high slope areas susceptible to erosion processes, as well as areas of riverbeds susceptible to flooding and Cartago's active volcanic range.

6.4 Hydrogeology

6.4.1 Introduction

The Geoaptitude Hydrogeology factor represents the suitability of land for human use based on the potential for contamination of underground aquifers or, failing that, the involvement of water recharge areas. In this sense, areas where water rocks emerge on the surface coincide with the most vulnerable areas.

On the other hand, these same lands offer the possibility of groundwater extraction for human use with low financial investments. In conclusion, low values of the Geoaptitude factor Hydrogeology have two ambiguous senses: on the one hand, it is a good basis for future development to have easily accessible underground aquifers, on the other hand the high vulnerability to contamination it involves certain development constraints in order to protect this important resource.

The categorization of 5 levels I-V with a growing value for human use is defined as follows: "I - very high (high danger of aquifer contamination)" towards "V - very low (no danger of aquifer contamination)".

It is important to note that information on hydrogeological geogeological geofitness does not replace hydrogeological assessments that may occur in specific geographical areas and on a smaller scale, in order to determine whether or not groundwater exists with potential for exploitation or to determine its vulnerability to pollution. The IFA study can guide, given the most inclusive and general vision it has, about the geographical spaces in which such studies need to be carried out, prior to the development of projects, works or activities.

The analysis of the hydrogeology of the study area presented here constitutes an integration of the information obtained by the two pathways indicated above. On the one hand, it is based on the interpretation of geological and geomorphological data in this regard to the hydrogeological potential. And the other important source for hydrogeological studies are water well data such as static/dynamic water level, flow or permeability of underground aquifers.

6.4.2 Regional Hydrogeology

Arredondo (1994) summarizes the general data of the hydrogeology of the Central Valley. Arredondo and Suarez (1994) publish a hydrogeological map for the Greater Metropolitan Area on a regional scale.

As a basis for the work, the aforementioned authors use various publications and regional and partial hydrogeological studies carried out in the area. Particularly relevant is the Hydrogeological Map of the Central Valley of Costa Rica (BGS & SENARA, 1985), among other publications.

Arredondo (1994) establishes a petrophysical classification of aquifers, in order to use it as a technical basis for regionally characterizing the aquifers of the Central Valley. This classification is presented in Table 6.1.

According to Arredondo (1994) in the northern and central part of the Central Valley, the most important aquifers develop in lavas, while pyroclastic flows (tuffs and ignimbrites) form aquitards and occasionally aquiclude. Figure 6.9 shows the main aquifers present in the northern and eastern sector of the Central Valley. For its part, according to the author, in the eastern sector of the Central Valley, it reports the existence of two aquifers: one deep in lavas and one shallow in collusive material – alluvial and lahars. Table 6.2 presents a general descriptive synthesis of the regional aquifers of the Central Valley, according to Arredondo (1994) and other authors. Arredondo (1994) concludes by noting that in the southern sector of the Central Valley it consists mainly of igneous and sedimentary rocks that are characterized by their low porosity and permeability, so they are generally lacking hydrogeological importance.

Hydrogeological domains of the central sector of the Greater Metropolitan Area

Given the importance of the central sector of the study area as a population settlement, it has been selected to further analyze its hydrogeological situation. This in order to have a better view of your situation and to have a more accurate base of land use planning that is also useful to promote comprehensive management of the water resource.

From the analysis of the formations and geological units identified for this sector, it is possible to separate three main geological domains, namely:

1) South sector (Mountain Range)
2) Northern sector (southern slope of the Volcanic Range)
3) Central sector (Central Plateau).

These geological domains relate to different origins for the formations that make up them, particularly for the northern and southern sectors, while the central sector represents a boundary or transition zone between the two domains.

Ref.	Name	Definition	Potential flows
1.	**Porous aquifers**	Developed in **<u>unconsolidated sediments,</u>** such as alluvial, in which sandy, silt and clay sections predominate.	In general, they are able to produce approximate flow rates of 5 to 10 liters per second.
2.	**Cracked aquifers**	They occur in **<u>ignimbrites and tuffs</u>** (among other rocks). They have little primary porosity, but due to their secondary porosity (fractures) allow the transit and storage of groundwater. They usually act as aquitard.	The average flow rates present are approximately 2 to 8 liters per second.
		<u>Pyroclastic lavas and</u> deposits, which, in addition to secondary porosity in fractures, also have characteristics of significant primary porosity, such as vacuoles and gaps, in some important aquifer regions.	They can yield flows greater than 80 liters per second.
3.	**Non-water rocks**	Different deposits of continental origin, such as **<u>lahars, river terraces</u>** of a classic nature with little permeability. In general, they can be considered as aquitards.	They flow small, in the order of 2 liters per second.

		Igneous and sedimentary rocks that have low primary porosity and recalcification phenomena do not generally exhibit effective secondary porosity. Water circulation and storage occurs in special cases in meteorized and fractured areas.	Individual wells give small flow rates, usually less than 1 liter per second.

Table 6.1. Classification used by Arredondo (1994) to regionally characterize aquifers in Costa Rica's Central Valley.

Taken from Arredondo (1994).

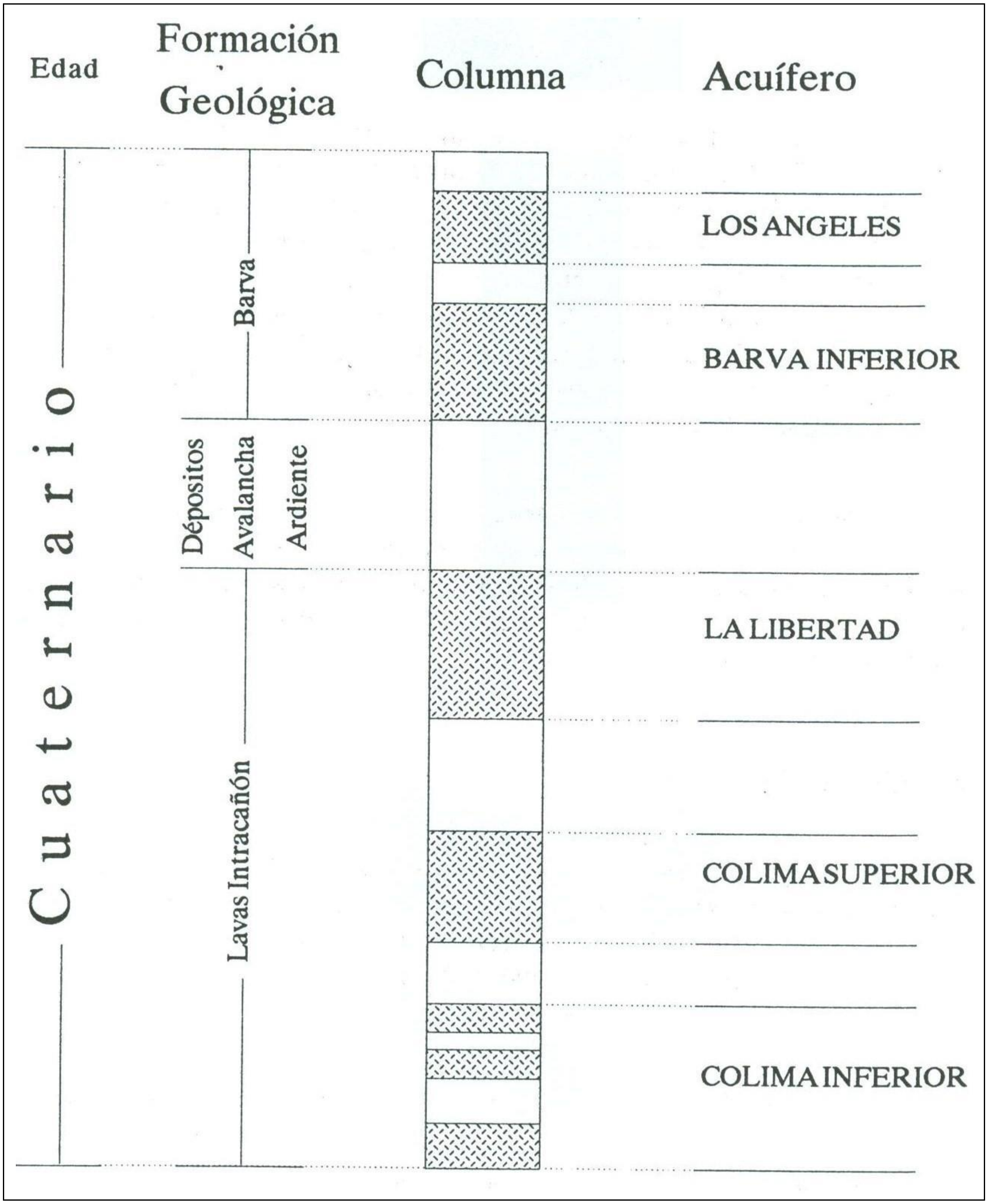


Figure 6.9. Regional aquifers of the northern and central sector of the western Central Valley, within the GAM. Taken from Arredondo (1994).

No.	Name	Rock	Thickness	Extension	Production	Recharge	Observations
1	**Los Angeles**	Wash	Dozens of meters	Upper parts of the Brava Volcano	Unquantified	Direct infiltration of rainwater and riverbeds	It features springs
2.	**Lower Barva**	Fractured andesitic lavas with high permeability	Several dozen meters	Southern slope of the Brava Volcano to the county of Bethlehem	Flow rates up to 20 l/s in wells	Direct infiltration of rainwater and riverbeds	Numerous springs. Feed the Ojo de Agua spring.
3	**Freedom**	Wash	110m	Southern slope of Barva Volcano	Unquantified	Infiltration from the area's rivers	It has springs.
4	**Upper Colima**	High permeability by brechose texture	55 m	Southern slope of the Barva Volcano and Volcanic Plateau	High performance	Vertical percolation from aquifers	It features springs in the canyon of the Virilla River
5.	**Lower Colima**	Lava and twists	Several dozen meters	Southern slope of the Barva Volcano and Volcanic Plateau	High performance	Vertical percolation through the watering that over-yes	Water level at depths of 100 m below the surface.
6.	**West Sector of the Central Valley**	Deeper undifferentiated pyroclasts and lavas	Several dozen meters	West Valley Sector	With the order of 5 l/s	Direct infiltration from the ground	The rocks of the Avocado Group have hydrothermal alteration and fractures, are impervious and are classified as a regional barrier.
7.	**Superior Aquifer of the Eastern Central Valley Sector**	Colluvium deposits – alluvial and semi-confined type lahars.	Dozens of meters	According to distribution of geological units	1 – 2 l /s	Direct infiltration from the ground	
8.	**Aquifer lavic from the eastern sector of the Central Valley**	Lavas with secondary fissure porosities	Dozens of meters	According to distribution of geological units	Median production, in the order of 10 l /s	Direct infiltration from the ground and recharge of the upper aquifer	

Table 6.2. General descriptive synthesis of central Valley regional aquifers.

Source: BSG – SENARA (1985, 1988) and Arredondo (1994)

Unsurprisingly, the geological nature of each domain also influences its hydrogeological behavior, so that it can be said that each identified geological domain also represents a different hydrogeological domain. Below is a brief contextualization of each of these domains along with a summary of their key hydrogeological data.

DOMAIN 1 - SOUTHERN SECTOR (MOUNTAIN RANGE)

For the study area extends throughout the southern sector, covering the entire Talamanca Precordillera that is presented in it. It covers from the hills of the Carpintera to the east to the hills of Tarbaca to the west. To the north extends to Desamparados or to the northern foothills of Alto de Las Palomas, near the southern bank of the Virilla River.

From a morphological point of view, it covers the mountainous portion of the left bank of the Virilla River basin.

Much of the sedimentary succession present in this domain corresponds to sedimentary and volcanogenic rocks from the Miocene and Pliocene. Covering these rocks, to the northeast part of the sector in question is presented a volcanogenic filling of the Quaternary, composed of the upper Grifo Alto Formation, the Intracañón Lavas Formation, the Burning Avalanche Deposits Formation (Tiribí), Lahars and Ashes formation and finally recent soils and colluvial deposits (see back).

From a hydrogeological point of view, the most important aquifers present in this sector correspond to the Colima Inferior and Colima Superior aquifers. Both aquifers are separated by a layer of tuffs and ignimbrites about 40 meters thick, identified by the map of SENARA – BGS (1985) as the Puente de Mulas Member. The Lower Colima Aquifer is housed in fractured and brechose lavas casts, which can cause this aquifer to present yields of up to 60 l/s per well (in ibid, 1985). The Upper Colima Aquifer is housed in the layers of lavas above the tuffs of the Bridge Member of Mulas.

Due to the geological nature of the southern sector it is possible to say that neither of the two aquifers has an extension below the mountainous mountain range. On the contrary, such a mountain range represents a hydrogeological wall or barrier. This means that the Colima aquifers (Lower and Higher) will only be presented in the flat part north of the mountainous mountain range.

As far as the mountainous mountain range is concerned, its hydrogeological geofitness potential is classified as low to very low, due to the low to very low porosity condition presented by its geological formations. It is important to note that this does not imply that groundwater and low-potential aquifers cannot be housed in such formations. Vargas & Mora (1999) carried out an analysis of this situation for the Pacacua and Peña Negra formations and point to groundwater production in the springs of these aquifers ranging from 0.4 to 24.4 l/min, i.e. in the order of 0.25 to 0.50 l/s , hence its rating as a low aquifer potential. Data from these authors suggest that these aquifers are low volume and local in nature.

DOMAIN 2 - NORTHERN SECTOR (SOUTHERN SLOPE OF THE VOLCANIC RANGE)

This other geological-hydrogeological domain covers almost all of the southern slope of Barba Volcano, part of the southeastern slopes of the Póas Volcano and the southwest of the Irazú Volcano.

Its southern boundary extends to an approximate latitude that joins the cities of Alajuela, southern Santa Barbara, Barba and Heredia.

From the geomorphological point of view, it covers all the areas of moderate to high slopes that make up the southern slope of the Central Volcanic Range and in particular the mountainous area located on the right bank of the Virilla River.

As previously described, the vast majority of geological units present in this domain are relatively recent, originating during the Quaternary, particularly during the last million years (Late Pleistocene). The explanation for this is that these geological units represent part of the building that makes up the same Barva Volcano, whose maximum age is 1 million years.

From the stratigraphic point of view in this domain, unlike the Domino 1, appears the so-called Barva Formation, which consists of 6 members or stratigraphic units (from the ceiling to the base: Crater, Bambinos, Los Angeles, Porrosatí, Carbonal and Bermudez).

Infracting the Barva Formation, particularly in the topographically lower areas of this domain, are volcanic rocks that correlate with the volcanic rocks that culminate in the stratigraphic column of Dominion 1. As part of these units are identified the Avalanche Burning Formation and Intracañón Lavas, the Mulas Bridge and Bethlehem members, and the Zurquí and Old Lavas units.

Due to the characteristics of lithopetrophysics (porosity and permeability) that present the levels of volcanic rocks arranged in the subsoil of Domain 2, in the territory of the same develop a stratified and staggered series of very important aquifers.

These aquifers that correspond with (top to bottom): Upper Barva, Local Aquifers (Porrosatí and Carbonal), Lower Barva, La Libertad, Colima Superior, Colima Inferior.

By the size of these aquifers they can be divided between local aquifers and regional aquifers. The Colima and Barva aquifers fall into the latter category, while the remaining aquifers form more local aquifers.

Local aquifers (or hanged) occur in the middle and upper slopes of the Barva Volcano, while regional aquifers occur in their lower part, translating with the plateau area.

It is important to emphasize that these local and hung aquifers, not because they are smaller than the regional ones, cease to have great value as a source of groundwater.

According to SENARA – BGS data (1985) the Bermúdez Aquifer can produce water in wells with flows of up to 20 l/s, while the La Libertad hanging aquifer can originate springs up to 100 l/s.

Regional aquifers, since they are mainly presented in the plateau area and that is where they are most exploited are analyzed in the next section.

Regarding Domain 2, it is important to note that since some of the rock formations that house aquifers hung or serve as a recharge for regional aquifers, they are presented by emerging or exposed on the surface, and taking into account their capacity to retain and transmit water to the subsoil, it is clear that these exhibition sites become water recharge areas of great strategic value, which require special administration to prevent them from deteriorating or serving as a source of water pollution of the various groundwater levels present in this area of the Central Valley.

DOMAIN 3 - CENTRAL SECTOR (CENTRAL VALLEY PLATEAU)

This Domain differs with ease since it covers the entire flat part of the study area that divides the mountainous area of the volcanic mountain range north of the mountainous area of the southern sector of San José. In addition, on this volcanic plateau, sits the Great Metropolitan Area of the Central Valley, in which the cities of San José, Heredia and Alajuela stand out.

The plateaus in question, for the study area has a northwest orientation – southeast and its main axis (east – west direction) is represented by the Virilla River.

In order to have better clarity on the geological and hydrogeological condition of this area, it is subdivided into two sectors. The first corresponds to the northwest portion of the domain, that is, in the sector of the county of Belén, on the right bank of the Virilla River. The second sector corresponds to the left bank of the Virilla River study area, and particularly under the city of San Jose.

Northwest sector of the Plateau on the right bank of the Virilla River

In the case of the northwest portion of the Plateau, the highest part of the geology of the sector, presents in addition to the lahars and/or ash of the top, the "distal" part of the Barva Formation, which in turn over-links the pyroclastic deposits of the Avalan Formation Cha Ardiente and you are in turn to the volcanic rocks of the Incañón Lavas Formation. Below that last formation it is quite possible that a stratigraphy such as that represented for Domain 1 is presented, at least partially.

From a hydrogeological point of view, at least two conspicuous aquifers, the Lower Barva Aquifer and the Upper Colima Aquifer, are presented in this sector. It should be clarified that it is also possible that below the latter, the Lower Colima Aquifer is also presented, however given the importance of the first as a water source, most wells in this area have only been limited to drilling up to that Depth. Hence, at least for now, and for practical reasons, there is no deepening into the subject in this document.

The **Lower Barva Aquifer** has a relatively wide extent and comes from Domain 2 to the northern part of Domain 3, i.e. from the slopes of Volcano Barva to the northern portion of the Plateau, coinciding with the expanse of the rocks of the Barva Formation. According to SENARA – BGS (1985) the permeability in this aquifer is given by fissures and by the brecciation of the lavas. Some wells can produce up to 20 l/s in this aquifer.

It is important to note that for the northern portion of the Plateau Sector and since it is the lower parts of the Barva Formation, the aquifer in this sector is presented in a water discharge area, where springs are common. The most conspicuous example of this type of springs is that of "Ojo de Agua" in San Rafael de Alajuela.

Water discharge zones with the development of springs or with the extraction of water by means of wells is an issue that, from the point of view of management of underground water resources requires a somewhat deeper analysis.

The **Upper Colima Aquifer** is developed on the rocks of the upper section of the Intracañón Lavas Formation. According to the data available and emanated by SENARA, this aquifer is large and has high production per well (up to 100 l/s with little despondency). Its permeability is presented in fissures and brechose parts. It is an aquifer of great strategic value for the population of the Central Valley as it is used as one of the most important water sources, in particular by the Costa Rican Institute of Aqueducts and Sewers (AyA).

It is important to mention that to the east of the area of Plateau, already in Dominio 2 (area of Santo Domingo, San Juan and San Vicente) above the Upper Colima Aquifer, and separated by a layer of roasting material about 10 meters thick , there is a level of brecciated and fractured andesitic lavas, almost 110 meters thick, with the so-called La Libertad hanging aquifer, which also originates springs with flows of up to 100 l/s in the area. The rocks of this aquifer emerge at the base of the Virilla River and the Tibás River in all its high portion and given their porous and permeable nature they make them have an influential behavior and therefore with high vulnerability to pollution.

Southeast plateau sector on the left bank of the Virilla River

The top layer of the geological column for this sector, is made up of a thick layer of volcanic ash, which becomes thicker in the direction to the northwest, reaching thicknesses of up to 30 to 35 meters in the sector of Santo Domingo and Moravia (see Moya et al. , 2000).

Below the ash layer and also laterally is a layer of lahars of varying thickness (several meters up to 15 meters), which may eventually contain sandy lenses that make up small local aquifers that can produce up to 3 l/s in wells, but generally less than 1 l/s of water with variable chemical quality.

Due to the flat topography of the area, the rest of the geological information of the area is obtained in two complementary ways. On the one hand, directly by observing relatively few hard-to-reach outcrops. On the other hand, the analysis of the lithological data provided by the relatively numerous groundwater wells that there is this area (see Schosinsky & Vargas, 2001, and Campos, 2002).

Below the lahars layer are pyroclastic deposits attached to the Tiribí Formation (Schosinsky & Vargas, 2001), or the Burning Avalanche Deposits Formation (Denyer & Arias, 1991). It consists of tuffs and ignimbrites, whose thickness for this area is close to 30 meters.

Under the pyroclasts, an andesitic lavas level of approximately 45 meters thick is presented stratigraphically attached to the Colima Superior unit (Schosinsky & Vargas, 2001). These authors describe them as dense, possibly vacuolar lavas, which may have secondary fracturing and brecciation, which gives them potential for the formation of an aquifer (Upper Colima).

Below this level of andesitic lavas and separated by a level of tuffs and ignimbrites of low permeability and low aquifer potential there is a lava of porphyritic texture very vesicular and fractured black with a very high apparent permeability and that , according to the authors cited, forms the[1] Lower Colima Aquifer.

The hydrogeological base of the area is interpreted as the sedimentary rocks that underlie the volcanic coverage and which the cited authors attach to the Pacacua Formation.

In short, from the hydrogeological point of view, below this southwest area of the Central Plateau, there are at least two aquifers of significant importance, the Upper Colima and the Lower Colima. The ceiling of the Upper Colima is presented at average depths of 20 – 25 meters below the ground and some outcrops of the lavas containing it are exposed along the river channels of the area (Tiribí, Torres and María Aguilar) , which may mean that rivers may be contaminating the aquifer by an influential behavior (Schosinsky et al., 2001; Schosinsky & Vargas, 2001).

6.4.3 Local Hydrogeology

The hydrogeology analysis of the study area is based on three main sources:

1. Previously known and published regional and local data (see previous sections),
2. The interpretation of geological and geomorphological data on hydrogeological potential, obtained from the geological and geomorphological maps carried out in this study, and

[1] It is important to note that there is a possibility that Schosinsky & Vargas (2001) is interpreting these two aquifers as the Upper and Lower Colima, but that it is actually the equivalent of the Aquifers La Libertad and Colima Superior. However, in the absence of further studies, the stratigraphic model suggested by these authors is assumed here.

a. The general data obtained by processing technical information of groundwater extraction wells, available in the National Well Archive of SENARA.

Annex 4 (MG 6.1 to MG 6.3) presents the hydrogeological maps of the study area.

Based on the data processed and synthesized, the following hydrogeological units are identified in the study area:

1. Aquifers in Volcanic Rocks (high to very high potential)
2. Aquifers in Volcanic Rocks (moderate to low potential)
3. Open Alluvial Aquifers (potential: moderate to high)
4. Open Alluvial Aquifers (moderate to low potential)

An overview of these aquifer units recognized in the study area according to Map 9 is provided in the following section. This description is complemented by the regional information described above for the entire study area and the hydrogeological domains of the central sector of the Central Valley.

Aquifers in volcanic rocks

LOW POTENTIAL AQUIFERS

It is presented in geological units of volcanic origin that show very limited conditions of effective porosity and porosity, in consideration of which, their ability to store and transmit water is limited. They usually function as aquitards.

Included as part of this low-potential aquifer unit are the volcanic rock units of the so-called Zurquí Member that emerges north of the counties of San Rafael, San Isidro and Moravia. Also included as part of this unit are the volcanic deposits of the Avocado Group that are presented in the eastern sector of the county of Paradise. Finally, as part of this low aquifer potential group, magmatic and metamorphic rocks attached to the Intrusive Escazu and the Cornubian Unit are also included.

In the vicinity of fault zones, where the fracture of the rocks can be increased the rocks of this aquifer unit can improve its storage capacity and develop local aquifers. However, due to the hardness of the rocks and the possible depths of the groundwater mantle the cost and risk of drilling in this unit would be significantly high.

Eventually they may have low flow springs, usually intermittent.

POTENTIAL MODERATE AQUIFERS

Rock units that present this condition are widely presented in the study area. It corresponds with rocks that have an intermediate or moderate condition of effective porosity and permeability.

They are able to store and transmit water, in a better condition than aquitards, but not as good as the rocks of high potential aquifer present in the study area. It forms intermediate condition aquifers with production flows of the order of 1 to 10 liters per second.

The pyroclastic rocks of the Porrosatí Member of the Barva Formation, which is presented north of the counties of Póas, Alajuela, San Rafael, Barva and Santa Bárbara de Heredia, are attached to this water integrated unit. Also included in this unit are the Sub-Recent Ashes that complete the filling of the Central Plateau.

The volcanic rocks of the Aguacate Group are mostly attached to this unit, including the sector of the Serranía de La Carpintera and the volcanoclastic deposits present in the east of Paradise

Many wells typically extract groundwater from these units for local supply of houses, farms and industries. Public supply from the wells of this unit is limited.

Moderate flow springs may occur within this aquifer unit. These springs emerge mainly in areas of negative topographical accidents, such as river valleys or ravines.

MODERATE TO HIGH POTENTIAL AQUIFERS

It corresponds to volcanic rocks that exhibit good effective porosity, either primary or secondary (by bills), and high permeability, which gives them great potential to store groundwater. Factor that is combined with the fact that in the region there are high average rainfall, which favors a high recharge of the aquifers that make up.

Included as part of this aquifer unit are the rocks of the Los Bambinos Member of the Barva Formation that emerge north of Santa Barbara, Barva and San Rafael. As discussed above, groundwater within this unit has been designated as Los Bambinos Aquifer.

Also, part of this unit are the rocks of the Los Angeles Member of the Barva Formation that are presented in the county of San Rafael and Barva de Heredia. As in the previous case, they form a high-flow aquifer designated as an Aquiferous.

Although they do not emerge widely in the study area, the volcanic rocks attached to the Intracañón Lavas Formation, if they present in the subsoil of a large expanse of the Volcanic Plateau of the Great Metropolitan Area (see previous section).

These rocks, as discussed above, have high aquifer potential and have developed three important aquifers namely: La Libertad (local) and the regional aquifers of Colima Superior and Colima inferior.

The vast majority of wells seen above on Map 9 in the Volcanic Plateau region are extracting water from this aquifer unit.

As in the Sector of the Barva Volcano, on the southern slopes of the Irazú Volcano and partly of the Turrialba Volcano, there are also important aquifers attached to this unit. The rocks of the Sapper, Birris, Ujarrás, Cervantes and Trapping formations, described for this region, within the counties of Cartago, Oreamuno, Alvarado and Paraíso have a high aquifer potential, very similar to that presented by the rocks of the Barva Volcano (see Ramirez, 2006).

The aquifers present in this unit have a high potential for groundwater production, mainly due to the development of abundant springs from moderate to high flows, but also by the extraction of groundwater from wells, particularly in low-lying areas.

In consideration of this fact and these aquifers, they represent the main source of water supply for human consumption of GAM populations, not only present, but also of the future, these aquifers are considered of strategic importance.

Open Alluvial Aquifers

POTENTIAL AQUIFERS LOW TO MODERATE

It comprises aquifers developed in clay conglomerates deposits originating as lahars and deposited as distal fans or as fillings of river valleys. Due to the presence of clay in the matrix of the clusters, the formation behaves rather like an aqueous, that is, it accumulates water, but that it releases or transmits it very slowly.

In the study area they are presented in the area in the flat areas, south of the county of San José, north of Desamparados, in Curridabat, in La Unión, Cartago, south of Oreamuno and northwest of Paraíso.

The waters of this aquifer have a limited quality due to the development of human activities of various kinds (urban and agricultural) on the infiltration area. By generating, they produce small outcrops of intermittent subsurface water.

6.4.4 Geoaptitude factor Hydrogeology

Important considerations

It is important to note that information on hydrogeological geofitness does not replace hydrogeological assessments that may occur in specific geographical areas and on a smaller scale, in order to determine whether or not groundwater exists with potential for exploitation or to determine its vulnerability to pollution.

The IFA study can guide, given the most inclusive and general vision it has, about the geographical spaces in which such studies need to be carried out, prior to the development of projects, works or activities.

As part of the hydrogeological analysis of a territory for territorial planning, the location of springs or wells and their respective areas of protection is not included due to the following reasons:

1. There is no systematic inventory of all intermittent and permanent springs within that territory.
2. Depending on the nature of the spring, the area of protection of the spring may vary (see technical document in Annex 7 of this Report).
3. Placing only some springs and others not on a territorial order map that can later become an official map, can mislead the user, making it assume that there are no other springs than those indicated on the official map.
4.Technical studies to determine the intermittent or non-intermittent condition of a spring, as well as its environmental hydrogeological situation, its nature, and whether or not it requires the definition of a protection area, should be carried out at scales of a catastrophic plane, i.e. the order of 1:500 or 1:1000, that is, they are of local type and therefore must be the subject of individual technical study for each development project.

In consideration of the above, the springs and wells, nor their areas of protection, when applicable, have been included in the environmental fragility maps. The consideration of them is done by means of a technical safeguard that is part of the set of technical reports to which this document subscribes.

Technical Results

The Geoaptitude Hydrogeology factor represents the suitability of land for human use based on the potential for contamination of underground aquifers.

In this sense, areas where water rocks emerge on the surface coincide with the most vulnerable areas. On the other hand, these same lands offer the possibility of groundwater extraction for human use with low financial investments.

In conclusion, low values of the Geoaptitude factor Hydrogeology have two ambiguous senses: on the one hand, it is a good basis for future development to have easily accessible underground aquifers, on the other hand the high vulnerability to contamination it involves certain development constraints in order to protect this important resource.

The categorization of 5 levels I-V with a growing value for human use is defined as the following: "I - very high (high danger of aquifer contamination)" towards "V - very low (no danger of aquifer contamination)". In accordance with the characteristics of the hydrogeological units that have been previously presented, the classification of the Geoaptitude hydrogeology factor has been established, as provided in the maps of Annex 4 (MG 7.1 to MG 7.3).

As you can see almost the entire extent of the TRP stroke passes through areas with the presence of aquifers in the subsoil. This aspect is important to take into account as it implies that constructive actions of the work must take into account preventive environmental measures to avoid soil and groundwater contamination.

Hydrogeological Geofitness Conclusions

The maps of Annex 4 (MG 7.1 to MG 7.3) which summarize the GAM's Environmental Frailty for Hydrogeological Geoaptitude Index may have a variety of use.

First, it can be used to recognize areas where important aquifers can be present in their upper subsoil, and consequently spring outcrops in topographic accidents. In this case the red and orange areas represent areas where there is potential aquifer potential within the GAM. These areas cover a large percentage of the territory of the study area, which is a clear indicator of the great groundwater potential of the Central Valley and the country in general (see Astorga & Arias, 2007).

Second, it allows to identify the reloading areas of STRATEGIC VALUE within the GAM. These areas define the sense that they occur in high areas, on geological formations of great hydrogeological aptitude, that is, of high capacity of accumulation and transmission of groundwater and that present feeding sources of high aquifers strategic value, either because they serve as the current source of supply for the population or as strategic reserves to be used in the future. These strategic recharge areas require a clear action plan to prevent their involvement and possible contamination of water resources.

Third, the IFA Hydrogeological Geoaptitude Map allows you to visualize it as a map of vulnerability to water pollution. For example, grey areas, defined as IFA – LOW Hydrogeological Geogeological Geofitness, represent areas of low vulnerability to pollution because they have very limited aquifer potential. As already indicated, these areas are suitable for the development of activities that generate a significant environmental burden on the physical environment.

6.5 Hillside stability (slips)

6.5.1 Introduction

Basic theoretical framework

The Threat by Sliding factor of the IFA Geoaptitude (cf. to the methodology of Executive Decree No. 32967 – MINAE) represents the suitability of land for human use depending on the threat related to slippage and landslide phenomena levies on masses.

In this sense, mountainous or relief areas represent potential sources of landslides, so in this case the Threat by Sliding factor of the GEOaptitude ISM reflects the degree of stability of the slopes and assesses the risk for the formation of slips in slope areas.

On the other hand, in the case of flat areas the same factor refers to the risk that chaotic gravity flows, including avalanches and mud flows among others, passing through the land resulting in serious losses with respect to constructions and infrastructure, as well as human life and other living beings.

It should be noted that the use of the term "slippage" is given here in a broad sense and rather as a synonym for the concept of "hillside stability phenomena" such and was raised by Mora & Mora (1994).

The authors cited, make an adaptation of the classification of Varnes (1978) and establish a classification of types of phenomena of instability of slopes applicable for the country and in particular for the area of study (see Table 6.3).

Figure 6.10 presents an illustrative drawing showing the different types of gravitational movements in mass (wide-ranging slips) in a tropical region, as is the study area analyzed here.

<table>
<tr><th>TYPE</th><th>CLASSIFICATION</th><th>DESCRIPTION</th><th>EXAMPLES IN GAM:</th><th>TYPES OF ROCKS</th></tr>
<tr><td rowspan="3">1. Rockslides</td><td>a. Rock column swinging</td><td>Forward rotation of one or more units over a pivot point at the lowest unit, by the action of gravity.</td><td>Alajuela, Virilla and Uruca river cannons</td><td>Intensely fractured lavas and ignimbrites.
Also in sedimentary rocks with high inclination.</td></tr>
<tr><td>b. Falling rock blocks</td><td>Sudden detachment of a rock mass of any size from a steep hillside.</td><td>Ujarrás Valley, Virilla River Canyon.</td><td>Rock slopes of different origin, exposed and fractured.</td></tr>
<tr><td>c. Rock slab slides</td><td>The rock mass advances downward along a more or less flat surface, defined by planes of weakness (faults)</td><td>Carretera San José - Ciudad Colón (Alto Las Palomas).</td><td>Rocks of the Burning Avalanche Formation.</td></tr>
<tr><td rowspan="2">2. Rotational and translational slips</td><td>a. Small volume</td><td>< 1 million m^3.</td><td colspan="2"><u>Rotational</u>: movement occurs along the concave rupture surface upwards, is influenced by faults, dialases, stratification planes and other discontinuities. Examples: in Tres Ríos, Aserrí, Fraijanes, Itiquís, Alto Tapezco in Santa Ana.</td></tr>
<tr><td>b. Significant volume</td><td>> 1 million m^3</td><td colspan="2"><u>Translational: the</u> movement of the mass is performed along a more or less flat surface and is usually controlled by surfaces of weakness such as faults, stratification planes, variations in the resistance of the strata. Examples: Ujarrás Valley, Reventado River Basin.</td></tr>
<tr><td rowspan="2">3. Debris flows (avalanches)</td><td>a. Significantly significant</td><td>> 15 thousand m^3</td><td colspan="2" rowspan="2">It occurs by a rapid movement of unconsolidated materials, which are highly mobile and move along surface streams (rivers and streams). They are the product of isolated events of considerable volume.
Examples: Cerro Doán, Orosi, Irazú Volcano National Park.
They are common in the Doan Formation.</td></tr>
<tr><td>b. Numerous small volume</td><td>< 15 thousand m^3</td></tr>
<tr><td>4. Soil reptation</td><td colspan="4">It develops on slopes with soils of fine, partial or fully saturated (water) granulometry, which are mobilized on relatively moderate slopes (5 to 30 o’). It involves thicknesses greater than 10 m, and it is a fairly common case that occurs in areas devoid of vegetation or subjected to inadequate agricultural practices. It is quite common in the Central Valley.</td></tr>
</table>

Table 6.3. Classification of slope instability phenomena according to Mora & Mora (1994) with examples for the Central Valley, but applicable for the whole country.

Source: Mora & Mora (1994).

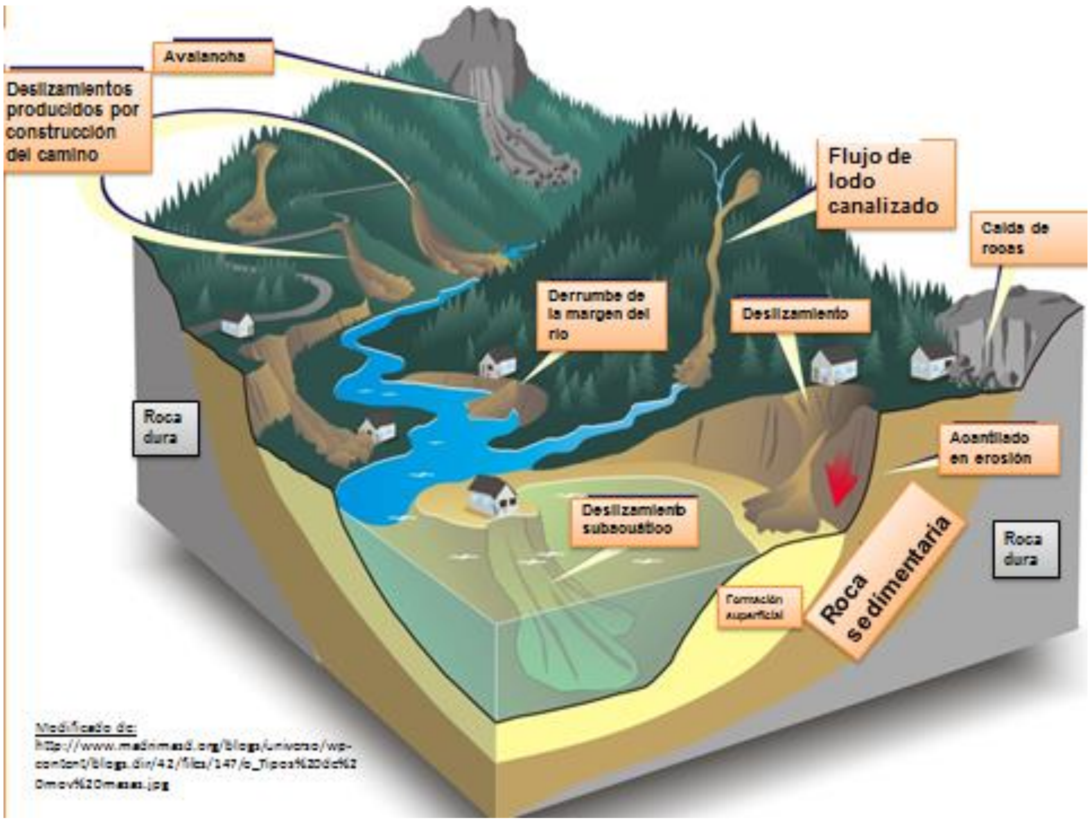


Figure 6.10. Illustrative drawing of the types of landslides (in broad sense) that a tropical region can be presented as our country.

A number of factors are required for a slippage to occur. Among them, the fact that there is a slope, as well as a coverage of material not lithified or compacted as a thick soil and also, precipitation conditions that favor the infiltration of water to that material. Sliding can occur by a simple weight effect, i.e. overload, or failing that, a detonating event can occur, such as a vibration produced by an earthquake. The dimensions of the slide will vary depending on the thickness and slope of the material involved, as well as the load of stored water.

Other types of landslides such as falling rocks or landslides may involve other factors, such as the presence of fracturing on the rocks.

Practical importance of the subject

The issue of hillside stability, or what is the same, the vulnerability of pending land to be affected by mass gravitational landslides processes (summarized as landslides), is an issue of great importance to a tropical country such as Costa Rica.

The reasons are many, more than 60% of the country has relief, that is, slopes or slopes, some of them very steep, the soils are usually thick, typical of tropical country, besides that there are geological formations in the upper subsoil, than by fracturing or abundance of clay, they are also very vulnerable and in addition, the territory of the country is one of the rainiest regions in the world (with average rainfall of 2500 mm per year).

Added to this is the fact that Costa Rica is also a highly seismic country with volcanic threat.

All of the above leads to landslides being, along with floods, the main and most frequent sources of disasters every year, with a feature, which are increasing year after year.

For all this, they are an element that must be taken into account in determining the environmental fragility of a terrain and establishing its Geoaptitude and with it, the vulnerability of a geographical space since this type of phenomenon occurs.

Combining the maps of geology, geomorphology and slopes, and their respective variables, together with two additional variables, such as the average rainfall of a given area and the parallelism between slope inclination and the lineage factor (scuba diving or tilting of layers, fracturing) of the geological formation of the upper subsoil, it is possible to generate the maps of IFA – Geoaptitude by Slope Stability (or Slippages). It should be remembered that in previous maps key variables are taken into account, such as the basic geological conditions of rock formations, soil thickness, their potential to store water, among others.

In the case of environmental fragility maps, according to the methodology established in Executive Decree No. 32967 - MINAE, generate 5 categories of IFA, from very high to very low. A terrain with a very high fragility to the landslides, will usually be characterized by thick soils and steep slopes. On the contrary, very low fragility terrains, are going to be areas with low slope, mainly.

In the case of the IFA methodology, the fact that a given ground qualifies as high or very high fragility, DOES NOT MEAN that it is prohibited from using land for the development of human activities. From the point of view of the GEOaptitude IFA, the question is to identify the technical limitation in question and that before making a decision on a human activity (crops, livestock, building or infrastructure) the issue is taken into account and compliance with technical conditions for land use.

The adaptation of the IFA methodology, for the objective of the study area, has led to the following:

1. Identification and mapping of recent active or historical landslides and their categorization according to a high to moderate degree of activity, as well as the identification of areas with the greatest potential for the development of new landslides, separated into at least two categories.
2. Factorial identification, according to the methodology of the IFAs, of the high and very high fragility areas by IFA Geoaptitude and its transfer to the map of the study area, as high and moderate areas risk of development of slips.

The following sections provide a more detailed explanation of the results obtained for the study area.

6.5.2 Results for the study area

Threat from landslides and gravity flows

Annex 4 (MG 8.1 to MG 8.3) presents the maps of IFA Geoaptitude by Slope Stability for the study area.

As part of the analysis of susceptibility to landslides, the land use of the land is also analyzed.

Thus, for example, the elimination of natural forest cover in high slope areas, inadequate management of surface drains, development of unstable debris fillers or lack of engineering measures for slope stabilization, could lead to increased effects of susceptibility and damage from such geological events.

Table 6.4 summarizes the characteristics of the main units of susceptibility to the phenomenon of slippage, identified and indicates the limitations and technical potentials of each of them, according to the condition of environmental fragility by the factor IFA Geoaptitude threat by Slippages.

UNIT	LIMITING	POTENTIAL
Areas of Very High Risk (active and potentially active gravity flows)	High to very high slope lands that exhibit conditions of obvious instability, highlighted by the presence of gravitational movements of rock and soil masses that have already happened or failing that are in motion or that has a condition of high probability of occurrence.	Given the conditions of obvious instability, these lands have very high limitations for the development of human activities of any kind, in particular those representing the installation of infrastructure works. These grounds require a stabilization process in order to minimize the effects of the sliding process. The management of runoff water and the development of plant cover, as well as the delimitation of the affected area to avoid occupancy, is of high importance.
High Risk Zones (Very High Frailty)	Very high slope terrain (greater than 60%) Limited geological conditions due to the presence of thick clay soils and fractured geological formations in the upper subsoil. In many cases without the presence of natural wood cover. In many cases, deficient surface water drains that favor the accumulation of surface water and the development of "hanging aquifers" that increase susceptibility to landslides.	Forest fitness grounds, with potential for the development of natural forests and the protection of wildlife. The possibility of the development of constructions should be determined by geological and geotechnical studies of detail that define specific design guidelines that exceed the indicated limits.
High Frailty Zones	High slope terrain (greater than 45%) Limited geological conditions due to the presence of thick clay soils and fractured geological formations in the upper subsoil. In many cases without the presence of natural wood cover or only secondary forest cover. In many cases, deficient surface water drains that favor the accumulation of surface water and the development of "hanging aquifers" that increase susceptibility to landslides.	The possibility of the development of constructions should be determined by geological and geotechnical studies of detail that define specific design guidelines that exceed the indicated limits. Agricultural and agricultural activities are possible but require the implementation of concrete environmental measures to reduce vulnerability, such as good agricultural practices, drainage management and local development of terrace systems.

Table 6.4. Summary of limitations and technical potentials of areas identified in the area of study as vulnerable to landslides.

As can be inferred from the map observation in Annex 4 (MG 8.1 to MG 8.3) a significant percentage of the territory covering the study area qualifies with an important degree of susceptibility to sliding processes. This situation is not coincidental, because, as already explained, there are significant limitations from the geological and geomorphological point of view, which adds to the fact that, in many sectors of the study area, despite the high slopes present and their climate conditions (see below), natural forest edifers have long been removed and replaced with unsupported land uses than these Geofitness conditions.

All of the above leads to the result that a significant percentage of the territory is vulnerable to slippage phenomena. Appearance to be taken into account in the design of the TRP both at surface level and in uneven steps.

6.6. Other natural threats

6.6.1 Introduction

The *Other Natural Threats* factor of the IFA Geoaptitude represents the suitability of land for human use based on the likelihood of natural threats.

In the case of the study area, relevant natural threats include river water flooding, seismic activity of regional tectonic origin or associated with local and active geological faults, as well as threats from volcanic activity.

In order to present the map of this factor of the IFA Geoaptitude more clearly, each of the indicated natural threats is represented in separate thematic maps.

The assessment of susceptibility to natural threats is based on the interpretation of geological, geomorphological and hydrogeological data supplemented by available data on harmful events that have occurred in the past (according to information from the Map of Threats from the National Commission for Risk Prevention and Disaster Care (CNE-). The information published on the subject has also been very valuable (see Denyer & Kussmaul, 1994).

Natural Threat Geoaptitude information is not a substitute for smaller-scale studies that on topics such as landslides or avalanches, seismicity, neotectonic faults, liquefaction, flooding or volcanic threat may be performed for specific geographical spaces, once it has been considered there is potential for such phenomena to occur in them.

However, the IFA study can guide, given the most inclusive and general view it has, about the geographical spaces in which such studies need to be carried out, prior to the development of projects, works or activities.

6.6.2 Seismic Threat

According to Morales & Aguilar, the seismic threat corresponds to the potential occurrence of a destructive earthquake, which can occur in a given area and time. Seismicity, on the other hand, is the spatial and temporal distribution of earthquakes, i.e.: place, depth, magnitude, time and date of occurrence of tremors or earthquakes.

It is important to note that, like the rest of this area of the Central Valley, the study area is subject to two types of main seismic source, the first of which corresponds to the subduction-originated seismic and the second source by intraplate seismicity (local fault). Both are explained below.

Subduction seisms

The seisms originated by the first mechanism are genetically related to the plate subduction zone that occurs off the Pacific coast of Costa Rica. This area is subdivided (according to the authors cited) into two main sections:

a) The area that extends from the so-called Mesoamerican Pit, where the subduction of the Coconut Plate begins under the Caribbean Plate, to the coast or coast. This area has depths of seismic sources that increase in the direction towards the earth, from 5 km to 50 km., and with maximum expected magnitudes (Richter scale) of up to 7.5 degrees, and which tend to cause maximum intensities (Mercalli scale) from VIII to 8 coast (exceptionally IX for certain coastal locations.

b) The area that, penetrating inland the country, with depths between 50 - 100 km., with maximum expected events of magnitude (Richter) of 7.0 degrees. The county of San Pablo analyzed here is located above this area.

For the Pacific area of Costa Rica, two main seismic zones have been defined, named by Morales as the Papagayo and Nicoya areas. Because these areas expect the occurrence of a major earthquake in the future, it is important to present some details about its nature.

The Papagayo area covers the area of the Santa Elena Peninsula, the Gulf of Papagayo and the northern Nicoya Peninsula, whose southern boundary correlates, grossly, with the Discontinuity of Tamarindo Bay.

According to Morales[2], the last major earthquake in this area was the one in February 1916 and had an approximate magnitude of Ms. 7.0. Seismic threat studies conducted for this area indicate that a similar event is likely to recur in the coming years.

The Nicoya area extends from the Discontinuity of Tamarindo Bay to the south of the Nicoya Peninsula, specifically in front of the Promontory of Herradura. MORALES outlines this area according to[3] the areas of rupture of the strong tremors of 1939 (Ms s 7.3) and in particular the tremor of 1959 (Ms s 7.7).

According to the author, this area does not show a stable period of recurrence, but it ranges from 8 to 28 years. Other seismic threat studies carried out in the area, in particular by the National University's Vulcanological and Seismological Observatory, have indicated that there is also an important probability that a major earthquake will occur in this area in a near future.

Since this seismic event in 1950, seismic energy has been accumulating for more than 50 years due to the continuation of the Coco plate subduction process below the Caribbean plate (9.1 cm/y), so the probability of a new high-energy seismic event is growing every year.

In addition to subduction earthquakes that can originate in the Central Pacific, the Central Valley and the territory of the County of San Pablo, it can also be affected by subduction earthquakes in the Central Pacific, the South Pacific and also in the Caribbean region. In the case of the Central Pacific, the seismic sources detected for the Herradura Promontory, the Parrita region and in particular the Quepos sector are presented.

Regarding the South Pacific, two important seismic sources stand out, that of the Golfito sector and that of the Panama Fracture Zone. Finally, in the Caribbean region, particularly in the coastal sector south of Puerto Limón, there is a type of intraplate subduction within the Caribbean Plate, which has originated a deformed tectonic belt that is a source of important seismicity that eventually impacts the Central Valley. The most recent example of this activity corresponds to the so-called Lemon Earthquake that occurred in April 1991 (Magnitude 7.2).

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[2]Morales L.D., 1985: The seismic zones of Costa Rica and surroundings. Geological Journal Central America, No. 3, pages 69-101.

[3]Abiddem.

In this sense, it is important to consider that the risk for constructions, related to high-energy seisms, is a direct function of the lithopetrophysical characteristics of the subsoil.[4]

Generally, unlitized soil units pose an increased risk because they can amplify acceleration caused by a high-energy earthquake. Likewise, the surface layer of unlithified river sands, which forms the shallow part of the subsoil of the project area, demonstrates this characteristic. For the same reason, the recommendations of the Costa Rican Seismic Code should be respected EXTRICTLY for all constructions, especially regarding the design of the foundations and the quality of the materials used for construction.

Table 6.5 summarizes the most important historical figures originating in or near the Central Valley, which have generated significant effects. Figure 6.11 shows the location of the epicenters of these historical seisms[5].

Regional intraplate source seisms

Intraplate mechanisms correspond to the active geological faults that can be found in the vicinity of the study area. From a regional perspective, the main source of intraplate seismicity corresponds to Costa Rica's [6] Transcurrent Fault System that runs through and originates the Central Valley.

[4]Schmidt, V., Moya, A., Climent, A., Rojas, W., Boschini, I. 2005. Seismic Microzoning of San Jose, Costa Rica. University of Costa Rica.

[5] The security parameters of the image prevent improving its resolution, however it has been included according to its historical value as a bibliographic reference.

[6]Astorga, A., Fernández, A., Barboza, G., Campos, L., Obando, J., Aguilar, A. & Obando, L. (1989): Sedimentary Basins of Costa Rica: Superior Cretaceous Evolution-Cenozoic and Hydrocarbon Potential. Symposium on the Energy and Mineral Potential of the Central American-Caribbean Region, San Jose, Costa Rica, March 6-9, 1989, Circumpacific Council. See also Astorga, A., Fernández, A., Barboza, G., Campos, L., Obando, J., Aguilar, A. & Obando, L. (1991): Costa Rica sedimentary basins: geodynamic evolution and hydrocarbon potential. – Geological Journal of Central America, 13: 25 -59; and ASTORGA, A.; FERNANDEZ, J.A.; BARBOZA, G.; CAMPOS, L.; OBANDO, J.; AGUILAR, A. & OBANDO, L.G; 1995: Sedimentary basins of Costa Rica: Late Mesozoic-Cenozoic evolution and hydrocarbon potential. -Circum-Pacific Council for Energy and Mineral

Possibly, the most important seismic event that has occurred historically in the vicinity of the study area corresponds to the so-called Earthquake of the Gulf of Nicoya (National Seismological Network, 1991).

This event, whose epicenter was located 17 km east of Cabuya (Nicoya Peninsula), originating in 1990, had a magnitude of 7.0 (Richter scale) and a depth of 17 km.

Number in Fig. 6.11	Name	Year	Magnitude Ms	Damage
1	Barva earthquake	1772	5.5	The earthquake hurts Barva's church.
2	Carthage's earthquake	1834	5.2	No damage was reported.
3	Alajuela earthquake	1835	5.4	Few damage to Alajuela.
4	Carthage's earthquake	1841	**5**.8	First destruction of Carthage; 38 people died.
5	Alajuelita's earthquake	1842	5.4	Damage to Alajuelita.
6	Fraijanes earthquake	1851	5.5	Significant damage to Alajuela, San José and Cartago.
7	Fraijanes earthquake	1888	5.8	It strongly affected the cities of Alajuela, Heredia and San José.
8	Tablezo earthquake	1910	5.0	Damage in San Jose.
9	Tablezo earthquake	1910	5.2	Damage to Homeless and San Jose.
16	Cartago's earthquake	1910	6.4	Severe destruction of Cartago, 600 people were killed.
Off the map	Toro Amarillo Earthquake	1911	6.1	Sliding, ground fracturing, destruction in Toro Amarillo.

Resources, Earth Science Series, 16. MILLER, R.L.; ESCALANTE, G., REINEMUND, J.A. & BERGIN, M.J. (EDS.): Energy and Mineral Potential of the Central American-Caribbean Region. Springer-Verlag, Berlin.

Off the map	Sarchi earthquake	1912	6.2	Sarchí was severely destroyed, 15 people were killed.
10	Tres Ríos Earthquake	1912	5.2	Damage in Tres Ríos.
11	Paraíso Earthquake	1951	5.2	Paradise was greatly affected by this event.
12	Patillos earthquake	1952	5.8	Major damage to the west flank of the Irazú volcano; Twenty-one people died.
Off the map	Toro Amarillo Earthquake	1955	5.5	Great destruction in Bajo del Toro, evacuation of the village; Ten people died.
13	Piedras Negras Earthquake	1990	6.0	Piedras Negras of Mora, three dead and many damages.
14	Piedras Negras Earthquake (replica)	1990	5.1	Damage to the Alajuela Guácima.
Off the map	Limón earthquake	1991	7.6	Damage at 8,000 km^2 in Costa Rica and Panama, cortical lift of south coast of Limón: 138 dead and 4,900 wounded.
Off the map	Cinchona earthquake	2009	6.2	Severe damage to Chinchona and Vara Blanca, 42 deaths from direct and indirect effects (slips)
Off the map	Nicoya earthquake	2012	7.6	Damage to Nicoya Peninsula area, 2 killed and 78 injured

Table 6.5. Historical seisms of significant magnitudes with epicenters in the Central Valley or its surroundings. Source: Schmidt et al Adjusted. (2005).

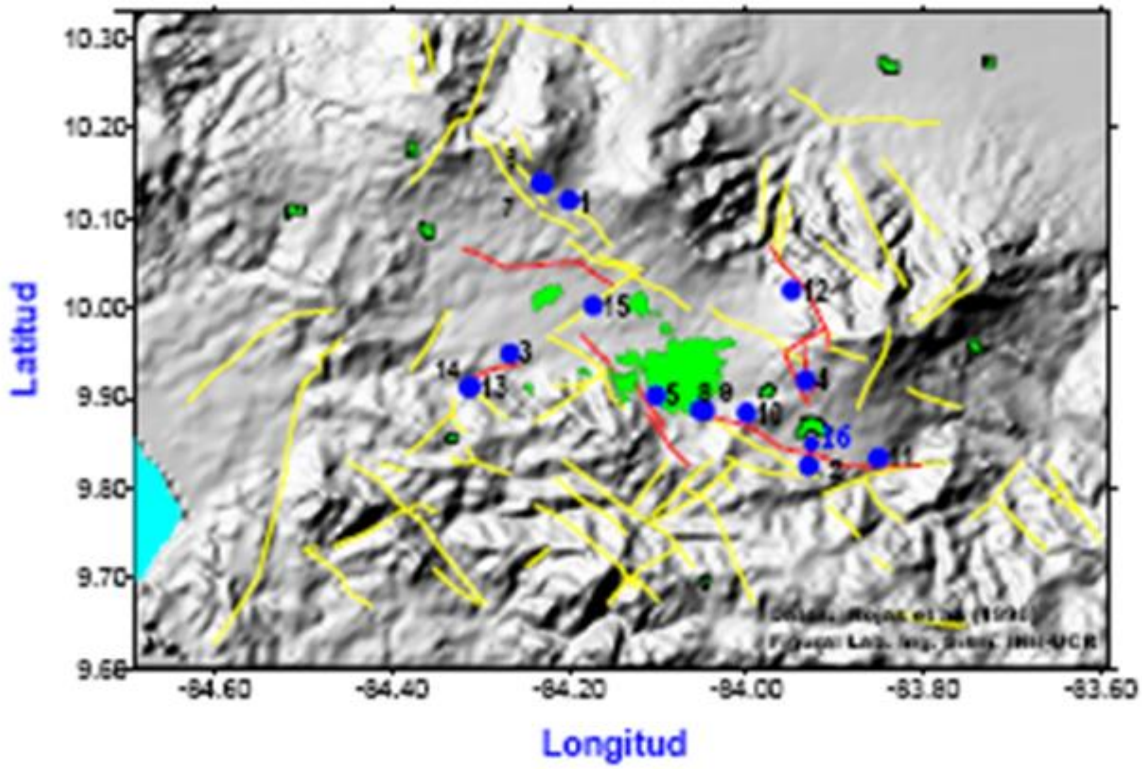


Figure 6.11. Map of location of historical seismic epics of the Central Valley and surroundings. Taken from Schmidt (2005).

Possibly, the most important seismic event that has occurred historically in the vicinity of the study area corresponds to the so-called Earthquake of the Gulf of Nicoya (National Seismological Network, 1991). This event, whose epicenter was located 17 km east of Cabuya (Nicoya Peninsula), originating in 1990, had a magnitude of 7.0 (Richter scale) and a depth of 17 km.

The Seismic Threat to the Study Area

Two different aspects should be taken into account with regard to the seismic threat:

1. On the one hand, as already mentioned, the location of the project area within the morphotectonic unit of the Volcanic Arch with a high degree of seismic activity, related

to the subduction of the Cocos ocean icy plate under the Caribbean plate. This implies an increased risk with respect to the threat of high-energy seismic events caused by the same subduction process.

In this sense, it is important to consider that the risk for constructions, related to high-energy seisms, is a direct function of the lithopetrophysical characteristics of the soil and the upper subsoil. [7] Generally, units of unlithified soils, as in the case of alluvial fan deposits that occur in the central areas of the study area, signify an increased risk because they can amplify acceleration caused by a high earthquake energy, which is why it receives a natural threat factor of 3.

2. On the other hand, the presence of active geological faults within the study area that, as already mentioned, occur within the study area, represent a source of seismic risk or surface rupture (see below), for which a factor of natural threat of 4.

In consideration of all of the above, it is advisable to establish a well-crafted anti-seismic concept for any type of construction project that you want to execute in the area, in order to ensure the stability of long-term constructions. As a minimum condition, all recommendations of the Costa Rican Seismic Code must be strictly complied with, especially with regard to the design of the foundations and the quality of the materials used for construction.

From all of the above and the previous data and the results of the IFA Geoaptitude Lithotrophic and IFA Geoaptitude maps by External Geodynamics, Annex 4 (MG 9.1 to MG 9.3) present the seismic threat maps for the study area.

As you can see almost all of the study area is located above a moderate seismic threat zone, except in section 3 (Figure 9.3), where they present areas of active geological faults.

[7] Schmidt, V., Moya, A., Climent, A., Rojas, W., Boschini, I. 2005. Seismic Microzoning of San Jose, Costa Rica. University of Costa Rica.

6.6.2 Threat factor for surface rupture potential from active geological faults

Local geological faults that occur in the study area, if active, are not only a possible source of seismic waves, but, if they are close to the surface, can cause a rupture phenomenon in the area, causing damage to the works that can limestone on or near its trace. Montero,[8] for its part, presents in the Seismological and Neotectonic Map of the Great Metropolitan Area the main geological faults identified for this sector of the Central Valley.

Annex 4 (MG 10.1 to MG 10.3) present the neotectonic maps of the study areas, which identify the main geological faults that affect it. This map has integrated the data on geological faults generated by other authors previously, as well as the geological faults identified as a product of the geological and geomorphological study carried out.

Information on the geological faults included in the maps indicated has been exceeded by the seismic data of instrumental seismicity recorded by the National Seismological Network of Costa Rica and the Central American Seismic Network.

The seisms of various magnitudes developed at shallow depths have been included, i.e. less than 20 kilometers below the surface.

The main criteria used for geological faults included in the study area are as follows:

a. Geomorphotectonic alignment: a clear existence of a morphological alignment that shows the presence of a remarkable structural element that delimits the relief changes of the area. This element indicates the existence of a possible geological fault.

b. Local geomorphotectonic alignment: alignments of mountain ranges, as well as alluvial valleys and eventually, of watercourses of different dimensions are presented.

c. Local tectonic escarpment: in some sections, where the stroke of the fault controls a mountain range, develop, slopes of high slope (up to 80o) aligned represent tectonic escarpments associated with the fault.

d. Geological criteria: based on the fact that the fault represents changes in the types of rocks that are outnumbered or failing in the structure of the rocks.

[8]MONTERO, W., 1994: Seismicity and neotectonics. - In: DENYER, P. & KUSSMAUL, S. (eds.): Atlas Geological Great Metropolitan Area. - Technological Ed. de Costa Rica: 147-160.

The geological faults included are confined into 4 main groups:

1. Regional geological faults (lengths greater than 20 km).
2. Local geological faults (smaller lengths of 20 Km).
3. Regional faults established by Montero (1994) and Denyer et al. (2003).
4. Faults associated with volcanic rift zones.

For all geological faults included in the neotectonic map, the results of the geological and geomorphological studies carried out in this study, as well as the data provided by other authors cited above, it is concluded that they qualify as POTENTIALLY ACTIVE faults.

As a result of the above, and in accordance with the data of Executive Decree No. 32967 – MINAE, these faults are likely to establish a safety zone of 50 meters on both sides of the fault trace until a neotectonic study is carried out for each fault.

However, because this document refers to a regional IFA study, it has been chosen to identify the above situation so that it can be taken into account when conducting land-use planning at the level of each county.

In the case of IFA maps, with regard to geological faults, the criterion of establishing the safety zone has been followed only for those geological faults in which geomorphological, geological and instrumental seismicity determined that the qualifies as a potentially active fault. For the other faults, the technical recommendation is made that the corresponding neotectonic studies be carried out to determine their situation and in addition, and that no works be planned on the fault line or in its immediate vicinity.

6.6.3 Threat Factor by Volcanic Activity

Introduction

The volcanic threat refers to the possible negative effects of the entry into activity of a volcanic emission center. For most people, it is known that volcanoes, during their eruption release materials with various manifestations of energy and affecting an area of influence that is proportional to that volcanic eruption energy.

The effects of a volcanic eruption may correspond to falling pyroclasts, targeted explosions and emission of pyroclastic flows, volcanic avalanches, lava flows emission, mud streams, opening of new cones, dispersal volcanic gases and acid rain (Paniagua, 1994).

The map in Figure 6.12 shows the volcanic threat map of Paniagua (1994). Within this map are distinguished a series of areas potentially affected by volcanic activity in case some of the volcanic strata of the Central Volcanic Range (Póas, Barva, Irazú and Turrialba) make an eruption, similar to those that it has performed in recent history.

The distinguished areas are as follows:

1. **Zone**1. Maximum threat from pyroclastic drop (> 30 cm diameter), which corresponds to the closest area to the emission center or volcanic crater.
2. **Zone**2. Maximum threat from pyroclastic drop (6.4 to 30 cm in diameter), representing an area outside zone 1.
3. **Zone**3. Area of influence by volcanic ash fall, established according to prevailing wind patterns, according to historical trends.
4. **Zone**4. Volcanic "rift" zone, which corresponds to an area of bloating weakness. tectonics associated with volcanic activity and is therefore prone to the emergence and formation of new volcanic cones.

In addition to these areas are distinguished the areas of passage of mud flows (lahars) that can descend from the volcanic apparatus, as well as the areas where the alluvial and lahar ranges corresponding.

MAP of IFA Geoaptitude - Volcanic Threat

Annex 4 (MG 11.1 to MG 11.3) present the Map of IFA Geoaptitude – Volcanic Threat, on which the volcanic threat data of Paniagua (1994), presented in the Figure 6.12.

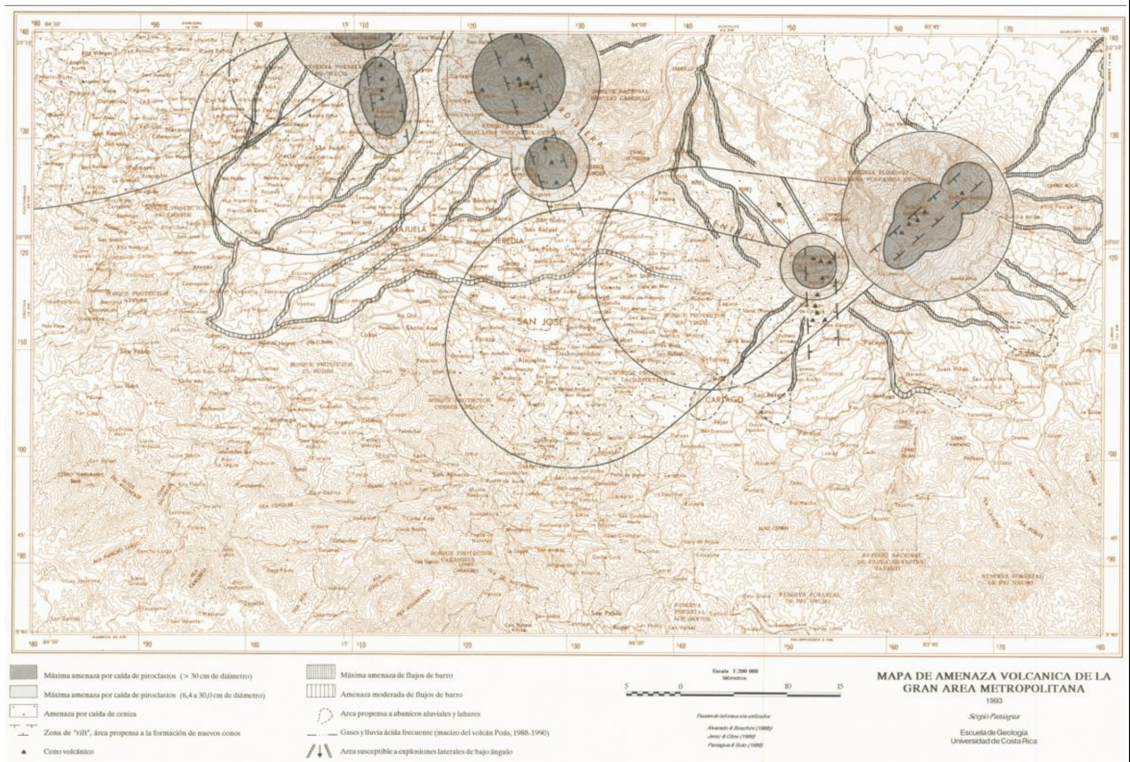


Figure 6.12. Central Valley volcanic threat map, according to Paniagua (1994).

Zones 1 and 2, described in the previous section, have been rated, according to the established methodology, as very high Frailty zones.

For its part, Zone 3 qualifies as High Frailty by volcanic threat.

Zone 3, on the other hand, qualifies as Very High and High Frailty.

6.6.4 IFA Geoaptitude Natural Threats (Georisks)

As a synthesis, Annex (MG 12.1 to MG 12.3) present the most important natural threat maps affecting the study area. High threat areas and very high landslides are identified. Also, high threats to volcanic activity and seismic threats, geological faults and flood phenomena.

Since the train infrastructure already exists these areas correspond to areas of high and very high risk that must be taken into account in the design of the TRP works.

6.7 Environmental elements sensitive to environmental fragility

6.7.1 IFA Sub-classification and environmentally sensitive sites

Annex (MG 13.1 to MG 13.3) present the map of the IFA Subclassification generated by Astorga et al. (2008) for PRUGAM and which are made official for the approval given by SETENA in 2009.

The categories of environmental fragility are the same as those established by THE PRUGAM (see Astorga et al., 2008). Table 6.6 shows the location and extent of these environmentally sensitive areas.

For their part, the current land-use maps for the study area are presented in Annex 4 (MG 14.1 to MG 14.3).

MAP 1 (Figure 13.1)			
SOUTH Line	North	East	Area
1.	11038000	472000	1A 100MTS
2.	1102800	475000	1B 200MTS
3.	1103000	478000	1A 1B 300MT
4.	1103200	481000	1A 100MTS
5.	1102000	482000	1A 1B 200M
6.	1101000	483000	1A 1B 700MT
7.	1100500	484000	1A 100MTS
NORTH LINE	North	East	Area
1.	1106500	477800	1A 1B 50 MT
2.	1106000	478200	1A 50MTS

MAP 2 (Figure 13.2)			
North Line	NORTH	EAST	Area
1.	1105000	487900	1A 1B 25MTS
2.	1103900	484000	1A 1B 50MTS
3.	1103000	488500	1A 1B 50MTS
4.	1102000	49000	1A 1B 300MT
5.	1101000	491000	1A 1B 50MTS
6.	1099000	492500	1A 1B 25MTS
South Line without restriction			
Single Line	NORTH	EAST	AREA
1.	1096000	500000	1A 1B 500MT
2.	1096000	5002000	1A 1B 500MT

MAP 3 (Figure 13.3)			
Single Line	NORTH	EAST	AREA
1.	1096000	50000	1A 1B 200MT
2.	1096000	501000	1A 1B 300MT
3.	1095800	504000	1A 700MTS

Table 6.6. Environmentally sensitive sites for the study area.

7 DESCRIPTION OF THE BIOLOGICAL ENVIRONMENT.

7.1. Introduction.

Below is the description of the biological environment of the Project area (PA) and Direct Influence Area (DIA) of the Rapid Passenger Train Project. They describe the different ecosystems present, biological corridors, as well as the flora and fauna that characterizes each type of ecosystems.

The flora and fauna are shown in two tables, which indicate the relevant aspects of the category of ecological risk by the IUCN and the CITES database, as well as the provisions of national wildlife legislation.

7.2. Terrestrial environment.

7.2.1. AP Protection Status.

The Project area is not directly affected by any protected wilderness area established by executive decree. The nearest protected area is the Cerros la Carpintera Protection Zone; however, it is not located in the PA.

With regard to biological corridors, the project passes in two sections the "Intercity Subcuencado Aguacaliente COBRI-SURAC Biological Corridor" (ACCVC). Figure 6.1 shows the location of these zones relative to the PA.

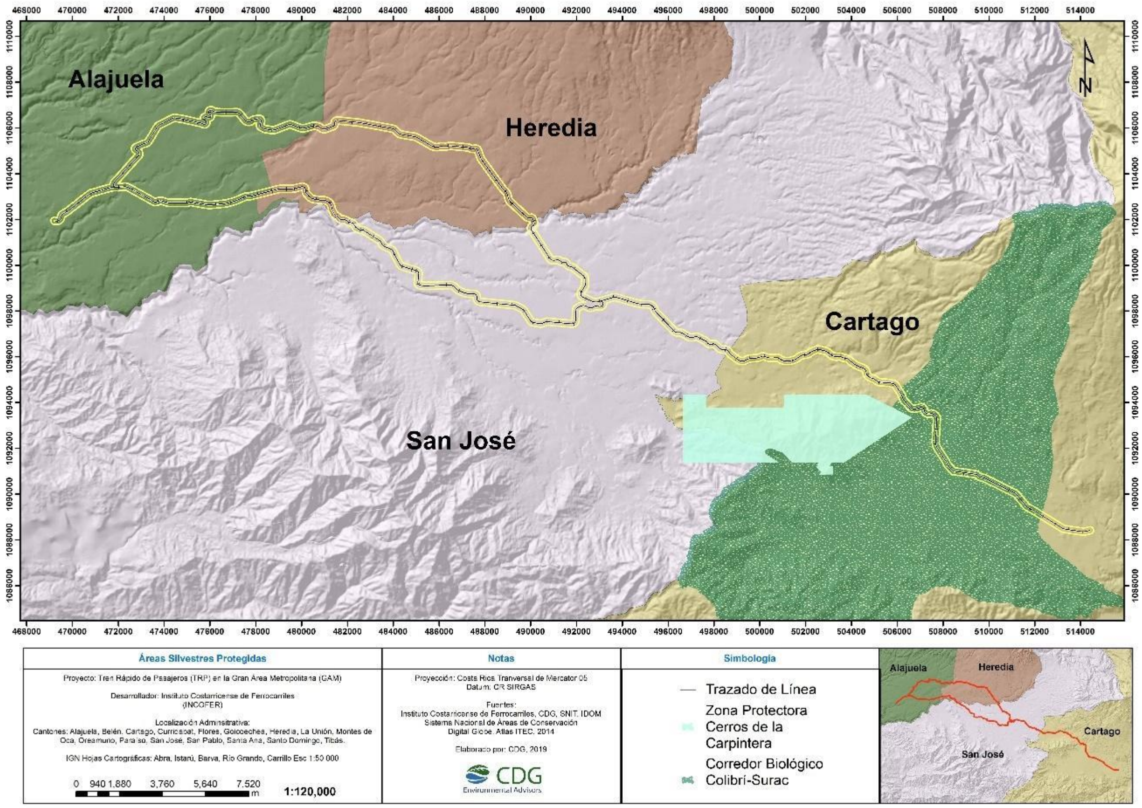


Figure 7.1. Location of the Cerros la Carpintera Protective Zone and COBRI-SURAC Biological Corridor with respect to the AP, National Geographical Institute (IGN); Atlas of Costa Rica, 2014.

7.2.2. Life areas.

In general, it can be said that the project is located in the living areas called Pre-mountain Wet Forest (bh-P), Very Humid Pre-mountain (bmb-P, Very Wet Mountain Low Forest (bh-MB) and Wet Forest Mount Low (bmh-MB). The average annual precipitation varies between 1200 and 4000 mm.

The bh-P comprises large area of Central Valley, is an area of extensive areas of volcanic and fertile soils. The bmb-P presents a wide variety of edaphic conditions, the bh-MB is located between the vicinity of Zarcero and Ochomogo, in its natural condition the forest of this area of life is low height, with two strata, little dense, with abundance of epiphytes, always green In the bmh-MB is very characteristic the presence of mist for long periods during the day and over the course of the year, the grounds of this area of life are mostly rugged topography, with exposed slope winds (which bring a lot of moisture). This formation is located in the Cordillera de Talamanca, where the genus Quercus (with more than 10 species), Alnus acuminata (jaúl), Cornus disciflora (cried), Magnolia poasana (magnolia) dominates. A good example is the forests of Cerro de la Muerte.

In the Guarco Valley rainfall is lower and the mists frequent, especially in the city of Cartago and surroundings. The annual rains are close to 1400mm, while in the foothills of the mountains surrounding the valley the precipitation is 2500 to 3000mm. The temperature ranges between 12 and 24 °C.

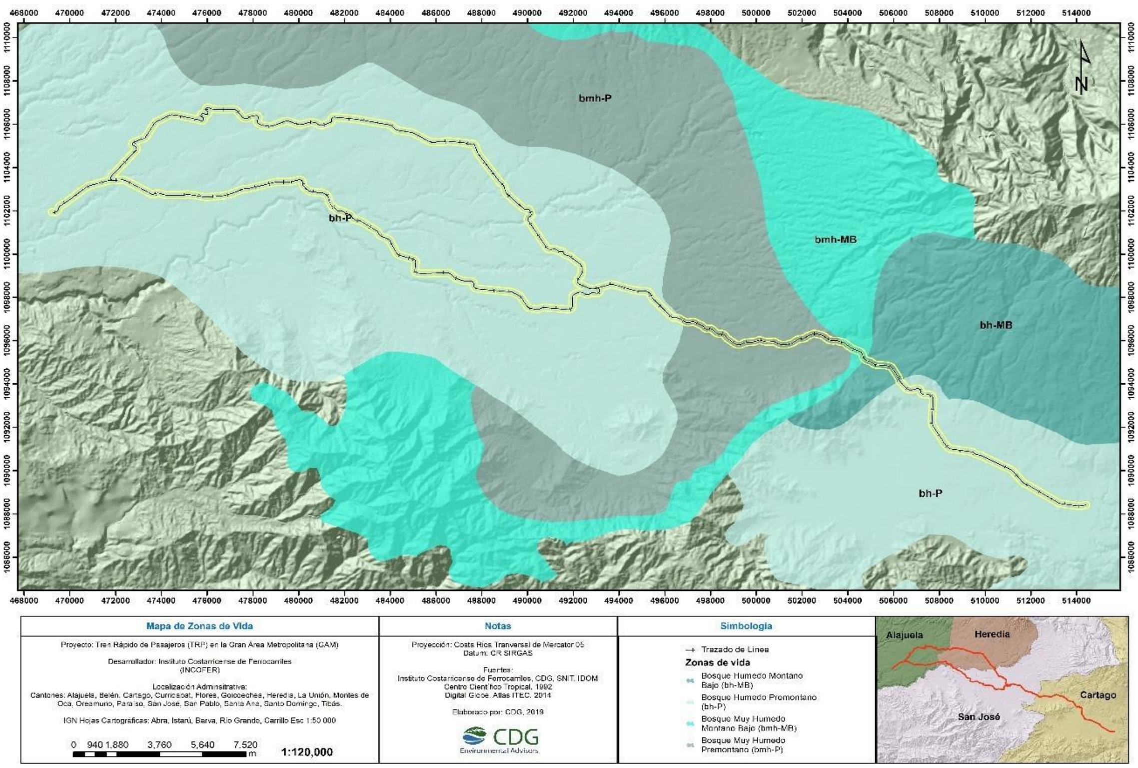


Figure 7.2. Living areas present on the TRP Project; Atlas of Costa Rica, 2014.

7.2.3. <u>Natural associations present.</u>

Along the existing railway track, as regards the right of way, what can be observed are altered areas as a result of the current use and maintenance of the tracks and, in addition, areas impacted by the same urban activity mainly and agricultural. Most of the right-to-track area crosses urban areas, some sections with scrub, wooded scrub, pasture areas, wooded pastures, ornamental trees of exotic species and others with native species; areas of protection of streams and rivers; areas dedicated to agriculture, mainly coffee plantations and very few sections of the road have an important wooded coverage very isolated and fragmented.

An important aspect of the project is the fact that when the different works are executed it will not be affecting or altering areas around or near the P.A., since work will be done only on the current right of way that has been modified for many years and in land according to land use, stipulated by the Municipalities, for the installation of the different temporary structures; so it is anticipated that the different plant associations or the scarce forest coverages that are nearby will not be changed or altered by the influence of the project.

7.2.4. Current plant coverage by natural association.

The railway line for intervening within the Rapid Passenger Train project, which includes from Parade de Carthage to Alajuela Plums, and with a length of 84,85 linear kilometers, the following uses can currently be found:

- **Scrub zones:** represents a low percentage of the project's surface and is mainly seen in the Paraiso – Atlantico section. The Atlántico– Alajuela and Atlantico – Ciruelas sections only present these environments in areas of protection of streams and rivers. It is characterized by narrow stripes with shrubs, as well as grasses or pastures by some sections. These may be extension of redoubts of the same coverage outside the project area or because they are unique swathes of the current right-of-way area for lack of maintenance, and where there is no connection to other areas mainly in some protection areas cracks and rivers. Species such as Guarumo (*Cecropia* sp), Heliconesacea, musaceae (Yute), some poaecea (Bamboo) and grasses can be seen, among others.

Figure 7.3. Area of scrub in the right of track, with predominance of grasses and some shrubs, both margins stretch Paraíso-Atlantico. April 2019.

Figure 7.4. Scrub area, both margins Paraíso-Atlántico stretch. April 2019.

- **Areas of wooded scrub:** This type of coverage represents a low percentage of the area of the right of way, noted mainly in the Paraíso-Atlantico section. The Atlantico–Alajuela and Atlantico–Ciruelas sections only present these environments in areas of protection of streams and rivers, this is because the railway runs through the main urban centers of the Central Valley. It can be seen in slope areas or in depressions (track fill areas). It is also common in continuous areas to productive farms where it has stopped giving it the corresponding maintenance but mainly in areas of protection of streams and rivers. The species identified in this category are characterized by pioneering species, indicators of altered areas and in recovery. Some of them are: Laurel (*Cordia alliodora*), Balsa (*Ochroma pyramidale*), Giant pore (*Erythrina poeppigiana*), among others, in different succession states own altered areas.

Figure 7.5. Area of scrub in the right of track, with predominance of grasses and some shrubs, both margins stretch Paraíso-Atlantico. April 2019.

Figure 7.6. Wooded scrub area, right bank stretches Atlantico-Ciruelas. April 2019.

- **Waterway Protection Zones:** These zones constitute 50 sites between streams and rivers that are influenced by the current railway. In all, a modification of the channel has been presented, due to the current structure of the bridge during their respective construction processes in previous years; and subsequent processes for maintenance.

  Areas of protection can be observed with bush species and pastures, areas with only pastures, in other cases surfaces with tree species of different vegetation and others totally discovered of vegetation.

Figure 7.7. Area of protection of channels with presence of pastures, scrub and some trees of different wingspans, Atlantico-Alajuela section. April 2019.

Figure 7.8. Area of protection of waterways with presence of pastures, shrubs and some trees of different wingspans, Paraíso-Atlantico section. April 2019.

- **Urban, commercial and residential** area: these areas represent the highest percentage in the AP. They have surfaces covered, in some cases, of fruit trees, ornamental trees and palms, surfaces with grasses trimmed in a green area way, and predominant areas of parking of restaurants, general trade, highways, urban centers and housing. There are even buildings on the right-of-way.

Figure 7.9. Residential area right bank Stretch Atlantico-Ciruelas. April 2019.

Figure 7.10. Urban and commercial area both margins, Paraíso-Atlantico stretch. April 2019.

7.2.5. Indicative species by natural ecosystem.

Exotic forest species such as*eucalyptus* sp and cypress (*Cupressus lusitanica)*can be found in the surrounding areas near the Project. There are also small and fragmented blocks of native species such as The Sabana Oak (*Tabebuia rosea),* Gavilán

(*Penthaclethra macroloba*), Laurel (*Cordia alliodora*) Balsa (*Ochroma pyramidale*), Espavel (*Anacardium excelsum*), among others. Many of the species present in the project area correspond to fruit species, between exotic and native, such as Oranges (*Citrus sinensis),* Lemon (*Citrus* sp), Bread fruit (*Artocarpus altilis*), Guava (*Psidium guajaba*), and Cocotero (*Cocos nucifera*); ornamental speciessuch as Pride of India (Lagerstroemia*speciosa*), Laurel of India (*Ficus benjamina*), Flame of the Forest (*Spathodea campanulata),*among others. In the surrounding agricultural areas, you can see coffee crops mainly and to a lesser extent vegetable.

Figure 7.11. Ornamental planting area of Eucalyptus, left bank, Paraíso-Atlantico stretch. April 2019.

Figure 7.12. Area with native and agricultural species, left bank, Paraíso-Atlantico stretch. April 2019.

- **Floristic composition.**

Based on a preliminary study conducted in recent weeks, in areas with presence of secondary forest and areas in regeneration, it is possible to determine that the species present in general are typical of the Pre-mountain Wet Forest (bh-P), Very Wet Forest Pre-mountain (bmb-P, Very Wet Mountain Low Forest (bh-MB) and Low Montane Wet Forest (bmh-MB) of Costa Rica, where there is a dominance of fast-growing colonizing species and remnant species at hard-to-reach sites or by conditions Weather.

- **Flora.**

The following table shows the species of flora found within the PA.

Species	Vernacular	Botanical family	Habit	Status
Bambusa vulgaris	Bamboo	Poaceae	Woody	To
Cocos nucifera	Coconut	Arecaceae	Palm	To
Cupressus lusitanica	Cypress	Cupressaceae	Tree	I
Anacardium	Espavel	Anacardiaceae	Tree	Is
Eucalyptus deglupta	Rainbow	Myrtaceae	Tree	I
Penthaclethra	Sparrowhawk	Fabaceae	Tree	Is
Cecropia obtusifolia	Guarumo	Urticaceae	Tree	To

Ficus sp	Higuerón	Moraceae	Tree	Is
Cordia alliodora	laurel	Boraginaceae	Tree	To
Ficus benjamina	Laurel of India	Moraceae	Tree	I
Citrus sp	Lemon	Rutaceae	Tree	I
Spathodea	Forest Flame	Bignonaceae	Tree	I
Cojoba arborea	Parrot	Fabaceae	Tree	To
Gliricidia sepium	Black Wood	Fabaceae	Tree	Ma
Citrus sp	Orange	Rutaceae	Tree	I
Lagerstroemia	Pride of India	Lythraceae	Tree	I
Erythrina	Pore	Fabaceae	Tree	I
Tabebuia rosea	Savannah oak	Bignonaceae	Tree	Is
Zygia longifolia	Horse Zota	Fabaceae	Tree	To
Ochroma	balsa	Malvaceae	Tree	Is
Wagnerian Heliconia	Platanilla	Heliconaceae	Grass	To
Coffea sp.	Coffee	Rubiaceae	Arbusto	I

Table 7.1. List of plant species observed in the project area.

Source: Own elaboration with field observation, 2019. A: Abundant; MA: very abundant; ES: Scarce; I: introduced.

✔ **Fauna.**

Being a railway and being that most of the PA is urban area, where most of the vegetation along the route are pastures and thickened isolated trees, the fauna that has been identified in the area, is mainly passing. Flying fauna is relatively common in any area with and without project and with respect to mammal species, many are related to patches of vegetation surrounding the DIA. During the visit a variety of animal species were found which are found in the following table.

Class	Family	Scientific name	Common name	Habitat	IUCN / CITES	State	Place Obs.	Notes of environments Characteristic
Amphibia	Hylidae	*Agalychnis callidryas*	Red-eyed frog	BHP, BMHP	IUCN-CITES	Lc	aid	Ditch with water
	Bufonidae	*Rhinella horribilis*	Giant Toad	BHP, BMHP	IUCN	Lc	aid	Urban, grassland
	Centrolenidae	*Hyalinobatrachium fleischmanni*	Fleischmann Glass Frog	BHP, BMHP	IUCN	Lc	aid	River Basin
	Eleutherodactylidae	*Diasporus diastema*	Frog Bell	BHP, BMHP	IUCN	Lc	aid	Wooded scrub
Mammalia	Procyonidae	*Procyon lotor*	Raccoon	BHP, BMHMB, BMHP, BHMB	IUCN	Lc	aid	River basin, urban
	Muridae	*Rattus rattus*	House Rat	Bhp	IUCN	Lc	aid	Urban
	Didelphidae	*Didelphis marsupialis*	Furny Fox	BHP, BMHP	IUCN	Lc	aid	Wooded scrub
	Bradypodidae	*Bradypus variegatus*	3 toed sloth	Bhp	IUCN	Lc	aid	Wooded scrub
	Sciuridae	*Sciurus variegatoides*	Squirrel	Bhp	IUCN	Lc	aid	Wooded scrub
Reptilia	Boidae	*Boa imperator*	Boa	Bhp	IUCN	Lc	aid	Wooded scrub
	Teiidae	*Festive Ameiva*	Chisbala	BHP, BMHP	IUCN	Lc	aid	Wooded scrub
	Viperidae	*Bothrops asper*	Fer de lance	Bhp	IUCN	Lc	aid	Scrub
Birds	Cathartiformes	*Coragyps atratus*	Black buzzard	Bhp	IUCN	Lc	aid	Urban, grassland

Class	Family	Scientific name	Common name	Habitat	IUCN / CITES	State	Place Obs.	Notes of environments Characteristic
	Thraupidae	*Thraupis episcopus*	Viudita	BHP, BMHMB, BMHP, BHMB	IUCN	Lc	aid	Urban
	Psittacidae	*Psittacara finschi*	Red parrot	Bhp	IUCN	Lc	aid	Wooded, urban scrub
	Tyrannidae	*Pitangus sulphuratus*	Large bienteveo	BHP, BMHMB, BMHP, BHMB	IUCN	Lc	aid	Wooded, urban scrub
	Turdidae	*Turdus grayi*	Yigüirro	Bhp				Urban
	Icteridae	*Quiscalus mexicanus*	Grackle	BHP, BMHMB, BMHP, BHMB	IUCN	Lc	aid	Urban

Table 7.2. List of fauna species displayed and reported in the project area and areas of influence of the project, CDG Environmental Advisors, May 2019.

AP: Project Area; AID: Direct Influence Area; LC: minor concern; NT: almost threatened; LR/LC: Low risk/minor concern; LR/NT: Low risk-minor concern; A-I: Appendix I CITES; A-II: Appendix II CITES.

7.2.6. Endemic Species, Threatened and Endangered Populations.

Flora.

None of the observed tree species are on the list of endangered species according to Decree 25700-MINAE for Costa Rica. With respect to the IUCN and CITES species list, none of the above species are not included either. There are rather introduced species such as Eucalyptus, Cypress, Indian Laurel, Pride of India, Forest Flame, various citrus, among others.

Fauna.

Of the observed and registered species of the AID it can be concluded that none is under threat or danger of extinction, with respect to the list of species of the IUCN and CITES. Only the red-eyed frog (*Agalychnis callidryas*) is inside Appendix II, according to CITES. However, there are a number of species that frequent the passage on the current road or AP that may be affected, so the corresponding mitigation measures should be proposed, such as wildlife crossings.

7.2.7. Ecosystem Fragility.

The area of the project is characterized, for the most part, by having little plant cover, which is mainly composed of wooded pastures, scrub and wooded areas of various capacity only in areas of protection of rivers and ravines. These areas of protection of channels are the fragile ecosystems identified. However, it should be remembered that areas of protection for streams and rivers are already involved by the existence of the current bridges.

8. DESCRIPTION OF THE SOCIO-ECONOMIC ENVIRONMENT.

8.1. Current land use in surrounding sites.

8.1.1. Urban use

The Rapid Passenger Train (TRP) is located in the Greater Metropolitan Area (GAM), Costa Rica's main metropolitan area that engulfs four of the country's seven provinces: San José, Alajuela, Cartago and Heredia, and has approximately 3.7 million 2019 INEC projections, about 73.5% of the country's population.

Provincial head	**County**	**Direct influence by district**
San Jose	San Jose	Carmen, Hospital, Catedral, Uruca, Mata Redonda, Pavas.
	Tibás	San Juan, Cinco Esquinas, Colima.
	Montes de Oca	San Pedro.
	Curridabat	Curridabat, Granadilla, Sanchez.
	Goicoechea	San Francisco, Calle Blancos.
Alajuela	Alajuela	Alajuela, San José, San Antonio, Guácima, San Rafael, Río Segundo, Desamparados, Turrúcares.
Cartago	Cartago	Eastern, Western, Carmen, San Nicolás.
	Paraíso	Paraíso, Llanos de Santa Lucia.
	The Union	Tres Ríos, San Juan, San Rafael, Concepción, Dulce Nombre.
	Oreamuno	San Rafael.
Heredia	Heredia	Here, Mercedes, San Francisco.
	Santo Domingo	Santa Rosa.
	Belén	San Antonio, Rivera, Asunción.
	Flores	St. Joaquin, Llorente.
	San Pablo	Rincón of Sabanilla.
4	**15**	**45**
TOTAL		

Table 8.1. Urban cores in direct influence area, Grand Passenger Fast Train Metropolitan Area

Source: National Institute of Statistics and Census (INEC), June2019.

8.1.2. Industrial-commercial.

There are commercial constructions, industry sectors in free zones, sale of services, sale of vehicles, warehouses, establishments for wood processing, stone extraction cuts, workshops for machinery maintenance weight, food industry, sale of agricultural products, parking, among others. The land on either side of the route constitutes a strip of significant commercial and industrial value, which has generated over the years the area of the country with the highest commercial value and services, as shown in Figure 8.1 on the main industrial infrastructure , commercial and services on the Fast Passenger Train route.

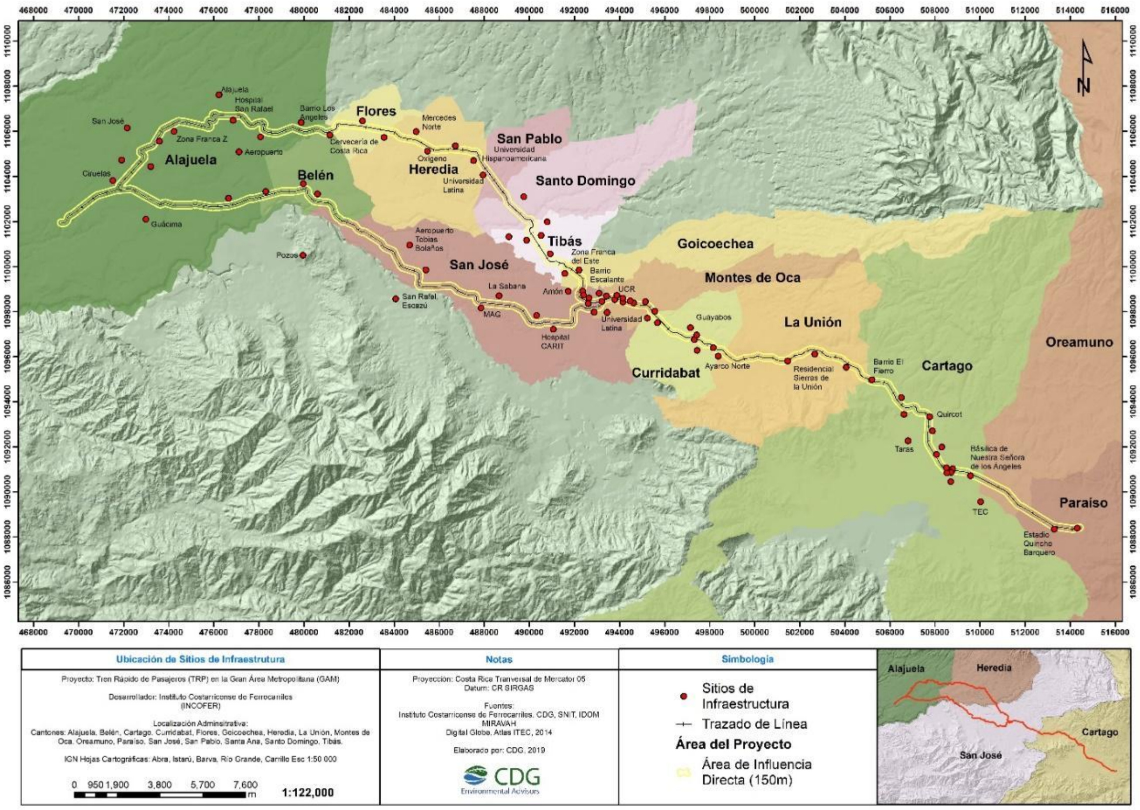


Figure 8.1. Location of the main industrial, commercial and services infrastructure, TRP Project; Atlas of Costa Rica, 2014.

8.1.3. Agricultural.

The route of the train includes the transfer through flat terrain with light slopes, in the past due to its physical and chemical soil characteristics the agricultural productive potential was exploited but currently the use is urban, services or industrial, with some agricultural exceptions such as the county of Paradise, in a sector of Alajuela find tomato and pasture sown in Bethlehem of Heredia belonging to the Pedregal Event Center.

The soil will be mainly affected by the movement of land, compaction of bridge bases and subbases, new railway rails and by rehabilitating, opening drains, circulation of heavy machinery and ordinary solid waste.

8.1.4. Setting

The project will impose an alteration of the current landscape during construction, as it involves a large-scale work and movements of the current right of way. In the operational phase, the project could become a positive and modern element of the urban landscape.

There will be increased noise impact during the construction phase due to the use of heavy machinery for ground leveling, bridge rehabilitation, overpassing, stations and other structures; then for transporting material and equipment to the job site. During the operational phase, the typical noises of activities such as these are foreseen.

The generation of emissions and particulate matter that could affect air quality would be timely and temporary during the construction phase of the Project. In addition, it can be affected by the transit of vehicles in the transfer of materials and personnel.

8.1.5. Effects of the project on Land Use.

The project during the construction stage there is a potential temporary adverse effect, from the point of view of the alteration of the commercial, services and residential dynamics, because it will affect the current situation of entry of people to the shops and residences, as a result of road improvement works. All this situation can cause temporary transfer of accesses, generating a negative socio-economic impact of a temporary nature.

Regarding the effects of the project during the operational stage; the dynamics of services, trade, residential and productive areas are expected to be revived; because there are better access conditions and higher traffic conditions that allow for greater visitation and frequency of customers. In addition, land is expected to increase its economic value and a further proliferation of urban, residential and commercial projects on the land designated for such purposes and changes in land use in properties dedicated to activities agricultural and livestock.

It corresponds to the level of social well-being and quality of life of the people who inhabit the communities of most GAM counties, not just those located in the DIA. The project can have a positive impact on people's economic competitiveness and quality of life by reducing vehicle congestion. For employment purposes, it can be an important source of work for labor of different levels of training.

8.2. Land tenure in surrounding sites.

In the counties and districts affected by the TRP, the project will be developed within the existing right of way. Expropriations will be limited to specific sites such as stations and maintenance yards. The definitve design will focus on limiting expropriations and executing most of the works within the right of way, except when more space is required based on engineering considerations. However, after years of inactivity and increased urban pressure, some commerces, residences and even public institutions have invaded the right of way. The possibility of total or partial demolition of commercial or residential structures is most likely to generate social conflict in informal settlements and marginal communities.

Figure 8.2. Urban area, Heredia-Atlantic section right Hospital San Rafael, Alajuela- Pacifico Abril, 2019.

8.3. Characteristics of the population.

Populations affected by the Passenger Rapid Train Project (TRP) are identified from their place of residence and work sites in the counties and districts that will be directly intervened. From a political-administrative point of view these are grouped into 4 provinces, 15 counties and 45 districts of direct incidence.

In the province of San José, the following counties were considered: San José (Carmen, Hospital, Catedral, Uruca, Mata Redonda, Pavas), Goicochea (San Francisco, Calle Blancos), Tibás (San Juan, Cinco Esquinas, Colima), Montes de Oca (San Pedro) and

Curridabat (Curridabat, Granadilla and Sanchez). In the province of Alajuela, it was considered the county that bears the same name and contemplates the districts of Alajuela, San José, San Antonio, Guácima, San Rafael, Río Segundo, Desamparados and Turrúcares. While the province of Cartago involves the counties of: Cartago (Oriental, Occidental, Carmen, San Nicolás), Paraíso (Paraíso, Llanos de Santa Lucia), La Unión (Tres Ríos, San Juan, San Rafael, Concepción, Dulce Nombre) and Oreamuno (San Rafael). Finally, the province of Heredia comprising the counties of Heredia (Heredia, Mercedes, San Francisco), Santo Domingo (Santa Rosa), Belén (San Antonio, Rivera, Asunción), Flores (San Joaquín, Llorente) and San Pablo (Rincón de Sabanilla).

