

			ENVIRONMENTAL IMPACT ASSESSMENT FOR THE RUMICHACA – PASTO DIVIDED HIGHWAY PROJECT, SAN JUAN – PEDREGAL SEGMENT, CONCESSION AGREEMENT UNDER THE APP NO. 15 OF 2015	
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6 ENVIRONMENTAL ZONING

The following is an analysis of the environmental sensitivity of the physical, biotic, socioeconomic, and cultural environments for the development of the activities proposed in the Area of Influence of the Rumichaca – Pasto Divided Highway Project, San Juan – Pedregal Segment. This zoning exercise analyses the physical, biotic, socioeconomic, and cultural aspects of the zone of study, which are interpreted sequentially starting with the first step to assign values to the variables, to then determine the susceptibility of the environmental units according to the environmental impacts identified in Chapter 8 Environmental Assessment of this EIA. This is to meet the requirements defined in the terms of reference for preparing Environmental Impact Assessments – EIA, for highway and/or tunnel construction projects M-M-INA-04 (ANLA, 2015), adopted by means of Resolution No. 0751 on March 26, 2015 by the Ministry of the Environment and Sustainable Development (MADS for the Spanish acronym).

The environmental zoning was obtained starting with a synthesis of the diagnosis of the baseline for the study, based on the environmental description and characterization of the area, and an overall look at the conditions of the ecosystems and natural resources found in the zone. It consists of overlaying thematic maps obtained from the environmental characterization, analyzing each component separately to subsequently categorize and prioritize those factors that determine the sensitivity of a place. Said zoning determines the degree of environmental sensitivity of each of the ecosystems in a determined area, in response to the impacts generated by the different activities proposed in the project's area of influence.

The result of the environmental zoning, together with the project's environmental evaluation, is the basis for establishing the Environmental Management Zoning for the activities to be undertaken in the area of influence of the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment, described in Chapter 9, which presents the areas where intervention is prohibited, restricted, or permitted.

Environmental zoning is determined based on a geographic information system fed by the data produced by the qualitative and quantitative analysis of prioritized variables in the physical, biotic, socioeconomic, and cultural zoning, and the areas of dominant or special sensitivity. This is used to establish the different categories for environmental sensitivity for the project.

The scoring for the variables uses a range from 1 to 4 points, based on which the basic sensitivity is defined of the areas in the area of influence, with categories that vary from Low to Very High Sensitivity.

A weighted overlay was done for thematic maps obtained from the environmental characterization, analyzing and assessing each component separately to subsequently categorize the areas according to their environmental sensitivity. The following aspects and criteria were taken into account, among others, to determine environmental importance:

- Areas with special environmental significance such as protected natural areas, sensitive ecosystems, buffer areas around bodies of water, biological corridors, zones with endemic or threatened (vulnerable, endangered, and/or critically endangered) species, areas of importance for breeding, reproduction, feeding, and nesting, and wildlife corridors and flyways for migratory species.
- Areas in environmental recovery such as eroded areas, or places where there is conflict over land use.

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- Areas that are threatened or at risk, such as landslide areas.
- Economic production areas, such as ranches, farms, mines, or others.
- Areas with social importance, such as human settlements, with physical or social infrastructure, or of historical or cultural importance.

6.1 ZONING FOR THE ABIOTIC ENVIRONMENT

To determine environmental sensitivity from an abiotic point of view, there are multiple variables. In the case of this EIA, four (4) variables considered to be of great importance (**Figure 6.1**) were integrated spatially. They are: General stability of the terrain (represented by the geotechnical zoning), potential land use, degree of the slope, and hydrogeology (intrinsic vulnerability using the DRASTIC method. These were determined previously in **Chapter 5. Characterization of the Area of Influence**. Those variables can be materialized based on a characterization of aspects related to geology, geomorphology, edaphology, slope, local climate, and a hydrogeological characterization specific to the region under study, as presented in the following table:

Figure 6. 1 Variables established for zoning the abiotic component.