8.3.1. Demographic characteristics.

According to INEC projections for 2019, Costa Rica has a total population of 5,057,999 inhabitants; of this total population 3 721 758 people, reside in the Greater Metropolitan Area, area of direct impact (TRP), which distributed by province and descending order are located as follows: San José 1 648 561 inhabitants, Alajuela 1 016 421 inhabitants, Cartago 537 606 inhabitants and Heredia 519 170 inhabitants.

Continuing with the projections established by INEC, the following table is shown that quantifies the total inhabitants according to province, county and district. (Table 8.2). Noting this data that Pavas in the province of San José is the district that concentrates the largest population (86 968 people), in contrast to San Francisco de Goicochea that adds up to the lowest amount of population (2,375 people) of the counties and districts that are part of this study.

Province	Total population by province	County	Total population per county	Population of direct incidence	
				District	Total population by district
San Jose	**1 648 561**	San Jose	344 851	Carmen	3 023
				Hospital	23 490
				Catedral	15 517
				Uruca	41 169
				Mata Rendonda	10 025
				Pavas	86 968

		Goicoechea	137 328	San Francisco	2 375
				White Street	22 904
		Tibás	84 215	san juan	25 955
				Cinco Esquinas	8 308
				Colima	17 656
		Montes de Oca	62 310	San Pedro	29 064
		Curridabat	78 961	Curridabat	32 567
				granadilla	18 604
				Sánchez	6 673
Alajuela	**1 016 421**	Alajuela	310 248	Alajuela	47 885
				San Jose	50 654
				San Antonio	30 356
				Guácima	25,425
				San Rafael	32 808
				Rio Segundo	13 055
				Desamparados	32 241
				Turrúcares	9 134
Cartago	**537 606**	Cartago	162 944	oriental	12 402
				occidental	10 394
				Carmen	19 062
				Saint Nicholas	29 130
		Paraíso	62 480	Paraíso	21 369
				Llanos de Santa	18 943
		La Union	111 369	Tres Ríos	9 331
				san juan	15 366
				San Rafael	15 787

				Conception	18 667
				Dulce Nombre	8 947
		Oreamuno	49 604	San Rafael	28 942
Heredia	**519 170**	Heredia	141 683	Heredia	19 143
				mercedes	29 383
				San Francisco	57 879
		santo domingo	48 581	Santa Rosa	8 968
		Belén	26 237	San Antonio	11 479
				Rivera	7 488
				asuncion	7 270
		Flores	24 603	San Joaquin	8 248
				Llorente	11 201
		St Paul's	31,000	Rincón de	9 731
Total	**3 721 758**	**Total**	**1 676 414**	**Total**	**964 986**

Table 8.2. Direct incidence of the total population project, according to province, county and districts

Source: INEC - Population projections as of June 30, 2019.

Continuing with the data recorded by the INEC, in the last population census carried out in 2011, it was obtained, that the total area in square kilometers, comprising the four provinces included in the route of the Rapid Passenger Train totals 20,506 km^2, the province of Alajuela has the largest area with 9,758 km2,followed by San José with 4,966 km2, Cartago 3,125 km^2 and Heredia with 3,657 km$^{2.}$

Individuals' preferences in choosing their place of residence relate to their characteristics and those of their environment. Individuals always show a clear propensity to be located in places near their workplaces, professionals or leisure centers. In this perspective, the quality of transport infrastructures is an important factor in ensuring mobility and promoting the homogeneous dispersion of individuals in a territory. This is how population density, called relative population, refers to the average number of inhabitants of an urban or rural area relative to a given area unit. That is, it measures the number of inhabitants living per kilometer. As for the population density of GAM, San José has a relatively high population concentration of a total of 283 inhabitants per km 2, it is followed by Heredia with 163 inhabitants per km^2 and finally the provinces of Cartago and Alajuela with 157 and 87 inhabitants per km^2 respectively.

For every hundred people, 86.4 of them reside in urban areas in the province of San José, in similar data is the province of Heredia (86.0), followed by Carthage (82.5) and Alajuela (60.7). The latter province with the least number of people in urban areas stand out.

As for the relationship of men and women, in these provinces, it is highlighted that for every hundred women in San José there are 91.6 men, Alajuela retains a closer data in relation to women adds 98.5, Carthage 96.3 men and finally Heredia adds 95% of men.

To calculate the population dependence of the inhabitants by province, all those under the age of 15 and 65 and over are taken into account for every hundred people of productive age (the latter group being understood as people between 64 years of age). In the case of the provinces under study it was obtained (according to INEC-2011) that the province of Alajuela is the one that concentrates the largest number of dependents with a total of 48.1, secondly, is Cartago with 45.2, followed by the provinces of San José and Heredia with 44.4 and 42.9 people respectively (table 8.3).

Demographic characteristics and Geographical	**Country**	**Province**			
	Costa Rica	**San Jose**	**Alajuela**	**Cartago**	**Heredia**
Total population	4,301,712	1,404,242	848,146	490,903	433,677
Surface area (km^2)	51,100	4,966	9,758	3,125	2,657
Population density *People per km^2*	84	283	87	157	163
Percentage of urban population *People living in urban area per 100*	72.8	86.4	60.7	82.5	86.0
Ratio men-female *men for every 100 women*	95.9	91.6	98.5	96.3	95.0
Demographic dependency ratio *Dependent persons (under 15 years of age or 65 and older) per 100 people of productive age (15 to 64 years)*	47.2	44.4	48.1	45.2	42.9

Table 8.3. Demographic and geographical characteristics, Census 2011.
Source: INEC-Census 2011.

Cultural change, women's longer life expectancy and incorporation into working life mean that women's-based households continue to gain ground in the country. One of the controversial topics in recent decades, in the study of the contemporary family is that of women-led domestic units. Of the four provinces under study, San José and Heredia have the highest percentage of female headquarters households (34.6% and 30%), while Carthage and Alajuela rank third and to 27.7% and 26.1% of households involving a woman as head of household.

Many women-led households, as noted, arise due to the increased female life expectancy, as well as the lower incidence of subsequent unions among widows. However, it is of special interest to those households with dependent children that respond to increased separations, divorces, male abandonment and pregnancies in young women who then remain single or in unions sporadic, especially when man disassociates himself from the responsibilities that result from these different events. This is due to economic, cultural and subjective factors, including the strength of the social bond between mother and child, the absence of effective sanctions against parents who do not contribute to family support and difficulties increasing people who face to get fulfilling jobs and be economic providers. In addition, account must be taken of the increase in women's schooling and labor participation, which can facilitate more than before the breakdown of unsatisfactory or violent marital unions, and the subsequent establishment of households headed by women (Oliveira et al., 1999; García y Rojas, 2002).

On the other hand, and always in this same line of household formation, the percentage of households with shared headquarters in ascending order is as follows: Cartago (7.3%), San José (7.6%), Alajuela (7.7%) and Heredia (9.3%).

As for the percentage of population born abroad, considering that this indicator reflects migration in populations (Province, counties and districts), it is important to emphasize that the percentage of migrants established in Costa Rica, on average 9% and according to INEC data the province of San José has 10.6% of inhabitants born outside the national territory, followed by the provinces of Alajuela, Heredia and Cartago with 10.4%,10% and 4.2%, respectively.

As for the issue of health and insurance condition, the province of Heredia has the lowest percentage of the population of uninsured people (11.6%), followed by the population of San José (13.2%), in third position is placed Cartago with 13.7% and finalize Alajuela is the province with the highest number of people who do not have the coverage of some type of health insurance (table 8.4).

Social characteristics	**Country**	**Province**			
	Costa Rica	**San Jose**	**Alajuela**	**Cartago**	**Heredia**
Percentage of population born abroad	9.0	10.6	10.4	4.2	10.0
Percentage of population with disabilities	10.5	11.1	9.9	9.1	10.0
Percentage of uninsured population	14.5	13.2	16.6	13.7	11.6
Percentage of households with female headquarters	30.0	34.6	26.1	27.7	30.0
Percentage of households with shared headquarters	7.4	7.6	7.7	7.3	9.3

Table 8.4. Social Characteristics, Census 2011.

Source: INEC-Census 2011.

Another important indicator of highlighting in this study is that of the population with disabilities; because with the development of time and knowledge, the focus on disability has been transformed, from an assistential model, to a more comprehensive, grounded in the promotion of human rights and citizen participation of people with Disability.

In this sense, it is clear that disability, being a human condition that can be of multi-causal origin either by genetic condition, poverty, malnutrition and inadequate habits of health and hygiene, occupational disease or accident, sports, recreational and environmental pollution, political, social and structural violence etc. In Costa Rica it is discriminatory that historically the state circumscribes the actions dedicated to this population to the areas of health and special education, today there is a paradigm shift that leads to the social inclusion of this population in all areas and areas of life (including access to means of transport). Continuing with the provinces subject to study, according to the INEC for the year 2011 the province of San José had a total of 11.1% of its population with some type of disability, Heredia added 10%, followed by Alajuela with 9.9% and Cartago 9.1% of people with disabilities (table 8.5).

County	Disability indicators according to county, 2011 Census.					
	Percentage of population with at least one disability	Percentage of men with at least one disability	Percentage of women with at least one disability	Population 0 to 17 years old with at least one disability	Population aged 18 to 64 with at least one disability	Population age 65 and older with at least one disability
Costa Rica	10.5					
San Jose - Province	11.1					
San Jose	12.3	11.2	13.3	4.5	11.4	39.6
Goicoechea	11.7	10.8	12.5	4.4	11.0	39.0
Tibás - County	11.5	10.4	12.4	3.8	10.1	36.9
Montes de Oca	11.1	10.5	11.6	3.7	9.6	34.6
Curridabat	9.5	9.0	9.9	3.4	8.8	33.2
Alajuela - Province	9.9					
Alajuela	9.6	9.5	9.8	3.3	9.2	38.8
Cartago - Province	9.1					
Cartago	8.6	8.5	8.7	3.4	7.9	34.3
Paraíso	8.0	7.9	8.2	3.5	7.7	32.9
La Union	9.4	8.9	9.9	3.9	9.6	35.6
Oreamuno	8.3	8.2	8.4	3.6	7.9	35.5
Heredia- Province	10.0					
Heredia	10.5	10.0	11.0	3.7	10.1	38.5
santo domingo	9.8	9.2	10.4	3.0	8.9	34.4
Belén	8.8	9.0	8.7	2.5	8.0	32.6
Flores	9.4	9.2	9.6	3.7	8.9	34.4
San Pablo	11.0	10.2	11.7	4.2	10.6	39.2

Table 8.5. Indicators of population with disabilities, according to gender and age, Census2011.

Source: INEC-Census2011.

8.3.2. Social and cultural characteristics

For a project of this magnitude (TRP) it is important to shelter all the social areas in which it involves the intervention of the same, as well as to have indicators related to the issue of housing and educational level of people residing, working and mobilizing in the different districts that make up the four provinces involved in this project.

Thus, in the subject of housing, by 2011 Costa Rica totaled 1,211,964 of occupied houses, of which 890,762 are located in the provinces of San José, Alajuela, Cartago and Heredia (see table 8.6). The average occupant per home for the provinces of San José and Heredia is 3.5 people per residence; while for Carthage it is 3.7 and Alajuela 3.6 inhabitants. Regarding the conditions of the infrastructure of these homes, it was found that in the province of Heredia is located the highest percentage of homes in good condition (73.9%), followed by the province of Cartago with 70.9%.

Overcrowding is an important indicator of highlighting in a study like this, as it allows us to calculate the actual percentage of inhabitants per home and the impact that a project such as the Rapid Train of People, can generate on families. Overcrowding means homes in which more than three people must share the same bedroom, according to the INEC for every 100 dwellings 4.9%,4.6%,3.9% and 3.5%, corresponds to the percentage of overcrowding that exists in the provinces respectively of Alajuela, San José, Heredia and Cartago. Highlighting Wing with the highest percentage of overcrowding.

Housing	**Country**	**Province**			
	Costa Rica	**San Jose**	**Alajuela**	**Cartago**	**Heredia**
Occupied individual homes	1,211,964	400,961	236,927	130,464	122,410
Average occupants *Average number of people per individual occupied housing*	3.5	3.5	3.6	3.7	3.5
Percentage of homes in good condition	63.7	67.4	64.1	70.9	73.9
Percentage of overcrowded homes Homes with more than 3 people per bedroom for every hundred occupied dwellings	5.2	4.6	4.9	3.5	3.9

Table 8.6. Housing Indicators by Occupation, State and Overcrowding, Census2011.
Source: INEC-Census2011.

On the issue of education and literacy, fortunately the country retains a fairly favorable percentage at the national level (97.6%), the positives of this national percentage are passed to the four provinces under study which add up to high percentages of literacy population (can read and write). San José has to add 98.5%, Heredia 98.4%, Cartago 97.9% and Alajuela 97%. Literacy population. Obtaining an average schooling (number of years approved in regular education) of 9.8 years in Heredia, 9.4 years in San José, 8.4 years in Carthage and 7.9 years in Alajuela.

The percentage of the population attending regular education is summarized in the following table, described by age group according to the province.

EDUCATIONAL FEATURES	Costa Rica	San Jose	Alajuela	Cartago	Heredia
Percentage of regular education attendance	32.9%				
Under 5 years old	13.7%	16.4%	12.2%	18.3%	18.2%
5 to 17 years old	87.6%	89.0%	87.4%	88.7%	89.7%
18 to 24 years old	44.1%	47.9%	41.9%	47.8%	49.9%
25 and older	8.2%	9.2%	7.2%	8.6%	9.3%

Table 8.7. Educational characteristics Census 2011.

Source: INEC-Census 2011.

This is reflected in the average educational level of the country's 18-year-old population, where according to the 2011 Census, the majority of the population has a complete primary, followed by 23.0% of the higher education population and only 3.8% of the population does not have any educational degree, as shown in the following figure:

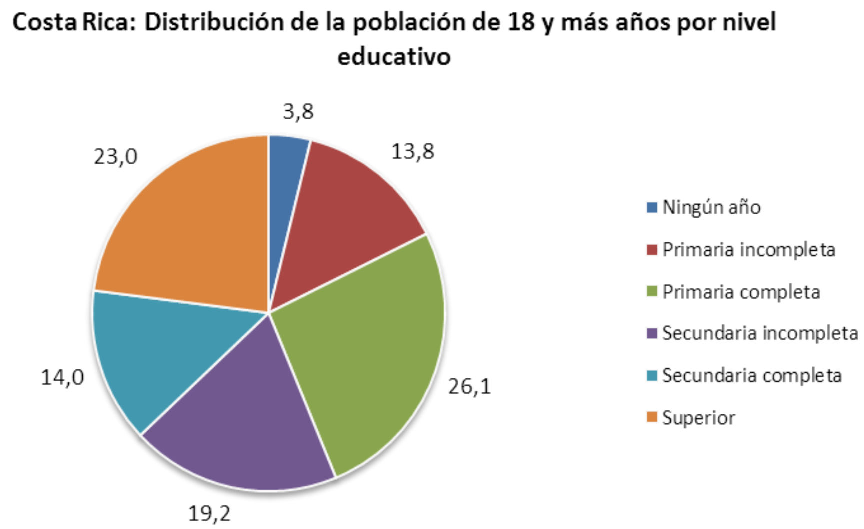


Figure 8.3. Distribution of Costa Rica's active economic population, according to educational level, Census 2011.

Source: INEC, Census 2011.

Education is one of the factors that most influences the advancement and progress of people and societies. In addition to providing knowledge, education enriches culture, spirit, values and everything that characterizes us as human beings.

Education is necessary in every way. To achieve better levels of social welfare and economic growth; to level up economic and social inequalities; to promote people's social mobility; to access better levels of employment; to raise the cultural conditions of the population; to expand opportunities for young people; to invigorate civic and lay values that strengthen societies' relationships; democratic progress and the strengthening of the rule of law; for the promotion of science, technology and innovation.

Education has always been important for development, but it has become more relevant in today's profound transformations, motivated in part by the dizzying advancement of science and its applications, as well as by the no less accelerated development of media and information technologies.

In modern economies, knowledge has become one of the most important factors in production. The societies that have made the most progress in economic and social are those that have managed to cement their progress in knowledge, both that transmitted through schooling, and that generated through research. Increasingly, economic productivity and competitiveness, as well as much of the social and cultural development of nations, depends on education, science and technological innovation.

Global experience shows a close correlation between countries' level of development, in their broad sense, with the strength of their education systems and scientific and technological research. According to studies by the Organization for Economic Co-operation and Development (OECD), an additional year of schooling increases a country's GDP per capita by 4 to 7%. (OECD, Economic Outlook for Latin America, 2009).

8.3.3. Economic Features.

The indicators selected to identify the characteristics of the populations involved in the Rapid Passenger Train project, from the economic perspective of the identified populations are the people who make up the workforce of the between 15 years and older, the average rate for Costa Rica is 46. of the population, while, for the provinces, Alajuela has the highest rate with 47.1, Cartago with 46.6, followed by San José 44.0 and finally Heredia with a rate of 46.6.

The net participation rate corresponds to the people in the labor force occupied and unemployed for every 100 people between 15 years and older, in the country there is a net participation rate of 72.1 men per 100 economically active-age inhabitants while that the average rate of women is significantly reduced to just 36. This behavior is similar for each of the provinces, as shown in Table 13, the province of San José presents the highest net participation rate of women with 41.3 while the province of Alajuela has the lowest rate with 33.1.

With respect to percentage of the occupied population that is not insured, the country average is about at 14.5%

Economical features	**Country**	**Province**			
	Costa Rica	**San Jose**	**Alajuela**	**Cartago**	**Heredia**
People outside the workforce (15 years and older)	46.5	44.0	47.1	46.6	42.7
Net participation rate	53.5	56.0	52.9	53.4	57.3
People in the workforce (occupied and unemployed) for every 100 people aged 15 and over					
Men	72.1	72.7	73.4	73.2	73.7
Women	36.1	41.3	33.1	34.8	42.1
Percentage of uninsured occupied population	14.5	13.2	17.2	14.1	10.8

Table 8.8. Economic characteristics, Census 2011.

Source: INEC-Census 2011

With respect to the percentage of the population occupied by economic sector: primary (agricultural), secondary (industrial) and tertiary (services), in Costa Rica services represent 68.2% of the occupied population, that is to say that the activity whose companies generate intangible goods, such as commerce, transport, communications, education, social services, public, communal, personal, among others, this occupation is followed by that sector that is characterized by its activities they make close to natural resource sources, transform raw materials into other goods, are generally industrial-type activities, including manufacturing and construction, the secondary sector groups 18.0% occupation, while the sector 13.7% of the population.

This panorama at the province level reflects the dynamics of the Greater Metropolitan Area and its urban dynamics, where the primary sector is lower than the country average, in San José practically the agricultural sector disappeared with only 0.6% occupancy, followed by only 0.6% occupancy, followed by Here's 1.2% occupation in the agricultural sector as shown in the following figure (figure 8.4).

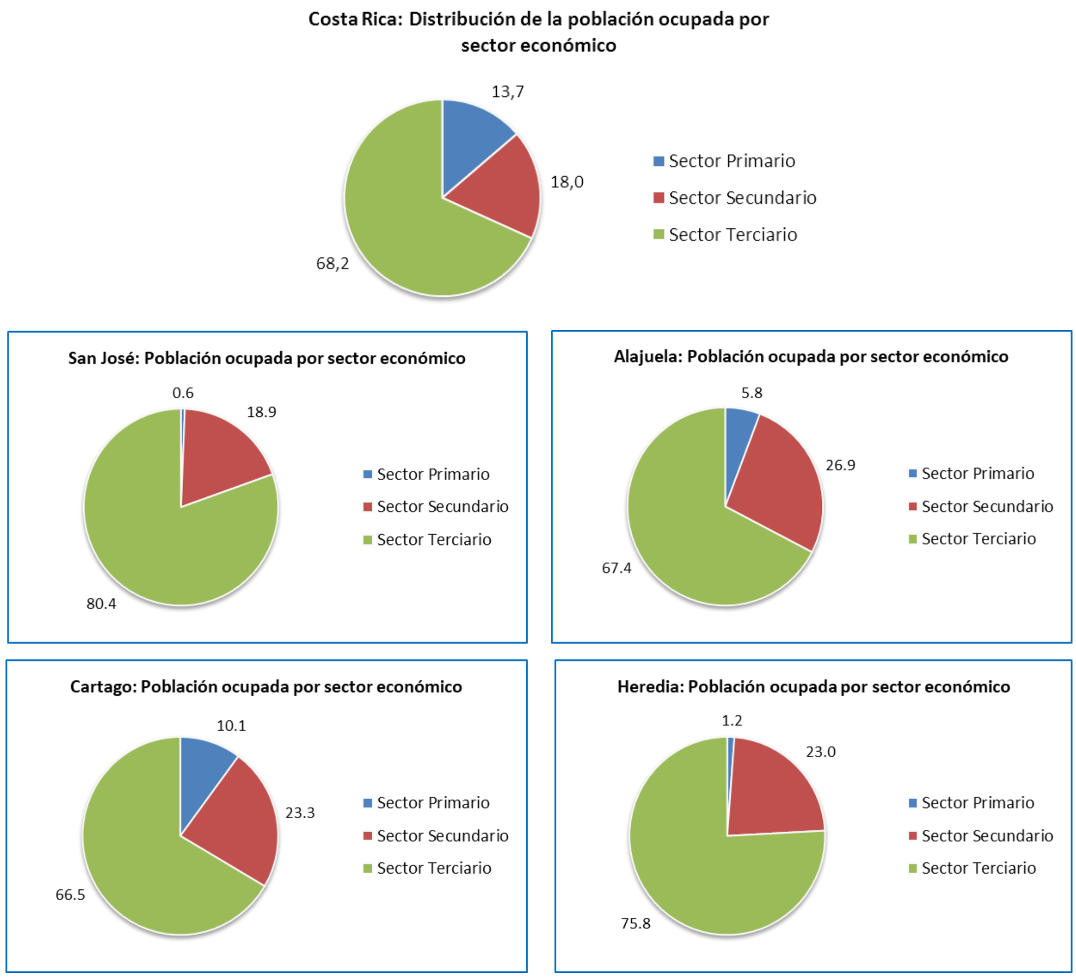


Figure 8.4. Distribution of the working economic population, by economic sector, country and provinces. 2011 Census.

Source: INEC, Census 2011.

The economic characteristics of the country have varied in recent years and this is evidenced by the most recent study of the State of the Nation, 2018, where 2017 the Costa Rican economy grew by 3.2%, less than in 2016 and the average of the last Ten years. All components of demand, with the exception of government spending, reduced their dynamism.

2017 saw the largest job loss in the last twenty years: 30,645 jobs, this reduction focused on the most vulnerable groups: unskilled people, micro-enterprises, 15- to 35-year-olds and women. Young people will have to uphold the pensions of one of the largest generations of older adults in national history, face adverse conditions, as the market does not offer them enough job opportunities, despite their better educational profile and that they are the ones who, despite the loss of jobs, the unemployment rate remained stable, due to a reduction in labor participation and population growth.

The actual income of the occupied had a minimum increase of 1%, insufficient to shorten the social gaps. 55% of income inequality among the employed is explained by the wage differences between and within the branches of activity. In 2017, slight increases in inflation, exchange rates and interest rates (known as macro prices) were observed. In a context of slowdown, this further limit consumption, investment and opportunity generation.

Tax revenues increased by 5.4% in 2017, the lowest figure since the 2009 economic recession. The adjustment required to heal public finances is estimated at 5.1% of GDP far higher than that calculated in 2016.

Domestic risks, such as higher variable-rate debt issuance, in foreign currency increased in 2017. Overall for 2018 the Costa Rican economy showed an adverse development and, in the short term, the outlook for economic opportunity, solvency and stability is negative.

Road safety, current vehicle traffic conflicts.

8.3.4. Road safety analysis.

- **Background**

"The project is to provide public transport users in Costa Rica's Greater Metropolitan Area with an electric train connecting a main axis from east to west, between the cities of Cartago, San José, Heredia and Alajuela; allowing mobility, between different points, in a safe, clean, fast and efficient way, favoring the reduction in users' travel times and road decongestion; contributing to the decrease in hydrocarbon emissions from the daily portion of vehicles in the vehicle fleet that would cease to circulate by gam, contributing to the country's proposed neutral carbon target." (Project Profile - TRP Incofer)

The project to be developed will be carried out in the existing right of way of the National Railway Network (approximately 84,85 km) between the cities of San José, Cartago, Alajuela and Heredia de la GAM. In general, the implementation of this project aims to turn the current RIGHT of the AIR, into a mass transit corridor of people.

- **Problem Identification**

The identification of the problem was carried out by the INCOFER Planning Office in 2013, however it is important to mention that it remains in force, since despite having today rail passenger routes, they do not satisfy the demand. Current mobilization, on the other hand, has been increasing due to the increase of the vehicle fleet transiting through the GAM, causing road congestion, thus defining the problem as "Increasing road congestion in the Greater Metropolitan Area".

- **Identification of the Target Population.**

The target population is the GAM inhabitants that already uses public transport and that will have, in addition to traditional means such as buses and taxis, a complementary and integrated system with these other means of transport to properly complete their journey from the source to the final destination. This population belongs to all socioeconomic strata including those most vulnerable and people with disabilities.

Another potential population of users, although probably lower than the above-mentioned demand, corresponds to people who currently use private transport, who see on the railway and additional means of public transport, an option for avoid the congestion, high travel times and the high operating costs they currently incur for mobilizing by vehicle.

- **Characterization of the current situation**

The country has a high concentration of population and employment (66%) in the Central Region (INEC 2017), in this area, on average, about 1.5 million people move to work from one county to another daily. Similarly, for work reasons, nearly 37,000 people are transferred to GAM from peripheral counties in the Central Region.

According to the State of the Nation published in 2018, 28 districts of high level of road congestion were identified in GAM, Costa Rica is one of the Latin American countries with the most vehicles, per thousand inhabitants (231 units), second only to Argentina (315) and Mexico (278), and combined with this daily, the main road corridors of the GAM circulate an average of up to five thousand heavy vehicles

Among the main reasons mentioned, in the GAM 50% of workers work in a different county than their place of residence, so they use 34% of the workers as the main means of transporting the bus and by private vehicle another 33% of the population.

For the working population, economic costs from congestion in GAM account for about 3.8% of GDP. A direct consequence of the dispersed city structure are the travel times of both people and goods, which make the population lose competitiveness and quality of life.

The transport sector is responsible for 66% of hydrocarbon consumption and 54% of carbon emissions in the country. 30% of those killed on site in road accidents are cyclists and pedestrians.

90% of the High Capacity Network does not meet the parameters of the National Transportation Plan in terms of the number of lanes. In the absence of changes, the percentage of routes with the greatest traffic problems would increase from 48% in 2017 to 86% in 2025.

The urban railway currently operating in Costa Rica is a well-received alternative by the public. However, even though it offers superior service speeds compared to buses and private vehicles, it loses competitive advantage due to limitations in service schedules and rolling stock. With the implementation of the TRP, the travel time will improve but the primary benefit will be the expanded service availability, with a daily transfer capacity that would increase from 16,000 to 250,000 people. The operational characteristics of the current train service and the Rapid Passenger Train proposal are shown in Figure 8.5 below.

Características operativas del servicio actual y de la propuesta del tren rápido de pasajeros (TRP)

Características	Servicio actual	TRP[a/]
Capacidad máxima (pasajeros por tren)	480	600
Velocidad (km/h)	25	35
Intervalo mínimo (minutos)	30	3
Frecuencia máxima (trenes/hora)	2	20
Factor de ocupación máxima en tramo crítico (porcentaje)	100	95
Horario	05:30-10:00/15:00-20:00	5:00-21:00

a/ Los datos del tren rápido de pasajeros corresponden a un estudio de ingeniería de valor que efectuó el Incofer en octubre de 2018.

Figure 8.5. Operational features of the current service and the TRP, 2018.

Source: State of the Nation, Costa Rica 2018.

- **Project beneficiaries:**

Residents of the cantons and GAM districts, by which is the layout of the railway project, between the cities of San José, Cartago, Heredia and Alajuela, belonging to all socioeconomic strata, people with disabilities and senior citizens.

The benefits to the population will occur in many forms. First, a considerable improvement in the public transportation service, to the direct benefit of the inhabitants of the TRP influence areas. Related to this, a significant reduction in the use of private vehicles is expected, improving the traffic conditions for the people who live and work in the GAM.

In terms of pedestrian safety and traffic conflict with private vehicles, the TRP project will have far superior conditions than the current train service, resulting in an important reduction in potential incidents. The main intersections will have modern detection, alert and traffic control systems. The option of building overpasses or underpasses in some of these intersections also remains option. The train-tram technology of the rolling stock allows for braking distances similar to those of a bus or truck, far better than the existing train. In the more urban areas, the design will be fully integrated into the city landscape, with sidewalks and green spaces that will provide a safer and more pleasant experience for users and pedestrians.

8.4. Available Emergency services

8.4.1. Red Cross

The Costa Rican Red Cross is one of the largest providers of pre-hospital emergency care in the country, not only in the care of daily emergencies resulting from road accidents, and therefore fully qualified for care railway situations.

For emergency care the Regional Emergency Committees of the Red Cross most relevant for their proximity to the impact area of the Project. These contain the right structure to support essential services.

Red Cross Emergencies			
Province	**County**	**District**	**Phone**
San Jose	San Jose	Carmen	25425000
	Goicoechea	Guadalupe	22536568
	Tibás	san juan	22366587
	Curridabat	Curridabat	22722784
Alajuela	Alajuela	Alajuela	24413939
		Guácima	24389238
		Turrúcares	24877693
Cartago	Cartago	occidental	25521117
	Paraíso	Paraíso	25746066
		Llanos de Santa Lucia	25746066
	La Union	Tres Ríos	22794191
Heredia	Heredia	Heredia	22626955
	Belén	San Antonio	22933283
	Flores	San Joaquin	22654608
	San Pablo	Rincón de Sabanilla	22444965

Table 8.9. Red Cross Emergency Committees present in the vicinity of the Project Area.
Source: Own elaboration

8.4.2. Fire Department

Fire stations located near the train track are identified to access them in a sinister situation.

Fire Emergencies		
Province	**county**	**Phone**
San Jose	San Jose	25746160
Alajuela	Alajuela	24406521
Cartago	Cartago	25912890
Heredia	Heredia	22612198
	Belén	25078700

Table 8.10. Regional Fire Stations present in the vicinity of the Project Area.

Source: Own elaboration.

8.4.3. Public force

It is a permanent civil police body, which by constitutional mandate must ensure the security and exercise of the rights and freedoms of every human being located within Costa Rican territory, in alliance with the community, within the nearest delegations is:

Public force		
Province	**County**	**Telephone**
San José	San José	22580629
	Pavas	22313649
Alajuela	Alajuela	24301085
Cartago	Cartago	25746587
	Paraíso	25920648
	La Unión	22787582
Heredia	Flores	22384314
	San Pablo	22384314

Table 8.11. Public force delegations present in the vicinity of the Project Area.

Source: Own elaboration.

8.4.4. Hospitals

The hospitals identified near the Rapid Passenger Train project are the main public hospitals in the country, it should be noted that within each of the district population centers there are a large number of Health Areas, as well as private clinics and hospitals.

Hospitals		
Province	**Hospital**	**Telephone**
San José	Hospital San Juan de Dios	25478000
	Hospital Calderón Guardia	22121000
	Hospital Mexico	22426700
	Hospital de la Mujer Adolfo Carit	22228851
Alajuela	Hospital San Rafael	24361001
Cartago	Hospital Max Peralta Jimenez	25501999
Heredia	Hospital San Vicente de Paul	25628100

Table 8.12. Regional and local medical centers present in the vicinity of the Project Area.

Source: Own elaboration

8.5. Available basic services.

As for access to basic services, according to the national census reveal that the four provincial heads through which the Rapid Passenger Train passed have parameters higher than the national average, relative to landline, cell phone, computer, internet, electricity, sanitary services and water.

In health services San José is the lowest percentage with 96.6%, in the other indices the county of Alajuela is the one that reports the lowest percentage in relation to San José, Heredia and Cartago, but never below the national average, as shown in the following figure:

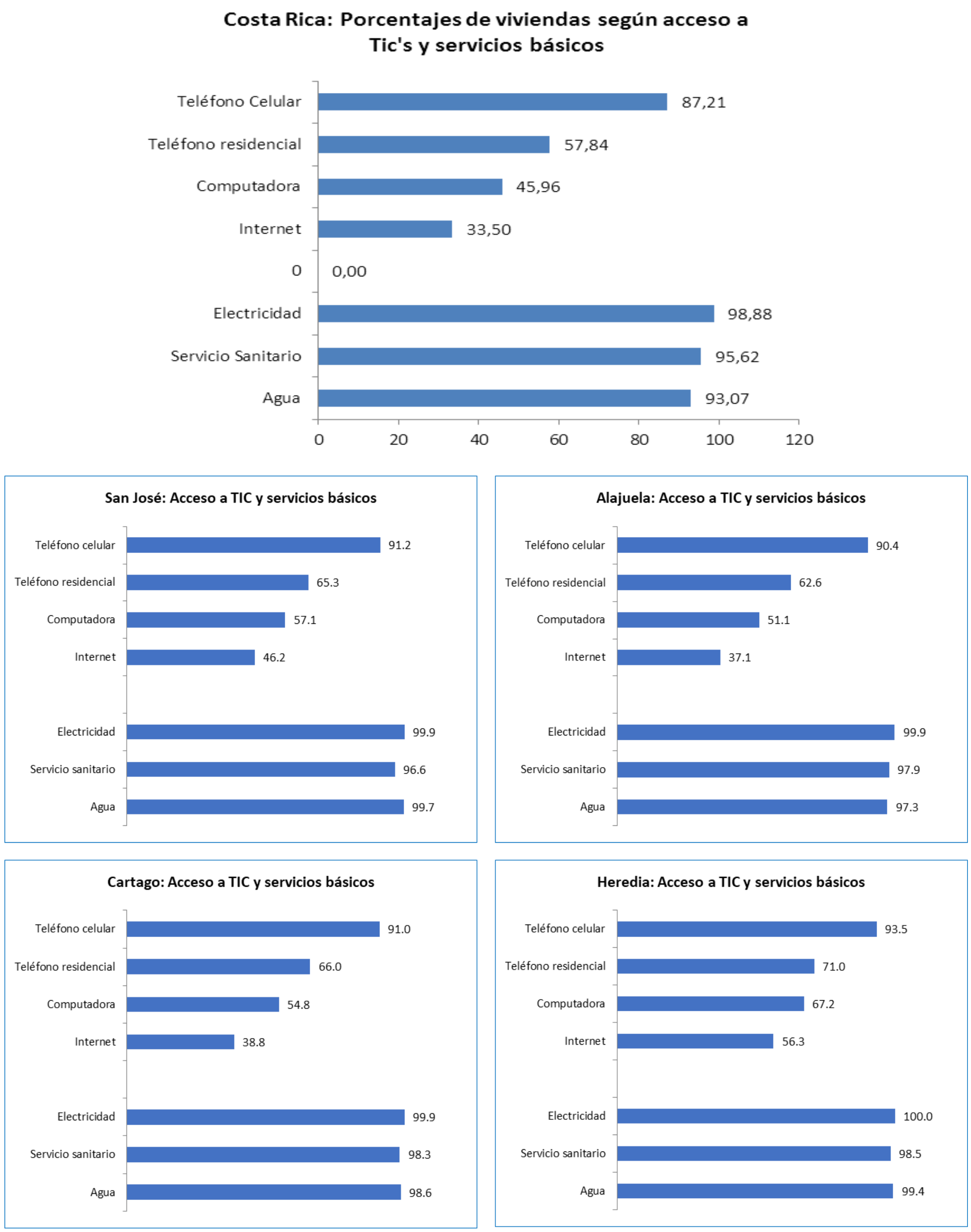


Figure 8.6. Percentage of housing with access to technology and basic services, by county and province, Census 2011.

Source: INEC, Census 2011.

8.6. Local perception of the project.

Positives	Negatives	Corrective Measures
Reducing mobilization times	No knowledge of the whole project, the population has incomplete information	In the planning and construction stage, inform the affected population, consisting of the TRP project
Reducing transfer costs	Increased costs and mobilization times due to conventional train closure during the construction phase	Coordination of the public transport system, for proper project management
Less pollution to the environment as an electric train, as well as lower costs in energy consumption since on flat routes it can generate its own energy	Sonic and visual contamination during the construction stage by the use of materials and heavy machinery.	Proper waste management, do not use noisy equipment at night hours and staggered use in hospital areas, universities, and residential areas.
Increased supply to cover more population	Eviction from families currently invading the railroad	Social and legal assistance as well as relocation of families in informal settlements in coordination with public institutions to generate decent living conditions.
Increased schedule frequencies as well as being modern, safe, efficient and comfortable transport	Increasing public debt	Rational use of resources, which are used efficiently and effectively
Regional communication, covering more districts and providing better service, continuity to avoid making stops and use of other means of transport	Social conflict over the demolition of commercial, residential and public sector infrastructure that is invading	Participatory and coordinated social mediation process responsibly by the competent institutions
Reduction of the vehicle fleet in the GAM as private transport users would move to the use of the TRP	Increased citizen insecurity in isolated terminals during the operation stage.	Efficient street lighting, closed surveillance circuits and police presence, especially at night times.
There is already the right of way available for the project	Increasing the number of transit action by having a faster TRP in the operating stage.	Road safety advertising campaigns, Safety measures such as over/underpasses in high-traffic areas, needles, pedestrian areas to prevent people from crossing the train line. Modern tram-train design and technology offers shorter breaking distances and greater

		integration with the urban landscape.
Generation of new jobs in both the planning, construction and operation stage.	In the execution and operation stage it affects the passage of pedestrians as residences, shops and services are located on the edge of the train journey.	Coordination with the Directorate General of Transit Police the regulation and access of pedestrians and vehicles to work or residence sites.

Table 8.13. Study of local perception and measures to be implemented.

Figure 8.7. Social perception about the project, San José - Cartago April 2019.

8.7. Negotiating mechanisms used for expropriation and relocation of communities

The negotiating mechanisms for the process of expropriation and relocation of owners, as indicated by Law 7495, The Expropriation Act, which clearly states that the administrative processes necessary to compensate persons or real estate companies where some new sections of the current Passenger Rapid Train route have to be drawn, as well as the relocation of people who will be affected..

8.8. Communal infrastructure.

Communal infrastructure is understood as a set of activities aimed at solving particular needs of a community, present in its habitable physical environment, generating structures that contribute to the functioning of the community as an agency directly affecting their habitat, their way of interacting and relating, among the main communal infrastructure found in the area of direct impact in addition to the basic services mentioned in the previous section, sewerage storm, solid waste collection and road infrastructure, near the railway line at approximately 150m, is the following infrastructure (table 8.14). Annex 6 shows the infrastructure map of the area of influence.

Infrastructure	Name
Universities / Educational Centers	Costa Rica Institute of Technology (ITCR)
	Autonomous University of Central America (UACA)
	University of Costa Rica (UCR)
	Distance State University (UNED)
	Universidad Latina de Costa Rica
	Universidad Hispanoamericana
	San Marcos University
	National Institute of Learning (INA)
	Calazanz College of Costa Rica
	Liceo José Joaquín Vargas Calvo
Hospitals	Hospital San Rafael
	CARIT Hospital
	Calderon Guardia
Institutions	Old Barracks
	Costa Rican Petroleum Refiner (Recope)
	Federated College of Engineers and Architects
	Ministry of Agriculture and Livestock (MAG)
	Ministry of Urban planning and human dinking (MIVAH)
	Former Customs
Airports	Tobias Bolaños Airport
	Juan Santamaría International Airport
Religious Center	Basilica of Our Lady of Angels
	Cathedral Our Lady of Carmen

Table 8.14. Communal infrastructure present in the area of influence.

8.9. Socially sensitive areas

8.9.1. Informal settlements

For the United Nations (UN), informal settlements are residential areas in which the inhabitants do not hold the right of tenure over the land or dwellings in which they live, under the modalities ranging from the illegal occupation of a home up to informal rent; neighborhoods often lack basic services and urban infrastructure and homes may not comply with regulations and are often geographically and environmentally located in hazardous areas.

Slums are the most deprived and excluded informal settlements and are characterized by poverty and large agglomerations of shabby homes, usually located in the most dangerous lands. In addition to the instability of the right of tenure, the inhabitants of the neighborhoods do not have basic infrastructure and services, public space and green areas, and are constantly exposed to eviction, disease and violence. According to data obtained by MIVAH (2011-2012), the four provinces under study total a total of 20 informal settlements defined along the railway, highlighting from this information that the provinces of San José and Cartago are those that have more settlements totaling seven places each. As shown in Table 20, 6 informal settlements with a potential conflict with the TRP layout have been identified as a preliminary stage. In these 6 areas some relocations of housing may have to be carried out, although in all localities it will be necessary to follow an awareness-raising protocol that seeks to meet basic needs for safety of movement and access, to the same time to reduce potential for conflict for the project.

Province	County	District	Informal Name	MIVAH name	Initial settlers	Current families	Potential conflict with railway
ALAJUELA	Alajuela	Alajuela	Precario 11 de Abril, Alajuela	Precario 11 de Abril, Alajuela	10	14	NO
		Gucima	La Managüita	La Managüita	N/R	N/R	NO
	San Rafael	San Rafael	Futurito	Futurito	168	49	NO
CARTAGO	Cartago	San Nicolas	La Esperanza	La Esperanza	N/R	*39*	NO
			Barrio Miguel Trejos	Barrio Miguel Trejos	N/R	*30*	NO
			Maria Auxiliadora	Barrio Maria Auxiliadora-Diques Norte	680	200	NO
		El Carmen	Barrio Nuevo los Diques	Barrio Nuevo-Diques Norte	200	155	NO
			Barrio Linda Vista	Linda Vista-Diques Norte	N/R	30	NO
			B° Corazón de Jesús or Sta Eduviges	Santa Eduviges_Elena_ Sagrado Corazon	26	100	NO
			Miraflores-Higueron Diques	Miraflores - Higueron Diques Norte	35	120	NO
SAN JOSE	San José	Pavas	Bella Vista	Bella Vista de Pavas	60	110	YES
			Nueva Esperanza 1	Metropolis II	N/R	N/R	YES
			Nueva Esperanza 2	Nueva Esperanza de Pavas	30	56	YES
			Cristal Antes Línea Del Tren	Linea del Tren	N/R	50	YES
			Santa Fe	Linea del Tren	N/R	N/R	YES
			Bendicion 1	Bendicion 1	N/R	N/R	YES
			Bendicion 2	Bendicion 2	N/R	N/R	YES
	Tibas	León XIII	El Progreso	El Progreso	N/R	N/R	NO
		Cinco Esquinas	El Plantel	El Plantel	N/R	N/R	YES
HEREDIA	San Domingo	Santa Rosa	Precario 12 de junio (previously Santa Rosa)	Santa Rosa	125	10	YES

N/R= information not registered.

Table 8.15. Informal settlements on the railway, according to province, county and district, MIVAH 2011-2012.

Source: Own elaboration based on information from the Ministry of Housing and Human Settlements (MIVAH), 2011-2012.

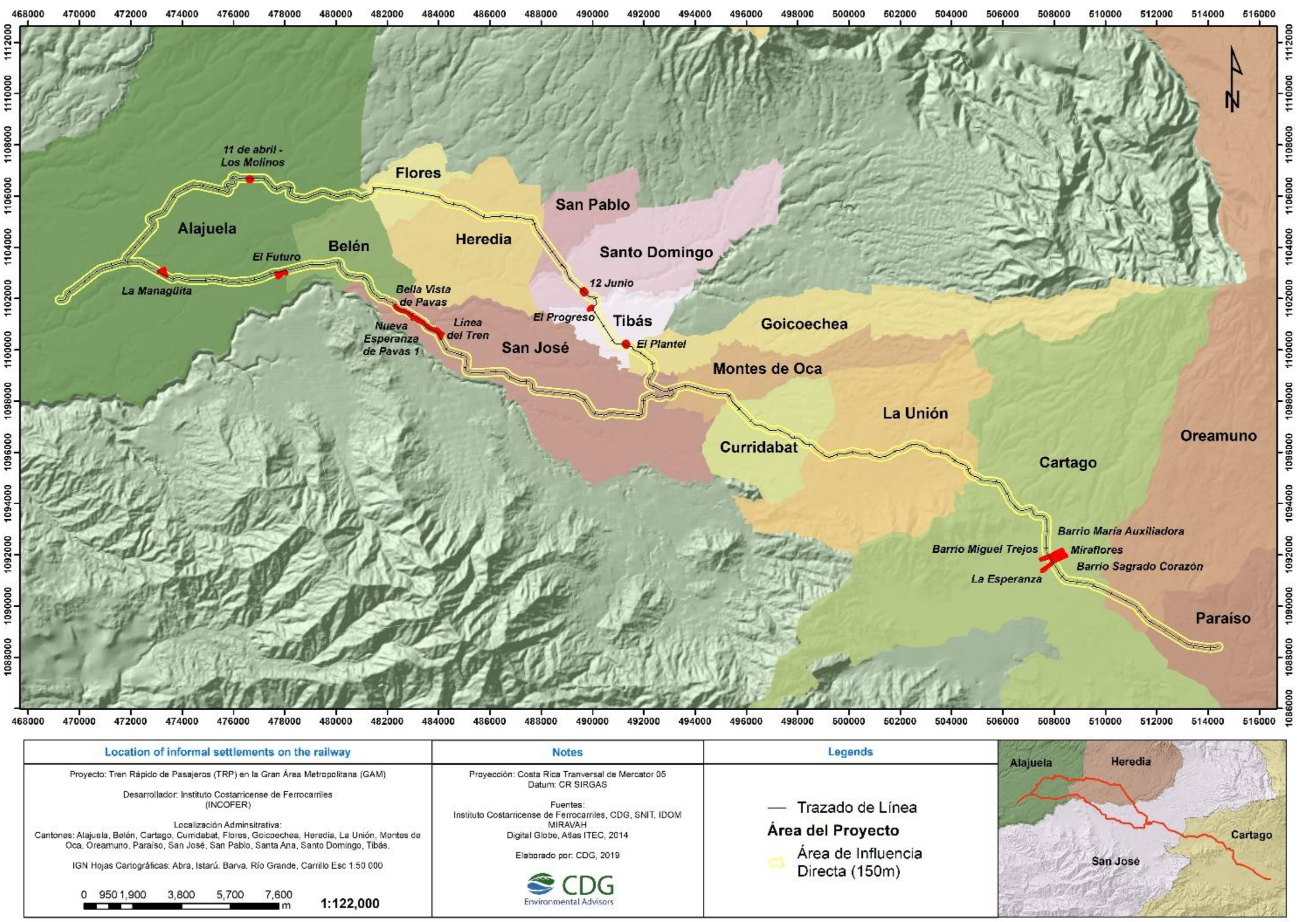


Figure 8.8. Location of informal settlements on the railway, according to province, county and district. Own elaboration from MIVAH 2011-2012.

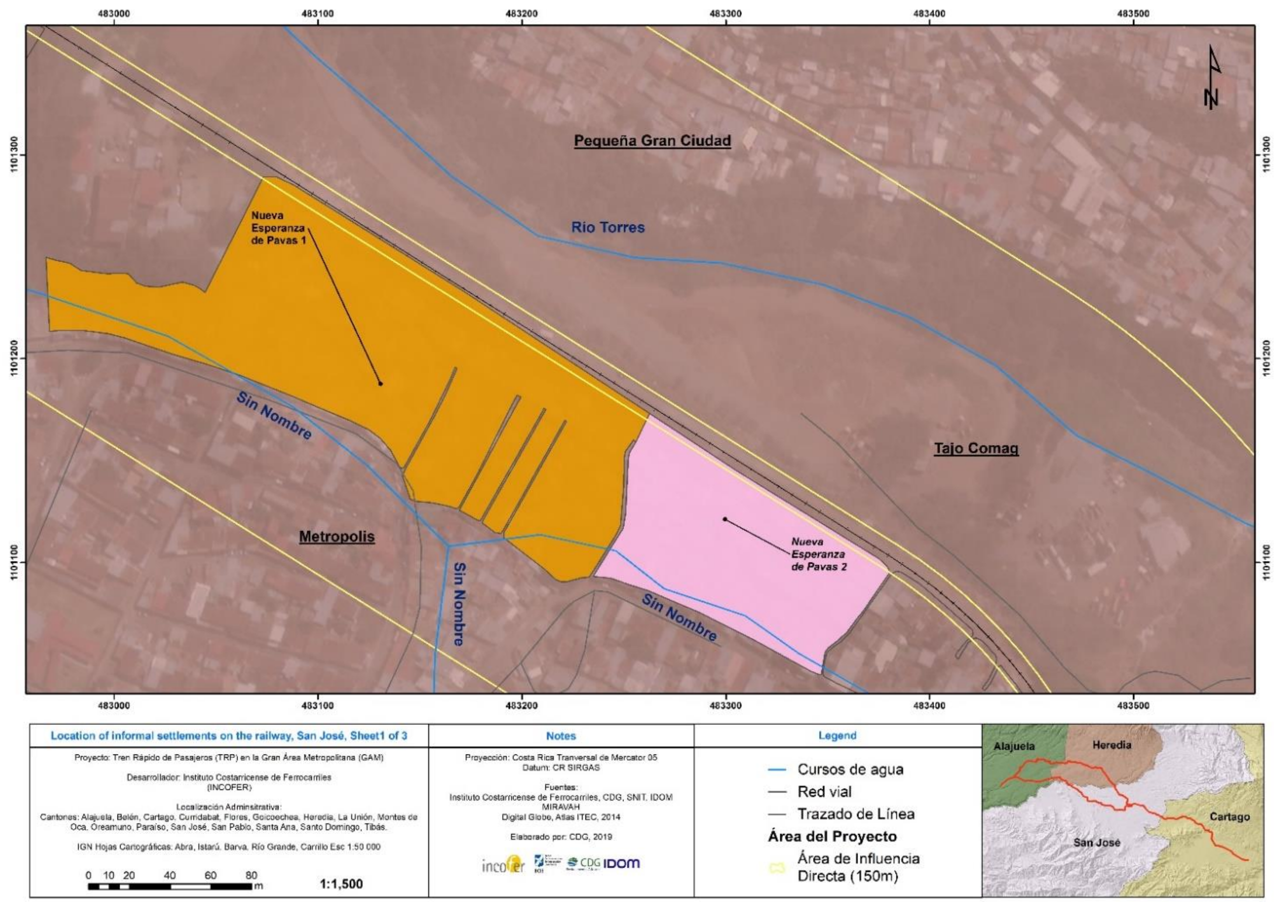


Figure 8.9. Location of informal settlements on the railway in San José province, sheet 1.Own elaboration from MIVAH 2011-2012.

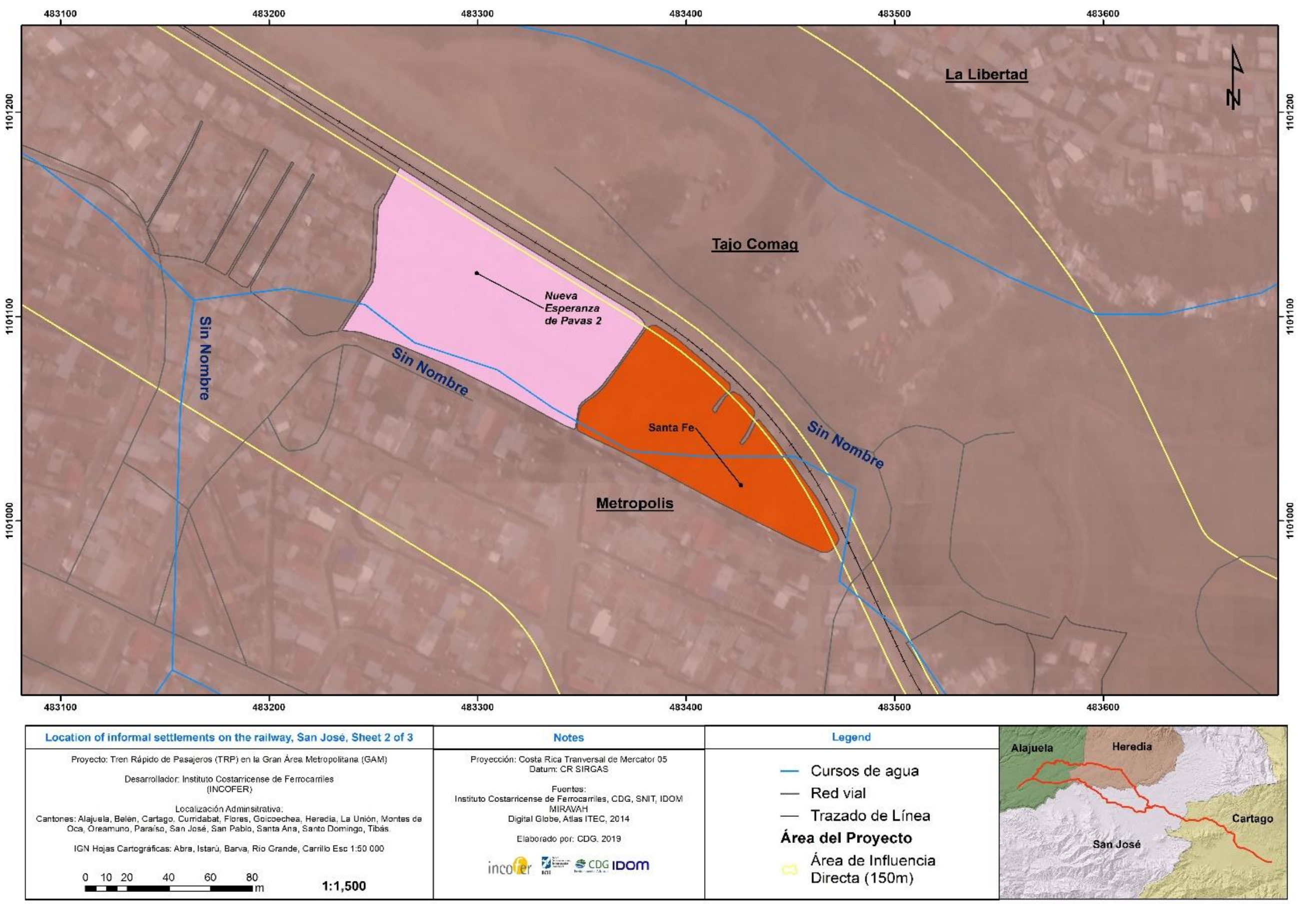


Figure 8.10. Location of informal settlements on the railway in San José province, sheet 2. Own elaboration from MIVAH 2011-2012.

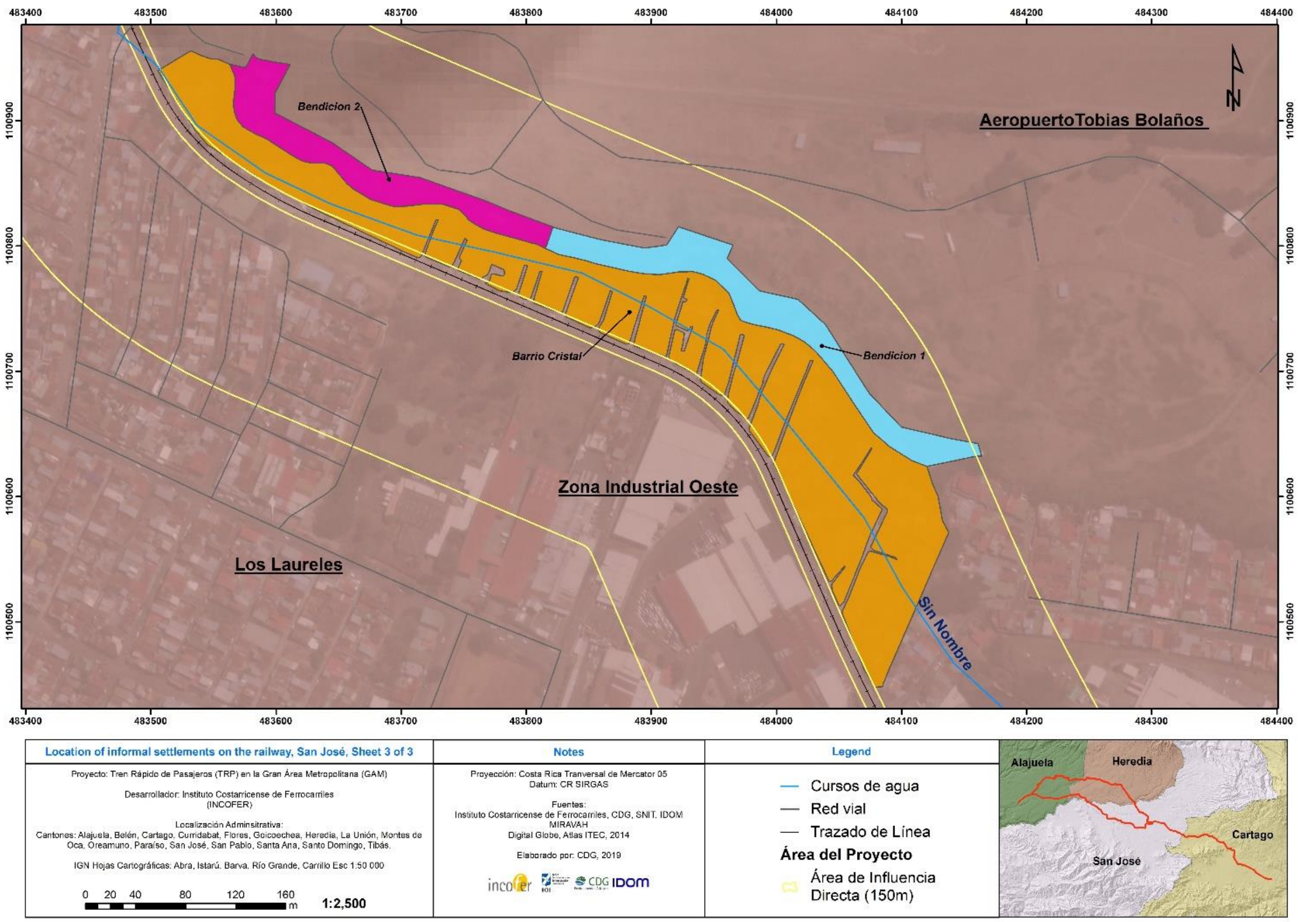


Figure 8.11. Location of informal settlements on the railway in San José province, sheet 3. Own elaboration from MIVAH 2011-2012.

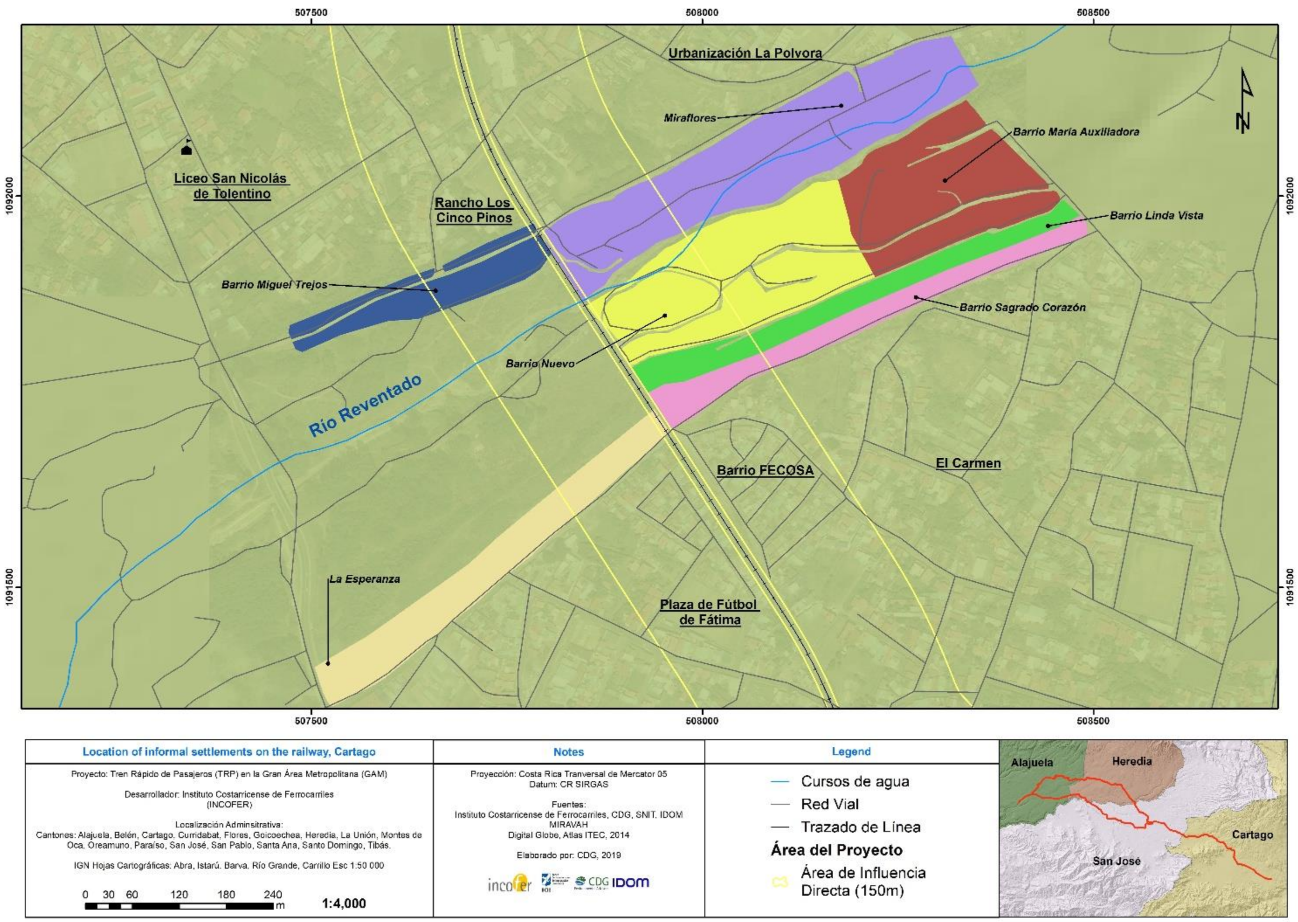


Figure 8.12.Location of informal settlements on the railway in Cartago province. Own elaboration from MIVAH 2011-2012.

Human settlements, located in the places around the railway line, should take into account new safety alerts such as being aware of train schedules, education and care for minors, people with disabilities and other populations vulnerable to train use as well as safety measures to transit or live near the railway.

Families residing in the vicinity of the railway must respect the limit involved and will not be able to build on the land destined for this route. Otherwise, the legal proceedings must be used for the respective recovery of the Incofer's land. This has a significant social impact because due to the conditions of poverty and extreme poverty in which families are relocated in these areas, they expect to benefit from economic subsidies and housing bonds, causing an effect of increase in families that claim to be helped, social welfare homes range from 7,000,000 to 7,500,000 colonists for the eldest adult population or population with disabilities, with a construction area of $40m^2$ and a land purchase for 3,000.00 0 million colones as the maximum amount, and the minimum area accepted is 120 m^2. (IMAS 2019).

It is important to note that the TRP project will not affect indigenous communities. However, among vulnerable populations, there is a high percentage of migrants currently in the country who are sheltering in marginal urban areas, these people being excluded from some subsidies and aid by the State because of their status irregular migration. This means that it will be a challenge the eradication of urban dwellings, or relocation, in the areas that circumscribe the Greater Metropolitan Area railway line.

As indicated previously, this study corresponds to preliminary development stage, so it is too soon to confirm or dismiss which informal settlements represent potential socioeconomic conflicts with the railway. The social dynamic is very complex and until a more definitive intervention process can be carried out, with direct communication and mediation with the inhabitants of each settlement, potential conflicts with the TRP project cannot be fully discarded.

However, by assessing the size of the settlements, the proximity to the railway, social vulnerability indicators and the current experiences of INCOFER, it is possible to identify the primary sources of potential conflict with the railway, placing emphasis on those settlements located in San Jose, primarily in the central county and in Tibás.

In the past few years, there is a notable acceleration in the creation of new settlements, which can be tied directly to the increase in poverty and general social degradation provoked by the current political and socioeconomic realities that create imbalances in the organization of the country's geographic distribution, especially near the capital, as observed along the railway. This phenomenon is accentuated in the area of Pavas, as evidenced in the following settlements:

- Bella Vista: irregular terrain, unsuitable for construction in certain areas, adjacent to a quarry and split by the railway. The Municipality owns most of the land in this sector, expansion occurs to the west.
- Nueva Esperanza 1 (Metrópolis II) y Nueva Esperanza 2: area with a lot of shanties, with moderate to steep slopes towards the river. The terrain does not allow for further expansion. The land belongs to the Municipality and also public lands in the river protection areas.

In the county of Tibas, district of Cinco Esquinas, the area with most potential for conflict is the settlement known as El Plantel. The terrain is mostly flat, with some flooding hazard near the creek Quebrada Rivera, the land belongs to the Municipality of Tibas and the terrain does not allow for expansion.

Informal settlements are considered an adaptative response by marginalized social groups generally located in land that is close to rivers and not being put to productive use.

Figure 8.1. Informal settlements in Alajuela. On the right Pavas, April 2019.

The railway has been essential in the organization of the territory and in the restructuring of the networks of cities, giving prominence to those that became nodes of the railway system.

Cities that were left out of the network's layout struggled to compete with others in economic development.

The railway in the city constitutes an extensive and complex space that is part of the city. There is no denying that the railway system could become a macroelement of difficult integration in the city. But one thing is its intrinsic difficulty and another very different thing is to come to postulate that the railway negatively impacts, *per* se, the railway must be integrated with the urban setting.

Among the rail problems the main social problems identified along the railway line include:

- Insecurity in the circulation (lack of pedestrian spaces parallel to the railway, and the recklessness of many citizens),

Figure 8.2. Informal pedestrian crossings in Alajuela. To the right Cartago, April 2019.

- The physical barriers that railway roads often pose have been a reference in the socio-spatial segregation consented to or supported by planning and urban management. And this has been how physical barriers have become social barriers, so that the railway is not the cause, but a mere external argument for socioeconomic segregation (social inequity and spatial fragmentation with the railway barrier as a tool).

- Inappropriate passages of motorcycles and bicycles.

Figure 8.3. Informal routes, Path Alajuela -Airport, April 2019.

- Environmental deterioration, cleaning and caring for internal edges, improving the image of the railway corridor.

Figure 8.4. Informal Settlements, Alajuela-Ciruelas Route, April2019.

- Destitution, occurs in low-traffic areas and mainly in places with little lighting.

Figure 8.5. Informal Settlements, Alajuela-San Rafael Route, April2019.

- Animal impact incidents, although very rare, tend to occur at a higher rate in informal human settlements, where spaces are small, and pets lack proper care.

Figure 8.6. Informal Settlements Heredia right Belen, April 2019.

8.9.2. Gender Perspective

Public transport systems are complex and different, to understand them, study them and be able to plan them in a sustainable way it is necessary to understand the perception that users and those who live on a daily basis with any of the components of transport systems. The above is that the relationship between public transport and gender is found, as men and women maintain different ways of relating.

Taking that gender perspective into account when planning public transport allows for progress towards gender equality, allowing women to access opportunities that by variables such as mobilization had not been able to do before. Annex 8 presents the TRP Gender Perspective Study and its corresponding Action Plan.

9. ENVIRONMENTAL DIAGNOSTICS.

For purposes of the Environmental Diagnostics of the Rapid Passenger Train Project, Leopold's Matrix methodology will be applied in order to identify potential impacts that could be generated. In this analysis, all impact-generating activities should be considered, both in the construction and operational phases,

9.1. Project summary.

The project involves the expansion and modernization of the urban passenger train service in a journey of 84,85 km on the current right of track.

1. Route of 84,85 km in three main sections to double track on plate, double track in ballast, double track in viaduct and single track on plate.
2. Rehabilitation and expansion of bridges over more than 50 channels in the public domain.
3. Construction/remodeling of 47 stations, including 10 intermodal stations.
4. Complementary works such as a central workshop, 4 courtyards/garages, an administrative building, 24 substations (to be specified in the Third Report), catenary and power supply to stops, relocation of public services (where possible drainage and road connectivity works.

In addition, the need to build temporary structures such as camps, engineering offices, machinery and material warehouses, prefabricated structure plants, concrete mixing plants, and asphalt mixing plants is foreseen. It should be coordinated with Municipalities and other governmental bodies to ensure that these structures are installed on public lands near the AP; otherwise, agreements with private actors will be necessary. In the same way, the sites (quarries) authorized for the extraction of the material necessary for the project must be identified in time, as well as the decompressions or fillers that can receive what the project should have. Ideally, these sites will be located near the AP and along the route under construction, for efficient operation.

9.2. Elements of the project generating environmental impacts.

Below are the activities that will potentially generate environmental impacts at each stage of the Project (tables 9.1 and 9.2).

9.2.1. Constructive Phase.

Activities	Definition	SOURCES OF IMPACT
Elimination of vegetation.	Action of cutting trees, palms and shrubs.	Emission of gases and noise due to the use of machinery and vehicles. Organic waste generation. Alteration of the existing environment.
Earthworks.	It consists of the leveling and filling of the terrain for the formation of the tracks, as well as the placement of the bases of the bridges and other structures of the track; rehabilitation of drains and the shaping of slopes.	Constant transit of light and heavy vehicles. Use of heavy machinery that generates noise and air pollution. Runoff sedimentation. Alteration of the terrain and landscape.
Enabling temporary buildings.	It consists of enabling specific areas in some surrounding properties to deposit ***organic*** construction material, as well as residential camps, warehouses for material and machinery, offices of engineers and personnel, prefabricated, Concrete and asphalt mixing plants.	Impact on the local economy by land rent. Movement of vehicles in and out of the right of way of the AP. Noise and dust generation. Alteration of the terrain and landscape.
Transport of material and equipment.	Transfer of usual construction material to the AP, to the decompression points, to the prefabricated plants and concrete and asphalt mixers.	Circulation of heavy vehicles. Entering and exiting vehicles to the AP. Noise and dust generation. Gas emissions from the combustion of fossil fuels.

Civil works	Rehabilitation and construction of the track and complementary works.	Impact at the level of employment, local economy, social welfare and value of land. Entry and exit of light and heavy vehicles. Use of heavy equipment and tools that generate noise. Generation of common waste and debris. Alteration of ecological processes and the existing environment.
Generation of Residual Waters	Wastewater generated during construction activity.	Contamination of surface and groundwater sources. Affectation of ecological processes.
Solid waste generation	Domestic, industrial and construction waste.	Damage to the landscape by waste, surface water contamination and soil involvement.

Table 9.1. List of potential environmental impact activities at each stage of the Project during the construction phase.

9.2.2. Operative Phase.

Activities	Definition	SOURCES OF IMPACT
Operation and maintenance of the railway and related works	Staff are needed to maintain the various road structures, as well as in the right of way and complementary works.	Employment impact, local economy, social welfare, decreased surface runoff, decrease in natural fixation. Less vehicle flow with the consequent reduction of gas emissions by lower consumption of fossil fuels.
Generation of Residual Waters	Industrial wastewater is generated in the operation process.	Surface water contamination. Deterioration of soil that is located near the different road structures.
Solid waste generation	Waste mainly domestic by the transit of vehicles and from the maintenance activities, typical of the project.	Soil and air pollution, and landscape affectation.

Table 9.2. List of potential environmental impact activities at each stage of the Project during the operational phase.

9.3. Environmental factors likely to be impacted.

The environmental factors that can potentially be impacted by the realization of this Project are described as follows:

- Surface and groundwater:

Surface water could be affected by sedimentation and waste generation processes at all stages of the project. There are rivers, permanent and intermittent ravines and areas of poor drainage that can be directly affected, as well as runoff or erosion. Groundwater may be affected by leaching of some kind of waste; precautions should be established in the different plants installed. They can also be affected by alterations in the drainage capacity of the terrain.

- Sonic Quality:

There will be increased impact during the construction phase due to the use of equipment for tree cutting, heavy machinery for ground leveling, bridge rehabilitation, overpassing, stations and other structures; then for transporting material and equipment to the job site. During the operational phase, the typical noises of activities such as these are foreseen.

- Air quality:

The generation of emissions and particulate matter that could affect air quality would be timely and temporary during the construction phase of the Project only, mainly due to tree cutting, earth movement, and constructions of the various Structures. In addition, it can be affected by the transit of vehicles in the transfer of materials and personnel, preparation of the asphalt mixture, among others.

- Flora:

There is no need to remove vegetation significantly, as the right of way is still tree-free today. When it is necessary to cut down trees, it will be done by processing all the respective permits as set out in the regulations. Most sectors of the AP, are devoid of trees, are areas with pastures and scrub.

- Fauna:

It is disturbed and/or driven away by noise and short ground and land movement. There is potential for habitat fractionation and the increased frequency of service may represent a barrier or threat to wildlife that circumstantially passes through the area.

- Soil:

The soil will be mainly affected by the movement of land, compaction of bridge bases and subbases, new railway rails and by rehabilitating, opening drains, circulation of heavy machinery and ordinary solid waste.

- Employment:

There will be a positive impact from direct and indirect jobs during the construction and operation of the Project.

- Local Economy:

The impact it will generate is the increase in job opportunities, payment of taxes, real estate rent, consumption of goods and inputs. In addition, engineers, technicians, and other project workers, during project installation, will need to meet some needs that arise. This situation will be beneficial for the local population as they will have the opportunity to meet the demands of inputs and/or services. The economic driver effect of this project is significant and regional in scope throughout GAM.

- Landscape:

The project will impose an alteration of the current landscape during construction, as it involves a large-scale work and important earth movements on the current right of way. In the operational phase, the Project could become a positive and modern element of the urban landscape.

- Social welfare:

It corresponds to the level of social well-being and quality of life of the people who inhabit the communities of most GAM counties, not just those located in the AID. The project can have a positive impact on people's economic competitiveness and quality of life by reducing vehicle congestion. For employment purposes, it can be an important source of work for labor at different levels of training. On the other hand, constructive activities can cause disruption to the daily activities of the inhabitants and users, inconvenient that must be compensated with efficient mechanisms of traffic regulation on each front of work.

9.4. Environmental impacts that the project will produce and its options.

The following describes the different impact-generating activities of the Project, and the potential effects they would have on the physical, social, and biological environment.

- Vegetation removal:

It corresponds to the elimination of plant cover, mainly and not woody that grows along the right of the railway route. This cleanup is carried out, in order to free up the space to initiate the activities of earthmoving and relocation of existing basic services. Direct impacts are generated on the fauna due to disruption of its habitat. On the other hand, it also generates positive impacts by generating temporary sources of employment, which generates a benefit in the local economy, the social welfare for the income received.

- Earthworks:

It corresponds to the removal of the organic layer from the soil, the removal of low quality soil and replacement of it with another quality material that allows the stability of the structures that will support the different layers of the railway, bridge structures, bases of uneven steps, and other structures.

Direct soil involvement is perhaps the greatest impact caused by this activity, as well as the generation of dust or particles into the air. In addition, consideration should be given to the noise produced by machinery and the constant movement of wagons, graders, tractors, compactors, backhoes, excavators, among others; that have a greater impact, in magnitude and extent, on the biota and the landscape.

In addition, mishandling could lead to contamination of water sources within the AP, and these movements can – by altering the structure of the terrain – affect the drainage capacity of the soil.

Air may be temporarily affected by the generation of dust and by the combustion of hydrocarbons by engines of the machinery used, which would depend on the quantity and mechanical condition of the same.

The generation of labor and the impact on the local economy by possible recruitment of staff and by the increase of commercial activities, are positive factors that must be considered.

- Enabling Temporary Structures:

It corresponds to the enabling of selected sites outside the right of way, such as camps, areas for the deposit of organic waste material resulting from the movement of earth (composites), warehouses of materials and machinery, location of offices of the Construction personnel, Prefabricated plants, Concrete and asphalt mixing plants. Enabling these sites requires the removal of the plant layer, compaction and baling of often undeveloped areas.

These temporary works can cause alterations during the project implementation phase, affect infiltration and surface runoff regimes, as well as alter ecological processes and landscape disturbance. On the other hand, it would generate benefits to the local economy, due to the rent or rental of land for the period of execution of the work and social welfare in case the structures installed on communal and municipal lands are donated.

- Transport of material and equipment:

It corresponds to the transport of equipment and materials in the project area, which must be done in containers, wagons or heavy platform trucks. These vehicles will generate gas emissions into the atmosphere. The frequency of transport in and out of the AP is high, which can affect the inhabitants of the neighboring communities, by the noise that is generated and the possibility of traffic accidents. In addition, it could generate particulate matter in the area or deterioration of the public road.

- Civil works:

It consists in the expansion and modernization of the railway on the existing right of road, the expansion and rehabilitation of bridges, construction of uneven crossings, accesses, stations and other infrastructure described. This activity involves more unskilled, semi-skilled and skilled labor, which could be supplied by neighboring communities, which favors the economy of a large extent of GAM. There could also be a temporary increase in local trade in goods and services on labor fronts, contributing directly to an increase in social welfare.

An impact is foreseen to the ground, because of the activities that this activity entails in addition to the waterproofing that a structure causes to the ground in any type of project. Mishandling could lead to contamination of ravines, rivers, wells, running through or relatively close to the site.

The construction of new civil works in this project could generate an even greater impact of the existing one, on the landscape and local fauna, because there is an increase in the area built so that the obstacles that would hinder the passage of species would be increased animals from one sector to another.

- Operation and Maintenance of the new train service and associated buildings:

It corresponds to the start-up and operation of the Project. The TRP operation will generate direct jobs, albeit possibly in less than the construction phase, but with better wage projection and stability over time. There may be affectations to wildlife and landscape due to the increase in the frequency of service. There will also be positive impacts such as direct and indirect contributions to the local economy, improvements in competitiveness at the GAM and country level, reduction of vehicle flow, improvements to air quality by replacing a diesel train with an electric service.

- Solid waste generation:

Solid waste of domestic and industrial origin if not handled well can cause significant associated negative impacts as it includes: landscape impact, odor involvement (air quality), potential risk of generating pests, leachate involvement, obstruction of public roads, among others.

- Wastewater generation:

Liquid waste that is foreseen in both the construction and operational stages are mainly ordinary, mishandling would involve contamination to water bodies and risks to human health.

9.5. Identification and assessment of impacts

As a summary, the following tables are presented that identify and assess potential impacts in three scopes:

- Nature of Impact: If impact is positive (+1) or negative (-1)
- Impact Duration: Whether the impact will be temporary (T) or permanent (P)
- Importance of Impact: if a Low (1-3), Medium (4-6) or High (7-10) impact is expected

IMPACTED ENVIRONMENTAL FACTORS		IMPACTING ACTIONS														
		CONSTRUCTION PHASE											OPERATION PHASE			
		Expropiation	Demolition	Vegetation clearing	Construction of different project components	Enabling dump sites	Installing worker camps	Transport of materials and equipment	Alteración de drenajes	Generación de desechos sólidos	Generación de aguas residuales	Construction of bridges and general structures	Railway maintenance	Vegetation Clearance	Yard maintenance	Operation of the new transport service
PHYSICAL/CHEMICAL COMPONENT	Sonic quality		-1	-1	-1			-1				-1	-1	-1	-1	1
	Air quality		-1	-1	-1	-1		-1		-1		-1	-1	-1	-1	1
	Surface and groundwater			-1	-1	-1	-1		-1	-1	-1	-1			1	
	Soils			-1	-1	-1	-1			-1		-1		-1		
BIOTIC COMPONENT	Fauna		-1	-1	-1				-1			-1	-1	-1		-1
	Flora			-1	-1				-1			-1		-1		
SOCIAL COMPONENT	Heritage				1							1	1			
	Employment			1	1			1				1	1	1	1	1
	Local economy	1		1	1			1				1	1	1		1
	Landscape		1	-1		-1	-1		-1	-1		-1				
	Social well-being	1		1	1			1			-1	1	1	1	1	1

POSITIVE IMPACT	1	NEGATIVE IMPACT	-1

Table 9.3. Summary table of the nature of potential impacts, construction and operation phases.

IMPACTED ENVIRONMENTAL FACTORS		IMPACTING ACTIONS														
		CONSTRUCTION PHASE											OPERATION PHASE			
		Expropiation	Demolition	Vegetation clearing	Construction of different project components	Enabling dump sites	Installing worker camps	Transport of materials and equipment	Alteración de drenajes	Generación de desechos sólidos	Generación de aguas residuales	Construction of bridges and general structures	Railway maintenance	Vegetation Clearance	Yard maintenance	Operation of the new transport service
PHYSICAL/CHEMICAL COMPONENT																
	Sonic quality		T	T	T	T		T				T	P		P	P
	Air quality		T	T	T	T		T				T	P	P		P
	Surface and groundwater			T		T	T		T			T				
	Soils					T	T					T		P		
BIOTIC COMPONENT																
	Fauna		T	T		T		T				T	T	T		P
	Flora			P								T	P	P		
SOCIAL COMPONENT																
	Heritage											T				
	Employment		T		T	T	T	T				T	P	P	P	P
	Local economy				T	T	T					T	P	P		P
	Landscape		P			T	T			T	T					
	Social well-being				P	T	T				T	T	P	P		P

TEMPORARY IMPACT	T	PERMANENT IMPACT	P

Table 9.4. Summary table of duration of potential impacts, construction and operation phases.

IMPACTED ENVIRONMENTAL FACTORS		IMPACTING ACTIONS														
		CONSTRUCTION PHASE											OPERATION PHASE			
		Expropiation	Demolition	Vegetation clearing	Construction of different project components	Enabling dump sites	Installing worker camps	Transport of materials and equipment	Alteración de drenajes	Generación de desechos sólidos	Generación de aguas residuales	Construction of bridges and general structures	Railway maintenance	Vegetation Clearance	Yard maintenance	Operation of the new transport service
COMPONENTE FÍSICO/QUÍMICO	Sonic quality		5					4				5	5	4		8
	Air quality		4	6				6				6	5	6	3	9
	Surface and groundwater			5		6	4		10		5	7		6	7	
	Soils	7	6			3						7				
COMPONENTE BIÓTICO	Fauna		3	5		2		4	2			5		6		
	Flora			6		2						5		6		
COMPONENTE SOCIAL	Heritage											7				
	Employment		7	8	8	4		7				8	7	9	5	9
	Local economy				7		5	7				5		5		8
	Landscape			5		6	4		4	3		7		4		
	Social well-being	6			7			6				7	7	6	4	9

1-3 Low importance
4-6 Medium importance
7-10 High importance

Table 9.5. Summary table of the importance of potential impacts, construction and operation phases.

9.6. Selecting the project option.

The Rapid Passenger Train Project is the culmination of a process of studying approximately 10 years on the modernization of the urban train system in GAM. In these studies, we have analyzed different alternatives looking for the best balance between feasibility, level of service and total cost. In the prefeasibility study carried out by LCR Logistics in 2016, the option called "2 A" was chosen as the best alternative for the development of the work. In turn, IDOM's 2018 value engineering study took the "2 A" option as the base scenario for performance optimization, reducing projected costs by 50% while maintaining an equivalent service standard. This proposal derived from the value engineering study is the one that is now analyzed on the basis for the feasibility study, including this Preliminary Environmental Study. The result of this new series of studies will then serve as a direct input for the detailed studies phase, which will be the basis of the tender poster for the construction and operation of the project.

10. MITIGATION MEASURES

10.1 Physical medium

10.1.1. Construction Phase.

For the physical/chemical medium, the following significant impact was identified:

- **Air quality:**

Air quality may be mainly affected by the introduction or enabling of new temporary structures. This can have a direct effect on the generation of suspended particles or dust, odors, as well as emissions from machinery and heavy vehicles inside during the execution of the works. This could cause discomfort for neighbors, or health problems among workers from direct and continuous inhalation of emissions.

Corrective measures:

- ✔ Establish manuals for the safe operation of the different equipment and machinery used in excavation, material transfer and construction, being mandatory compliance of the operators to ensure the good use and condition of these.
- ✔ Establish working schedules and alternate tasks in the use of heavy machinery according to the section of the layout and according to the work, in order not to hinder the movement of vehicles on related routes and trying to alter as little as possible the quality of life of the local populations.
- ✔ Wet work surfaces by tank or manual spray system to prevent clouds of dust from rising from work areas and access streets during periods of dry or rainy season in the area. Intensify these tasks in accordance with wind conditions, solar radiation and proximity to agricultural, commercial or industrial production areas, as well as population centers or housing.
- ✔ Regulate the speed of wagons and other heavy equipment in the work areas, at speeds that do not favor the lifting of dust curtains.
- ✔ Quickly remove the leftover materials resulting from earth movements or the construction of the different works of the Project.
- ✔ Temporarily cover with some type of material that retains or decreases dust particles from materials or mounds of earth that are more than one day in the same location.

- ✔ Store dusty or fine grain yolumetry materials in ideal places that prevent air pollution or are easily dispersed.
- ✔ Protect by means of plastics the stacks of ground debris, in order to prevent them from serving as a source of air pollution inside the AP and its AID.
- ✔ Cover the load of the wagons with tarpaulins or some other cover, to avoid the generation of dust.
- ✔ To define adequate maintenance and adjustment, so that the machinery meets the requirements established by the current legislation (Vehicle Technical Review) and that, in this way, the minimum impact on the air is guaranteed.
- ✔ Vehicles and machinery with anomalies at the gas outlet must be removed from the Project area and repaired at a suitable site.
- ✔ Solid waste is recycled and stored in suitable places for later collection, thus avoiding the generation of odors.
- ✔ Avoid burning garbage or debris.
- ✔ Ensure the good use and maintenance of sanitary cabins, performing a proper periodic cleaning and labeling the measures that users must comply with.
- ✔ Asphalt, concrete, crushers, workshops, service yards and other related facilities shall be established in areas removed from residential centers and according to the regulatory plans of each municipality as established by national regulations; In addition, material deposits must be covered. Waste and waste derived from these works shall be deposited in containers or in the properly identified sewage system and intended for this purpose for proper treatment.
- ✔ Employees should wear personal protective equipment for work or occasions that require protection to avoid respiratory conditions or eye conditions from any dust or particulate matter.
- ✔ Coordinate with the competent authorities or assign qualified personnel for transit regulation tasks during the execution of the different construction activities and transfer of materials to the AP.
- ✔ Establish efficient communication mechanisms for road users and inform them of possible temporary closures as works progress so that they take alternate routes and avoid unnecessary agglomerations on the different fronts of execution of works.

- **Surface and groundwater**

There could be a direct impact in water sources near the project area, due to the earthworks, installation of temporary facilities, generation of wastewater and general construction activities.

The machinery in the project area and other defined project sites could be a cause of pollution, due to spillage of paint, emulsions, asphalt mixes, concrete mixes, fuels or oils, all of which could infiltrate into the soil or be carried away by stormwater. Earthworks also leave exposed soil that could be carried off to nearby water bodies. If solid wastes and wastewaters are not properly managed, they could also generate a negative impact due to accidental leachate release or elevated levels of certain pollutants.

Corrective measures:

- ✔ Protect existing plant cover that does not need to be removed, where possible, in areas of the right of way where bridges, drains and other infrastructure go to conserve water bodies.
- ✔ Establish devices to capture sediments, whether through meshes, mesh pits, sediment trap drainage channels, settling dams, or some other means, in work areas before runoff water reaches bodies of water. At this point, a periodic maintenance system of these devices should be in place to prevent sediment saturation, while depositing them at the points intended for these types of materials or waste.
- ✔ Establish protective ditches at the base of the slopes, in order to contain and direct sediments arising from runoff erosion into sediment traps. These can be located in the middle of the slope cut, when these are in the form of terraces, such as at the top and its base.
- ✔ Use machinery in good condition to prevent spills of oil, fuel or some other polluting material.
- ✔ Placement of containment structures such as buttresses, retaining walls, gabions and rock counterweights, as well as placing at the exit of the sewer or laundry to contain the deposition of solid waste.
- ✔ Establish a preventive maintenance program for machinery outside the project's work areas and away from water bodies.
- ✔ Fueling only machinery that cannot be removed from the AP and by appropriate devices that do not risk spillage or that meet the safety of personnel.

- ✔ Perform repairs in a waterproofed shed near the AP or locate suitable areas for a maintenance workshop near the project.
- ✔ Establish a spill emergency care program.
- ✔ Keep track of the use and maintenance of mobile latrines, septic tanks, treatment or pumping plants of treated water for reuse, as well as protocols for the transfer of waste by the use of these devices.
- ✔ Have staff, containers and containers for the collection of ordinary and special solid waste, if any; the latter must be properly labeled. As far as possible, the classification of waste shall be promoted in order to promote its reuse, recycling and its differential handling and disposition depending on its nature and degree of danger.
- ✔ Avoid the development of the activity of earth movements during periods of heavy rain, in order to minimize the hauling of sediments from the work areas to the receiving channels.
- ✔ Have efficient control of solid waste collection in the drainages of the site, as well as the bodies of water, in order to keep free of any waste material or waste, product of construction activity and formation of the track, bridges, or any structure of the project.
- ✔ Implement measures for the management of solid and liquid waste according to a Structured Waste Management Plan in each of the activities involved in the project.
- ✔ Use water-efficient equipment and devices, both in the construction of bridges, sidewalks, bus bays, cycleways, pedestrian bridges, plant processes and dust mitigation tasks, to prevent leakage and water loss.
- ✔ Do not use water from surface bodies of water to mitigate dust or for construction, unless appropriate use of the resource is available.
- ✔ Machinery and equipment operators shall carry out their cleaning and maintenance work in areas or sites away from the bed of surface currents, in places properly established for these tasks and where an appropriate system is available for the treatment of grey water.
- ✔ Waterproof vulnerable areas, areas for solid waste deposits, material warehouse floors and fuel management areas, in order to avoid possible leaks in the soil with the consequent contamination of the bodies of water.
- ✔ In the case of storage and use of fuels and chemical materials, the different areas where their handling and use is available should be labeled warning of the risks and precautionary measures to be implemented.

- ✔ Wineries or areas of chemical materials and flammable substances shall be located in waterproofed areas with double containment systems; under the authorization of MINAE and duly closed, labeled and restricted access as required by national law.
- ✔ Asphalt, concrete, crushers, workshops, service yards and other related facilities shall be established in areas outside natural drains as established by national regulations; In addition, material deposits must be covered. Waste and waste derived from these works shall be deposited in containers or in the properly identified sewage system and intended for this purpose for proper treatment.
- ✔ Avoid contamination of water with concrete products during the construction of bridges or other structures. This can be implemented by preparing the mixture or concrete product outside the drainage areas or the crack or river protection areas; or by efficiently using equipment that prevents contamination of water sources or drainage channels.
- ✔ Avoid minor or unnecessary hydrological modifications and occasional contamination episodes. This requires delimitation of work areas, establishment of environmental safety standards, clear drainage design and seeking as little disruption as possible according to quality standards and national regulations for such works.
- ✔ Establish efficient wastewater collection and treatment mechanisms at each of the sites established for camps, material and machinery holds, prefabricated plants, concrete and asphalt mixing plants.
- ✔ Prohibit washing equipment or machinery in surface water sources or bodies such as ravines, rivers or lagoons.
- ✔ Prohibit direct discharge of wastewater that occurs in temporary buildings, or that are moved in different equipment and machinery, directly into municipal sewer systems, public or private drains, and bodies of water without prior treatment that complies with national regulations.
- ✔ Prevent the obstruction of waterways with debris or excess material from the earthworks, unless it is part of the process to reinforce and/or build bridges, and always under proper environmental supervision.

- **Soils:**

Impacts on the soil are generated primarily during earthworks, the installation of temporary facilities, transportation of materials and equipment, generation of wastewater and solid waste, and general construction activities.

Evidently the soil conditions vary because of the earthworks and the ground leveling activities for dump sites, access ways to material deposits, and installation of temporary facilities and material warehouses. Generation of solid waste and wastewater could result in accidental release of leachates or other pollutants. Permanent structures such as bridges, service roads, over/underpasses, among others, create conditions of ground impermeability.

Corrective measures:

- ✔ Earth movement work shall, as far as possible, be carried out in the driest periods or periods of the day that there is no rainfall.
- ✔ Ground movements shall be made only according to the technical criteria established in the design of the project and approved by the national authorities. Unnecessary or outside earth movements are not permitted in the design of the work.
- ✔ The removal of solid or leftover waste should be coordinated with the progress of excavation and construction work, with the aim of reducing dust or the drag of sediments by rain.
- ✔ Excavation and filling shall be carried out only within the surfaces belonging to the right of way and in accordance with the designs of the project.
- ✔ Drainage systems shall be installed in accordance with the designs of the project, as soon as possible, and prior to the execution of the fillings in order to avoid excess moisture and to reduce erosion.
- ✔ Emphasis is placed on the construction of energy dispensers in pipe outlets, ditches, drainage sewers or so on to reduce land undermining.
- ✔ Erosion-resistant materials are used in the different road structures to prevent undermining.
- ✔ An appropriate cut of the slopes is maintained, with the required angle that prevents the collapse of the slopes. It follows the technical aspects of the design of the project, seeking cuts on terraces and with the angles appropriate to the floor type of the AP.
- ✔ Build temporary cobbled bowls on the slopes, in order to reduce material, drag and erosion.
- ✔ Separate the fertile or organic layer from the soil so that it can then be used, either within the same project or outside it, in soil restoration work. Specific sites for the deposition of these materials will be available for this measure but complying with dust and erosion control measures (plastic or other material covers).
- ✔ Green hedges are used as far as possible for slope containment.
- ✔ Appropriate drainage systems are installed to reduce runoff erosion.

- ✔ Containment systems for slopes or slope exposed surfaces, by geotextiles or other material that prevent direct exposure to rain dripping or wind are installed.
- ✔ Leftovers from the asphalt mixture must be collected and sent in dump trucks to the asphalt plant for recycling or final disposal.
- ✔ Soils intended for decompressions must be suitable for topography, drainage, texture, and so on, for the deposition of these materials and in accordance with the regulatory plan of each municipality.
- ✔ Equipment and machinery in good condition should be used to prevent oil spills.

10.1.2. Operative Stage.

Two potentially significant impacts were detected for the operational stage, as shown below:

- **Soil:**

Mainly the maintenance of the different works and the areas of the right of way, could generate a negative impact on the ground if not implemented properly. The renovation of the infrastructure also causes waterproofness on the ground.

Corrective measures:

- ✔ Solid waste should be disposed of in the same work site on a temporary basis, while placed in containers or on equipment arranged for such purposes.
- ✔ Avoid equipment and machinery maintenance activities within road areas that may generate hydrocarbon or fuel spillage.
- ✔ Use equipment in good condition and with proper mechanical maintenance.
- ✔ Train operational personnel for the good use of equipment and for efficient work in maintenance work.
- ✔ Recycle or reuse solid waste generated by maintenance activity or give them adequate treatment to deposit it at authorized sites.
- ✔ Avoid solid waste clusters on the right of track for periods longer than 24 hours. Waste from maintenance work must be collected immediately for transfer to authorized facilities.
- ✔ Avoid deposition of toxic or polluting materials over green areas or drainage.

- **Air Quality:**

A significant positive impact on air quality is expected by the replacement of diesel trains and locomotives with state-of-the-art electrical equipment. A reduction in the movement of private vehicles is also anticipated, by the implementation of a modern and efficient mass transport system, which will contribute to the reduction of greenhouse gas emissions. There will also be a decrease in noise levels, both from the one emitted by the rolling equipment in its operation, and by the virtually total elimination of the use of the train horn.

Enhancing measures:

- ✔ Generate a communication strategy to disclose the potential for reducing polluting emissions by switching from a diesel train to an electric system and the benefits that this brings to human health and well-being.
- ✔ Implement a protocol that promotes and facilitates intermodal transport, taking advantage of connections with various bus lines.
- ✔ Dialogue with owners of land or other properties near the stations to develop parking facilities for cars, motorcycles and bicycles, serving the population that uses individual means of transport. The purpose is to align incentives for more people to use the mass transit system and reduce the use of their particular vehicles.
- ✔ Maintain effective means of communication for citizens and train users, in case maintenance fronts are met and alternative transportation options are required.

10.2. Biotic medium.

10.2.1. Constructive Phase.

For the biotic medium, the following significant impact was identified:

- **Fauna:**

During the execution of the work there could be an indirect impact on the fauna of the area, due to the construction of civil works.

The work of shaping the construction spaces of civil works, the extension of lines and bridges, the construction of entrances, drainage and other complementary works, are elements that could cause various impacts during the construction phase. The effects temporarily, the result of habitat fragmentation, could manifest as the loss of food, shelter and nesting sources of some species of birds, reptiles and mammals.

Corrective measures:

- ✔ To make a gradual advance and by sections of the construction of the different structures of the work, which allows the migration of the existing fauna to areas conducive to the surrounding areas.
- ✔ Promote connectivity between protection zones in the way of corridors, either through artificial or natural wildlife crossings, where species can move through different zones. This is particularly important in the area where the project is located within the COBRI-SURAC Biological Corridor.
- ✔ Keep mobile latrines in good condition to prevent spillage of sewage and odors, away from drains or bodies of water.
- ✔ Maintain artificial coverings such as plastics or textiles on temporary deposits of solid waste to prevent leachate spillage or exposure of hazardous materials that are at risk to animals.
- ✔ Establish maintenance protocols for wastewater tanks or containers containing solid waste, to ensure the non-exit of leachates that harm aquatic life or existing animals.
- ✔ Maintain solid waste either organic or as a result of construction activity, in containers properly designated, labeled and with an airtight lid; pose a risk to existing wildlife.
- ✔ Establish protocols for the initiation of land movement or construction work, where prior verification of the non-presence of animals on work fronts or in the areas of opening of works is made to avoid damage or mortality. This protocol should include measures for the relocation of fauna that may be found on the frontlines.

  - **Flora:**

The execution of the work could have a direct impact on the existing flora, due to the elimination of vegetation, and the enabling of temporary buildings.

Constructive work entails a series of activities within the PA, including the elimination of vegetation, which occurs in a specific area (no trees are observed on the right of way, the need for short is limited) and with a non-cumulative effect, but with the time can be recovered. In the other works, such as the building of temporary works, it is considered moderate, depending on the conditions of coverage presented by the land selected for such works. The impact generated will require corrective measures that provide the restoration of altered spaces; otherwise it could create an imbalance to the environment of the project because of the ecological importance of plant cover.

Corrective measures:

- ✔ In the event that trees need to be cut, carry out all the legal procedures required for the project to comply with current regulations and under the consent of the state authorities.
- ✔ Advise of long-experienced forestry professionals, who guarantee an efficient process, both in the census of the existing forest mass and in the respective short permit procedures.
- ✔ The work of eliminating plant cover will be done mechanically and manually, no such work may be carried out through the use of agrochemicals or through controlled burning practices.
- ✔ For the elimination of trees in areas of protection of public domain channels, the respective permits of the Ministry of Environment and Energy and the Declaration of National Convenience of the Project must be available.
- ✔ Carry out the cutting of the trees with the supervision of forest engineers and complying with all the safety measures established for this type of operation.
- ✔ At the limits of the protection areas of rivers and ravines or at the limits of the right of way where it is not clearly displayed, the trees to be cut should be delimited with colored ribbons or paint so that it differs from those that are not to be cut.
- ✔ The limits of the area of removal of the plant cover should be clearly indicated in the field, using visible signals (colored or other ribbons), which allow to verify the limits of the cutting area. This protects the areas adjacent to the project by preventing machinery from entering those sites.
- ✔ Restore, as far as possible, the plant cover removed in some surrounding areas of the AP, through reforestation with native species to maintain ecological balance.
- ✔ Develop dismounting activities only at those strictly necessary sites (construction footprint).
- ✔ Promote as far as possible, the development and protection of the native species of the area, as part of the actions of protection and environmental development of the green areas located within the AP.
- ✔ Non-usable waste arising from the tree cutting process shall be removed from the right of way and deposited in areas clearly established for the treatment of such types of organic waste.
- ✔ Waste derived from tree cutting will not be burned in any of the cases, except with the authorization of the Ministry of Health.

- ✔ Establish and execute an arborization plan with native or native species with the aim of recovering the intervened areas, especially areas of protection of rivers and streams, giving a landscape sense to the stretches that allow a more organized arborization.
- ✔ The timbers resulting from the processes of disposal of plant cover will be destined for schools as stipulated by national legislation, the mechanisms used for the delivery of such goods will be carried out in a transparent manner by the competent authorities and reported by the national written and oral media.

10.2.2. Operative Stage.

Two significant impacts were detected for the operational stage, as shown below:

- Fauna:

The operational phase of the work could have an indirect impact on the fauna of the area, mainly due to the operation of the new train system, and in a more minor way, due to the activities and constant movements that are carried out in the maintenance work, that can scare away some species of birds, reptiles and mammals or generate a broader physical barrier that prevents the passage from one sector to another if corrective action is taken.

The fauna can be affected and driven away, due to the increase in the frequency of rail traffic. However, it should be reiterated that the project is built on an existing right of way, in some cases for more than 100 years, this being an already impacted area. The additional impact expected would be mild or low with respect to current conditions.

On the other hand, without adequate management of surface water discharges, it would create problems in the quality of the environment for some animals.

Corrective measures:

- ✔ Properly maintain equipment, auxiliary plants (if used), maintenance equipment for green areas and personnel transfer equipment so that they do not emit excessive noise during their operation.
- ✔ Give proper maintenance to wildlife passage or artificial connectivity structures at critical points identified by wildlife specialists.
- ✔ Ensure the proper functioning of established fauna crossing structures that allow better mobilization of the fauna species of the area.
- ✔ Avoid the use of loudspeakers or high-volume hearing media that can scare away local wildlife species.

- ✔ Establish mechanisms for the care of injured animals or facilitate specialized animal rescue institutions to assist cases of injured animals through coordination with national authorities.
- ✔ Signal areas or hotspots of wildlife passage using INCOFER-approved devices so that drivers are aware and more attentive to a potential collision with an animal.

10.3. Socio-economic environment.

10.3.1. Constructive Phase.

For the socio-economic environment, the following significant impacts were identified:

- **Heritage**

The project contemplates the restoration and maintenance of certain structured considered to be physical heritage, according to the Cultural Heritage Research and Conservation Center of the Ministry of Culture and Youth.

Enhancing Measures:

- ✔ Coordinate with Cultural Heritage Research and Conservation Center and other authorities for the design and preparation of blueprints, so that the renovation and maintenance of buildings is performed according to technical guidelines and other applicable norms.
- ✔ In case of doubt on the possible affectation to cultural heritage, prior consultation with the pertinent authorities must be carried out before proceeding with the works.

Comply with all recommendations of the restoration plan and submit the progress reports in the established period.

- **Landscape:**

The possible impacts that the landscape could experience would be due to vegetation removal, land movement, enabling temporary buildings, generating solid waste, and building civil works.

The landscape is irretrievably impacted, as it is intended to expand and rehabilitate a railway infrastructure project; however, by mainly affecting the existing right of way, it is expected to be moderately impacted. Given this, it is recommended:

Corrective measures:

- ✔ Recover, as far as possible, plant cover along the right of way and in the protection areas of the water bodies.
- ✔ Plan the work in such a way that the coverage presents in the AP and in the vicinity of the borders, serves as a buffer barrier to the landscape effects of the project.
- ✔ Sow native species of the area in areas that do not intervene with the project to mitigate the visual impact. Exotic species should not be introduced in order to preserve the biological quality of natural ecosystems.
- ✔ Perform ordered earth movements, in accordance with ground conditions and following technical guidelines to ensure stable slopes.
- ✔ Make earth movements only in the necessary sites and in the necessary quantities, without exceeding the dimensions stipulated by the designs of the work.

- **Employment, local economy and social welfare.**

The potential positive impacts that the project could generate during the construction phase are on the part of increasing employment, improving the local economy and social welfare, the product of the activities of the elimination of vegetation, movement of enabling temporary buildings, generating wastewater, generating solid waste and building civil works.

Enhancing measures:

- ✔ Hire staff from neighboring communities for different construction sites, vegetation removal, land movement, temporary building clearance and construction maintenance.
- ✔ Non-area project workers demand services such as food, lodging and recreation.
- ✔ Workers and local commerce in general receive economic income from services provided in accordance with national legislation and for the rental of real estate for the installation of temporary structures.
- ✔ Communicate any utility interference at least three days in advance.
- ✔ To pay attention to any complaint or discontent that the project's neighbors may have.
- ✔ Establish close coordination with local authorities such as Municipalities, the Fire Brigade, the Red Cross, the police authorities, the regional offices of the Ministry of the Environment and the Ministry of Health, as well as A and A, ICE, ESPH, JASEC, Local Emergency Commission and other community groups and NGOs, which could eventually provide some collaboration, when the development of the project could affect basic services or any of its components poses some unplanned risk.

- ✔ Demarcate well the areas of work, maintain the safety and prohibition measures of entry to individuals, maintain the order of the vehicle flow during construction work.
- ✔ Do not invade, or cause damage to the private land of the neighbors or communal, municipal or State properties during any constructive or logistical activity.
- ✔ Report alternative transport measures for current urban train users when there is a temporary suspension of service by construction activity.
- ✔ Communicate to the public about the location of work fronts or partial closures through oral and written means.
- ✔ Maintain good design of the works to allow entry to private, communal, state property; ensuring the safety of all users.
- ✔ Training of personnel in the different technical and operational areas.

10.3.2. Operative Phase.

For the socio-economic environment, the following significant impact was identified:

- **Heritage**

The project contemplates the restoration and maintenance of certain structured considered to be physical heritage, according to the Cultural Heritage Research and Conservation Center of the Ministry of Culture and Youth.

Enhancing measures:

- ✔ Promote and facilitate public access to heritage sites, as long as it is safe and convenient, to establish links between the community and its history and culture.
- ✔ If the heritage site is used for commercial purposes by any dimension of the project, public compensation measures must be implemented for said use, both in tangible (economic income) and intangible (education and awareness) terms.
- ✔ Maintain active supervision of all heritage sites, so that the operation and maintenance is carried out under a continuous improvement approach.

- **Landscape.**

The maintenance and operation of the train system can generate impacts on the landscape due to the permanent transformation of certain areas and the considerable increase in the frequency of service.

Corrective measures:

- ✔ With more lighting at intersections, stations, catenaries and other structures, the landscape will certainly be affected, although in the face of consultations some people perceive change as neutral or positive. As a mitigation, elements of landscape design can be incorporated through a joint work of architecture and the advice of professionals who can recommend the right species according to the ecological and aesthetic need.

- **Employment, local economy and social wellbeing.**

The potential positive impacts the project could experience on the employment, local economy and social welfare part would be due to the operation and maintenance of the project, wastewater generation, and solid waste generation.

Enhancing measures:

- ✔ Maintain well signposted the different intersections and routes to ensure the safety of users and avoid conflicts or accidents with vehicles and pedestrians.
- ✔ Keep the lighting system in good condition at junctions and intersections, such as in safety bays to avoid traffic accidents and problems of citizen insecurity.
- ✔ Carry out the proper maintenance of the works, in time of care and the quality of the work to ensure the fluidity of the new transport service.
- ✔ Explore potential productive linkages with other commercial or industrial activities near the TRP stations, to strengthen the links with the community and expand the benefits of the project beyond public transport.
- ✔ Implement an outreach program for new job opportunities, so that they are communicated in an inclusive manner, taking into account women, disabled people and other vulnerable groups.
- ✔ Provided that the requirements for the position are met, prioritize the hiring of inhabitants from the communities located in the TRP influence areas.
- ✔ For engineers and operators in charge of the rolling equipment, implement IFC protocols regarding rest and electric safety, to ensure that the operation and maintenance of the TRP is carried in a safe and secure manner.

11.ENVIRONMENTAL MANAGEMENT FORECAST-PLAN (P-PGA)

11.1. Project organization and implementer of measures.

In the summary table of the Environmental Management Plan, the proposed executor of the measures is presented in each case. These include the project developer, the contractor and responsible professionals such as the Environmental Regent.

A projection of the costs associated with the implementation of the different environmental measures proposed to mitigate or optimize, as appropriate, the potential impacts of the project is derived from the table of the Environmental Management Plan. These estimates are summarized in Annex 11. It should be noted that these amounts are preliminary estimates and that because of the development phase in which the project is located, it is impossible to make detailed calculation reports to determine with certainty the costs of each environmental measure. This analysis should be done in the Environmental Impact Study (EsIA), when progress has been made with engineering and design studies with a degree of detail that allows to establish, with greater certainty, the volumes associated with water consumption, extraction of materials , movement of machinery, equipment requirements and other development parameters of the TRP. For this Preliminary Environmental Study, the projections are based on what was observed in other infrastructure projects of similar scope and it is suggested a budget reserve be made for $9-10 million.

In addition, Annex 9 presents specific protocols related to land movements, road conflicts and the social awareness strategy of the TRP.

11.2. Environmental management forecast-plan.

The following table shows the Project's Environmental Management Forecast-Plan.

Impacting action	Impacted environmental factors	Socio-environmental impact	Related regulations	Mitigation or enhancing measures	Applica-tion time	Responsible Parties	Compliance indicators	Synthesis of environmental commitments
Dismount and Vegetation Removal Recovery of the right of way (demolition) Expropriations Temporary camps Enable sites for decompressions Transport of materials and equipment	• flora • Land and flying fauna • Landscape • Employment	• Affectation in terrestrial and flying fauna when losing spaces of foraging, food, shelter and perch. • Loss of plant cover. • Noise generation • Surface water pollution	• Forest Law (Law No. 7575) • Biodiversity Act (Act No. 7788) • Organic Law on the Environment (Law No. 7554) • Wildlife Conservation Act (Act No. 7317) • General Safety and Hygiene Regulations.	• Develop dismounting activities only in those strictly necessary sites. • Promote as far as possible, the development and protection of the native species of the area, as part of the actions of protection and environmental development of the areas of the right of way, maintaining or cultivating species of low size. • Trees to be removed must be identified and marked with colored ribbons, paint or others according to the permission granted. • All necessary precautions should be taken to protect the remaining trees in the AP from damage or mutilation. • Appropriate measures should be taken to avoid the supply of sediments and organic matter to nearby bodies of water and to the storm drainage network before initiating plant cover removal activities in heavy rainy periods. • Green areas within the AP are recovered with the planting of grass and ornamental plants. • Workers have personal safety equipment. • To abide by and respect Forest Law 7575 and Biodiversity Act 7788. • Eliminate only tree species that are strictly necessary. ✔ Prohibit any unauthorized cutting,	Stage Constructive. Operational Stage	• Developer • Construction company • Environmental Regent • Forest Regent	• The trees to be cut are clearly marked. • Short authorization will be available from MINAE. • Remaining trees have no injuries • No dead fauna is observed due to short-cut activities. • Waste is piled up in suitable places for later transfer. • Green areas are developed within the AP. • It is placed grass and plants ornaments. • 100% of the staff has the protective equipment and is monitored daily by the person in charge of occupational health. • Once a month, the RA will record compliance in the environmental log.	• Mitigation of the effect of activity on flora and other factors that could be impacted. • Cut trees with MINAE permission, conservation of coverage that does not require cutting. •

				extraction or marketing of floristic species. ✔ Avoid or minimize maintenance dismount in riverside areas. ✔ Perform the respective pruning along the right of way, using the corresponding safety equipment and apply environmentally friendly chemicals in the cuts made to avoid diseases in individuals.				
Earth movements	• Soils • Air quality • Landscape	• Particle and gas contami-nation. • Noise and vibration pollution. • Hydrocarbon spill contami-nation. • Increased erosive processes. • Loss of soil fertility. • Alteration of the storm drainage system. • Elimination of plant cover • Change in soil structure • Visual impact. • Affectation of wild species habitats.	• Soil Use, Management and Conservation Act (Act No. 7779) • Regulations to the Soil Use, Management and Conservation Act (No. 7779) • General Safety and Hygiene Regulations (No. 1). • Biodiversity Act (Act No. 7788) • Organic Law on the Environment (Law No. 7554) • Wildlife Conservation Act (Act No. 7317)	• Adapt the design of the project to the original characteristics of the terrain, trying to avoid unnecessary modifications in the topography. • Perform excavation only in areas where necessary according to the design. • Perimeter closure on fronts of work and/or proper and visible rotation. • Wet exposed surfaces, particularly during dry season, to prevent dust lifts. • The material resulting from earth movements must be moved or deposited in suitable sites with their respective contingency measures. • Any archaeological find within the AP is protected. • Areas where green areas will be allocated and organic soils are identified, promoting plant recovery. • Workers have personal safety equipment. • Follow the recommendations made in the Geotechnical Study regarding soil conditions and the most appropriate	Construction Phase	• Developer • Construction company • Environmental Regent	• Temporary sediment traps are built and cleaned once a week. • Vertical signage is warning the population of heavy machinery. • 100% of the wagons leave the AP with the tarp positioned correctly. • A record of reprimands for non-compliance with this measure is carried out. • Exposed surfaces are watered twice a day in case of high wind and dry conditions. The materials are covered with tarpaulins or plastics.	• Prevention of wind and water erosion of the soil.

		• Generating expectations, workplaces and the use of goods and services • Occupational hazards for the development of work in hazardous conditions.		type of foundations. • Comply with the current Costa Rica Seismic Code and Foundation Code. • Suitable cuts according to contours and with individual mitigating measures for each section of the work, emphasizing the sites with the highest slopes. • As far as possible perform earth movements in dry season. • Perform excavations by breaking, lifting and loading by means of the use of excavators, to minimize the presence of several machines. • Use cutting and filling practice. • Remove daily excavated materials that need to be replaced. • Use suitable material in fillers. • Prepare the floor of the taxing area for the wagons. • Protect, reinforce and point with red ribbons the periphery of excavations. • Condition the floor for the management of runoff, using ditches. • Form the AP ground bank at an appropriate level, to avoid erosion and sediment trawling. • Finish excavation works in the proposed time.				
Dismount and remove vegetation Earthworks Machinery movement	• Sonic quality	• Increased noise levels associated with different project activities.	• Noise Pollution Control Regulations (No.39951-S) • General Safety and Hygiene Regulations (No. 1).	• Activities will be carried out during the day so as not to affect the dynamics of the area. • Work that allows noise confinement will be performed in this way. • Breaks are made during workdays.	Construction phase Phase of Operation	• Developer • Construction company • Environmental Regent	• A perimeter temporary enclosure is used on the AP. • Noise protective equipment is used during cutting work.	• Activities are carried out during daytime hours; appropriate safety equipment is used for this purpose and noise is confined.

Noise and vibration Construction of works Station construction Track maintenance Operation of the new means of transport Maintenance yards							• Ballots are available for the registration of complaints • There is no inconvenience from the neighbors. • Barriers are installed to confine noise	
Dismount and remove vegetation Ground movement Dump sites Construction of works Station construction Track maintenance	• Air quality	• Generation of particles suspended in the air • Greenhouse gas emission of machinery present in the project area • Transporting equipment • Construction of works • Waste from operations on the AP • Waste from trains and passenger terminals	• Air Quality Regulations for Pollutants (No. 39951-S) • Noise Pollution Control Regulations (No. 39428-S)	• Wet work surfaces to prevent clouds of dust from rising from work areas, during periods of dry season or absence of rain in the area. • The perimeter is temporarily covered with some type of material that retains or decreases dust particles. • Protect with suitable materials, piles of ground debris, in order to prevent them from serving as a source of air pollution within the AP and its AID. • Cover the load of wagons to avoid dust generation. • To define adequate maintenance and adjustment, so that the machinery meets the requirements established by the current legislation (Vehicle Technical Review), and that, in this way, the minimum impact on the air is guaranteed. • Vehicles and machinery with anomalies at the gas outlet must be	Construction phase Phase of Operation	• Developer • Construction company • Environmental Regent	• No clouds of dust are observed. • There is no inconvenience from the neighbors. • Vehicles with RTV are checked per day. • No odors are felt from waste accumulation. • The ordinary solid waste collection service is available. •	• Maintain control of machinery, mechanical condition, up-to-date documentation

				removed from the Project area and repaired in a suitable location. • Ensure that waste is not burned. • Maintain proper disposal of waste.				
Dismount and remove vegetation Ground movement Dump sites Construction of works Drain disruption	• Surface water	• Possible spillage of hydrocarbons from vehicles associated with civil works, which could eventually affect surface water from runoff. • Contamination by sedimentary particles.	• Forest Law (Law No. 7575) • Biodiversity Act (Act No. 7788) • Organic Law on the Environment (Law No. 7554) • Wildlife Conservation Act (Act No. 7317) • Soil Use, Management and Conservation Act (Act No. 7779) • Regulations to the Soil Use,	• Use machinery in good condition. • Establish a preventive maintenance program for machinery. • Fuel supply on site only to machinery that cannot be removed from the AP. • Perform repairs in a waterproofed shed near the AP or search for a maintenance workshop near it. • Comply with the spill emergency prevention and care protocol. • Arrange containers for the collection of solid waste, which must be properly labeled. • Promote the classification of waste so that its reuse, recycling and its differential handling and disposition	Construction phase Phase of Operation	• Developer • Construction company • Environmental Regent	• Properly labeled containers for the collection and separation of solid waste are observed in the AP. • There is no sediment drag onto the receiving bodies. • Sediment trap systems work properly. • There is a protocol for spills and a team	• Reduce the risk of surface water contamination by sediment trawling, ordinary and construction waste and hydrocarbons.

Building bridges Solid waste generation Wastewater generation Maintenance yards Track maintenance Operation of the new means of transport		• Disruption of the local storm drainage system • Leached from ordinary waste • Waste of construction products	Management and Conservation Act • Water Act (Law No. 276) • Wastewater Discharge and Reuse Regulations (No. 33601)	are promoted according to their nature and degree of danger. • Avoid the development of the activity of earth movements during periods of heavy rain, in order to minimize the hauling of sediments from work areas to the receiving channels • Quick and timely finish of the work. • Implement the proposed mitigation measures for soil erosion. • Consider within the management, proposals related to earth movements, runoff control, good use and maintenance of machinery and occupational safety measures. • Keep existing coverages to the maximum. • Carry out earthworks activities during dry season. • Control water management through drainage systems, ditches, against ditches, energy sinks and barrier placement. • Integrate the building elements for the management of stormwater. • Machinery maintenance should be performed outside the AP, or at an appropriate site, where there is no risk of spillage, which can be driven to neighboring properties, or nearby bodies of water. • Request the relevant permits from the Water Department before any implementation of works in a public domain channel located in the vicinity of the AP.				

Handling liquid waste	• Soils • Human health • Surface water	• Affecting human health. • Surface water contamination by accumulation and release of substances.	• Water Act (Law No. 276) • Wastewater discharge and reuse regulations (No. 33601). • General Safety and Hygiene Regulations (No. 1).	• Implement a correct stormwater management system. • Enabling sanitary cabs from the start of construction • Proper maintenance of the wastewater treatment system.	Construction phase Phase of Operation	• Developer • Construction company • Environmental Regent	• Temporary sediment traps are built and cleaned once a week. • Sanitary sheds are placed and there is a maintenance contract in the AP office. • Monthly maintenance is given to the PT and a record is carried out in the administrative office.	• Proper management of ordinary wastewater.
Solid waste management	• Air quality, • Soils • Surface water, • Human health, • Basic services • Landscape	• Affecting human health by vector creation. • Affecting landscape by rubbish • Soil contamination by accumulation and release of chemicals. • Surface water contamination by accumulation and release of substances.	• Water Act (Law No. 276) • Ordinary Solid Waste Management Regulations (36093-S) • General Safety and Hygiene Regulations (No. 1).	• Place waste dumps for solid household waste in the work and snack area • Keep the dumpsters covered and protected from rain. • Transport debris in clogged wagons to an authorized final disposal site. • Separate recyclables and residual building materials. • Coordinate weekly with the collecting company for the collection and transportation of the material to its final deposit site. • At train stations, recycling batteries are placed	Construction phase Phase of Operation	• Developer • Environmental Regent	• There is a collection center for construction residual materials. • There are three dumpsters classified according to material type for ordinary solid waste. • The dumpsters have a lid and are protected from rain. • All wagons are covered with the AP and there is a record of warnings for non-compliance by the construction company.	• Proper management of solid waste during both stages.

							• There is no scattered trash inside the AP • Workers are aware of the recycling system and use it • The stations have waste batteries and are kept clean.	
Machinery movement	• Employment • Social welfare • Local economy • Heritage • Air quality • Sonic quality • Soil	• Air quality by dust particles and gases. • Sonic quality by noise emission by machinery carrying materials • Sedimentary particle pollution	• General Law on Public Roads (Law No. 5060) • Land Road Transit and Road Safety Act (Act No. 9078) • Intake of Air Pollutants Regulation (39951-S) • Noise Pollution Control Regulations (39428-S)	• Install heavy machinery inlet and outlet signs in accordance with current regulations • Use directional signals at the output and input to the AP • Use awnings in wagons to prevent falling material on public roads • Driving at low speed over the streets around the AP • No accidents caused by AP vehicles • There are no violations of the traffic law. • Trained personnel regulating traffic	Construction phase Phase of Operation	• Developer • Construction company • Environmental Regent	• Preventive signage (vertical signage) is placed. • There are no accidents related to the project's activities. • At the AP office, there is a person in charge of public service and complaints or inconvenience from neighbors are recorded in a log.	• Preventing any negative effects on road safety and inhabitants within the AID
General construction	• Local Economy • Employment • Landscape • Social property • Sonic quality • Social welfare • Fauna	• Changes in soil structure and chemical composition, creating the possibility of erosion. • Hygiene and human safety (communities/ workers) • Possible	• General Law on Drinking Water (Act No. 1364) • Construction Act (Law No. 833) • Urban Planning Act (Act 4240) • Soil Use, Management and Conservation Act (Act No. 7779) • Costa Rica Seismic	• Channel rainwater correctly from the start, to minimize soil washing and sediment trawling • Comply with all measures indicated for the General Operation (Occupational Health) • Temporary perimeter closure is placed to reduce visual impact. • Place clear and prominent warning signs on the working fronts. • There is a neighbor service office within the AP.	Construction phase	• Developer • Construction company • Environmental Regent	• The labeling is readable and visible to passers-by. • There is an office and a person in charge of attending external inquiries. • There is a log where queries from neighbors	• Mitigation of the Effect of waterproofing the soil and the landscape effect of the work. • Prevention of occupational accidents.

		modification of the surrounding landscape by the removal of vegetation and construction of new buildings, modification of habitat for land and air species. • Potential surface water contamination from oil spill, sedimented particles, wastewater and wastewater. • Possible affectation on human health by noise emissions, particulate matter, wastewater management and wastewater. • Risk of	Code (No. 37070)	• Machinery outputs are kept sediment-free. • Condition the green areas of the AP to improve the visual impact on the landscape. • Proper management of ordinary waste and wastewater. • Plan the work in such a way that the team present in the AP and in the vicinity of the borders, serves as a buffer barrier to the landscape effects of the project. • Perform orderly earth movements, in accordance with ground conditions and following technical guidelines to ensure stable terraces • Train workers in on-track personal safety procedures. • Implement action plans to address both potential and confirmed exposure levels.			and other individuals are logged. • There are no workplace accidents. • There is vertical signage warning the neighbors of the exit of heavy machinery. • In the AO office, there is a contingency plan in case of accidents. • There is a person responsible for occupational health/occupational safety performing daily inspections and log-scoring compliance or non-compliance with safety measures.	

		electrocution • Occupational accidents • Risks from seismic failure • Risk of volcanic eruptions • Riersgo sliding down slopes						
Operation of the new means of transport Railway infrastructure presence Maintenance yards Dismount and remove vegetation Maintaining the	• Local economy • Landscape • Social property • Employment • Heritage • Sonic quality • Air quality • Fauna • Surface water	• Possible impact on human health, landscape, surface channels and wildlife by improper management of ordinary waste. • Potential impact from wastewater management pollution on human health, wildlife, soil and surface water. • Risks for users and workers in the daily operation of the train.	• Labor Code (No. 6727) • Occupational Risks Act (Act No. 6727) • Regulations on the Approval and Operation of Wastewater Treatment Systems (No. 31545-S-MINAE). • Wastewater Dumping and Reuse Regulations (No. 33601)	• Implement an occupational health program • Have all the safety devices established by the Law (hull, vest, among others) • Having local health and emergency services phones • Apply the Contingency Plan in case of emergencies • Keeping your equipment always in good condition • Not allowing the use of bad equipment • Be aware of the measures by the gang • Giving proper training in professional risks • Train staff in the handling of equipment and machinery • Provide protective equipment to machinery operators that produces noise greater than 85 dB • Provide professional risk policies to all staff • Have protocols in case of	Operational phase	• Developer • Construction company • Environmental Regent	• Both the equipment and machinery are in good condition • The crew complies with safety measures • No workplace accidents • In the case of accidents, the response is quick and adequate • There is no ordinary waste in or around the AP • It has emergency protocols, accidents, etc. • Containers are available for the proper separation of waste.	• Accident prevention.

tracks				emergencies (natural accidents of traffic). • Design stations to ensure that the authorized route is safe, clearly marked, and easy to use. • Educate the population about the potential dangers of the project operation. • Establish recycling programs at local facilities (terminals and passenger stations), duly labeled.				

Impacts based on general AND rail IFC guides.

Table 11.1. Forecast-Environmental Management Plan of the Rapid Passenger Train project.

12. RISK ANALYSIS AND CONTINGENCY PLANS.

12.1. Types of risks and threats

The main risks of physical disasters and natural threats are described in depth in Chapter 6. Also presented is a series of maps corresponding to Annex 4, Geophysical Atlas of the TRP project.

In addition, Annex 7 presents zoning parameters in accordance with the SETENA approved Environmental Fragility Indexes for the Greater Metropolitan Area. IFAs determine the different vulnerability factors for different zones and make technical sustainability recommendations for proper land use.

12.2. Emergency Plan

Annex 10 presents a proposal for an Emergency Plan for the GAM Rapid Passenger Train Project. The proposal is based on current regulations and focuses on the general guidelines and protocols to be implemented by the project for the prevention and response to accidents during the development of the project.

This plan is presented in a general manner and should be completed with more detailed and specific measures as progressed with the development of studies and designs of the TRP.

The main risks of physical disasters and natural threats are described in depth in Chapter 6. Also presented is a series of maps corresponding to Annex 4, Atlas Geophysical of the TRP project.

In addition, Annex 7 presents zoning parameters in accordance with SETENA approved Environmental Fragility Indexes for the Greater Metropolitan Area. IFAs determine the different vulnerability factors for different zones and make technical sustainability recommendations for proper land use.

13. PA ENVIRONMENTAL QUALITY, BIOPHYSICAL AND SOCIAL INFLUENCE AREA.

Regarding the environmental quality in the AP, analyzed from the quality of life currently enjoyed by those who access this space, it should be recalled what is mentioned in Chapter 7 linked to the description of the socio-economic environment. Areas of social influence include communities of 15 counties in the four GAM provinces, which are located in the AID. They are communities where an important variety of productive activities are observed, from large-scale industry and services to small shops and agricultural plots. It should be reiterated that the indirect effect of the project can be extended to virtually all communities within the GAM and for this reason no IIA was specifically defined.

With regard to access to resources and services, quality of life can be considered as good as access to education, drinking water, health services, electrification and public transport. However, there are growing concerns about unemployment, cost of living and insecurity, which affect people's quality of life. A project such as the TRP can be a catalyst for economic activity at the regional level, generating chains that stimulate the creation of new jobs. The generation of opportunities and recovery of urban public spaces are key elements in the reduction of crime rates.

From a biological point of view, it can be said that the environment is predominantly urban and mixed, with a mixture of commercial, industrial, residential and even agricultural plots; you can see some areas with forest plantations or simply in regeneration (scrub), with some wooded patches located mainly in the protection areas of rivers and ravines. For this reason, diversity in both fauna and flora is characteristic of altered and recovering areas.

13.1. Forecasting the environmental quality of the area of biophysical and social influence.

The forecast of environmental quality in the area of social influence of the project involves various aspects to be taken into account.

Because of its scale and nature, the Project will generate various positive and negative impacts, which are perceived in the natural environment and surrounding communities, as can be seen in the previous chapters. It can be said that impacts on the construction stage, such as the removal of vegetation and earth movements, generate noise, dust and soil degradation, however, these are classified as momentary and reversible impacts. For these impacts, a number of prevention and mitigation measures are considered, to ensure the least possible impact on the social and biophysical environment. It should be mentioned that job creation and economic activity in the construction phase will bring significant benefits for the social environment.

The impacts in the operational stage have mainly to do with the operation and maintenance of the train system and its respective components, being of very low impact to the environment and to the biota of the area, especially if the recommendations are applied in steps of fauna and landscaping with native species. On the other hand, a number of benefits are foreseen for the communities surrounding the Project, such as the most efficient shuttle service, reduction of vehicle congestion and improvement in air quality; benefits that can impact far beyond areas of direct impact, as mentioned above. It is important to coordinate efforts to enhance the capacities of the inhabitants of the area, mainly people in vulnerability, so that they can be inserted into the social and commercial dynamics, and take advantage of the growth of their communities that can be generated through TRP.

13.2. Environmental commitments and project conclusions.

Below are the general conclusions of the Preliminary Environmental Study of the Rapid Passenger Train (TRP) Project, drawn up on the basis of the terms of reference dictated by INCOFER in Section 3 of Annex 1 of the Tender for *Technical, Economic-Financial, Environmental, Social and Vulnerability Studies for Construction, Equipment, Commissioning, Operation and Maintenance under the Modality of Public Works Concession with Public Service, of the Train System Greater Metropolitan Area Passenger Fast.*

The work carried out analyses the environmental and social feasibility of the TRP and, therefore, should not be confused with the definitive Environmental Impact Study (EsIA), which will be carried out by the future concessionaire and must be executed to obtain the Environmental Viability National Technical Secretariat (SETENA). Having said that, this study follows the guidelines of Resolution N^{or} 746-2018-SETENA, so that the Preliminary Environmental Study serves as a direct input for the eventual development of the definitive Environmental Impact Study.

It is important to bear in mind that the TRP project consists of the modernization and expansion of an existing rail transport service, therefore, the work to be carried out is on the same right of way, which is intended precisely to service could be expanded in the future, in line with the needs of cargo movement and people. Therefore, work will be carried out on a previously impacted area that is exposed day by day to the risks of impacts typical of a working train service. In this context, the TRP project is analyzed with respect to its interaction and interrelationship with the physical, biological and socio-economic environment. It also provides an analysis of potential threats of natural or anthropic origin in the project area.

This analysis allows to predict the potential impacts that could be generated on each of these components, and identify possible prevention, mitigation and/or remediation actions.

Spatial scope is defined as the physical, biological and socioeconomic environment within which the Project will be developed. For the purposes of this study, three geographical spaces are delimited for the assessment of potential impacts: the Project Area (AP), which corresponds to the current right of route area over the nearly 84,85 kilometers covering the different sections of the TRP and where the construction and operation phases will be carried out; the Direct Influence Area (AID), which is defined as the area that will potentially receive biological, physical, and social impacts directly; and the Indirect Influence Area (IA), where the impacts generated indirectly by the Project will be perceived. As noted above, these areas have already been impacted by the construction and operation of the railway currently existing.

The Rapid Passenger Train project consists of the main mass transit initiative currently under development in Costa Rica. It is a priority project for the Government of the Republic, as a strategy to alleviate road congestion in the most populated areas of the country, which also implies an increase in the economic competitiveness of the environment, improvements in the quality of life of and a decrease in air pollution. By moving from a diesel train and locomotive system to a state-of-the-art electrical system, a significant reduction in greenhouse gas emissions will also be achieved. It is for this reason that the TRP is one of the core projects of the National Decarbonization Plan 2018-2050.

The INCOFER as the executor of the work, is committed to that the development and operation of the FAST Passenger Train of the GAM is done in compliance with the highest quality standards and following the environmental standards in force for this type of project, both at the national level implementing international best practices. A focus on continuous improvement of the environmental and social management of their works will be maintained, always committed to receiving input and feedback from public and private entities related to the project, local governments, local organizations and leaders community, with the hope of incorporating into the development of tRP all those actions that are possible to improve the performance and ensure the safety of all its users during the life.

As part of its environmental guidelines, it is committed to providing adequate management of waste, both solid and liquid, to work on reducing air pollution, promoting the conservation of local fauna and flora, promoting health and safety implement protocols for reducing road and pedestrian accidents, reducing noise levels and managing disaster risks. This list is not exhaustive or definitive, it must be constantly adapted as other significant potential impacts occurring within the AP or its areas of influence are detected, in order to minimize the likelihood that they may affect adjacent ecosystems and neighboring populations.

In addition, once the construction work has been completed and the operation has been initiated, a balancing condition should be sought in the altered environment and measures should be applied to recover soils and vegetation on all work fronts and areas where they placed the temporary complementary works, in order to reduce the impacts to the future while improving the remaining landscape. INCOFER shall establish the relevant controls to direct the prospective concessionaire and other undertakings contributing to the construction and operation of the TRP, in order to develop the works in compliance with the relevant environmental legislation, always maintaining a sustainable development perspective. INCOFER will maintain the appropriate communication channels to deal with third-party complaints against any contractor working on behalf of the institution on the railway or in the surrounding areas.

During all phases of the project, specialized professionals should be maintained to ensure compliance with the environmental commitments stipulated in this preliminary study and in the future Environmental Impact Study. These professionals shall have the capacity and willingness to serve the competent authorities or other stakeholders interested in the social and environmental management of the project's construction and operation activities.

This Preliminary Environmental Study is developed on the basis of national legislation, general and sectoral guidelines on the environment, health and safety for railways of the World Bank and the IFC Performance Standards, incorporating the natural, biotic and socio-economic physical components of the project's area of influence, as well as impacts, measures and environmental-social management programs.

As noted above, the layout of the right of way identified by INCOFER is analyzed in the pre-feasibility study prepared by L.C.R. Logística S.A. (November 2016 report, scenario 2A) and redefined in the Value Engineering Study IDOM (Final Report 2018), in the light of the conclusions drawn from the diagnosis and the identified impacts in this process.

This preliminary study includes:

- An explanation of the procedures and requirements needed to comply with Costa Rican environmental legislation and international standards, including those of the World Bank, the Central American Bank for Economic Integration and the FVC.

- The identification, analysis and characterization of the environmental and social impacts generated by the actions of the project throughout the proposed route.

- The determination and approach, at the preliminary level, of general and specific environmental and social measures and works aimed at the prevention, mitigation, correction and/or compensation of negative environmental and social impacts, in such a way that these can be integrated into engineering designs and tender specifications.

Several types of environmental issues are distinguished that can be associated with the construction and operation of a railway system. In the specific case of the Fast Passenger Train which will run for track rights already in existence for more than 100 years and which arises from a conception of the use of that right of track to install in it a modern electric train. This new train replaces the current system that uses obsolete, noisy, unsafe and unsafe equipment, moved to diesel, by modern machines and cars powered by electricity. All current tracks that are narrow track width, full of irregularities and slopes throughout the route are changed, lines mostly at ballast level and some perfectly balanced and renewed plotted plate sections, which meets l strict standards required, in all these areas, by the railways today.

For this analysis, the Guidelines for Environmental, Health and Safety Railways of the International Finance Corporation (IFC) of the World Bank were taken into account and integrated into the Environmental, Health and Safety Railway Guides of the International Finance Corporation (IFC):

- In terms of habitat alteration and fragmentation it can be ensured that this fragmentation and alteration occurred more than a century ago, and although in some of the sections contemplated, they are not in use today, the negative impact is very low, especially taking in consideration of the benefits that the new system will bring. It should be noted that most of the route of the train is done within the urban environment.
- In emissions into the atmosphere there will be a drastic reduction in these as the train will use renewable electricity as a source of energy power.
- In reference to fuel handling, for the same reason above, it will be reduced to a minimum and if required will be in the selected places for workshops and patios in a very controlled way.
- In relation to wastewater, the main wastewater emission points shall be the stations and areas of workshops and parking of rolling stock. Stations and workshops, as

well as TRP offices and other buildings will have wastewater disposal systems that comply with applicable national regulations and standards. Similarly, in the control yards and rolling stock parking areas, drainage and disposal systems for stormwater and wastewater shall be included as required.

- The other waste from the different stages of construction and operation will be arranged in such a way as to comply fully with the respective national regulations and international standards. The TRP should aim to be a clean train in every way.
- The current train noise level is very high, as it is not only engine noise, but noise from the interaction of the rolling equipment with the irregularities of the current railway. Noise is now spreading both into the external environment and inside the wagons. When all equipment currently operating is replaced by electric propulsion systems and modern design, this noise will be greatly reduced. One of the main sources of noise at present is the horn that given the current operating conditions, in areas where neither the different types of vehicles that drive on the surrounding routes or that cross the railway, nor pedestrians respect the free movement of the train, for safety reasons the driver is honking his horn almost continuously to alert the train. In terms of noise for passengers, the improvement of the environment will also be a lot, since the new rolling equipment will be hermetically closed and isolated from noise produced by the train itself and also by external factors.

Although the area of direct influence of the Rapid Passenger Train is impacted environmentally and socially, since it would be executed on the current railway there is no fact that the project has given the socio-environmental viability, this is one of the studies more complex and timeless, because it requires the mediation and negotiation of the parties involved and the interests are diverse so developing a transparent and orderly process is essential to avoid legal conflicts that involve the implementation of the Project.

It is important to mention that, since the end of 2017, INCOFER processes the Environmental Impact Assessment before SETENA under file N^{or} D1-21743-2017. The Terms of Reference issued by the Secretariat in resolutionNo. 746-2018-SETENA, lay down the specific requirements for the Environmental Impact Study (EsIA) of the Project. It was agreed with INCOFER that this feasibility work would generally follow the terms of reference dictated by SETENA, in order to provide a direct input for the development of the EsIA, which will be carried out by the future concessionaire when the TRP project at that stage of development.

The social process for the construction of the TRP requires close institutional coordination between competent entities such as MIVAH, IMAS, PANI, CONAPAN, CONAPDIS, INAMU, Ombudsman's Office, Municipalities among others, given the sensitivity of relocation, expropriation and demolition of structures, currently 20 informal settlements on the right of way are identified, so there must be planning, alternative solutions, but above all good communication with the involved and human sensitivity to carry the project on good terms.

Among the main expected effects of this project are the improvement in the quality of life of people, as it reduces travel times, polluting emissions, the increase the daily capacity of passenger transport, as well as the saving of money, it is estimated that, on each route, the TRP could transport up to 1,000 people and reduce traffic by between 250 and 1,000 vehicles per day according to the Presidency of the Republic.

The urban train currently operating in Costa Rica is a well-received alternative by the public. However, it offers the same service speed as buses and private vehicles, which causes you to lose competitive advantage that is characteristic of this system, the Fast Passenger Train would come to remedy this situation would already have a higher speed and so the better transfer times.

The system would have an 84,85-kilometer extension and its direct influence is over 15 counties and 45 GAM districts. Together with the TRP, the interconnection of mass transit networks, which provide greater coverage and accessibility, should be created or strengthened, this means establishing cross-sectoral routes mainly of buses.

As indicated at the outset, this Preliminary Environmental Study was carried out always bearing in mind that the project consists of the extension of an existing route, and that the work will be carried out on the same right of way, therefore, work will be done on an area previously impacted and that is exposed day by day to the risks of impacts typical of a railway in operation. Having conducted an analysis of the factors that can potentially further impact both the Project area and areas of direct and indirect influence, it follows that the positive impacts far outweigh the negative impacts, and that the project is therefore socially and environmentally viable. The positive impact of the project will be increased with the implementation of preventive and mitigation measures that are established at the time of preparing the Environmental Impact Study, which together with socio-economic measures, will bring large benefits for communities surrounding the TRP, such as for the provinces of Carthage, San José, Heredia and Alajuela, and for the country in general.

With regard to mitigation measures, this work focuses on the impacts of significance on the natural and social environment. According to the indicator of potential impacts, resources that would have a significant negative potential impact if the corresponding mitigation measures were not taken, in the case of negative impacts, or if their effects are potentialized in the case positive are:

- Flora and fauna.
- Surface and groundwater.
- Air quality.
- Soils.
- Employment.
- Local economy.
- Landscape.
- Social welfare.

A variety of mitigation measures have been listed in this analysis of the various environmental components. The synthesis of environmental commitments for each of them is presented in the Project's Environmental Management Plan Forecast table. Preliminarily, an estimate of the cost of implementing environmental measures is made, but it is important to emphasize that these projections are merely indicative; actual costs can only be determined when the details of the final designs are taken and the field studies are carried out with greater depth. By way of reference, for all these mitigation measures in an infrastructure project of similar dimensions, the extension of Route 32 between Rio Frio and Limón, a reserve of $10 million is budgeted.

This project is of great importance and importance for the development of the country, and in particular for the Greater Metropolitan Area, because it contributes, in a great way, to solving the problems of transporting people and congestion of all GAM routes, helps progress towards meeting the national and international climate change targets and is of significant social benefit as it positively affects a large number of people who are solving the problem of safe and efficient daily transport.

The TRP project also has an enormous potential to be a dynamic work of the national economy, because it represents a very important investment in infrastructure, the productive chains that this generates and the creation of employment opportunities, both directly and indirectly. Preliminary estimates can be made based on the GAM TRP feasibility study carried out and the experience of the professional team in other projects of similar scope, in order to be able to specify a figure for the employment generated by the project. It is estimated that around 1,200 people will need to be hired throughout the construction process, particularly if work is to be carried out on different fronts simultaneously. As for the operational phase, it is anticipated that 1,460 direct posts will be required (700 in operation, 700 maintenance and 60 administration). The recommendation of the Gender Action Plan (Annex 8) should also be followed and a strategy designed to facilitate women's access to the employment opportunities that will arise from the construction and operation of the TRP.

For these reasons it is considered that the Rapid Passenger Train Project should be declared as a work of public interest and national expediency, thus allowing public units to participate in a certain stage of management and implementation of the project, or in stages after the construction of the project, give it priority and preferential procedure.

14. BIBLIOGRAPHY

ABARCA, A. (2013). Percepción de los usuarios del servicio de transporte tren, Costa Rica, Mayo de 2012. *Revista Ciencias Económicas 31 (1)*, 169-179.

ACEVEDO, H.; BUSTAMANTE, J.; PANIAGUA, L.; CHAVES, R., 2002: Ecosistemas de la cuenca hidrográfica del Río Savegre Costa Rica.- 352 págs. Editorial INBIO (1ª Edición), Costa Rica.

AGUILAR, T., 1998: Revista Geológica de América Central Nº 21: Primer hallazgo de Serpulidos (Rotulana Clymenoides) en el Eoceno de Costa Rica. - págs. 61-67, Editorial de la Univ. de Costa Rica, San José.

ALPIZAR, R., 1995: Estudio Geológico Integral de Distrito San Roque y alrededores, Cantón de Grecia Provincia de Alajuela, Costa Rica., 80 págs. Univ. de Costa Rica. (Camp. Geológ).

ALVARADO, E., 1994: Estudio Geológico Ambiental y Estratigrafía de la Región Oeste de San Ramón parte de la Hoja San Ramón Escala 1:10 000 Alajuela, Costa Rica., 55 págs. Univ. de Costa Rica. (Camp. Geológ).

ALVARADO, G.E., VEGA, E. CHAVES, J. & VASQUEZ, M., 2004: Revista Geológica de América Central Nº 30: Los grandes deslizamientos (volcánicos) de tipo debris avalanche en Costa Rica. 83-99 págs. Editorial de la Univ. de Costa Rica, San José.

ALVARADO, G. E.; VEGA, E.; CHAVES, J. & VÁSQUEZ, M., 2004: Revista Geológica de América Central Nº 30: Los grandes deslizamientos de tipo debris avalanche en Costa Rica. 83-99 págs. Editorial de la Univ. de Costa Rica, San José.

ARAYA, A., 2000: Revista Informe Semestral Vol. 36: Aspectos del ordenamiento ambiental dirigidos al manejo de cuencas hidrográficas.-95 págs. Instituto Geográfico Nacional.

ARCE, R. 2004. Resumen Diagnóstico Cuenca Reventazón. ECHO-Comisión Europea, UNICEF, CNE, RN. 15 pp En la red: http://www.cne.go.cr/CEDO-Riesgo/docs/2655/2655.pdf

ARIAS, O. & DENYER, P., 1991: Revista Geológica de América Central Nº 12: Estructura geológica de la región comprendida en las hojas topográficas Abra, Caraigres, Candelaria y Rio Grande, Costa Rica. 61-74 págs. Editorial de la Univ. de Costa Rica, San José.

ARIAS, O. & DENYER, P., 1991: Revista Geológica de América Central Nº 12: Aspectos neotectónicos y geológicos de Puriscal y alrededores. -págs. 83-95, Editorial de la Univ. de Costa Rica, San José.

ARREDONDO, S. & SOTO, G., 2006: Revista Geológica de América Central Nº 34-35: Edad de las lavas del Miembro Los Bambinos y sumario cronoestratigráfico de la Formación Barva. 59-71 págs. Editorial de la Univ. de Costa Rica, San José.

ARIAS, O. & DENYER, P., 1994: Revista Geológica de América Central Nº 17: Compresión y dilatación norte-sur en el suroeste del Valle Central, Costa Rica. 85-94 págs. Editorial de la Univ. de Costa Rica, San José.

ASTORGA, A., FERNÁNDEZ, A., BARBOZA, G., CAMPOS, L., OBANDO, J., AGUILAR, A. & OBANDO, L. (1989): Cuencas Sedimentarias de Costa Rica: Evolución Cretácico Superior-Cenozoica y Potencial de Hidrocarburos. Symposium on the Energy and Mineral Potential of the Central American-Caribbean Region, San José, Costa Rica, March 6-9, 1989, Circumpacific Council: 23 p.

ASTORGA, A., FERNÁNDEZ, A., BARBOZA, G., CAMPOS, L., OBANDO, J., AGUILAR, A. & OBANDO, L. (1991): Cuencas sedimentarias de Costa Rica: evolución geodinámica y potencial de hidrocarburos. – Revista Geológica de América Central, 13: 25 -59.

ASTORGA, A.; FERNANDEZ, J.A.; BARBOZA, G.; CAMPOS, L.; OBANDO, J.; AGUILAR, A. & OBANDO, L.G; 1995: Sedimentary basins of Costa Rica: Late Mesozoic-Cenozoic evolution and hydrocarbon potential. -Circum-Pacific Council for Energy and Mineral Resources, Earth Science Series, 16. MILLER, R.L.; ESCALANTE, G., REINEMUND, J.A. & BERGIN, M.J. (EDS.): Energy and Mineral Potential of the Central American-Caribbean Region. Springer-Verlag, Berlin.

ASTORGA, A., CAMPOS, L. (2001): El cartografiado de geoaptitud de los terrenos (Mecanismo catalizador para sintetizar y facilitar la contribución de las Ciencias Geológicas en el Ordenamiento Territorial).- Revista Geológica de América Central, 24, 103 - 110.Astorga, A. (1997): El puente-istmo de América Central y la evolución de la Placa Caribe (con énfasis en el Mesozoico).- Profil, 12: 1-201; Stuttgart (Alemania).

ASTORGA, A., 2003: Revista Geológica de América Central Nº 29: Mapa de geoaptitud hidrogeológica de Costa Rica: Implicaciones respecto a la gestión ambiental de desarrollo. -págs. 95-101., Editorial de la Univ. de Costa Rica, San José.

AVILA, M., 1984: Geología y microsismisidad de San Ignacio de Acosta y alrededores (sur oeste del Valle Central de Costa Rica).- 33 págs. Univ. de Costa Rica, San José. (Tesis Lic.)

BARRANTES, M., 1991: Revista Geológica de América Central Nº 12: Comentarios Petrográficos de algunas rocas aflorantes en la Región Central de Costa Rica. -págs. 75-82, Editorial de la Univ. de Costa Rica, San José.

BAUMGARTNER, P. & DENYER, P., 2006: Evidence for middle Cretaceous accretion at Santa Elena Peninsula (Santa Rosa Accretionary Complex), Costa Rica.- 341 págs. Universidad de Costa Rica, San José.

BERGOEING, J. P. & MALAVASI, E., 1981: Carta Geomorfológica del Valle Central de Costa Rica: Hoja Abra, Escala: 1:50 000. Instituto Geográfico Nacional.

BERGOEING, J. P. & MALAVASI, E., 1981: Carta Geomorfológica del Valle Central de Costa Rica: Hoja Barba, Escala: 1:50 000. Instituto Geográfico Nacional.

BERGOEING, J. P. & MALAVASI, E., 1981: Carta Geomorfológica del Valle Central de Costa Rica: Hoja Río Grande, Escala: 1:50 000. Instituto Geográfico Nacional.

BERGOEING, J. P & BRENES, L. G., 1983: Sistema Fluvial de Tárcoles: Mapa Geomorfológico, Escala 1:200 000, Instituto Geográfico Nacional

Bergoing, J.P. (1998): Geomorfología de Costa Rica. Instituto Geográfico Nacional de Costa Rica, 415 p.

BERRANGÉ, J. P., 1992: The Osa Group: An auriferous Pliocene sedimentary unit from the Osa Peninsula, southern Costa Rica. 67-93 págs. Editorial de la Univ. de Costa Rica, San José.

BRENES, J., 2003: Geología y peligros volcánicos del flanco oeste y suroeste del Volcán Barva, Costa Rica.- 82 págs. Univ. de Costa Rica, San José. (Tesis Lic.)

Burgos, R. 2002. Geo Costa Rica: una perspectiva sobre el medio ambiente 2002. PNUMA- MINAE. Ed. Observatorio del Desarrollo Universidad de Costa Rica. San José, Costa Rica 161 pp

Campos, L. (2001): Geology and Basins history of Middle Costa Rica: An intraoceanic island arc in the convergente between the Caribbean and the Central Pacific Plates. Tübinger Geowissenschftliche Arbeiten (TGA), Band 62, 138 p.

CARBALLO, M.A., 1978: La Formación San Miguel (Mioceno Inferior; Costa Rica).- 113 págs. Univ. Costa Rica, San José. (Tesis Lic.).

Carballo, M.& Fischer, R. (1978): La Formación San Miguel.- Ministerio de Obras Públicas y Transporte, Inst. Geog. Nacional, Informe Semestral - Enero a Junio, 48-144.

CARRILLO, S. & CARRILLO, M., 2004: Estudio de la Amenaza de Inestabilidad de Laderas y Estimación Preliminar de la Vulnerabilidad en la Cuenca del Río Purires, Provincia de Cartago, Costa Rica: Informe de Avance.- 71 págs. Univ. de Costa Rica, San José. (Tesis Lic.).

CASTILLO, R., 1969: Geología de los mapas básicos Abra y partes de Río Grande, Costa Rica.- 14 págs. Univ. de Costa Rica.

CASTRO, A. L., 1999: Caracterización Hidrogeológica y manejo de los recursos hídricos en la cuenca alta del Río Tibás Macizo Zurquí, Valle Central Costa Rica.- 164 págs. Universidad de Costa Rica, San José. (Tesis Magister Scientiae).

CASTRO, J. F., 1977: Geología de zona comprendida entre San Miguel-Alto Burío, Cantones Aserrí-Desamparados.- 21 págs. Univ. Costa Rica, San José. (Bach.)

CENIGA-MINAE, 2006: Atlas de Datos Fundamentales.- 146 págs. Imprenta Nacional, Versión Nº2, San José, Costa Rica.

CHAVES, C. & AVILES, L., 1993: Estudio geológico integral de la hoja topográfica Cirrí Alajuela, Costa Rica.- 153 págs. Univ. de Costa Rica, San José. (Campaña Geológica)

CHÁVEZ, J., 1976: Geología de una parte de la hoja abra.- 12 págs. Univ. Costa Rica, San José. (Bach.)

COMISION NACIONAL DE EMERGENCIA, DIRECCION DE PLANES Y OPERACIONES Y COMITE REIONAL DE EMERGENCIAS CARTAGO, 1991: Plan Regional de Emergencias (Plan piloto preliminar).-108 págs.

CORPORACIÓN FINANCIERA INTERNACIONAL (IFC). (2007) Guías sobre medio ambiente, salud y seguridad para ferrocarriles. Recuperado de https://www.ifc.org/wps/wcm/connect/71afa7804885596b82fcd26a6515bb18/0000199659ESes%2BRailways%2B%2Brev%2Bcc.pdf?MOD=AJPERES

DEMETS, C., GORDON, R.G., ARGUS, D.F. & STEIN, S. (1990): Current plate motions.- Geophysical Journal International, 101: 425-478.

DENGO, G. (1985): Mid America; tectonic setting for the Pacific margin from southern Mexico to northwest Columbia.- In: Nairn, A.E.M. & Stehli, F.G. (Eds.) (1985): The ocean basins and margins, Vol. 7, 123-180.

DENGO ET AL. (2016): Estudio de Impacto Ambiental: Proyecto Ampliación de Ruta Nacional No. 32, Sección entre intersección de Ruta No. 4 y Limón. CDG Environmental Advisors.

DENYER, P. & MONTERO, W., 1989: Mapa Geo-Estructural y Sismo del Valle Central.- 24 págs. Instituto Geográfico Nacional. San José, Costa Rica.

DENYER, P. & ARIAS, O., 1990: Geología de la Hoja Abra. Escala 1: 50 000. Litografiado por el Instituto Geográfico Nacional.

DENYER, P. & ARIAS, O., 1990: Geología de la Hoja Río Grande. Escala 1: 50 000. Litografiado por el Instituto Geográfico Nacional.

DENYER, P. & ARIAS, O., 1991: Revista Geológica de América Central Nº 12: Estratigrafía de la región central de Costa Rica. -págs. 1-59, Editorial de la Univ. de Costa Rica, San José.

DENYER, P. & KUSSMAUL, S., 1994: Atlas Geológico- Gran Area Metropolitana. -275 págs, Editorial Tecnológica. de Costa Rica.

DENYER, P. & SOTO, G.J., 2000: Revista Geológica de América Central Nº 23: Análisis de los trabajos geológicos de William M. Gabb sobre Costa Rica, a la luz del paradigma geológico del siglo XIX. - 97-118 págs., Editorial de la Univ. de Costa Rica, San José.

DENYER, P.; MONTERO, W.; ALVARADO, G., 2003: Atlas tectónico de Costa Rica.- 79 págs. Editorial de la Univ. de Costa Rica, San José.

DENYER, P. & ALVARADO, G., 2003: Mapa Geológico de Costa Rica 2007.- Escala 1:400 000. Librería Francesa .

DIRECCIÓN DE GEOLOGÍA, MINAS E HIDROCARBUROS, 1983: Sistema fluvial de Tárcoles, Escala 1:200 000. Instituto Geográfico Nacional.

DONDOLI, C., 1972: Información general geológico-petrográfica y mineralógica sobre Costa Rica.- 18 págs. Univ. de Costa Rica, San José.

EAE BUSINESS SCHOOL. (S.F.) Transporte intermodal: presente y futuro. Recuperado de http://www.transcontvalencia.com/documentos/B0893-EAE-Transporte-intermodal-presente-y-futuro.pdf

ECHANDI, E., 1981: Unidades volcánicas de la vertiente norte de la cuenca del Río Virilla.- 123 págs. Univ. de Costa Rica, San José. (Tesis Lic.)

ECHANDI, E., 1983: Sistema fluvial de Tárcoles; Mapa Hidrogeológico, 1: 200 000. Instituto Geográfico Nacional.

ESPINOZA C.E. Y R. VILLALTA 2004. Primera Etapa del Plan de Manejo Integral del Recurso Hídrico: La Estrategia nacional para la GIRH en Costa Rica. (ATN/WP 8467-CR) Estudio de caso sobre la contaminación de la cuenca de los Ríos Virilla y Grande de Tárcoles (Cuenca 24). MINAE 28pp En la red: http://www.drh.go.cr/texto/Estudio_de_caso_Rio_Tarcoles.pdf

FERNANDEZ, M., 1996/1997: Revista Geológica de América Central Nº 19/20: Evaluación del hipotético sistema de falla transcurrente este-oeste de Costa Rica - págs. 57-74, Editorial de la Univ. de Costa Rica, San José.

FERNANDEZ, M. PACHECO, J. & MORALES, T., 1996/1997: Revista Geológica de América Central Nº 19/20: Complejidad de la estructura sísmica de la región central de Costa Rica según un análisis multifractal - págs. 29-36, Editorial de la Univ. de Costa Rica, San José.

FERNANDEZ, M. & PACHECO, J., 1998: Revista Geológica de América Central Nº 21: Sismotectónica de la región central de Costa Rica. - págs. 5-23, Editorial de la Univ. de Costa Rica, San José.

FERNANDEZ, M., MORA, M. & BARQUERO, R., 1998: Revista Geológica de América Central Nº 21: Los procesos sísmicos en el volcán Irazú (Costa Rica). - págs. 47-59, Editorial de la Univ. de Costa Rica, San José.

Fischer, R. & Franco, J. (1979): La Formación Coris (Mioceno, Valle Central, Costa Rica).- Ministerio de Obras Públicas y Transporte, Inst. Geog. Nacional, Informe Semestral - Enero a Junio, 15-71.

FITZPATRICK, E. A., 1978: Introducción a las ciencias del suelo.- 197 págs. Publicaciones, Cultural S.A. México.

FITZPATRICK, E. A., 1984: Suelos: su formación, clasificación y distribución.- 430 págs. Compañía Editorial Continental, S.A. de C.V., México.

FLORES, H., HERNANDEZ, E. & VEGA, E., 1988: Cartografiado geológico de parte de las Hojas de Abra y Río Grande (Ciudad Colón y alrededores, C. R.)., 50 págs., Univ. de Costa Rica.

FLORES, W., 1997: Identificación y análisis de los procesos erosivos en la subcuenca del Río Uruca.- 120 págs. Univ. Nacional, Heredia, Costa Rica. (Tesis Lic.).

FONDO MUNDIAL PARA EL MEDIO AMBIENTE (GEF). (2009). *Invertir en el transporte urbano sostenible: La experiencia del FMAM*. Recuperado de https://www.thegef.org/sites/default/files/publications/urban-transport-ES_0_3.pdf

GALVEZ, M., 1988: Geología de Candelarita y sus alrededores Provincia de San José, Costa Rica.-36 págs., Univ. de Costa Rica, San José. (Camp. Geológ.).

GRAHAM, G., 1996: Nitrate Attenuation Beneath Two Coffee Plantations in the Central Valley of Costa Rica.- 82 págs. University of Waterloo, Ontario, Canada. (Thesis Master of Science)

GOMEZ, D., 2002: Ordenación Territorial.-704 págs. Agrícola Española S.A.

GOMEZ, M.; SOLIS, L., 2001: Inestabilidad de taludes: Estudio de suelos, San Antonio de Coronado. Univ. Costa Rica, San José. (TCU)

GUTIERREZ, A. & REYES, M. (2017). Mujeres entre la libertad y la obligación. Prácticas de movilidad cotidiana en el Gran Buenos Aires. Revista *Transporte y Territorio (16)*, 147-166.

HERRERA, I.R., 1990: Geoquímica Ambiental y Geopedología de los suelos de una parte del Valle Central Occidental, Provincia de Alajuela, Costa Rica.-302 págs. Univ. de Costa Rica, San José. (Tesis Lic.).

HERRERA, J., 1977: Geología de la zona sur y oeste de Ciudad Colón.- 29 págs. Univ. de Costa Rica, San José. (Bach.)

HIDALGO, P. J.; ALVARADO, G. E. & LINKIMER, L., 2004: Revista Geológica de América Central Nº 30: La lavina del Valle Central (Costa Rica): ¿lahar o debris avalanche? 101-109 págs. Editorial de la Univ. de Costa Rica, San José.

HOFFSTETTER, R.; DENGO, G.; WEYL, R., s.a.: Costa Rica con un Mapa. 224-295 págs.

Holdridge, L. 2000. Ecología: basada en zonas de vida. Instituto Interamericano de Cooperación para la Agricultura, 1996. Ed. IICA. San José, Costa Rica. 216 pp

HONORATO, R., 2000: Manual de Edafología.- 267 págs., Alfaomega Grupo Editor

INGEOSA, 1991: Estudio Neotectónico de la Urbanización Paraíso Industrial, Cartago, Costa Rica.-55 págs., Ministerio de Vivienda y Asentamientos Humanos, Comisión Especial de Vivienda , Comisión Nacional de Emergencia.

INSTITUTO GEOGRÁFICO NACIONAL, 1967: Hoja Barva, Escala 1:50 000. Litografiado por el Instituto Geográfico Nacional.

INSTITUTO GEOGRÁFICO NACIONAL, 1988: Zonas de vida de Costa Rica, Escala 1:200 000. Instituto Geográfico Nacional.

INSTITUTO COSTARRICENSE DE FERROCARRILES. (2018). *Informe Anual de Estadísticas Operativas*. Recuperado de http://www.incofer.go.cr/wp-content/uploads/2018/01/Informe_Final_Estadistica_Operativas_2017.pdf?x28024

INSTITUTO METEOROLÓGICO NACIONAL (2005). Clima en Costa Rica Valle Central. MINAE. En la red: http://www.imn.ac.cr/educacion/climacr/index.html

INEC. "Costa Rica: Cálculo de Población por provincia, cantón y distrito al 1 de enero de 1999". San José, Costa Rica: Ministerio de Economía Industria y Comercio, Instituto Nacional de Estadística y Censos (INEC), Sección Estadísticas Vitales; 1999.

IFAM. "Atlas cantonal de Costa Rica". San José, Costa Rica: Instituto de Fomento y Asesoría Municipal (IFAM); 1987.

IFAM. "Cantones de Costa Rica: datos básicos". 6ª Edición. San José, Costa Rica: Instituto de Fomento y Asesoría Municipal (IFAM); 1992.

INSTITUTO VASCO DE LA MUJER. (2013). *La Evaluación de Impacto en Función del género en el Transporte y la Movilidad*. Recuperado de http://www.emakunde.euskadi.eus/contenidos/informacion/politicas_evaluaciones_2/es_def/adjuntos/materiales.sectoriales.transporte.y.movilidad.pdf

KAPPELLE, M., CASTRO, M., ACEVEDO, H., GONZÁLEZ L. Y MONGE H. (2002). Ecosistemas del Área de Conservación Osa (ACOSA). Heredia, Costa Rica. Ed. INBio 496 pp

KNOBLICH, K. & MANZ, E., 1993: Revista Geológica de América Central Nº 16: Discusión sobre los sitios para los vertederos de desechos sólidos de San José (Costa Rica). - págs. 95-101, Editorial de la Univ. de Costa Rica, San José.

KUNIEDA, M. & GAUTHIER, A. (2007*). Género y transporte: Inteligente y Asequible. Texto de Referencia para formuladores de políticas públicas en ciudades de desarrollo*. Bogotá, Colombia: Editorial Carlos F. Pardo.

LAURITO, C., 1993: Revista Geológica de América Central Nº 16: Revisión del Toxodonte de Bajo de los Barrantes (Prov. de Alajuela, Costa Rica).- págs. 61-68. Editorial de la Univ. Costa Rica, San José.

LAURITO, C., 2003: Revista Geológica de América Central Nº 29: Roedores fósiles del Pleistoceno Superior de la localidad La Palmera de San Carlos, provincia de Alajuela Costa Rica .- págs. 43-52. Editorial de la Univ. Costa Rica, San José.

LEÓN, C.; LEANDRO, G.; GRANADOS, R.; TORRES, C., 1981: Estudios de deslizamientos en margen derecho de Río Chiquito de Tres Ríos.- 29 págs.

LOPEZ, A., 1975: Geología de la hoja Abra, provincia de San José, Costa Rica.- 23 págs. Univ. Costa Rica, San José. (Bach.)

MAG (1995): Metodología para la determinación de la Capacidad de Uso de las Tierras de Costa Rica.- 60p., San José, Costa Rica.

MADRIGAL, O., 1975: Geología de una parte de la hoja de Río Grande.- 24 págs. Univ. Costa Rica, San José. (Bach.)

MALAVASI, E. & SUAREZ, A., 1953: Estudio Geológico del Macizo de la Carpintera.-57 págs. Univ. Costa Rica, San José. (Tesis Lic.).

MALAVASI, L., 1977: Geología de área comprendida entre San Miguel-Poás, Cantones Desamparados-Aserrí.- 27 págs. Univ. Costa Rica, San José. (Bach.)

MANUALES PARA EDUCACION AGROPECUARIA, 1997: Suelos y Fertilización (basado en el trabajo de H.A. Graetz).- 80 págs., Editorial Trillas, México

MENDE, A. (2001): Sedimente und Architektur der Forearc-und Backarc-Becken von Südost-Costa Rica und Nordwest-Panamá.- Profil 19, 1-130, Stuttgart (Alemania).

MINISTERIO DE OBRAS PÚBLICAS Y TRANSPORTE (MOPT) (2013). Estudio de Impacto Ambiental Ruta Nacional No. 257 Sección Sandoval – Moín. Elaborado por la Unidad de Gestión Ambiental y Social (UGAS) de la Dirección de Planificación Sectorial.

MINISTERIO DE TRANSPORTE Y TELECOMUNICACIÓN (MTT). (2018). *Política de Equidad de Género en Transporte*. Recuperado de https://www.mtt.gob.cl/wp-content/uploads/2018/06/Politica_Equidad_Genero_Transportes.pdf

MINISTERIO DE VIVIENDA Y ASENTAMIENTOS HUMANOS (2006). Geo Gran área metropolitana del Valle Central de Costa Rica: Perspectivas del medio ambiente urbano 2006. MIVAH, MINAE, PNUMA. 1ed. San José, Costa Rica. MINAE, 2006. 268pp

MINISTERIO DE VIVIENDA Y ASENTAMIENTOS HUMANOS (MIVAH). (2012). *Informe de actualización de la Base de datos de asentamientos en condición de precario y tugurio de Costa Rica, al año 2012*. San Jose, Costa Rica.

MONTERO, W.; OBANDO, L.; MORA, R.; SALAZAR, L.; LEANDRO, G., 1991: Informe Final: Proyectos habitacionales los diques y duarco-suerre. - 72 págs. Univ. Costa Rica, San José.

MONTERO, W.; PANIAGUA, S.; KUSSMAUL, S. & RIVIER, F., 1992: Revista Geológica de América Central Nº 14: Geodinámica interna de Costa Rica. 1-12 págs. Editorial de la Univ. Costa Rica, San José.

MONTERO, W., 2001: Revista Geológica de América Central Nº 24: Neotectónica de la Región Central de Costa Rica: Frontera oeste de la microplaca de Panamá. 29-56 págs, Editorial de la Univ. Costa Rica, San José.

MONTERO, W., BARAHONA, M., ROJAS, W. & TAYLOR, M., 2005: Revista Geológica de América Central Nº 33: Los sistemas de falla Agua Caliente y Río Azul y relevos compresivos asociados, Valle Central de Costa Rica . - 7-27 págs, Editorial de la Univ. Costa Rica, San José.

MONTERO, W. & KRUSE, S., 2006: Revista Geológica de América Central Nº 34-35: Neotectónica y geofísica de la falla Agua Caliente en los valles Coris y del Guarco. - 43-58 págs, Editorial de la Univ. Costa Rica, San José.

MONTIEL, M. 2000. Introducción a la Flora de Costa Rica. Esbozo Fitogeográfico de Costa Rica. Luis A. Fournier. Escuela de Biología. Universidad de Costa Rica. Ed. UCR. San José, Costa Rica. 19-32 p

MORA, M., 1995: Estudio geológico de un sector al sureste del cantón de Grecia provincia Alajuela, Costa Rica.- 107 págs. Univ. de Costa Rica, San José.

MORA, R., 1992: Revista Geológica de América Central Nº 14: Análisis probabilístico de caudales poico para la estación El Humo, cuenca Reventazón- Parismina, Costa Rica. 13-37 págs. Editorial de la Univ. Costa Rica, San José.

MORA, R., 1993: Proyecto de Geología Urbana del Gran Área Metropolitana: Cantón de Alajuelita.- 60 págs. Univ. de Costa Rica, San José.

MORA, R., 1996/1997: Revista Geológica de América Central Nº 19/20: Modificaciones en el estado de esfuerzos y cálculo de la capacidad de carga admisible de una toba meteorizada. Santo Domingo, Heredia, Costa Rica: Caso cimentación circular - págs. 145-153, Editorial de la Univ. de Costa Rica, San José.

MORA, R., 1998: Revista Geológica de América Central Nº 21: Propiedades físicas, hidráulicas y mecánicas de suelos de origen volcánico, en sitios seleccionados del Valle Central, Costa Rica., págs.. 81-98. Editorial de la Univ. de Costa Rica, San José.

MORA, R. & VARGAS, A., 2001: Revista Geológica de América Central Nº 25: Características geotécnicas e hidrogeológicas de sitios propuestos como rellenos sanitarios en Costa Rica. págs. 63-76. Editorial de la Univ. de Costa Rica, San José.

MORA, R., 2002: Estabilidad de las márgenes de la quebrada Ipís a su paso por la urbanización Setillal, Ipis, Giocoechea, Costa Rica.- 14 págs. Univ. Costa Rica, San José. (TCU)

MORA, R. A., 2003: Contenido de metales pesados en los sedimentos de los ríos y quebradas adyacentes al relleno de Río Azul, Río Azul, San José, Costa Rica.- 101 págs. Univ. Costa Rica, San José. (Tesis de grado)

MORA, R.; RAMIREZ, C. & FERNANDEZ, M., 2004: Revista Geológica de América Central Nº30: Resumen de la actividad de los volcanes de la Cordillera Central, Costa Rica, entre 1998 y 2002 . 189-197 págs. Editorial de la Univ. de Costa Rica, San José.

MORA, R., 2000: Revista Geológica de América Central Nº 23: La variación de la posición del nivel freático y su influencia en la capacidad de carga de cimentaciones superficiales: caso zapata corrida infinita en un suelo de origen volcánico, Juan Viñas, Cartago, Costa Rica.-págs. 17-23 págs. Editorial de la Univ. de Costa Rica, San José.

MORA, S., ALVARADO, G. & MORALES, 1992: Revista Geográfica de América Central Nº 25 y 26, Mapa preliminar sintético de amenazas geológicas de Costa Rica, su importancia en el desarrollo de la infraestructura civil., págs. 355-371.

MORA, S. (2014). Hogares en asentamientos informales en Costa Rica: quiénes son y cómo viven. *Notas de Población (99)*, 107-132.

MORA-ULATE, 2000: Estudio de los procesos de flujo y transporte de contaminantes en la zona no saturada tobácea del botadero de basura de Santo Domingo, provincia de Heredia, Valle Central de Costa Rica.- 160 págs. Universidad de Costa Rica, San José. (Tesis Maestría)

MORALES, L. D. & MONTERO, W., 1984: Revista Geológica de América Central: Los temblores sentidos en Costa Rica durante: 1973-1983, y su relación con la sismicidad del país. 29-56 págs. Editorial de la Univ. Costa Rica, San José.

MORALES, L. D., MONTERO, W. & MADRIGAL, R., 1992: Revista Geográfica de América Central Nº25 y 26, El Terremoto de Fraijanes de 1888 y el sistema de fallas de Alajuela, implicaciones del peligro sísmico potencial para el Valle Central Occidental. págs. 227-240.

MOUTHON, A. F.; BLANCO, A. R.; ACEVEDO, G. A.; MILLER, J., 2002: Manual de evaluación de estudios ambientales.- 252 págs. Servigraphic Ltda. Bogotá, Colombia.Manso, P., Stolz W. y Fallas J.C. 2005. El régimen de la precipitación en Costa Rica. IMN. AMBIENTICO. Escuela de Ciencias Ambientales Universidad Nacional. Edición Septiembre del 2005. San José, Costa Rica. Pp. 7-8

OBANDO, L.G., 2004: Revista Geológica de América Central Nº 30 Geología y petrografía del cerro Buenavista (Cerro de la Muerte) y alrededores. - págs. 31-39, Editorial de la Univ. de Costa Rica, San José

OBANDO, L., BOTTAZZI, G. & ALVARADO, F. (1994): Depósitos costeros del Mioceno medio y superior del Valle Central (Costa Rica, Valle Central).- Profil 7, 335-349, Stuttgart (Alemania).

ORGANIZACIÓN DE LAS NACIONES UNIDAS (ONU). (2017). *Género y transporte: experiencias y visiones de política pública en América Latina*. Santiago, Chile: ONU.

PERALDO, G. & MOLINA, F., 1993: Revista Geológica de América Central Nº 16: Reconstrucción histórica del deslizamiento de Santiago de Puriscal. - págs. 85-94, Editorial de la Univ. de Costa Rica, San José.

PÉREZ, S. & VAN GINNEKEN, P., 1978: Capacidad de uso del suelo: Limón, escala 1:200 000. Intituto Geográfico Nacional de Costa Rica.

PINILLA, G., 1992: Geoquímica regional de las hojas Abra y Barba, Valle Central, Costa Rica.- 101 págs., Univ. de Costa Rica, San José. (Tesis Lic.).

PROGRAMA DE INVESTIGACIÓN EN DESARROLLO URBANO SOSTENIBLE DE LA UNIVERSIDAD DE COSTA RICA (PRODUS). (2016). *Estudio de demanda de pasajeros y estudio de satisfacción de los usuarios de transporte remunerado de personas, modalidad ferrocarril, prestado por el Instituto Costarricense de Ferrocarriles en las rutas de Pavas, Heredia, Cartago y Belén*. Estudio técnico. San Jose, Costa Rica.

PROGRAMA ESTADO DE LA NACIÓN (PEN). (2005). *Undécimo Informe Estado de la Nación en Desarrollo Humano Sostenible*. San José, Costa Rica.

PROTTI, R., 1996/1997: Revista Geológica de América Central Nº 19/20: Evidencias de glaciación en el Valle del General (Costa Rica) durante el Pleistoceno Tardío. - págs. 75-86, Editorial de la Univ. de Costa Rica, San José.

PROTTI, R., 1996/1997: Revista Geológica de América Central Nº 19/20: Monitoreo de desplazamientos a lo largo de la falla La Garita (Costa Rica) entre marzo y diciembre de 1990. - págs. 183-185, Editorial de la Univ. de Costa Rica, San José.

QUESADA, J.D., 1986: Estudio Geológico de los alrededores La Esperanza, Pejibaye de Jiménez, Cartago, Costa Rica -36 págs., Univ. de Costa Rica, San José. (Camp. Geológ.)

RAMIREZ, P., 2006: Revista Geológica de América Central Nº 34-35: Caracterización de la dinámica de flujo mediante la aplicación de un modelo numérico hidrogeológico. Caso de la cuenca del Río Birrís - págs. 83-97, Editorial de la Univ. de Costa Rica, San José.

RAMIREZ, R., SANTANA, G. & CHACON, O., 1996/1997: Revista Geológica de América Central Nº 19/20: Mapa de amplificación sísmica del Valle Central, Costa Rica - págs. 37-55, Editorial de la Univ. de Costa Rica, San José.

RAMIREZ, R. & ALFARO, A., 2002: Revista Geológica de América Central Nº 27: Mapa de vulnerabilidad hidrogeológico de una parte del Valle Central de Costa Rica - págs. 53-59, Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: ICE-UCR, 1986: Revista Geológica de América Central Nº5: Resumen de la actividad sísmica y volcánica de Costa Rica. 103-108 págs. Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: ICE-UCR, 1987: Revista Geológica de América Central Nº6: Resumen de la actividad sísmica y volcánica de Costa Rica. 121-126 págs. Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: ICE-UCR, 1988: Revista Geológica de América Central Nº10: Resumen de la actividad sísmica y volcánica de Costa Rica. 101-106 págs. Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: ICE-UCR, 1989: Revista Geológica de América Central Nº11: Resumen de la actividad sísmica y volcánica de Costa Rica. 99-104 págs. Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: ICE-UCR, 1992: Revista Geológica de América Central Nº14: Resumen de la actividad sísmica y volcánica de Costa Rica en 1991. 97-101 págs. Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: ICE-UCR, 1994: Revista Geológica de América Central Nº 17: Resumen de la actividad sísmica y volcánica de Costa Rica en 1993. 105-107 págs. Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: (RSN: ICE-UCR) 1996/1997: Revista Geológica de América Central Nº 19/20: Resumen de la actividad sísmica y volcánica de Costa Rica en 1995- págs. 187-191, Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: ICE-UCR, 1998: Revista Geológica de América Central Nº 21: Resumen de la actividad sísmica y volcánica de Costa Rica en 1996. 105-109 págs. Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: (RSN: UCR-ICE), 2001: Revista Geológica de América Central Nº 25: Actividad sísmica y volcánica 1997-2000. 107-113 págs. Editorial de la Univ. de Costa Rica, San José.

RED SISMOLÓGICA NACIONAL: ICE-UCR, 2002: Revista Geológica de América Central Nº26: Resumen de la actividad sísmica y volcánica de Costa Rica durante el año 2001. 101-105 págs. Editorial de la Univ. de Costa Rica, San José.

ROJAS, J. F., 1976: Geología de una parte de la hoja abra.- 12 págs. Univ. Costa Rica, San José. (Bach.).

ROJAS, F. 2005. Principales especies forestales introducidas en Costa Rica. Kurú: Revista Forestal (Costa Rica) 2(4), 2005. Instituto Tecnológico de Costa Rica. Cartago, Costa Rica. 13pp en la red: http://www.itcr.ac.cr/revistakuru/anteriores/anterior4/pdf/nota3.pdf

SALAZAR, J.H., 1995: Estudio Geológico Ambiental de la Hoja Topográfica Puente Piedra 3346-lll-19 y alrededores (escala 1:10 000) Cantón de Grecia Provincia Alajuela, Costa Rica.-97 págs. Univ. Costa Rica, San José. (Camp. Geológ.).

SALAZAR, L. G., OBANDO, L. & MORA, R., 1992: Revista Geológica de América Central Nº 14: Acueducto Metropolitano, tramo embalse El Lano – Río Navarro

(Costa Rica): Un sitio bajo amenaza. 85-96 págs. Editorial de la Univ. de Costa Rica, San José.

SANDOVAL, F., 1971: Geología de una parte de la Región Noreste del Valle Central (Hoja Grecia).-14 págs., Informes Técnicos y Notas Geológicas Nº 44, Dirección de Geología Minas y Petróleo.

SANDOVAL, L. P.; SAENZ, R.; ACUÑA, J.; CASTRO, J. F.; GÓMEZ, M.; LÓPEZ, A.; MEDEROS, B.; MONGE, A.; VARGAS, J. E.; FERNÁNDEZ, T.; ULATE, R.; RAMÍREZ, C., 1982: Mapa Geológico de Costa Rica: Limón, Escala 1:200 000. Instituto Geográfico Nacional.

SAVITSKY, B. G.; TARBOX, D. P. & VAN BLARICOM, D., 1995: Habitats de Costa Rica, Escala 1:500 000. Programa de Cooperación de Ciencias y Tecnología de la Oficina del Asesor de Ciencias de la Agencia Internacional para el Desarrollo de los Estados Unidos. (USAID).

SCHOSINSKY, G., 1998: Revista Geológica de América Central Nº 21: Modelo de flujo para la zona no saturada: ZONOSA.- págs. 69-80, Editorial de la Univ. de Costa Rica, San José.

SCHOSINSKY, G. & LOSILLA, M., 2000: Revista Geológica de América Central Nº 23: Modelo analítico para determinar la infiltración de agua con base en la lluvia mensual.- págs. 43-55, Editorial de la Univ. de Costa Rica, San José.

SCHOSINSKY, G. & VARGAS, A., 2001: Revista Geológica de América Central Nº 24: Hidrogeología de un sector de la margen izquierda del Río Virilla, provincia de San José, Costa Rica.- págs. 93-102 Editorial de la Univ. de Costa Rica, San José.

SCHOSINSKY, G.; VARGAS, A., & STIMSON, J., 2001: Revista Geológica de América Central Nº 25: Orígenes de contaminación de aguas subterráneas en un sector de la margen izquierda del río Virilla, San José, Costa Rica.- págs. 85-92 Editorial de la Univ. de Costa Rica, San José.

SOLÍS, O., 2005: Clima de Heredia.- 29 págs. Univ. Nacional. Heredia, Costa Rica.

SOTO, G. & ALVARADO, G., 2004: Revista Geológica de América Central Nº30: La Vulcanología y su entorno ambiental.- 226 págs. Editorial de la Univ. de Costa Rica, San José.

SOTO, G. & PANIAGUA, S., 1992: Revista Geográfica de América Central Nº 25 y 26, La Cordillera Volcánica Central (Costa Rica): sus peligros potenciales y prevenciones págs. 291-304.

SPRECHMANN, P., 1984: Manual de Geología de Costa Rica, Volumen 1: Estratigrafía, -320 págs.- Editorial Universidad de Costa Rica, San José, Costa Rica.

VAHRSON, W.-G. & CARTIN, N., 1992: Revista Geográfica de América Central Nº25 y 26, Deslizamientos en la cuenca media y superior del Río Reventado, Cartago, Costa Rica. págs. 171-192.

Valerio, C. 1999. Costa Rica: ambiente y biodiversidad. Heredia, Costa Rica. Ed. INBio 139 pp.

VARGAS, A., 1996/1997: Revista Geológica de América Central Nº 19/20: Ventajas del proceso de reforestación sobre la atenuación de la erosión y propuesta de protección y desarrollo de un área de recarga en el Valle Central - págs. 155-165, Editorial de la Univ. de Costa Rica, San José.

VARGAS, A., 1998: Revista Geológica de América Central Nº 21: Balance hídrico en la cuenca alta del Río Reventazón, Costa Rica.- págs. 37-46., Editorial de la Univ. Costa Rica, San José.

VARGAS, A., 2001: Revista Geológica de América Central Nº 24: Contribución a la geología y geomorfología de una parte del cantón de Coronado; Costa Rica.- págs. 67-78., Editorial de la Univ. Costa Rica, San José.

VARGAS, A., 2002: Revista Geológica de América Central Nº 27: Manantiales de una parte del Valle Central de Costa Rica.- págs. 39-52., Editorial de la Univ. Costa Rica, San José.

VARGAS, A. & AGUILAR, T., 2002: Revista Geológica de América Central Nº 27: Impacto de la variabilidad climática sobre la recarga a los acuíferos en la cuenca del río Poás, Valle Central, Costa Rica.- págs. 75-83., Editorial de la Univ. Costa Rica, San José.

VEGA, L. M. & VALERIO, J., 2002: Análisis del crecimiento urbano del Área Metropolitana de San José.- 187 págs. Univ. Nacional, Heredia, Costa Rica. (Tesis Lic.)

VILLEGAS, A., 1994: Geología de una parte de la Hoja Oratorio 3346-III-12, Provincia Alajuela, Costa Rica, 130 págs. Univ. de Costa Rica, San José. (Camp. Geológ.).

VILLEGAS, A., 2004: Revista Geológica de América Central Nº 30: La Formación Alto Palomo: flujos pumíticos de la Cordillera Volcánica Central, Costa Rica. 73-81 págs. Editorial de la Univ. de Costa Rica, San José.

ZUCCHINI, E. (2015). Género y transporte: análisis de la movilidad del cuidado como punto de partida para construir una base de conocimiento más amplia de los patrones de movilidad. El caso de Madrid. Tesis Doctoral. Madrid, España: Universidad Politécnica de Madrid.

15. ANNEXES

Annex 1. Procedure for water harvesting and extraction

The Rapid Passenger Train (TRP) project crosses about 50 public domain channels. All of these channels are crossed by bridges of various sizes, some of which have been in service for more than 100 years. They are channels whose basins are very populated and in which are the main cities of the Great Metropolitan Area (GAM) and in which urban development has generated the waterproofing of important percentages of the area thereof.

Many of these rivers go in very deep canyons that make the extraction of water from them unfeasible. Other of these bodies of water are highly contaminated so the potential for use of their waters is very limited.

- It is important to note that throughout the tRP path there is availability of drinking water pipes of different calibers. The INCOFER shall, for all tasks that require high quality water, use these sources of supply as far as possible. To do this, the respective arrangements must be made with the Costa Rican Institute of Aqueducts and Sewers (AyA) or the relevant ASADAS. It is very important, then, to leave water requests only for those cases where there is no appropriate source in the vicinity of the point of use. This avoids the complicated procedures for applying for water concessions to the MinaE Water Directorate.

- For other purposes, such as dust containment, irrigation and the likeapplications, the Environmental Impact Studywill cover all possible water intake points along the entire length of the railway Projected. This study will serve as a general reference framework for all project activities. In addition, detailed information will be presented for each shooting point, including the geographical coordinates, the period of use of each of the points, the flows to be extracted, the use and average flow of the corresponding river at the point of extraction of the water , including references to the historical record used and methodology for calculating these average flows and ecological flows.

- Given the nature of the project, the issue of concessions for the use of water during construction should be presented by means of a table including all rivers and with detailed data from each takeover point on each river, including periods of activity scheduled for each of those points. In this way the Water Directorate will give a single authorization for the whole project.

- It is important, in the period near the start of construction, that a fluid line of communication be established between INCOFER and MINAE to establish a framework of commitment and cooperation to provide maximum support to the management and processing of works in a course and that of water use during construction.

1. The request for water extraction from rivers and creeks along the Fast Passenger Train (TRP) journey shall be made on the basis of the conditions of use and quantities set out in the Commission Agreement Plenary of SETENA on the amendment to Resolution 2373-2016-SETENA VERY LOW IMPACT PROJECTS, ACP-030-2018-SETENA. The requested water uses must be adjusted, given the nature of the project which can be classified as very low environmental impact in terms of water use, flow rates to be extracted from low channels and temporary extraction, in order to accelerate the procedures for obtaining concessions for the temporary use of water collected from public domain channels that are crossed by the right of the Fast Passenger Train (TRP). There should be no case where the requested flow rates exceed 74 cubic meters per day indicated as the maximum limit in that document. The following are the most important aspects of the SETENA Plenary Committee Agreement mentioned above:

"NINTH: That according to the criterion of the Directorate of Waters of MINAE (DA-275-2018), according to the historical record of that unit, in water authorizations for irrigation of roads, the public entities that are subjects of this extractive activity, are the Ministry of Public Works and Transport (MOPT), the National Road Council (CONAVI) and the Municipalities, which concludes that there is a total maximum demand for all the catches, corresponding to a daily volume of 74000 liters...

In addition, the extraction has special characteristics, differentiated from other water uses, such as:

There is no alteration of the channel or water as long as there is no permanent derivation of water by means of stable civil works within the channel.

• It is extracted by means of portable pumping system and small mackerel.

It is not a permanent extraction, on the contrary, it is an exploitation of displaced events in the 24 hours.

• Water is extracted to fill tanks or tanks of predefined volume.

• The extraction flow rate is punctual per event.

• Extraction time of one hour on average.

Not all events are concentrated in a single river, but in several, as the extraction is carried out scheduled according to the progress of the repair, extension or keeping of the road or road.

TENTH: That, within the framework of its competences, the Water Directorate of MINAE, must issue a resolution with a technical recommendation to the Minister for its assessment and signature, the priority of the intervention of the public domain channel for the use in the process of repair and maintenance, both national routes (roads - highways) and municipalities, (roads), in accordance with Article 17 of the Water Law No. 276. This technical recommendation by the Water Directorate shall provide for the requirements established by that administrative unit.

ELEVENTH. That, from the point of view of environmental assessment, it is possible to consider the activity described in the previous recitals, as of very low environmental impact (in the indicated flow and volume, as if by its temporality), as the temporary use of water captured from public domain channels to be transported by means of cisterns, for conditioning and mitigation work, as well as for complementary works of the same development activity, since the effects they are limited to what is stated in recital no. In addition, please note that, even in the case of a work with very low environmental impact, it must be subject to the controls provided by the MINAE Water Directorate, for authorisation.

TWELFE: Likewise, this Committee considers that they can be considered as very low-impact works in public domain channels, small-sized works, which aims at civil protection in single-family homes or with some productive development of subsistence, sewer steps in access to public or internal properties with lengths not greater than 10 meters, repair and maintenance of protective walls that protect or containment in land with housing affected, which were affected by erosion or landslides, due to extraordinary floods or seisms.

For its part, it is understood as activities of very low environmental impact the activity of cleaning channels, understood as the extraction of trees, logs, large rocks, or objects outside the river and deposited on the firm floor of the riverbed, which prevent the free circulation of water. Cleaning in that it should not mediate the activity of collection neither the floor nor walls of the riverbed. These are minor interventions in the way of the urgent need and technical verification of the existence of a risk to the life of people and infrastructure such as housing, public works such as schools, hospitals, health centers, sports, prisons, among others.

In the two above cases and in the event of a risk, there must be prior to resolving by the Water Directorate, technical report emissed by professionals of the National Commission for Risk Prevention and Emergency Care (CNE), so that the works raised by the applicant are in line with the respective report.

This concludes that sewer passage works no larger than 10 meters, the repair and maintenance of protective walls or containment of land with adjoining properties, cleaning of channels (extraction of trees, logs large rocks size, or objects outside the river and deposited on the firm floor of the channel without gathering), can be classified as works of Very Low Environmental Impact.

THEREFORE, THE PLENARY COMMITTEE RESOLVES

In Ordinary Session No. 25 -2018 of this Secretariat, held on 13 March 2018, Article No. 029 agrees:

FIRST: Under the competence conferred by Law No. 7554 to this Secretariat, it is amended and added to resolution No. 2373-2017-SETENA, of the 15 hours 00 minutes of December 21, 2016, regarding environmental assessment for activities, works or projects for which a very low potential environmental impact has been determined, so that its provisions are read in accordance with the amendments made to the General Regulations on Environmental Impact Assessment Procedures (EIA), Decree Executive No. Executive Decree No. 31849-MINAE-S-MOPT-MAG-MEIC, as amended and added by Executive Decree No. 37803-MINAE-S-MOPT-MAG-MEIC, of July 17, 2013.

SECOND: Modify Article 5 to:

"Article 5.- Activities. Activities, works or projects that do not require an Environmental Impact Assessment are as follows:

51. Temporary extraction of water, not always in the same channel of public domain, or at the same point of extraction of water for the irrigation of roads and roads (public road work), being complementary activities as the works of public infrastructure, whose demand does not exceed a maximum daily volume of 74000 liters, equivalent to a flow rate of 0.21 liters/second, with special characteristics dictated by the Water Directorate. 52. Cleaning of channels understood as the extraction of trees, logs, large rocks, or objects outside the river and deposited on the firm floor of the channel, which prevent the free circulation of water. Cleaning that should not mediate the activity of re-digging or the floor or walls of the public domain channel.

53. Sewer passage works no more than 20 metres, repair and maintenance of protective walls or containment of land with adjoining properties, cleaning of waterways (extraction of trees, large rock logs, or other objects to the river and deposited on the firm floor of the channel without any retraction)".

- Hydrological studies required for the design of the works related to bridges and sewers of the project should provide information on average and ecological flow rates for each of the points at which water extraction is planned.

- Occasionally a document applying for water extraction permits will be prepared for different uses in the right of way and which meet the requirements of RESOLUTION 2373-2016 of SETENA as modified in ACP-030-2018. This document should include three tables, the first with information on the water intake points and volumes to be extracted, the second with the flow data to be granted compared to the average and ecological flow rates for each point, and the third with the schedule d and construction of each of the bridges and similar works.

- Water extractions shall be carried out by means of pumps, always ensuring that no amounts of water greaterthan those set out in the SETENA Resolution indicated above are extracted. At each extraction point, a water extraction log will be held in which the extracted volumes will be recorded each day.

- The water of each of these points will be used in the construction work of the extraction site and in addition, at other stages of the construction process, water will be transported by means of cisterns for dust suppression and irrigation works, among others. The INCOFER shall inform the Water Directorate of the time when work requiring water transport will be initiated, as well as a detailed list of trucks or tank cars to be used for this purpose and their characteristics Specific.

The following table shows an example of plans to harvest and extract water from surface sources.

METRO RAPID TRAIN: Statistics for Water Extraction for Construction Enlargement									
No.	**River name**	**Using water**	**X-Coordinate**	**Y-coordinate**	**Average daily dose (m3/day)**	**Average daily dose (l/sec)**	**Water extraction period**	**Maximum total daily dose (m3/day)**	**Maximum total daily dose (l/sec)**
1	Quebrada Pollo	Construction of the Bridge StackPerforation Stack	513677.11622	1088420.80235					
		Construction under the Beam							
2	Blanquillo River	Bridge Stack Construction (Drill Stack)	511804.89233	1089363.01329					
		Construction under the Beam							
3	Quebrada Manta	Bridge Stack Construction (Drill Stack)	511320.80373	1089847.89394					
		Construction under the Beam							
		Base Construction							
		Water Stabilized Base Maintenance							
		Irrigation to Clean Dust							
4	Rio Tatiscu	Bridge Stack Construction (Drill Stack)	511133.91351	1090036.17744					
		Construction under the Beam							

		Base Construction							
		Water Stabilized Base Maintenance							
		bridge superstructure							
		water truck							
		Irrigation to Clean Dust							
5	Chinchilla River	Bridge Stack Construction (Drill Stack)	510823.99289	1090194.36484					
		Construction under the Beam							
6	Rio San Nicolas	Bridge Stack Construction (Drill Stack)	510678.89223	1090266.71415					
		Construction under the Beam							
7	Toyogres River	Bridge Stack Construction (Drill Stack)	509989.93759	1090610.23704					
		Construction under the Beam							
8	Rio Reventado	Bridge Stack Construction (Drill Stack)	507846.07724	1091866.00837					
		Construction under the Beam							

9	Quebrada Norberta	Bridge Stack Construction (Drill Stack)	507714.28981	1093354.32231						
		Construction under the Beam								
		Base Construction								
		Water Stabilized Base Maintenance								
		Irrigation to Clean Dust								
10	Taras River	Bridge Stack Construction (Drill Stack)	507664.35009	1093439.50488						
		Construction under the Beam								
11	Arriaz River	Bridge Stack Construction (Drill Stack)	506973.60507	1093780.59760						
		Construction under the Beam								
12	Quebrada Quirazu	Bridge Stack Construction (Drill Stack)	506001.35889	1094643.52199						
		Construction under the Beam								
		Base Construction								
		Water Stabilized Base Maintenance								

		Irrigation to Clean Dust							
13	Quebrada Fierro	Bridge Stack Construction (Drill Stack)	504587.17465	1095453.00362					
		Construction under the Beam							
14	Rio Chiquito	Bridge Stack Construction (Drill Stack)	502992.51344	1096180.14293					
		Construction under the Beam							
		Base Construction							
		Water Stabilized Base Maintenance							
		Irrigation to Clean Dust							
15	Rio Tiribi	Bridge Stack Construction (Drill Stack)	501722.60735	1096009.12353					
		Construction under the Beam							
		Base Construction							
		Water Stabilized Base Maintenance							
		Irrigation to Clean Dust							
16	Quebrada Union	Bridge pilot base construction (perforated piles)	500759.30833	1095961.02882					

		construction of the lower bridge							
		bridge superstructure							
		water truck							
		irrigation and planting							
17	Rio Salitrillo	Bridge pilot base construction (perforated piles)	500142.67890	1096025.51202					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							
18	Rio Maria Aguilar	Bridge pilot base construction (perforated piles)	498125.90679	1096479.94136					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							
19	Quebrada Tacaco	Bridge pilot base construction (perforated piles)	497610.49447	1096711.23876					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							

20	Quebrada Zopilote	Bridge pilot base construction (perforated piles)	496572.91429	1097052.40578					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							
21	Rio Puruses	Bridge pilot base construction (perforated piles)	496111.75759	1097288.93017					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							
22	Rio Ocloro	Bridge pilot base construction (perforated piles)	495494.19865	1097925.37561					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							
23	Rio Torres	Bridge pilot base construction (perforated piles)	492375.61529	1099195.44169					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							

24	Quebrada Cangrejos	Bridge pilot base construction (perforated piles)	492366.62569	1099377.58891					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							
25	Quebrada Rivera	Bridge pilot base construction (perforated piles)	491230.91249	1100224.16501					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							
26	Bermudez River	Bridge pilot base construction (perforated piles)	488935.43685	1103181.86979					
		construction of the lower bridge							
		bridge superstructure							
		irrigation and planting							
27	Quebrada Gertrude		488402.3119	1103865,334					
28	Quebrada Tropical		487916.9529	1104532,952					
29	Virilla River		481645,848	1102054,951					
30	Rio Pirro		487589,966	1105104,015					

31	Rio Segundo		480566.5566	1106099,419					
32	Quebrada Canas		478214.7853	1106049,185					
33	Rio Burio		483836.9208	1105998,429					
34	Ciruelas River		477226.5504	1106676,337					
35	Quebrada Targua		477762.5785	1106283,379					
36	Quebrada Barro		475532.5141	1106244.82					
37	Quebrada Lagunilla		472889.3109	1104940.671					
38	Ditch		472079.6749	1103906,591					
39	Rio Torres		482320.9705	1101722,898					
40	Virilla River		490114.2818	1101980.331					
41	Bermudez River		480166,8355	1103283.2					
42	Quebrada Seca		478595.4318	1103232,192					
43	Ditch		476061,287	1102646.221					
44	Ditch		475484.8633	1102713,119					
45	Rio Segundo		475341.7458	1102738.04					
46	Break		473384.0848	1102878,414					
47	Ditch		472605.5959	1103309,293					

48	Ciruelas River		471938.0336	1103421,036					
49	Ditch		470767.4251	1103124,665					

Table 33. Example of plan for the use and extraction of water in surface sources

Annex 2. Public domain channels located in the project area.