Source: GEOCOL CONSULTORES S.A., 2017.

6.1.1 General Stability of the Terrain

The regional geotechnical behavior of the area has a direct relationship with the dominant type of soils and rocks in the region, due to the geomechanical characteristics of rocks, deposits, and soils, and a greater or lesser degree of meteorization of the rock mass.

The scoring for the stability variable took into account the geological and geo-morphological units that affect the stability of an area to a great degree. In general, the geotechnical zoning was obtained based on a susceptibility analysis relative to the occurrence of mass wasting processes, defining five geotechnically homogeneous areas, and assigning a qualifier to the degree of stability (**Table 6.1**).

Table 6. 1 Score and Characterization of the General Stability of the Terrain

Geotechnical Zone	Degree of stability	Main characteristics	Qualifier for Sensitivity by variable	Numeric score
I	Very low	Rocky materials, steep slopes, and presence of intense morphodynamic processes	VERY HIGH	4
II	Low	Moderate slopes, soft soils, and presence of moderate to intense morphodynamic processes	HIGH	3

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Geotechnical Zone	Degree of stability	Main characteristics	Qualifier for Sensitivity by variable	Numeric score
III	Medium	Competent soils, moderate slopes, and presence of low intensity morphodynamic processes	MEDIUM	2
IV	High and Very High	Competent materials and volcanic ash, shallow slopes, presence of scattered and pinpoint morphodynamic processes, or the absence of morphodynamic processes, and high values for shear strength	LOW	1

Source: GEOCOL CONSULTORES S.A., 2017.

6.1.2 Potential Land Use

The potential land use in the area of influence was determined according to the opinion in Manual 210 of the US Soil Conservation Service (Klingebiel and Montgomery, 1961), updated in 2010 by the IGAC. That manual determines that the classification is provided by classes and subclasses, which increase in numeric value as the limitations increase. For this EIA, sensitivity is presented with the qualifiers Low, Medium, or Very High (Table 6.2) for the land-use units in the area of influence.

Table 6. 2 Value and Score for Potential Land-use in the Area of Influence.

Soil classification	Mapping Unit	Limits on use	Potential Use	Type of Use	Qualifier for Sensitivity by variable	Numeric score
IIIsc	ARBb, ARBc	Scant rains with poor distribution, and moderate effective soil depth.	Plantain, corn, pineapple, fruit trees, critic trees and drought-resistant grasses.	Intensive annual crops (CTI for the Spanish)	LOW	1
IIIc	AMAc	Limited by periodic freezes, some soils have low moisture retention, and moderate effective depth.	Wheat, barley, potatoes, peas, corn, carrots, barley, and wheat. Can also be used with cattle ranching with improved grasses.	Intensive annual crops (CTI for the Spanish)	LOW	1
IIIt	ALBc, ALDd	Steep slopes and susceptibility to erosion are the main limitations on the use of these lands.	Potatoes, vegetables, onions, broad beans, peas, banana passionfruit, blackberry and introduced grasses.	Intensive annual crops (CTI for the Spanish)	LOW	1
IVts	MLEd	Moderately rugged relief, susceptibility to erosion, moderate effective depth of the soil, high saturation of aluminum and low fertility in the soils.	Potatoes, vegetables, onions, broad beans, peas, banana passionfruit, blackberry and introduced grasses.	Semi-intensive annual crops (CTS for the Spanish)	MEDIUM	2
VIIIc	ARCF2, , AMEd2,	Very rugged relief, little effective depth, high saturation of aluminum,	Preservation and conservation of protective-	Areas for conservation and/or	VERY HIGH	4

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Soil classification	Mapping Unit	Limits on use	Potential Use	Type of Use	Qualifier for Sensitivity by variable	Numeric score
	AMEf2, AMEg2	highly susceptible to erosion, and low fertility.	productive natural forests and wildlife.	recovery of nature, and recreation (CRE for the Spanish)		

Source: GEOCOL CONSULTORES S.A., 2017.