CATEGORY	Name	Branch	Right- way	X	Y
PERMANENT	Quebrada Pollo	Cartago-Paraíso	6.70	513677.11622	1088420.80235
PERMANENT	Rio Blanquillo	Cartago-Paraíso	6.70	511804.89233	1089363.01329
PERMANENT	Quebrada Manta	Cartago-Paraíso	6.70	511320.80373	1089847.89394
PERMANENT	Rio Tatiscu	Cartago-Paraíso	6.70	511133.91351	1090036.17744
PERMANENT	Rio Chinchilla	Cartago-Paraíso	6.70	510823.99289	1090194.36484
PERMANENT	Rio San Nicolas	Cartago-Paraíso	6.70	510678.89223	1090266.71415
PERMANENT	Rio Toyogres	Cartago-Paraíso	6.70	509989.93759	1090610.23704
PERMANENT	Rio Reventado	Cartago-Tres Ríos	6.70	507846.07724	1091866.00837
PERMANENT	Quebrada Norberta	Cartago-Tres Ríos	6.70	507714.28981	1093354.32231
PERMANENT	Rio Taras	Cartago-Tres Ríos	6.70	507664.35009	1093439.50488
PERMANENT	Rio Arriaz	Cartago-Tres Ríos	6.70	506973.60507	1093780.59760
PERMANENT	Quebrada Quirazu	Cartago-Tres Ríos	6.70	506001.35889	1094643.52199
PERMANENT	Quebrada Fierro	Cartago-Tres Ríos	6.70	504587.17465	1095453.00362
PERMANENT	Rio Chiquito	Cartago-Tres Ríos	6.70	502992.51344	1096180.14293
PERMANENT	Rio Tiribi	Cartago-Tres Ríos	6.70	501722.60735	1096009.12353
PERMANENT	Quebrada Unión	Tres Ríos-Atlantico	6.70	500759.30833	1095961.02882
PERMANENT	Rio Salitrillo	Tres Ríos-Atlantico	6.70	500142.67890	1096025.51202
PERMANENT	Rio Maria Aguilar	Tres Ríos-Atlantico	6.70	498125.90679	1096479.94136
INTERMITENT	Quebrada Tacaco	Tres Ríos-Atlantico	6.70	497610.49447	1096711.23876
INTERMITENT	Quebrada Zopilote	Tres Ríos-Atlantico	6.70	496572.91429	1097052.40578
PERMANENT	Rio Puruses	Tres Ríos-Atlantico	6.70	496111.75759	1097288.93017
PERMANENT	Rio Ocloro	Tres Ríos-Atlantico	6.70	495494.19865	1097925.37561
PERMANENT	Rio Torres	Atlantico-Heredia	6.70	492375.61529	1099195.44169
PERMANENT	Quebrada Cangrejos	Atlantico-Heredia	6.70	492366.62569	1099377.58891
PERMANENT	Quebrada Rivera	Atlantico-Heredia	6.70	491230.91249	1100224.16501
PERMANENT	Rio Bermudez	Atlantico-Heredia	6.70	488935.43685	1103181.86979
PERMANENT	Quebrada Gertrudis	Atlantico-Heredia	6.70	488402.31194	1103865.33361
INTERMITENT	Quebrada Tropical	Atlantico-Heredia	6.70	487916.95293	1104532.95229
PERMANENT	Rio Virilla	Atlantico-Heredia	6.70	481645.84799	1102054.95112
PERMANENT	Rio Pirro	Atlantico-Heredia	6.70	487589.96602	1105104.01509
PERMANENT	Rio Segundo	Heredia-Alajuela	6.70	480566.55663	1106099.41863
PERMANENT	Quebrada Canas	Heredia-Alajuela	6.70	478214.78531	1106049.18479
PERMANENT	Rio Burio	Heredia-Alajuela	6.70	483836.92082	1105998.42874
PERMANENT	Rio Ciruelas	Heredia-Alajuela	6.70	477226.55036	1106676.33664
INTERMITENT	Quebrada Targua	Heredia-Alajuela	6.70	477762.57851	1106283.37949

CATEGORY	Name	Branch	Right- way	X	Y
PERMANENT	Quebrada Barro	Alajuela-Ciruelas	7.62	475532.51405	1106244.81983
	Quebrada Lagunilla	Alajuela-Ciruelas	7.62	472889.31094	1104940.67068
PERMANENT	Acequia	Alajuela-Ciruelas	7.62	472079.67488	1103906.59089
PERMANENT	Rio Torres	Belen-Pacifico	6.70	482320.97048	1101722.89776
PERMANENT	Rio Virilla	Atlantico-Heredia	6.70	490114.28185	1101980.33071
PERMANENT	Rio Bermudez	Belen-Pacifico	6.70	480166.83548	1103283.19951
PERMANENT	Quebrada Seca	Belen-Ciruelas	7.62	478595.43180	1103232.19158
PERMANENT	Acequia	Belen-Ciruelas	7.62	476061.28698	1102646.22118
PERMANENT	Acequia	Belen-Ciruelas	7.62	475484.86334	1102713.11945
PERMANENT	Rio Segundo	Belen-Ciruelas	7.62	475341.74579	1102738.04045
PERMANENT	Quebrada Dona Ana	Belen-Ciruelas	7.62	473384.08481	1102878.41353
PERMANENT	Acequia	Belen-Ciruelas	7.62	472605.59591	1103309.29289
PERMANENT	Rio Ciruelas	Belen-Ciruelas	7.62	471938.03359	1103421.03559
PERMANENT	Acequia	Belen-Ciruelas	7.62	470767.42514	1103124.66456

Annex 3. Elements to consider for work permits in channels

Permits to build works in public domain channels must comply with the provisions of the MINAE Water Directorate. It is important to note that in order to facilitate the issuance of permits, the Project must submit an application that includes all public domain channels in which work will be done, however minors. The application requires the submission of hydrological and hydraulic studies that include, but are not limited to:

1. Total bridge width (old bridge + new bridge);
2. Map of the river basin or corresponding body of water;
3. Calculation memory of design flow rates and average flow rates.
4. Water-modifying modelling calculation memory;
5. Cross sections upstream and downstream of each point
6. Overview of design flow rates;
7. Overview on riverfront protection works;
8. Overview of temporary works, fords, ataguides, diversion channels, etc.
9. Design plans.
10. Timeline of construction of the works.
11. The environmental assessment of each of these public domain channels should be part of the environmental impact study of the entire project. This document should cover all requirements for track work.

All this information must be submitted using the form DA-GRH-0011 of the MinaE Water Directorate, which is annexed to this document, and which is accompanied by a table containing all 50 channels of public domain that are crossed by the Train Fast Metropolitan and requiring bridges and other works in which it is necessary to do work that somehow affect these channels.

In order to complete all hydrological and hydraulic information of the points where it is necessary to intervene the channels to carry out the works required by and project, such as bridges and sewers, a study should be prepared that covers what is shown in the following table of contents, and which includes summary tables with the results of the analysis carried out and the drawings of the works to be carried out at each point:

Content

APPLICATION FOR WORKS IN THE PUBLIC DOMAIN

REQUIREMENTS TO SUBMIT THIS APPLICATION

- ❑ 1. Fill out this form by machine or with legible letter.
- ❑ 2. Attach the following documents:
  - ❑ a) Certification of ownership of the land related to the works to be carried out. It must be original, have less than three months of issued by the Public Registry or by Notary and contain location, area, nature and borders.
  - ❑ b) Certification of Legal Status, where the applicant is a legal person. You must be less than three months old issued by the Public Registry or Notary
  - ❑ c) Catastrophic drawing in which the work to be performed is marked.
  - ❑ d) Hydrological and hydraulic study signed by the responsible professional.
  - ❑ (e) Cross-sections of the natural and modified channel.
  - ❑ f) Design plans
  - ❑ (g) In accordance with the Organic Law on the Environment, environmental assessment shall be submitted as indicated by the SETENA (Environmental Technical Secretariat) of MINAE.
  - ❑ (h) If the work is carried out on the property of third parties or in the adjoining place, you must provide a declaration of the latter with the anountiality to its realization. The signature must be authenticated.
  - ❑ (i) Any other requirements that, depending on the type of work, management requires at the time of studying the application.
  - ❑ (j) Certification of being up to date in the employer workers' quotas issued by the CCSS (Art.74, Law No. 17 of October 22, 1943)

IMPORTANT NOTES

- For any inquiries about your request, you must refer to the file number to be assigned to you.
- In order to deliver a receipt, please bring a photocopy of this form.
- If you want to provide any additional information that you think is appropriate, you can do so in additional sheets.
- By signing this document, the applicant attests, under oath, that the information is true. If the permit is granted, it does not authorise the felling of trees in the protective area of channel.
- Regardless of authorized works, the channel remains the property of the State in an imprescriptible and inalienable manner.
- No construction is allowed on the channel. In case of tubing, the signer undertakes to leave the area on the pipe as a green area and public access.
- The applicant assumes responsibility for the works to be carried out

SPACE FOR EXCLUSIVE OFFICE USE

EXPEDIENT

#____

____

- ❑ This application was received from the applicant, who signed in my presence and displayed identity card.
- ❑ This request was received from

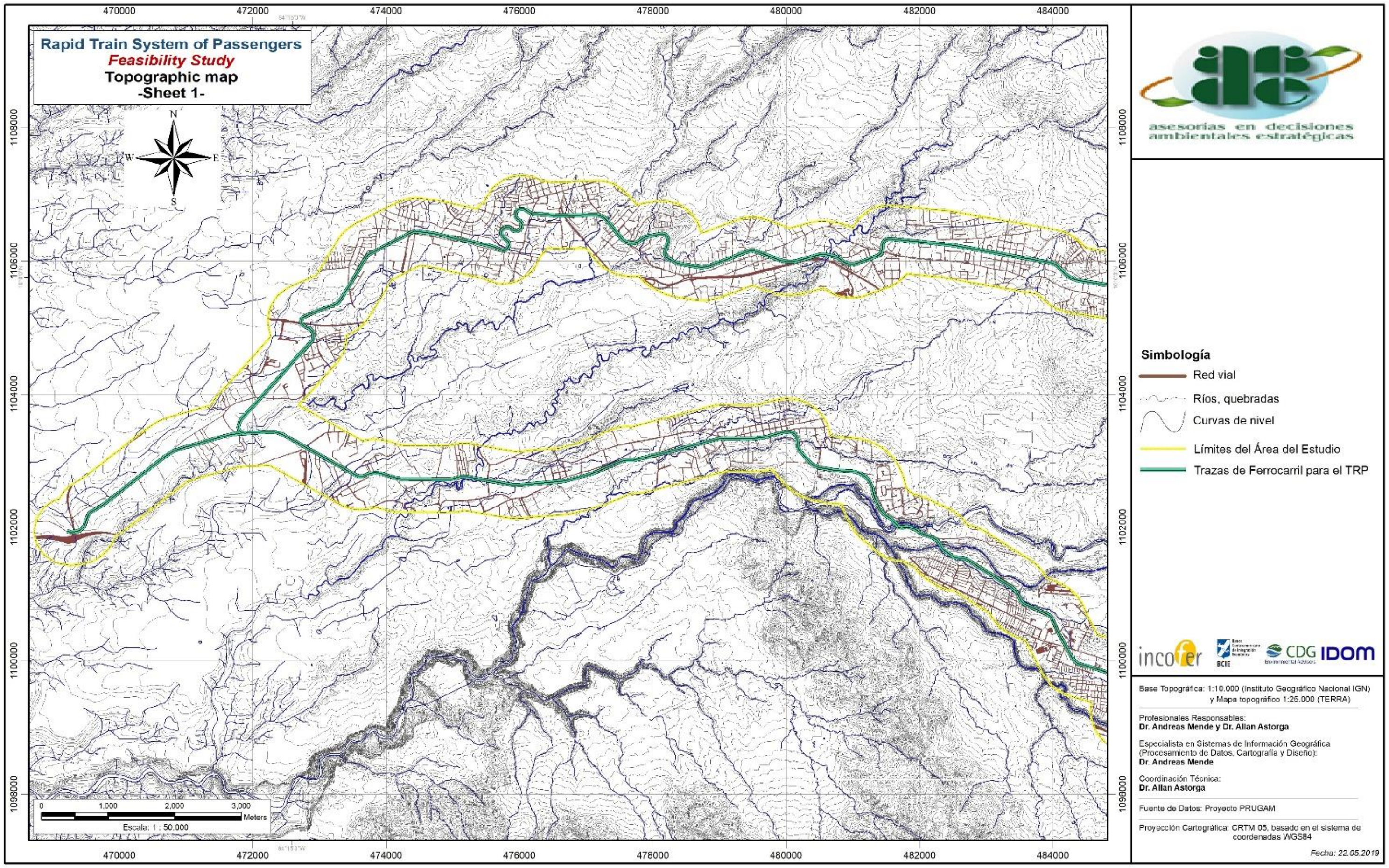
____

____

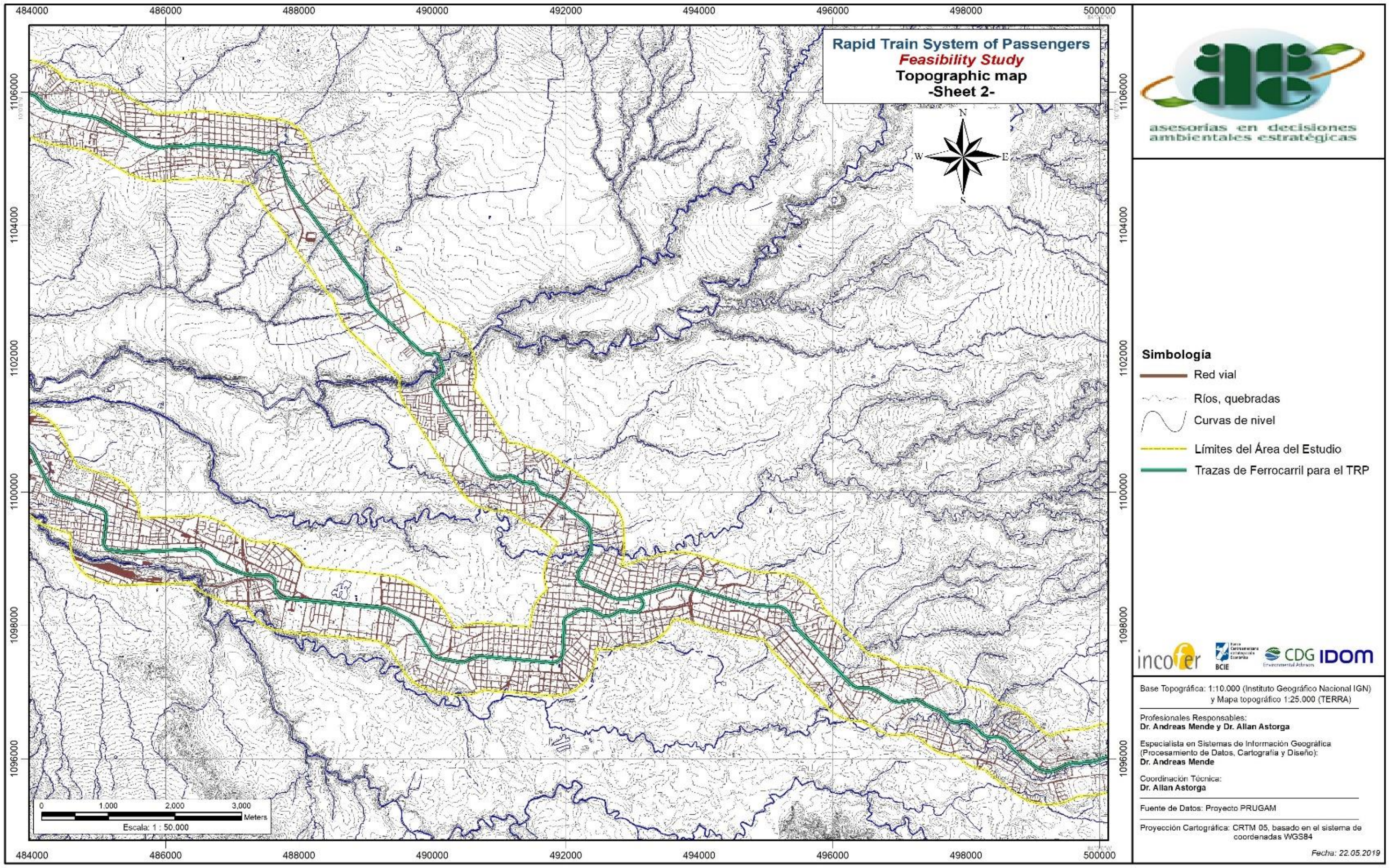
Annex 4. Geophysical map atlas.

Note: The maps in this section are prepared at a 1:10,000 scale, which is what SETENA requests for evaluating the environmental fragility index of a given area. The maps are based on the existing cartographic and topographic information. Improving the scale to 1:5,000 would require better cartography, which can be obtained with further fieldwork. It is recommended this to be carried out during the detailed studies phase, once the railway path is finalized and the location and number of stations is fully defined.

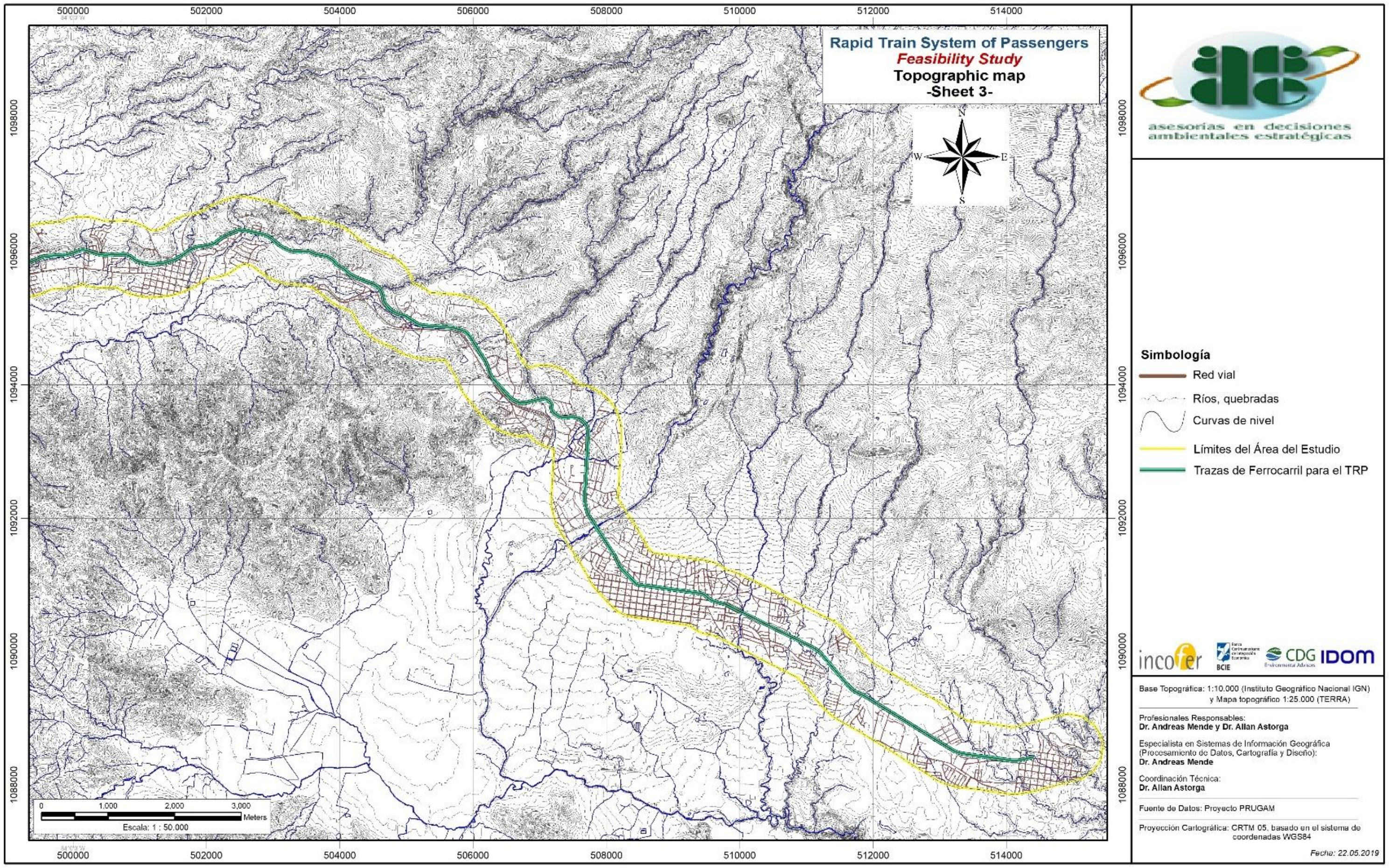
MG 1.1. Topographic map, Sheet 1



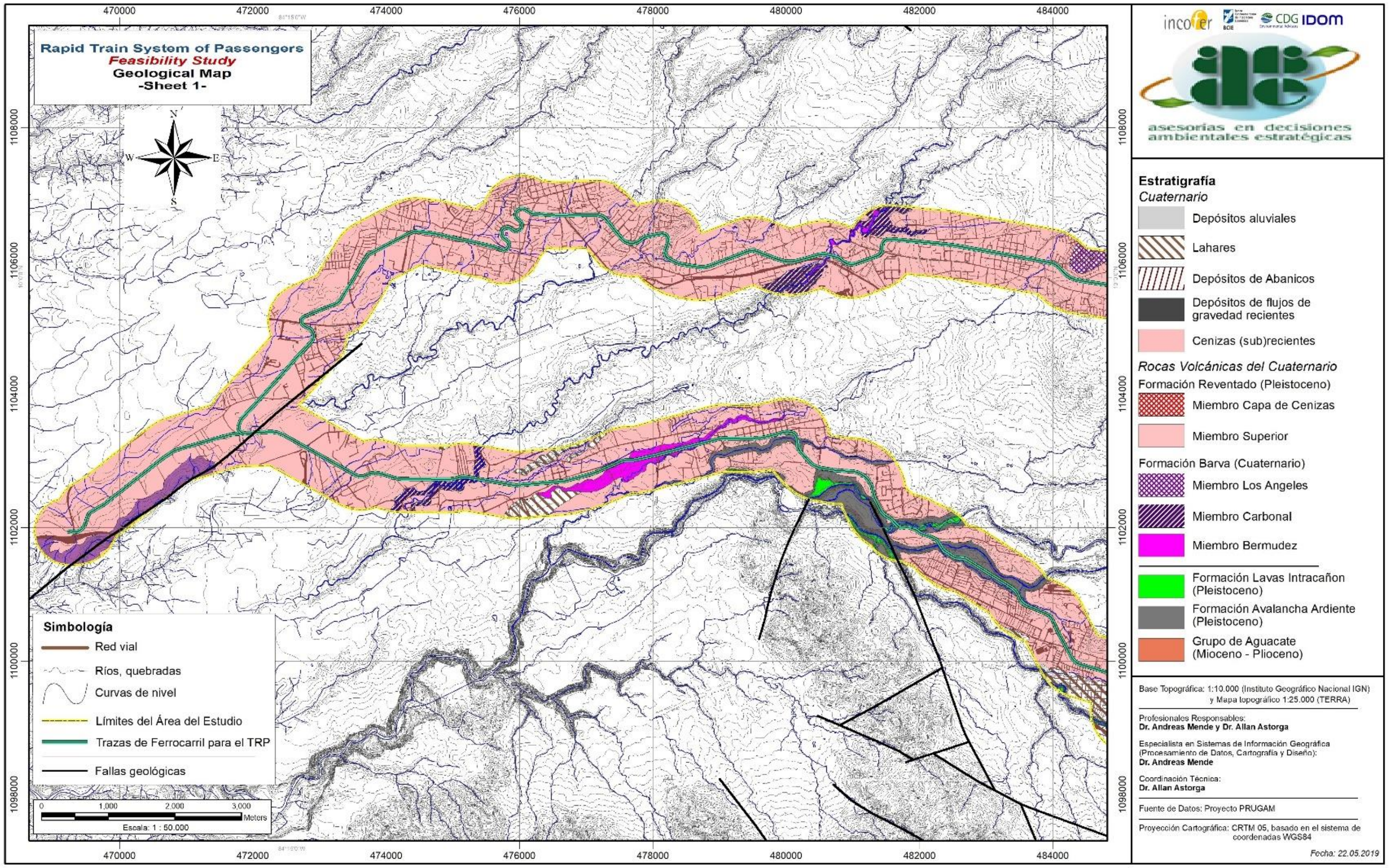
MG 1.2. Topographic map, Sheet 2



MG 1.3. Topographic map, Sheet 3



MG 2.1. Geological map, sheet 1



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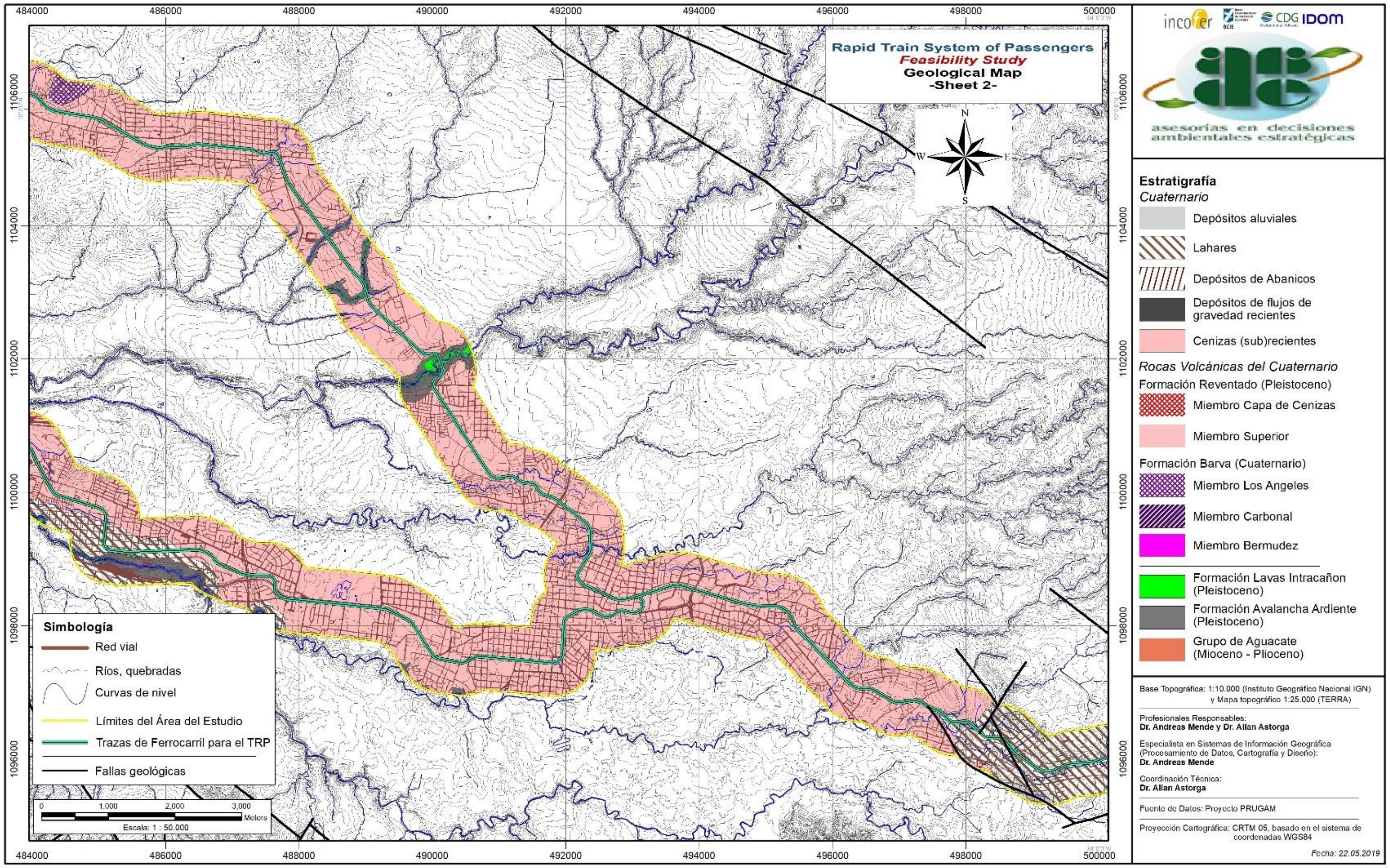
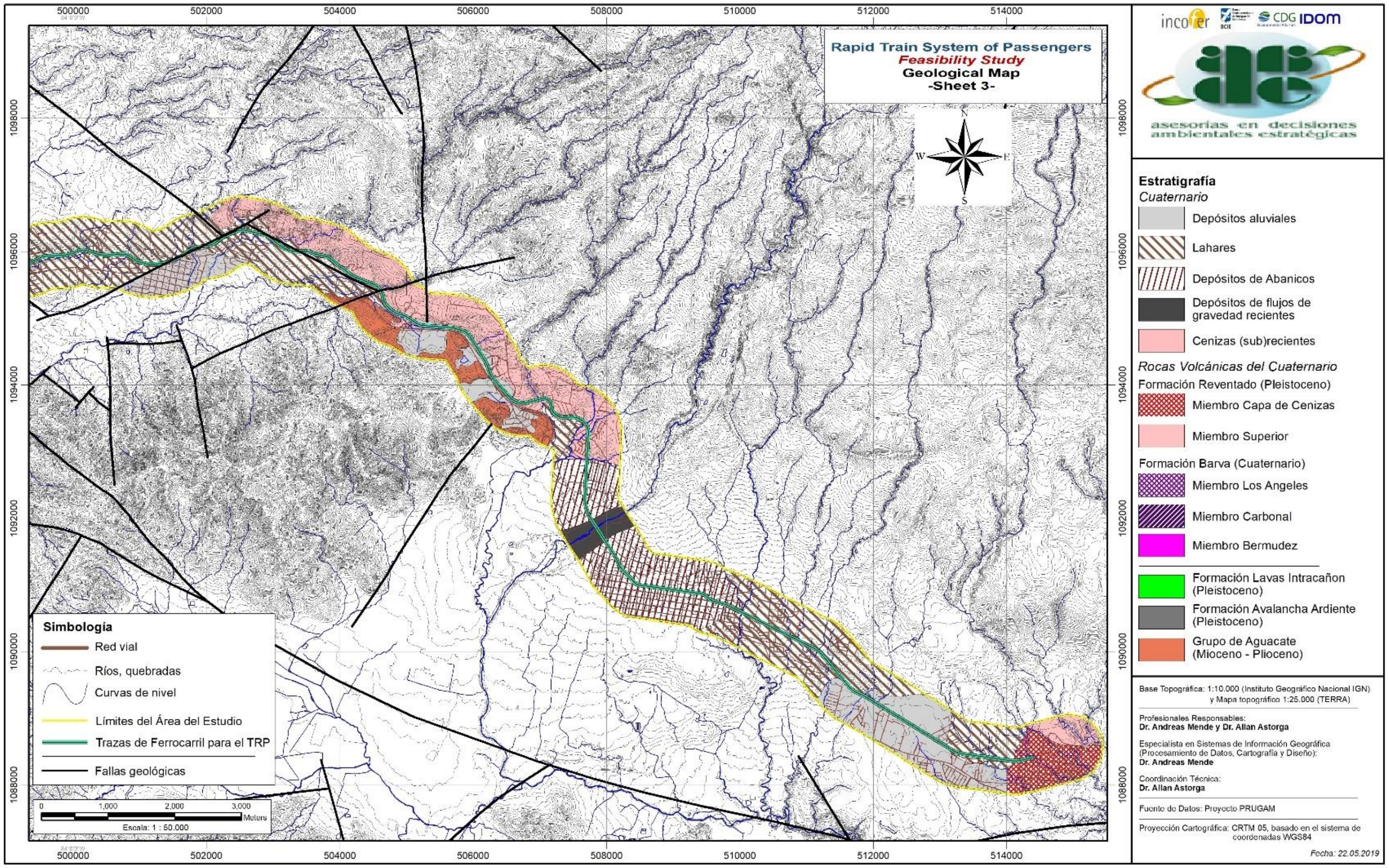
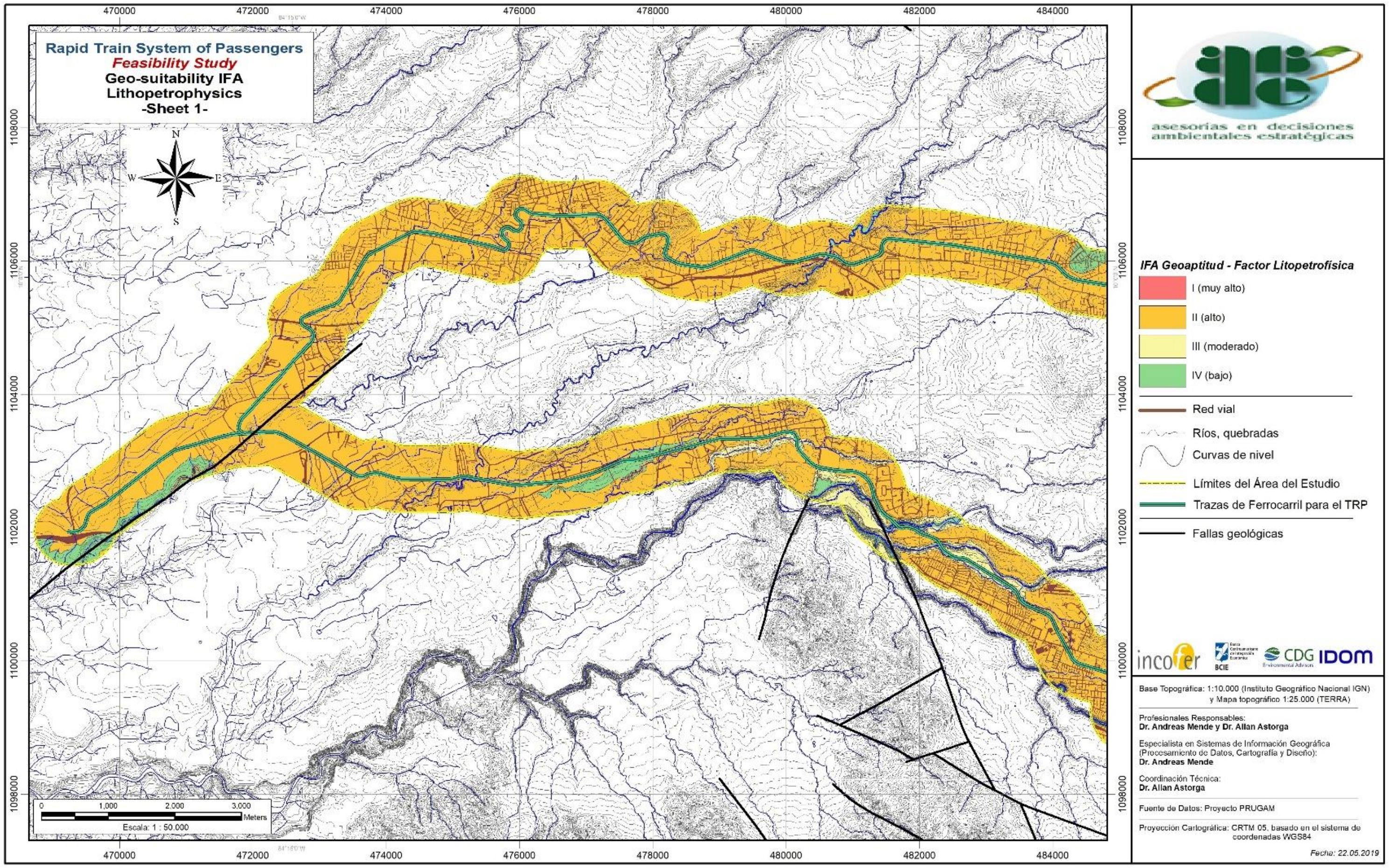


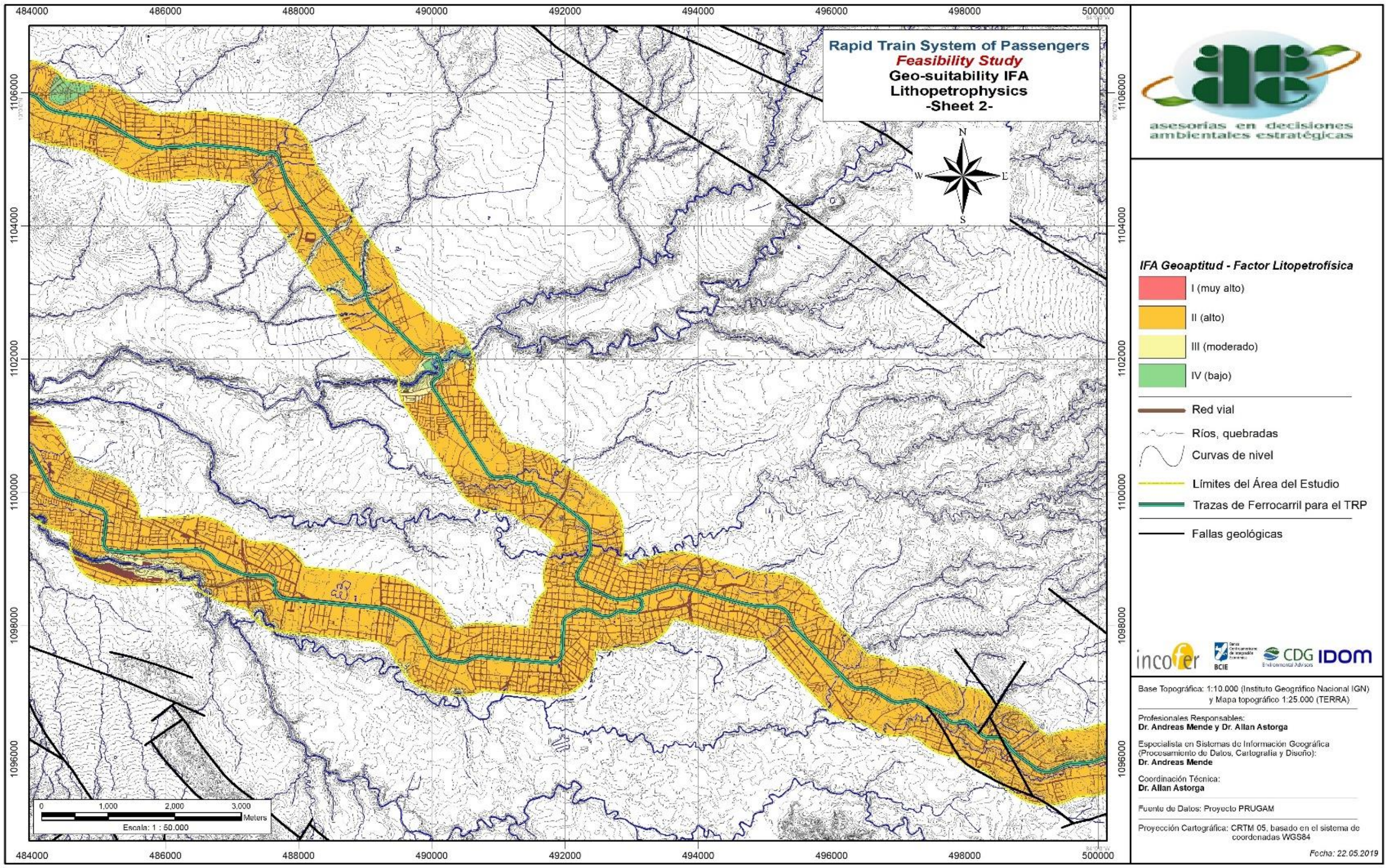
MG 2.3. Geological map, sheet 3



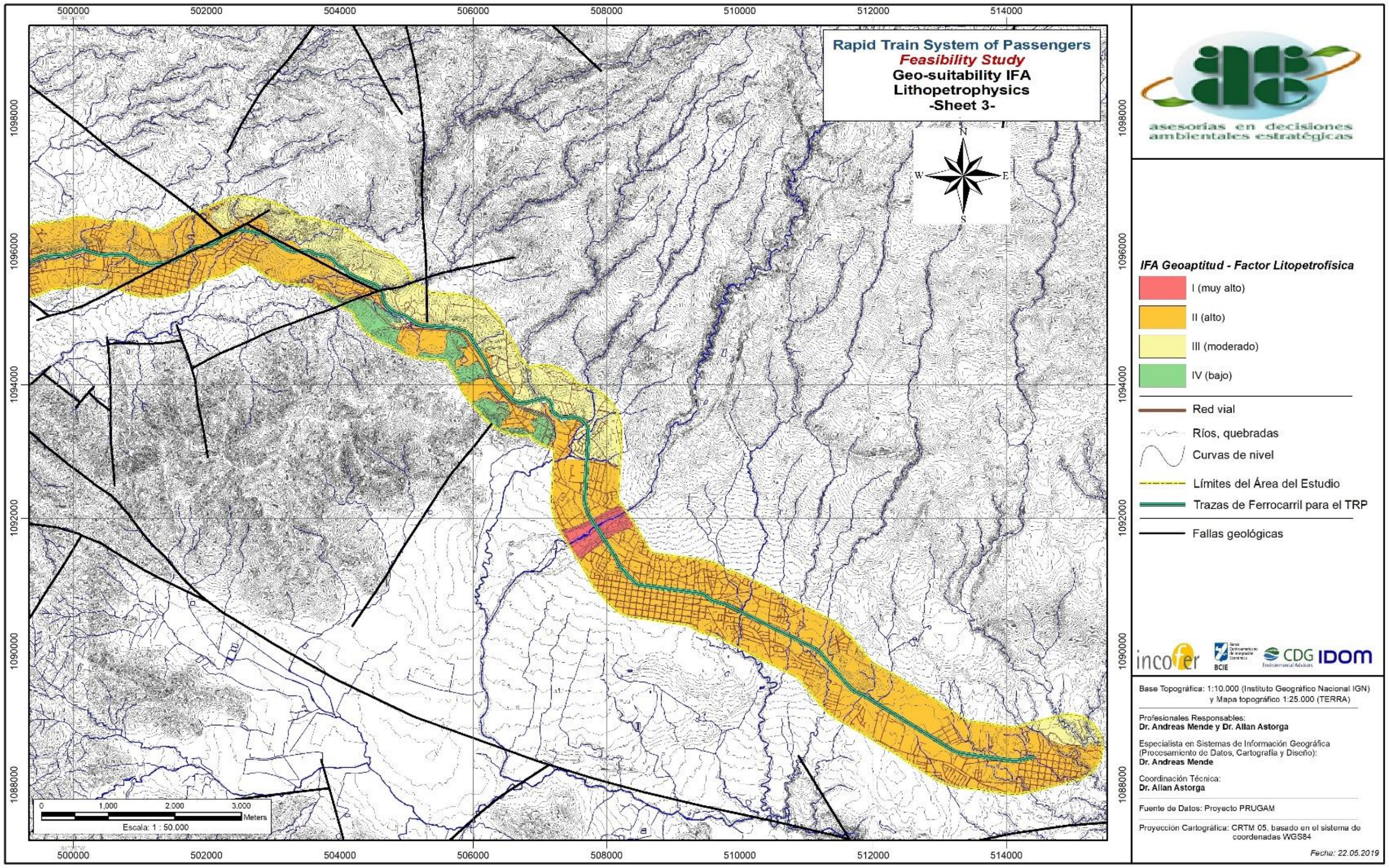
MG 3.1. Lithopetrophysics IFA map, sheet 1



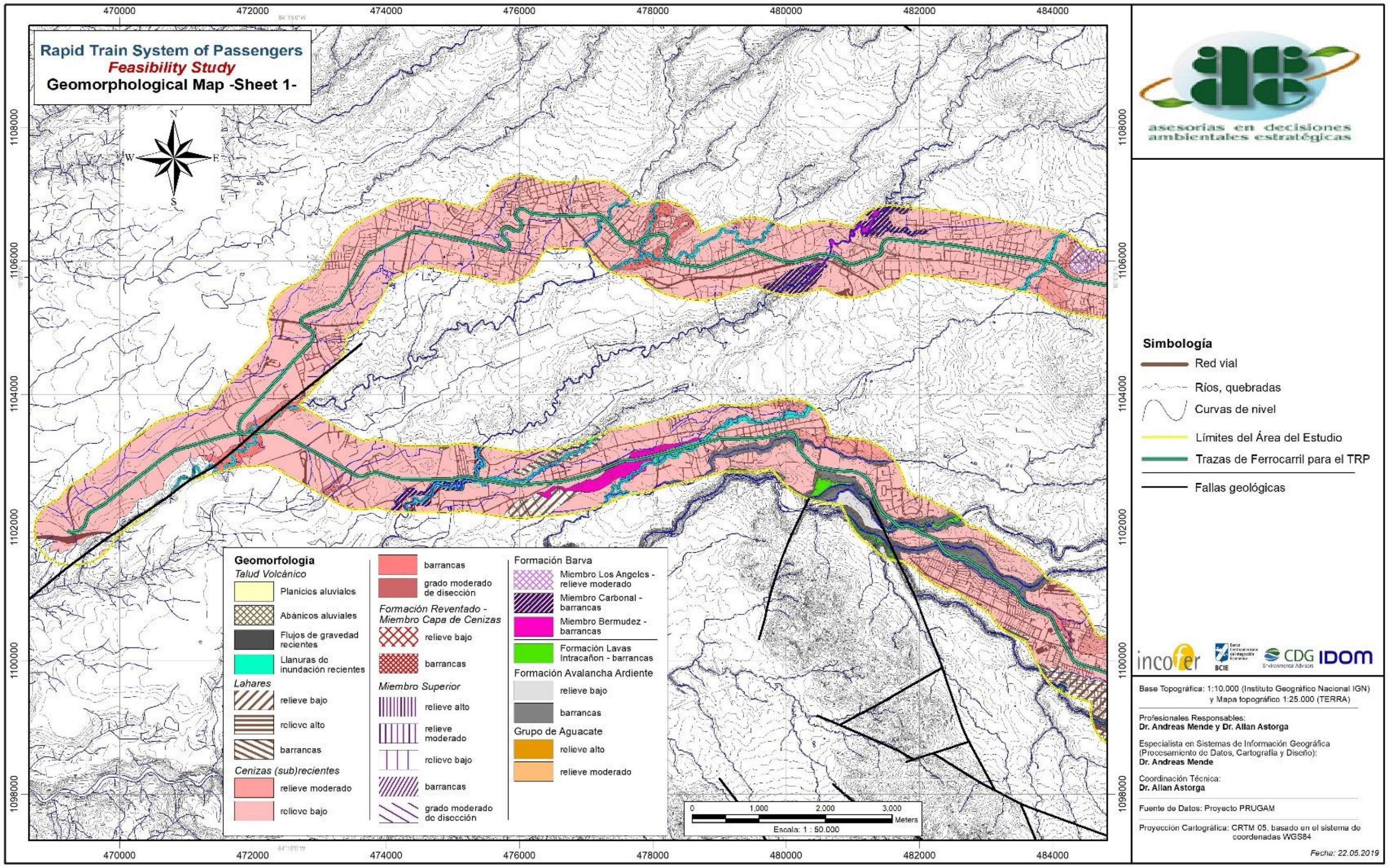
MG 3.2. Lithopetrophysics IFA map, sheet 2



MG 3.3. Lithopetrophysics IFA map, sheet 3



MG 4.1. Geomophological map, sheet 1



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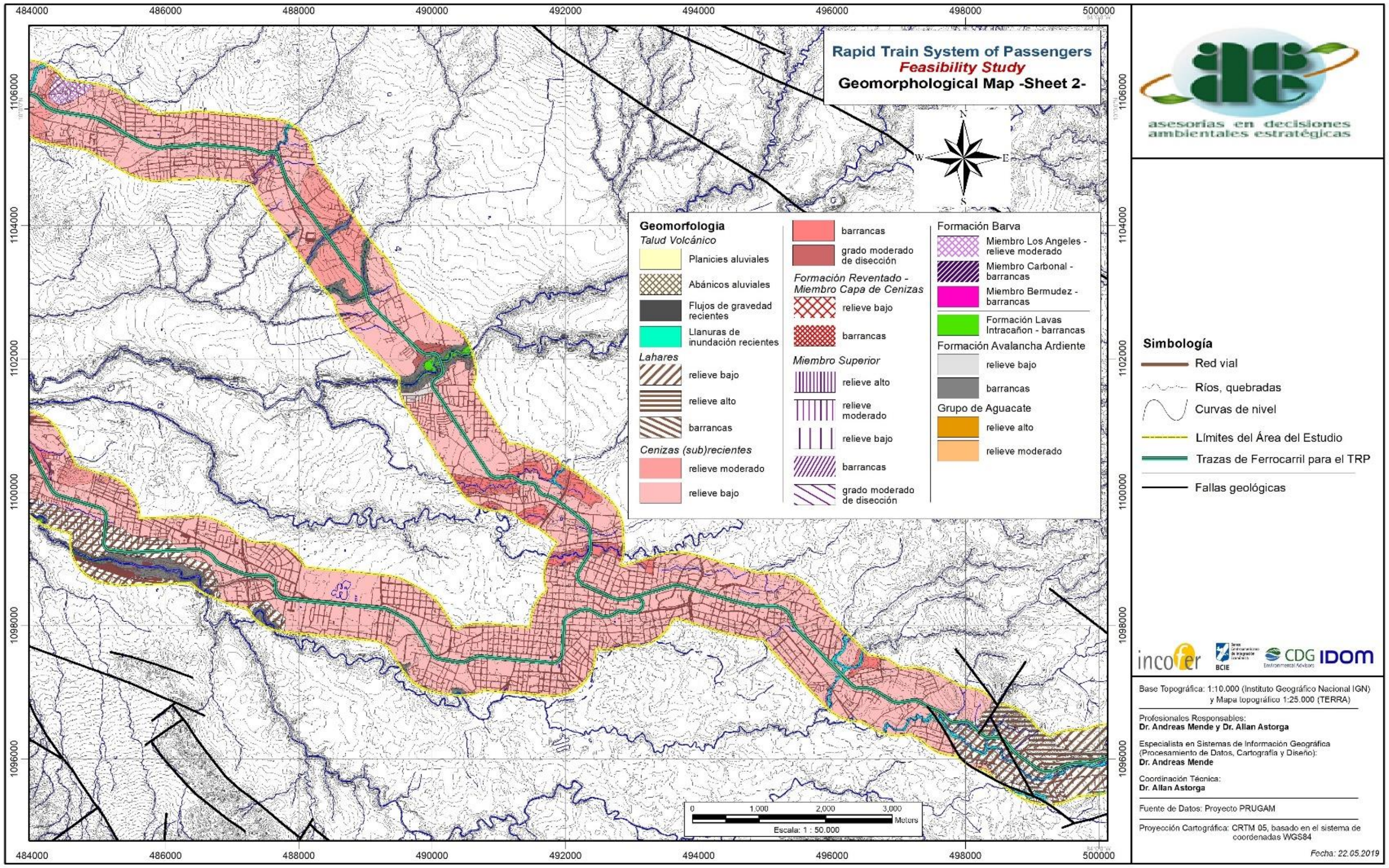

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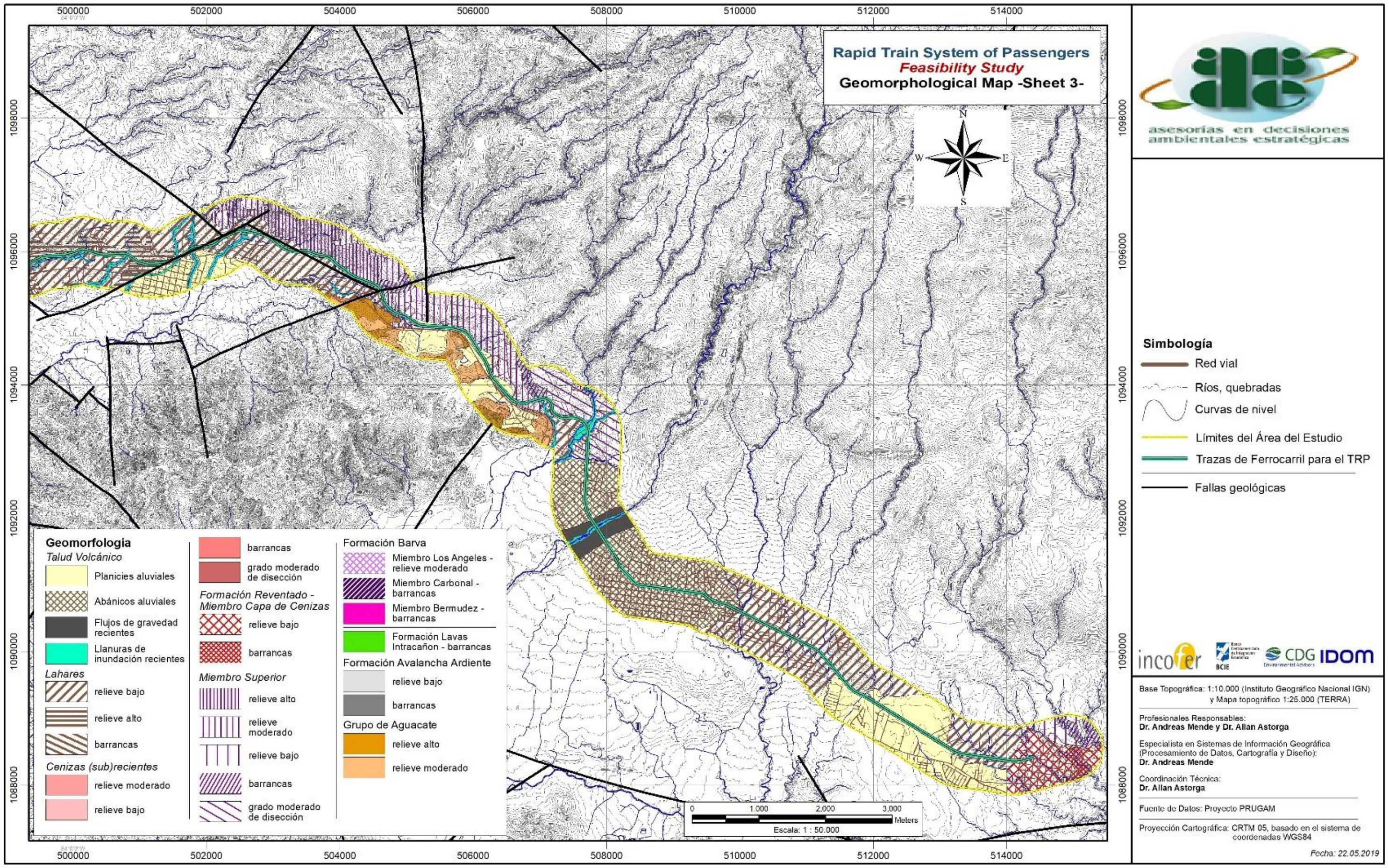
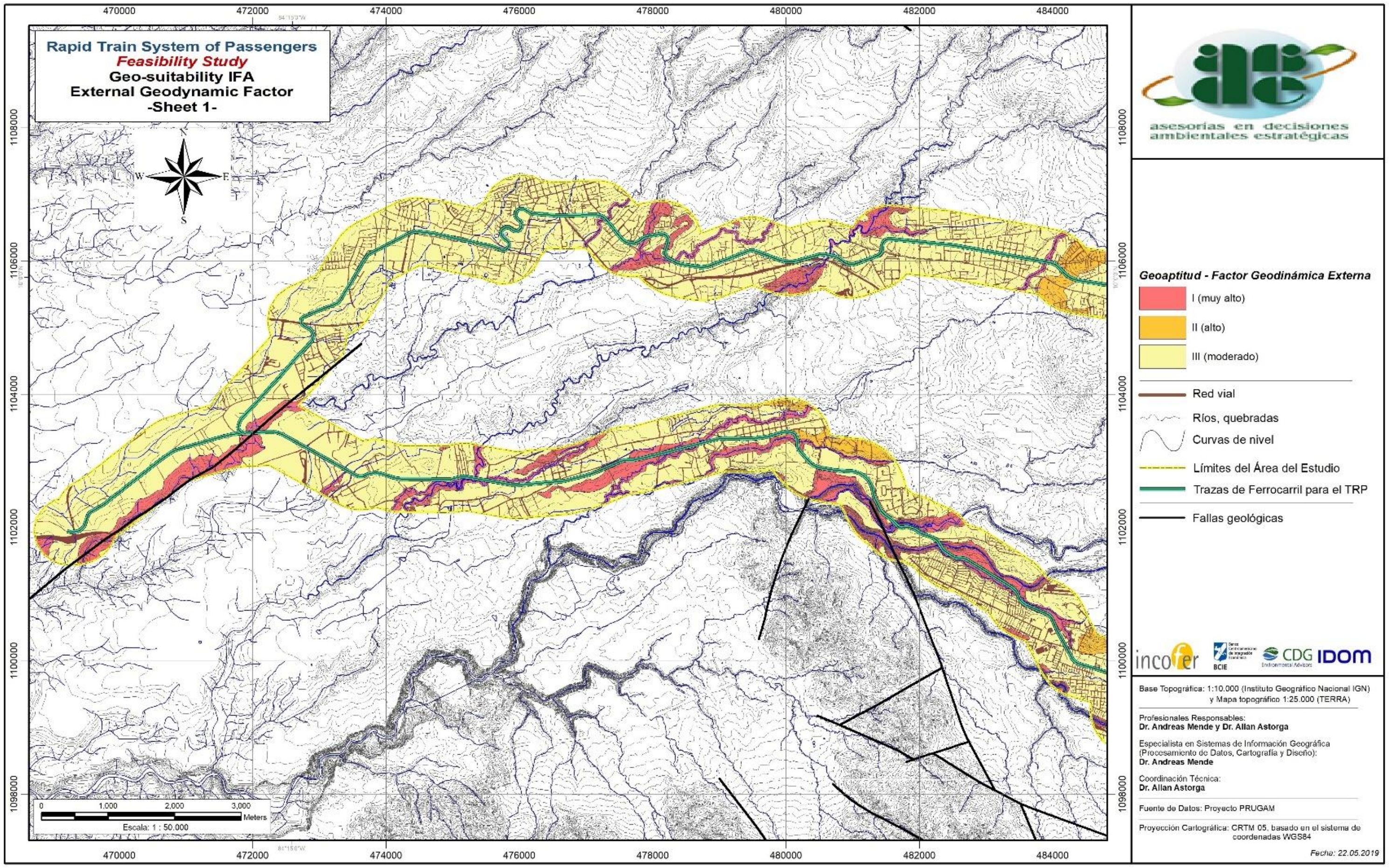


MG 5.1. External geodynamic factor, sheet 1



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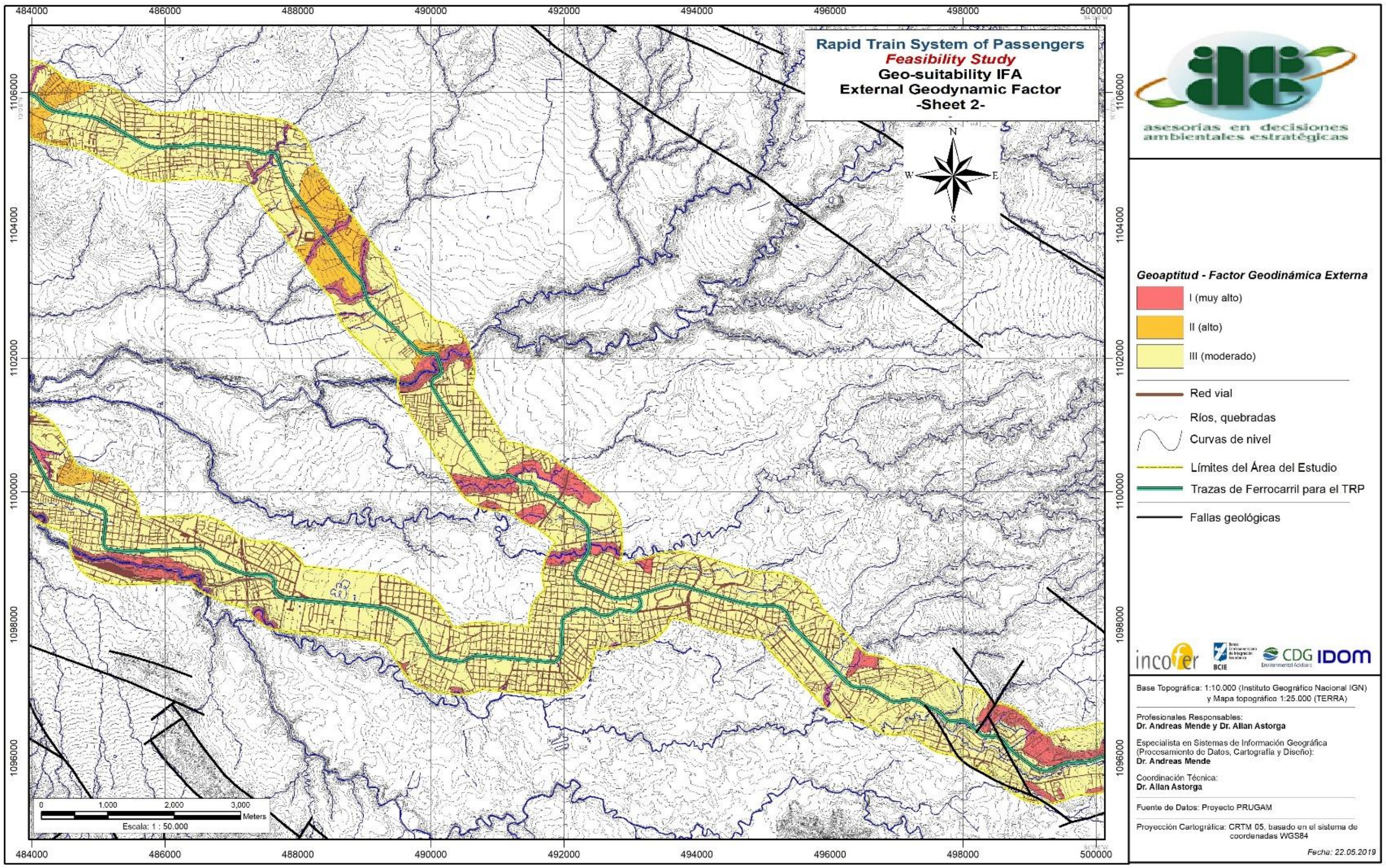
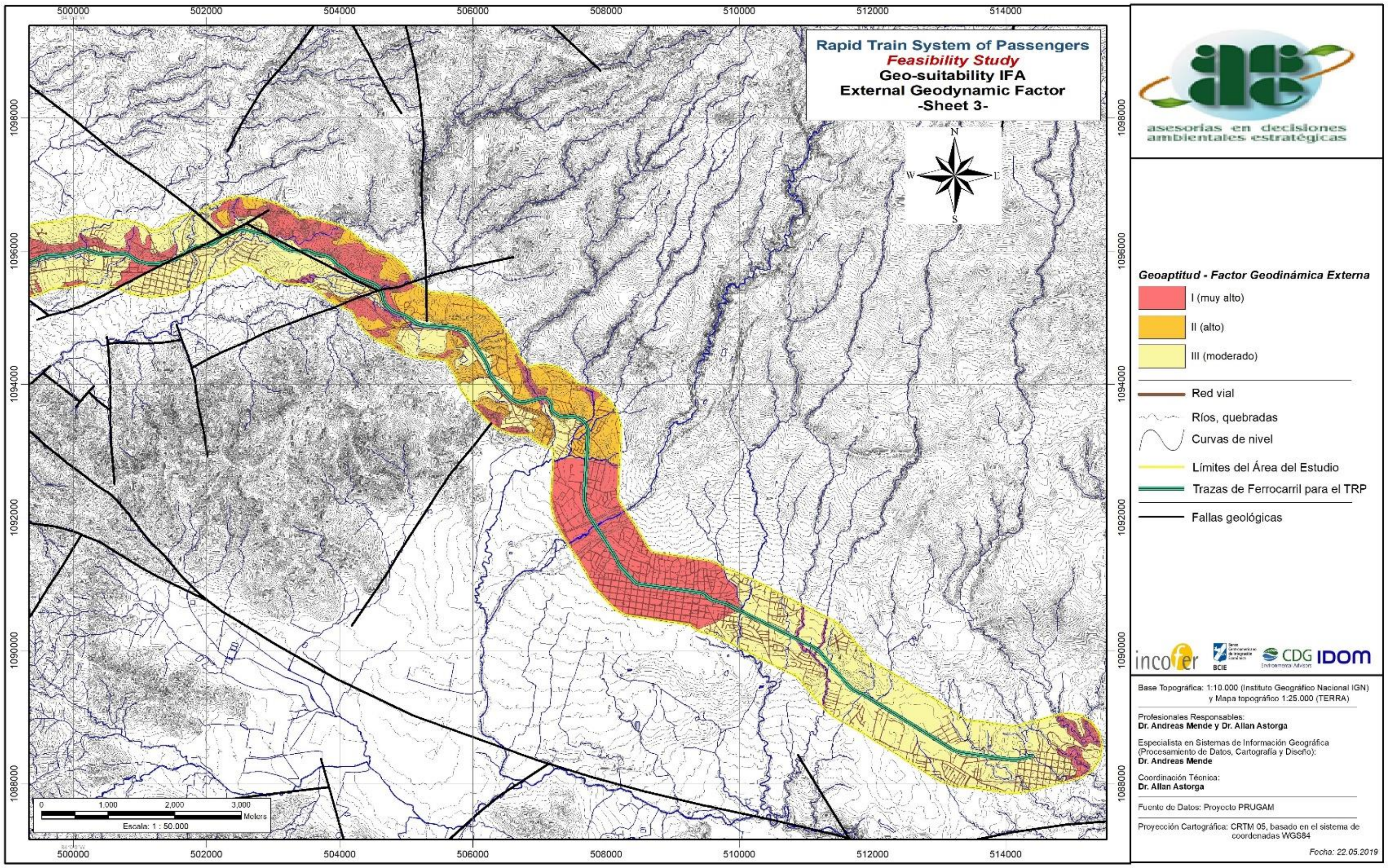
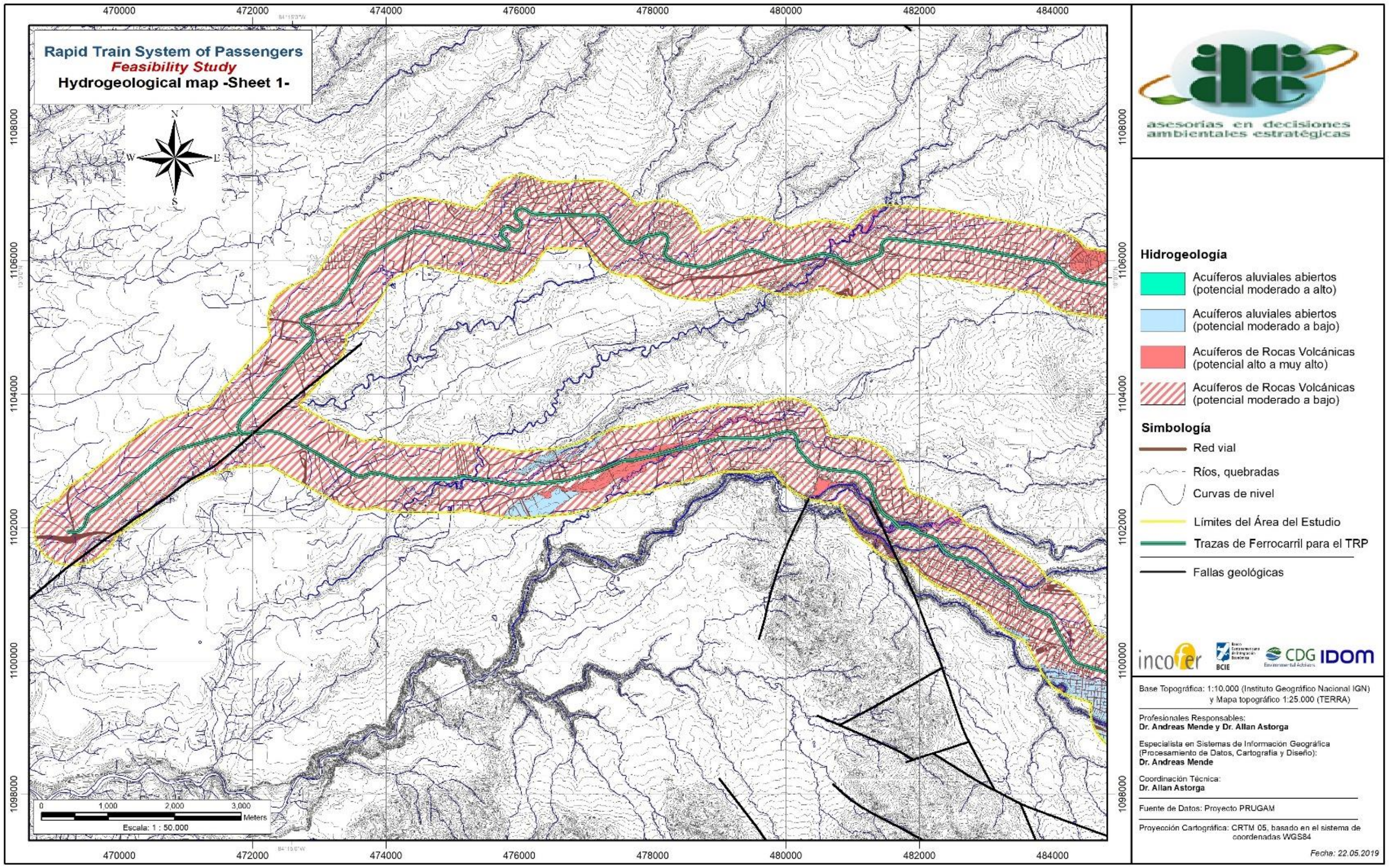


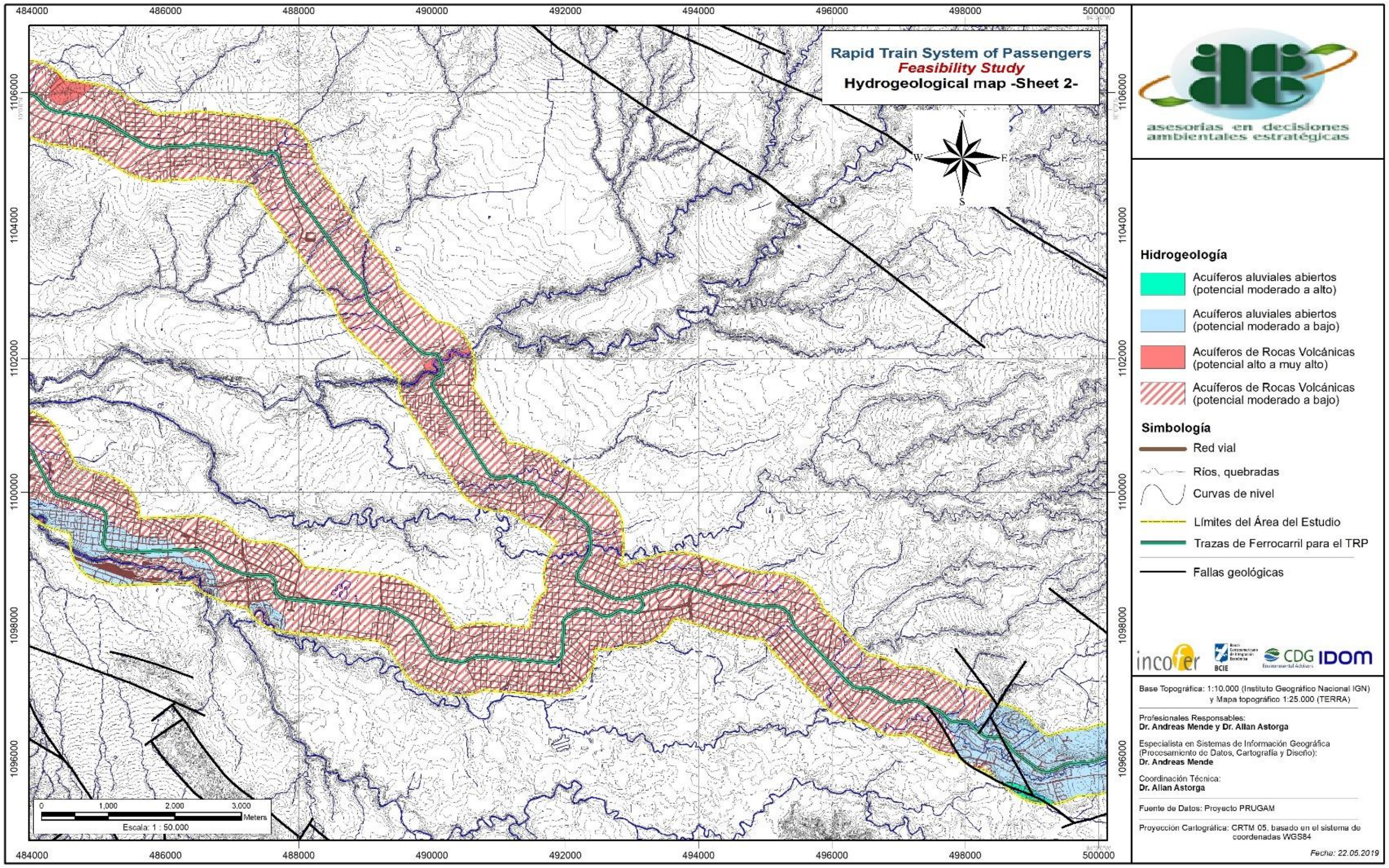
MG 5.3. External geodynamic factor, sheet 3



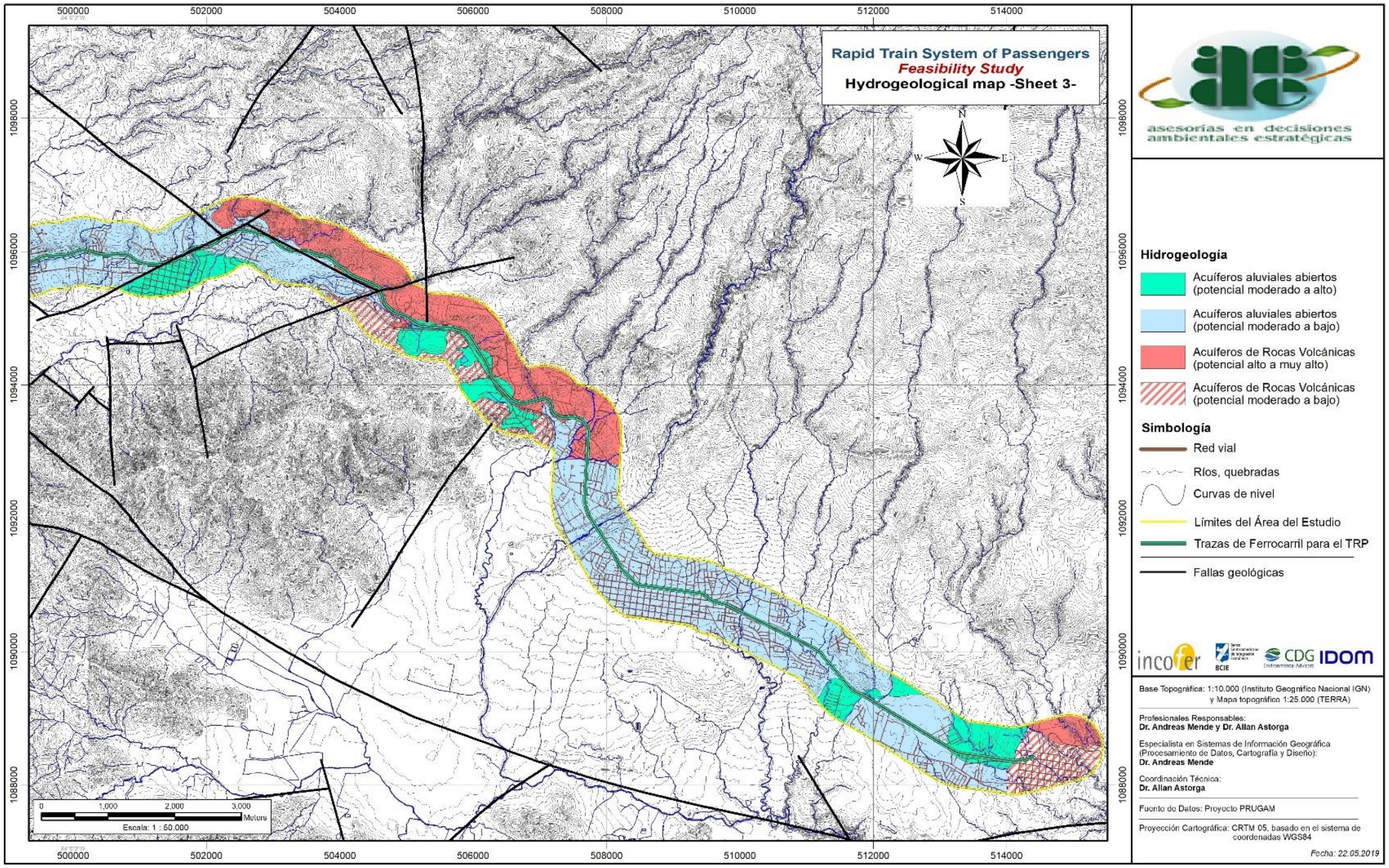
MG 6.1. Hydrogeogological map, sheet 1



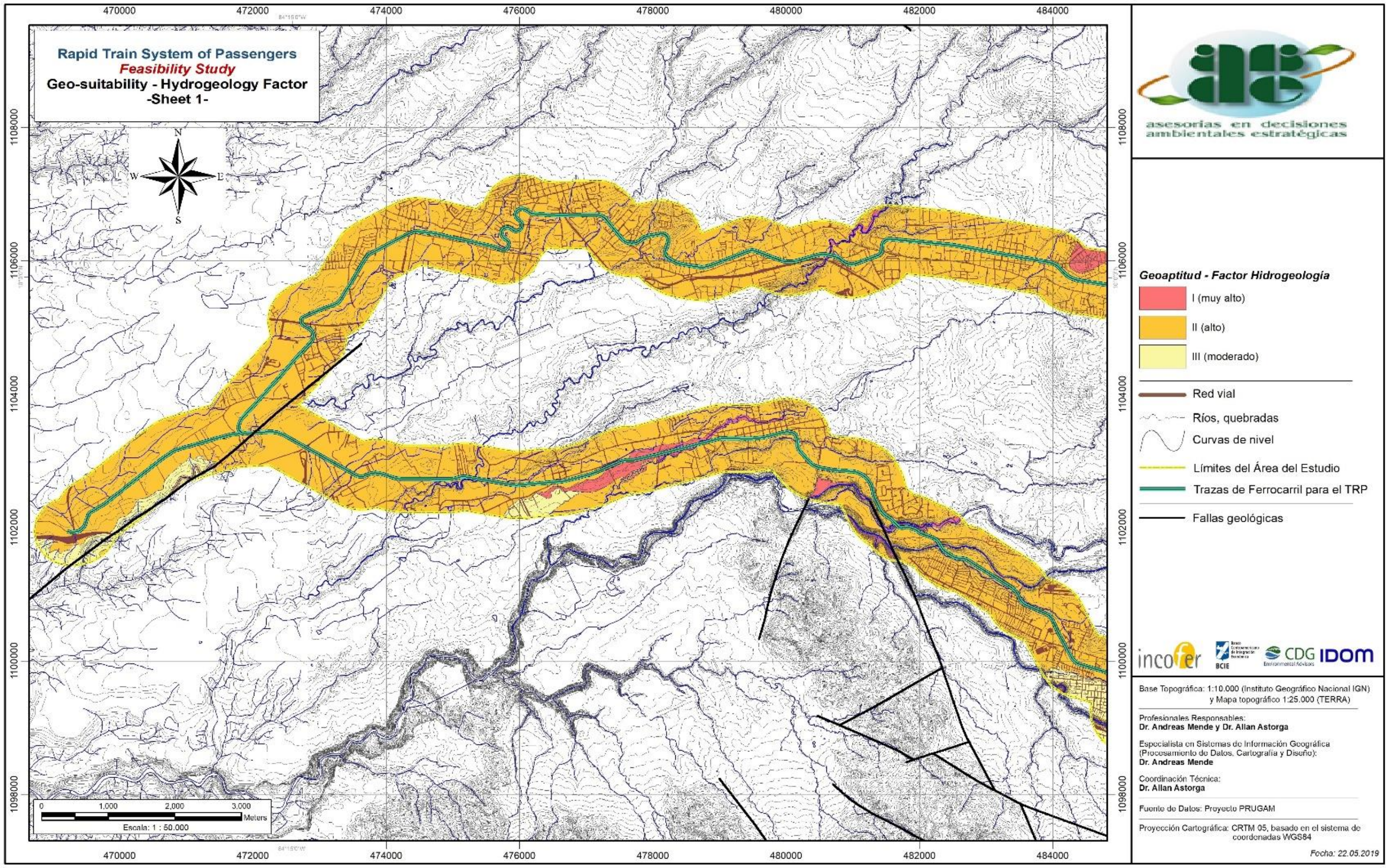
MG 6.2. Hydrogeogological map, sheet 2



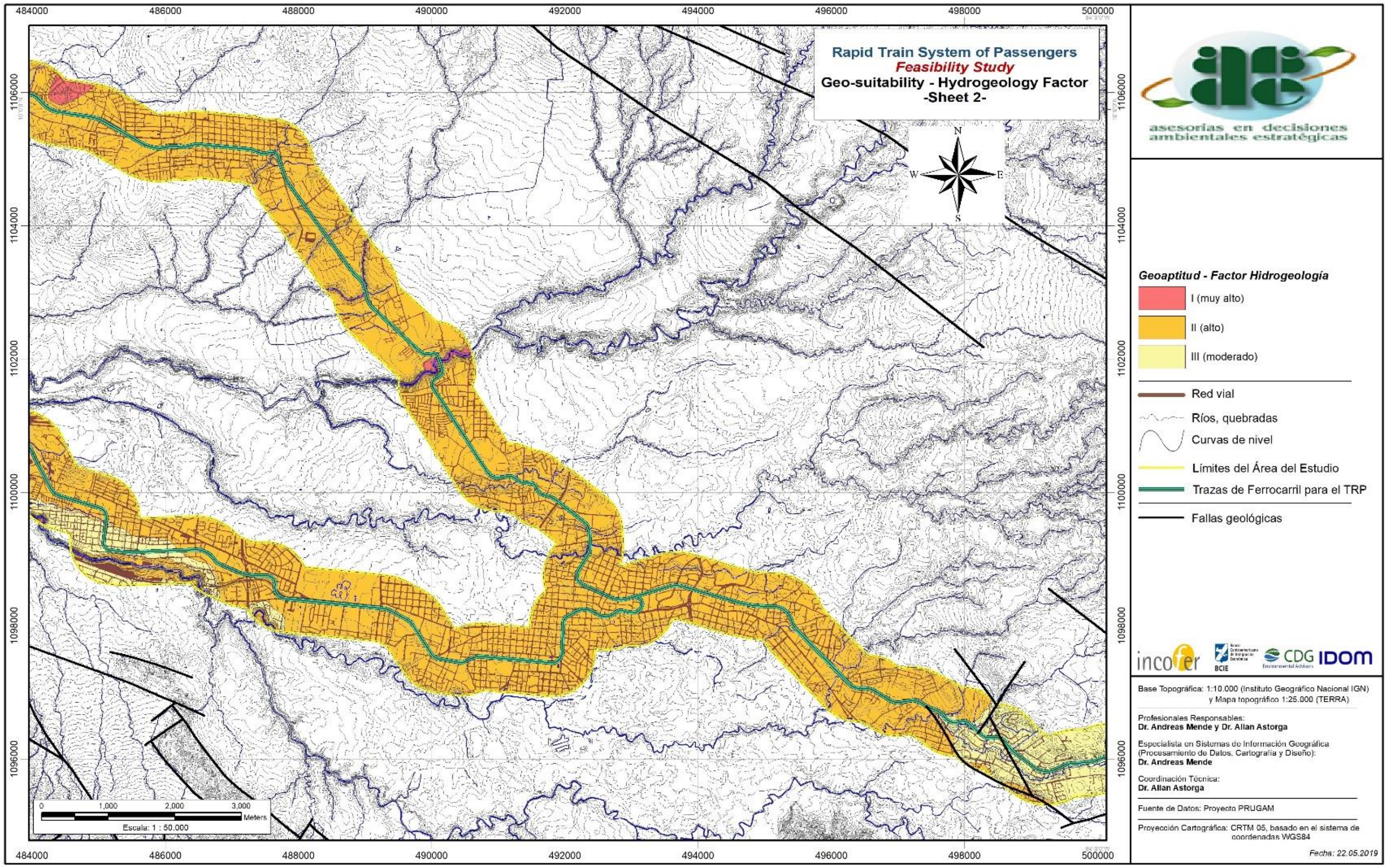
MG 6.3. Hydrogeogological map, sheet 3



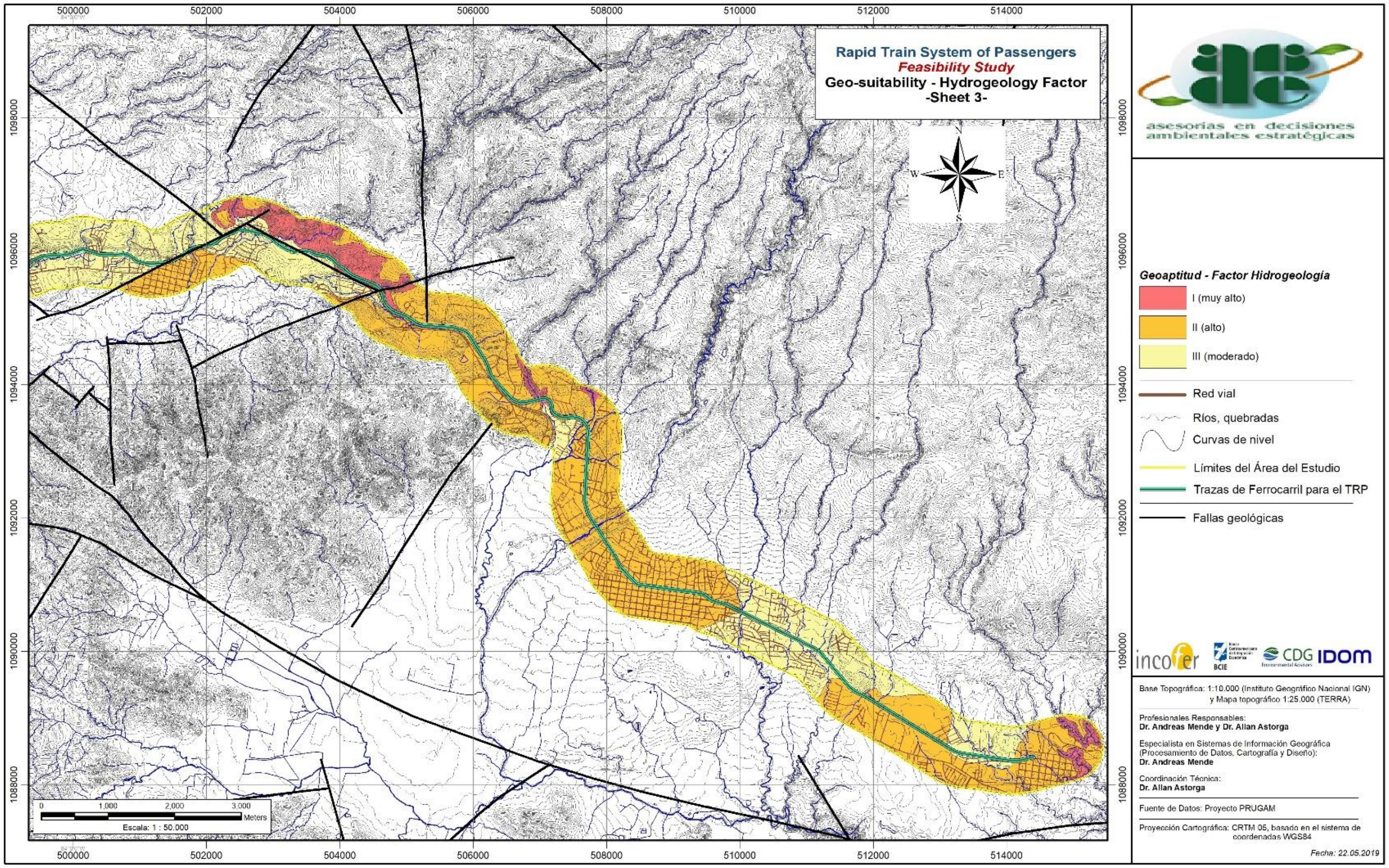
MG 7.1. Geo-Sustability Hydrogeogological factor, sheet 1



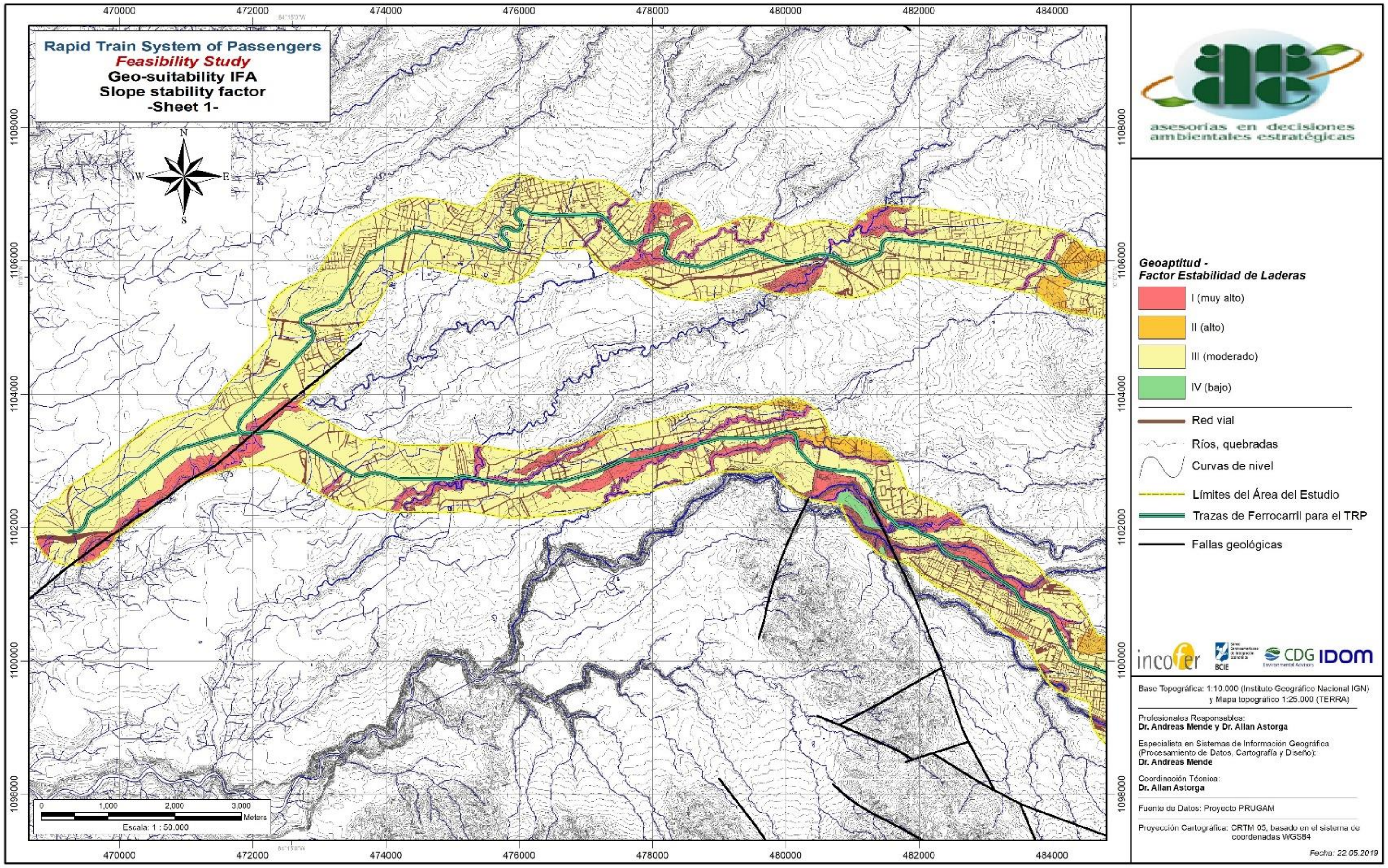
MG 7.2. Geo-Sustability Hydrogeogological factor, sheet 2



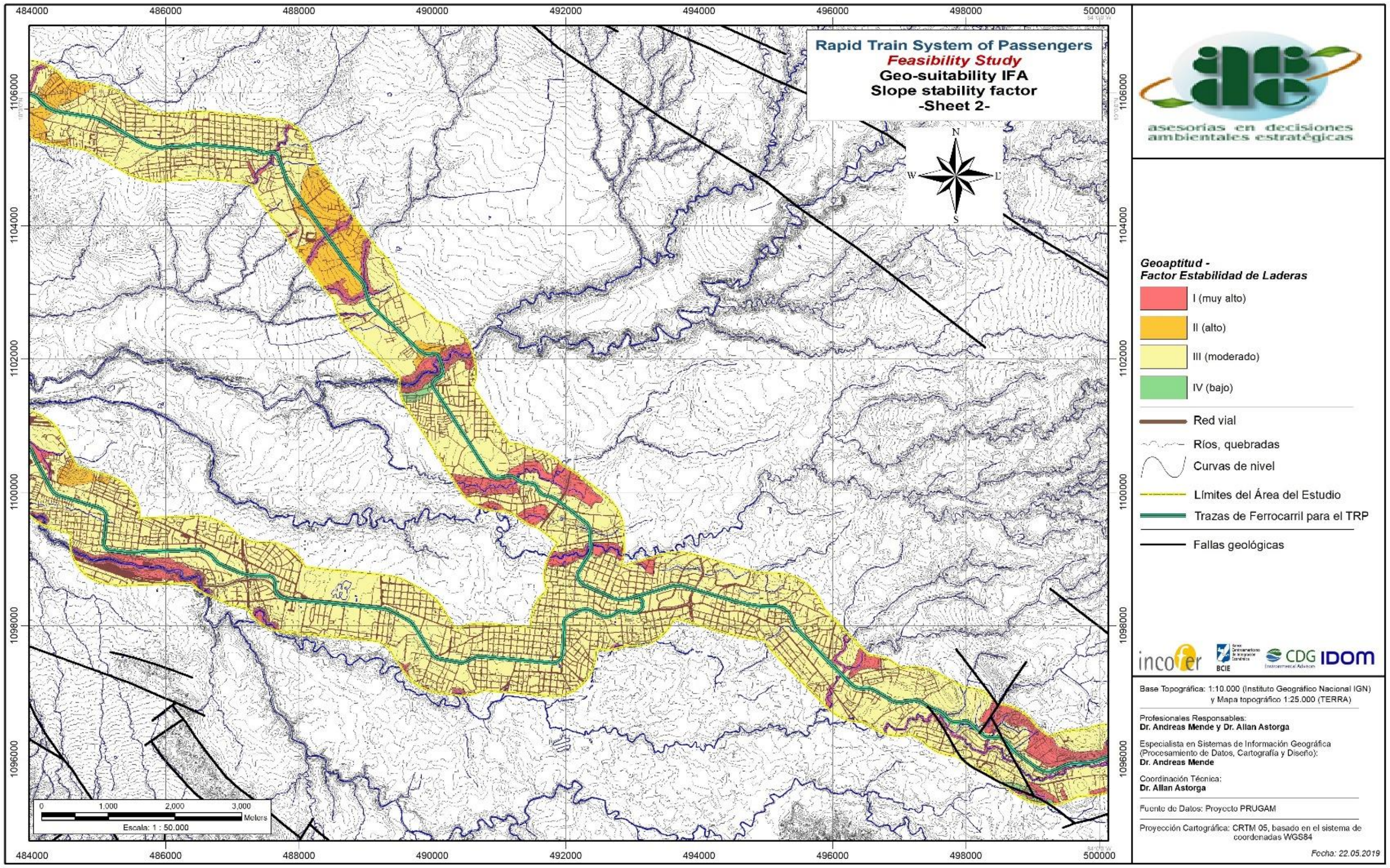
MG 7.3. Geo-Sustability Hydrogeogological factor, sheet 3



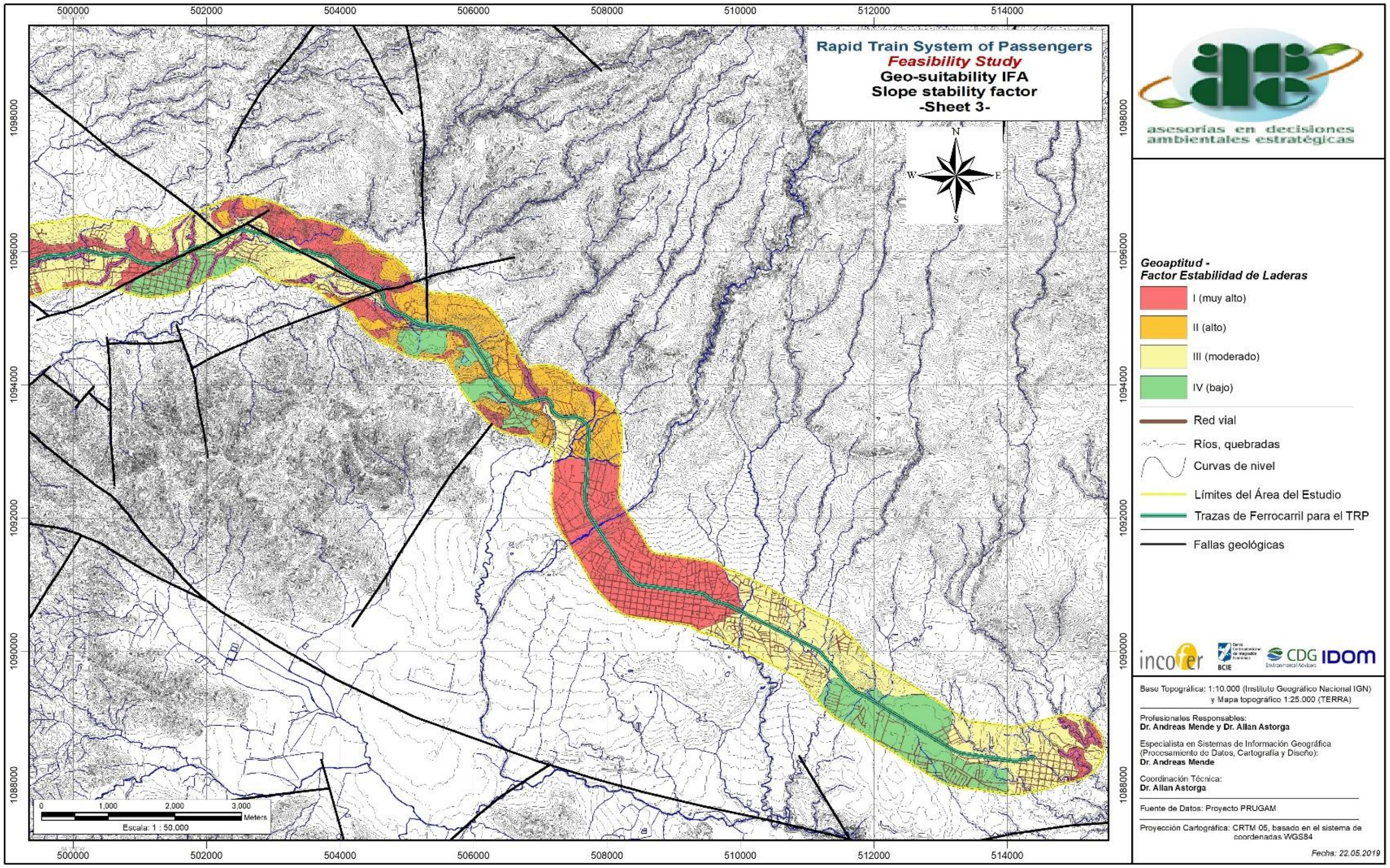
MG 8.1. Slope stability factor, sheet 1



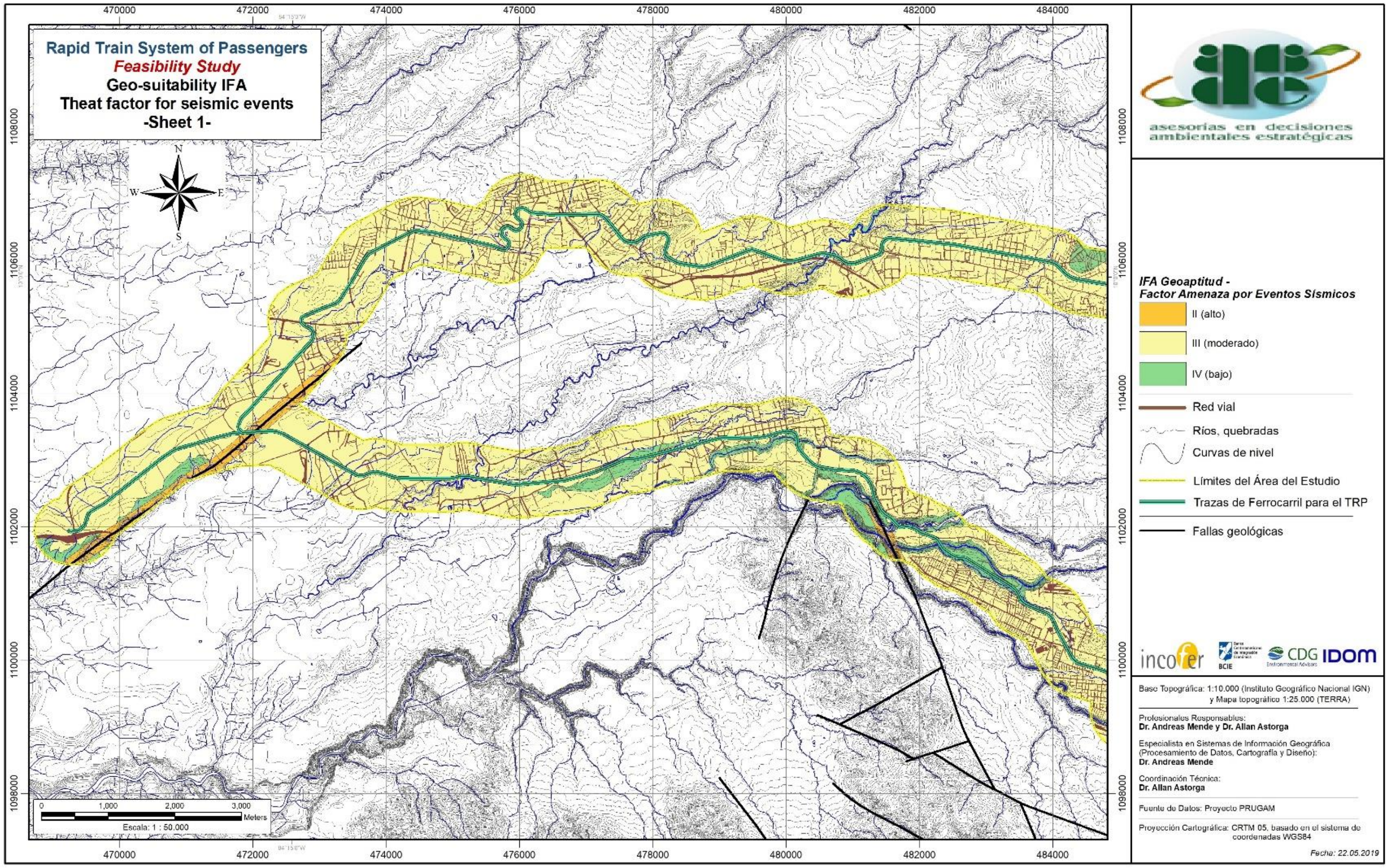
MG 8.2. Slope stability factor, sheet 2



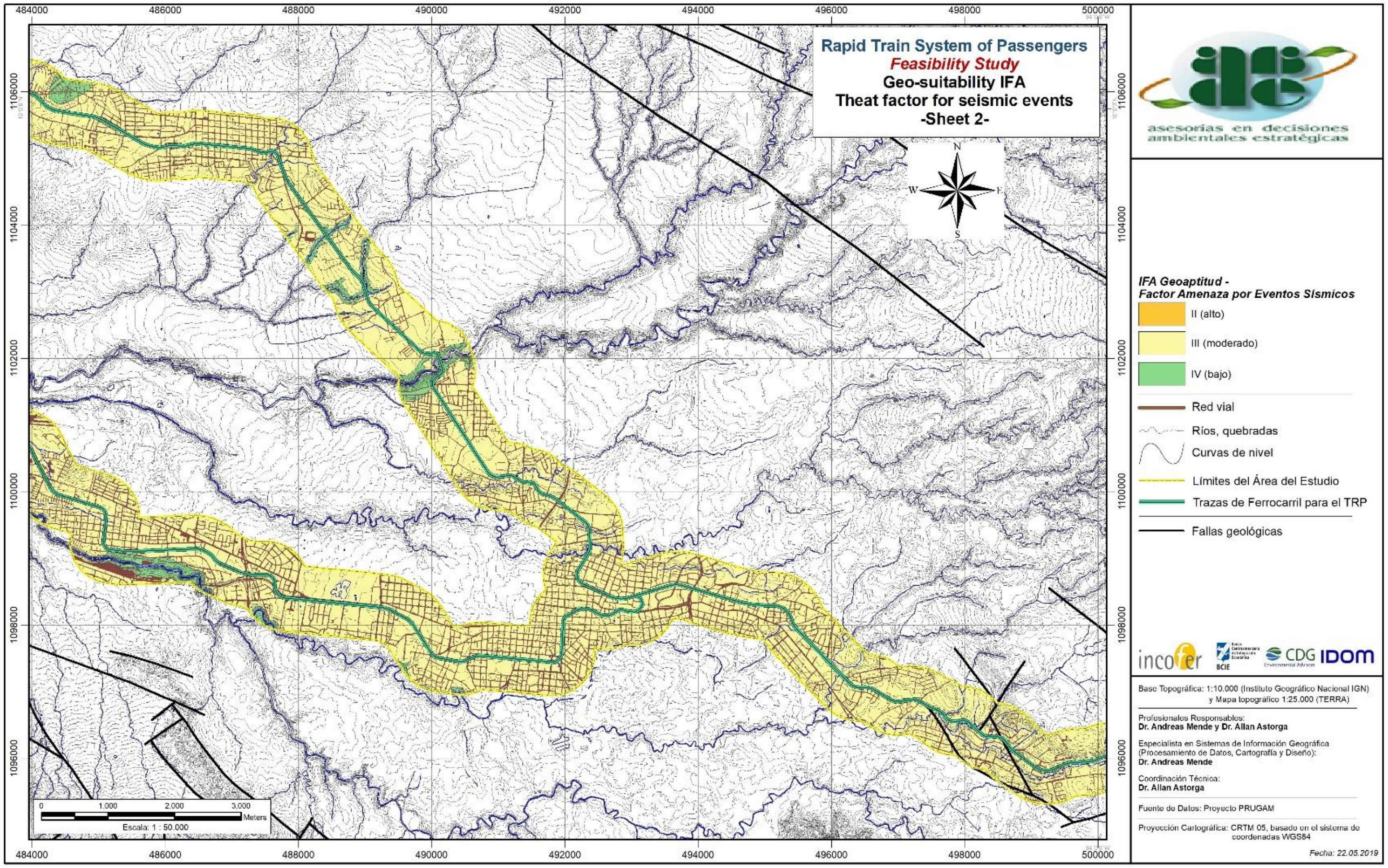
MG 8.3. Slope stability factor, sheet 3



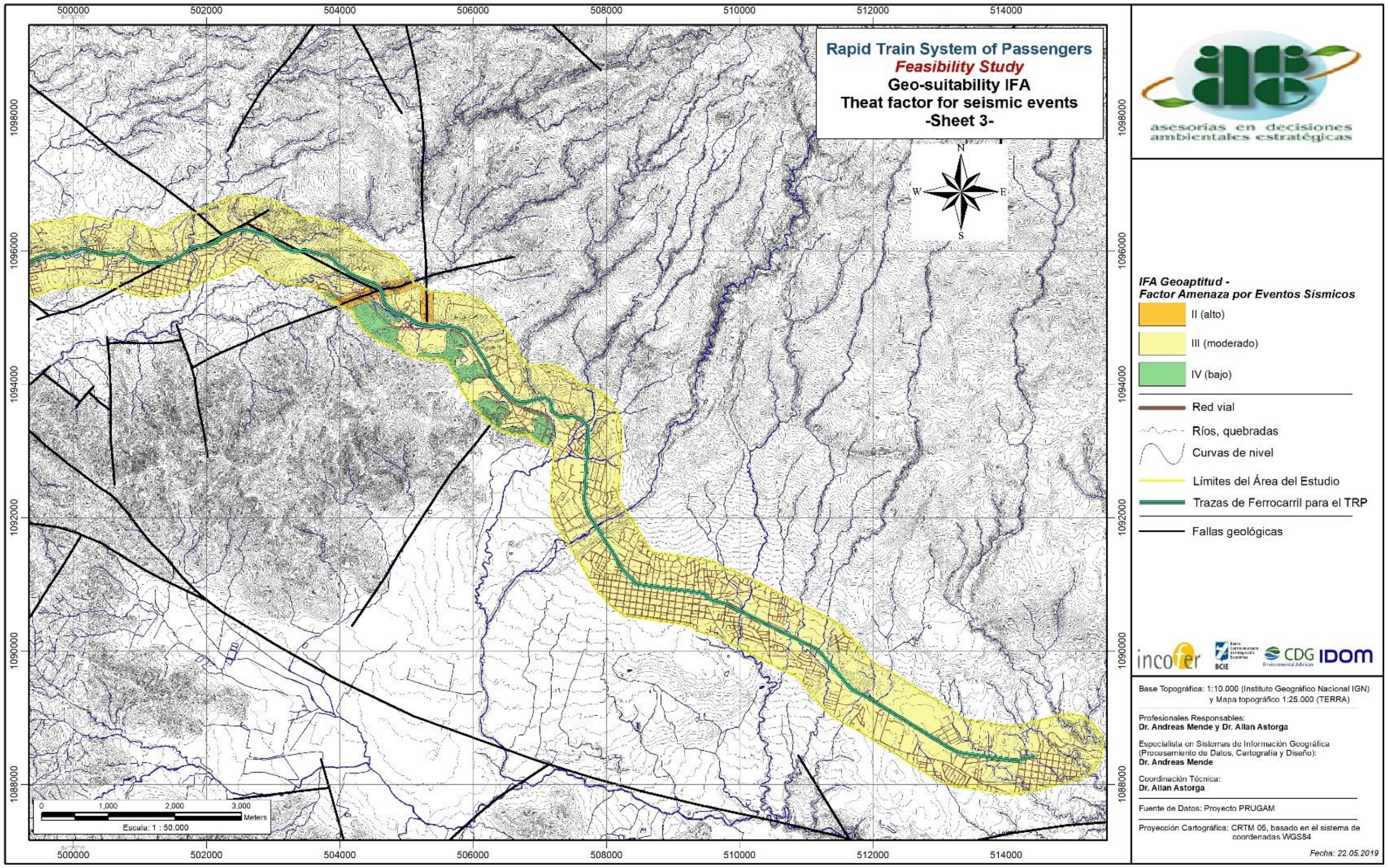
MG 9.1. Threat factor for seismic events, sheet 1



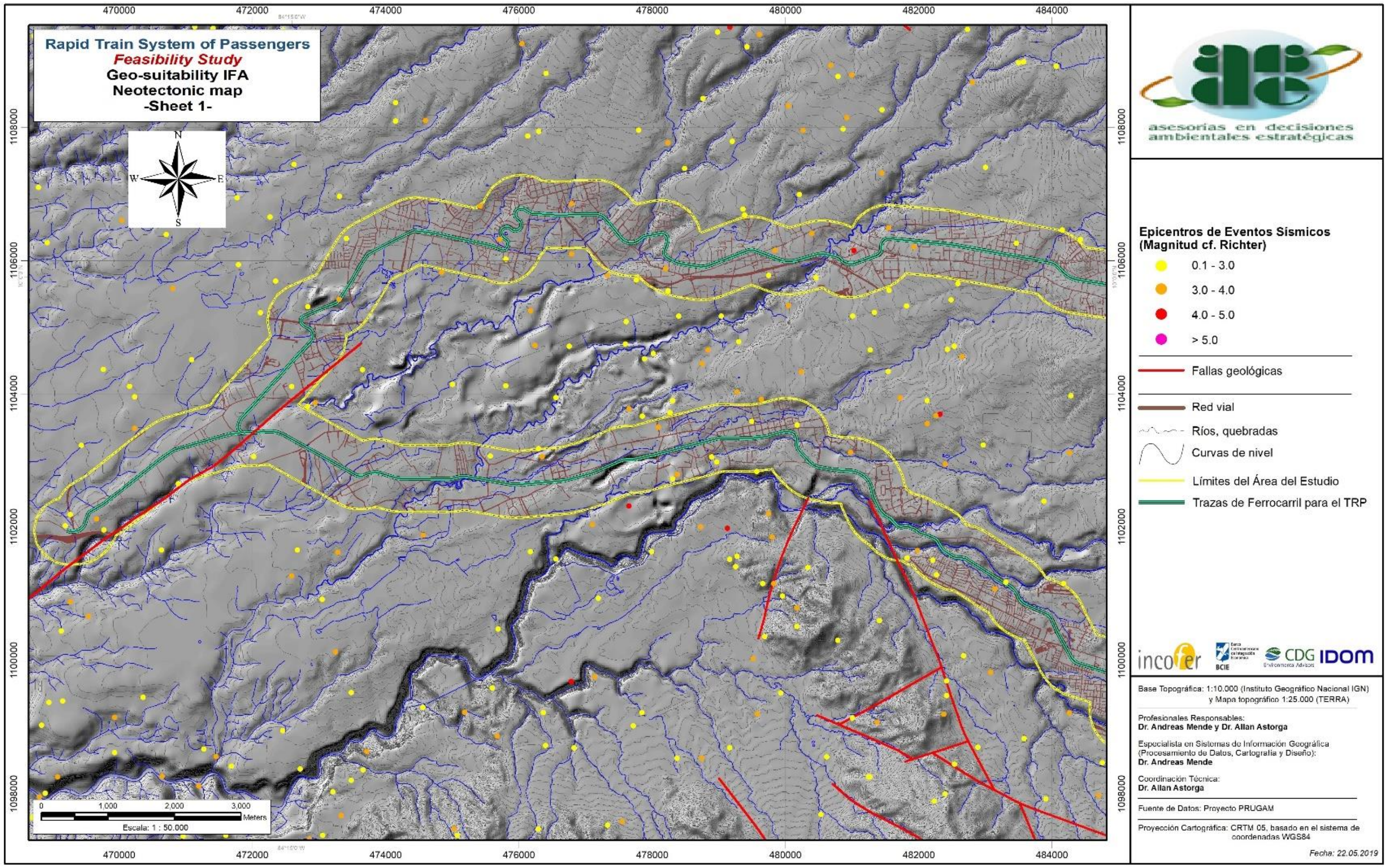
MG 9.2. Threat factor for seismic events, sheet 2



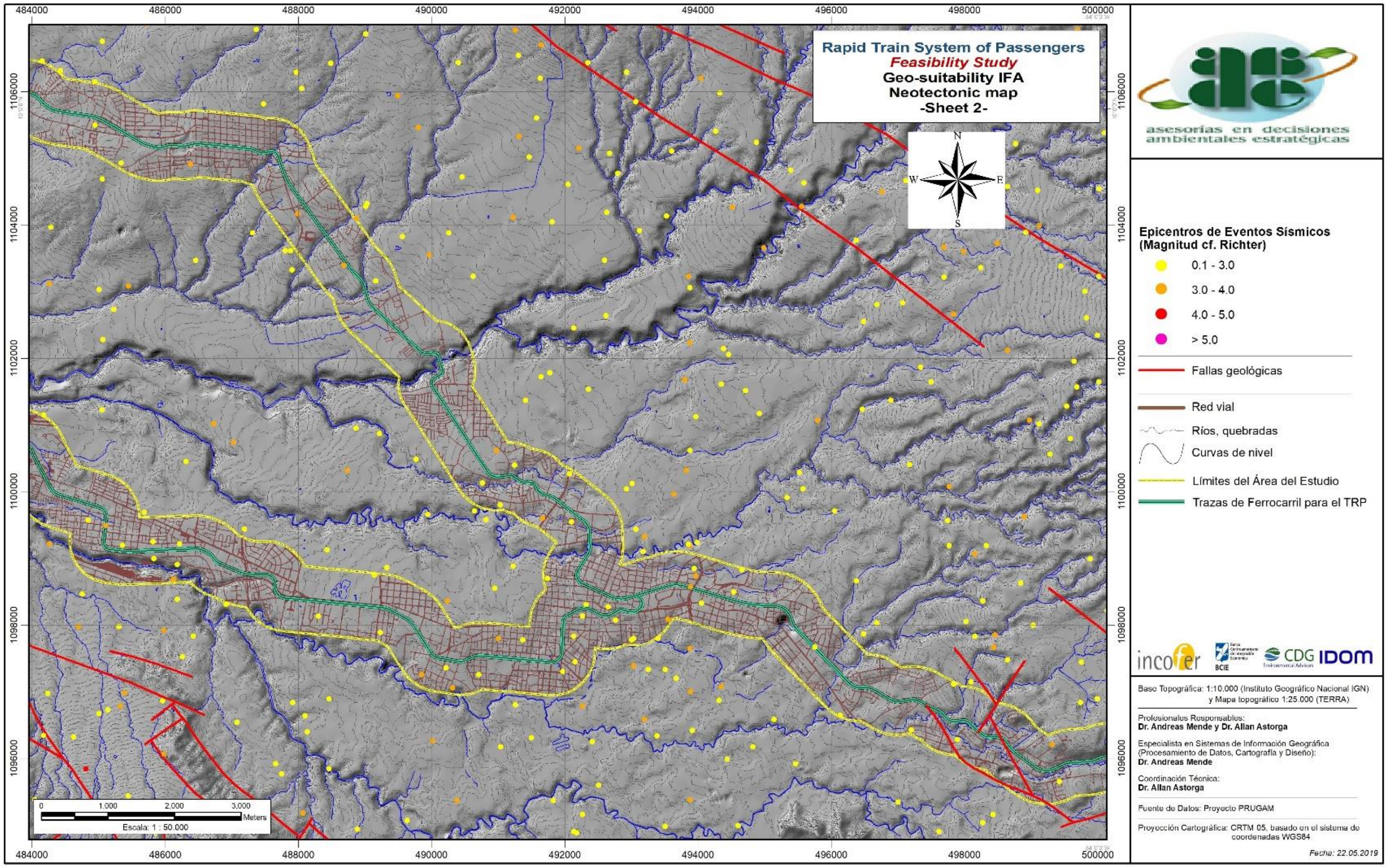
MG 9.3. Threat factor for seismic events, sheet 3



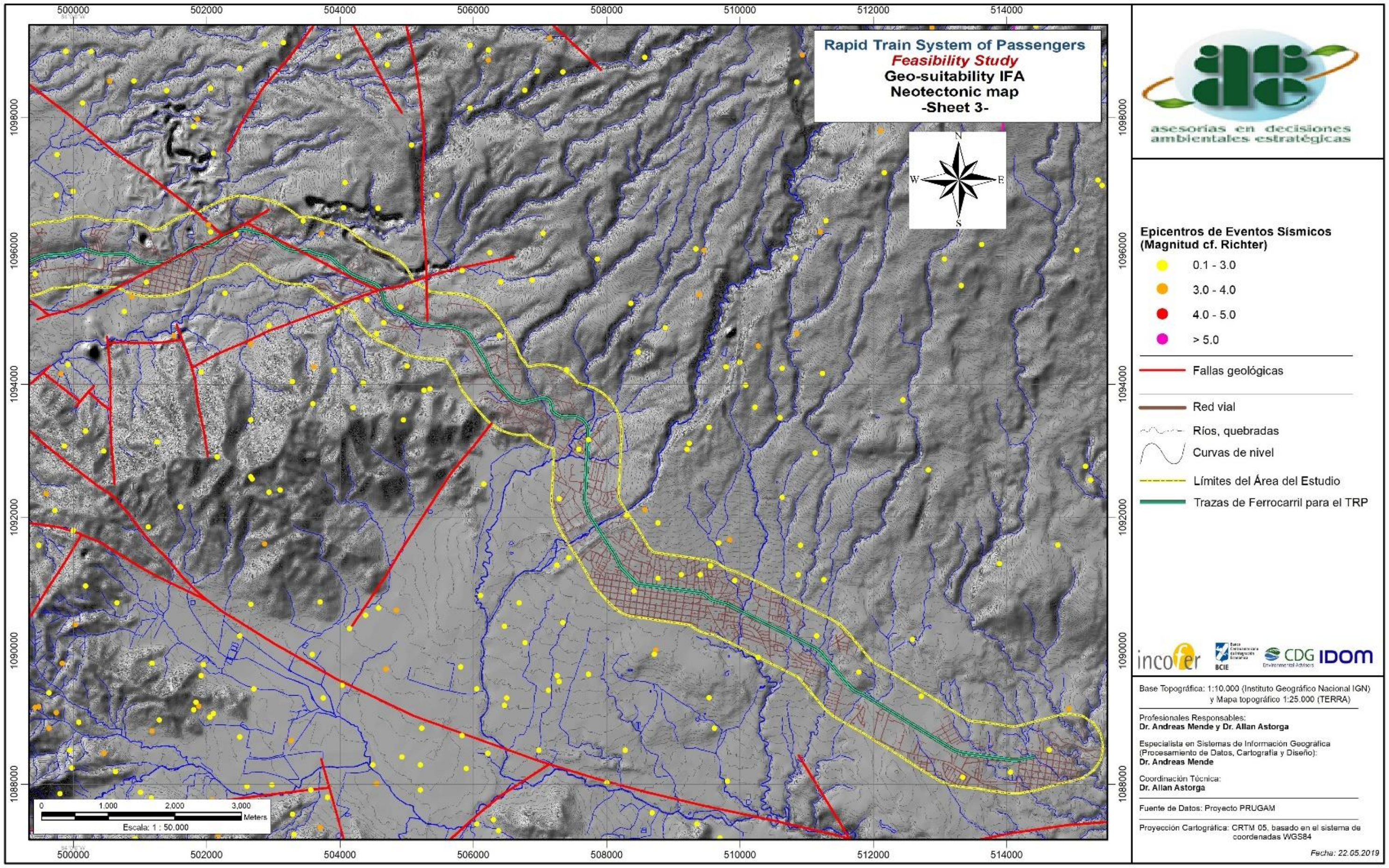
MG 10.1. Neotectonic map, sheet 1



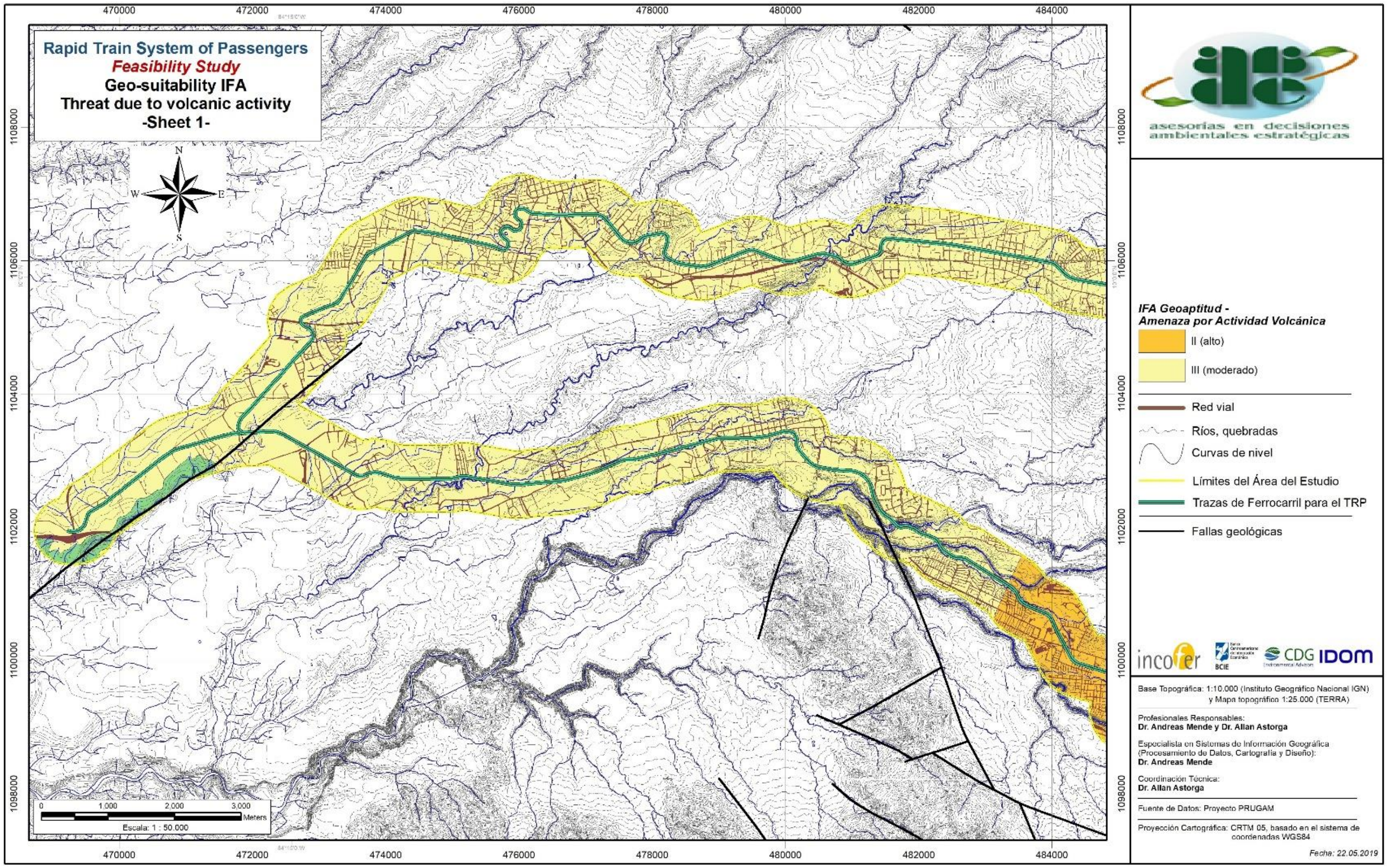
MG 10.2. Neotectonic map, sheet 2



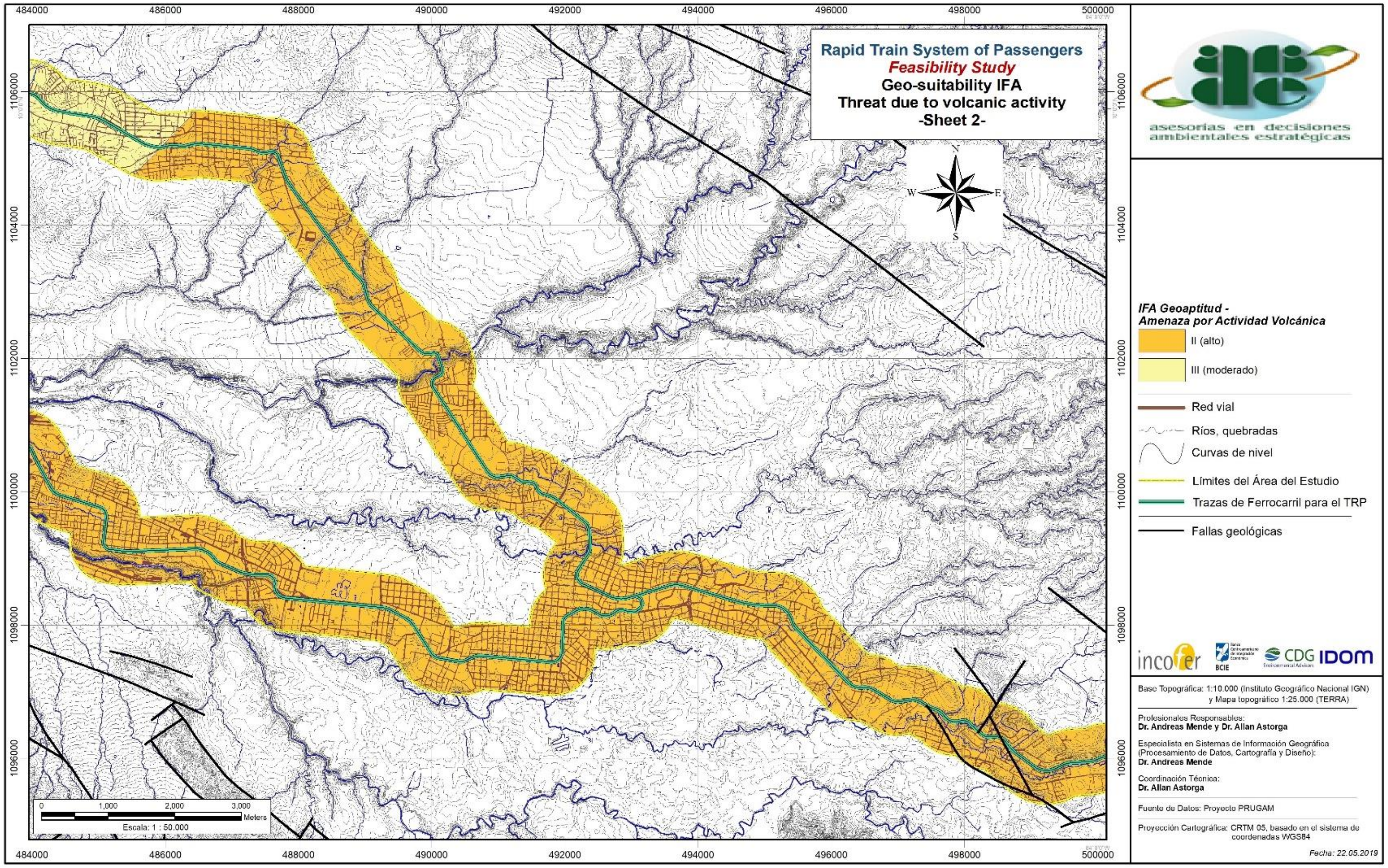
MG 10.3. Neotectonic map, sheet 3



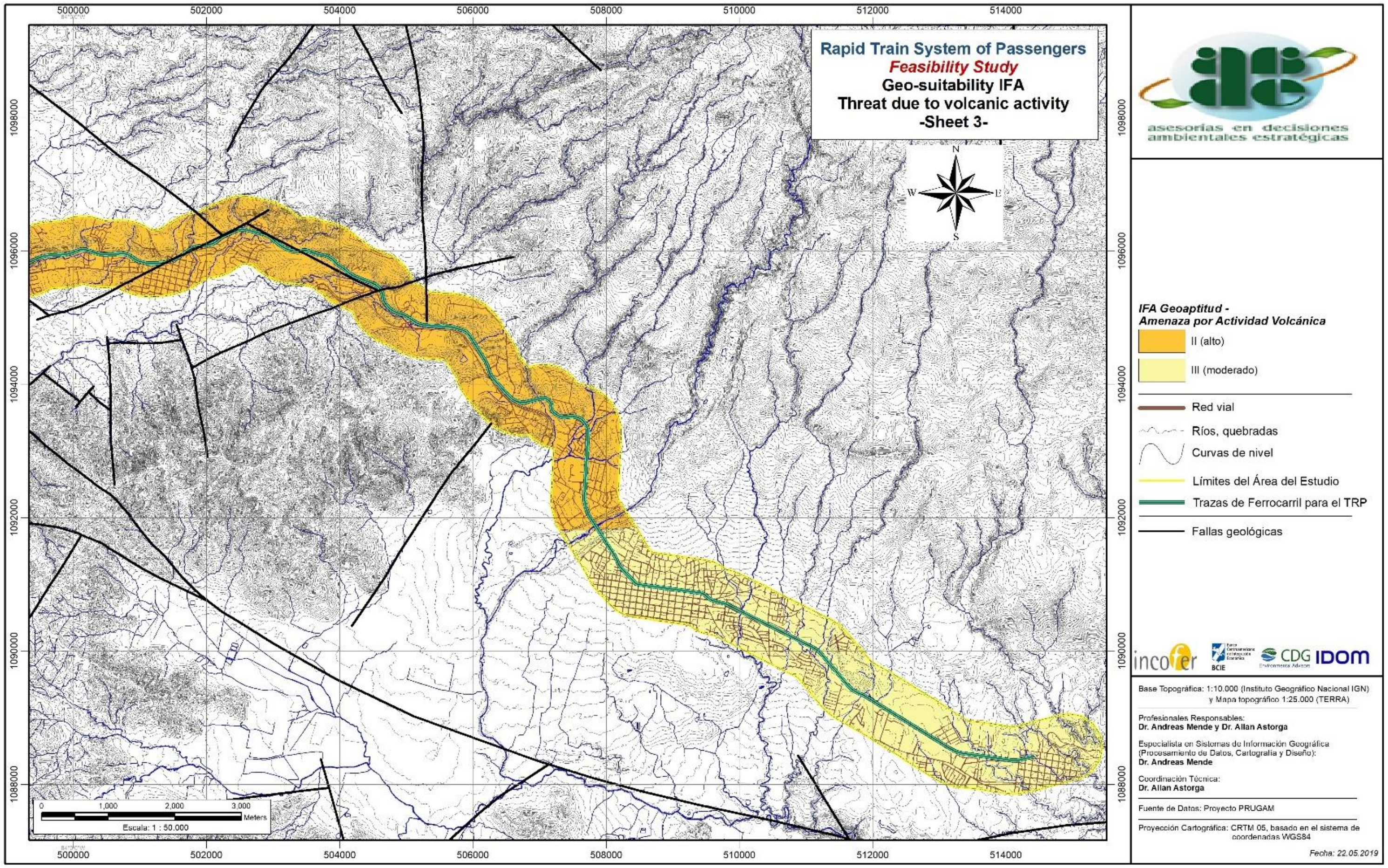
MG 11.1. Threat due volcanic activity, sheet 1



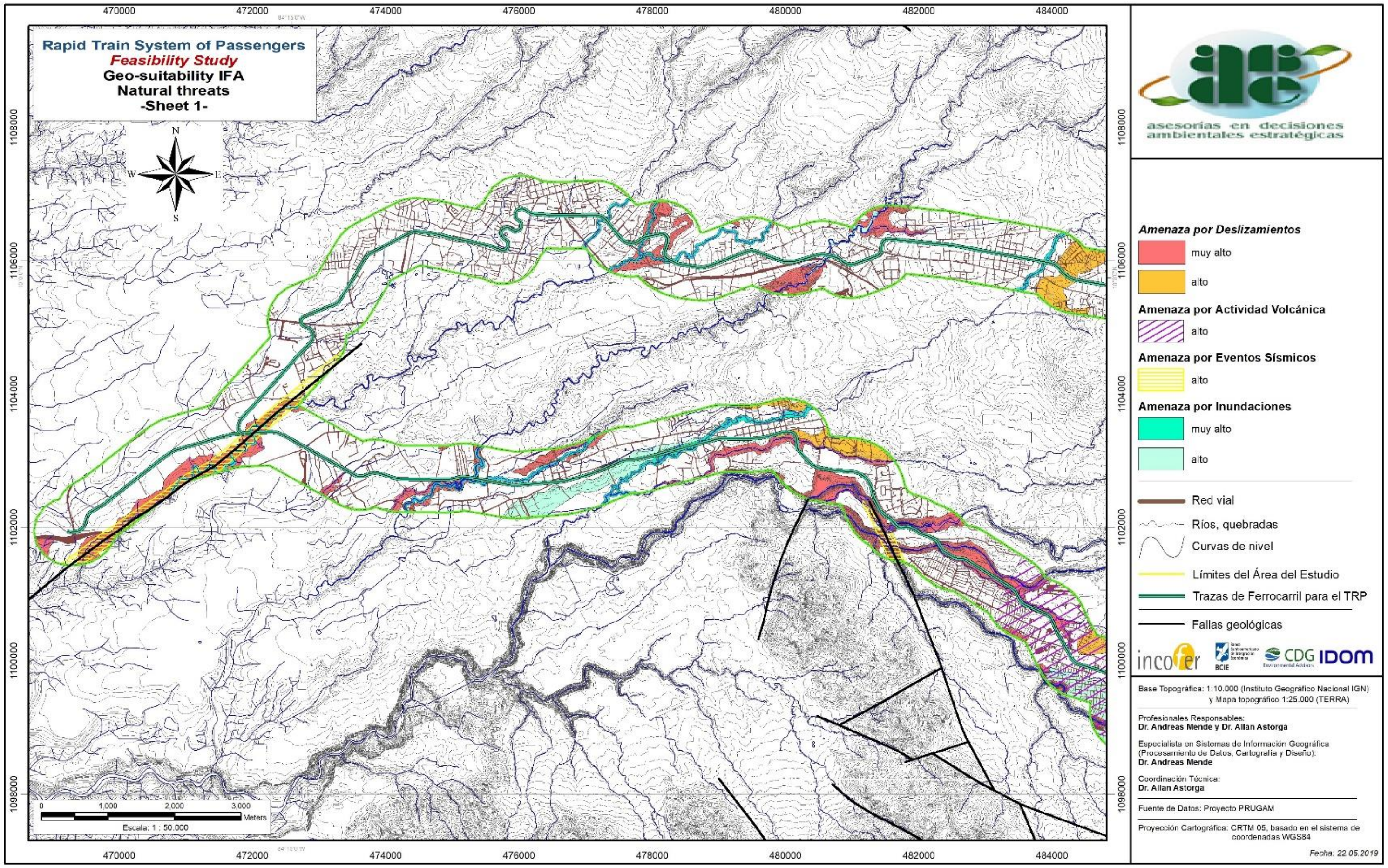
MG 11.2. Threat due volcanic activity, sheet 2



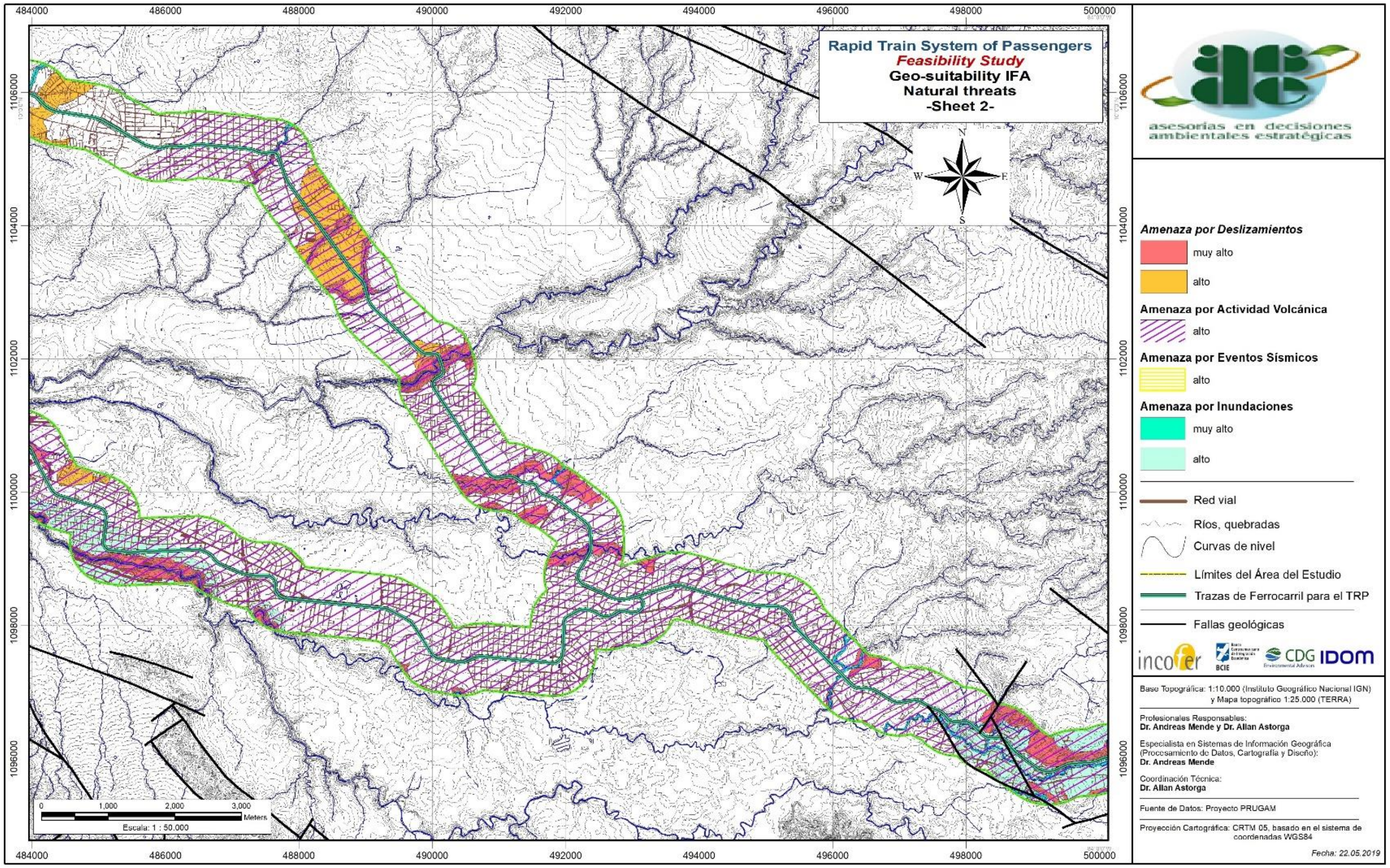
MG 11.3. Threat due volcanic activity, sheet 3



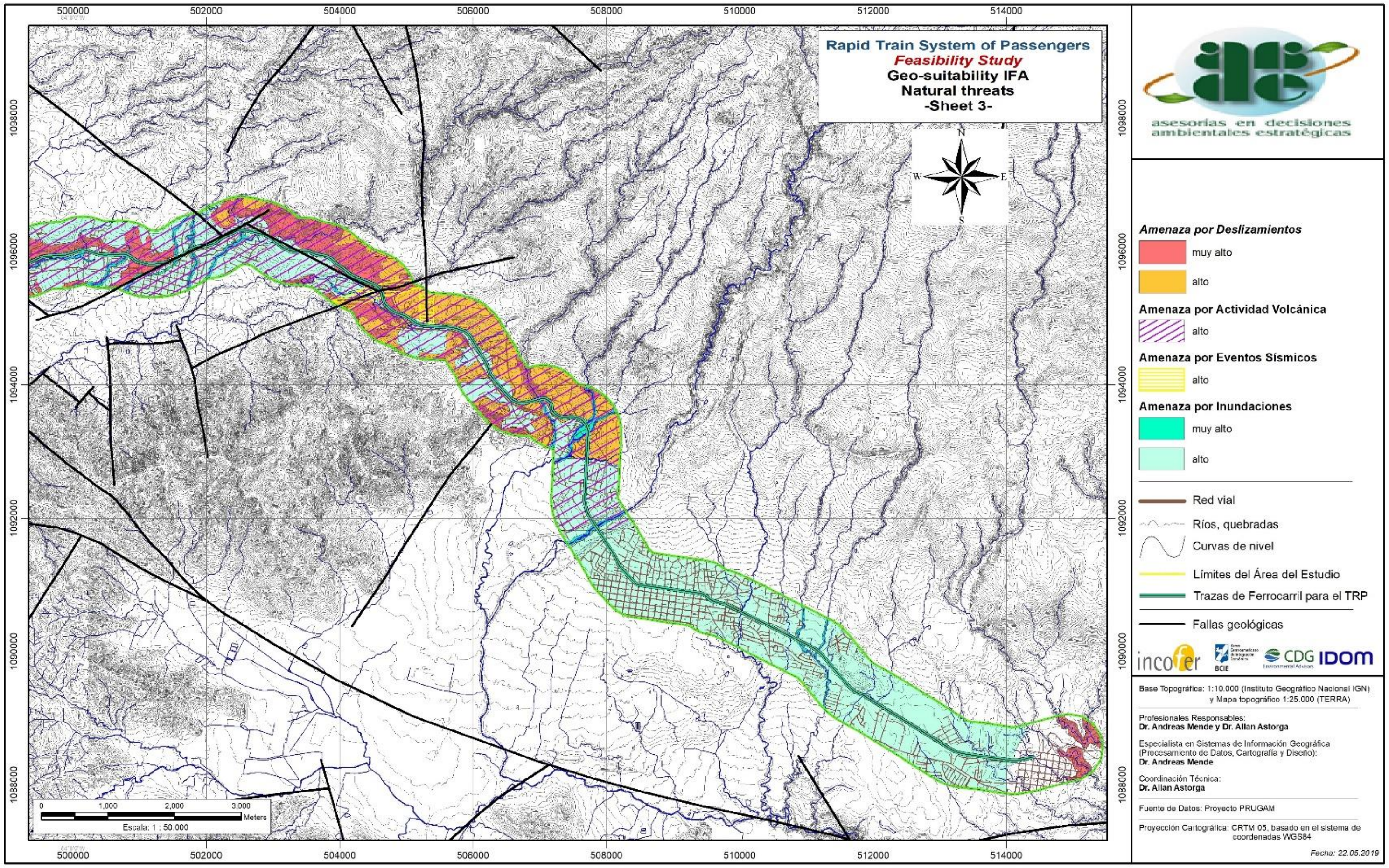
MG 12.1. Natural threats map, sheet 1



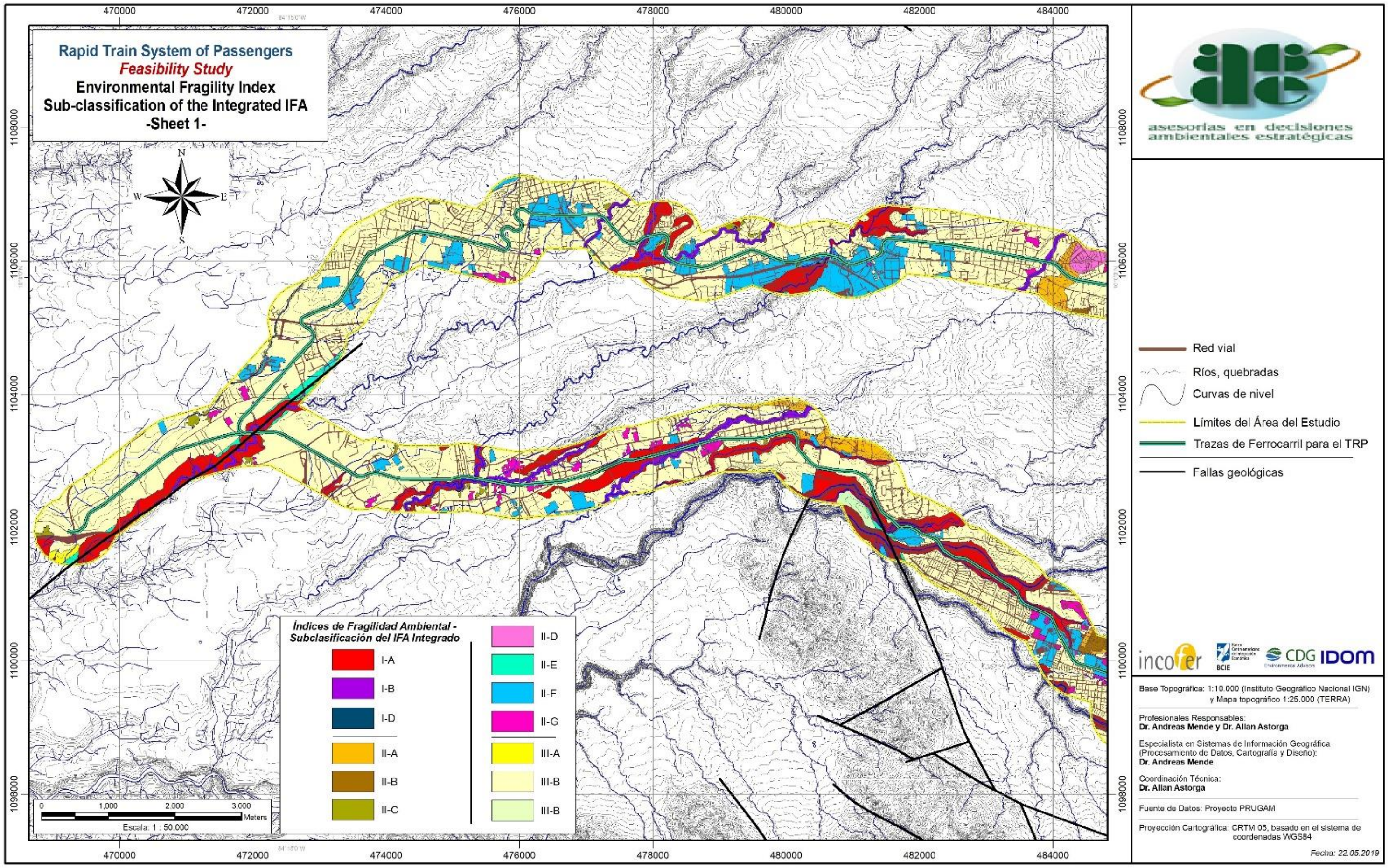
MG 12.2. Natural threats map, sheet 2



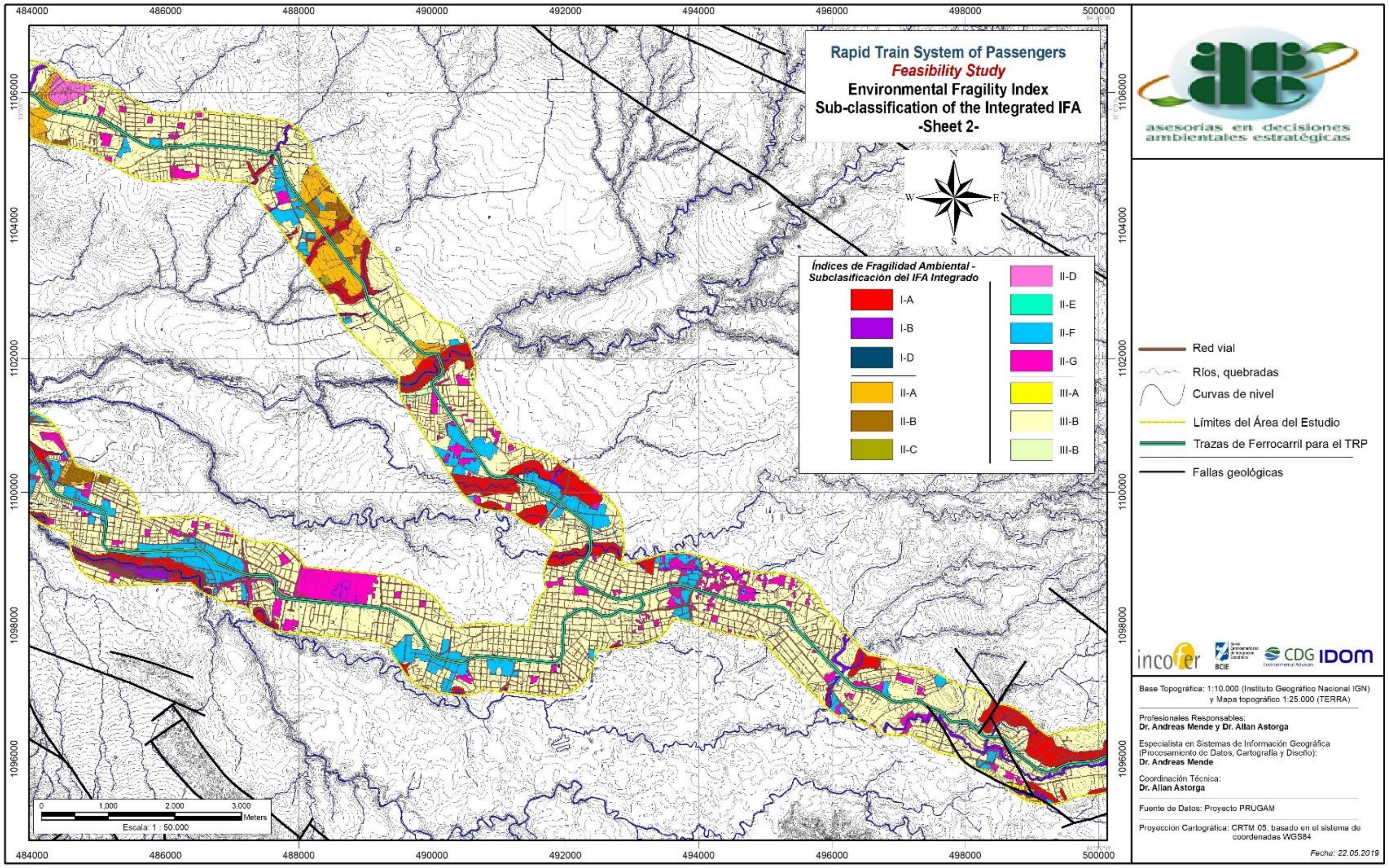
MG 12.3. Natural threats map, sheet 3



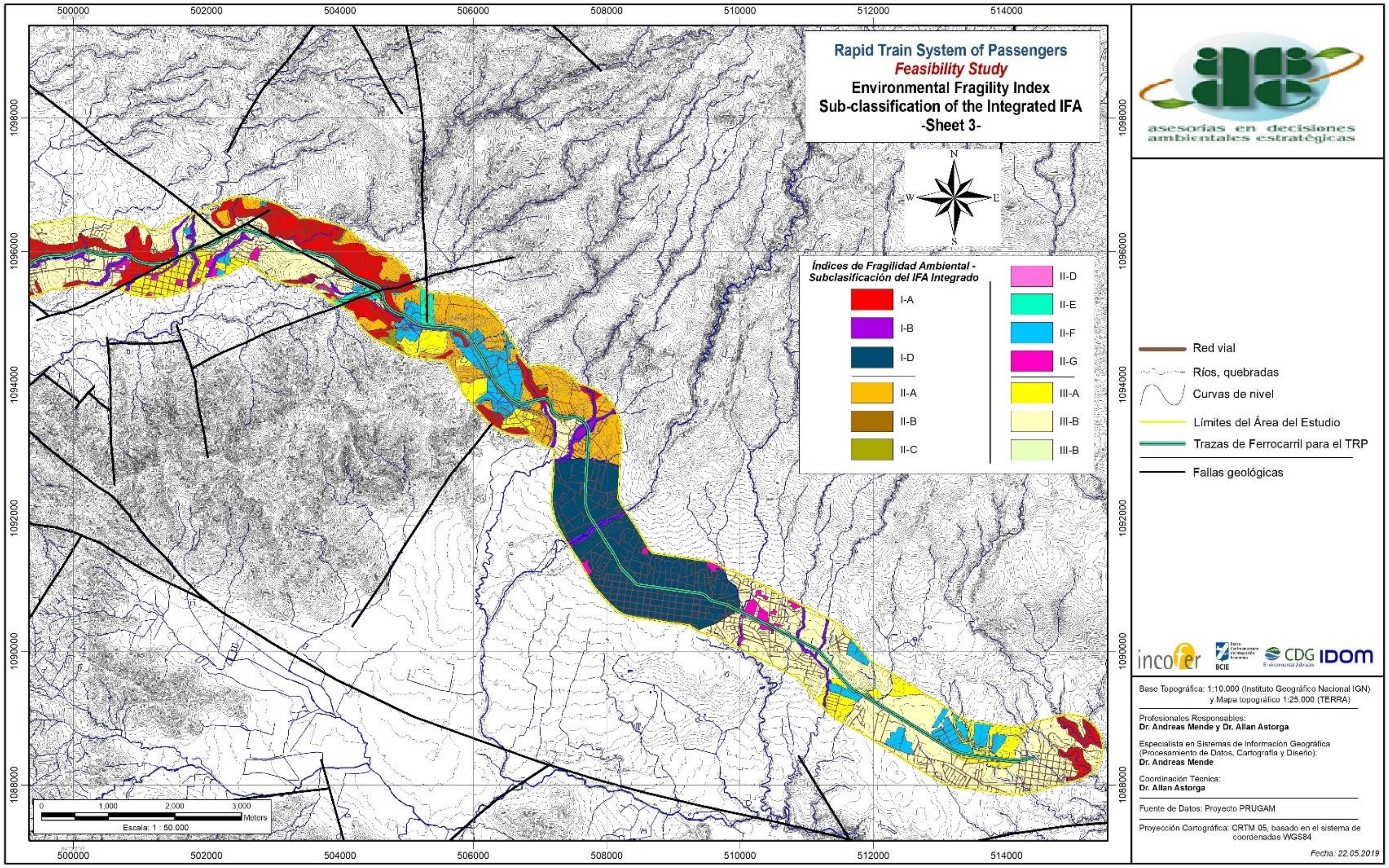
MG 13.1. Sub-classificacion of the integrated IFA, sheet 1



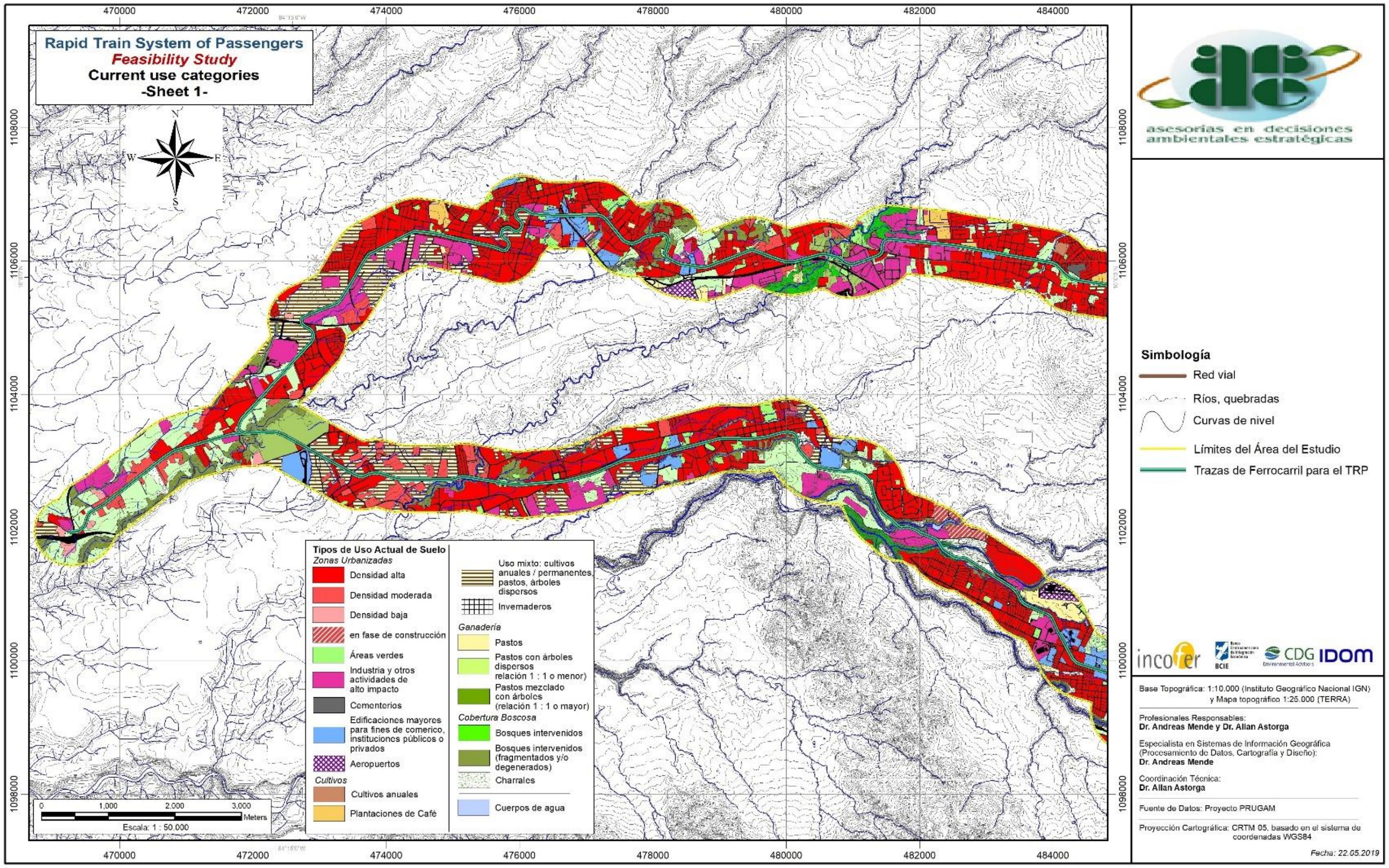
MG 13.2. Sub-classificacion of the integrated IFA, sheet 2



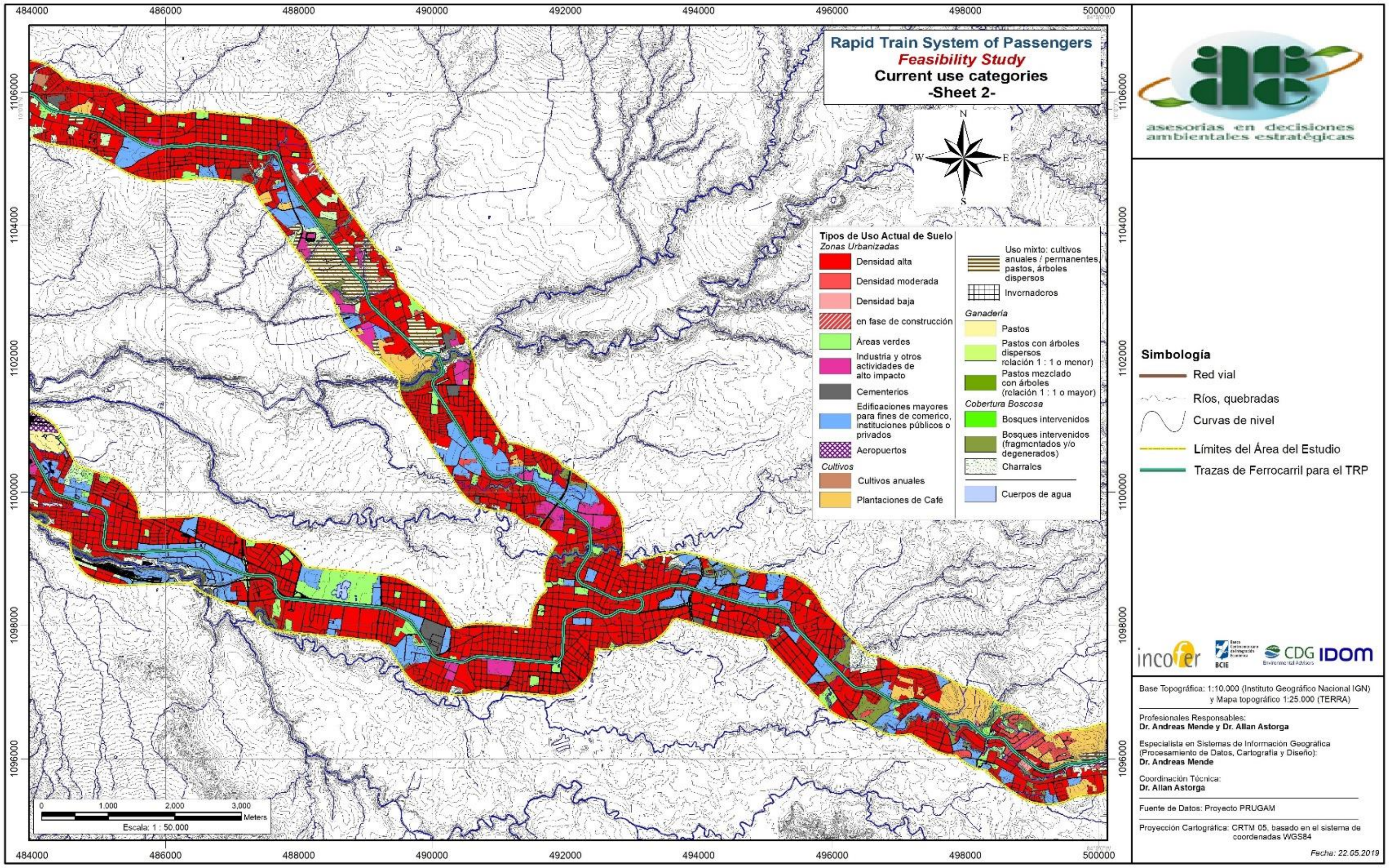
MG 13.3. Sub-classification of the integrated IFA, sheet 3



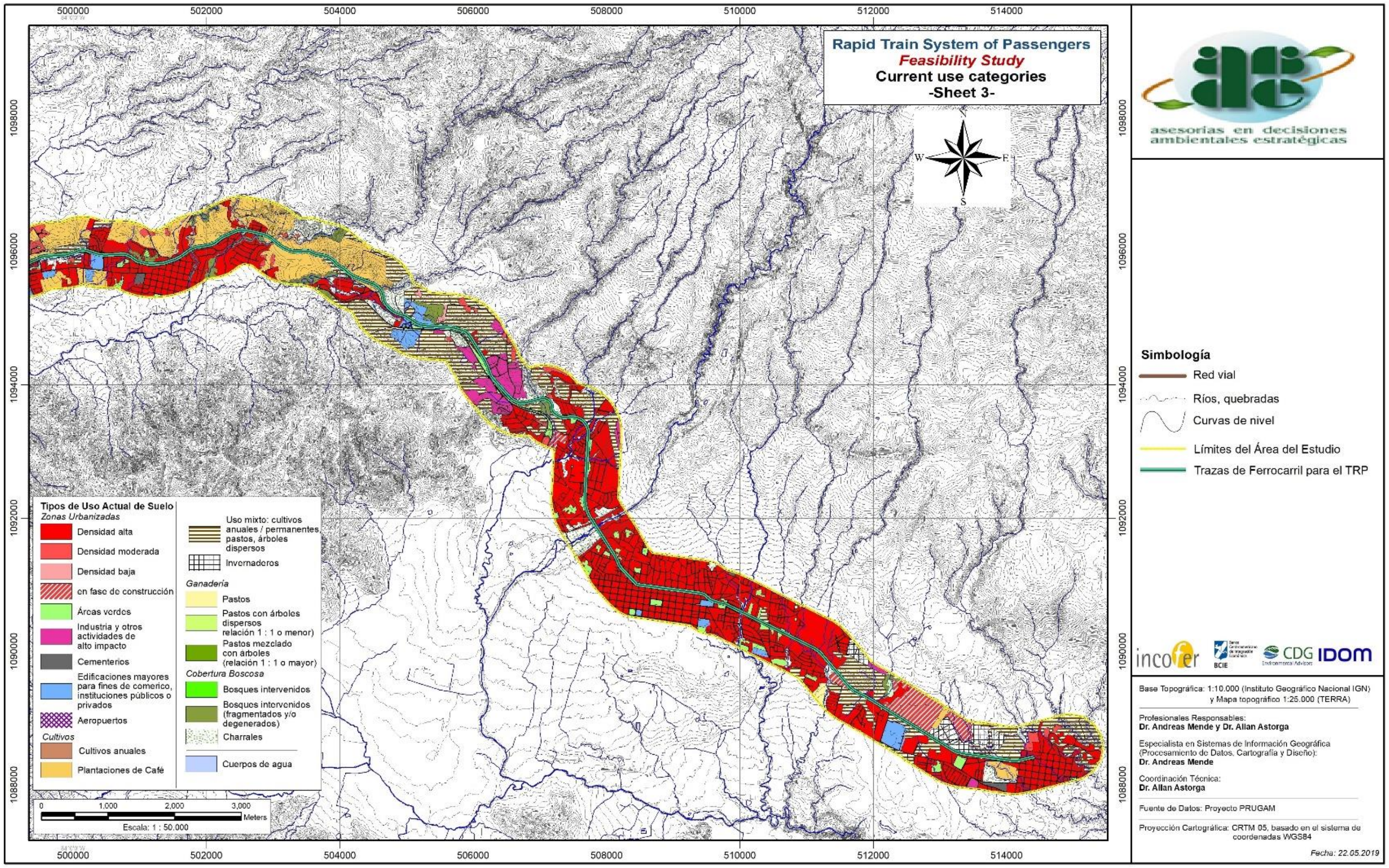
MG 14.1. Current use categories, sheet 1



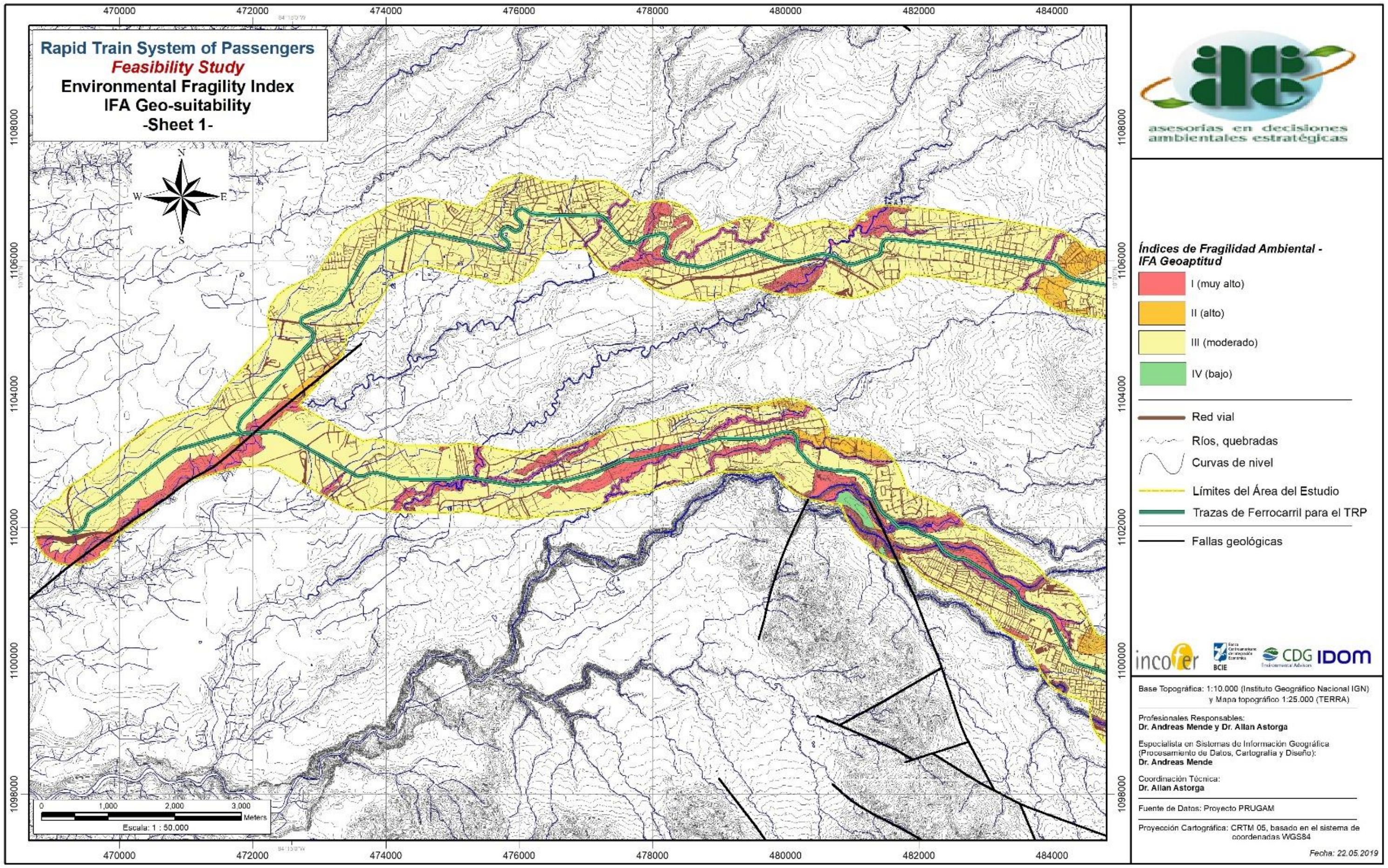
MG 14.2. Current use categories, sheet 2



MG 14.3. Current use categories, sheet 3



IFA Geo-suitability, sheet 1



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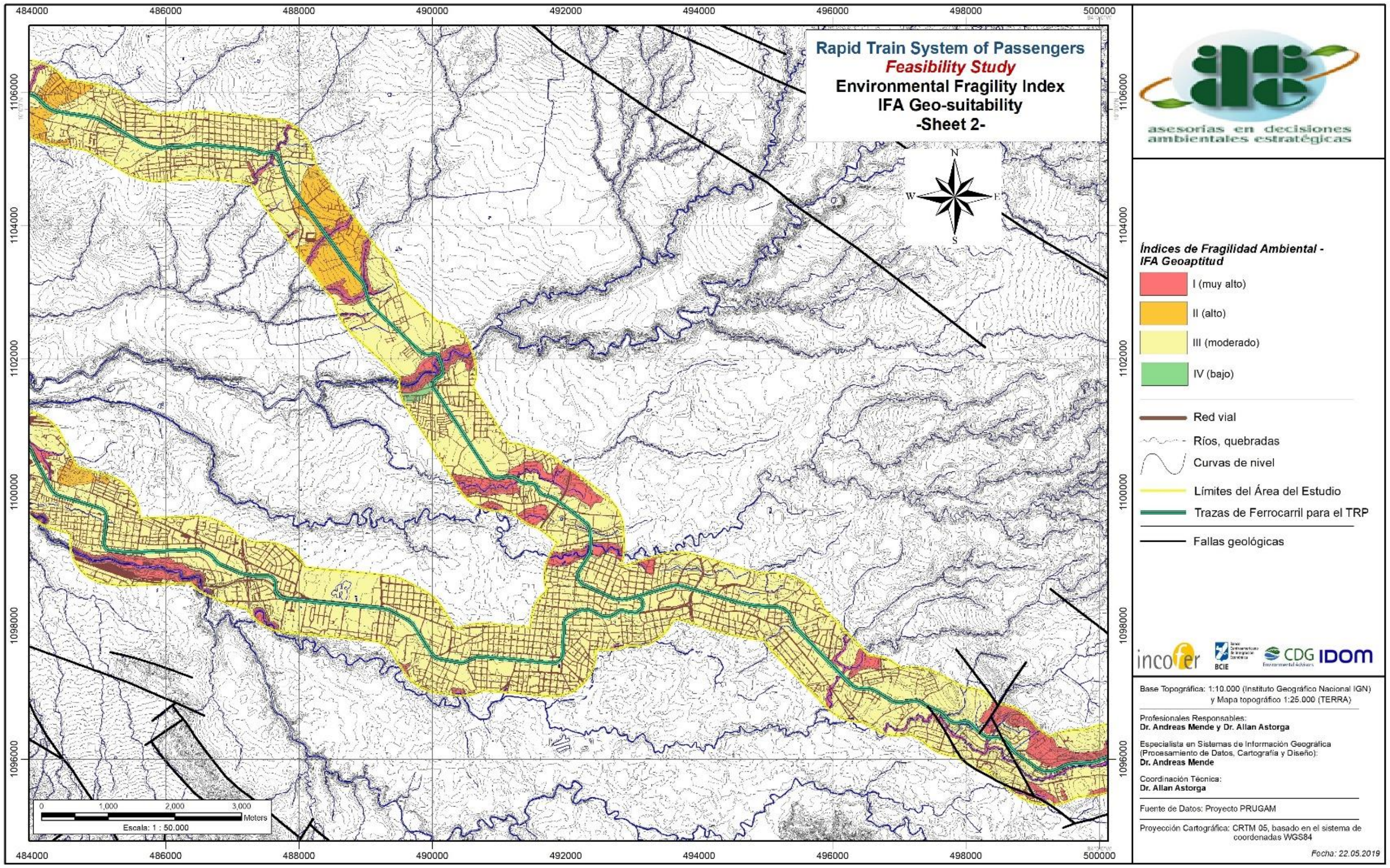
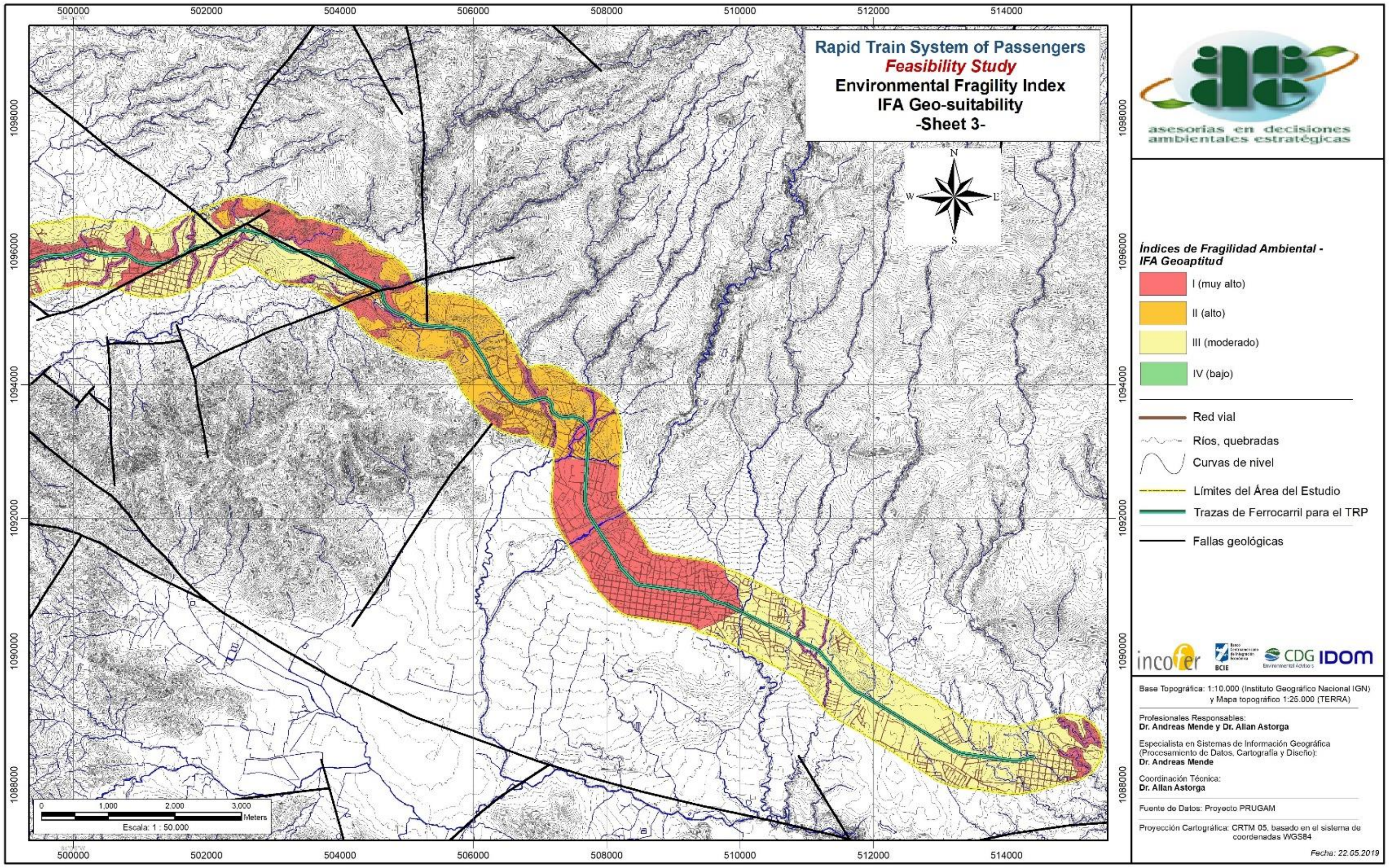
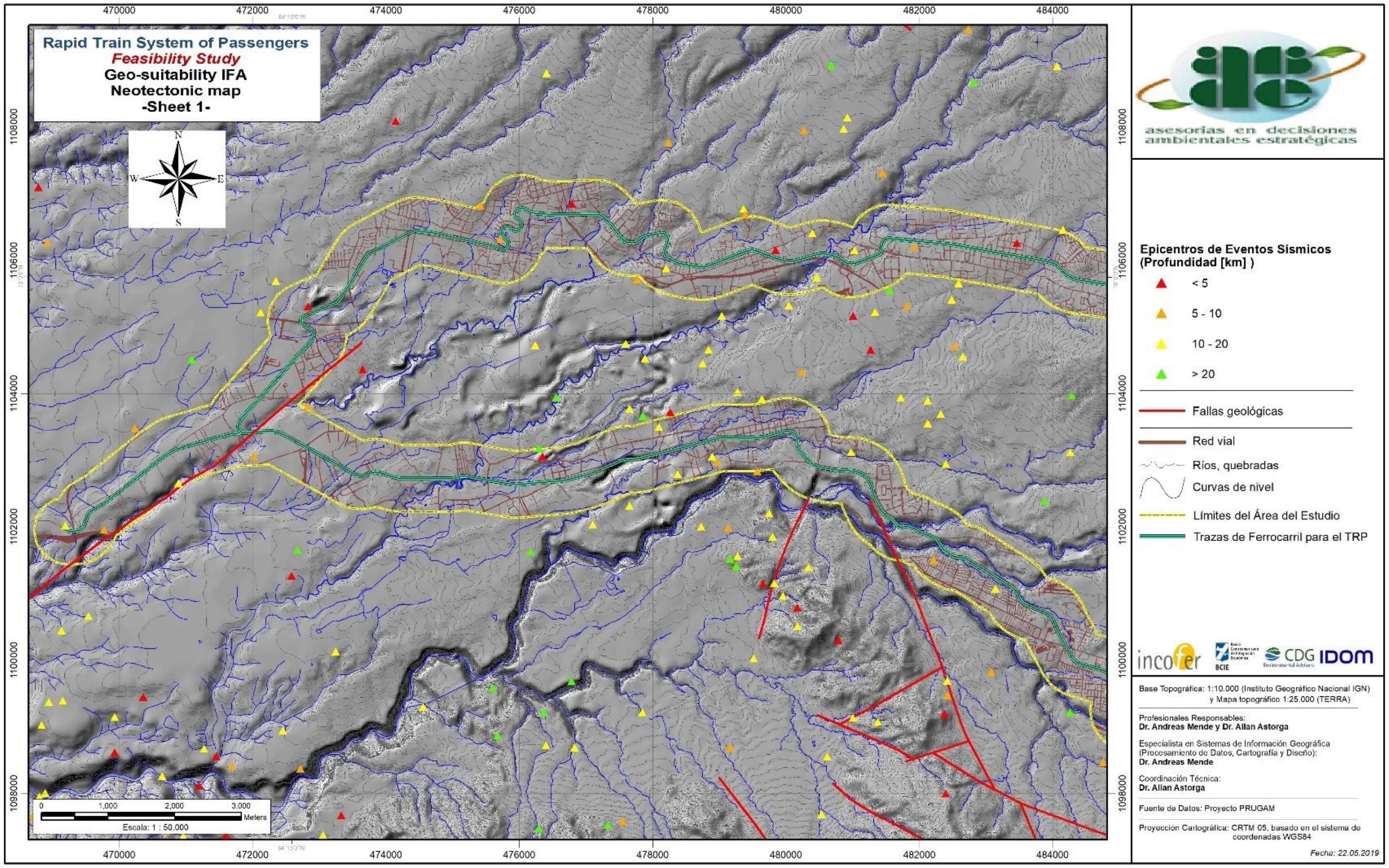


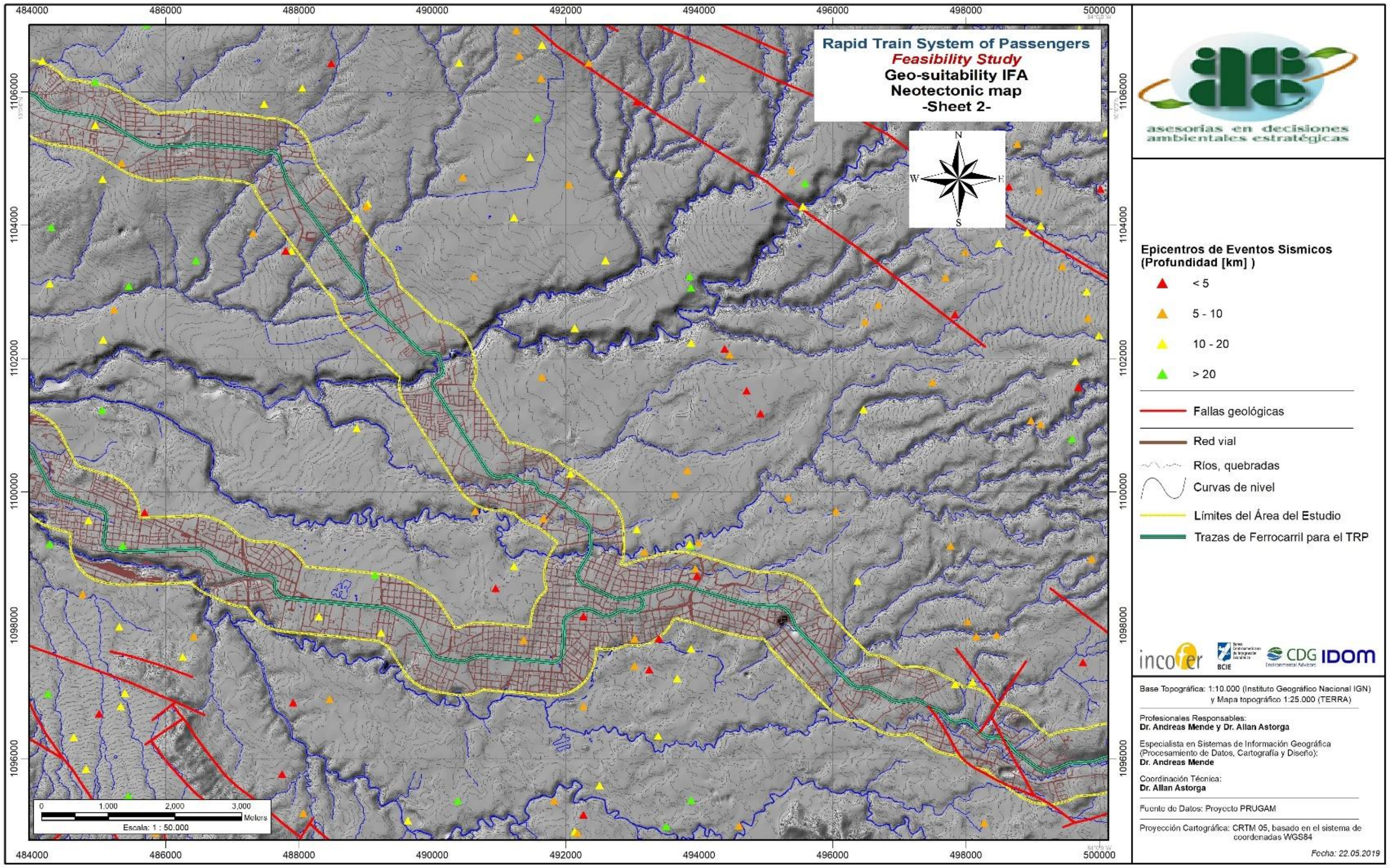
IFA Geo-suitability, sheet 3



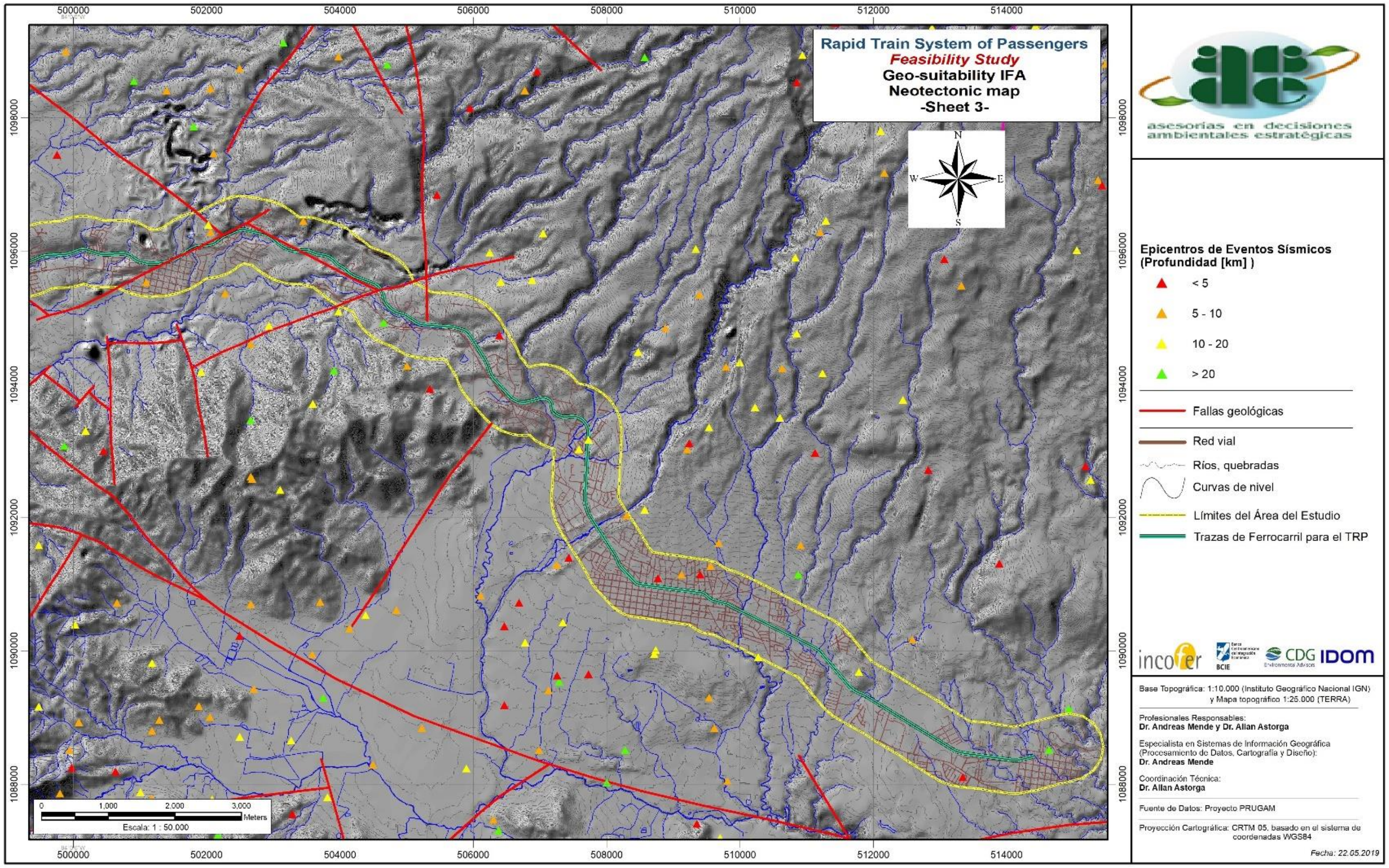
Neotectonic map, sheet 1



Neotectonic map, sheet 2

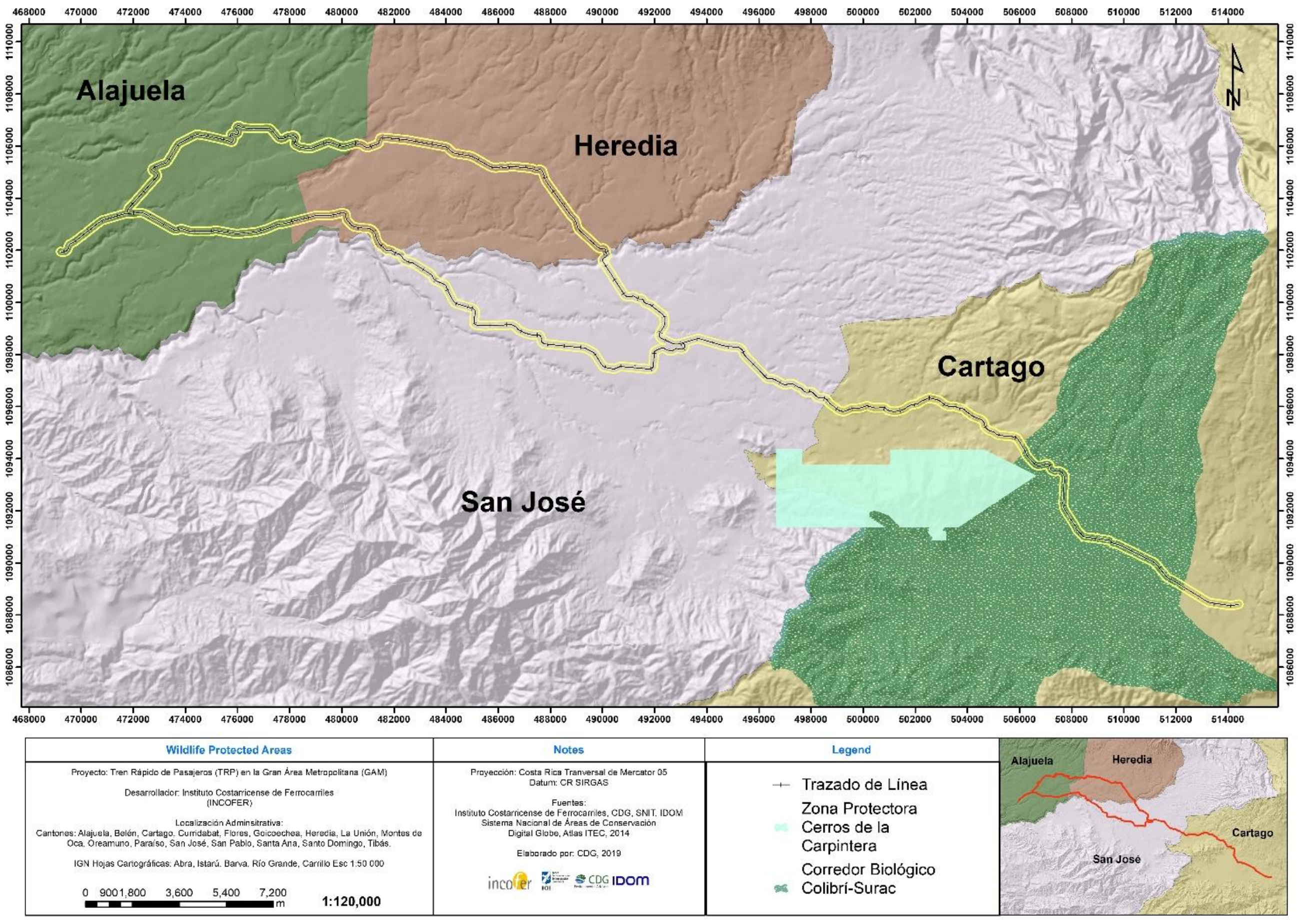


Neotectonic map, sheet 3



Annex 5. Environmental map atlas.