6.1.3 Hydrogeology (Intrinsic Vulnerability using the DRASTIC Method).

The DRASTIC method classifies and weights intrinsic parameters that reflect the natural conditions of the environment. It is the most widely used to determine the vulnerability of groundwater. In **Table 6.3**, the DRASTIC ranges are grouped together as used in item number **5.1.8.13 Analysis of Vulnerability to Groundwater Contamination**, in order to obtain the four (4) degrees of vulnerability for groundwater in the area of influence.

Table 6. 3 Vulnerability of the Groundwater in the Area of Influence by Ranges using the DRASTIC Method.

Overall Vulnerability		
Range according to DRASTIC	Degree of vulnerability of groundwater	Numeric score
23 – 105	Low	1
106 – 146	Moderate	2
147 – 187	High	3
188 – 230	Very High	4

Source: Modification by Aller et Al., 1987.

6.1.4 Slope of the Terrain

The area of influence has a topography with slopes from level to very steep, with a predominance of slopes of less than 25% (topography that is flat to strongly sloped). **Table 6.4** presents the qualifiers and scores by ranges of slopes for the area of influence. It is the result of grouping by slope ranges, as presented in item number 5.1.2.2.1 Descriptive Morphology.

Table 6. 4 Score and Qualifier by Slope Range

Range (%)	Description	Qualifier for Sensitivity by variable	Numeric score
0 – 25%	Level to strongly sloping	LOW	1
25% – 50%	Somewhat rugged or somewhat steep	MEDIUM	2
50% – 75%	Moderately rugged or moderately steep	HIGH	3

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Range (%)	Description	Qualifier for Sensitivity by variable	Numeric score
> 75%	Very rugged or very steep	VERY HIGH	4

Source: GEOCOL CONSULTORES S.A., 2017.

6.1.5 Map Overlay and Obtaining Intermediate Maps

The abiotic sensitivity map is generated by integrating the variables for geotechnical zoning (stability of the terrain), susceptibility to erosion, hydrogeology (vulnerability of groundwater), and the slope of the terrain. Its valuation of the different categories is summarized in Table 6.5.

Table 6. 5 Scoring for the Variables used in the Abiotic Sensitivity Zoning in the EIA for the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment.

Abiotic Sensitivity Zoning	
Zoning of the Stability of the Terrain	
Zones with very low stability (very high sensitivity)	4
Zones with low stability (high sensitivity)	3
Zones with medium stability (medium sensitivity)	2
Zones with high and very high stability (low sensitivity)	1
Zoning of Potential Land-use	
Zones of very high sensitivity based on potential land-use	4
Zones of medium sensitivity based on potential land-use	2
Zones of low sensitivity based on potential land-use	1
Zoning of Hydrogeological Vulnerability	
Zones with a high degree of hydrogeological vulnerability	3
Zones with a moderate degree of hydrogeological vulnerability	2
Zones with a low degree of hydrogeological vulnerability	1
Zoning of the Slope of the Terrain	
Zones with a very steep slope	4
Zones with a steep slope	3
Zones with a medium slope	2
Zones with a gentle slope	1

Source: Modified by ECOPETROL (2003).

When the 14 possible zones obtained above are finally overlaid, duly scored and geo-referenced on the respective map, the Abiotic Zoning Map is obtained. This map allows a spatial arrangement of the characteristics of stability, potential land-use, degree of the slope of the terrain, and hydrogeological vulnerability of a determined area of interest.

Table 6.6 presents the score ranges for environmental sensitivity for physical zoning, based on adding up the scores for the four (4) variables.

Table 6. 6 Score Ranges for Environmental Sensitivity from the point of view of Abiotic Zoning.

Abiotic zoning (environmental sensitivity)	Range
Very High	13 - 16
High	9 - 12
Moderate	5 - 8
Low	1 - 4

Source: GEOCOL CONSULTORES S.A., 2017.

6.1.6 Results of the Environmental Zoning of the Abiotic Environment

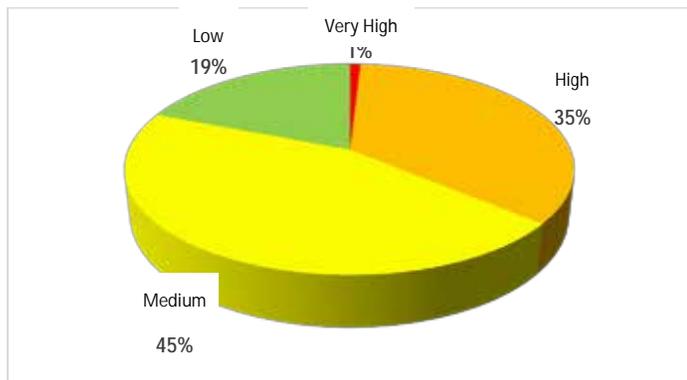
The abiotic zoning was obtained for the area by adding together the four (4) mentioned variables. Those results are presented in **Table 6.7** and **Figure 6.2** Zoning Map for the Abiotic Component (also see **Map Appendix, Map No. 29 Zoning of the Abiotic Component**). **Figure 6.3** presents the distribution of percentages for the different categories of sensitivity of the abiotic component.

Table 6. 7 Summary of Abiotic Zoning for the Area of Influence and the Area of Intervention of the EIA for the Rumichaca – Pasto Duel Carriageway Project, San Juan - Pedregal Segment.

Abiotic Sensitivity	Area of influence		Area of Intervention	
	AREA (HA)	%	AREA (HA)	%
Very High	36,68	0,91	20,89	1,28
High	1422,03	35,20	604,96	37,13
Moderate	1812,06	44,85	621,88	38,17
Low	769,56	19,05	381,51	23,42
TOTAL	4040,33	100,00	1629,23	100,00

Source: GEOCOL CONSULTORES S.A., 2017.

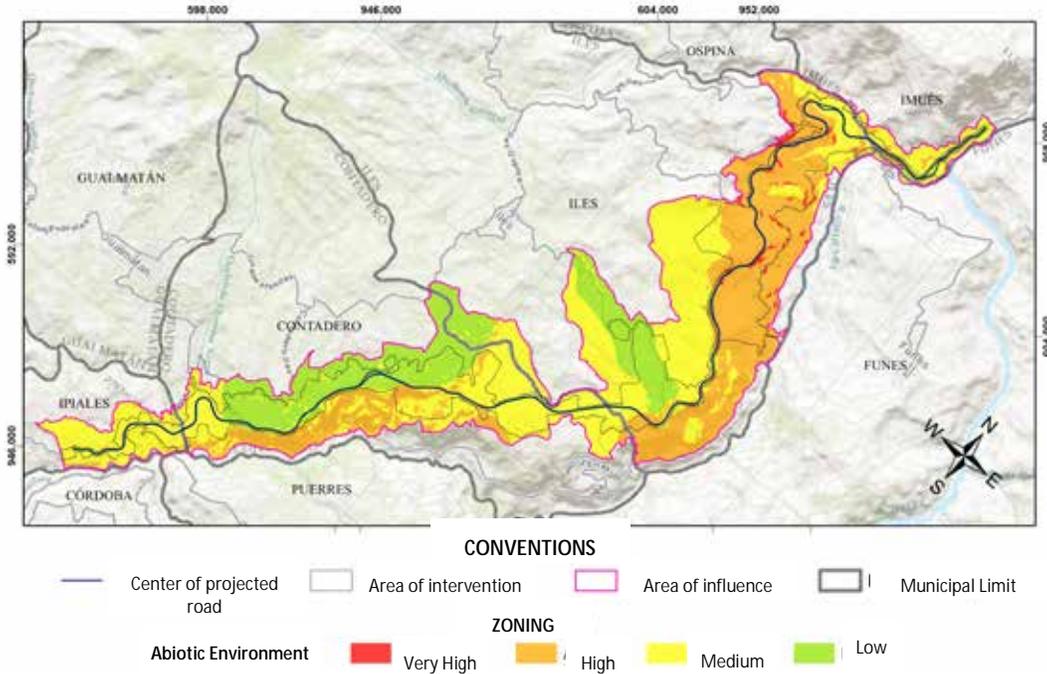
Figure 6. 2 Percentages of Sensitivity Categories for the Abiotic Component for the Area of Influence of the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment.