MA WPA


Alajuela
Heredia
Cartago
San José
Wildlife Protected Areas
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
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1:120,000
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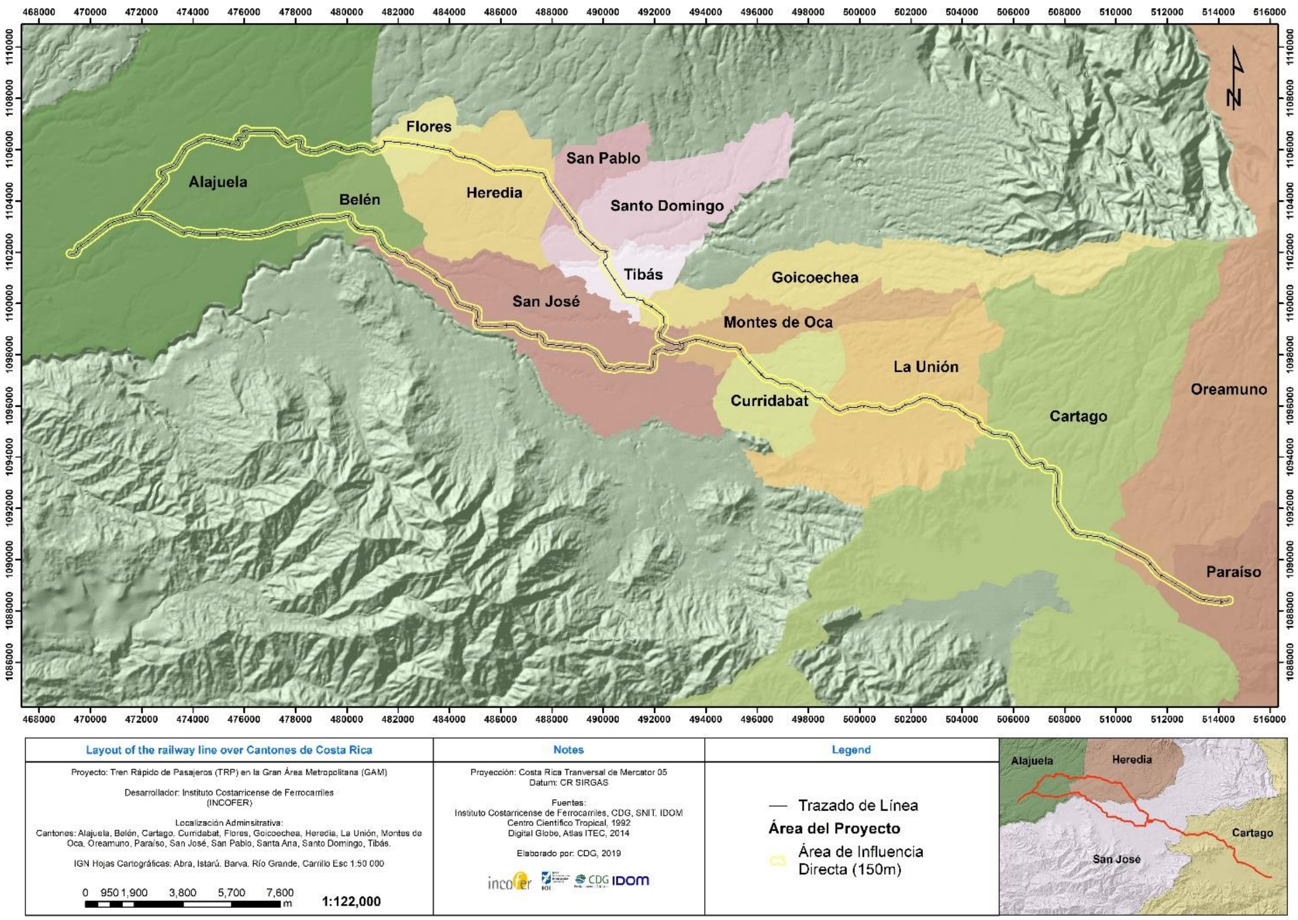
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Sistema Nacional de Áreas de Conservación
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Trazado de Línea
Zona Protectora Cerros de la Carpintera
Corredor Biológico Colibrí-Surac

MA COUNTYES



Flores
San Pablo
Alajuela
Belén
Heredia
Santo Domingo
Tibás
Goicoechea
San José
Montes de Oca
La Unión
Curridabat
Oreamuno
Cartago
Paraíso
N
Layout of the railway line over Cantones de Costa Rica
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
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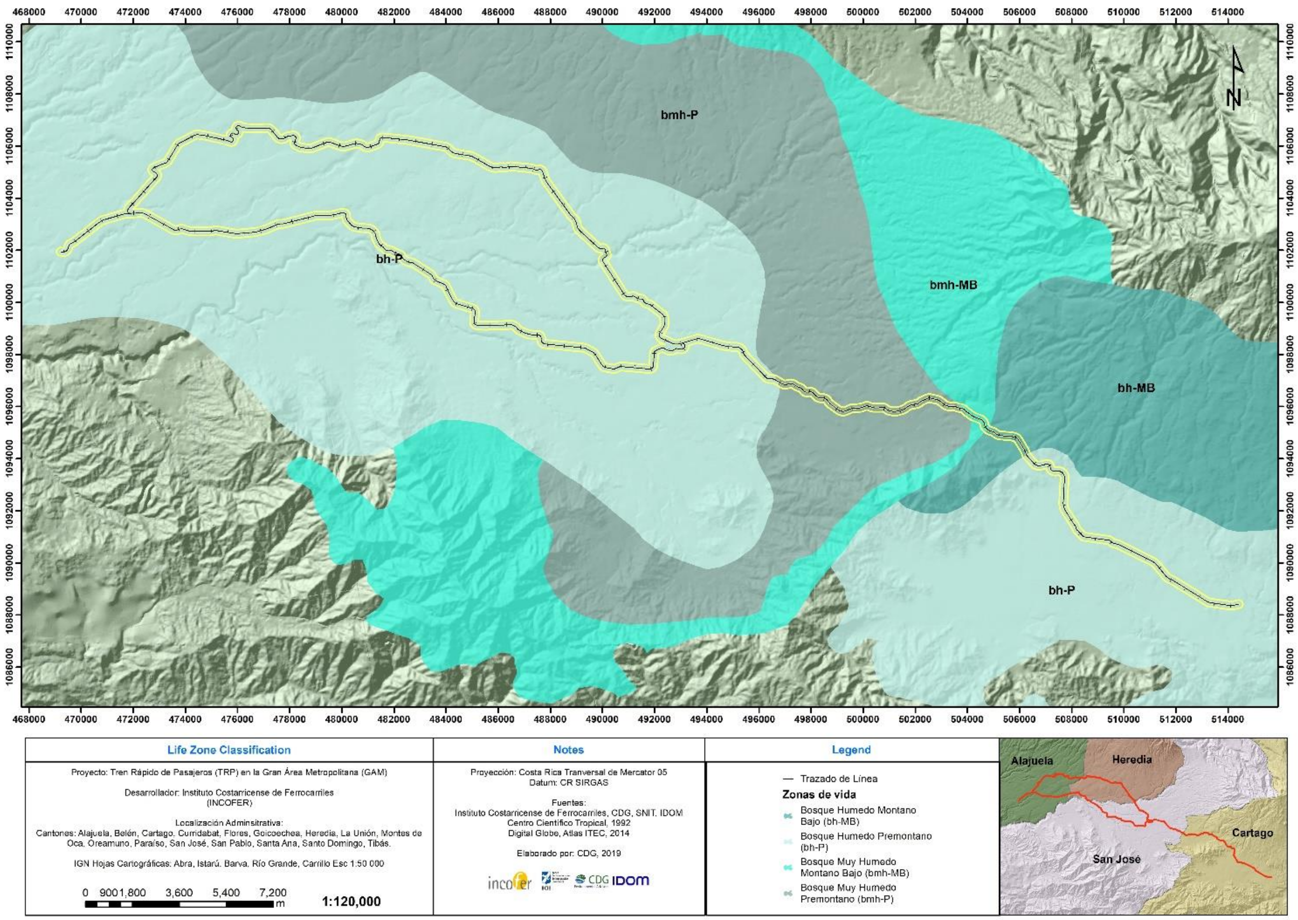
Centro Científico Tropical, 1992
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Trazado de Línea
Área del Proyecto
Área de Influencia Directa (150m)
Alajuela
Heredia
San José
Cartago

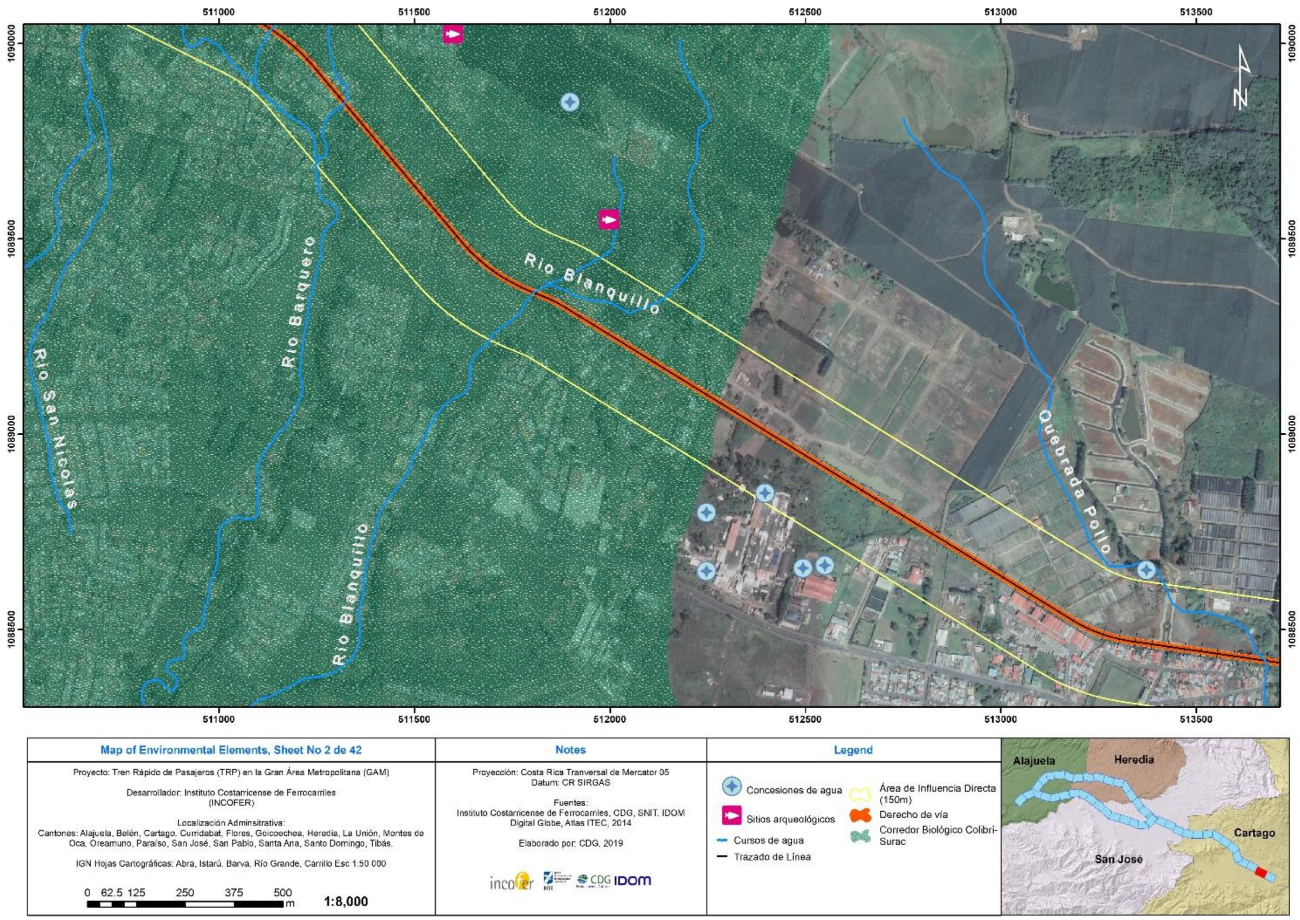
MA Life zones



MA Sheet 1

Map of Environmental Elements, Sheet No 1 de 42	Notes	Legend
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM) Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER) Localización Adminsitrativa: Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás. IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000 0 62.5 125 250 375 500 m 1:8,000	Proyección: Costa Rica Tranversal de Mercator 05 Datum: CR SIRGAS Fuentes: Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM Digital Globe, Atlas ITEC, 2014 Elaborado por: CDG, 2019	Concesiones de agua Cursos de agua Trazado de Línea Área de Influencia Directa (150m) Derecho de vía Corredor Biológico Colibri-Surac

MA Sheet 2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Rio San Nicolas
Rio Barquero
Rio Blanquillo
Rio Blanquillo
Quebrada Pollo
Map of Environmental Elements, Sheet No 2 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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1:8,000
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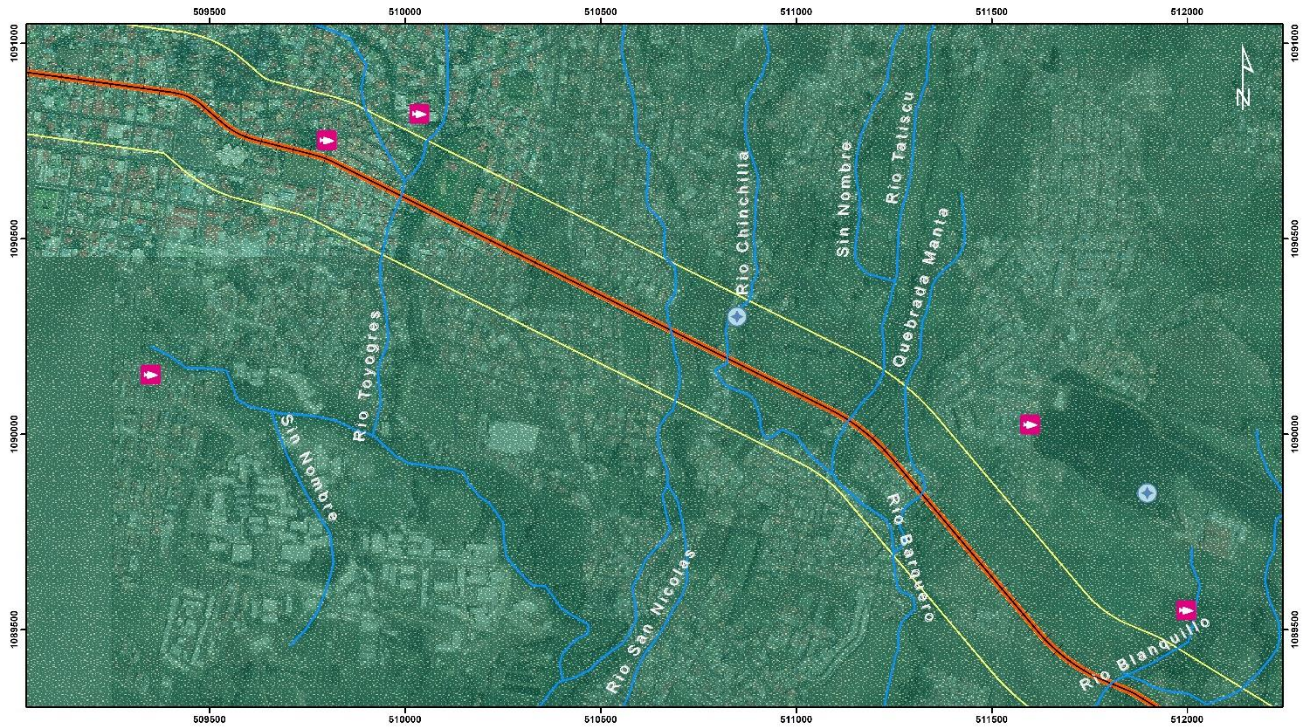
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de vía
Corredor Biológico Colibri-Surac
Alajuela
Heredia
Cartago
San José

MA Sheet 3



Map of Environmental Elements, Sheet No 3 de 42	Notes	Legend
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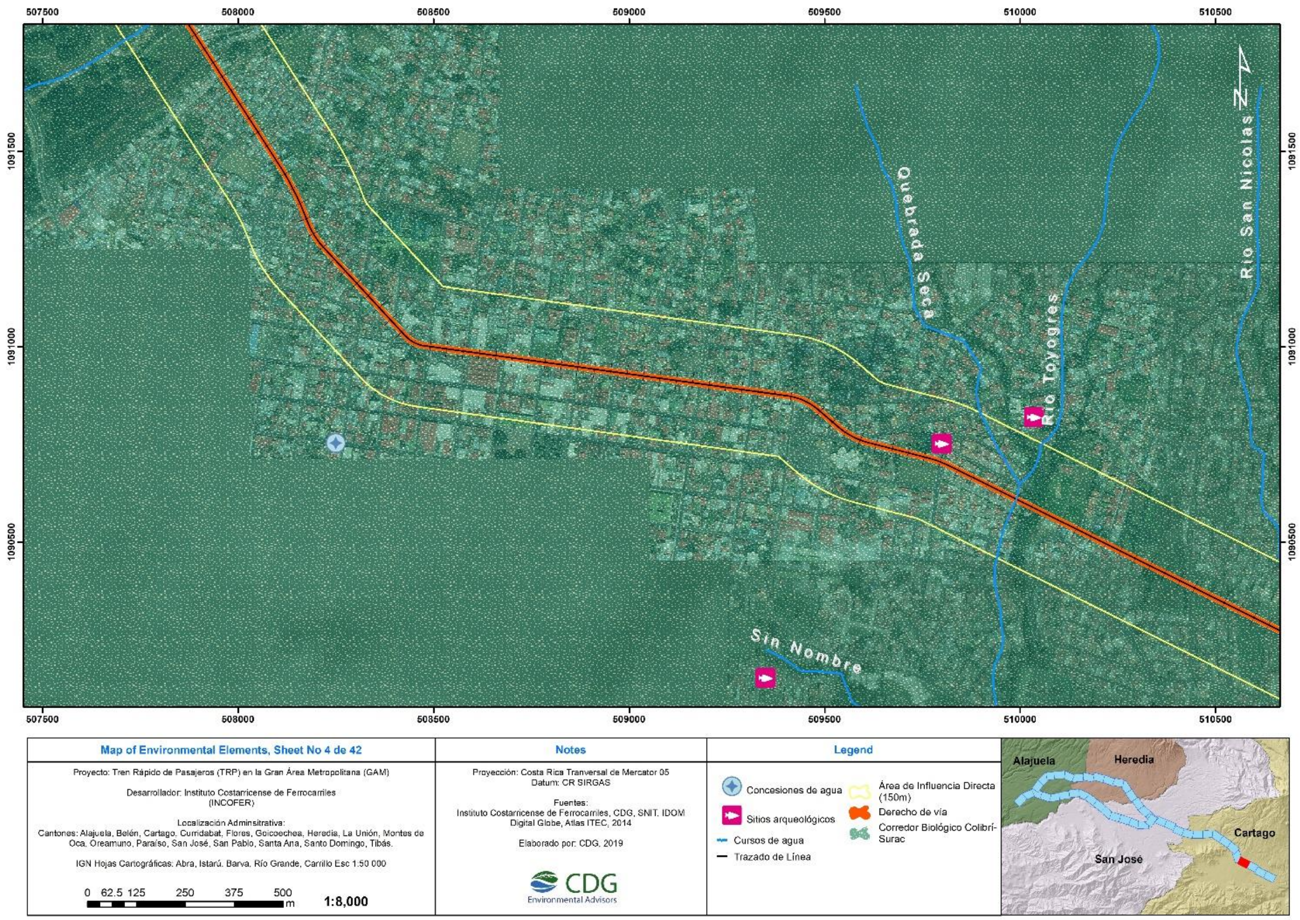
MA Sheet 4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508500
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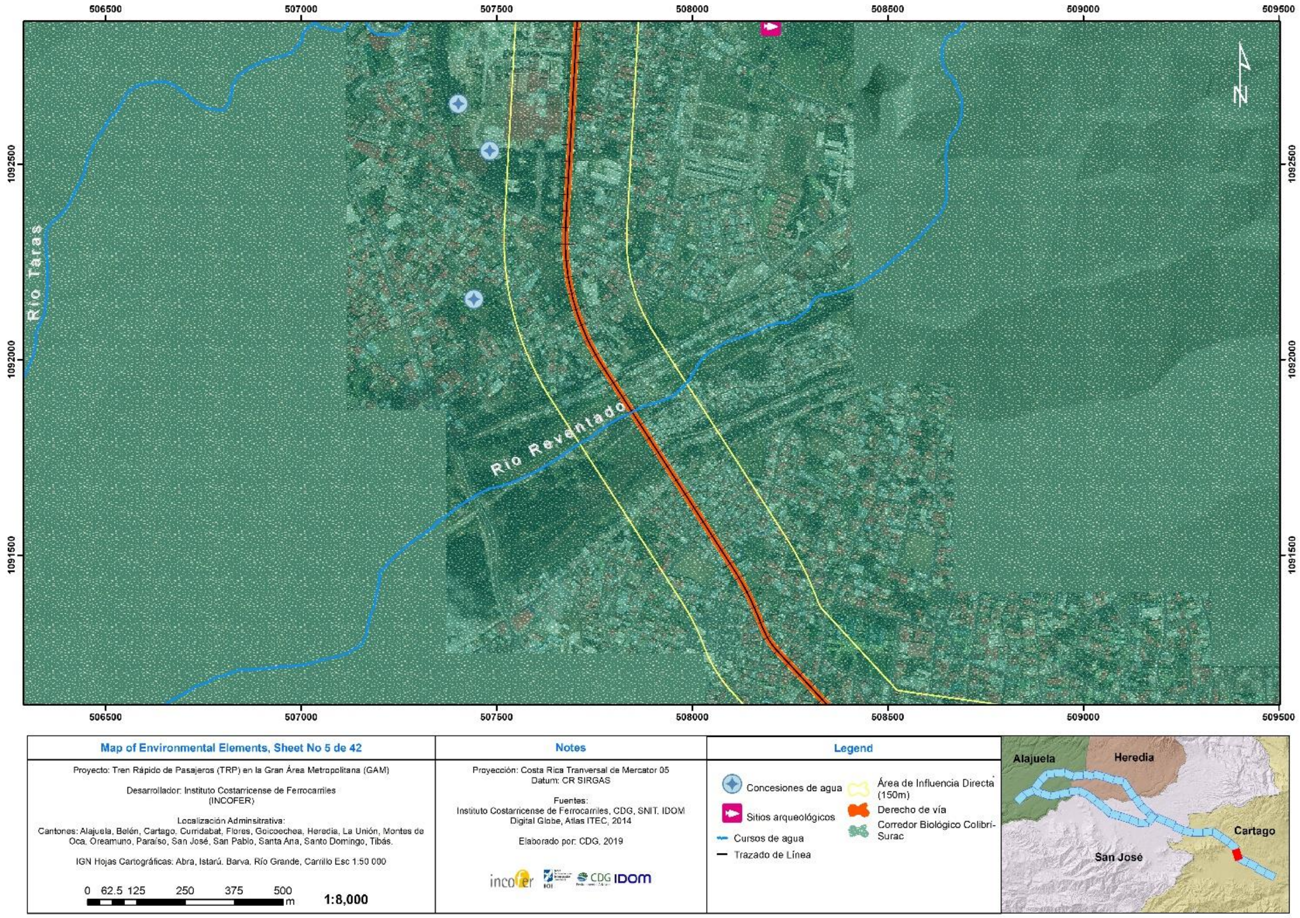
509500
510000
510500
1091500
1091000
1090500
Quebrada Seca
Río Toyogres
Río San Nicolas
Sin Nombre
N
Map of Environmental Elements, Sheet No 4 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
CDG Environmental Advisors
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de vía
Corredor Biológico Colibrí-Surac
Alajuela
Heredia
Cartago
San José

MA Sheet 5



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509000
509500
1092500
1092000
1091500
Río Taras
Río Reventado
N
Map of Environmental Elements, Sheet No 5 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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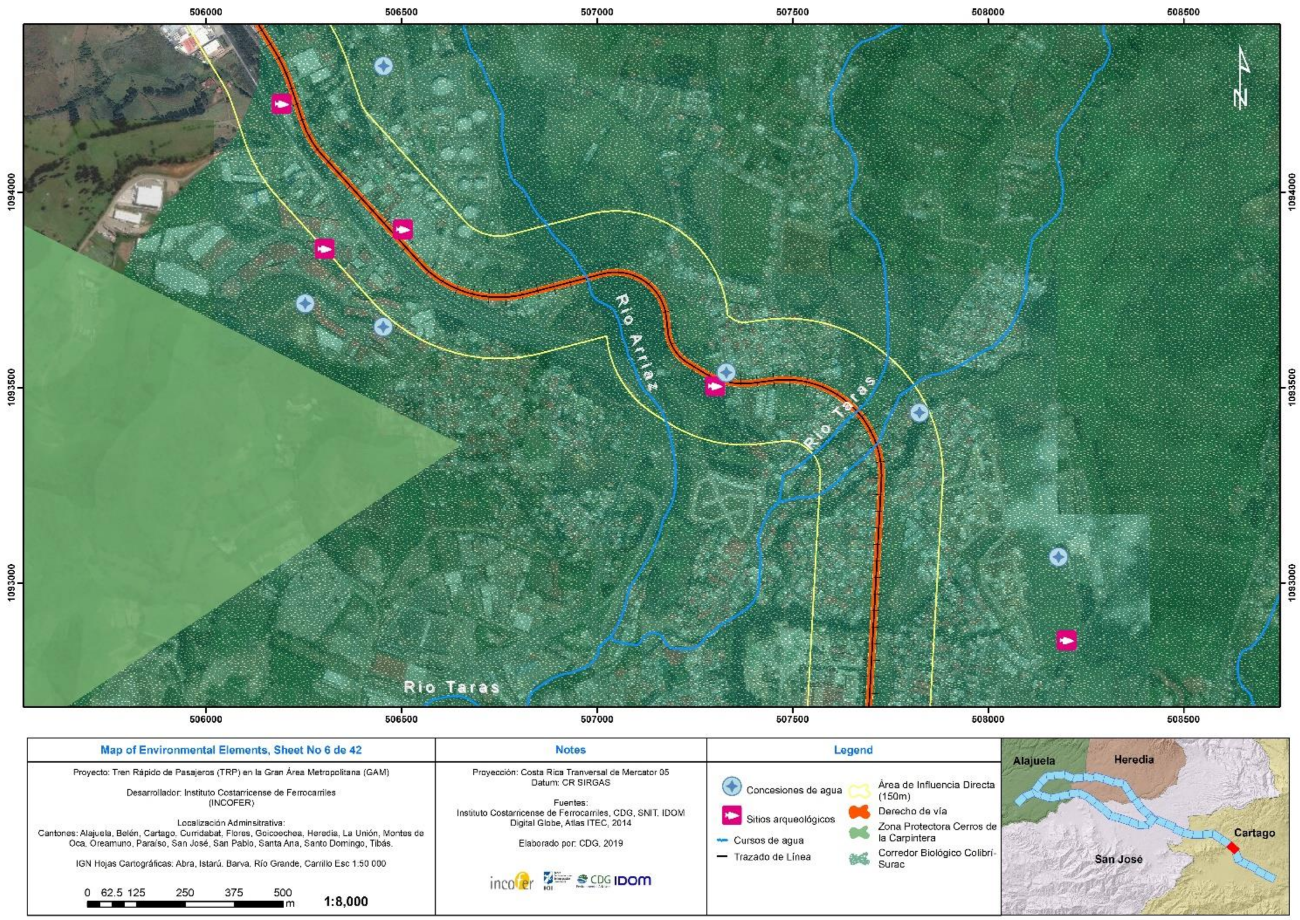
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de vía
Corredor Biológico Colibri-Surac
Alajuela
Heredia
Cartago
San José

MA Sheet 6



Río Arriaz
Río Taras
Río Taras
Map of Environmental Elements, Sheet No 6 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
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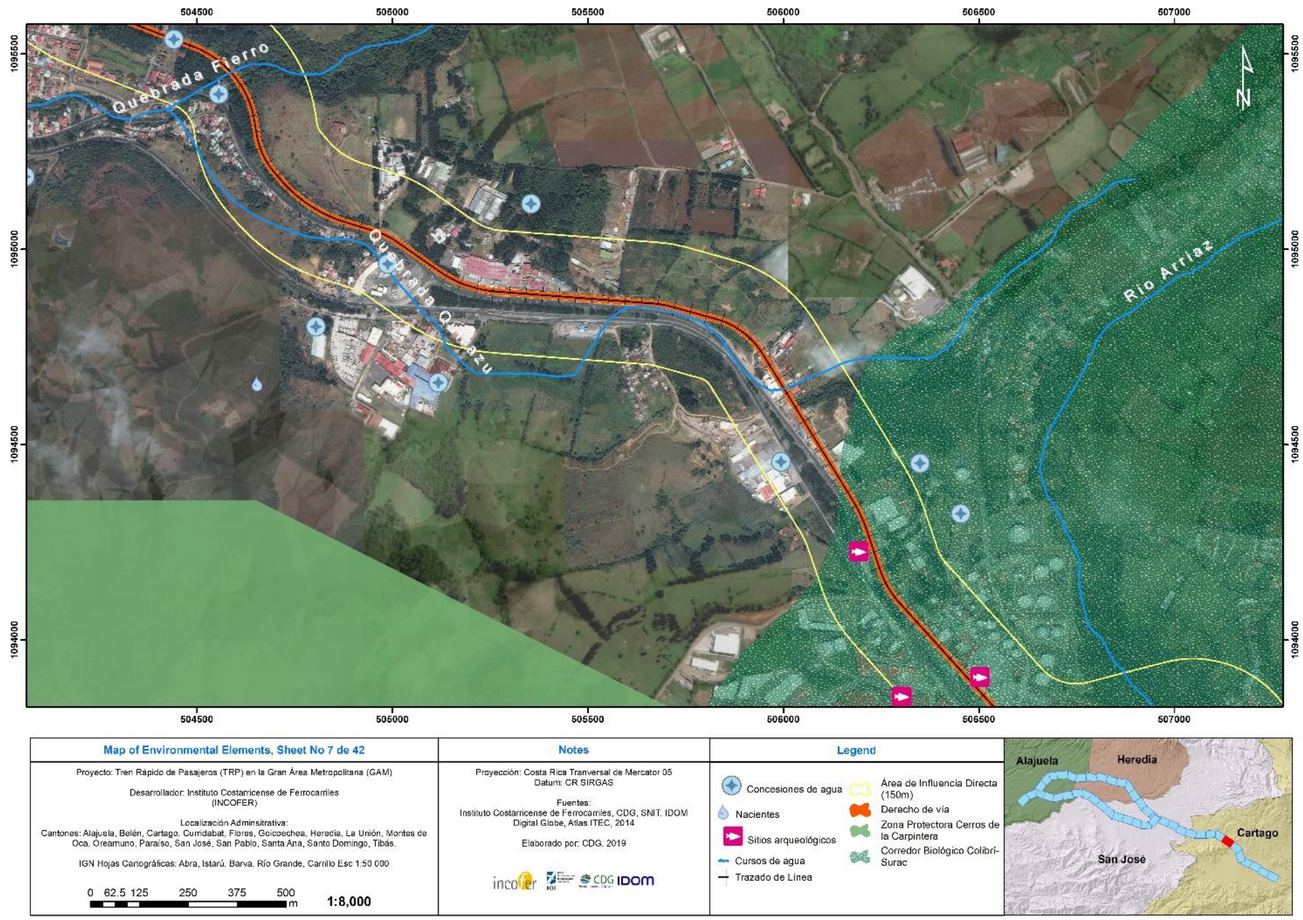
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de vía
Zona Protectora Cerros de la Carpintera
Corredor Biológico Colibrí-Surac
Alajuela
Heredia
San José
Cartago

MA Sheet 7


Quebrada Fierro
Quebrada Quirazu
Rio Arriaz
504500
505000
505500
506000
506500
507000
1095500
1095000
1094500
1094000
Map of Environmental Elements, Sheet No 7 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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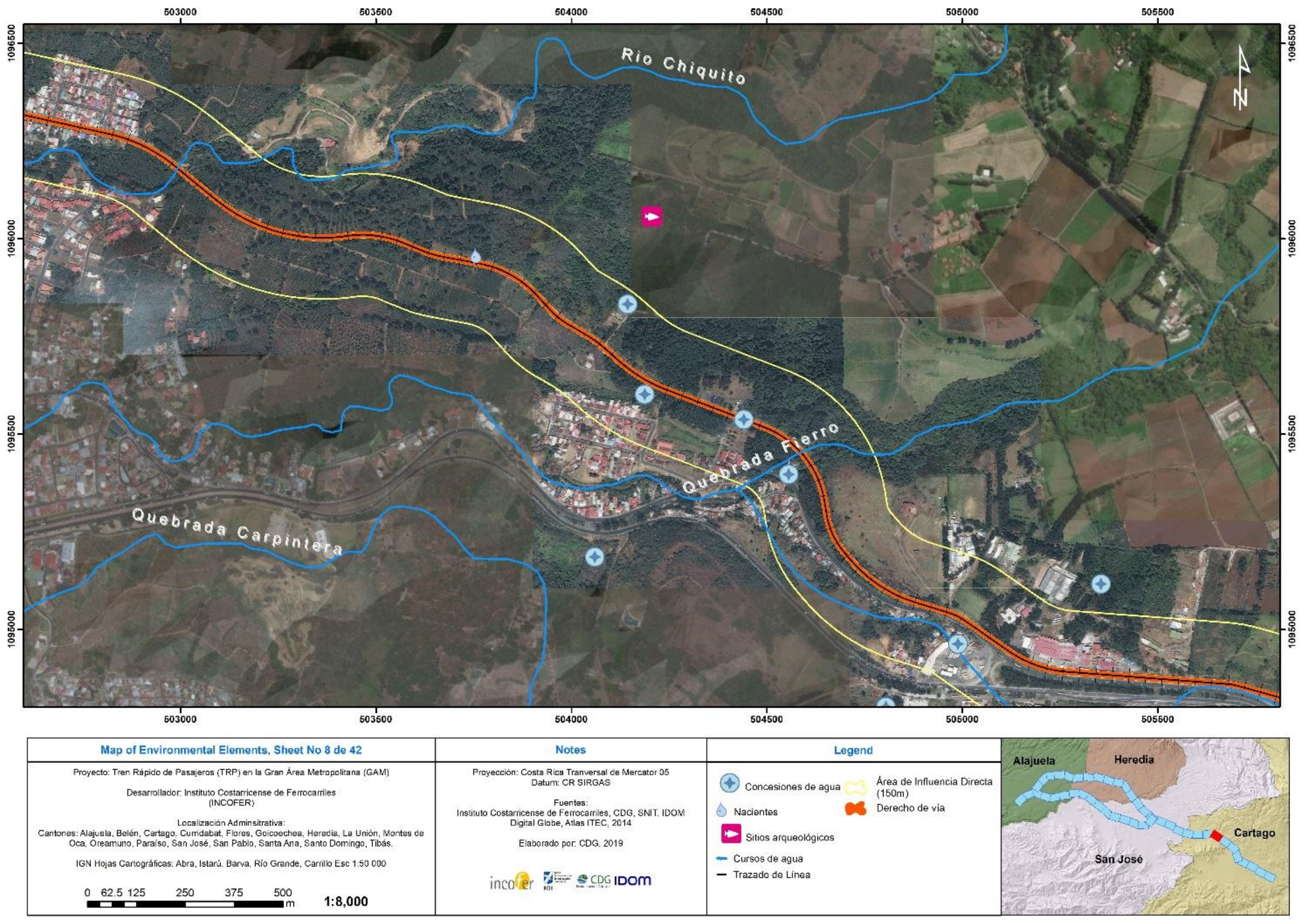
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Nacientes
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Zona Protectora Cerros de la Carpintera
Corredor Biológico Colibrí-Surac
Alajuela
Heredia
San José
Cartago

MA Sheet 8



503000
503500
504000
504500
505000
505500
1096500
1096000
1095500
1095000
Rio Chiquito
Quebrada Fierro
Quebrada Carpintera
N
Map of Environmental Elements, Sheet No 8 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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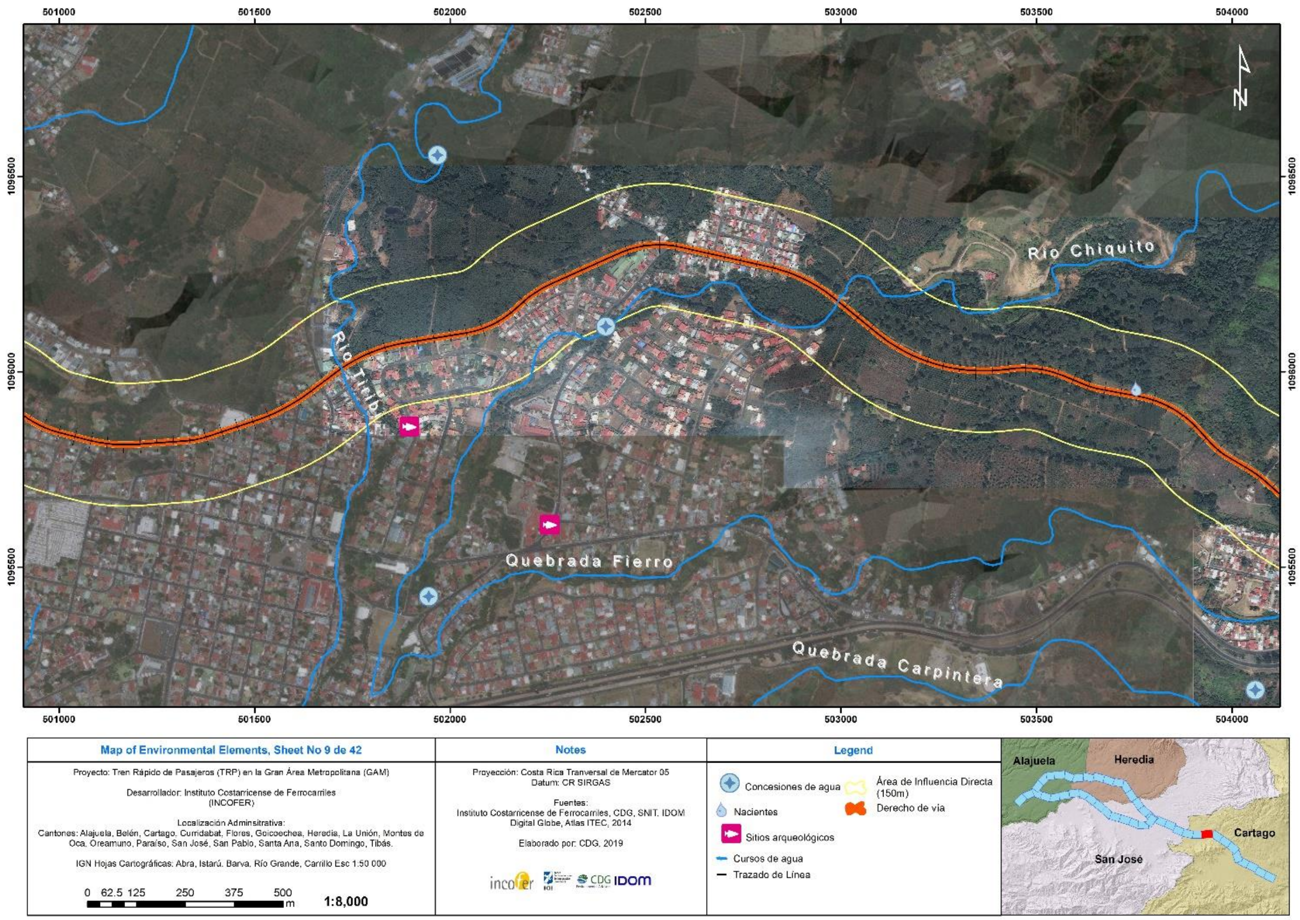
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Nacientes
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 9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501500
502000
502500
503000
503500
504000
1096500
1096000
1095500
N
Río Chiquito
Río Tiribí
Quebrada Fierro
Quebrada Carpintera
Map of Environmental Elements, Sheet No 9 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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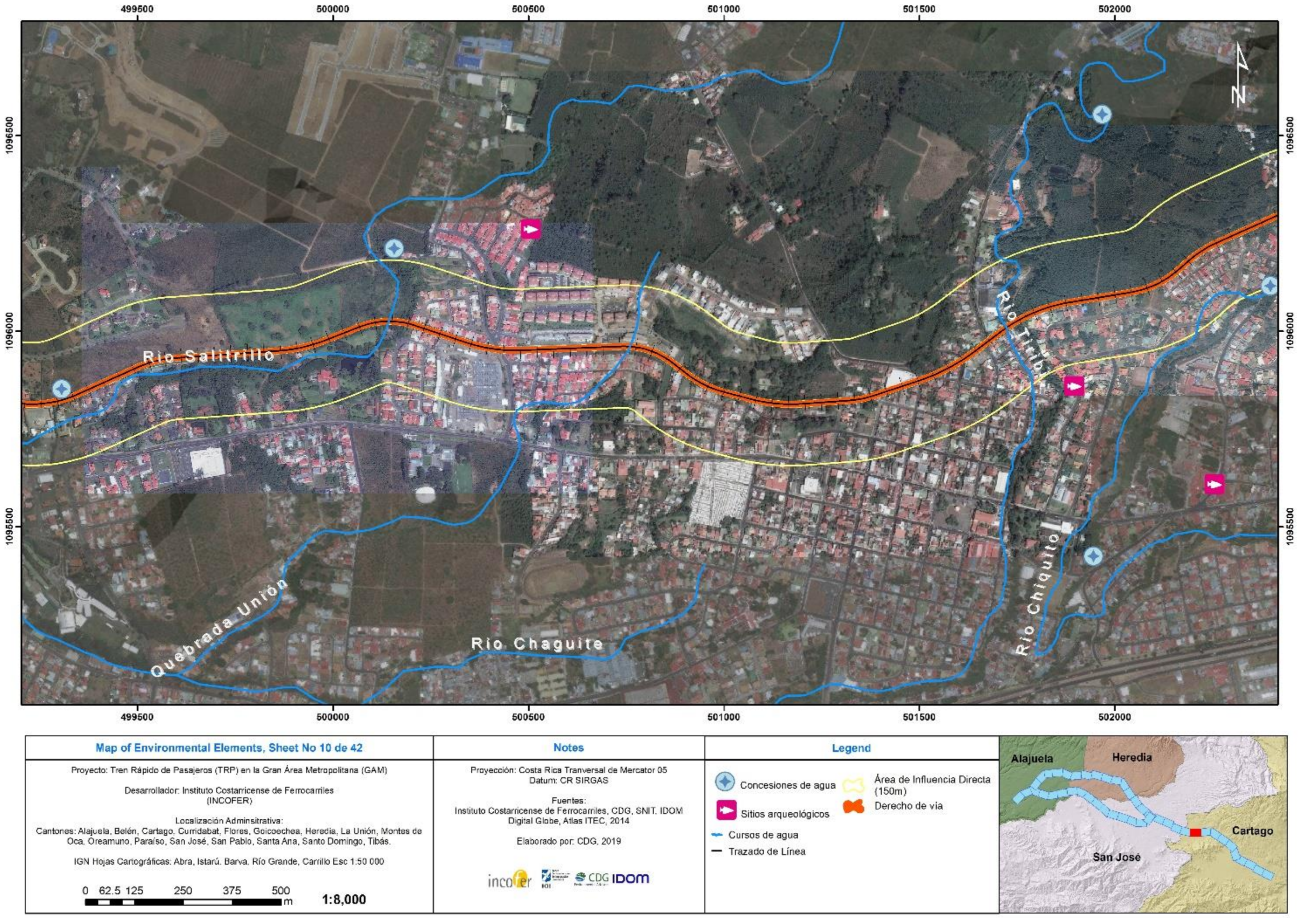
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Área de Influencia Directa (150m)
Nacientes
Derecho de via
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Alajuela
Heredia
Cartago
San José

MA Sheet 10



499500
500000
500500
501000
501500
502000
1096500
1096000
1095500
N
Río Salitrillo
Río Tiribí
Río Chiquito
Río Chagüite
Quebrada Unión
Map of Environmental Elements, Sheet No 10 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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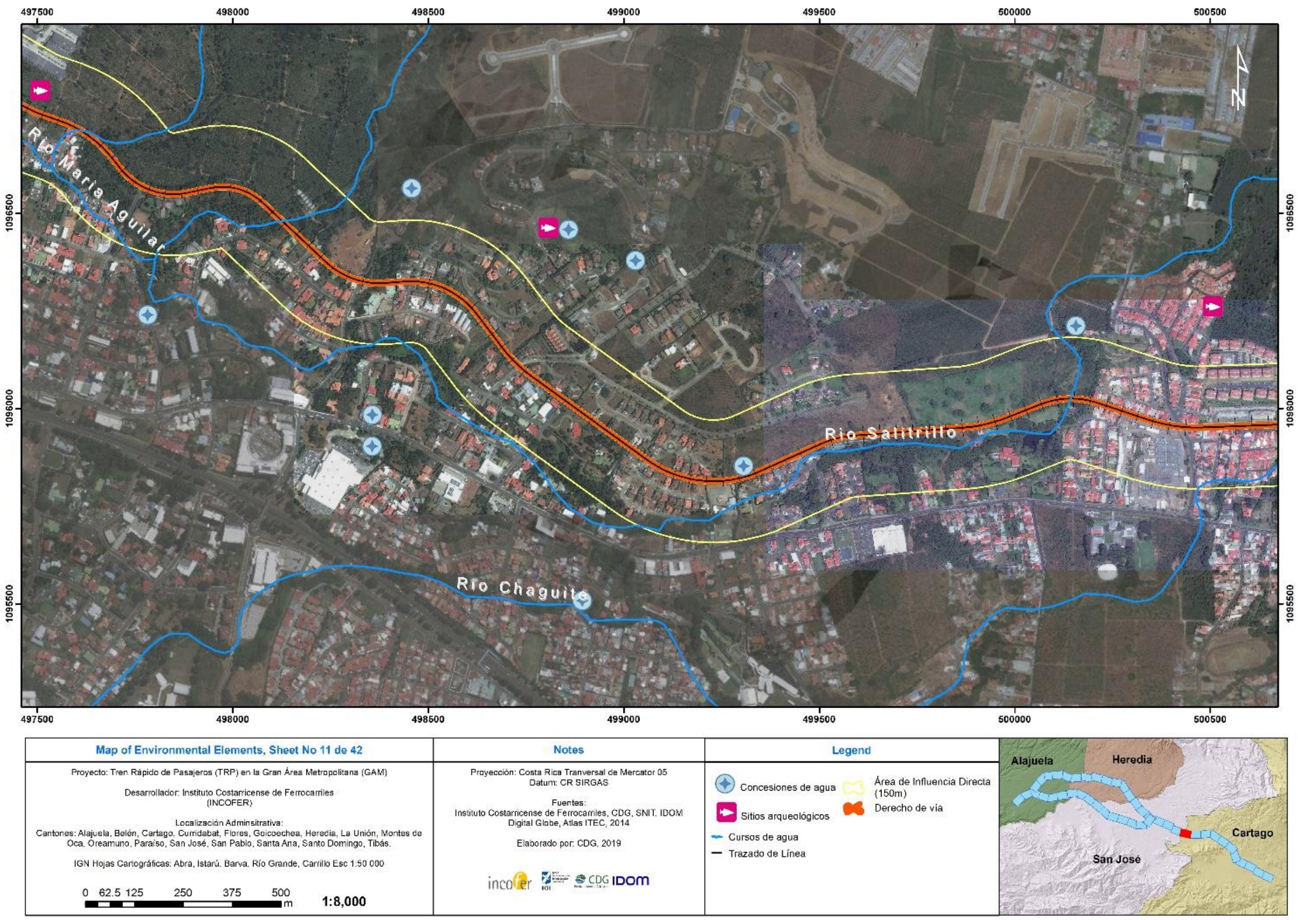
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
San José
Cartago

MA Sheet 11



497500
498000
498500
499000
499500
500000
500500
1096500
1096000
1095500
N
Río María Aguilar
Río Salitrillo
Río Chaguite
Map of Environmental Elements, Sheet No 11 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
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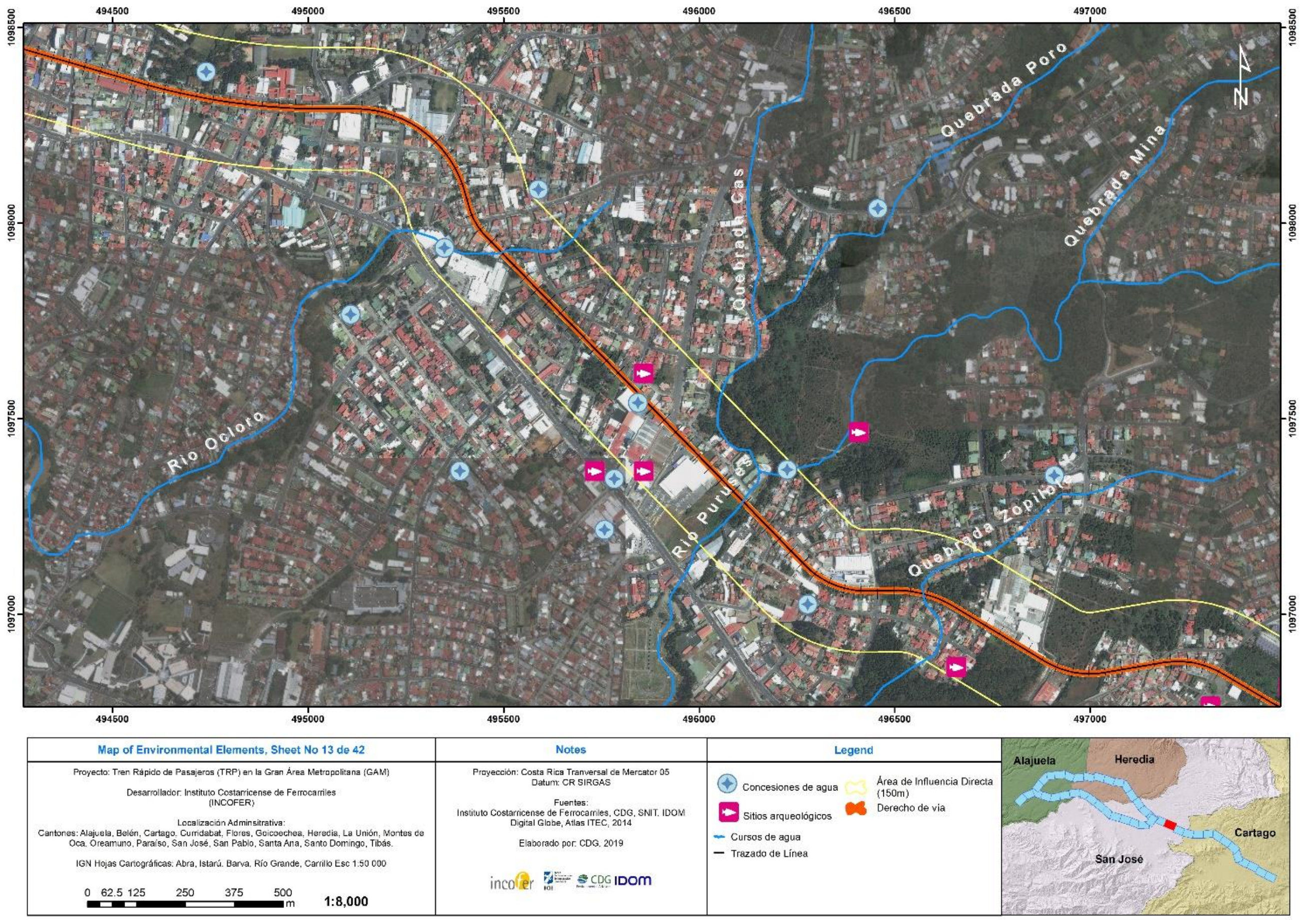
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
San José
Cartago

MA Sheet 12


Quebrada Poro
Quebrada Mina
Quebrada Cas
Río Ocloro
Río Purires
Quebrada Zopilote
Map of Environmental Elements, Sheet No 13 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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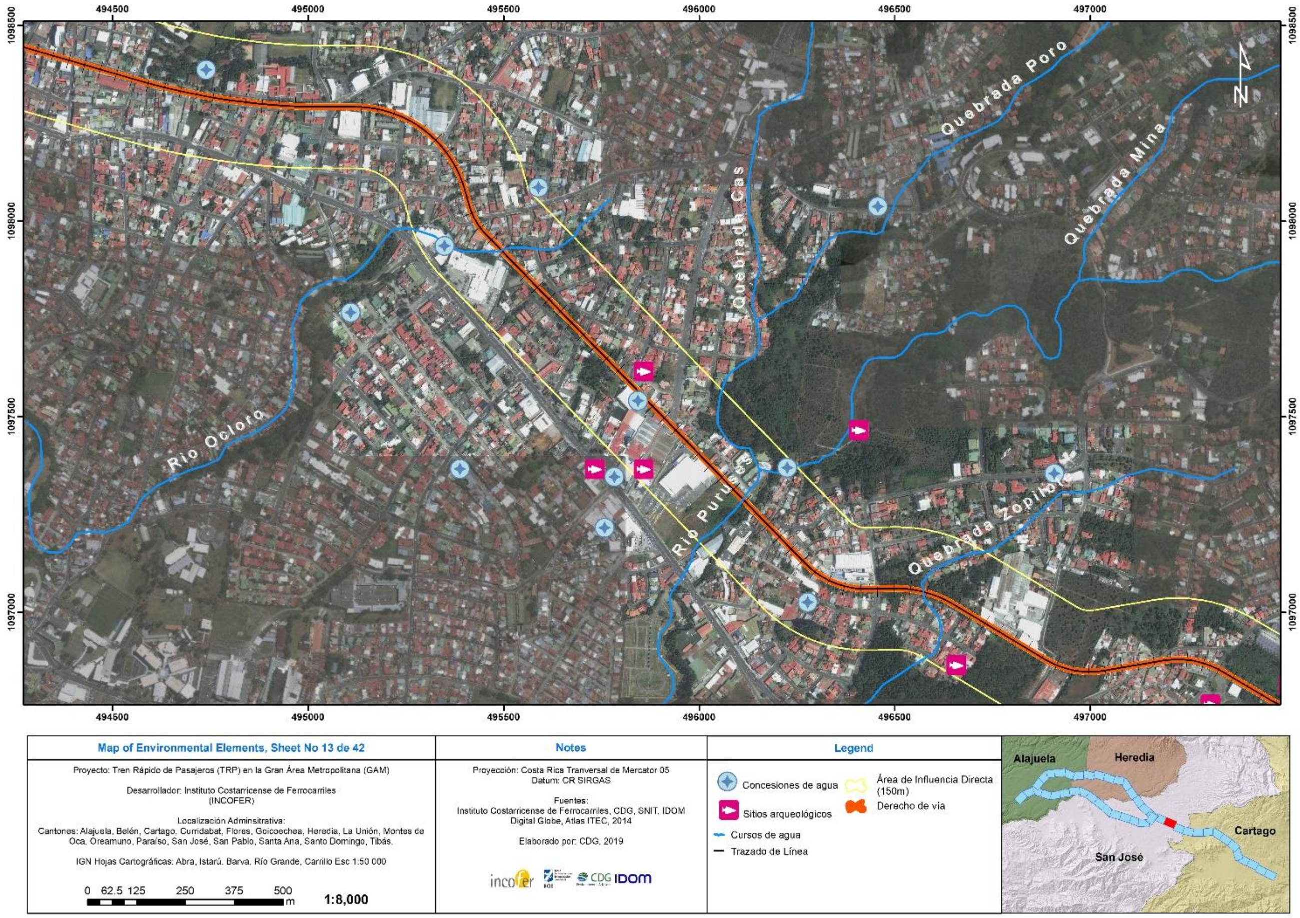
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 13



Quebrada Poro
Quebrada Mina
Quebrada Gas
Río Ocloro
Río Purires
Quebrada Zopilote
Map of Environmental Elements, Sheet No 13 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
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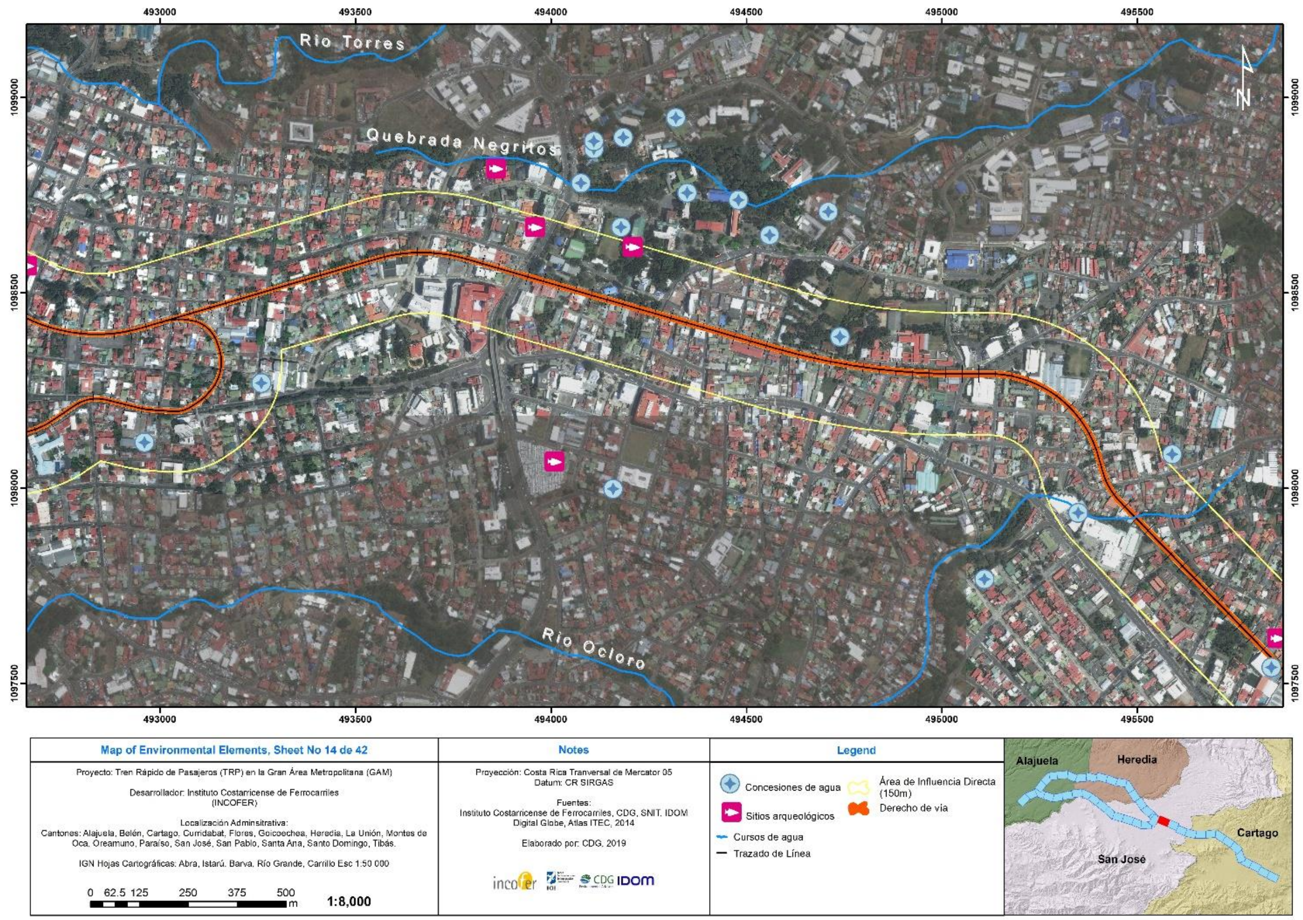
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de vía
Alajuela
Heredia
Cartago
San José

MA Sheet 14



Rio Torres
Quebrada Negritos
Rio Ocloro
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494000
494500
495000
495500
1099000
1098500
1098000
1097500
N
Map of Environmental Elements, Sheet No 14 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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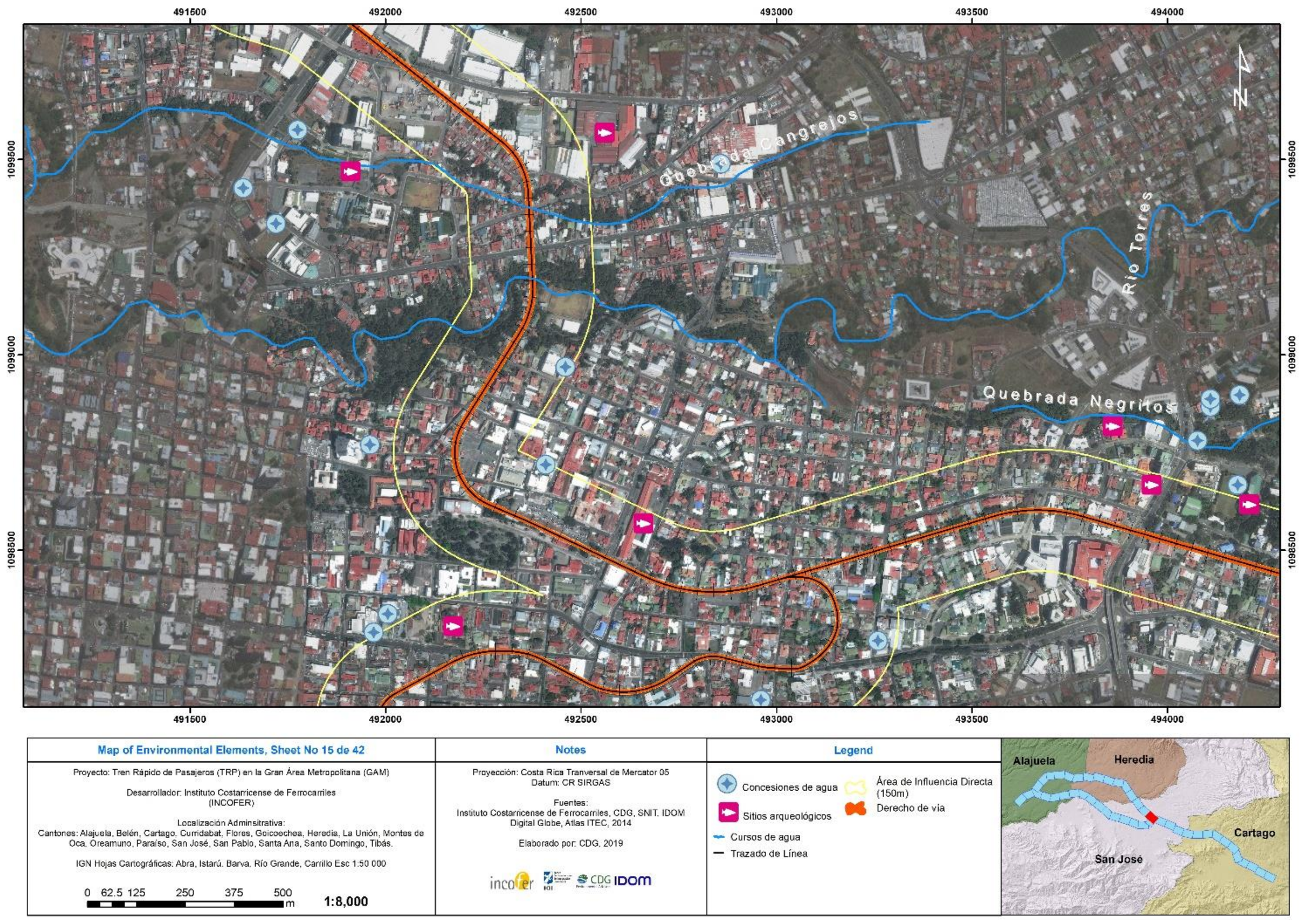
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 15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494000
1099500
1099000
1098500
Quebrada Cangrejos
Río Torres
Quebrada Negritos
N
Map of Environmental Elements, Sheet No 15 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de vía
Alajuela
Heredia
Cartago
San José

MA Sheet 16


490000
490500
491000
491500
492000
492500
1101000
1100500
1100000
1099500
N
Quebrada Rivera
Rio Torres
Map of Environmental Elements, Sheet No 16 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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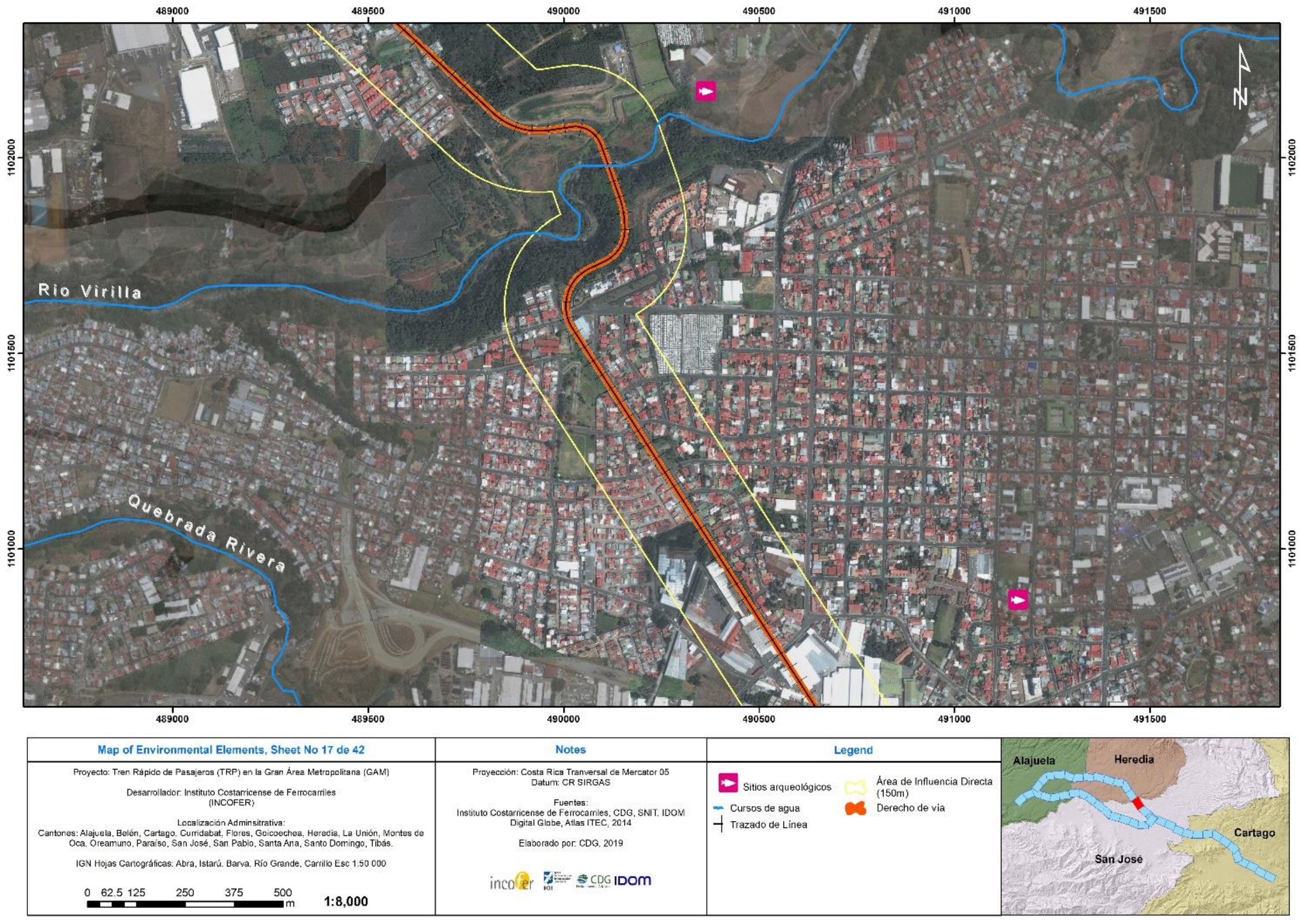
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 17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489500
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490500
491000
491500
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1101500
1101000
Rio Virilla
Quebrada Rivera
Map of Environmental Elements, Sheet No 17 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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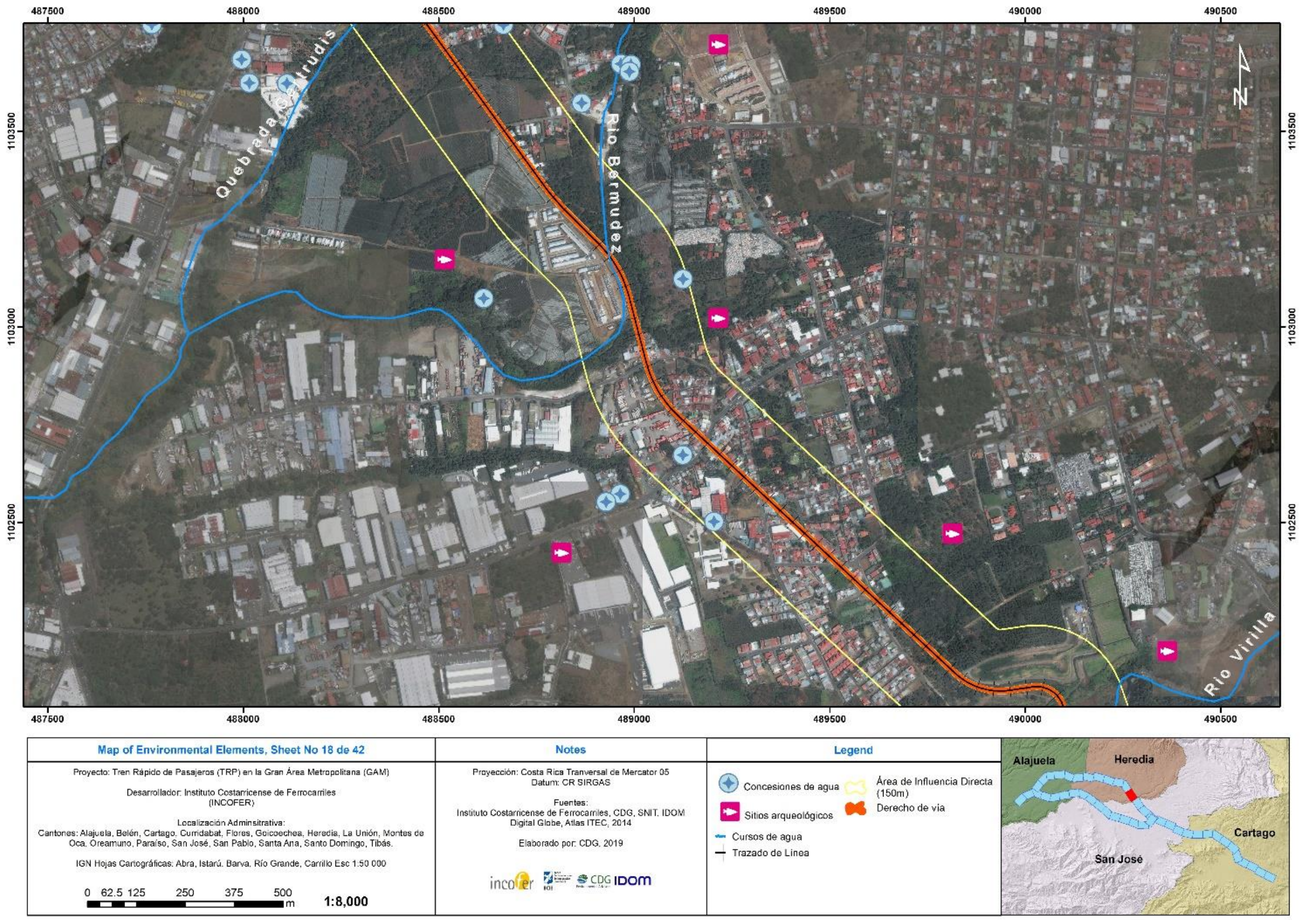
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
San José
Cartago

MA Sheet 18



Quebrada Gertrudis
Río Bermúdez
Río Virilla
Map of Environmental Elements, Sheet No 18 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
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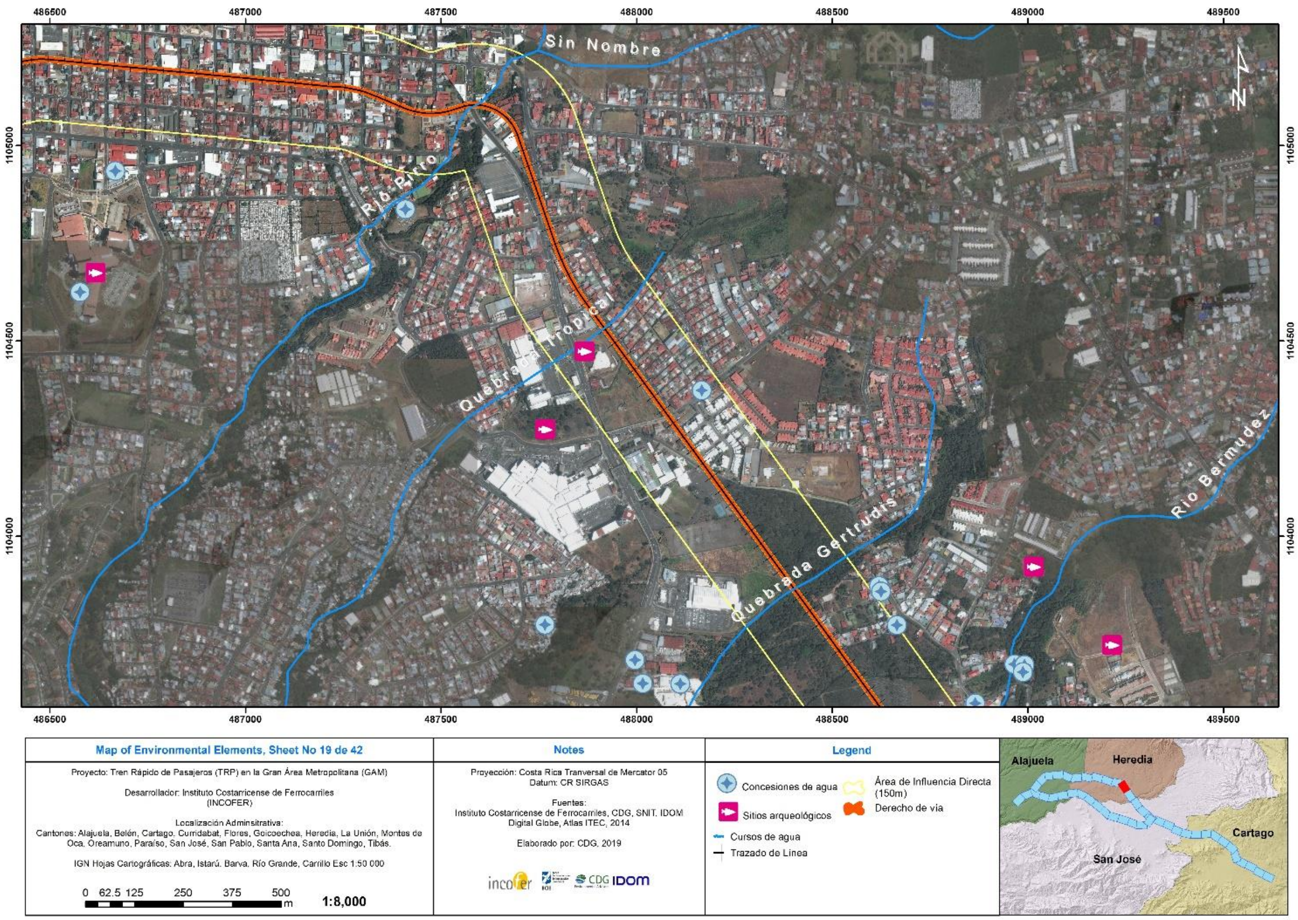
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Área de Influencia Directa (150m)
Sitios arqueológicos
Derecho de via
Cursos de agua
Trazado de Linea
Alajuela
Heredia
Cartago
San José

MA Sheet 19


Sin Nombre
Río Pirro
Quebrada Tropical
Quebrada Gertrudis
Río Bermudez
486500
487000
487500
488000
488500
489000
489500
1105000
1104500
1104000
Map of Environmental Elements, Sheet No 19 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Linea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 20


485500
486000
486500
487000
487500
488000
1106000
1105500
1105000
1104500
Rio Burio
Sin Nombre
Rio Pirro
N
Map of Environmental Elements, Sheet No 20 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
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1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Linea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 21

Map of Environmental Elements, Sheet No 21 de 42

Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)

Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)

Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.

IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000

0 62.5 125 250 375 500 m

1:8,000

Notes

Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS

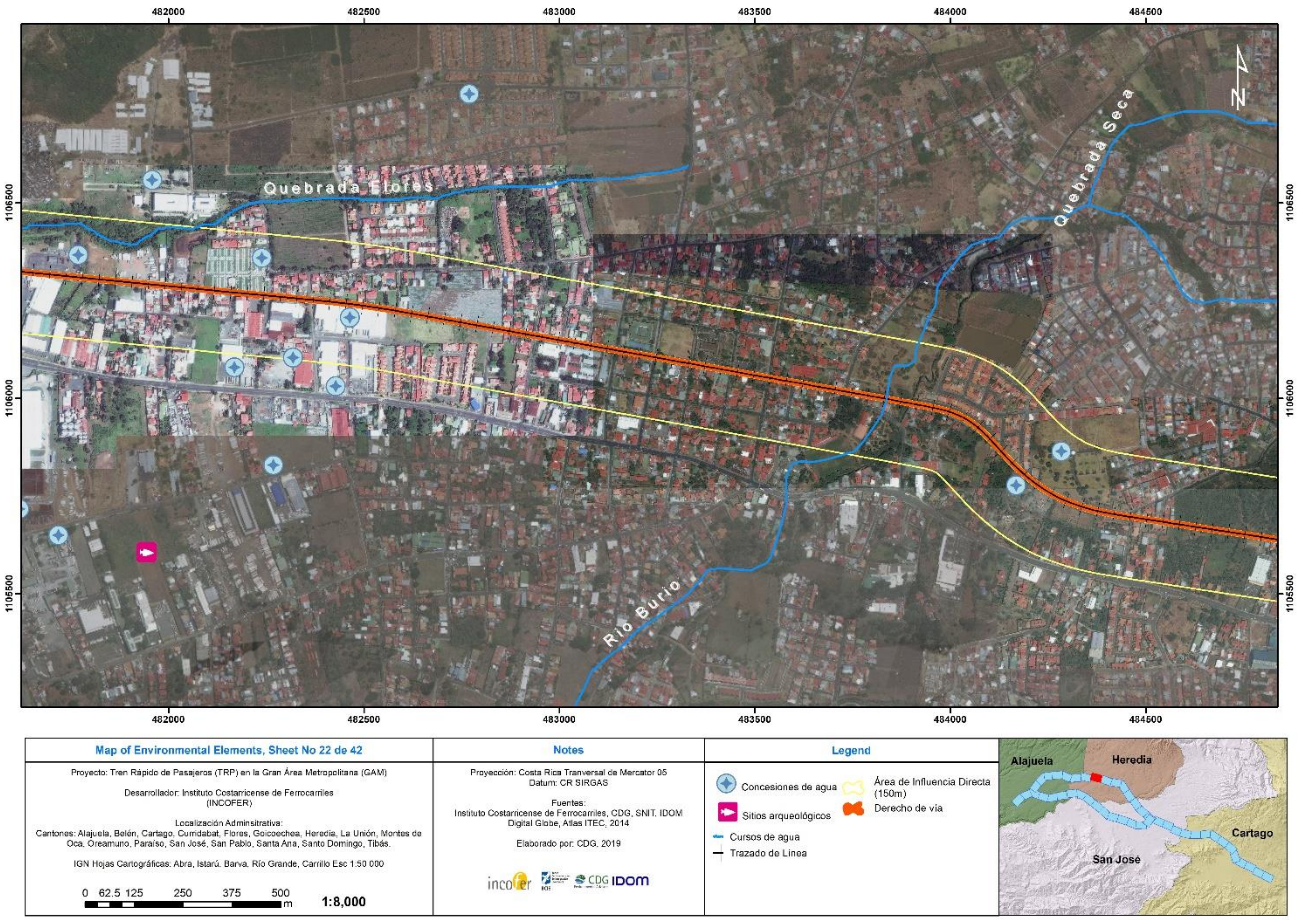
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014

Elaborado por: CDG, 2019

Legend

- Concesiones de agua
- Sitios arqueológicos
- Cursos de agua
- Trazado de Linea
- Área de Influencia Directa (150m)
- Derecho de vía

MA Sheet 22



482000
482500
483000
483500
484000
484500
1106500
1106000
1105500
Quebrada Flores
Quebrada Seca
Río Burío
N
Map of Environmental Elements, Sheet No 22 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Linea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 23

480000
480500
481000
481500
482000
482500
1106500
1106000
1105500
Quebrada Flores
Rio Segundo
Map of Environmental Elements, Sheet No 23 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
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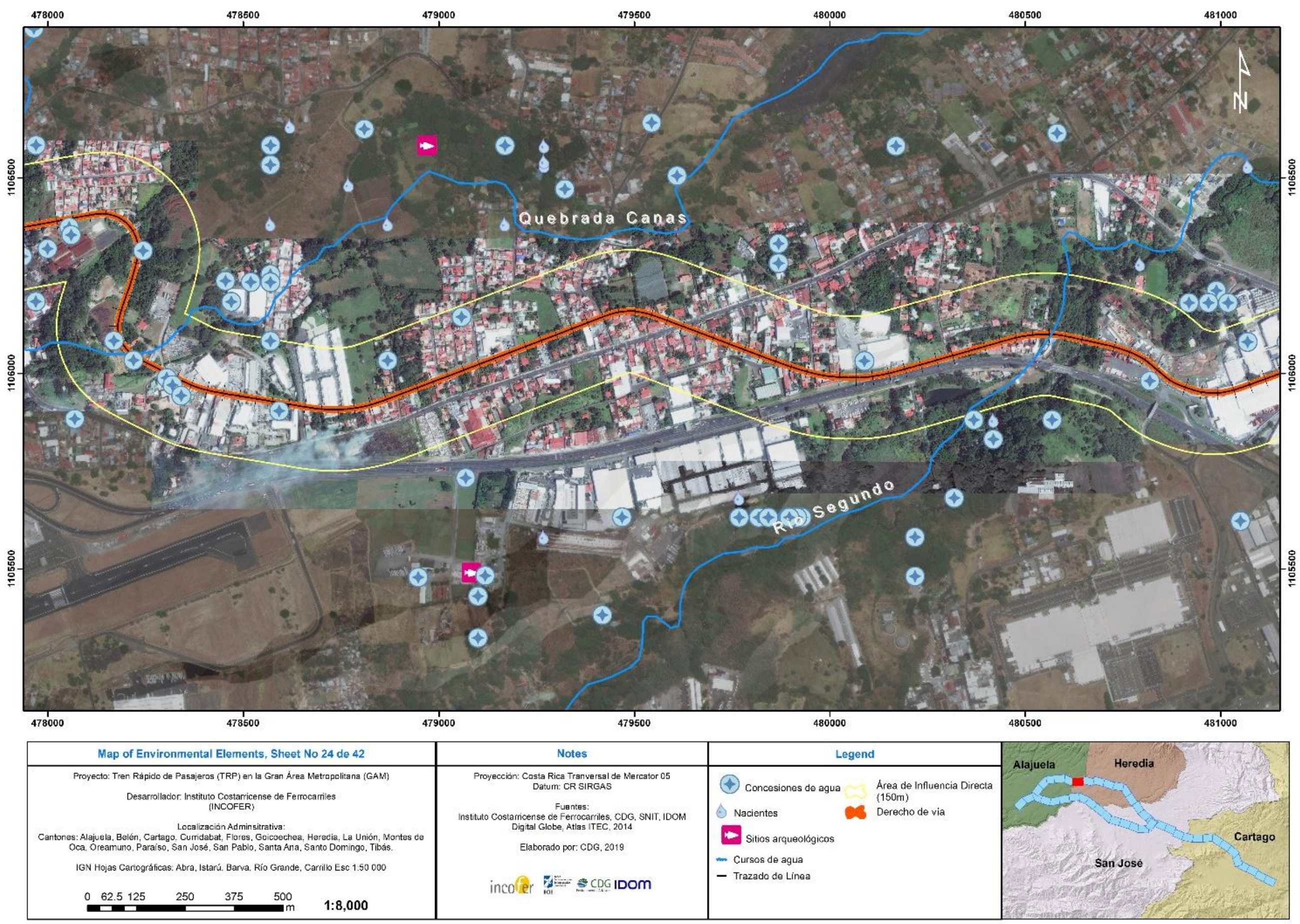
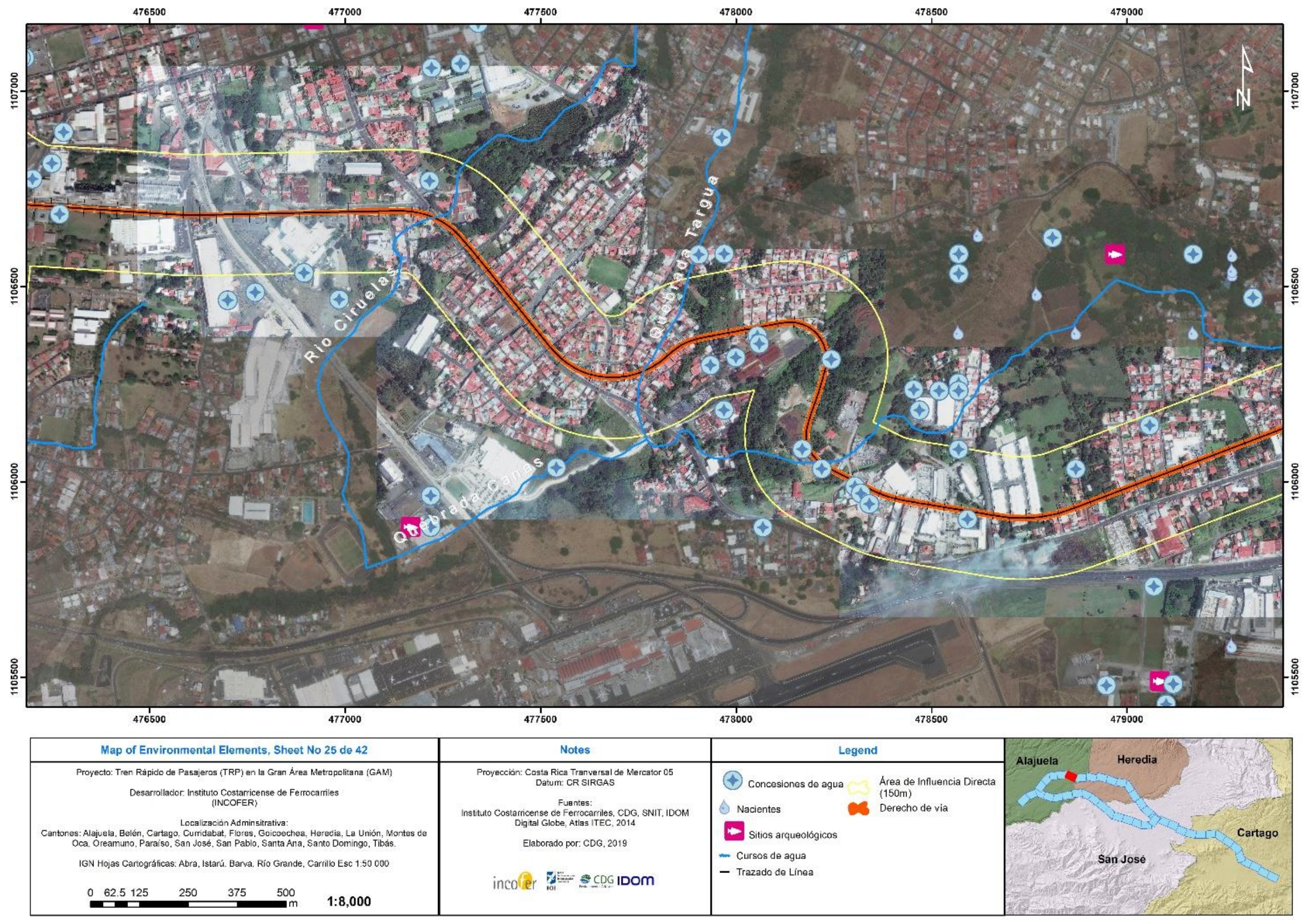
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Nacientes
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de vía
Alajuela
Heredia
Cartago
San José

MA Sheet 24

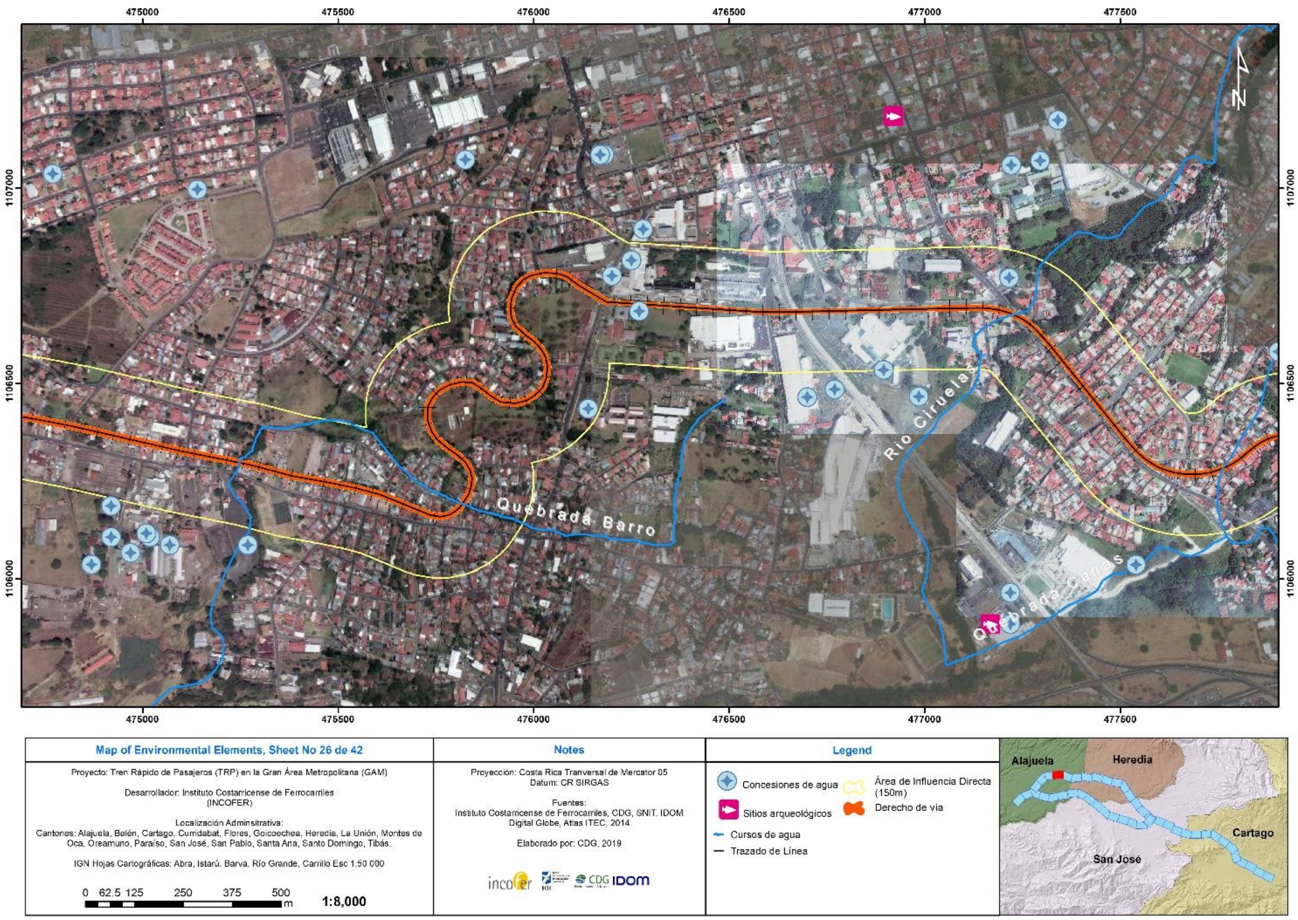


478000
478500
479000
479500
480000
480500
481000
1106500
1106000
1105500
Quebrada Canas
Río Segundo
N
Map of Environmental Elements, Sheet No 24 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Nacientes
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

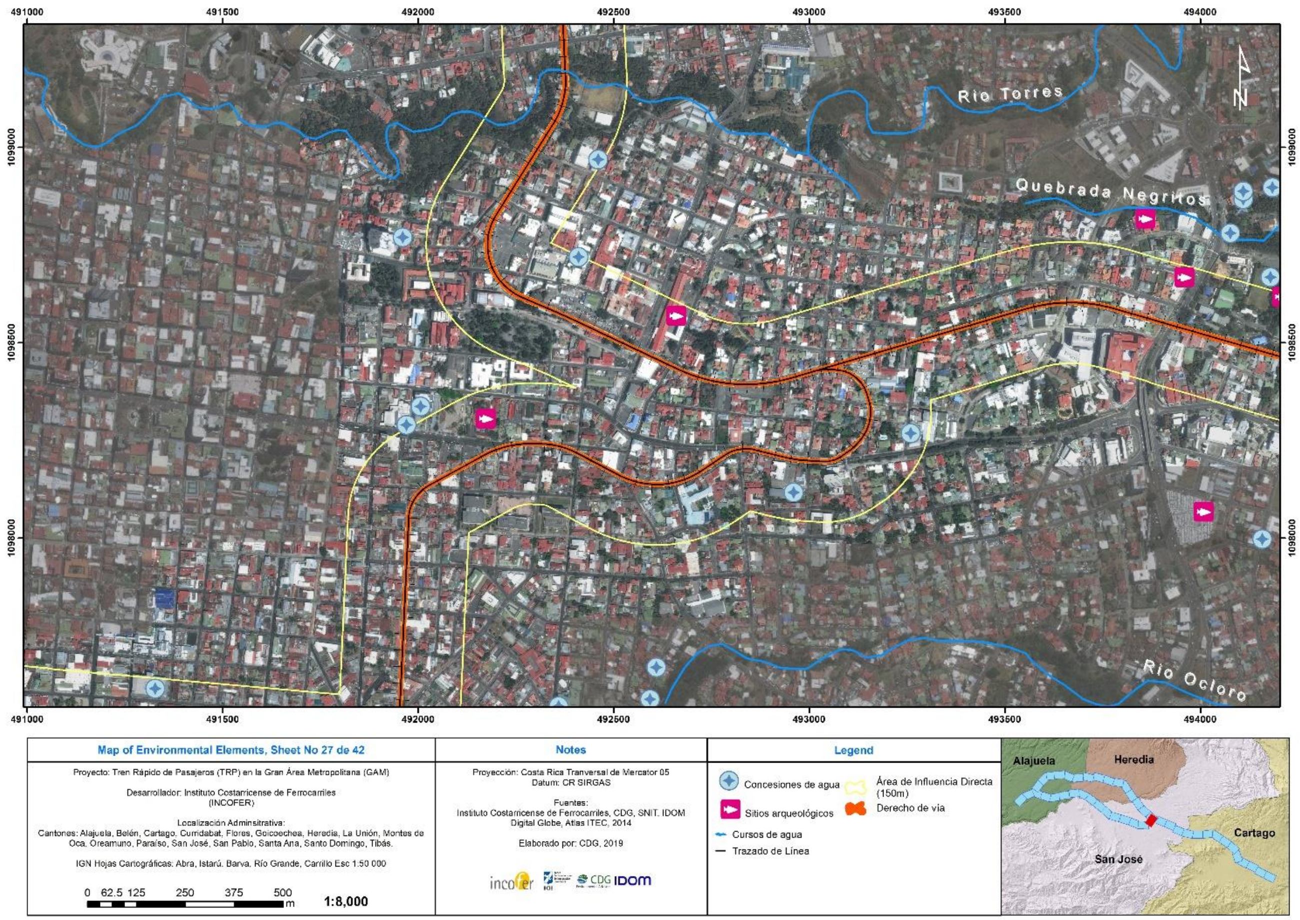
MA Sheet 25


476500
477000
477500
478000
478500
479000
1107000
1106500
1106000
1105500
Río Ciruelas
Quebrada Targua
Quebrada Cañas
N
Map of Environmental Elements, Sheet No 25 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva, Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Nacientes
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

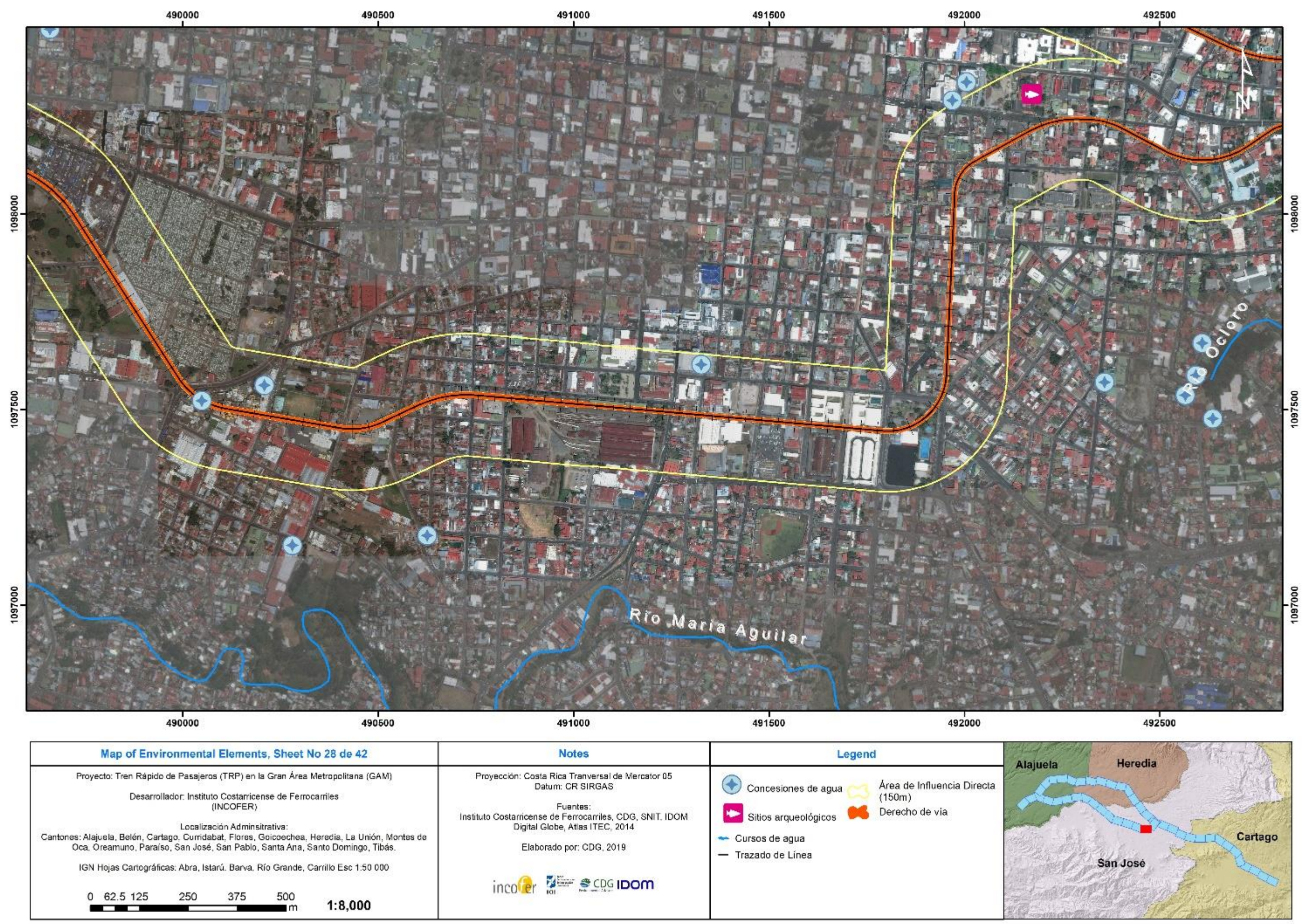
MA Sheet 26


475000
475500
476000
476500
477000
477500
1107000
1106500
1106000
N
Quebrada Barro
Río Ciruelas
Map of Environmental Elements, Sheet No 26 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT. IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Área de Influencia Directa (150m)
Derecho de via
Cursos de agua
Trazado de Línea
Alajuela
Heredia
Cartago
San José

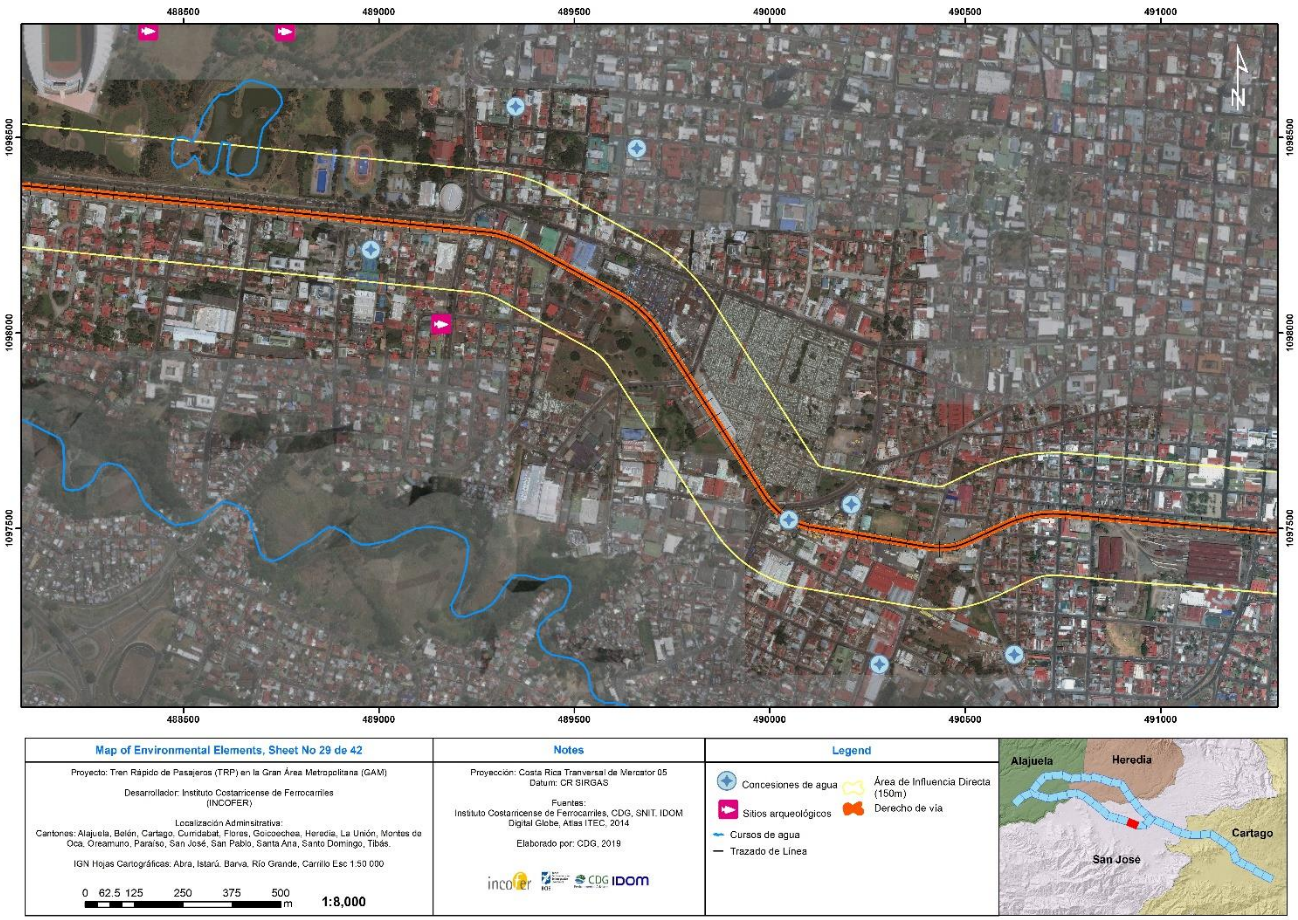
MA Sheet 27


491000
491500
492000
492500
493000
493500
494000
1099000
1098500
1098000
Río Torres
Quebrada Negritos
Río Ocloro
N
Map of Environmental Elements, Sheet No 27 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva, Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Área de Influencia Directa (150m)
Sitios arqueológicos
Derecho de via
Cursos de agua
Trazado de Línea
Alajuela
Heredia
Cartago
San José

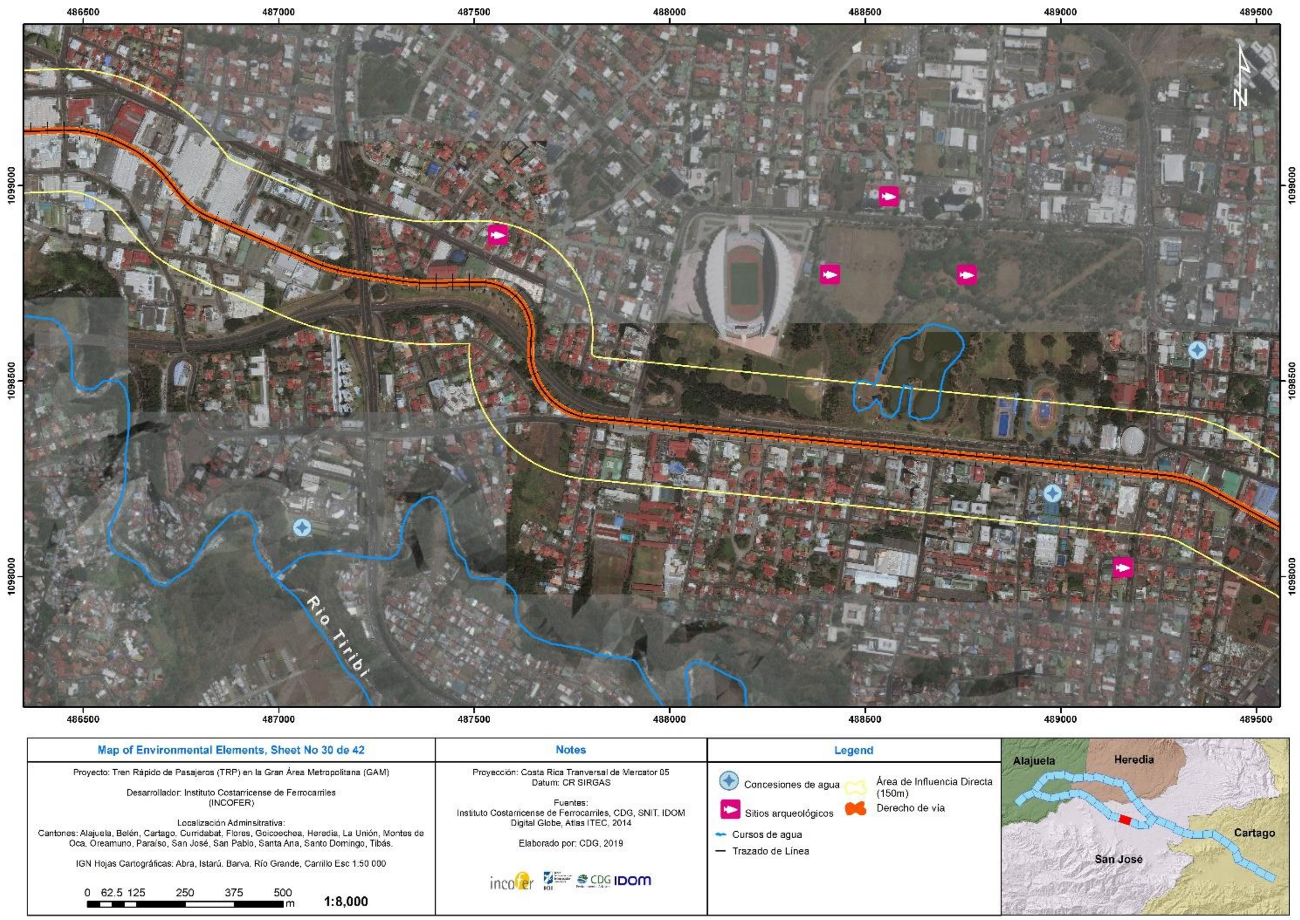
MA Sheet 28


490000
490500
491000
491500
492000
492500
1098000
1097500
1097000
Río Ocloro
Río María Aguilar
Map of Environmental Elements, Sheet No 28 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT. IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Área de Influencia Directa (150m)
Sitios arqueológicos
Derecho de via
Cursos de agua
Trazado de Línea
Alajuela
Heredia
Cartago
San José

MA Sheet 29


488500
489000
489500
490000
490500
491000
1098500
1098000
1097500
Map of Environmental Elements, Sheet No 29 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT. IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de vía
Alajuela
Heredia
Cartago
San José

MA Sheet 30



486500
487000
487500
488000
488500
489000
489500
1099000
1098500
1098000
Río Tiribí
N
Map of Environmental Elements, Sheet No 30 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT. IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Área de Influencia Directa (150m)
Sitios arqueológicos
Derecho de via
Cursos de agua
Trazado de Línea
Alajuela
Heredia
Cartago
San José

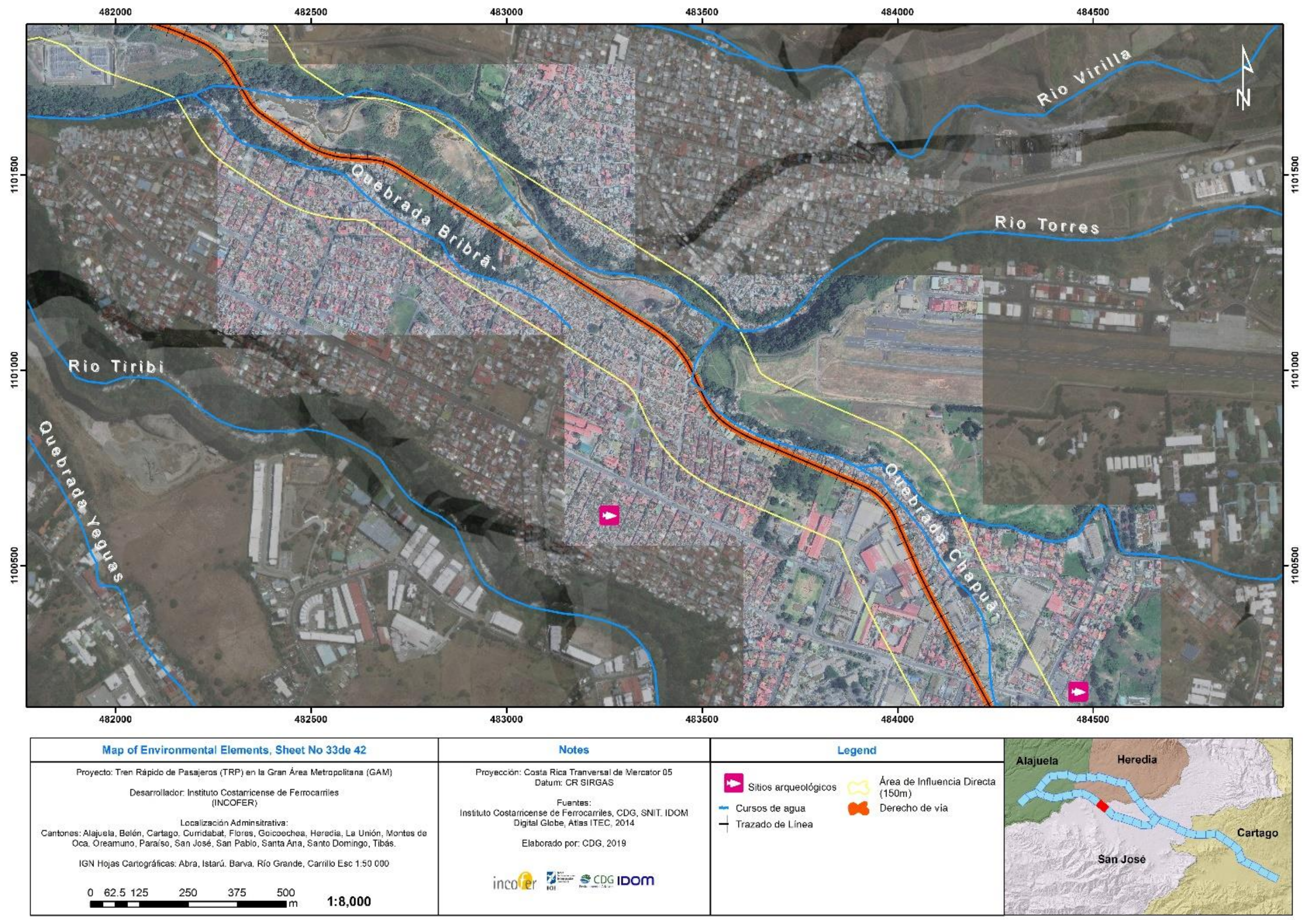
MA Sheet 31

485000
485500
486000
486500
487000
487500
1099500
1099000
1098500
Río Torres
Río Tiribí
Río Tiribí
Map of Environmental Elements, Sheet No 31 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Área de Influencia Directa (150m)
Sitios arqueológicos
Derecho de via
Cursos de agua
Trazado de Línea
Alajuela
Heredia
Cartago
San José

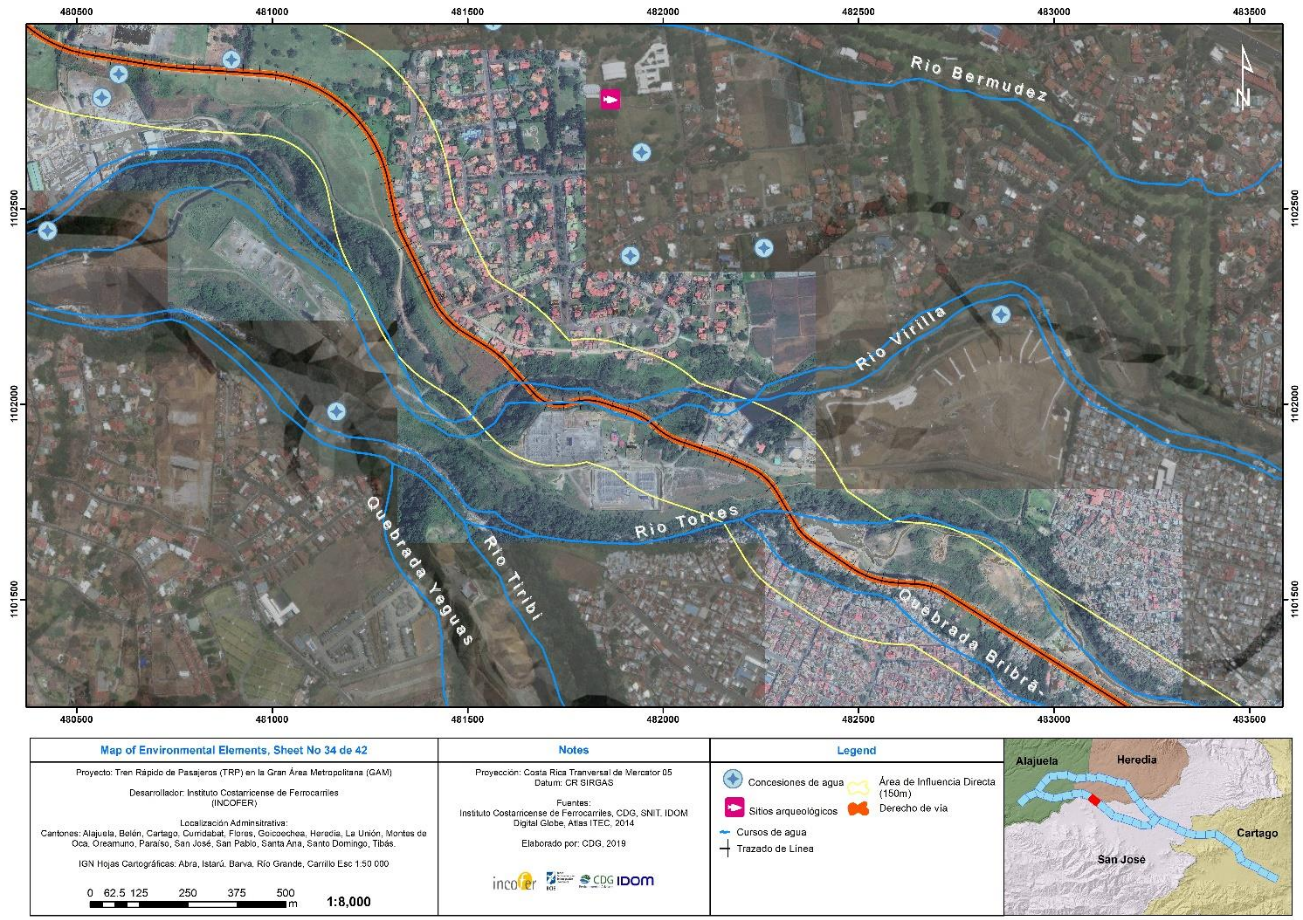
MA Sheet 32


483500
484000
484500
485000
485500
486000
1100500
1100000
1099500
1099000
Rio Tiribi
Rio Tiribi
Map of Environmental Elements, Sheet No 33de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT. IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 33


482000
482500
483000
483500
484000
484500
1101500
1101000
1100500
N
Rio Virilla
Rio Torres
Quebrada Bribrí
Rio Tiribi
Quebrada Yeguas
Quebrada Chapuí
Map of Environmental Elements, Sheet No 33de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú, Barva, Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 34

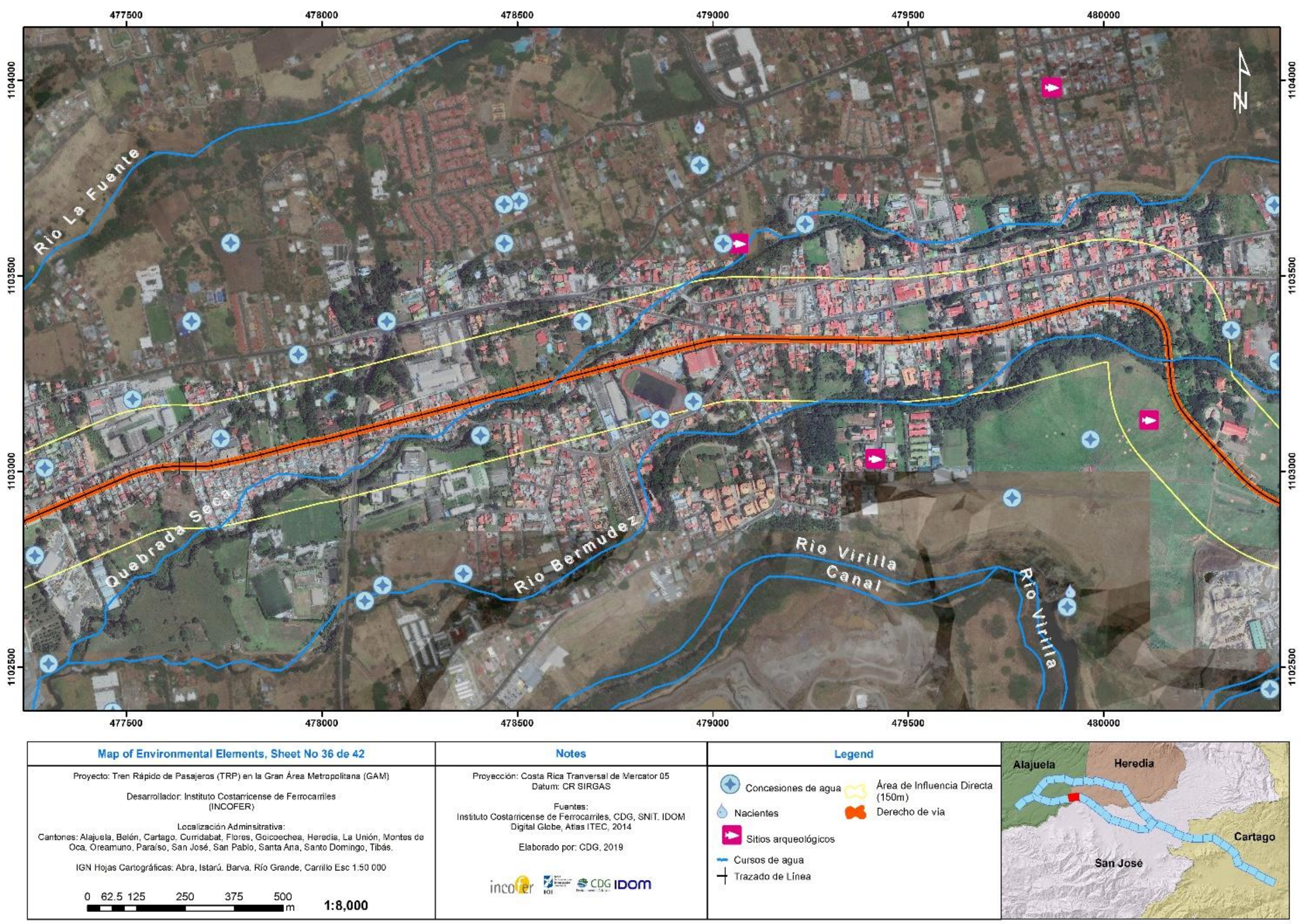


Rio Bermudez
Rio Virilla
Rio Torres
Quebrada Yeguas
Rio Tiribi
Quebrada Bribra
N
480500
481000
481500
482000
482500
483000
483500
1102500
1102000
1101500
Map of Environmental Elements, Sheet No 34 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Área de Influencia Directa (150m)
Sitios arqueológicos
Derecho de via
Cursos de agua
Trazado de Linea
Alajuela
Heredia
Cartago
San José

MA Sheet 35


479000
479500
480000
480500
481000
481500
482000
1103500
1103000
1102500
Quebrada Seca
Rio Bermudez
Canal
Rio Virilla
Rio Virilla
Rio Virilla
Rio Torres
N
Map of Environmental Elements, Sheet No 35 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Nacientes
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
San José
Cartago

MA Sheet 36



Rio La Fuente
Quebrada Seca
Rio Bermudez
Rio Virilla
Canal
Rio Virilla
N
477500
478000
478500
479000
479500
480000
1104000
1103500
1103000
1102500
Map of Environmental Elements, Sheet No 36 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
IGN Hojas Cartográficas: Abra, Istarú. Barva. Río Grande, Carrillo Esc 1:50 000
0 62.5 125 250 375 500 m
1:8,000
Notes
Proyección: Costa Rica Tranversal de Mercator 05
Datum: CR SIRGAS
Fuentes:
Instituto Costarricense de Ferrocarriles, CDG, SNIT. IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Nacientes
Sitios arqueológicos
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de via
Alajuela
Heredia
Cartago
San José

MA Sheet 37


475500
476000
476500
477000
477500
478000
478500
1103500
1103000
1102500
Rio Segundo
Rio La Fuente
Acequia
Rio Bermudez
Acequia
Quebrada Seca
Rio Virilla
Canal
N
Map of Environmental Elements, Sheet No 37 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
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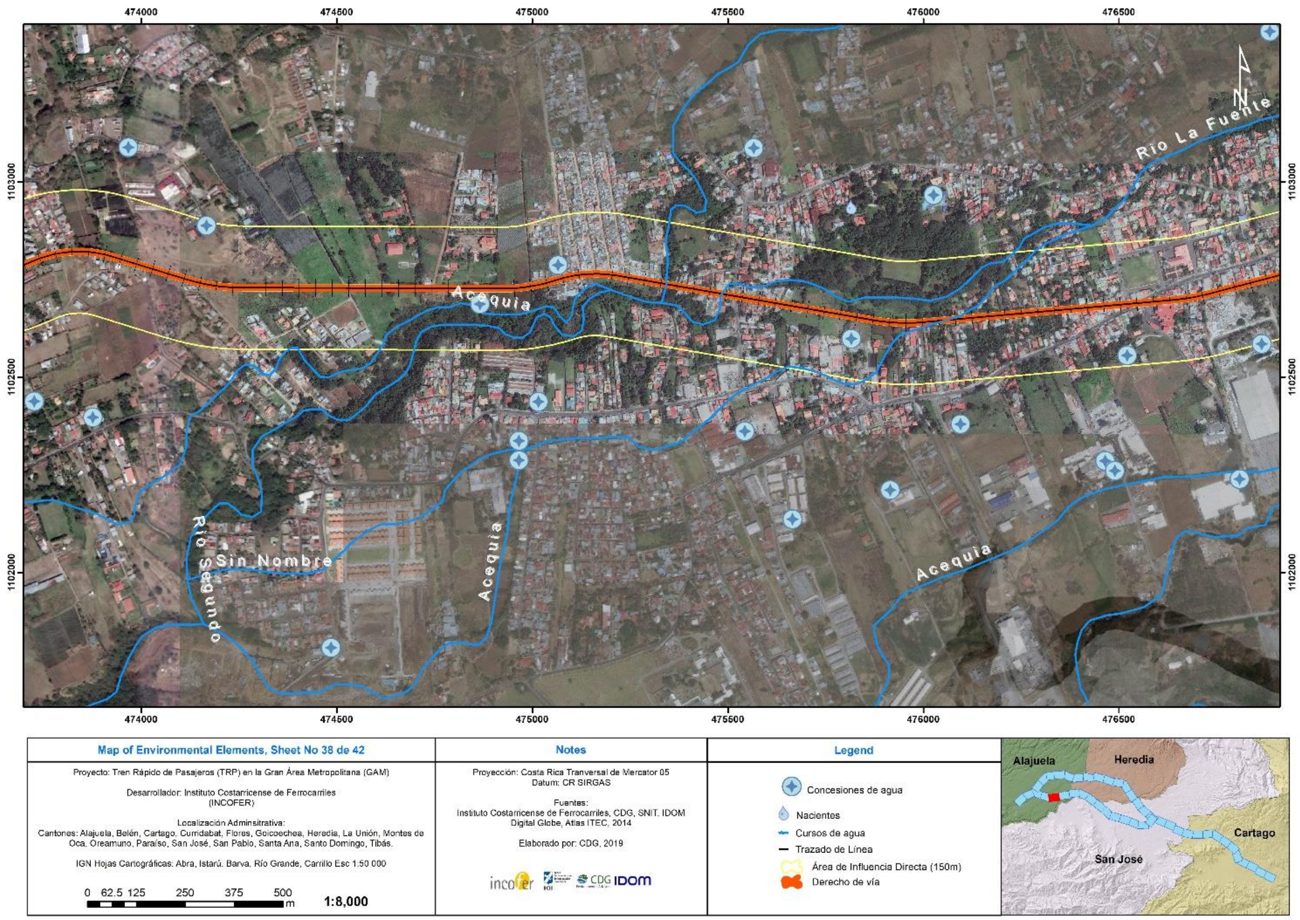
Instituto Costarricense de Ferrocarriles, CDG, SNIT, IDOM
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Cursos de agua
Trazado de Linea
Área de Influencia Directa (150m)
Derecho de vía
Alajuela
Heredia
Cartago
San José

MA Sheet 38



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Río La Fuente
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Río Segundo
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Map of Environmental Elements, Sheet No 38 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
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Trazado de Línea
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Alajuela
Heredia
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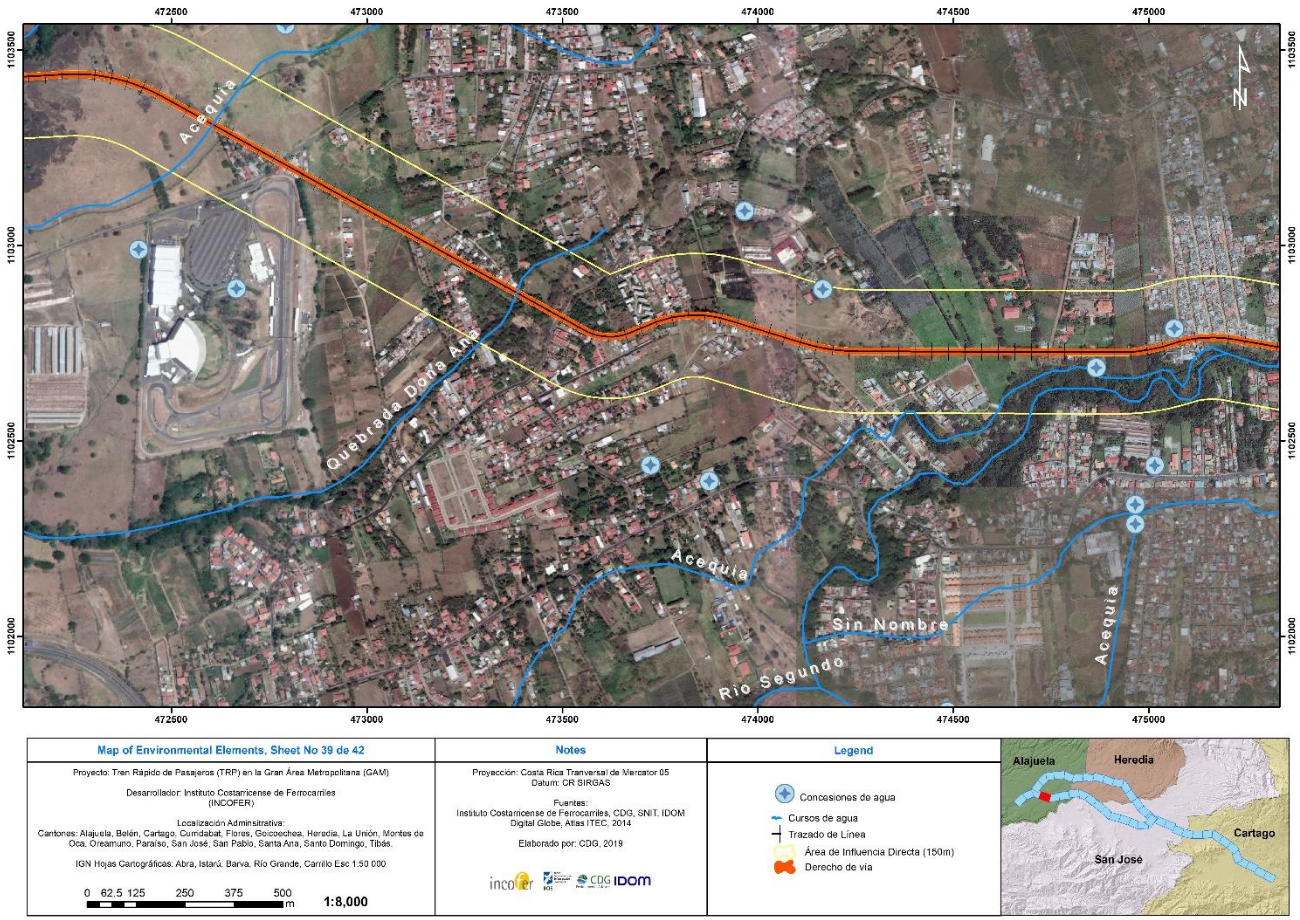
Cartago

MA Sheet 39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Sin Nombre
Río Segundo
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Map of Environmental Elements, Sheet No 39 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
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Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
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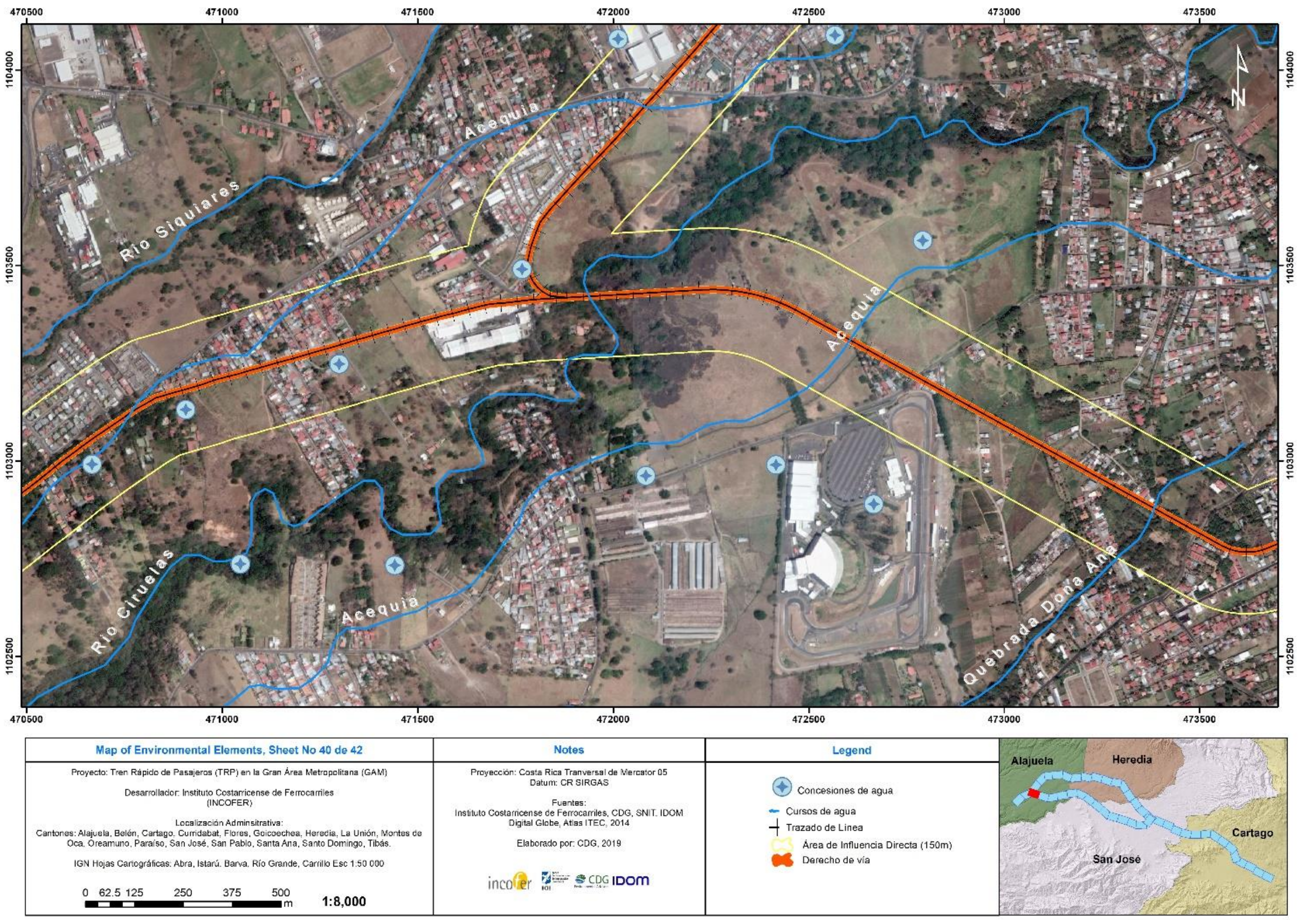
Concesiones de agua
Cursos de agua
Trazado de Línea
Área de Influencia Directa (150m)
Derecho de vía
Alajuela
Heredia
Cartago
San José

MA Sheet 40



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Rio Ciruelas
Quebrada Doña Ana
N
Map of Environmental Elements, Sheet No 40 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
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Digital Globe, Atlas ITEC, 2014
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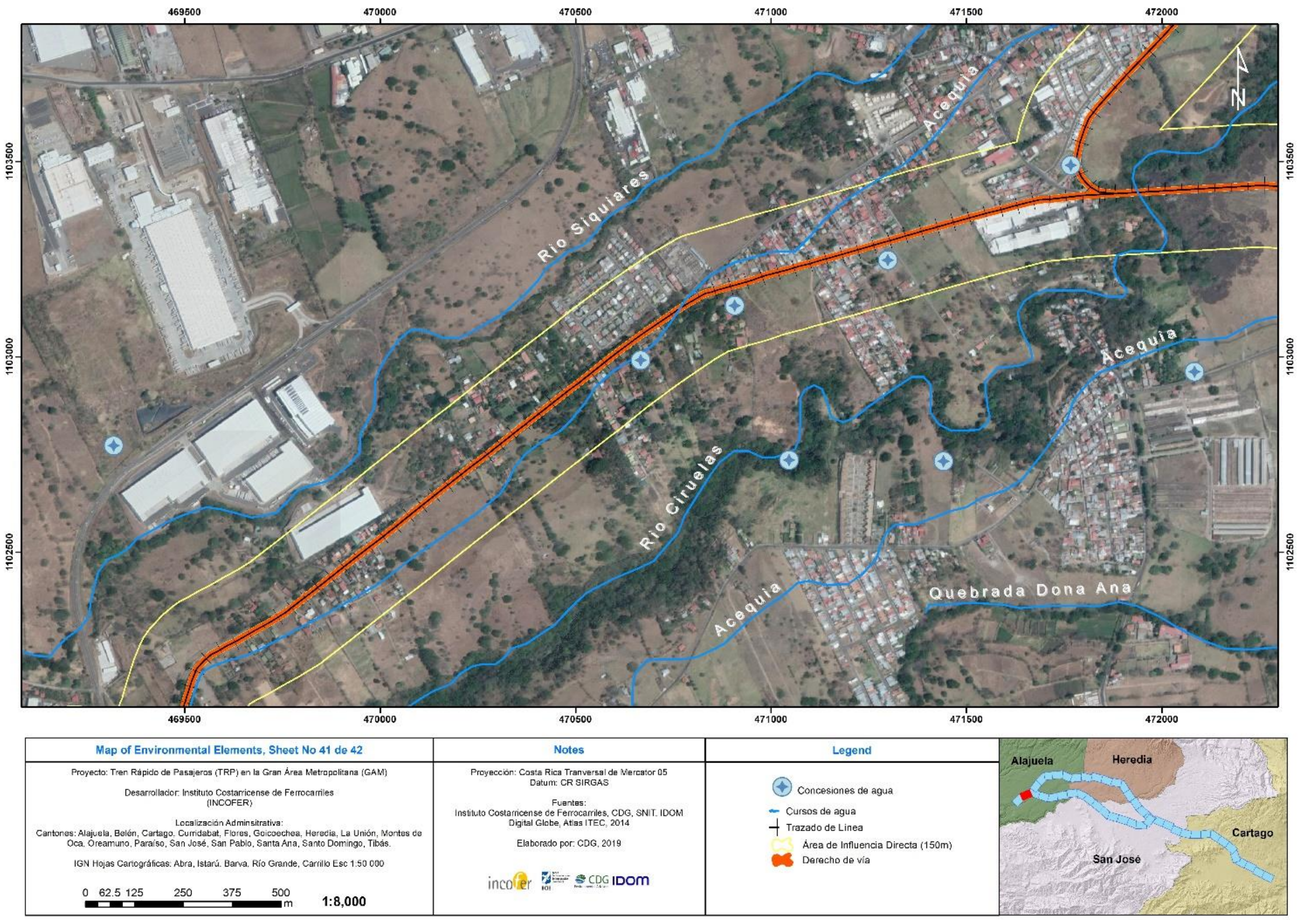
Concesiones de agua
Cursos de agua
Trazado de Linea
Área de Influencia Directa (150m)
Derecho de vía
Alajuela
Heredia
Cartago
San José

MA Sheet 41



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Rio Siquiares
Acequia
Rio Ciruelas
Acequia
Acequia
Quebrada Dona Ana
Map of Environmental Elements, Sheet No 41 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
Localización Adminsitrativa:
Cantones: Alajuela, Belén, Cartago, Curridabat, Flores, Goicoechea, Heredia, La Unión, Montes de Oca, Oreamuno, Paraíso, San José, San Pablo, Santa Ana, Santo Domingo, Tibás.
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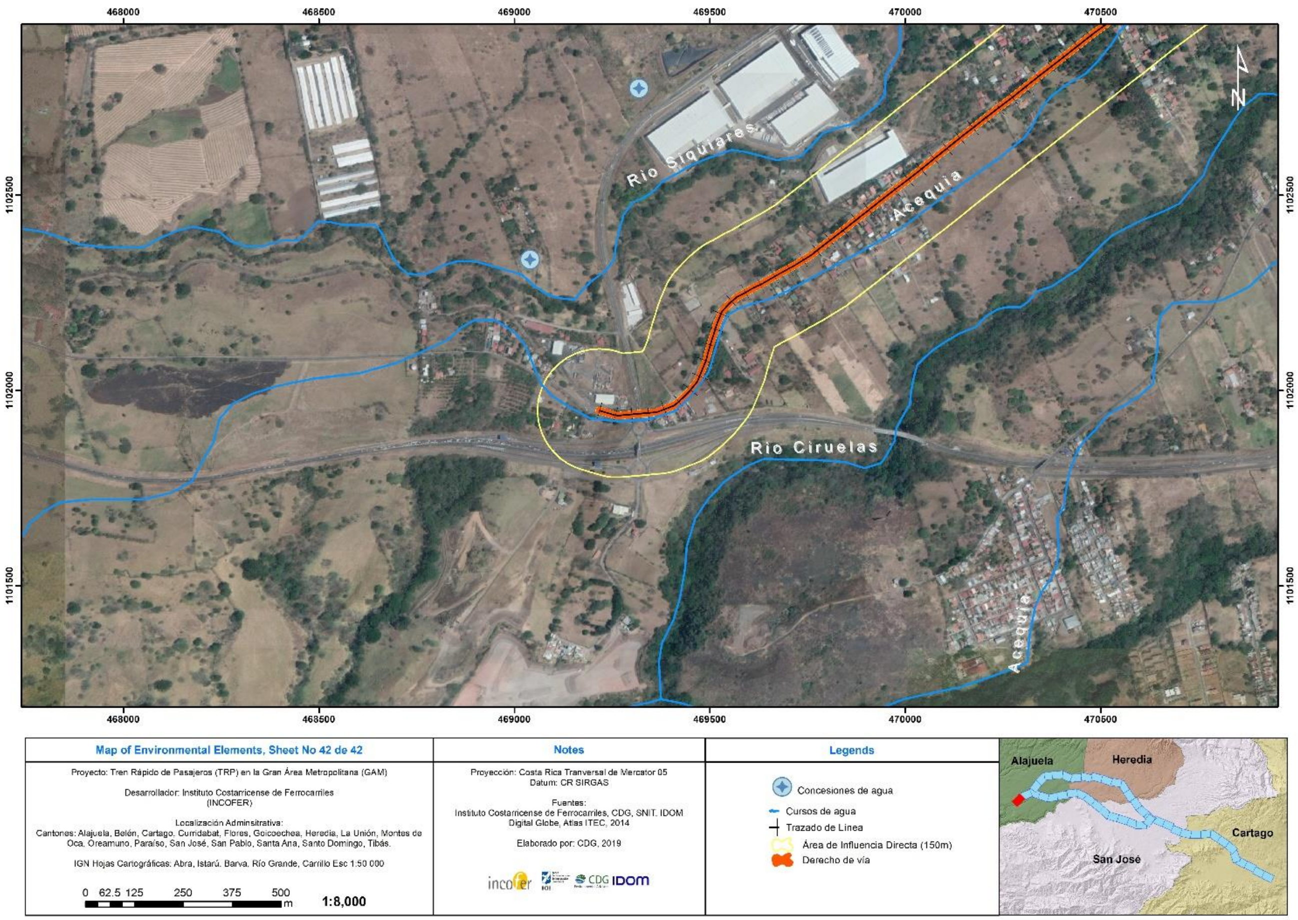
Digital Globe, Atlas ITEC, 2014
Elaborado por: CDG, 2019
Legend
Concesiones de agua
Cursos de agua
Trazado de Linea
Área de Influencia Directa (150m)
Derecho de vía
Alajuela
Heredia
Cartago
San José

MA Sheet 42



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Rio Siquiares
Acequia
Rio Ciruelas
Acequia
N
Map of Environmental Elements, Sheet No 42 de 42
Proyecto: Tren Rápido de Pasajeros (TRP) en la Gran Área Metropolitana (GAM)
Desarrollador: Instituto Costarricense de Ferrocarriles (INCOFER)
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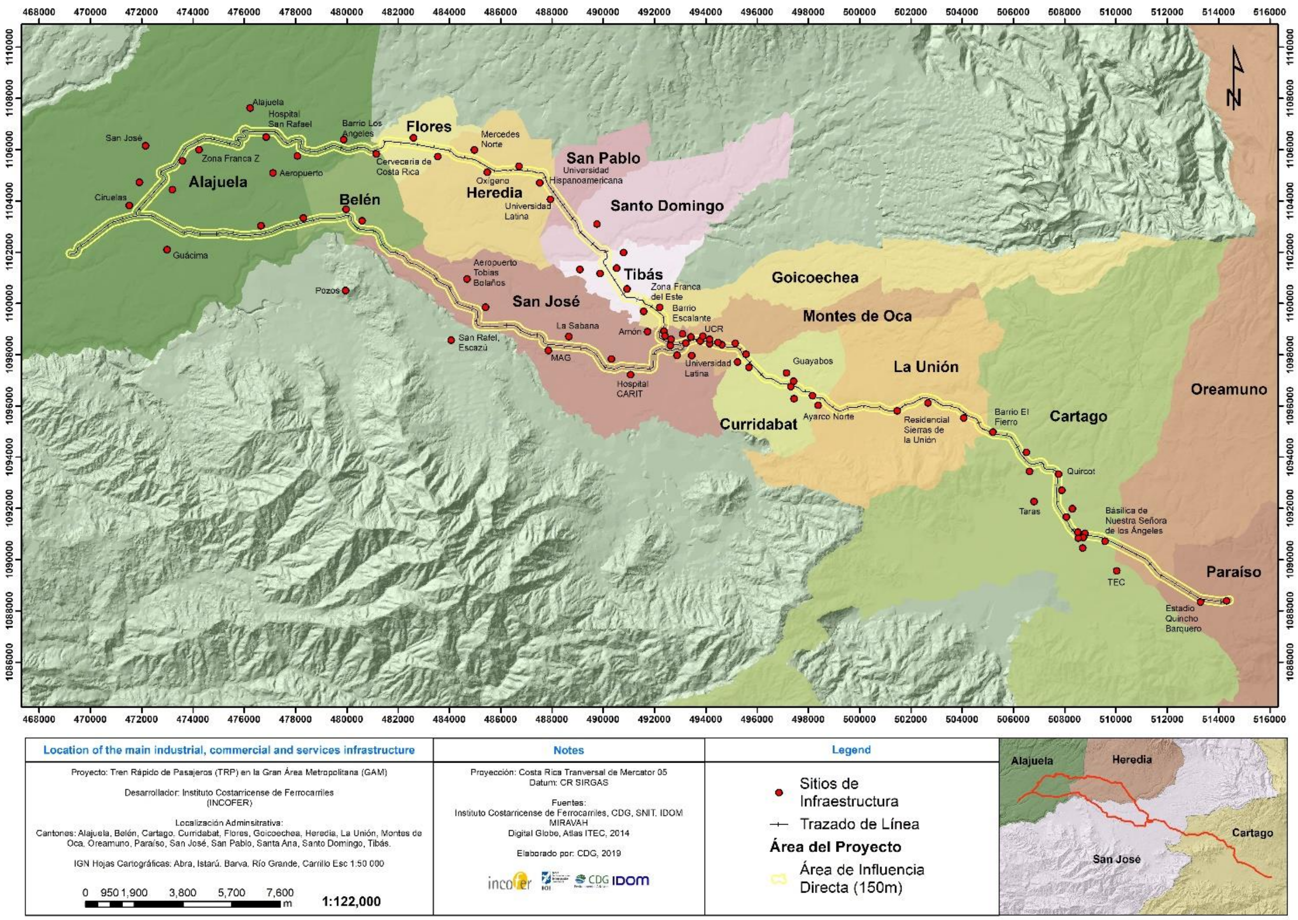
Heredia
Cartago
San José

Annex 6. Social maps atlas

MS Main Industrial, commercial and service infrastructure



Annex 7. IFA zoning for gam.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
I-A	Lands made up of different geological units: Formations with considerably reduced stability comprise almost all volcanic formations of the Cordillera Central (especially the Upper Trap Formation, Sapper Formation, Birís Formation, Barva Formation, as well as ash and lahars (sub) Recent. In addition, the following Tertiary formations of sedimentary rocks show very weak geotechnical characteristics: Coris Formation, Peña Negra Formation and San Miguel Formation (in the case of the latter because of the Karst phenomenon). In the case of the Formation Avocado Group (volcanic rocks of the Tertiary) the geotechnical characteristics show a very variable stability from very hard and stable to deeply weathered. Apart from the primary lithology (solid vulcanites,> stable, ash/lahares> very unstable) their characteristics are strongly controlled by the very variable degree of hydrothermal alteration (stability grows based on a decrease of the degree of disruption).	Presence of shallow residual soils, with high vulnerability to erosion processes. (Capacity of Use: VI to VIII). It usually corresponds to land that has a forest aptitude.	In most cases, the land in this category is used for livestock (grasses, pastures with scattered trees and pastures mixed with trees); Apart from that there are areas with annual as well as permanent plantations and in some cases urbanized areas of low to moderate density. Given the high danger from sliding, in many cases, these types of human use are considered questionable, since it does not adapt efficiently to the technical limitations that the terrain has. Despite this, given its height, landscape potential and view conditions, as well as its climatic conditions, these lands, in recent years are considered as real estate, tourism and ecotourism potential.	Within areas with increasing urban development, as in the case of GAM, areas of agricultural use show considerable value as ecosystems: these are one of the last refuges for wildlife. Some of these sectors could play an important role as small biological corridors between protected areas. In this respect are particularly important, the areas of protection of waterways.	Due to the predominance of high to very pronounced reliefs and extremely low hillside stability, terrains of this category are classified as areas with high limitations for permanent human occupation. In the vast majority of the geographical area of this CATEGORY of IFA the most recommended use is the development of forest cover that retains and protects the floor from erosive processes. At the same time, this way the water recharge capacity can be improved. Forest cover increases the potential for underground infiltration due to the increased permeability caused by the well-developed root network; on the other hand, the treetops act as sponges with the potential to retain a large part of the stormwater that would contract it directly to the river beds. For the same reason, it is highly recommended to establish reforestation projects with native and pioneering species. Obviously, these projects must be carried out in common with the private owners of the area in question. In this context, the payment of environmental services can be used as a very useful tool to promote this change in land use. In order to use the available natural resources more efficiently, more detailed geomorphological-geological studies (scale 1:5,000 or less) are recommended to define areas with greater environmental fragility, where a change in use is most urgent. Failing that, as an alternative to this element, the sectors within this zone that qualify in critical overuse condition can be selected for thispurpose. Similarly, areas can be established for the development of construction works, which have less technical limitations, so that their designs adapt to the conditions of the terrain. Although this area has significant limitations for the development of works of permanent human occupation (residential, ecotourism, tourism, mainly), a certain degree of occupation of very low density (no more than 10 %) it could be given to certain sectors where environmental technical studies (geotechnical, geology, geomorphology, among others) more accurately define (scales 1:5,000 or less) the technical limitations of the

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	High-relief to very pronounced dominance, which implies a high importance of erosion and nudation processes, very low slope stability, high risk for the generation of landslides and other types of gravity flows, especially in the case of Volcanic slope of the Cordillera Central as well as mountainous areas formed by the Peña Negra, Coris San Miguel and Grupo Aguacate Formations, due to its very low geotechnical stability. Most of the land in this category acts as important water-reload zones, especially in the case of the volcanic slope of the Cordillera Central, almost all major GAM aquifers are predominantly recharged through the infiltration of water into this volcanic slope. For the same reason, the danger from groundwater contamination is assessed as high to very high. Localpresence of active/potentially active regional/local faults.				terrain and allow to generate designs that exceed them. Due to the environmental conditions indicated the high-rise buildings (more than 2 floors) are not recommended. The development of buildings should not include the felling of trees, on the contrary, in parallel with the development of low infrastructure density, intensive programmes of reforestation and environmental and landscape improvement of this area should be implemented. Other human works linked to this type of development will have to adapt to this environmental condition. Due to its high importance as an aquifer recharge zone, the application of pesticides must be carried out in a controlled and restricted manner. The development of agricultural activities of type organic agriculture, as well as the intensive application of good practices of use, management and conservation of soil, is recommended. The use of conventional septic tanks for sewage treatment is not a recommended solution. Individual or collective treatment systems (in the case of already urbanized areas) that prevent soil and groundwater contamination should be used. In areas of pronounced topographical changes within this area, springs of various types and categories may be presented. In consideration of this, any type of development that arises should consider, as part of its environmental assessment, the analysis, both in its area of the project, and of its area of influence (up to 500 meters) the existence of springs and their areas of protection, in flow tubes, in order to adjust land use to these water-geological technical limitations. Given the conditions of emphasis presented by this area, the development of actions (human constructions) of any kind, should always consider an adequate landscape insertion in order to avoid deterioration of the landscape and visual pollution.
I-B	Surface formations directly related to the main riverbeds. Intermediate geotechnical stability for building support.	Moderate to high fertility soils, depending on their granulometric composition between	Lands with predominance of different types of agricultural use, less often are areas of forest cover as well as urbanized areas.	Within areas with increasing urban development, as in the case of GAM, areas of agricultural use show considerable value as	Due to the moderate to high vulnerability to erosion and sedimentation processes and natural threats (especially river floods and in several cases also lahars/avalanches), they are classified as high-limitational land for human occupation.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	Moderate to high erosion activity and river sedimentation. Moderate to high risk of flooding associated with riverbeds. Aggravation of the threat in the case of the presence of solid waste in the channels. Presence of alluvial aquifers, moderate to high vulnerability to groundwater contamination. In the case of channels of the volcanic slope of the Cordillera Central, a high to very serious danger is present in regard to the threat by lahars and avalanches, (especially in the case of the Resale River). Locally, presence of active/potentially active local faults.	gravels, sands, sludge and clays. Technical limits for agronomic production mainly include (1) a higher degree of flood hazard and river sedimentation/erosion and (2) an increased degree of stonyness in the case of a thick granulometric composition.		ecosystems: these are one of the last refuges for wildlife.	They have the potential for use for agricultural purposes as long as the potential risk of a loss of these resources is taken into account if events linked to the natural threats described occur. Due to the moderate to high vulnerability to groundwater as well as surface water pollution, the application of pesticides should be carried out in a controlled and restricted manner. It is recommended to use organic farming practices. In or near urbanized areas, it is advisable to establish corridors of green areas on both sides of the riverbed, which will avoid economic losses as well as human lives and at the same time increase the quality of life for citizens and they're in environmental lathe. In some cases, the development of containment and protection works would be necessary in order to reduce vulnerability conditions, requiring the development of specific technical studies to determine their convenience and design. In the case of channels of the volcanic slope of the Cordillera Central it is very important to consider the high to very serious danger in regard to the threat by lahars and avalanches, especially during times with heavy rains and / or increased volcanic activity. The most serious case concerns the Resale Edo. River. The extraction of geological materials in the riverbeds and on the banks of rivers, should be regulated and evaluated very carefully, since there is the possibility that there are areas of springs and that, in addition, mining activity may cause problems stability of the hillside. Despite this, well-planned and executed mining projects could produce space for the mobilization of water flows, and avoid the load of the channel, diminishing its potential for overflow and development of erosive processes. In all cases, the zone protection zone, established through forest law, must be strictly respected. The main use of these areas should be that of biological corridors or green areas.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
I-C	Lands formed by different geological units; whose geotechnical behavior varies depending on the lithological characteristics of the corresponding geological formation. For the most part these are terrains with high to steep slopes, characterized by a high importance of erosion and sedimentation processes as well as a condition of high vulnerability to landslides and avalanches. Areas of forest edify within mountainous areas represent key areas for water recharge: on the one hand they increase the potential for infiltration to the subsoil due to the increased permeability caused by the well-developed network of roots, on the other hand the Treetops act as sponges with the potential to retain a large part of the stormwater to reach riverchannels directly. Locally, active/potentially active regional/local faults may occur.	Predominance of shallow residual soils, very vulnerable to erosion processes. (Capacity of Use: VII to VIII). It usually corresponds to land that has a forest aptitude.	Human occupation within areas of this category to this day is presented as very small. Despite this, given its height, landscape potential and view conditions, as well as its climatic conditions, these lands, in recent years are considered as real estate, tourism and ecotourism potential.	This category of IFA is primarily defined by the presence of primary forest coverage. The areas in question represent extraordinary value as an ecosystem, especially because of the high rate of deforestation within the entire GAM area. It is therefore one of the key measures to establish a protection regime for the areas of this category.	Given the high importance of the lands of this category as the last true refuges for wildlife within the GAM, it is of extraordinary importance to preserve its forest cover, within a protection regime, such as that of Wildlife Refuge. In large part, these are water-reloading zones of strategic value, which is why forest management plans and forest exploitation should not be carried out. In addition, it is highly recommended to try to extend the forest areas through reforestation projects. Human activities within this area should be very restricted and should focus more on the use of research, education and ecotourism. Although this area has significant limitations for the development of works of permanent human occupation (residential, ecotourism, tourism, mainly), a certain degree of occupation of very low density (no more than 10 %) it could be true for certain sectors where the legal land-use regime so permits and also environmental technical studies (geotechnical, geology, geomorphology, among others) more precisely define (scales 1:5,000 or less) the technical limits terrain and allow to generate designs that exceed them. Due to the environmental conditions indicated the high-rise buildings (more than 2 floors) are not recommended. The development of buildings should not include the felling of trees, on the contrary, in parallel with the development of low infrastructure density, intensive programmes of reforestation and environmental and landscape improvement of this Area. Other human works linked to this type of development will have to adapt to this environmental condition. In the same vein, the environmental restrictions established for Zone 1 – A apply.
D	Lands formed by deposits of active fans of the volcanic slope of the Cordillera Central with predominance of lahares/avalanche deposits and a variable	Given the high geodynamic activity within the lands of this category, very young shallow soils dominate.	Terrains in this category show two different types of use: (1) Within a large part are present urbanized areas, especially most of the city of	Urbanized areas do not have a value of consideration in the context of the protection of wildlife. In contrast, areas of agricultural use show	Due to the condition of high geodynamic activity, especially related to the generation of different types of gravity flows within the upper parts of the volcanic slope of the Cordillera Central, they are classified as lands with high limitations for human occupation.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	content of sediments of river origin (gravels, sands and silts). Stability and support for buildings is usually reduced, especially in the case of the presence of lahars with a high content of a limo-clay matrix. May include expansive soils. Given the extremely low stability of the volcanic slope, especially in the ravines of the main channels, terrains of this category show a high geodynamic activity. The main hazard is related to the generation of different types of gravity flows (e.g. mud flows, avalanches, landslides) within the upper parts of the volcanic slope, especially within the walls of the ravines. The areas of the fans form the main areas where these flows deposit their materials, as for example in the case of mud flows of the years 1963-65, which have strongly affected the resaleed river range. Such flows can move with high speeds that leaves a very short time to save people and goods outside the affected area. In the case of the Casita Volcano in Nicaragua, an avalanche generated during Hurricane Mitch (1998) has killed more than 2500 people and destroyed the	They usually show moderate fertility. (Capacity of Use: III to IV)	Carthage. Given the existing danger associated with the generation of gravity flows, this type of use represents a use with strong environmental limitations, particularly when associated with a period of activity of the Irazú volcano. (2) On the other hand, there are large areas with the presence of agricultural activities, a much more suitable form of land use.	considerable value as ecosystems in the case of areas with increasing urban development.	They have the potential for use for agricultural purposes as long as the potential risk of a loss of these resources is taken into account if events linked to the natural threats described occur. In view of the fact that a large part of the city of Carthage is built within land of this category of IFA and that it is obviously not feasible in any way to relocate such a large number of buildings to less vulnerable areas, it is important to take in it has the following recommendations: (1) Perform as detailed an analysis as possible (scale 1:5,000 or less) on the geology and geomorphology of the entire Resale River basin in order to quantify the risk associated with the generation of gravity flows for the different parts of the city Carthage. With this basis it is possible to make well-informed decisions, concerning which areas or sectors would require promoting changes in the use of corrective type land. (2) Establish a prevention alert system including above all periodic field visits to the most critical areas, defined within the framework of geological-geomorphological analysis (compare (1)). It is very important to densify field visits during critical times, i.e. times with heavy rains and/or tropical storms as well as phases with increased volcanic activity. (3) Establish an emergency plan for the detection of a high-hazard state. In this sense, it is key to inform the entire population of Carthage that it is located within areas with the greatest potential risk, on the best way to act in emergencies. Due to the presence of vulnerable aquifers it is a high priority to establish a well-crafted wastewater treatment system, which includes a sewerage system as well as treatment plants. In the case of agricultural activities, the application of pesticides should be carried out in a controlled and restricted manner. In all cases, practices of use, management and conservation of soils should be applied to prevent their degradation. It is highly recommended to use organic agriculture.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	two cities "Rolando Rodriguez" and "El Porvenir". Presence of alluvial aquifers, moderate to high vulnerability to groundwater contamination.				Areas not yet urbanized, where the conditions of geological – geomorphological and geotechnical studies allow, could be subject to controlled urban development, with coverages of up to 40 – 50 %, and population densities low to very low.
I-E	Areas directly related to different types of eruptive centers of the Cordillera Central. They are made up of the different products of the proximal facies of volcanic buildings, including lava flows, volcanic bombs, pyroclasts and ash. Due to its structure characterized by a set of very irregular layers of materials with a very variable hardness (e.g. pyroclasts and ash with very hard lava flow collations) these are very weak structures with high importance of processes of erosion as well as a serious danger to the generation of different types of gravity flows. Predominance of high to steep slopes. Apart from that, there is obviously a very high danger in the case of volcanic eruptions. Areas in this IFA category represents very important water recharge areas.	Given the direct influence of volcanic eruptions as well as the predominance of high slopes resulting in a very strong vulnerability to erosion processes, they dominate residual soils with a very reduced depth to almost zero. (Capacity of Use: VII to VIII). It usually corresponds to land that has a forest aptitude.	Human occupation within areas of this category to this day is presented as very small. They dominate areas of primary to secondary natural forests.	Areas with forest coverage represent a high value as an ecosystem, especially because of the high share of deforestation that has occurred, historically, within the entire GAM area. For this reason, one of the key environmental measures is the establishment of a protection regime for the lands of this category.	Land with very significant technical limitations for the development of human occupation works, including above all the very high danger in the case of volcanic eruptions as well as the high risk for the generation of different types of gravity flows. Due to the geofitness conditions of the rocks that make up this unit, particularly due to the presence of porosity and permeability, combined with the prevailing climatic conditions, especially high rainfall, the land of this area is qualify as water-top areas of strategic value, which is why land use must be restricted to this condition. Existing forest cover must be protected and safeguarded to the maximum. Forest management plans that cause tree removal should not be promoted. It is recommended that the land in this area be included as part of a protection regime. Human occupation in these areas should be restricted mainly for educational, research and ecotourism purposes. In the event that, for reasons of these activities it is necessary to develop infrastructure works, they must strictly comply with the development of environmental measures that allow them to develop causing the minimum environmental impact. In the case of areas not covered by forests that are in place of agriculture, it should consider the fact that these are areas of water recharge of a strategic type, which is why the use of pesticides should not occur. The development of organic agriculture should be promoted.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
II-A	Lands made up of different geological units: - Formations with considerably reduced stability comprise almost all volcanic formations of the Cordillera Central (especially the Upper Trap Formation, Sapper Formation, Birís Formation, Barva Formation, as well as ash and lahars (sub) Recent. - In addition, the following Tertiary formations of sedimentary rocks show very weak geotechnical characteristics: Coris Formation, Peña Negra Formation and San Miguel Formation (in the case of the latter because of the Karst phenomenon). In the case of the Formation Avocado Group (volcanic rocks of the Tertiary) the geotechnical characteristics show a very variable stability from very hard and stable to deeply weathered. Except for the primary lithology (solid volcanites,> stable, ash/lahares)> very unstable) their litopetrophysical characteristics are tightly controlled by the very variable degree of hydrothermal alteration (stability grows according to	Land with presence of residual soils of low to moderate depth, characterized by a moderate condition of vulnerability to erosion processes. (Capacity of Use: IV to VI)	In most cases, land in this category is used for livestock (grasses, pastures with scattered trees and pastures mixed with trees); apart from that there are widespread areas with annual as well as permanent plantations and in some cases urbanized areas of low to moderate density. Given the presence of some danger due to the generation of landslides as well as an intermediate importance of erosion processes, this type of use represents a considerable environmental burden, especially in the case of annual plantations and urbanized areas.	Within areas with increasing urban development, as in the case of GAM, areas of agricultural use show considerable value as ecosystems: these are one of the last refuges for wildlife.	Land with moderate relief and considerable importance of erosion and denudation processes do not show very favourable conditions for permanent human occupation. In the case of rural areas, especially land with annual plantations represents a rather questionable type of use. In most cases there is a high danger regarding soil layer loss due to vulnerability to erosion processes. In these cases, the minimum measure to be applied is the establishment of a set of soil conservation practices, one of the most important being to orient the ground plow parallel to the contour of the terrain (i.e. contours) to ev itar that the grooves of the land at work act as preferable steps for the streams of water that produce soil erosion. In cases where erosion is already strongly affecting the soil layer, it is necessary to change the type of land use to less impactful forms. The same recommendations count in the case of permanent plantations, although in this case the danger from soil erosion is of less serious. Grass with a variable tree density means a reduced hazard in soil erosion and mostly represent sizing for land in this CATEGORY of IFA. The development of human occupation infrastructure could be permitted, under the condition that it is low coverage (no more than 20 %) and that the planning and localization respond to the development of a geological - local geotechnical study of slope stability and that in the design and construction of the work are taken into account, both the technical recommendations emanating from those studies and the limitations as defined in this document. Vertical building, due to topography conditions and geofitness conditions of the formations, should be restricted, and any case should not exceed 4 floors. As sewage treatment systems suggest the development of treatment plants, however, treatment by septic tanks could be feasible as long as the local environmental hydrogeology technical studies determined by local environmental hydrogeology are carried out the

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	a decrease in the degree of alteration). Moderate relief dominance and moderate vulnerability to erosion and nudity processes. Low to moderate danger from landslides. Moderate to high potential for groundwater contamination, especially in the case of the volcanic slope of the Cordillera Central due to the presence of lava flows in the deepest subsoil with a high aquifer potential. Many areas in this IFA category represent a high value as reload zones. In the case of the volcanic slope of the Cordillera Central there is considerable danger due to the threat of volcanic eruptions, especially related to the fall of ash. Locally presence of active or potentially active local faults.				technical feasibility of the proposed solution. In any case, it is recommended, in the event that it is not possible to install wastewater treatment plants, to install modified septic tank systems, from which no contamination to the soil and groundwater is possible. The land in these areas are areas of aquifer recharge of intermediate value, which requires to be considered in the use of land to be planned, in particular with regard to human uses involving activities of moderate high and high environmental risk.
II-B	Land consisting of different types of unlitized Quaternary deposits, including alluvial fan deposits, intramountain valley deposits as well as different types of recent bodies to underrecent gravity flows such as lahars or Landslides. The vast majority of these deposits show moderate to low	Soils with presence of moderate fertility soils. In the case of alluvial fans and intramountain valleys, the main limitings include stonyness and a reduced depth of soil layer. (Capacity of Use: III to IV)	Lands with predominance of different types of agricultural use, less often is urbanized areas of moderate to low density.	Within areas with increasing urban development, as in the case of GAM, areas of agricultural use show considerable value as ecosystems: these are one of the last refuges for wildlife.	Due to the condition of moderate to high vulnerability to erosion and sedimentation processes and natural threats, they are classified as lands with certain significant limitations for permanent human occupation. They have the potential for use for agricultural purposes as long as the potential risk of a loss of these resources is taken into account if events linked to the natural threats described occur. In or near urbanized areas, it is advisable to establish green corridors on both sides of permanent waterways in order to avoid or reduce economic losses, as well as

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	geotechnical stability. May include expansive soils. Lands of this category of IFA are mainly defined by the presence of significant external geodynamic activity, including above all different types of erosion and sedimentation processes such as in the case of alluvial fans, intramountain valleys or the different types of bodies recent to subrecent gravity flows. Presence of open alluvial aquifers with a vulnerability to moderate to high pollution. Locally presence of active or potentially active local faults.				human lives and at the same time increase the calid living for citizens and their environment. In some cases, the development of containment and protection works would be necessary in order to reduce vulnerability conditions, requiring the development of specific technical studies to determine their convenience and design. The development of human occupation infrastructure could be permitted, under the condition that it is low to moderate coverage (no more than 40 %) and that planning and localization respond to the development of a local geological-geotechnical study of slope stability and that in the design and construction of the site are taken into account, both the technical recommendations emanating from those studies such as the technical limitations defined herein. Vertical building, conditioned by the topography and geofitness of the formations, can be possible, as long as it conforms to conditions of landscape impact. From 6 to 8 floors is possible. The development of treatment plants is suggested as sewage treatment systems. In any case, it is recommended, in the event that it is not possible to install wastewater treatment plants, to install modified septic tank systems, from which no contamination to the soil and groundwater is possible. The land in these areas are areas of aquifer recharge of intermediate value, which requires to be considered in the use of land to be planned, in particular with regard to human uses involving activities of moderate high and high environmental risk. In areas of strong urban development, coverage could be increased by up to 60% if effective measures are considered for rainwater (uncontaminated) to recharge the aquifer and not overload the surface water drainage system. In all cases, the zone protection zone, established through forest law, must be strictly respected.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
II-C	Lands formed by different geological units; the geotechnical behavior varies depending on the lithological characteristics of the corresponding geological formation. For the most part these are terrains with high to steep slopes, characterized by a high importance of erosion and sedimentation processes as well as a condition of high vulnerability to landslides and avalanches. Areas of forest edify within mountainous areas represent key areas for water recharge: on the one hand they increase the potential for infiltration to the subsoil due to the increased permeability caused by the well-developed network of roots, on the other hand the treetops act as sponges with the potential to retain a large part of the stormwater from reaching riverchannels directly. Localpresence of active/potentially active regional/local faults.	Predominance of shallow residual soils, very vulnerable to erosion processes. (Capacity of Use: VII to VIII). It usually corresponds to land that has a forest aptitude.	Human occupation within lands of this category to this day is presented as reduced. Despite this, given its height, landscape potential and view conditions, as well as its climatic conditions, these lands, in recent years are considered as real estate, tourism and ecotourism potential.	Areas with secondary forest coverage represent a high value as an ecosystem, especially because of the high deforestation quota within the entire GAM area. It is therefore advisable to establish an effective protection regime for the land in this category.	Given the high importance of the lands in this category as one of the last true refuges for wildlife within the GAM, it is of high importance to preserve its forested cover, under a protection regime as established in the legislation in force. In addition, it is highly recommended to extend forest areas through reforestation projects, within a recovery framework for fragile overused areas. The land in these areas are intermediate-value aquifer recharge areas, which is required to be considered in the land use to be planned. Although this area has significant limitations for the development of works of permanent human occupation (residential, ecotourism, tourism, mainly), a certain degree of low coverage occupancy (no more than 20 %) it could be true for certain sectors where the legal land-use regime so permits and also environmental technical studies (geotechnical, geology, geomorphology, among others) more precisely define (scales 1:5,000 or less) the technical limits terrain and allow to generate designs that exceed them. Due to the environmental conditions indicated, height buildings (more than 4 floors) are not recommended. The development of buildings should not include the felling of trees, on the contrary, in parallel with the development of low infrastructure density, intensive programmes of reforestation and environmental and landscape improvement of this area should be implemented. Other human works linked to this type of development will have to adapt to this environmental condition. In the same vein, the environmental restrictions established for Zone 1 – A apply.
II-D	This category is mainly defined by the extent of the most recent lava flows of the Irazú Volcano, which are sorted stratigraphically in the Cervantes Formation. These are basalt - andesitic	Due to the very recent age of lava flows of the Cervantes Formation, in most cases to this day a soil layer has not	Lands with predominance of different types of agricultural use, less often is urbanized areas of moderate to low density.	Within areas with increasing urban development, as in the case of GAM, areas of agricultural use show considerable value as ecosystems: these are one	Lands with considerable variability in regard to their aptitude for different types of human occupation. In the case of high to far-fused relief terrain, the only suitable use is forest cover. On the other hand, internal depressions, where a soil layer has been developed based on recent accumulations of ash, can be quite

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	flows with a spoofal to very fractured texture. Collapsed flow tubes have often been found. Due to the very recent age of these flows, the lavas are unaffected by the weather, so they show a high hardness of rock. The stability for constructions depends mainly on the internal texture of these lava flows. Especially the presence of underground caverns can generate serious stability problems in the case of heavier buildings. The topographic surface of these lava flows today is presented as very irregular, including depressions with a smoothed relief due to the accumulation of recent ash, but also very steep areas, especially in the case of walls of collapsed flow tubes. The aforementioned scoreace to very fractured texture generates a very high primary permeability, ideal conditions to form a good quality aquifer. They also represent very important areas for water reloading, because the rocky body is not covered by any soil layer or meteoritization layer, a factor that hinders the infiltration of stormwater into the subsoil. On the other hand, the same fact means	been developed and in many parts the rocky body is present on the topographic surface. Only in the case of internal depressions are there areas where a soil layer has been developed that has been formed from recent accumulations of ash. (Capacity of Use: III to V)		of the last refuges for wildlife.	useful for agricultural production, due to the high fertility of the soil. In all cases, the main limitation of land in this category relates to very high vulnerability for groundwater contamination. This area qualifies as an area of water recharge of strategic value. For this same reason, in the case of agricultural and similar activities, the application of pesticides must be carried out in a very controlled and very restricted manner. It is recommended that organic farming practices be applied, as well as soil management and protection. Given the geological and geotechnical limitations presented by this area, urban development in it must be controlled and low density. Maximum coverage must not exceed 20% and vertical building is not possible. Urbanization areas should be established with more detailed geological – geotechnical studies at 1:5,000 scale or less. The use of septic tanks is not an acceptable solution for wastewater treatment. High-impact or environmental risk activities such as industrial plants or intensive crops, such as flower greenhouses and ferns, represent high-risk types of use, which cannot be allowed within land of this category.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	a very high vulnerability to groundwater contamination, because there is no waterproof layer with the potential to prevent toxic substances from quickly coming into contact with the body aquifer.				
II-E	Terrain within the possible direct buffer of active or potentially active regional faults, danger of surface ruptures in the case of high-energy seismic events. Variable stability depending on the stratigraphic units that make up it. The importance of erosion and sedimentation processes varies with the specific characteristics of the corresponding geomorphological unit. The potential for aquifer contamination is variable. The vulnerability condition to slippages is variable.	Soil conditions are variable, from thin soils to thick, good-fertility residual soils	The degree of human occupation varies from areas with forest cover to high density urbanized areas.	Compare IFA Anthroposaptitud	Areas at risk of surface ruptures of active or potentially active regional faults, which pose a serious risk to any type of construction. For this reason, it is highly recommended to carry out more detailed neotectonic studies in order to make informed decisions, concerning the need to establish safety zones where constructions with permanent human occupation cannot be allowed. With regard to the zoning of Regulatory Plans it would be best to include all the land in this category of IFA in its own area, where any type of construction project should develop a neotectonic study in order to analyze the threat seismic events and geological fault in more detail. In this way it is also possible to accumulate very valid information about the effects of seismic activity within the GAM. Ideally, all this information would be handled by a single institution, in this case the most convenient would be the National Emergency Commission (CNE) as established by Decree 32967- MINAE. With regard to the human occupation infrastructure that already exists and is located near or on the course of active geological faults, it is recommended to develop activities aimed at reviewing the stability of the structure, the identification of points vulnerable or critical, information to the occupants and the development of emergency systems, which take into account the results of local building analyses.
II-F	This category of IFA is mainly defined by the presence of different types of human occupation with a high degree of environmental impact.	Soil conditions are variable.	Presence of different types of human occupation with a high degree of environmental impact, including industry areas, important cuts and	Land of this category of IFA has long lost its value as an ecosystem.	Due to the presence of different types of human occupation with a high degree of environmental impact, the essential in the context of the prevention of damage to the environment in direct proximity as well as in the area of influence, is to establish a series of regulations in order to d and initiate responsible management

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	The characteristics of the GEOaptitude IFA vary according to the geological and geomorphological units present within the lands in question.		greenhouses of flowers and ferns.		practices for different activities with a high degree of impact or environmental risk. In this sense, the most important thing is the continuous monitoring of compliance with established regulations. Here it is essential, to think first about how it would be possible to establish effective and continuous control rather than define regulations. Another important aspect concerns environmental certifications, offered by a variety of non-governmental organizations for industrial and agro-industrial production companies. In this context it should be borne in mind that there are several cases in which compliance with defined environmental standards is only controlled by previously announced visits, a fact that decreases the effective control in a substantial way. It is therefore of great importance that the system of environmental control and monitoring of these high-impact or environmental risk activities can be monitored, in detail, by government authorities. This control activity is one of the essential roles of good government practice. In the case of land-use changes for the development of new activities, they need to be conditioned from an environmental point of view in order to improve the pre-existing situation.
II-G	This category of IFA is mainly defined by the presence of green areas within urbanized areas. The characteristics of the GEOaptitude IFA vary according to the geological and geomorphological units present within the lands in question.	Soil conditions are variable.	Residual green areas within urbanized areas represent a very high value for citizens of densely urbanized areas, because they offer some of the few opportunities easily accessible to citizens to have places of recreation or recreation, as part of life in the city.	Urbanized areas, from the point of view of ecosystem conservation, do not present much value, because the richness of flora and fauna has long since been lost. For the same reason, residual green areas within urbanized areas represent a very high value: they form ecological islands (urban biotopes) where a small part of the wildlife is preserved.	Land in this category represent areas with a key function to maintain social as well as ecological balance within densely urbanized areas. On the one hand, they offer some of the few opportunities easily accessible to citizens to have places of recreation or recreation, as part of life in the city; on the other hand they form ecological islands (urban biotopes) where a small part of the wildlife is preserved. In this context, it is essential to establish permanent maintenance plans in order to save these areas in the long term in an attractive way for the two "communities present": citizens as well as residual parts of wildlife.
III-A	Land predominantly made up of alluvial plain deposits	Predominance of fertile soils that form a good	The degree of human occupation varies from	The ecological value of the land in this CATEGORY of	Land with few technical limitations for the development of permanent and non-permanent human occupation

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	(limos, sands and gravels) with stability and intermediate downward hardness; can include expansive soils. Low to flat relief predominate in which the condition of vulnerability to erosion and sedimentation processes is classified as very small. Moderate to high potential for groundwater contamination, made up of local alluvial aquifers. Moderate to low danger due to the threat of volcanic eruptions.	basis for agricultural production.	areas used for different types of agricultural activity to high-density urbanized areas.	IFA varies depending on the type of current land use (compare IFA Antropoaptitud).	infrastructure, as long as the geotechnical replacement of soil with limited supporting capacity is taken into account, including the presence of soils and the fact that there is a moderate to high degree of vulnerability to water pollution. It is possible to develop urban development of various types, residential, commercial, industrial, mixed or similar. This type of land has load capacity to assimilate high to very high population densities, but with percentages of occupation or coverage restricted to values not greater than 50%. In consideration of this, it is possible to propose the development of vertical buildings that consider as an intrinsic part of their design, the existence of green areas that allow the infiltration of water to the subsoil, decrease the waterproofing of the land and the surface runoff water and also use wastewater treatment systems such as treatment plants or sanitary sewerage that have subregional plants as part of the process. The height of the buildings must respond to landscape impact control patterns. Heights of 12 to 14 floors could be possible. In areas of strong urban development, coverage could be increased by up to 70% if effective measures are considered for rainwater (uncontaminated) to recharge the aquifer and not overload the surface water drainage system. As sewage treatment systems suggest the development of treatment plants, however, treatment by septic tanks would be feasible as long as the technical studies of local environmental hydrogeology are carried out to determine the feasibility of the proposed solution. Where such studies determine that the use of conventional septic tanks is not feasible, develop alternative solutions with modified septic tank systems that reduce soil and groundwater contamination. It is important to analyze the geotechnical behavior of the soil in the framework of geotechnical studies for any type of construction project in order to take appropriate measures to ensure its long-term stability and safety. Land with few technical limitations for the development of industrial or commercial type infrastructure classified

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
					as low and moderate environmental impact or risk. There are also no significant technical limitations, except those already mentioned on water vulnerability. With regard to land use in agricultural and agricultural activities, the use of pesticides must be subject to effective control. Given the conditions of vulnerability to water pollution, the development of organic agriculture, as well as good practices of use, management and conservation of soil, would be advisable.
III-B	Lands made up mainly of different types of lahars. These types of deposits represent products of avalanches and other gravity flows, which form in the upper parts of volcanic buildings. They consist of matrix support gaps with blocks of volcanoes with very variable diameters in a limo-clay matrix. In many parts these deposits are reworked through erosion and river sedimentation. Geotechnical support is usually reduced, especially in the case of a high content of a limo-clay matrix. May contain expansive soils. Lands of this category of IFA are located in the distal parts of the volcanic slope of the Cordillera Central, where they dominate low to flat reliefs with little importance of erosion and sedimentation processes. Only in the case of catastrophic events of voluminous avalanches, generated in the upper parts of the volcanic slope, the	Predominance of soils of moderate to high fertility. (Capacity of Use: III to IV)	The degree of human occupation varies from areas used for different types of agricultural activity to high-density urbanized areas.	The ecological value of the land in this CATEGORY of IFA varies depending on the type of current land use (compare IFA Antropoaptitud).	Land with few technical limitations for the development of human occupation infrastructure, except for the geotechnical replacement of soil with limited supporting capacity including the presence of expansive soils and the fact that there is a moderate to high degree vulnerability to water pollution. It is possible to develop urban development of various types, residential, commercial, industrial, mixed or similar. This type of land has load capacity to assimilate high to very high population densities, with occupancy percentages with values of up to 60% to 70%. Vertical and horizontal development may arise, provided that appropriate measures are put in place for the management of surface runoff water. Heights of 12 – 14 floors are possible, provided that they are designed according to geological studies – local geotechnical and strictly respecting the Seismic Code. As sewage treatment systems suggest the development of treatment plants, however, treatment by septic tanks would be feasible as long as the technical studies of local environmental hydrogeology are carried out to determine the technical feasibility of the proposed solution. In this sense it is mandatory to analyze whether there is a danger that a contamination of the surface layer can affect the important aquifers below the surface layer of the lahars. It is important to analyze the geotechnical behavior of the soil in the framework of geotechnical studies for any type of construction project in order to take appropriate measures to ensure its long-term stability and safety.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	land in question could be directly affected. Due to the presence of a limo-clay matrix, lahars usually do not show a potential aquifer of consideration. Hydrogeologically function more as aquitards. On the other hand, it is important to consider that under these deposits are the most important aquifers of the Central Valley, which are related to different types of lava flows with brechous to fractured textures. Locally presence of active or potentially active local faults.				Land with few technical limitations for the development of industrial or commercial infrastructure. There are also no significant technical limitations, except those already mentioned on water vulnerability. With regard to land use in agricultural and agricultural activities, the use of pesticides must be subject to effective control.
III-C	Lands formed by different geological units; the geotechnical behavior varies depending on the lithological characteristics of the corresponding geological formation. This category of IFA includes low-relief areas within mountainous areas, where erosion and sedimentation processes play a small role. Most of the land in question is important as an aquifer recharge zone, especially in the case of the presence of geological formations with permeabilities such as the sandstones of the Coris Formation or the limestones	Presence of moderate depth residual soils, given the predominance of a low relief, vulnerability to soil erosion processes is reduced. (Capacity of Use: III to IV)	Lands with predominance of different types of agricultural use such as coffee farms or pastures used for livestock. This type of human occupation is in good balance with the natural conditions of the land in question.	Within areas with increasing urban development, as in the case of GAM, areas of agricultural use show considerable value as ecosystems: these are one of the last refuges for wildlife.	Areas with good aptitude for agricultural production. The only technical limitation of consideration concerns the importance of most of the land in question as water-recharging zones, so it is important that the application of pesticides is carried out in a controlled and restricted manner. Given their rural environment, the land in question is not suitable for high-density urban projects. Your occupation should not exceed 30%. Depending on the topography conditions, vertical development could be considered, but not larger than 4 floors. Given its rural status, this type of land has potential for the development of tourism, ecotourism or recreational projects. Regardless of the land use in these lands, given the conditions of fragility from a hydrogeological point of view, they should be proposed as a solution to the management of wastewater, treatment plants or in their defects modified septic tanks that prevent any contamination of soil and groundwater.

Area	IFA Geoaptitude	IFA Edafoaptitud	IFA Anthroposaptitud	IFA Bioaptitude	Land use recommendations
	of the San Miguel Formation.				In case, for planning situations, it is desired to change the land use from agricultural activity (rural area) to urban area for urban development, it is possible, in its different variants: residential, commercial, industrial low and moderate impact, mixed or similar. In this case, this type of land has load capacity to assimilate high to very high population densities, but with percentages of occupancy or coverage restricted to values not greater than 50%. In consideration of this, it is possible to propose the development of vertical buildings that consider as an intrinsic part of their design, the existence of green areas that allow the infiltration of water to the subsoil, decrease the waterproofing of the land and the surface runoff water and also use wastewater treatment systems such as treatment plants or sanitary sewerage that have subregional plants as part of the process. The height of the buildings must respond to landscape impact control patterns. Heights of 12 to 14 floors could be possible. In areas of strong urban development, coverage could be increased by up to 70% if effective measures are considered for rainwater (uncontaminated) to recharge the aquifer and not overload the surface water drainage system.

Annex 8. Gender perspective diagnosis

Gender Study in the "Fast Passenger Train Project in the Greater Metropolitan Area”.

1 ASSESSMENT OBJECTIVE

This gender assessment is a proposal designed for the project entitled "Fast Passenger Train in the Greater Metropolitan Area", which aims to identify the possible technical aspects and opportunities that are presented that allows to integrate into the project the gender approach. In addition, the study identifies what information gaps exist and are needed to work towards successful gender inclusion in each phase of the project.

2 PROJECT CONTEXTS

Transport is the basis of the economic and social development model of any region, since they allow people to access different work points or learning sites, as well as to mobilize any type of material or goods, acquiring [Global Environment Facility (GEF), 2009]. However, urban transport systems have been forgotten within debates and decision-making around the quality of life of citizens and how dynamic they are is.

Within this broad and diverse dynamic, people's perceptions of urban transport are taken into account, from different perspectives, including gender. Without the above it is impossible to talk about sustainable urban transport, i.e. it is efficient, affordable, green (environmentalfriendly) and safe (Kunied & Gauthier, 2007). And towards this conversion of urban transport to sustainable is that they are beginning to migrate models globally, within each country or region.

In Costa Rica, the urban transport system is mainly concentrated in the Greater Metropolitan Area, which is where there is a greater flow of users who mobilize privately and publicly. However, it is in the public part that in the country it is made up of buses, taxis and trains, is where little or no sustainable service has been given, so that state initiatives have emerged to sectorize and improve public transport to move towards the condici ideals that allow sustainable transport in the Greater Metropolitan Area and thus contribute to the quality of life of people. As part of these initiatives is the "Fast Passenger Train in the Greater Metropolitan Area" project.

3 METHODOLOGY

The methodology developed was divided into three main components, which are described below:

- Initially, a comprehensive literature review was conducted on the relationship between gender and transport, and what has been the gender impact that has been the result of the development of similar projects in the region, allowing to have a perspective on the aspects that must be evaluated to suit Costa Rica.

- A collection of bibliographic data was also carried out, which allow us to make a description of the population involved with the project, both of users and of the informal settlements located around the infrastructure of the train, with this we can have an insight into the roles and behavior presented by the population involved.

As part of this collection of bibliographic data, information was also sought to enable us to identify the context of informal settlements. For this was the recovery of data from official country reports, statistics and censuses carried out in previous years, also took into account the dialogues held with members of informal settlements during the field tour that took place 30 April and June 3 of this year.

- Finally, with respect to the study generated and the recommendations, the action plan, which includes targets and indicators for the main expected outcomes, were carried out to ensure a real gender perspective throughout the process.

4 KEY RESULTS OF THE ANALYSIS

4.1 Relationship between public transport and gender:

Public transport systems are complex and different, to understand them, study them and be able to plan them in a sustainable way it is necessary to understand the perception that users and those who live on a daily basis with any of the components of transport systems. The above is that the relationship between public transport and gender is found, as men and women maintain different ways of relating. Therefore, the patterns of displacement and relationship with transport will depend on the behaviours, responsibilities and role that each gender [United Nations Organization (UN), 2017] develops at the social and economic level.

Taking that gender perspective into account when planning public transport allows for progress towards gender equality, allowing women to access opportunities that by variables such as mobilization had not been able to do before.

In studying this relationship between gender and transport in the urban area, which is the area of impact of the project, it should be taken into account that people relate in different ways to transport, which encompasses relationships such as users, workforce and contact by communities close to the mobilization areas. That is why a description is made for each of these relationships.

With regard to users, there is a different use between men and women, being the majority of female users, this because they have less economic capacity to acquire their own private means of transport or because of the nature of the travel, the transport represents an option that allows them to optimize time. Women make a greater number of displacements, of a shorter duration and in more varied times, in addition the mobilization of women is categorized as "chain travel" because they try to cover different points to fulfill different functions. In addition, women can also travel alone or in company with children or older adults, when traveling with those companies tend to material loads that facilitate displacement (Kunieda & Gauthier, 2007).

This responds to the responsibilities and roles associated with women, such as home maintenance, which involves commuting to make purchases, purchasing materials, attending health facilities, and mobilizing minors' educational centers or extra activities, or to move for themselves go to fulfill their studies. Women also use public transport to mobilize their respective jobs, but a variable is added that is more found in women and domestic employment, i.e. women also mobilize to go working hours with schedules which means that many need transportation in times when there are even no more services (Kunieda & Gauthier, 2007).

On the other hand, men tend to mobilize more in private transport, this because they have greater capacity to acquire private media, therefore there is a lower percentage of male users.

Men as users make fewer trips, medium and long routes, without fragmentation or intermediate "stops", i.e. they travel on a single round trip line. In addition, they mobilize more during hours of increased congestion and travel frequently on their own and should not carry any additional burden to the equipment they use to work.

Men's travels respond to their job functions, i.e. they move to go their work points to a greater extent, there is also mobilization to go to carry out more administrative financial procedures, to access educational centers or to move to entertainment venues. To a lesser extent, men's travel is identified for household functions (UN, 2017).

The choice of public transport will also vary by gender, women take into account characteristics such as accessibility in terms of prices, because they maintain lower or zero incomes, so they must make rational advantage of the money they they also take into account the safety of different types of public transport, as they record cases of violence and sexual offences. They also take into account the routes that each type makes, to avoid transiting through more dangerous or shaded areas and consider the efficiency of the service that they want to use, this because they need to move to different points, so they have a varied agenda they need to complete [Ministry of Labor and Telecommunication (MTT), 2018].

While men consider as a priority, when making the choice of public transport, the one that is more efficient, which allows them to arrive on time to meet their working hours, which leads them to invest money. Also, secondaryly they take into account price access, but as mentioned they can generate a greater investment in order to obtain quality in the service. The security issue is not a priority feature for men when making the choice (Kunieda & Gauthier, 2007).

By studying the relationship between gender and public transport, from the labor market part, it concludes that it is a field traditionally occupied by men, so that the presence of women is very low, however different countries are doing efforts to promote and enable the inclusion of women. The existence and consolidation of social roles, stereotypes and prejudices was identified, as well as conditions that complicate women involved in the public transport labor market. Women who are working in this area also receive a lower salary than men (MTT, 2018).

The presence of women can occur from the part of building the infrastructure or during the execution of this, as drivers, security, planners, evaluators or position of means and senior management, for decision-making (Basque Institute of Women, 2013).

The last analysis of the relationship between public transport and gender was from the experience of people who live in places that connect or are in areas belonging to the State to develop the infrastructure for public transport. Poverty and social exclusion have resulted in these informal settlements being found in these areas, which develop an entire relationship with public transport since they are access to or part of the development of these settlements (Kunieda & Gauthier, 2007).

Women, who live in the highest percentage of informal settlements, are often unemployed or with occasional jobs, so they are more engaged in household functions, a high percentage of women in informal settlements are heads of household. Another responsibility they make is that they move to take minors to schools. When they have an occasional or informal job, then they mobilize to go to work (Mora, 2014).

While men in precarious have other functions of "heads of household", so the trips they make are to go to work, which can be a formal or informal.

For any mobilization they make, they must first leave the informal neighborhoods, whose access – as mentioned above – is usually the infrastructure built for public transport. In addition, that infrastructure is used as a shorter route, which means income savings, which is of great impact for women with occasional jobs (Gutierrez & Reyes, 2017).

4.2 Reality of the project:

The purpose of the project is the implementation of the fast passenger train in the Greater Metropolitan Area, for that reason in the local analysis, we focus on the reality of people's relationships with respect to the train, from the gender approach of the person users, area workers and people living in precarious women who are on the right of track of the train infrastructure or its surroundings. For this part of the analysis, a gap of information was found regarding the actual data on the number of men and women in each of the scenarios under study, so the analysis could not be further explored.

With regard to users, the Costa Rican Institute of Railways in 2018 in its Annual Report of Operational Statistics, reported for the year 2017 a total of 3,983,902 (), that is approximately 331, 991 users on a monthly basis, the route to Heredia the most Used. The same report shows an increase in the number of users using the train service.

Despite not obtaining data on the number of women and men using the train service, the study was carried out with the data existing at the general level, extrapolating situations at the regional level.

The train in Costa Rica is mainly used by hardworking and student workers, this because the stations are located in central points and in universities (ProDUS, 2016), which means that despite increasing demand, it still does not meet the needs various sectors, including women who use public transport for other functions beyond commuting to work, which means that they have to use other types of public transport such as buses or taxis, resulting in increased demand for polluting vehicles. The price of the train is a fair price and allows access for people who do not have high incomes.

With regard to the infrastructure of the train, access is currently complex so it is a barrier for people with disabilities and for women who must carry some extra load like cars, since there is no platform that facilitates entry. Therefore, it can be made to be visibilized that the train does not take into account women that in their daily routine involves infants, this was possible to observe during the tour of recognizing the route.

Also, in terms of infrastructure the lack of lighting inside the train creates greater insecurity for female users, the same applies to train stations (Abarca, 2013). In addition at different points along the route, you can observe around the infrastructure areas of "matorral", which generates a negative impact at the landscape level, promoting the feeling of insecurity in the users, in addition to the presence of "scrub" so close to the train tracks increases the danger of an accident [International Finance Corporation (IFC), 2007].

With regard to the same security issue, there have been reports of sexual harassment on train trips, for which the Costa Rican Institute of Railways and the National Institute of Women have implemented the campaign "Triple Commitment" consisting of education on the harassment in public spaces and training to staff of the Costa Rican Institute of Railways and companies that provide logistics services of the train. Even though harrassment cases are infrequent, this is an aspect that can be improved through the implementation of the TRP so that users can feel safe when using this service.

As for the reality of the labor market around the train, as mentioned there is also a gap in information on the proportion of male and female workers, however from the bibliographic study it can be observed that in Costa Rica the Executive President of the Instituto Costarricense de Ferrocarriles, is a woman, then you can observe the presence of women in decision-making regarding the issue of the train, however in the phase of execution, safety and management of the trains, there is a majority presence of men. This is something that has been improving lately at INCOFER, with the incorporation of the first female operator in the month of June and the training of several others in process. Here is another area for improvement, through the implementation of inclusive hiring practices to promote female participation in the employment opportunities generated by the TRP.

By studying the gender perspective from the field of informal settlements that coexist with the train area, it was corroborated that the train passes about twenty informal settlements [Ministry of Housing and Human Settlements (MIVAH), 2012]. In this case, the number of men and women living in these settlements could not be verified, due to the information gap.

The informal settlements under study are distributed in the four provinces that make up the Great Metropolitan Area, which are San José, Cartago, Alajuela and Heredia, and are located in areas of high vulnerability. The main accesses to these informal settlements are by the infrastructure developed for the operation of the train, which with this project will be modified, which in some places would remove access to these informal neighborhoods. During the reconnaissance tour it was noted that people in these neighborhoods have no knowledge of the impact the project will have on their communities.

As mentioned above, in informal or precarious settlements (common denomination) there is a high poverty rate, which corresponds to studies, to a greater extent for women (Mora, 2014) who represent approximately 25% of the heads of [State of the Nation Program (PEN), 2005] therefore limiting them access to work or housing is to close opportunities for these women-led groups, which would increase that poverty condition they are currently in.

Also in these informal neighborhoods there are problems of insecurity, which would affect both men and women, but increases the risk to women, in addition to the reporting of cases of domestic violence, but because of the fact that they cannot use the train tracks access, makes it impossible for the police to act effectively, so women's vulnerability increases.

The use of train tracks – as mentioned – is given to access informal neighborhoods, according to conversations with people from different informal neighborhoods, the use of women is to mobilize their sons and daughters to schools or recreation spaces, in addition to make purchases or go to health centers. Some women also commented that they use the infrastructure to go out to school or work. While men make the use to go to work, focusing mainly on construction work, on businesses and free zones.

As part of the infrastructure used by people in informal neighborhoods are the train bridges, which connect communities, the use of these is mainly to reduce the length of the routes and save on bus tickets. This occurs between Pavas and Bethlehem and in points of Carthage mainly. Another use in informal settlements is for recreation for children and adolescents, which increases the risk of an accident.

At the landscape level these neighborhoods, being informal do not have plans to manage or control the landscape, which causes a negative impact. In addition to safety, theftof infrastructure materials for the train has been reported. All of the above increases the negative impact on the relationship between public transport and gender in informal settlements.

4.3 Recommendations

With regard to the study, a number of elements could be identified that allowed to make recommendations necessary to incorporate mechanisms that ensure the inclusion of the gender perspective in the project, during each of its phases. The recommendations are described below:

- Due to the information gap it is initially recommended to carry out a study that allows to obtain the actual gender data in the different areas that focused during the study such as users, labor market and informal settlements. Figures on men and women are needed to deepen the issues and ensure that there is a gender-equality participation.

In addition, a monitoring mechanism, such as surveys, should be generated to update the data on an annual or every two years. This is also how this relationship between public transport and gender varies over time and on the basis of that consider the necessary modifications.

- In addition to the previous recommendation, work should be added with people living in informal settlements who relate in some way to the fast passenger train that is planned to be implemented. This work makes it possible to raise awareness among people about the importance of it and can serve as a platform for training them and organizing to work on alternatives. Women leaders can be trained to develop positive actions in their neighbourhoods and allow them to have a new image, which also provides a sense of security to the users of the train.

- This work would be at action tables, those who set up these tables could receive training from different state institutions, even thinking of projects for the issue of location in formal settlements to improve conditions.

- As there is a high presence of women, who tend to be in poverty, one could think of training them for small ventures they can develop, including waste management.

- It is recommended to add more stations whose locations make the use of the train more efficient for women, this because this would allow them to travel different points, on shorter routes and optimizing time. This is because women make "chain travel" i.e. they perform different roles in a single journey (Kunieda & Gauthier, 2007).

- Intermodality is another necessary recommendation, which seeks effective, low-cost management and socio-environmental benefits through the combination of different means of transport (EAE Business School, s.f.), with the above improving the conditions for promoting women's use of the train more frequently, and it would be more interesting for other users of public transport.

It is then proposed to implement alliances or actions that allow to generate these combinations, such as the construction of bicycle parking in the stations (Zucchini, 2015), it also considers working with the municipalities where they find the higher-flow ingest stations, to generate a county bicycle loan service, so users can use them to move towards their various points.

- The access to the train should be carried out with ramps and platforms that allow people with disabilities to enter the train and use wheelchairs or crutches, or who are non-seers, also of pregnant women or women with extra cargo such as cars. In addition, all units must include a large area that the above-mentioned group can use during mobilization (Zucchini, 2015).

In addition, it is recommended that the stations are also easily accessible and that they must be free of obstacles that create barriers for people with disabilities or pregnant women or with extra burdens (Zucchini, 2015).

● Lighting both on the train and at stations is another factor that should be considered when working on adaptations of the existing infrastructure for the train. Dark spaces create greater insecurity and promotes that feeling in users, for this reason it is recommended that they be as enlightened as possible. As an important point, it is recommended to make use of solar panels (Abarca, 2013).

● The maintenance of the infrastructure is an important recommendation to ensure the proper operation of the fast train and avoid possible accidents, as part of that maintenance, it is recommended to apply control to the scrub that is located on the lines of the train and around him. This increases the chances of accidents and also creates a sense of insecurity in women who are mainly users (IFC, 2007).

As part of this maintenance, an integrated approach to vegetation management is proposed, which allows the infrastructure to be kept clean but also involves the planting of plant species at the edges of the infrastructure, which will be controlled but they're going to create a sense of security. This approach also suggests that trees can be controlled to be located further away from the line, for which a forest study would be needed to know which species to use, this would generate a positive impact at the landscape level and would be habitat for species of birds or mammals. Adaptations can also be generated to prevent any vegetation from entering the train tracks (IFC, 2007).

● Strengthening the "Triple Harassment" campaign is needed so that users, especially women, who are the main victims, have clarity on how it works and know how to act in case they are violent or harassed. It is also recommended to add cameras in the wagons, for daily monitoring. This promotes women to feel calm when using the train. At the moment, the implementation of women-only carriages is not considered necessary.