Source: GEOCOL CONSULTORES S.A., 2017.

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Figure 6. 3 Abiotic Zoning Map for the Area of Influence of the Rumichaca – Pasto Duel Carriageway Project, San Juan - Pedregal Segment.



Source: GEOCOL CONSULTORES S.A., 2017.

The very high sensitivity category (0.91% of the area of influence) is found in areas for conserving and/or recovering nature, mainly with very steep topography (>75%), with groundwater whose vulnerability is from low to moderate, and that belongs to geotechnical zone I (made up of rocky materials, with the presence of intense morphodynamic processes).

The High sensitivity category (35.20% of the area of influence), corresponds to geotechnical zones II and III, mainly with a predominantly low vulnerability of the groundwater, with variable slopes and made up mainly of areas for conserving and/or recovering nature.

The Moderate sensitivity category (44.85% of the area of influence) is made up mainly of geotechnical zone III (competent soils with the presence of low intensity morphodynamic processes), whose groundwater has a low vulnerability, whose terrain is level to strongly sloped, and has intensive to semi-intensive annual crops.

The Low sensitivity category (19.05% of the area of influence), is made up of geotechnical zone IV (competent materials and volcanic ash, with the presence of scattered or pinpoint morphodynamic processes, or the absence of the same, and high values for shear strength), whose groundwater has a low vulnerability, whose slopes are less than 25%, and have predominantly intensive annual crops.

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6.2 ZONING FOR THE BIOTIC ENVIRONMENT

The type of land cover predominant in a specific region in great measure is an expression of the characteristics and the processes that have occurred due to interaction between the weather, geology, geomorphology, and the availability of water, forming an ecological unit (or ecosystem) that can be organized either by zones or not using zones. In addition, the land cover units in an area are the result of alterations, changes, and modifications in the structure of ecosystems, due to different activities, such as the expansion of the frontier for agriculture and livestock to satisfy basic needs of the community, or the development of industrial activities, which causes a loss of biodiversity, both plants and animals, and an alteration in the food chains, ecological processes, and the provision of ecosystem services.

Because of this, *land cover and associated wildlife* were the variables selected for environmental zoning from a biotic point of view (Figure 6.4). Said variable was considered in accordance with its relevance and contribution to the particular conditions of the area of study, the type of study that will be done, and the criteria of the specialists who participated in the assessment.

Bearing in mind the parameters defined in the methodology and the land cover units identified in the characterization of land ecosystems, each of the areas was scored based on the perception of ecological importance on the part of the forestry and biology professionals, secondary information, and all the field data collected and analyzed in the corresponding chapters in this study.

The land cover units in the area of influence of the Rumichaca – Pasto Dual Carriageway Project, San Juan - Pedregal Segment, have been produced through the use and transformation of the structure of ecosystems. Said alterations have been caused mainly by agriculture and livestock activities, which have caused an alteration in the diversity of plants and wildlife, and in the ecological processes that occur in terrestrial and aquatic ecosystems. The current zoning identifies the ecosystems present in the area of study, with those prevailing that have greater environmental significance, the associated wildlife, and the goods and services that said ecosystems provide.