● It is also recommended to implement a strategy for the inclusion of women in train-related work, from the construction part of the adaptations in the train infrastructure, to the management and decision-making part. For this purpose, it is proposed to initiate gender-based training for current staff, which will allow to begin breaking stereotypes and prejudices regarding the inclusion of women. It is then recommended to move forward with free courses that allow women to receive the classes to obtain the license that generates the conditions to be able to access positions such as train drivers or assistant driver equipment (UN, 2017).

- The recruitment scheme must also be adapted, in order to be able to fulfill the days and generate a quality service, it is necessary to have a larger team (IFC, 2007) so it is recommended to give priority to women who apply, as long as meet the essential requirements. The same can be applied with regard to the process of building the adaptations.
- Partial relocation of some informal settlements that will be considered when the conflict cannot be eliminated via technical design or engineering measures.
- Whenever possible within the designs and technical parameters of the project, pedestrian bridges will be installed to communicate formal and informal communities and settlements to avoid pedestrian use of the train railway. These bridges can go parallel to the train bridges.

● Alternative pathways are needed so that women in informal settlements can continue their daily routines of taking minors to schools or shopping for the home. These alternate pathways should not involve spending money or expanding time.

5 PROPOSAL FOR ACTION PLAN FOR THE INCLUSION OF GENDER IN THE "FAST PASSENGER TRAIN PROJECT IN THE GREATER METROPOLITAN AREA".

Activities	Results	Indicators
Goal: Generate a gender database with respect to the train		
Preparation of quick surveys to apply to users to register gender, age, occupation and reason for travel.	Obtain a mechanism to generate the collection of data for the gender base and keep it up to date when applying surveys every one or two years.	Data disaggregation by gender.
That institutions and companies produce data on train-linked jobs that are occupied by women.	Generate a mechanism for controlling women's participation in the labor market linked to the train.	Disaggregation of positions by gender.
Preparation of surveys to be applied in informal settlements to collect the gender, age and occupation of people in these areas.	Implement a control mechanism in informal settlements that relate directly to the infrastructure of the train, which allows to evaluate this relationship through gender.	Data disaggregation by gender
Record the data obtained through the mechanisms implemented in users, institutions/ companies and informal settlements.	Preparation of the database.	Publication of the database.
Goal: Improve train infrastructure.		
Build more train stations.	To facilitate the travel routes that women make, scrolling on "chain trips", which means that they are mobilized at different points.	Number of stations built.

Activities	Results	Indicators
Condition stations and trains with quality lighting.	To provide safety to users and promote a sense of security in women users.	Number of lumens in trains and stations.
Build platforms at stations that allow accessibility to trains.	To facilitate access and mobility of people with disabilities and women with extra loads such as cars.	All stations have accessibility platforms.
Provide spaces on the train for the mobility of people with disabilities or women with extra loads such as cars.	To facilitate the mobility of people with disabilities and women with extra loads such as cars.	All units have the available space.
Develop a strategy for the control of the scrub that grows on the infrastructure of the train at different points along the route.	Prevent possible accidents and improve the landscape impact of the sites surrounding the train infrastructure, thus generating a sense of security in users.	Presence of scrub in the train infrastructure.
Goal: To promote the participation of women in jobs linked to the train.		
Develop a strategy to encourage women to access the labor market linked to the train. This strategy should include free courses to obtain driver's license trains and trainings through state institutions. It should also include raising staff awareness, to eradicate stereotypes or behaviors.	For women to access jobs that are linked to the train, in order to achieve better service planning involving situations experienced by women. That staff working in train-related work are free from stereotypes or behaviours that may function as a barrier to women's access to these spaces.	Number of women in jobs linked to the train.
Goal: Strengthen the bullying prevention campaign.		
Generate efficient communication with train users.	Let female users know what mechanism is in case of harassment in the units or stations of the train.	Scope of communication.

Activities	Results	Indicators
Goal: Include gender in intermodality.		
Plot the routes that users use according to their needs, by using a digital application that is easy to access and use.	That intermodality involves the need for women's mobility.	Number of possible routes.
Goal: Generate alternate routes for informal settlements.		
Construction of pedestrian bridges, parallel to the bridges used by the train.	Prevent people living in informal settlements from using train bridges as a cross-community access road.	Number of pedestrian bridges built.
Structure new routes that start in informal settlements and reach schools, health centers and work points.	To avoid frequent use of train infrastructure by people in informal settlements, especially women who must make several trips at different times.	Number of alternate routes.

Annex 9. Complementary activities protocols

Content index

Document 1: Awareness-raising strategy

Note: For the purposes of the TRP project, this document has been adapted from the document of the same name prepared by the Environmental and Social Management Unit of MOPT in 2013, for its use in the Environmental Impact Study of the project “National Route No. 257, Sector Sandoval – Moín”.

Strategy for building social interaction channels for the mitigation of social impacts that could be generated in populations, sectors and social organizations by building and operating the projected infrastructure.

Objective

Promote the formation of channels of interaction between populations, social sectors, local organizations and, in general, with any person who expresses interest or impact with the development of the works to be carried out in the project area or in the areas of direct and indirect influence with the project's executor, in order to mitigate the social impacts that are generated.

TARGET POPULATION/ACTOR	Action	Responsible	Costs
Local governments where the train travels	Promote an interinstitutional meeting in which INCOFER details the works to be carried out and the possible impacts they generate, as well as the proposed measures.	-INCOFER Management Unit. -Project Executing Unit. -Municipal representatives.	
Community leaders and members of social organizations interested in the project	-Schedule and execute outreach and communication events in which officials of INCOfER and the Executing Unit of the project clarify any doubts that the execution of the works may cause.	-INCOFER Management Unit. -Project Executing Unit. -Municipal representatives.	
Populations where the train travels	-Publish a document written in a simple language, informing the reader of the details of the works, possible impacts and proposed measures	-INCOFER Management Unit. -Project Executing Unit. -Municipal representatives.	

TARGET POPULATION/ACTOR	Action	Responsible	Term
National population	Disseminate in at least 4 mass media (written, radio and television) information about the works, possible impacts and proposed measures.	-INCOFER Management Unit. -Project Executing Unit.	
Affected by the process of releasing land within the right of way.	Organize an outreach activity with the residents of the strip where the land to be released is located to carry out the works in order to explain to them what the condition under which the release will be made, as well as what they are affected land on time.	-INCOFER Management Unit. -Project Executing Unit.	
National population Local population of areas of influence	Publication on the website of the Costa Rican Institute of Railways the memories of the forums carried out in which doubts and concerns were raised and with the answers to them.	-INCOFER Management Unit. -Project Executing Unit.	

Document 2: Awareness-raising mechanism

Note: For the purposes of the TRP project, this document has been adapted from the document of the same name prepared by the Environmental and Social Management Unit of MOPT in 2013, for its use in the Environmental Impact Study of the project "National Route No. 257, Sector Sandoval – Moín".

Awareness-raising mechanism of the Construction Project for the Rapid Passenger Train Project (TRP)

I. Background

With the implementation of the project for the construction of the Rapid Passenger Train within the metropolitan area, it has been identified through the Ministry of Housing and Human Settlements (MIVAH) areas that will be affected by the development of the works.

The process of communicating to communities has been in a focused and exploratory basis, allowing to identify a methodology for the information and awareness of the project to the population affected by the project of the construction of the Rapid Train of Passengers

The initial consultation process supplies will serve to make the information and awareness process.

II. Objective

1. Propose an information and awareness mechanism for the population close to the project, so that the pros and cons of the rapid passenger train construction project can be raised more widely

2. Describe the instruments that allow the understanding of the sociocultural reality around the project of the construction of the Rapid Passenger Train.

III. Population Under Study

The direct population subject of attention in the project of the construction of the Fast Passenger Train is as follows:

a. Neighborhood population in informal settlements

Province	County	District	Name of settlement
Alajuela	Alajuela	Guácima	La Managüita
Alajuela	Alajuela	San Rafael	El Futuro
Alajuela	Alajuela	Alajuela	11 de abril - Los Molinos
Cartago	Cartago	San Nicolás	La Esperanza
Cartago	Cartago	San Nicolás	Barrio Miguel Trejos
Cartago	Cartago	San Nicolás	Miraflores
Cartago	Cartago	Carmen	Barrio Maria Auxiliadora
Cartago	Cartago	Carmen	Barrio Nuevo
Cartago	Cartago	Carmen	Barrio Linda Vista
Cartago	Cartago	Carmen	Barrio Sagrado Corazón
San José	San Jose	Pavas	Bella Vista de Pavas
San José	San Jose	Pavas	Nueva Esperanza de Pavas 1
San José	San Jose	Pavas	Nueva Esperanza de Pavas 2
San José	San Jose	Pavas	Santa Fe
San José	San Jose	Pavas	Línea del Tren
San José	San Jose	Pavas	Bendición 1
San José	San Jose	Pavas	Bendición 2
Heredia	Santo Domingo	Santa Rosa	12 Junio
San José	Tibás	Cinco Esquinas	El Plantel
San José	Tebas	Colima	El Progreso

1. Other actors that will be part of the information and awareness process of the Rapid Passenger Train construction project are:

a. RECOPE campus

b. Universidad Latina and Universidad de Costa Rica

c. CCSS, Alajuela Hospitals and Calderón Guardia.

d. Costa Rica Brewery

2. Indirect actors who will be part of the awareness-raising process:

a. Community Development Associations that were consulted in the exploratory process.

b. Local Government for the district being serviced

c.Municipal government.

d.Costa Rican Electricity Institute

IV. Methodology for the information and awareness process of the Rapid Passenger Train project

The working methodology for the information and awareness-raising process for affected communities describes 2 strategic moments:

4.1. Information Stage

The stage describes the spaces that will be the subject of information for the affected population and for the general population.

Objective	Strategic action	Action plan
Propose a population **information** mechanism close to the project so that the pros and cons of the Rapid Passenger Train construction project can be raised more widely	Design posters, flyers	Sticking posters in mass concentration centers
		Church posters, bus terminal
	Virtual information (analyze feasibility)	Website design
		Blog design
		Facebook page design
	Personalized dialogue with people in the community	Information meetings with direct affected
		Information meetings with indirect affected
		Information meetings with independent groups

Responsible for implementation: Environmental Regency

Responsible for Monitoring and Control: Environmental Regency

Components to be considered in the information process:

1. Opportunity of communities.
2. Development opportunities
3. Compensation process
4. Relocation
5. Participatory-interactive consultation
6. Effervescence of the project
7. Improvement of the quality of life of its inhabitants.
8. Local development initiatives.
9. Community leaders in the project outreach process
10. Meeting spaces between INCOFER and the community

4.2. Awareness-raising stage

The awareness stage is a scheduled time with targeted groups of people, who need to be informed clearly, evacuate questions and expose the contents of the project.

Objective	Strategic action	Action plan
Propose a mechanism for **raising awareness** of the population close to the project so that the pros and cons of the Rapid Passenger Train project can be raised more widely	mechanism for a respond to queries	Via telephone
		Via email from public servants
		Through a virtual page
		Through trade
	Information workshops with targeted groups	Workshops with social organizations present in the territory affected by the project
		Private sector working days present in the territory affected by the project
		Presence in municipal councils to expose the project and its process.
	Institutional coordination	Coordination with State organizations present in the areas of influence that are linked to the project.
		Coordination with private companies present in the areas of influence that are linked to the project.

Responsible for implementation: Environmental Regency

Responsible for Monitoring and Control: Environmental Regency

Components to be considered in the awareness-raising process:

1. Designing the project layout
2. Environmental impact
3. Social Affectation
4. Perception of the different actors affected and unaffected
5. Interinstitutional coordination
6. Attention to inquiries
7. Monitoring and control of the process
8. Periods of work

Document 3: Transit Control Management Plan

Note: For the purposes of the TRP, this document has been adapted from the document of the same name from MOPT in 2016, for its inclusion as Annex 27 of the Environmental Impact Study of the project “Expansion or National Route No. 32, Sector Intersection with Route No. 4 – Limón”, prepared by CDG Environmental Advisors.

Project

FAST PASSENGER TRAIN (TRP)

TRANSIT MANAGEMENT PLAN*

BASIC CONSIDERATIONS FOR THE MANAGEMENT AND CONTROL OF THE TRANSIT

Introduction

The following document corresponds to the basic considerations that will need to be considered for the preparation of the Transit Management Plan, in order to maintain a continuous and safe flow of the users of the intersections on routes the routes where the railway line is drawn.

Each of the elements and actors affected during the works must be taken into account, so it is necessary to carry out an on-site survey of the elements that make up the routes, namely:

- Topography of the zona.
- Track geometry, number of lanes, widths, length, turning radius, vertical and horizontal curve.
- Existing signalling (vertical and horizontal)
- Location and geometry of the intersections of the route to intervene
- Number and location of the different shortcuts to the routes (both existing streets and developments located on the route).
- Location of elements of the right of way: trellises, cords, pipes and sidewalks.
- Location of bridges, storm wells, canals, ditches, electrical fluid poles.
- Definition of construction stages and their corresponding working areas.

All of the above must be known prior to the presentation of the proposal for the control signalling of the work, since each and every one of the elements mentioned can contribute or limit the clarity and efficiency that is sought with the transit management plan.

This Plan should be reviewed, without omitting the proposals of this plan and, where appropriate, extending or improving, by the corresponding professional(s).

BASIC PRINCIPLES

Strategies or basic elements, which according to the Central American Uniform Devices Manual, should be taken into account in order to achieve effective traffic control management, which according to the Central American Uniform Devices Manual consist of:

1. Maintain safety on an ongoing basis in all areas of control (transit and work) as a priority, taking into account the same road safety aspects and criteria that govern road design

2. Traffic fluidity should be impacted as little as possible, free from distinct obstacles to channeling devices and avoiding abrupt and unexpected changes in the geometry of the traffic control area.

3. Drivers and pedestrians should be warned while approaching and crossing a traffic control zone, using official signage that must meet size specifications based on route speed, and retro reflectiveness.

4. Situations such as accidents should be foreseen by generating in the workspace's areas called "side buffer zones", transitions of input and output through the use of the different control and signalling devices.

5. Provide training to construction personnel, to prevent them from affecting the safety of the traffic control area.

6. On each of the work fronts, a task should be assigned to maintain and monitor the order of the control areas. Check that the signage is maintained during the works regardless of the weather conditions and that it is removed completely after the completion of the works.

7. Disseminate about the works to the general public, where clearly the start date of the works as well as the alternating routes to users is clearly published in the different media.

BASIC ELEMENTS OF THE TRANSIT MANAGEMENT PLAN

Like all civil works, transit management plans must be carried out in advance, be in charge of a responsible professional and be properly designed and reflected in the plans that support the placement and planning carried out in the field during the constructive stage.

For final design drawings, they must contain the following information:

1. Geographic location of the site where the works will be carried out.

2. Route information to be taken: Route number and section(s).

3. Current situation of the track and sections to intervene. (Topographic and geometric survey, including current signalling).

4. Planes of alternating routes duly signposted, to ensure an expedited flow of traffic that usually uses the route to be intervened.

5. Design of the construction control proposal, which in turn must comply with all the guidelines stipulated in Chapter 6 of the Central American Manual of Uniform Control Devices (SIECA).

6. Specifications of control and signalling devices (type, size, separation), which must also comply with the provisions of the Central American Manual of Uniform Control Devices (SIECA).

7. Presentation of the drawings with the format established by the Federated College of Engineers and Architects, with the information of the company in charge of the works and signature of the professional responsible for the control of the works and transit devices.

Document 4: Expropriation Protocol

Note: The following protocol summarizes the process established in the Law of Expropriations No. 9268. This document describes the process approved by CONAVI for road projects, as presented in the Environmental Impact Study for the project “Expansion of National Route No. 32, Sector Intersection with Route No. 4 – Limón”, prepared by CDG Environmental Advisors.

Protocols

SUMMED EXPROPRIATORY PROCESS

ACCORDING TO LAW 9286 AND ITS REFORMS

Project

PROJECT: FAST PASSENGER TRAIN (TRP)

Previous Activities

Costa Rican Institute of Railways (INCOFER)

1. Approve the design and scope of the project.
2. Define the required terrain areas.
3. Generate the plans of land registry of real estate to be expropriated.
4. Formal request to start the expropriating process.

Administrative Management

A- Opening administrative file

1. Analyze documentation for expropriation.
2. Communicate to stakeholders.
3. Form the file.

B- Public interest statement

1. Generation of resolution of declaration of public interest.
2. Publication of the relationship in the Gazette.

C- Administrative Appraisal Generation

1. Conduct Market Study.
2. Visit property.
3. Issuance of the valuation report.

D- Property registration management

1. Owner accepts appraisal and property without legal impediment.
2. Make deposits of funds and authorization of registration.
3. Send it to the state notary.
4. They compose the parts and sign deeds.

E- Judicial Management

1. Owner does not accept appraisal and/or property has legal impediment.
2. Make expropriation agreements.
3. Send the PGR to sue in a court of law.
4. Initial judgment is issued by the court.
5. After the period of law, the property can be disposed of.

Document 5: Protocols on Soil-Vegetation-Debris Disposal

Nota: For the purposes of the TRP, this document has been adapted and expanded from the document of the same name from MOPT in 2016, for its inclusion as Annex 26 of the Environmental Impact Study of the project “Expansion or National Route No. 32, Sector Intersection with Route No. 4 – Limón”, prepared by CDG Environmental Advisors.

The MOPT protocol in turn is based on the work performed by MSc. Lizbeth Navarro P. and Ing. Silvia Campos F. for the project “Expansion of National Route No. 1, Sector Cañas – Liberia.”

Protocols

FINAL DISPOSAL OF SOIL AND VEGETATION MATERIAL

EXCESS SOIL AS FILL MATERIAL

DEBRIS DUMPS

Project

PROJECT: FAST PASSENGER TRAIN (TRP)

Content

1.Protocol for disposal of soil and vegetation material

2.Protocol for excess soil as a fill material.

3.Protocol for debris dumps

Introduction

The movement of earth and debris will be used as such and can be handled as fil material and land formation within the project area, provided they meet the necessary technical requirements.

The final disposal of the surplus debris of the earth movement, not used in the project, and which are available outside the PA, must have the corresponding requirements and permits issued by the relevant authorities, managed by each the Contractors, communicated to the Environmental Regency, for incorporation into the Regency Reports, with a copy to the Developer.

Debris or residue generated as a consequence of earthworks for the Project, are not to exploited commercially as mineral products and, therefore, are not subjected to the parameters of the Mining Code and its regulations.

Objective

Establish actions for the management of the activities of final disposal of land and material decreased vegetation (Landfill) in the Project Area, in order to prevent, minimize and control the impacts produced to the soil and vegetation.

Goal:

Store most of the soil and vegetation in optimal conditions resulting from movement and removal.

Impacts to be handled:

- Affectation and pollution to watercourses, housing, shops, interruption of vehicular flow.
- Affectation of adjacent plant cover.
- Disruption of landscape quality

Compliance indicator:

Preserved floor volume/floor volume removed

Type of measure to execute or set:

- Erosion control
- Prevention of dust generation.
- Mitigation of areas discovered in vegetation.
- Correction of the intervened areas
- Minimize soil and vegetation involvement

Considered Actions

- Discard sites that could affect bodies of water with sediment. The final arrangement areas of material should be sufficiently far removed from the bodies of water, to ensure that at no time the water level, during the occurrence of increasings or avenues, exceeds the lowest level of the materials placed in the collection area.
- It is prohibited to throw the excavation or cutting material into the watercourses.
- Estimate the transfer distance, in order to decrease the passage of wagons and vehicles on the road, to achieve the goal of moving land and material decreased.
- Regulate the speed of wagons in work areas and require that when circulating loaded outside the construction area is carried out with the gondolas covered by the awning, any carriage or vehicle carrying material on the roadway must be covered with the awning and this must be subject. The awning or tarpaulin must fall at least 30 cm from the top edge of the wagon drawer. As established by SIECA C.6.6 y CR.2010-111.05 c). Check that the tires do not contain mud that is scattered on the roadway. The above in accident prevention.

• No organic or inorganic waste is allowed to burn. Burning will not be a valid final disposition medium.

Site selection and usage definition:

1. The Contractor identifies the site within the right of way and verifies in blueprints that the selected site is not compromised by construction work.

2. The Contractor verifies that there are no public works at the selected site such as fiber optics, water wells, rural aqueduct passage, among others.

3. It submits to the Environmental Regency for consideration and together they make a preliminary visit to the proposed site.

4. The Environmental Regency locates the site politically and geographically; use GPS, place coordinates according to map, includes photographs of at least 4 angles.

5. The Environmental Regency submits to the consideration of the Engineer(s) of the work (Contractors); and the one highlighted on site by the MOPT, the proposed site and the use of it.

6. The Environmental Regency in conjunction coordinates with the Contractors, define the destination of each site: if it is proposed that it be only land the construction company(s) must follow the specific Protocol. If it is to promote organic fertilizer or humus, it may contain in addition to soil, decreased plant material; small branches, roots and leaf litter, as well as splinters that can be used with the beautification stage.

7. Once accepted by the INCOFER engineer (Developer), the Environmental Regency proceeds to give the site numbering, according to a specific table for this purpose, which allows to locate each place easily and give environmental monitoring and take control measures in case of Required. Likewise, the numbering will allow the material already decomposed in the beautification work to be used at the beautification stage.

8. The site must meet collection or storage conditions for the placement of waste material according to the future destination type. Subsequent reuse (humus generation or filling. The following measures should be considered for the plant layer:

8.1. Organic soil should be separated in order to conserve it and then reuse it in the intervened areas

8.2. The temporary storage site (must be located in an area that does not locate hazardous substances and so that it is not contaminated with sterile soil.

8.3. The decapitating material or waste must be stacked grass on grass, soil on land. The height must not exceed 1.5 meters, on a flat surface, which prevents compaction.

8.4. The soil should be handled with the lowest possible moisture content.

8.5. It is recommended that the collection area not obstruct vehicle, pedestrian or construction worker flows.

8.6. The collection site shall be marked (cordoned off) and that the risk of rain is not present, the sediments are directed to the bodies of water.

8.7. It is recommended that soil waste be covered, to avoid wind dispersion and rain protection.

8.8. Prohibit the passage of personnel and machinery over the storage or collection area.

8.9. Materials from the convertible that were not reused must be removed by the Contractor(s) to the sites authorized for the final disposal of solid waste.

9. The Contractor performs the topographic survey of the sector to estimate the storage capacity, so that it does not become saturated and does not compromise the landscape.

10. In the sites selected to be converted into sites for future use, plant material must be mixed with soil in fire prevention.

11. Approval by the INCOFER engineer of the selected sites.

Once the site is selected and its use has been defined, the following protocols apply.

PROTOCOL No. 1

FINAL DISPOSAL OF SOIL AND VEGETATION MATERIAL

1. The filling and placement of material must be carried out with the supervision of the company engineer and the Developer, as well as the environmental regency of the project.

2. Place information labels on what is being placed, as the case may be: soil or reduced organic matter. In the event that it is organic matter indicate by text that this material will be transformed into humus and used in beautification, this educates the population and avoids unfounded comments.

3. The beginning of the slopes of the filling must be at least 1.5 meters away from the private property, in order to prevent slips that could affect them.

4. For sites selected to place land; see the specific protocol for this purpose.

5. In case the material is very dry, and dust is being generated, have a water tank for irrigation of the material or cover it, to avoid wind dispersion and rain protection.

6. In cases of areas devoid of organic soil, the material may be reused in the restoration of these sites, in order to promote the revegetation of the area.

7. Individuals (trees) of the AP and area of influence will be protected. The placement of material affecting the shaft or roots of trees or shrubs shall be prohibited.

PROTOCOL No. 2

EXCESS SOIL AS FILL MATERIAL

1. The filling and placing of the material must be done with the supervision of the Responsible Engineer (Contractor(s)) and the Environmental Regency of the project.

2. Place information labels on what is being placed, as the case may be: soil or reduced organic matter. In the event that it is organic matter indicate by text that this material will be transformed into humus and used in the beautification work.

3. The beginning of the slopes of the filling must be at least 1.5 meters away from the private property, in order to prevent slips that could affect them.

4. In case the material is very dry, and dust is being generated, have a water tank for irrigation of the material.

5. The Contractor shall define the area for land arrangement with estimate of the volume to be deposited.

6. The Contractor must set the maximum dimension of the starting ground and the final maximum dimension.

7. Bodies of water should be marked by law withdrawals, demarcated with yellow tape and stakes, before filling.

8. As appropriate, the construction company shall carry out works for the management of stormwater within the site (ditches, against ditch, sedimentators, de-energizers).

9. The Contractor shall indicate, at the end of the material deposit work, the profile of the site.

10. The Contractor shall apply an effective compaction according to the type of material, as well as berms, and slopes, they will be approved immediately by the administration.

11. If necessary, after the works, the environmental regency will recommend the stabilization of the slopes with sowing of vetiver or similar grass type, as well as reforestation work on the site.

All activity of application of the protocols, must be deliver documented to the Environmental Regent, for incorporation into the Regency Report, with copy to the Developer and the Environmental Management Process.

PROTOCOL N° 3

DEBRIS DUMP SITES

General Considerations

- Before commencing vegetation clearing at the site, markers must be placed to indicate the working area and establish the setbacks from the property line.
    - If the property is adjacent to any water body, a setback of 30 meters from the margins is recommended.
    - A minimum setback of 1.5 meters must be established from the property line, or more if it is so determined by the land use parameters.
- A dump site can accommodate debris from construction/demolition, soil and sludge from earthworks, and vegetation material. Debris can only be deposited at the site if the materials are inert and present no contamination risks. Reciclabe or reusable materials will be separated previously for utilization. Potentially polluting materials must be treated as a waste and transported to the appropriate sites for disposal. Rails that must be removed should be cut in lenghts that are appropriate for transport (2-3 meters) and taken to recycling centers.
- For the recycling of crossties, crushing is an option to recover the Steel rebar and use the crush material as aggregate for construction, when dealing with concrete crossties. Wooden crossties may be chipped to be reused, burnt or deposited in a landfill authorized to handle wastes with chemical residues. Disposal of wooden crossties through incineration or recycling must consider emissions and residue from preservative chemicals and potential contamination from oil-based products.
- Much of the waste in a railway operation consists of ballast. Currently existing ballast has been exposed to pollution from oil or fuel leaks and must be taken to a properly authorized landfill with the capacity to handle chemical leaching. There is also the possibility of treating ballast by washing of the material, to be deposited in a landfill or reused as aggregate for construction. Any space conditioned for this purpose must be on paved surfaces with proper water channeling and drainage structures. It's recommended that any ballast cleaning stations be installed separately from dump sites, so that substances and byproducts generated by the operation are properly taken into account.
- Prior to the start of operation of the dump site, the working area must be divided for accommodating the different types of materials.
- Prior to the start of operation, entry, exit and circulation areas for machinery miust be defined.
- Earth deposits must be made in such a way that it is easily extendible in horizontal layers for ensuing compacting with machinery.
- The operating design must establish the maximum height of embankments, taking into consideration the characteristics of the terrain and materials.

- Drainage ditches must be conformed along the perimeters, to lead runoff waters into the discharge point. Ditches must have the proper sloping to ensure a continuous water flow.
- Sediment traps must be built before the discharge points to reduce the effluent sediment load. Sediment traps must have a capacity of 1 m^3.
- Ditches and sediment traps must be given periodic maintenance to ensure their functionality.
- For sludge pits, recommended dimensions are of approximately 10 m wide x 10 m long x 5 m deep, while keeping a distance of 3 meters between pits.
- In each pit, at a height of 4.5 meters measured from the bottom of the excavation, a drainage pipe will be placed to evacuate the clarified waters from the pit. The pipe will discharge into one of the drainage ditches on site.
- Sludge pits will be managed in series, meaning that the second pit will only be used until the first has reached full capacity, and so on. This will permit greater sedimentation and drying time for the sludge.
- Depending on the condition of the sludge, the dried sediments may be removed from the pits and deposited in the soil disposal area. This will reestablish capacity to the pits and extend the service life of the dump site.
- The professional in charge of the dump site must keep an updated record on the volumes of materials that have been deposited, so as to not exceed the design capacity.

Utilities and public services

Due to the type of activity, the availability of utilities and public services at the property is not a requirement. However, the site must have a sheltered resting area, drinking water and portable toilets in a sufficient proportion depending on the number of workers on site. If there is another work front adjacent to the dump site with suitable facilities, then the workers can use the facilities in the other work area.

Technical completion

To determine the technical completion, a field inspection will be performed with the environmental management team and the engineering team in charge of the design. The inspection will be to determine the compliance with the technical and environmental measures established in the design and the site's management plan.

The engineer in charge of the site will certify, in writing, the relevant site conditions at the moment of technical completion. Likewise, the environmental team will issue a technical opinion on the management conditions and any corresponding recommendations.

Document 6: Law 9286 - Expropriations Act

Disclaimer: the following is a translation of a law of the Republic of Costa Rica. Only the original version of the law in Spanish is considered valid for legal interpretation. This translation is provided as a tool to facilitate communication but should not be used as an official reference for legal purposes.

Law No. 9286

INTEGRATED REFORM OF LAW No. 7495, LAW OF EXPROPRIATIONS, OF 3 MAY 1995

EXPROPRIATION LAW AND ITS REFORMS

CHAPTER I

General provisions

Article 1.- Object

This Law regulates forced expropriation for reasons of legally proven public interest. Expropriation is agreed in exercise of the power of empire of the Public Administration and includes any form of deprivation of private property or legitimate rights or economic interests, regardless of its owners, by paying a compensation representing the fair price of the expropriated asset.

Article 2.- Acquisition of goods or rights

Where, in order to fulfil its purposes, the Public Administration needs to acquire goods or rights, it must comply with the regulations in force on administrative procurement, unless, because of the nature of the work, technical studies determine the goods or the rights to be acquired; in such a case, the procedures set out in this Law must be followed.

Article 3.- Previous studies

No owner or holder, by any title, may object to the practice, on his real estate, of the studies necessary to build, preserve or improve a public work. They are also obliged to show the movable property, for examination where there is a previously declared public interest in them. In the event of refusal of the owner, incidentally, the competent court must be asked for authorization in the matter and such acts shall be carried out before a judicial authority.

If such studies cause any damage, it will be compensated following the procedures provided for in this Law for temporary occupation.

Before conducting the studies, the commissioned officer shall communicate in writing to the data subject the date, time, type of study and the reasons for the study.

Article 4.- Precautionary measures

The Public Administration may take the necessary measures not to alter the conditions of the good to be expropriated.

In the case of goods of artistic, historical or archaeological value, such measures shall necessarily and in a timely manner be adopted by the expropriating body. As part of them, such assets may be prevented from leaving the country during the expropriation process.

Such measures shall be implemented for a maximum period of one year. The Administration shall indemnify for damages caused by unreasonable limitations on the right to property, especially where they affect the economic use of the good.

Article 5.- Active capacity

Only the State and public entities may agree on forced expropriation, where good affection for expropriation is necessary for the fulfilment of public purposes. The expropriation shall be agreed by the Executive Branch or the higher body of the expropriating body, as appropriate.

Article 6.- Passive persons

Expropriation measures shall be dealt with in as many separate files as there are owners of the property and as many the rights to be expropriated are; but in the case of co-owners, they will be processed in one.

If the property, furniture or right, affected by expropriation is at issue, as parts of the expropriation measures, those who appear on the file will be held as directly interested, the owners or the owners of the things or rights to whom are, with rights to the thing, in the relevant public register.

Article 7.-Interested Third Parties

During the processing of expropriation measures, all those who justify having, on the good for expropriation, interests that may be prejudiced shall be heard.

Article 8.- Surrogacy of Rights

The transmission of rights which are expropriated shall not prevent proceedings from continuing with the expropriator procedure. The new holder shall subrogate the former in its obligations and rights.

Article 9.- Intervention of the Office of the Attorney General of the Republic

In expropriation measures, the Office of the Attorney General of the Republic shall be taken as part, where the taxable person is a minor, incapacitated, absent or incapable of acting.

Article 10.- Intervention of the National Children's Board.

The National Children's Board (PANI) shall be held as a party, where an interested underage person exists in expropriation proceedings. This institution must not only be concerned, but also follow with interest the course of the procedure until the fixing of justice for a firm resolution. In addition, it shall be responsible for complying with the final paragraph of Article 34 of this Law.

Article 11.- Interests

The administration shall be obliged to acknowledge interest to the expropriated, without requirement (ex officio) and at the current statutory fee, from the dispossession of the good and up to the actual payment. When there is a deposit of administrative assessment, interest shall be calculated on the difference between it and the price.

Article 12.- Exactions and Assessments

The expropriated property shall be acquired free of exactions and assessments. However, bondage may be retained on it, if they are compatible with the new destination of the good and there is agreement between the expropriator and the right holder.

Where the expropriation of assessments or charges, the Judge shall separate, from the amount of the compensation, the amount necessary to cancel them and the respective amounts shall be issued, to whom appropriate, after hearing the expropriation.

Article 13.- Affecting rights and rights-of-way

The provisions of this Law shall apply to constitute bondage and for all types of affectation of goods and rights. Where, by the type of affectation, the availability of the good or duty is substantially limited to it, the processing as an affectation shall be unfair and must be carried out by the integral expropriation.

Article 14.- Right-of-way constituted

The establishment of a right-of-way in favor of the Administration, will be communicated to the institutions that, by law or regulation, grant building or reconstruction permits, to grant them only if the express authorization of the dominant administration. These institutions are prohibited from granting permits against the provisions of this article. Any administrative decision opposed to this mandate shall be absolutely void.

Where a public body other than the dominant administration is required to establish a right-of-way affecting the former, that body shall bear the costs incurred in the amendment of the right-of-way. In the event of a dispute, the Higher Administrative Court shall, in its sole instance, decide, in accordance with the formality of this Law, in the same way as compatible and necessary.

Article 15.- Lease or sale of the expropriated good

The expropriator may lease all or part of the expropriated property that he does not immediately need; In addition, it may sell crops or accessory goods that are not to be used in the work or public service. On an equal footing, preference will be given to the expropriation.

The respective contract must be concluded in accordance with the law.

Article 16.- Restitution

Ten years after expropriation, the expropriator shall return, to the original owners or to the owners who request it in writing, the property or the remaining parts that have not been fully used for the respective purpose.

The person concerned shall cover, at the expropriation authority, the present value of the good, the valuation of which shall be determined in accordance with the formalities provided for in this Law.

Article 17.- Partial expropriations

In the case of partial expropriation of a property and the unexpropriated part is inappropriate for the use or rational exploitation, the expropriation may require the expropriation of the entire property.

Urban land which, owing to expropriation, is lower than what is authorized by existing building regulatory provisions, shall be inadequate.

In the case of rural buildings, in each case inappropriate areas shall be determined, considering the exploitation carried out by the expropriation.

The parties may, by common agreement, determine the inadequate area to be included in the transfer of the domain. In an expropriation trial, the judge will fix that surface.

CHAPTER II

Administrative Procedure

SECTION I

Prerequisites for expropriation

Article 18.- Declaration of public interest

In order to expropriate, a reasoned act, by which the good to be expropriated is declared in the public interest, will be indispensable.

The public interest declaration must be notified to the interested party or his/her legal representative and published in the Official Journal.

Article 19.- Generic Declaration of Public Interest

Whereby law the public interest of certain goods is declared generically, recognition, in each specific case, must be carried out by reasoned agreement of the Executive Branch or by the higher body of the expropriating body, unless otherwise law.

Article 20.- Provisional entry injunction

In the decision declaring a public interest of the good, a provisional entry shall be issued in the relevant public register.

The entry, the transfer of ownership or the constitution of any right in rem in the good shall be deemed to have been carried out without prejudice to the annotator. The entry shall expire and be cancelled ex officio if, within the following year, the final entry order, issued by the administrative and civil tax court, is not submitted. ***(As amended by Law No. 7757 of March 10, 1998.)***

SECTION II

Determining the right price

Article 21.- Application for appraisal

Without prejudice to Article 4 of this Law, where it is necessary to acquire goods or affect rights for purposes of public interest, the Administration shall request the respective specialized unit or, if it does not exist, the Directorate-General ofDirect Taxation, to practice the corresponding administrative appraisal through its own staff, or with the help of the necessary personnel, according to the required specialty. The appraisal shall be surrendered within a maximum period of two months, counted from the receipt of the application. ***(As amended by Law No. 7757 of March 10, 1998.)***

Article 22.- Determination of the fair price

In order to determine the fair price, apart from the criteria set out in Article 40(2), the expert shall comply with the following provisions:

The administrative assessment shall indicate all the data necessary to assess the good that is expropriated and shall describe, in a broad and detailed manner, the method used.

As regards buildings, the opinion shall necessarily contain a clear and detailed reference to the following:

1. The topographic description of the terrain.
2. The current state and use of the buildings.
3. Current land use.
4. The rights of tenants or lessees.
5. Licenses or commercial rights, if applicable under the law, including but not limited to all direct and indirect production costs, national, municipal and insurance taxes.
6. Permits and licenses or concessions for the exploitation of deposits, duly approved and in force in accordance with the law, considering, inter alia, production costs, direct and indirect, payment of social charges, national taxes, municipal and insurance.
7. The estimated price of the adjoining properties and other properties in the area or sales made in the area, especially if it is a road or other project similar to that of the valued part of the property, to compare the prices of the environment with that of property that is expropriated, as well as to obtain a homogeneous and usual value according to the area.
8. The levies on the property and the value of the good, fixed by the owner for these transactions.
9. Any other elements or rights susceptible to valuation and compensation.

In the case of rural areas, considerable areas or both, the price shall be fixed per hectare. In case of urban areas, smaller areas or both, the price may be set per square meter.

At any time during the process, the expropriating administration, the owner or the judge may seek technical opinions from the Directorate-General for Direct Taxation, which may develop field studies, if deemed necessary. This opinion will be surrendered within five working days of receipt of the request.

In order to determine the value of the good, only permanent actual damages shall be considered; but future facts and expectations of law will not be included or considered. Capital gains derived from the project which gives rise to expropriation cannot be recognized either.

In the case of movable goods, each shall be assessed separately and the characteristics influencing their valuation shall be indicated.

(As amended by Law No. 7757, of 10-03-1998.)

Article 23.- Review of administrative assessment.

Where natural accidents vary the nature of the good or its place, and judicial proceedings have not yet been initiated by the Administration or the interested party may request a review of the appraisal to bring them into order to bring them into order to bring them into order to comply with the new characteristics of the good. If the owner accepts the new value, the direct transfer will be carried out.

If the owner has accepted the value of the good and more than six months have elapsed without being paid, he may request that the agreed value be updated in accordance with the inflation rates recorded by the Central Bank of Costa Rica.

(As amended by Law No. 7757, of 10-03-1998.)

Article 24.- Setting securities

The expert shall determine the value of the expropriated property at the date of his opinion. It will also determine any damage to the right to property caused by unreasonable limitations suffered when applying the precautionary measures. In addition, it will only consider the necessary improvements made after the public interest statement.

Article 25.- Notification of appraisal

The appraisal shall be notified to both the owner and the tenant, the tenant and the other interested parties, where appropriate, by literal copy that will be delivered to them personally or left at home.

In the same resolution ordering the notification of the appraisal, the administrator shall be granted a minimum period of eight working days to agree with the price assigned to the good, on the grounds that his silence will be kept as acceptance of the appraisal Administrative. If you accept the price, you will appear to grant the deed of transfer on the date that the Administration tells you.

Accepted administrative appraisal or after no response the period to oppose, the appraisal will be firm and there will be no further opposition at any stage of the administrative process.

The expropriation may not object in court, when he has expressly accepted the assessment in administrative proceedings.

Even if the owner does not accept the administrative assessment, he or she may change its criteria at any time, which will allow the expropriating administration to subscribe a direct transfer. If the case is already in the judicial stage, the judge will deliver judgment immediately, according to the value of the administrative assessment. For this purpose, the expropriation may request that the value be updated in accordance with the inflation rates recorded by the Central Bank of Costa Rica.

(As amended by Law No. 7757 of March 10, 1998.)

Article 26.- Appeal of administrative appraisal

(This article was repealed by Law No. 7757 of March 10, 1998.)

Article 27.- Arbitration

At any stage of the proceedings, the parties may submit their disputes to arbitration, in accordance with the legal regulations and instruments in force of international law.

Where the difference is found on the determination of the fair price and the dispute is governed by Costa Rican procedural law, the arbitration shall be of experts and the expenses shall be borne by the expropriating body.

Experts shall comply with the valuation criteria laid down in Article 22 and the fees referred to in Article 37, both of this Law.

When recourse to arbitration mechanisms stipulated in international instruments in force in Costa Rica, the regulations contained therein shall be subject to.

If the dispute concerns the nature, content, extent or characteristics of the right or by expropriating, the discrepancy shall be resolved before determining the fair price, by arbitration of law, with the expenses borne by both parties.

CHAPTER III

Unique SECTION

Expropriation

Special expropriation procedure

Article 28.- Expropriation agreement

The Administration shall issue an expropriation agreement in the following cases:

1. If there is timely non-conformity of expropriation with administrative appraisal.
2. If the expropriated good or right is at issue or has annotations, levies or levies.
3. If the holder or holder of the right to expropriate is absent or lacks the capacity to act or a legal representative.
4. If the owner has expressly or tacitly accepted a value of the good, but then refuses to grant the deed of the transfer, and is reluctant despite being dictated by the court, the Administration may ask the judge to appear to sign it by the owner.

(As amended by Law No. 7757 of March 10, 1998.)

Article 29.- Initiation of the special expropriation process

The Public Administration shall initiate the special expropriation process before the competent court within six months of the owner's opposition to administrative assessment

(As amended by Law No. 7757 of March 10, 1998.)

Article 30.- Subject to dispute

In the special expropriation process, only matters related to the review of the administrative appraisal of the expropriated property, according to the conditions under which it was located, will be discussed in order to determine the final amount of compensation.

(As amended by Law No. 7757 of March 10, 1998.)

Article 31.- Initial resolution, selection of the expert and possession of the good.

Upon receipt of the request of the administration, the Administrative Court shall, of its own motion, issue the injunction of final entry, in the corresponding public register, of the immovable property and rights to be expropriated.

In the same decision, the court will appoint an expert suitable according to his specialty and experience, to review the administrative appraisal.

The judge will choose the expert from the list submitted by the professional schools to the Executive Directorate of the Judiciary, who will publish it in the Judicial Bulletin once approved. A rigorous rotating order must be followed for the appointment, based on a register to be kept by the Judiciary.

The Office of the Attorney General of the Republic, the expropriating institution or the expropriated party may object to the appointment of the expert who is not suitable. Contrary to the judge's decision, appeal will be appealed to the superior.

The judge shall also fix the fees of the expert, in accordance with the provisions of article 37 of this law.

In the initial decision, the expropriated party shall be granted a period of two months to vacate the property, provided that the Administration has deposited the amount of the administrative appraisal. The judge is empowered not to order the vacancy of the property when, in its discretion, the amount of the appraisal does not correspond to the fair price principle, according to the precedents for similar cases.

(As amended by Law No. 7757 of March 10, 1998.)

Article 32.- Appointment of a legal representative

Where the expropriated good or right belongs to an entity which lacks a legitimate representative or a person who has died, and the succession trial has not yet been initiated, the Judge shall proceed in accordance with Articles 262 and 266 of the Code of Procedure Civilian; but the period between the first publication of the edict of call and that of the holding of the meeting will be reduced to ten working days.

Article 33.- Entry into possession

If after the two months stipulated in article 31 of this Law the property has not been vacated, the Judge will proceed to order the eviction; to do so, it will assist with public force and put the administration in possession of the good.

Article 34.- Withdrawal of the amount of administrative appraisal

The expropriation may withdraw from the court the amount of the administrative appraisal, without prejudice to requesting its review in the process.

When ordering the order, the judge shall take the forecasts to cancel the levies, notes, and levies ordered in article 12 of this law.

Compensation for minors without legal representative will be deposited with the National Children's Board of Education, if this situation continues. The Board shall ensure that the withdrawn sum obtains as much return as is reasonably possible.

(As amended by Law No. 7757 of March 10, 1998.)

Article 35.- Acceptance of the position of expert

Notified the expert, he will have an unrepeatable term of eight working days to accept the position in the administrative-administrative and civil court of finance. After the deadline has expired without having attended to accept the position, of its own motion you will be excluded for one year from the list of experts if, at the judge's discretion, it did not measure justifiable cause for non-acceptance, and another expert will be appointed. ***(As amended by Law No. 7757 of March 10, 1998.)***

Article 36.- Deadline for delivering the opinion

The expert shall deliver the opinion in original and two copies, within the unrepeatable period of one month from the acceptance of the charge. If you fail to comply within the deadline, you will be removed from the office and excluded for one year from the list of experts. The judge will immediately appoint another expert.

The opinion shall be subject to Article 22 of this Law and shall be intended to be revised by the administrative assessment to conform to the value of the good at the time it was assessed.

If the expert departs from the administrative assessment, he must explain in detail the reasons why he/she varies the criteria and considers that the good has another value.

(As amended by Law No. 7757 of March 10, 1998.)

Article 37.- Fees of the experts.

The court shall determine the fees of the expert in accordance with the hourly rates in force at each professional school or those established in the minimum wage decree in accordance with the effort and time necessary for its work. The latter shall be calculated according to the professional hours used in the report. In no case shall it be appropriate to estimate, fix or pay the expert fees that are calculated as a percentage of the value of the good.

At the request of the party or the judge, professional colleges shall monitor experts on the calculation methods used by them in the appraisals, as well as on the final value assigned to the good.

The payment of the trial expert's fees will be borne by the promoter. Other experts or tests that are carried out will be paid for by the proponent.

The Judge shall order to spin the expert's fees only when the hearing granted on the opinion has elapsed, if the parties have not requested for addition or clarification, or when, requested, the expert has complied with the arranged by the court.

(As amended by Law No. 7757 of March 10, 1998.)

Article 38.- Third expert in discord

At the request of a party, the Judge shall appoint a third expert in contention. You can also name it ex officio. As regards acceptance, the time limit for delivering the opinion, its conditions or its requirements, the above rules shall be followed.

Article 39.- Hearing on expert opinion

The Judge will grant the parties a ten-working-day hearing on expert opinions, and five days on their additions or clarifications.

(As amended by Law No. 7757 of March 10, 1998.)

Article 40.- Assessment of the proof and judgment.

In any expropriation process, the judge must practice judicial recognition of the property subject to expropriation, in order to form a better criterion of validity and reality

expertise and ensure that the value assigned by the expert or other evidence is in line with the actual circumstances. The parties, experts or other persons understood in the field shall be cited to present, from their own voice, the observations or considerations made on the appraisals.

In addition, the parties may provide other elements and (sic) evidence to the process, such as:

a. Reports from associations or chambers of real estate brokers on the good in question or on prices of the area or similar real estate.
b. Photographs, publications or advertisements made by the owner, the neighbors or neighbors, by any means, that offer for sale the expropriated estate or other properties of the area.
c. Value declared by the owner or set by the Administration for local or national tax cancellation purposes.
d. Value of the good or the adjoining, fixed for bank formalities.
e. Expert or expert reports.
f. Official or private entity price indices.
g. Any others that allow the valuation of the property.

All evidence, including the expert's report, will be assessed by the judge as a whole, in accordance with the rules of sound rational criticism and considering the criteria of article 22 of this law. To this end, the judge may depart from expert opinions or any other evidence in order to review the administrative assessment.

Upon termination of hearings on both the expert opinion and its additions and clarifications, and without any other evidence to be evacuated, the judge shall proceed to issue the final decision within fifteen working days.

In no case, the amount of compensation may exceed the largest sum estimated in the appraisals.

The final judgment shall be notified to the Directorate-General for Direct Taxation and the corresponding municipality for the determination of national or municipal taxes in accordance with the law.

(As amended by Law No. 7757 of March 10, 1998.)

Article 41.- Appeal

The party that disagrees with the final decision may appeal to the High Administrative Court within five working days of the date of notification.

With the appeal filed and the time limit for appealing has elapsed, the court will immediately raise the file.

(As amended by Law No. 7757 of March 10, 1998.)

Article 42.- Proof for a better provide

Upon receipt of the orders, the Superior Court will have fifteen working days to order the proof to better provide that it deems necessary.

Article 43.- Hearing on the main issue

After the period stipulated in the previous article or evacuated the evidence to better provide, the High Court shall grant the parties a period of five working days to submit the allegations they deem appropriate.

Article 44.- Second instance resolution

After the expiry of the period laid down in the previous article, the High Court shall issue the final decision within a fortnight.

Article 45.- Appeals

By reasoned letter, the orders in process may be appealed in a single way, within three working days, only where they relate to the following matters:

a) The entry into possession of the expropriated good.
b) The appointment of the experts.
c) The fixing of the fees of the experts.
d) Concerning the withdrawal, the amount and distribution of the appraisal.
e) Against orders ruling on annulment of proceedings and decisions.
f) Against the judicial order that resolve the incidents of nullity of the expert proceedings.

In other cases, the file shall only have an appeal for revocation within three working days.

(As amended by Law No. 7757 of March 10, 1998.)

Article 46.- Archiving of the proceedings.

At any time, the Expropriating Administration may request the file by filed. When requested in court, it must cover the costs of proceedings and personal matters. ***(As amended by Law No. 7757 of March 10, 1998.)***

Article 47.- Payment of the fair price.

The just price will be paid in cash, unless the expropriation accepts it in securities.

In this case the securities will be taken at their real value, which the National Securities Exchange will certify through its agents or, failing that, a sworn broker.

The judgment, payment of compensation or difference with the administrative assessment accepted, deposited and withdrawn by the owner, shall be made through the procedure established in the Law on Financial Administration of the Republic, in the case of the Central government. The other public bodies will make the payment agreement.

Three months after the failure is enforceable without payment to the expropriation, the Budget Office of the Ministry of Finance and the Office of the Comptroller General of the Republic shall order a reservation, in the regular or extraordinary budget of the Administration obliged to pay, up to the amount of the just price, to ensure compliance with the judgment.

(As amended by Law No. 7757 of March 10, 1998.)

Article 48.- Deposit of just price

When the expropriator does not withdraw the just price, he shall remain placed in the order of the court he knew of the expropriation.

The owners of the just price or their legal representatives may request their money order at any time.

Article 49.- Registration

When the judgment that sets the compensation is final, at the request of the expropriating party, the court shall make the file available to the Notary of the State to be appointed, so that it proceeds to protocolize the corresponding parts and manages the registration of the good in favor of the expropriating or promoting as appropriate, even if the good is not enrolled. This protocolization shall be a supplementary title. The National Registry is obliged to cancel all annotations, levies and levies on the expropriated good, based on the deed of protocolization of parts, without any further formality. *(As amended by Law No. 7757 of March 10, 1998.)*

Article 50.- Exemptions

The registration, in the corresponding public register, of the deeds granted by the application of this Law, shall be exempt from the payment of taxes, stamps, registration fees and other tax charges.

CHAPTER IV

Modalities of compensation

SECTION I

Relocation

Article 51.- Relocation of expropriation

By way of compensation and thus agreed with the expropriation, the expropriating administration may relocate the expropriation under conditions like those enjoyed before expropriation.

Article 52.- Relocation of Populations

Where it is necessary to move populations to carry out a utility or public interest work, the Executive Branch or the expropriating administration shall coordinate the respective relocation.

The entities and units to be involved in the implementation of the respective project shall include, in their budgets, the supplementary items required to provide their services. In addition, they shall ensure that technical standards in the installation and operation of the services are complied with.

Article 53.- Dissatisfaction with relocation

When the administrator considers that the property where he was relocated is of a lower condition than he previously occupied, he may appeal to the Administrative and Civil Court of Finance to have his claims resolved, following, as soon as it is compatible, the procedure established by this Act for judicial proceedings of expropriation.

SECTION II

Compensation for temporary occupation and other damages

Article 54.- Temporary occupation of property

When the Public Administration requires a property of an individual to be temporarily occupied, it shall issue a reasoned decision to declare that occupation of public necessity.

This resolution must be reasoned in the proper way. The period shall be expressly indicated, which shall not exceed five years, and the compensation applicable. In addition, those affected by the occupation shall be notified.

Article 55.- Dissatisfaction with compensation

If the expropriated party does not comply with the terms of the resolution referred to in the previous article, within eight working days of the respective notification, he may appeal to the government and expressly state the basis of their dissatisfaction.

The administration must resolve within two months, thereby depleting the administrative route.

Article 56.- Judicial procedure

If the expropriated party does not agree with the decision referred to in the preceding article, the administration concerned may benefit from the formalities prescribed by Chapter III of this Law, as applicable, in order to obtain judicial authorization to enter possession of good.

Article 57.- Compensation for other damages

Where, for serious reasons of public order or security, epidemics, floods and other calamities measures must be taken involving destruction, effective harm, occupation of property or particular rights, without the prior formalities to implement the various types of expropriation required by this Law, the injured individual shall be entitled to compensation, in accordance with the rules of the provisions relating to the temporary occupation of the property. The administration should, as soon as possible, initiate the respective dossier.

Article 58.- Subsequent damage

Damages, other than those which have been the subject of compensation, arising as a direct result of the occupation, shall be reassessed by the administration, following the procedure described above, all at the request of the Interested.

CHAPTER V

Final Provisions UNIQUE

SECTION

Article 59.- Responsibility of administrative officials

Officials involved in the administrative process and do not fall short of the deadlines set by this Law shall respond, personally, to the administrator for any damages that his delay may cause him, without prejudice to administrative sanctions or the responsibility of the administration.

Article 60.- Responsibility of judicial officials

Where judicial officials unreasonably fail to comply with the time limits laid down by this Law, they shall incur personal liability, without prejudice to the corresponding administrative sanctions. The Office of the Attorney General of the Republic or the expropriating body shall direct the appropriate actions to compensate the Public Administration for the economic damage caused to it.

Article 61.- Responsibility of experts

In preparing the reports, the experts shall be personally liable for the damages caused to the Administration when, by judgment, an expert opinion is taken, the overvaluation of which is subsequently determined. In such cases, the Expropriating Administration shall promote, against experts, appropriate administrative, civil and criminal actions.

If overvaluation of experts occurs, the expert will be excluded from the list of the Executive Directorate of the Judiciary, even if the opinion is dismissed in judgment.

Individuals may go to civil channels to claim any damage caused to them and originated in the reports of the experts.

The extension of section 26 of the Expropriations Act, No. 7495 of 3 May 1995.

(As amended by Law No. 7757 of March 10, 1998.)

Article 62.- Tax species and authentication

Expropriation measures shall be processed free of payment of tax species. The procedures that the expropriation personally proposes, in the administrative or judicial way, do not require authentication.

Article 63.- Prescription and expiration

The rights and actions arising from this Law are prescribed in ten years, counted from the day following the day on which the State took possession of the good or affected it.

The claim, by administrative means, will expire and will be held as a non-filing if five years have elapsed without the interested party activating the proceedings.

Article 64.- Repeals

The following provisions are repealed:

a) Law on Forced Expropriations, No. 36 of June 26, 1896 and its reform by Law No. 78 of June 24, 1938.
b) Law Expropriation of land for El Coco International Airport, Law No. 1371 of 10 November 1951.
c) Law Expropriations, processing and return of unused expropriated properties, Law No. 5123, of 22 November 1972 and its reform by N 5404, of 9 November 1973.
d) Landing grounds Act, No. 1550, of April 13, 1953.
e) INVU Expropriations Act, No. 1882, of June 7, 1955.
f) Law Expropriation of land by volcanic emergencies, Law No. 3382 of September 12, 1964.
g) The final paragraph of article 5 of the Law of the Directorate-General for Physical Education and Sports, N 3656, of 6 January 1966.
h) The second paragraph of Article 66 and Articles 67, 68 and 69 of the Urban Planning Act, No. 4240 of 15 November 1951 and its reform, N 4971, of 28 May 1972.
i) Article 11 of the National Emergency Law, N. 4374 of 14 August 1969.
j) The second paragraph of Article 4 of the Forest Law, No. 4465 of 2 December 1969 and its reform, N 7174, of 28 June 1990. The following text: "The Executive is

empowered to, through the Ministry of Natural Resources Energy and Mines, carry out the expropriations referred to in this Article, in accordance with the provisions of the Law on Expropriations, No. 36 of June 26, 1896 and their reforms".

k) Article 23 of the General Law on Public Roads, N 5060, of 22 August 1972; except for subparagraph (h), regarding the existence of a specialized body of experts, in the Ministry of Public Works and Transport.

l) Articles 157 to 170 of the Municipal Code.

m) Articles 233 to 241 of the Education Code.

n) Section 86 of the Wildlife Conservation Act, N. 7317 of 30 October 1992.

o) Article 2(ch) and Articles 63 to 77 of the Law on Agrarian Jurisdiction, No. 6734 of 25 March 1982.

p) Article 11(g) of the Law Establishing the Costa Rican Institute of Aqueducts and Sewers, N 2726 of 20 April 1961.

q) Article 27(4) of the General Law on Public Administration, No. 6227 of 2 May 1978.

Article 65.- Legal reforms

The following legal texts are reformed:

1. The first subparagraph, subparagraph (e), Article 5, of the Law establishing the Costa Rican Institute of Aqueducts and Sewers, N 2726, of 20 April 1961, the text of which shall read: "Process the expropriations necessary for the fulfillment of its purposes."
2. Article 20 of the General Law on the Grant of Public Works, No. 7404 of 3 May 1994, the text of which reads:

"Article 20. - Where it is necessary to acquire real estate or affect real rights for the purposes of this Law, will be carried out in accordance with the following procedures: The interested administration may acquire, directly, by property swap or by donation, upon a favorable report by the Comptroller General of the Republic, the goods or rights necessary for its purposes, whatever their value, as a result of the assessment made for that purpose. effect.

In the case of direct purchase, if the owner does not accept the fixed price, the procedures stipulated in the Expropriations Act will proceed. In the case of real estate to donate, for the administration to enter possession, the private document in which the owner promises the donation, before three witnesses, will suffice. The owner shall be obliged to grant the public deed to the Notary of the State, within fifteen days of the date of the private document."

a) Article 508 of the Code of Civil Procedure is reformed, the text of which will read: "The State, its institutions and the municipalities may also submit to the decision of arbitrators or experts, in accordance with the formalities of this chapter, the claims in which they appear as interested parties."

b) Section 5 of the Indigenous Law, No. 6172 of November 29, 1977, the phrase "Law No. 2825 of October 14, 1961 and its reforms" is deleted to read instead: "Expropriation Act"

Article 66.- Term

This Law is public policy and governs from its publicatio

Annex 10. Proposal for an emergency plan.

Note: The following plan has been prepared in compliance with the requirements established by the existing regulation, such as Executive Decree No. 39.408-MTSS, "Regulation on Committees and Offices or Departments for Occupational Health and Safety," and Norm CNE-NA-INTE-DN-01-2014, "Norm for Emergency Preparedness and Emergency Response Plans for Work Centers and Places of Public Occupation."

1 EMERGENCY PLAN AND ACCIDENT PREVENTION.

As defined by the National Emergency Commission, the Emergency Plan, it is the product of a series of analyses, observations and evaluations planned, directed and scheduled in a document, which is intended to serve as a guide for the prevention phases, mitigation, preparedness, response and rehabilitation, actions that must be taken in the face of emergencies, or imminent disasters, caused by the vulnerability of individuals, buildings or systems to threats nature's own, such as seisms, floods, hurricanes, volcanic activity, landslides, or man-made, such as fires, spills of dangerous products and explosions.

The emergency plan is the planning and human organization for the optimal use of the technical means envisaged in order to minimize the possible human and/or economic consequences that could arise from an emergency.

It follows from the definition that the emergency prevention and care plan aims to optimize the available resources, so its implementation implies having previously equipped the building with the necessary material or technical resources in depending on the characteristics of the building and the activity that takes place in it.

This in turn entails having previously carried out an identification and analysis of the risks or deficiencies of the building or project to be developed, essential to know the provision of means of prevention-protection that are specified in it.

1.1 Justification of the Emergency Prevention and Care Plan:

This document developed the outline of actions to be followed by the prospective contractor in the event of an emergency situation during the development of the GAM Rapid Passenger Train Project.

Based on the potential risks, as well as the means of protection to be available, is that the prevention and emergency care protocols to be developed are detailed in this plan of prevention and emergency care.

It is important to plan the reactions and actions to be taken at the time of an emergency, in order to avoid the loss of human life and to substantially reduce the risks of material and environmental losses.

Emergencies should be provided by a Plan that allows all people to travel to a safe place, at an appropriate time based on the foreseeable risk and with the necessary security guarantees.

It is important to remember that the panic element results in more injury and loss of life than the same emergency, as it affects orderly and safe evacuation.

Prevention and preparedness are the best way to deal with emergencies.

1.2 Objectives:

1.2.1 General Objective:

Provide greater safety to workers, project personnel, and road users, in the event of a hazardous situation in or around their temporary facilities, so that panic, serious injury or loss of human lives and material and environmental goods.

1.2.2 Specific Objectives:

- Protect the physical integrity of all possible persons affected by an emergency situation during the construction and operation of the GAM Rapid Passenger Train Project.
- Reduce losses that may cause an emergency.
- Have trained emergency care personnel.
- Have well-defined procedures to deal with an emergency, without endangering those who execute them.
- Seek the early resuming of work.

1.3 Definitions.

EMERGENCY:

Situation generated by the manifestation of an event, which severely modifies normal living conditions, making immediate intervention necessary. It is any unforeseen fact, situation or circumstance that alters a normal operating process and may result in a danger to human, animal and/or property damage.

Any state of disruption to a system that may jeopardize the stability of the system, whether in whole or in part, is considered an emergency. The concept of a system may refer to a small clinic, a hospital, or an entire community.

Because of the impact and significance of the effects of the emergency on the system that can even make it disappear, those responsible for administering it, i.e. senior management, must:

"SET: A GENERAL POLICY ON EMERGENCIES, IN KNOWLEDGE OF ALL PERSONNEL"

DISASTER: It is an event of natural or man-made origin, which occurs in most cases unexpectedly, causing intense alterations in the population, goods and the environment in general.

AMENAZA: It is a phenomenon that can potentially affect human life and activity adversely.

Some examples: earthquakes, volcanic eruptions, economic collapse, political crises, epidemics, landslides, deforestation, among others.

AMENAZA AREA: This is the coverage area of occurrence of the possible threat, regardless of the presence or not, of goods or persons.

EVACUATION: It is the action of evicting a unit, service or place, in which an emergency has been declared.

EVACUATION WAY: Expedited, signposted, continuous and safe path that from any point of the installation, leads to the safety zone.

SAFETY AREA: Place of temporary outdoor shelter, which must meet the characteristics of providing safety for the lives of those who reach that point, for its designation should be considered that there are no elements that can cause damage due to falls (trees, electrical wires, ancient structures, among others).

SCALE: Independent and transferable structure, composed of lengths joined transversely by horizontal steps or bars and at equal distance. You may have your own lift (scissor scale) or not (hand scale).

LADDER: Part of a road of circulation, composed of a series of steps or horizontal steps placed at equal vertical intervals, attached to the structure of a building.

FLOW OF OCCUPANTS: Number of people passing through the useful width of the evacuation route, in a unit of time, Expressed in people/minutes.

FIRE: Fire of great proportions that causes damage to people and facilities.

OUTBREAK OF FIRE: Fire started, discovered and extinguished as soon as possible and that does not cause damage or the caused is less than mild.

EXPLOSION: Fire at a higher speed, producing rapid release of energy, increasing the volume of a body, through a physical and chemical transformation.

SEISM: Ground movement, (will be discussed in length, in the procedure section in case of earthquake).

VULNERABILITY: It is the condition in which people and property exposed to a threat are found, which by their degree of information and training or, by their quantity, location, material conformation, functional disposition, among others, that have, have a certain degree of capacity or inability, to face or withstand the action of any possible event. Human vulnerability is related to the degree to which people can be susceptible to loss, damage, suffering and death. Vulnerability includes several factors: physical, economic, social, political and religious.

CAPACITY: These are the internal and external resources that individuals, families and communities have to deal with situations that threaten their lives and well-being.

RISK: This is the result obtained by relating or combining the intensity of a likely event (threat) and its vulnerability.

RISK AREA: It is defined, as the area where there are the highest degrees of threat and, the increased presence of people or goods likely to be affected.

RISK FACTORS: These are identified and measurable effects that are constituted in specific threats.

PORTABLE FIRE EXTINTOR: This is a device containing dust, liquid or gas, which can be expelled under pressure for the purpose of suspending or extinguishing a fire.

1.4 Existing types of evacuation:

1.4.1 Partial Evacuation.

- It will be done when it is necessary to evacuate in an emergency situation.

- Instructions will be given by the Chief or in charge of the Project Operation

-They also have the responsibility to accompany and lead the officials in their area, from their place of work, to the safety zone by the appropriate evacuation route.

1.4.2 Total Evacuation.

- It will be carried out when it is necessary to evacuate at the same time, all the dependencies of the company.

- The total evacuation order will be provided by the Head of the Evacuation Plan, or the Sub-Plan Manager.

- The evacuation order will be communicated to the staff in general, of the existing telephone system.

1.5 Description of the types of disasters:

1.5.1 By their origin they are classified into:

a. Natural: they are the ones that we cannot avoid, among them we have:

- Earthquakes.
- Tornadoes.
- Floods.
- Tsunamis.

b. Man-caused: among which we have:

- Fire.
- Technological disasters.
- Explosions.
- Terrorist acts.
- Spills of toxic substances, among others.

1.5.2 Because of their magnitude, they can be classified as:

a. Limited magnitude:

➢ They affect only part of the place that is identified as a disaster zone.

➢ Allows you to use all kinds of resources in place.

➢ It causes few personal injuries and there are usually no cases of death.

b. Median magnitude:

➢ The infrastructure suffers some damage, the material resources of the site cannot be used in full and human resources can be affected by the number of injured.

➢ Incorporation into the attention of results is gradual.

c. Great magnitude:

➢ It totally destroys the infrastructure.

➢ All services during the emergency phase will be provided from outside the disaster site;

➢ Human resources suffer heavy loss of life and injure.

- Great damage to the uninjured.

1.6 Threat and vulnerability level analysis:

It is based on the observation, recognition and study of the risk conditions that could be presented, both internally and externally of the Project, to determine potential hazards and situations that could be considered special during an emergency; either because of its consequences or damage that may cause people, facilities, systems and environment in general.

This stage allows us to have the necessary material to propose corrective measures to address these risks. (Aspects to be evaluated): External Level and Internal Level.

1.6.1 Existing threats:

Earthquakes and earthquakes: Being that Costa Rica is located in a seismic area, any place within the national territory is vulnerable to the occurrence of earthquakes.

Structural fires: the vulnerability in the fire will vary depending on the area of the Project where it develops, and how quickly people evacuate themselves. It is important to point out that this type of risk should be considered mainly for administrative buildings, camps, concrete and asphalt mixing plants, warehouses for machinery and equipment, cellars in general.

Forest Fires: it is a potential risk in the area, due to the extensive areas of pastures and scrub, the risk is latent, but with the implementation of the measures proposed here are considerably reduced.

Medical or traumatic emergencies: here you can present various medical emergencies such as: attacks of bronchial asthma, hypertensive seizures, attacks of epilepsy, drops at level and falls at heights, hits with tools, accidents of accidents caused by heavy machinery, electrocutions, among others.

Explosions: this type of emergency could be presented in this Project, caused by a vehicle that is parked in front of the control center facilities, or those that travel along the different access roads.

Terrorist act: although it is difficult in our country to find this modality, we must not rule out the possibility of this happening, so it is important to be prepared to face this situation if it were to happen.

1.7 Location of response entities or emergency care:

Firefighters: The fire departments closest to the Project are located in several county headquarters nearby. The estimated response time of the units is approximately 15 minutes. Phone number: 118.

Red Cross: the nearest posts are located in the nearby county centers; their response time is approximately 15 minutes. Phone number: 911.

1.8 Administrative Organization for Prevention:

1.8.1 Components and their respective roles and responsibilities:

Aware that the Organization is a key factor for emergency care, mitigation and rehabilitation, is that the management of the company in charge of the development, operation and maintenance of the GAM Rapid Passenger Train Project:

Emergency Committee:

It will be responsible for coordinating the execution of activities that are carried out before, during and after an emergency. The proper functioning of this Emergency Committee will depend on the approval and support of the highest hierarchies, to ensure compliance and effectiveness of this Emergency Prevention and Care Plan.

Members of the Emergency Committee must have decision-making and commanding power in order to lead the group in a state of emergency.

Proposed structure for the Emergency Committee:

1. General Coordinator.

2. Brigade Coordinator.

3. Mixed Emergency Prevention and Care Brigade: (Evacuation and Rescue, Communication, First Aid, Prevention and Fire Fighting).

Description of the functions of the Emergency Committee:

➢ Before:

• Evaluate the characteristics of the project installation or area and propose corrective measures to eliminate or reduce existing hazards.

• Monitor the operation of the Emergency Response Team as set forth in the Emergency Prevention and Care Plan.

• Coordinate with other companies and/or institutions activities and training related to disaster prevention, such as extinguishing practices, CPR, First Aid, among others.

• Disseminate the Emergency Prevention and Care Plan, as well as the safety and protection measures to follow among employees.

➢ During:

• Create a Command Post.

• Implement the Emergency Prevention and Care Plan.

➢ After:

• Evaluate the effectiveness of the Emergency Prevention and Care Plan.

• Prepare the respective report.

• Take the corrective measures necessary to improve responsiveness based on evaluation data.

Functions of emergency brigades during the phase of an emergency or disaster.

Members of the Emergency Brigade will be responsible for:

• Control and put out any incipient fires that occur within the Project facilities.

• Recommend fire prevention measures.

• Ensure the proper functioning of emergency care equipment.

• Participate in the trainings and internships that are scheduled in the Project.

• Support in cases of evacuation of personnel.

Rolls distribution:

Emergency General Coordinator:

• Control and direct all activities and actions related to the emergency prevention and care plan that are developed in the Project.

• Provide all staff with the necessary knowledge.

• Monitor that each area is the minimum number of trained personnel as set out in the Emergency Prevention and Care Plan.

• Provide information to the press;

• Design an annual emergency training program for each area of the Project.

• Participate in newly entered staff induction programs.

• Request assistance from 911 emergency bodies and ask the telephone exchange operator to contact such entities and wait for the respective information.

• The General Coordinator is the person responsible for triggering the emergency alarm and making the reports that will be addressed to the high authorities of the company, after investigating the causes that caused the incident.

• You will also be responsible for indicating the time of evacuation of personnel if this is necessary, either in an area or in its entirety of the Project facilities.

Brigade Coordinator:

• Receive information and indications about fires, spills or other situations deemed to be emergency in the Project.

• Direct actions to reduce or control any of the emergencies that may arise, first seeking the safety of the project's personnel and facilities.

• Request the presence of external aid bodies if deemed necessary. In the event of a large crowd fire, the request for help should be immediate.

• Ensure constant training of all groups and annual review of established procedures.

• Check the condition of all emergency response teams in each area of the Project.

• You will have under your responsibility everything concerning the coordination of care and the transfer of injured persons.

• You will be responsible for anything concerning fires, spills or another situation that is considered an emergency.

• You will be responsible for coordinating the evacuation of personnel.

• Move staff to sites referred to as safe.

Brigade Functions:

Evacuation and Firefighting:

• It will be up to you to evict staff who are in the Project and individuals who have not been injured in the event.

• Check that the evacuation plan is carried out as set out.

• Search and extract all potential victims of the event without causing them more injuries than already presented.

• You will have trained personnel to disconnect all electrical devices and machinery.

• You must monitor or minimize possible fire situations until outside aid arrives (fire brigade).

• You must check the status of existing fire equipment in the Project at least once a month.

• It will move evacuated persons, in addition to materials necessary for the extinction or saving of materials.

• They must cooperate with the implementation of preventive measures in case of fire.

• At the time of the emergency and/or evacuation, they will be in charge of checking that unauthorized persons outside the Project do not enter.

• Be vigilant to external fire signals in neighboring properties.

• Alert fire firefighters in areas near the PA.

First Aid:

• Provide basic care to victims of a disaster, according to their level of training.

• Review the emergency kits in the Project on a monthly basis, ensuring their proper equipment and location.

• Members of this brigade shall be trained, certified and trained by other persons or organizations authorized by the competent authority.

Communication Person:

• Count the evacuees.

• Direct rescue bodies to the emergency scene and provide all necessary information.

General Coordinator:

• Control and direct all activity and actions related to the company's emergency prevention and care plan.

• Provide all staff with knowledge of established plans.

• Monitor that in each area of the Project the fire equipment is in perfect working condition and in the places established for each one.

• Supervise the minimum number of trained staffs in each area as set out in the "Emergency Prevention and Care Plan".

• Provide information to the press.

• Coordinate with the higher administration decision-making in case of situations affecting the Project (earthquakes, volcanic eruptions, hurricanes, civil disturbances among others).

• Design an annual emergency training program for all Project staff.

• Participate in newly entered staff induction programs.

1.9 Rapid response plans:

1.9.1 NATURAL DISASTERS.

a. Earthquakes.

The most appropriate way to deal with a high-impact seismic event is to anticipate its occurrence. Therefore, the following preventive measures should be taken in the Project:

1. Build the temporary building according to the specification's resistant earthquake.
2. Prevent the fall of heavy objects such as shelves during a seismic event, fixing this type of object to the ground.
3. Perform drills, to test the actions to be taken in case of an earthquake.
4. It is necessary to designate evacuation routes, in case of uncovered and safe areas near the building, such as: courtyards or parks, which are not encircled by electrical wiring.
5. Responsibilities should be assigned to each employee of the company during an event of this nature, for example: there must be a person responsible for evacuating visitors, disconnecting electrical systems, among others.
6. In the absence of safe sites in case of earthquake around the building, it is necessary to locate the safest points or areas, where to remain during the occurrence of the earthquake.

Measures to be taken during the earthquake:

• Keep calm and order;

• Follow the evacuation plan previously established during the drills;

• If it is not possible to evacuate to a safer place, stay next to a large, sturdy object, such as a table or armchair. NEVER try to be located under these objects, it has been proven unsafe.

• Even if the shelf is fixed to the floor, avoid being located near the floor during a seismic event. Remember that they contain objects that can fall on you and hurt you.

• Avoid stairs are a weak element. Make sure people don't try to run away this way, usually all you get as a result are accidents.

• Call emergencies after the event, if there are injuries or people in crisis.

1.9.2 ANTROPIC DISASTERS.

a. Fire.

Preventive measures:

• Do not keep flammable material near energy sources or outlets.

• Review the proper functioning of the fire extinguishers in the Project. According to the procedure for use indicated in the Protocol on the Management of Portable Fire Extinguishers.

• Keep fire-fire rounds around the area of buildings, plants or camps.

• Keep hydrants in good condition and in use.

General procedure to be followed in case of fire:

• Press the alarm. If you don't have an alarm, alert your teammates.

• Stay calm. Walk fast but without running.

• If the fire is small (it is just starting), try to remove objects that can serve as fuel (paper, plastics, among others) from the outbreak, and turn it off using the portable fire extinguisher within reach.

• If the above measurement is no longer possible, leave the site using the emergency exits and call the firefighters.

• If the place concentrates a lot of smoke, leave the enclosure crawling. In the process keep your mouth and nose covered with a damp handkerchief.

• If any doors are found on your escape route, touch it with the back of your hand, if it is hot look for another exit.

• Call firefighters.

Before a person shrouded in fire:

• Throw the person to the ground.

• Wrap the person in a blanket or carpet.

• Remove the blanket and spray the person with water until it is completely wet.

b. Terrorism.

Prevention:

• In the event of a bomb threat or indication of placement in the construction of a suspicious object, call the police or call the emergency department.

• Do not touch the object and evacuate the area in an orderly fashion.

• Wait outside the premises to the authorities and let them know which areas most at risk within the building or construction are.

• Report on the characteristics of the person or group of them who left the artifact or object.

• Place yourself at all times behind a wall or barrier to avoid the explosive wave.

• Move away from the floor-to-ceiling windows.

• Finally, abide by the instructions of the authorities.

Evacuation plan:

In the event of a real emergency situation, teamwork will be required by all Project staff, and you should not forget to have the support of external relief forces.

Internal emergency warning:

1. Depending on the type of emergency, the existence of the emergency shall be indicated internally by means of:

• Alarm (several tones according to emergency rating, can be a tone in case of fire, two tones in case of flooding, three tones to evacuate, among others).

• Radio communicators.

2. The evacuation of the facilities will be effective when you hear the Alarm or Evacuation Siren (there are three types:

Fire, general evacuation by volcanic eruption, and bomb threat your difference is sound), or a direct order from the supervisor or chief. All personnel must leave the premises as soon as they receive the evacuation signal.

3. Upon receipt of the internal emergency notice, the Evacuation Committee shall immediately be mobilized to the command center to initiate the relevant work.

External Emergency Warning:

In the event of an emergency, external aid agencies shall be notified until the Committee authorizes calls. These alerts will be communicated between the members of the Evacuation Committee in the form of a key, by radio communicators.

Procedures for emergency care:

It is proposed to implement procedures for emergency care which must be reviewed and approved by the management of the company and communicated to all staff for their knowledge, in order to implement all activities necessary to cope with an emergency.

The proposed evacuation procedures are detailed below:

General procedure for evacuation in case of emergency:

• Follow the instructions of the persons responsible for carrying out an evacuation in the Project;

• Form a row to the nearest exit or safety zone, following the normal evacuation route.

• Remember, walk do not run.

• If a large amount of smoke occurs it should advance to cats, to avoid eye irritation or breathing problems.

• It is not returned for any personal effect, as the material is replenished, but human life is not;

• Staff should be addressed and located at the meeting point (SAFETY AREA) depending on where you are and never stay close to walls.

• All persons will remain in the designated location until members of the Brigade will have

Emergency of the Building or governmental entities such as Red Cross, Fire, Rural Assistance Guard or Municipal Police indicate otherwise.

Fire emergency evacuation procedure:

The most important thing is to avoid it, keeping electrical installations in good condition, not using unhealthy electrical devices, not throwing cigarettes or matches in inappropriate places, and making sure to keep all the material in appropriate places existing flammable in the company.

In the event that this occurs, the following should be done:

Fire extinguishers must disconnect the electrical and gas fluid in each section.

Managers should be appointed by area.

Before:

1. Receive training on the appropriate mode of use of portable fire extinguishers.

2. Identify the areas of greatest exposure and possible types of fire;

3. Have at your fingertips the basic fire prevention and combat equipment, located according to the most exposed area and according to the type of fire.

4. Define the alarm system to be used and the procedures for extinction.

5. Coordinate the trainings of all staff and conduct drills.

6. Ensure the good condition of portable fire extinguishers.

7. Know the telephone number of firefighters, the Red Cross and an emergency and ambulance service that can go to the company at the time of the emergency.

8. Keep flammable liquids in closed containers and in places where they pose no danger.

9. Perform preventive maintenance in electrical installations.

10. Prevent vehicle drivers from performing mechanical work in parking areas.

11. Prevent people from throwing glass in both the internal and external areas of the company.

12. Avoid keeping or leaving candles on the premises.

13. Ensure the installation of smoke censors, in the different places where there is storage of papers, or flammable liquids, as well as in the corridors.

14. Keep the fire rounds around the project always free of vegetation.

During:

1. Communicate to the emergency committee or activate the alarm immediately and inform the competent authorities.

2. The emergency committee or person in charge at the time of the emergency must request or proceed to be immediately advised of firefighters and whether it is necessary to seek the help of other institutions such as the Red Cross or Rural Guard or Municipal Police.

3. A person will be assigned to wait for Firefighters to indicate the location of the event and the type of materials at the site.

4. If the fire is controlled before firefighters arrive, they must wait at the scene to combat a restart, in case they cannot control it, the place must be evacuated immediately.

5. Proceed with the evacuation of the affected area and if necessary, from the rest of the installation.

6. If there are injured, they must first move to a safe place and then provide appropriate care.

7. Persons who do not have any special functions in the event of an emergency shall under no circumstances remain at the place of emergency if the order has been given to evacuate.

8. When the evacuation order is given, the work under way must be abandoned and obeyed.

9. Trained persons must go to the fire site to start combating the fire, provided that the appropriate equipment is available.

10. Suspend power to the emergency area.

After:

1. All Project staff, clients and visitors, must meet at the meeting point.

2. Try to reassure people.

3. The coordinator in charge should note that the entire crew is at this meeting point.

4. Do not obstruct the work of firefighters and relief agencies.

5. Make sure that no new fires have been left.

6. Once the fire is extinguished, ensure that the structure has not been weakened by expert personnel.

7. Assessed the effectiveness of the Emergency Prevention and Care Plan and prepared the respective report.

8. Take the necessary corrective measures for a better response in the future.

Fire Detection:

• The person who detects the fire within the project or in neighboring properties, must immediately inform a member of the Emergency Brigade, who will indicate the steps to be followed according to the procedure established for these cases as well as must ask the Fire Department for help.

Request for help:

• The Emergency Brigade should immediately call the Fire Corps at Number 118 in case of fire and 911 in case of other emergencies.

• You must provide the following information:

Place from where it is called, person's position, exact address, site within the facility where the event is occurring, type of emergency, immediate risk and phone number of the caller.

• You should wait if the call is rectified by the Fire Department.

Fire attack:

• The brigade must go to the site of the fire and proceed to the extinguishment of the fire.

• You must check before the type of material that is in combustion to proceed to use the appropriate extinguisher.

• If it is an external fire, surround the perimeter of the AP in order to attack any fire hotspot.

Evacuation:

• The brigade should assist in the evacuation of personnel from affected or at risk of being affected.

• Check that all personnel leave the premises immediately.

• When the evacuation order is given, all personnel must leave quickly and neatly by the established exits, without carrying anything in their hands or smoking.

Attack Body Support:

• A brigade member will wait for the machines or ambulance at the entrance and drive them to the event site.

• Firefighters will help if requested, show them hydrants or water intakes.

Disconnecting the electrical fluid:

• In case of fire the brigade or any designates it, it will be responsible for disconnecting the electrical fluid and closing pipes.

SPECIFIC RECOMMENDATIONS IN CASE OF FIRE:

• At the fire alarm signal exit neatly to the indicated site, using the installed evacuation routes.

• Fire extinguishers should use them if required;

• The Communications Committee should call firefighters via telephone or radio phone;

• Wet scarves covering nose and mouth are recommended while smoke is scattered or in contact with smoke.

• The person responsible for isolating the electrical fluid must do so before leaving the area;

• In the computer room close the electrical fluid before leaving the area, this must be done by whoever is in the moment.

Evacuation procedure in case of emergency by earthquake:

Earthquakes occur at any time, can have very varied magnitudes and intensities, usually the maximum intensity of the movement is reached within a few seconds after the earthquake is detected.

The damage caused by an earthquake can be structural or human. It is very important to apply the security measures as soon as the event is detected.

Before:

1. Define safety zones in case of event and ensure that the exit routes are kept in good condition.

2. Periodically inspect facilities for possible hazards or obstacles at the time of an evacuation.

During:

1. Suspend any activity you are doing immediately.

2. Disconnect all equipment that is being used.

3. Place yourself in a safe place and then look for the nearest security zone.

4. If instructed to evacuate the area.

5. Stand away from lamp shelves, anything that may fall.

After:

1. Evacuate to your safety zone and count people.

2. Move away from falling materials or objects.

3. Do not enter the building until the inspection has been completed and it has been determined that everything is in perfect condition and safe.

4. It is important to take some measures as soon as an earthquake is detected and in case the Intensity of it allows some kind of action.

6. Suspend work immediately.

7. Disconnect all equipment used and close the passage of supplies of liquid or gaseous materials.

8. Evacuate the area in case the earthquake is of significant proportions.

9. Move away from electrical cables because if they burst, they can be energized and cause electric shocks, move away from objects that may fall such as TVs and high shelves with materials and windows as they can break the glass and injure people.

10. Persons in case of earthquakes shall remain in their respective areas of work. Moreover, workplaces should be reviewed regularly to ensure that they are sufficiently safe and do not threaten the lives of the people working on the Project;

Evacuation procedure in case of medical or traumatic emergency:

Before:

1. Identify possible medical or traumatic emergencies that may bring a complication in the event of an emergency.

2. Have first aid equipment available and on hand.

3. Train employees on how to act in the event of a medical or traumatic emergency.

During:

1. Assess the person's condition, provide the medical assistance they need, and determine the need to apply for specialized personnel (Red Cross or Doctor).

2. Do not move the patient until it is immobilized and only move it if necessary (emergency movement).

3. Inform the senior headquarters of what happened.

After:

1. Evaluate the outcome of the action and prepare the respective report.

2. Take the corrective measures necessary to improve response capacity based on the assessment.

In the event of a severe accident:

• The Project Manager should be notified immediately.

• Communicate the emergency to the emergency committee coordinator.

• The person who detects the injured person must remove any conditions that may aggravate the injury of the affected person, provided that he or she is able to do so;

• The head of the Brigade shall determine the procedure to be followed.

• The head of the Brigade shall be responsible for authorizing them to request assistance from the support institutions.

• An area for the care of the injured or injured will be kept within the company.

• The safety zone will maintain a properly equipped medicine cabinet; In addition, there will be a portable medicine cabinet.

• Brigade personnel, to be prepared to provide the necessary care to any emergency due to sudden injury or illness must be trained.

• Any person suffering from a serious accident must be transported by the Red Cross or other ambulance. Where possible, the carriage of injured persons in other types of vehicles shall be avoided, unless the condition so warrants. If the injury is minor, the trained first aid personnel the assistance required.

Evacuation procedure in case of explosion:

Before:

1. Make periodic reviews of existing facilities and vehicles on the project site.

During:

1. If a potential source of explosion is detected, please inform the emergency committee coordinator, ask Firefighters for assistance if deemed necessary.

2. If an explosion occurs, if there are injured take them out to the front of the building, if you are trained (a) give first aid and proceed to call the Red Cross and Fire Department.

3. Uninjured persons move them to the front of the building on public roads until the emergency is controlled.

After:

1. Conduct a thorough investigation of what happened, generate a report to the Emergency Committee and proceed to the correction of the problem.

1.10 Inventory of resources that the Project must have at your disposal includes:

1. Personnel trained in the following topics: use of portable fire extinguishers, first aid, general safety standards, standards for working with electricity, among others.

2. Portable or stationary communication equipment.

3. Rescue teams, first aid.

4. Water sources.

1.11 Recommendations for planning and implementing the Emergency Prevention and Care Plan:

• Use machinery in good condition.

• Hire trained personnel for the operation of the machinery.

• Establish a preventive maintenance program for machinery.

• Perform machinery repairs outside the A.P. in a maintenance shop near the A.P.

• Respect current legislation on issues of pollution by hydrocarbon spill or noise generation.

It is important to consider some basic environmental measures that as a general guideline should be taken into account, such as:

• Use good quality building aggregates.

• Specify in contracts for the transport of materials that such transport must comply with the basic measures laid down in the legislation in force for the activity in question.

• Store in places conditioned for this purpose, the construction materials of dangerous type that are used in the activity, such as paints, solvents and other finishes.

• Collect packaging, cartridges and other similar materials used to pack or coat building raw materials and transport them to an authorized landfill; it is also strictly forbidden to burn these wastes on the site.

• Establish within the AP areas of loading and unloading materials as well as collection sites, which must comply with current legislation.

• Create a recovery plan for the collection areas in such a way that at the end of the Project they are in the same condition as before starting the activity.

During the construction period, land movement causes an alteration of the natural drainage of stormwater. This alteration is further accentuated when the works themselves are lifted, since there is an effect on the infiltration capacity of these waters that the land had and rather the waterproofing produced, increases the flow of runoff water that increases the flow of runoff water that should be directed towards a body of receiving water. In consideration of all this, it is necessary to implement a number of measures in order to reduce some of the most negative environmental effects, such as:

• Design the drainage system considering the load capacity of the receiving water body to assimilate the increase in stormwater or runoff flow that will represent the new work.

• Take appropriate measures for the provisional evacuation of stormwater, in order to avoid accumulation, erosion and trawling of sediments.

• Avoid the development of the activity of land movements during periods of heavy rain, in order to minimize the hauling of sediments from the work areas to the receiving channels.

• Build when required, retention barriers or other similar solutions or collect these waters through ditches and lead them to a rudimentary sedimentation trap before discharge, constantly enforcing because of temporary works built do not become a focus of vector development that transmits disease to the inhabitants of the surrounding areas.

• Coat, when required, the walls and bottom of the ditches with stable granular materials in order to prevent erosion.

• Reduce the speed of flow in the ditch by building steps (drill gradient wells), thus varying the slope or by installing obstacles (sandbags, sandbags, stones, among others) at regular intervals.

• Divert runoff water out of landslides.

• Maintain crews that maintain temporary stormwater works after each rain affecting the Project area; it is important that the Environmental Regent and the Project Engineer tell the staff assigned for this activity what is the importance of their task and how to perform it.

Like all work activities, construction requires occupational safety and hygiene measures to be applied, in order to avoid accidents at work for employees and third parties (See Building Regulations, with regard to the issue and protocols issued by the Ministry of Health and the Ministry of Labor), the following points must be complied with:

• Comply with regulations and technical regulations established by the authorities on Occupational Safety and Occupational Hygiene.

• Establish an Occupational Safety and Health Program, in accordance with current legislation, adapted to the conditions of the site where the work will take place. This program should be known to Project workers.

• Define the guidelines and safety measures that workers will have to apply for their personal safety, such as to prevent and prevent the fall of objects, and thereby affect people or things that are at lower levels.

• Place the Hazardous Products Use Manual in the appropriate warehouses to ensure their availability to employees.

• Provide employees with initial training and ongoing health and safety training.

• Create policies for the use of personal protective equipment (PPE), and train staff in the correct use of this equipment.

• Place fire extinguishers and portable first aid kits on the site, where they can be located immediately in an emergency and are protected, they can be material warehouses, office, camps, temporary workshops which are will keep you in operable condition.

• Place a label with the phone numbers of the relief bodies in a visible place.

• Design and implement a luminosity for both the construction and the final work, in which the minimum affectation of the wildlife that exists in the immediate environment of the project area is generated.

• Label basic services in order to have a reference that allows for rapid identification and access in case of technical or environmental inspection.

• Place water or hydrant pumps for use in the event of fire emergencies.

• Perform basic technical studies, both in the field, and in related institutions in order to establish whether some services already exist for the Project area so that they are not affected by the construction of the works in the Project.

• Plan and implement environmental measures that reduce the risk condition when services must traverse environmentally fragile areas.

• Establish a lighting system that favors the development of activities and does not cause inconvenience to neighbors.

• Carry out construction work in compliance with the limits established for nighttime (see Decree No. 78718-S).

• Dispose of solid waste collection containers, which must be properly

Labeled. To the extent possible, the classification of waste shall be promoted in order to promote its reuse, recycling and its differential handling and disposition depending on its nature and degree of danger.

• Avoid, as much as possible, the disposal of waste in areas surrounding the work in order to prevent its affectation and damage. In the event of accidents or unplanned incidents causing impacts in these areas, they should be cleaned and restored immediately.

• Strictly delimit work areas and plant cover areas that will remain intact in such a way that these limits are respected, and unnecessary alterations and impacts are not generated.

• Prevent the disposal of solid waste in plant cover areas.

• Avoid the extraction of species from these green areas, on the contrary they will ensure their protection and shelter.

• Perform the necessary cleaning and maintenance tasks.

• Sow new native species in the area. Exotic species should not be introduced in order to preserve the biological quality of natural biotopes.

• Label the species present in order to facilitate the recognition and understanding by the project's workers as well as the residents of the Project and third parties who visit it.

• Train construction project workers in the protection and maintenance of plant cover.

• Transport debris to sites previously authorized on the building permit.

• Treat debris in accordance with the country's legislation on ordinary and hazardous solid waste.

• Remove debris from the area as soon as possible and take it to collection sites or final disposal sites. It is forbidden to establish collection sites in risk areas and in areas of protection of waterways and bodies.

• Avoid burning garbage.

• Store hazardous wastes separate from ordinary solid waste.

• Construction waste should be stored in separate places and labeled in wooden spaces (e.g. Forift remains, which should be disassembled and removed by metals (rod remains, nails, pieces of zinc sheets, cutter discs, saw blades, etc.).

• For this purpose the construction company must allocate a pawn or coordinate with a company that provides the service and that is devoted to that task at the end of the working day; so that the next day the PROJECT AREA that corresponds to it, is free of waste for the corresponding day, this will ensure an environment of order and constant cleanliness.

• Household waste will be deposited in bags to be collected by the municipal service.

• Provide the camp and the work area with sanitary huts. For this purpose, it is recommended that the developer/contractor make a contract with the company in charge of providing the service, in which they detail aspects such as cleaning frequency and final disposal of wastewater. The company providing the service must attach a copy of the operating permit issued by the Ministry of Health, for the activity it is developing, as well as a letter of consent from the company that will receive and treat the liquid waste from the huts Health.

• Define adequate maintenance and adjustment, so that the machinery meets the requirements established by the current legislation (Technical Review of Vehicles) and that in a way, the minimum environmental impact to the air, emissions and noise is guaranteed.

• Use only the equipment strictly necessary, and as efficiently as possible, in such a way that environmental impact sources are limited to the maximum.

• Wet surfaces to prevent dust clouds from rising from work areas, during periods of dry season or absence of rain in the area.

• Protect by means of plastics temporary stacks of ground debris, in order to prevent them from serving as a source of air pollution of the Project area and its area of direct influence.

• Cover the load of the wagons to avoid dust generation.

• Comply with current noise regulations (see Decree No. 78718-S).

• The builder is responsible for the prevention of forest fires on the site; activities in the PA must comply with the regulations established in this regard, by the national forest entity.

• In addition to the above, follow the following rules for forest fire prevention:

1. Notify the authority responsible for the protection of the wooded area, in the event that the Project is located an area adjoining a protected area or significant forest cover, where the work is carried out.

2. Do not light campfires in unauthorized areas;

3. Place in all motorized or mechanized equipment used in wooded areas, a fire extinguisher in good condition

4. and according to recognized standards;

5. Place on all motors, exhaust pipes with anti-spark wall.

• Comply with the general environmental measures established on the subject of natural and anthropic threats included in the Code of Good Environmental Practices published by the Ministry of Environment and Energy, as well as by those other specific guidelines that could be issued by the local or national emergency authority on the issue.

• Collaborate as much as possible with the Local or National Emergency Commission in case of an emergency situation in the vicinity of the Project area.

• All the personnel of the company responsible for the design, planning and execution of the Project must be clear about the scope of comprehensive environmental management, so that the matter is not seen as a process that is carried out before an entity and can then be forgotten. Environmental analysis and management are the very image of the company and the Project. So, the integration of the environmental issue, as an intrinsic part of the different actions that are implemented, is the means to ensure that these procedures are simplified and that they are carried out without the greatest complication.

• Under the principle of environmental responsibility each entity must comply with its due and commands the law regarding the protection of the environment and the rational management of natural resources. It is the responsibility of the citizen in general to comply with good environmental management, with more reason companies or construction projects that by their nature generate significant effects on the environment.

• The Project must, as well as have managers of various areas of the construction process, with a responsible in the subject of environmental supervision that monitors its planning, execution and control.

• Internal safety standards should be defined on and within the park, access to generators, transport, unloading and lifting of material, among others.

• Safety equipment such as: personal protective equipment (PPE), fall control equipment, safety auxiliary equipment, load lifting, signaling systems, equipment maintenance, training and training should be available hydraulics, lifts guided by towlines, lifts guided by fixed guides, zipper-guided lifts (Operation).

• Rules of use. Emergency. Evacuation system), technical means of extinguishing fires, equipment and training to provide first aid.

• The work risk policy must be fully up to date.

1.12 Type of actions that the company will carry out to provide preventive and targeted information to people who are located within the Project temporarily or eventually:

In order to inform Project staff of the actions to be taken in the event of an emergency situation, a space will be carried out in writing and a space will be taken out in the staff meetings that will be held each month, the persons responsible for providing this will be the Coordinator of the company's Emergency Committee or project manager.

In the case of informing customers/visitors about what to do in an emergency at the Project facilities, it will be achieved through the people in charge of each area where they are located.

In addition, information related to this topic will be kept on an information board near the main entrance of the administrative building.

Annex 11. Preliminary Estimate of Environmental Management Costs

Category	Annual Cost $	Responsible Parties	Monitoring	Phase
Forestry inventory and tree cutting process	Inventory 20.000 Execution 50.000	INCOFER, Concessionnaire, Environmental Regent, Forestry Regent	Weekly	Design and Construction
Waste management and collection	Plan design and update 10.000 Monitoring 50.000	INCOFER, Concessionnaire, Environmental Regent	Weekly	Construction and Operation
Wildlife crossings	Assessment and desing 50.000 (once per section) Monitoring 72.000	INCOFER, Concessionnaire, Environmental Regent	Monthly	Construction and Operation
Wildlife rescue	Plan design and update 10.000 Monitoring and rescue 50.000	INCOFER, Concessionnaire, Environmental Regent	On demand	Construction and Operation
Archaeology and cultural heritage	Inventory 30.000 (once per section) Monitoring 36.000 Rescue 40.000 (once)	INCOFER, Concessionnaire, Environmental Regent, National Museum	Weekly	Design and Construction
Water quality monitoring	60.000 (personnel, laboratory testing)	INCOFER, Concessionnaire, Environmental Regent	Monthly	Construction and Operation
Dust control	100.000	INCOFER, Concessionnaire, Environmental Regent	Daily	Construction
Mud control	75.000	INCOFER, Concessionnaire, Environmental Regent	Daily	Construction
Traffic control	30.000	INCOFER, Concessionnaire	Daily	Construction
Chemical and hazardous substance management	Plan design and update 15.000 Monitoring 72.000	INCOFER, Concessionnaire, Environmental Regent	Weekly	Construction and Operation

Liquid waste management	250.000 (equipment rental and maintenance)	INCOFER, Concessionnaire, Environmental Regent	Weekly/on demand	Construction
Community relations	Plan design and update 10.000 Monitoring 48.000	INCOFER, Concessionnaire, Environmental Regent	Monthly	Design, Construction and Operation
Noise level monitoring	50.000	INCOFER, Concessionnaire, Environmental Regent	Weekly	Construction and Operation
Forestry compensation plan	Planting and maintenance of green areas 50.000	INCOFER, Concessionnaire, Environmental Regent, Forestry Regent	Monthly	Operation
Emergency Response Plan	Plan design and update 15.000 Monitoring 48.000 Equipment 75.000	INCOFER, Concessionnaire, Environmental Regent, Emergency Brigade	Monthly	Design, Construction and Operation
Occupational Health and Safety Plan	Plan design and update 15.000 Equipment 175.000 Monitoring 72.000	INCOFER, Concessionnaire, Environmental Regent, Occupational Safety Council	Weekly	Construction and Operation
ESTIMATED TOTAL	**$9.100.000***			

***Assumptions**

- Project divided in 3 sectors
- Active construction period of 5 years
- Measures extended for 2 years during operation