Figure 6. 4 Variables established for Biotic Zoning.



Source: GEOCOL CONSULTORES S.A., 2017.

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The environmental sensitivity and importance of the land cover and the wildlife of greater significance (endemic and threatened) was determined taking into account the intrinsic capacity of each type of land cover that makes it more or less susceptible to being changed or modified in its structure and/or functioning through external actions or conditions. Land cover is more sensitive that can be altered by minor intervention or modification, and has greater difficulty recovering or returning to its original conditions. In addition, this variable considered the environmental importance of the land cover in reference to its capacity to offer or provide goods or services to the surroundings, such as providing habitat for sensitive species of wildlife and native plants, hydric regulation, soil protection, conservation of the landscape, and others.

6.1.1 Valuation of Biotic Sensitivity

The identification and delimitation of land cover for the area of influence of the Highway Project, San Juan – Pedregal Segment, took place using the CORINE Land Cover methodology adopted for Colombia by the Hydrology, Weather, and Environmental Studies Institute (IDEAM) and the Ministry of the Environment, Housing, and Regional Development (MAVDT), currently the Ministry of the Environment and Sustainable Development (MADS), in such a way that homogeneous areas were defined in biotic terms that have affinity in terms of structural and functional features. The characterization and description of the land cover identified and verified in the field for the project are found in **Chapter 5** item number **5.2.1.1 Terrestrial Ecosystems** in this Environmental Impact Assessment.

The categories of sensitivity/importance are presented for the biotic environment, briefly describing the areas and percentages and the aspects that contribute to the final valuation in each one of the zones that forms a part of the biotic area of influence. It shows the land cover with the greatest incidence and representivity for the biotic environment in the study area. The determination of the sensitivity and environmental importance of each type of land cover will be established according to what is shown in **Table 6.8**, and the description and values adopted are found in **Table 6.9**.

Table 6. 8 Quantitative and Qualitative Scale for the Environmental Sensitivity and Importance of Land Cover and the Fauna

Qualifier for Sensitivity by variable		Description
Numeric	Qualitative	
4	VERY HIGH	Corresponds to land cover that is very susceptible to being drastically altered or modified in structure and/or functioning by relatively minor external actions or conditions. They are very intolerant to disturbances, with a very low or no capacity for recovery in the long-term. This land cover has a very high capacity to generate a supply of environmental goods or services to the surroundings (habitat for species of wildlife and native plants, hydric regulator, protector of soils, conservation of the landscape, etc.). Given their degree of conservation, in response to any alteration they can lose their capacity to provide goods and services in the short term.
3	HIGH	Corresponds to land cover susceptible to being altered or modified in structure and/or functioning by relatively minor external actions or conditions. They are intolerant to disturbances, and have a low capacity for recovery in the long-term. This land cover has a low degree of intervention and therefore a high capacity to generate and supply environmental goods or services to the community and to the surroundings (habitat for species of wildlife and native plants, hydric regulator, protector of soils, conservation of the landscape, among other services). Any external alteration can cause them to lose their capacity to provide goods and services in the medium term.

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Qualifier for Sensitivity by variable		Description
Numeric	Qualitative	
2	MEDIUM	Land cover that is moderately susceptible to being altered or modified in structure and/or functioning by relatively minor external actions or conditions. They are moderately tolerant to disturbances and have the capacity to recover in the midterm, through the adoption of management measures. This type of cover has a moderate degree of intervention, which produces a moderate capacity to generate a supply of goods and services to the community and to the surroundings (habitat for species of wildlife and native plants, hydric regulator, protector of soils, conservation of the landscape, and other services). In response to relatively significant alterations they lose part of their capacity to generate and supply services in the medium run.
1	LOW	Land cover that is not very susceptible to being altered or modified in structure and/or functioning by relatively strong external actions or conditions. They are tolerant to disturbances and have a good capacity for recovery in the short and medium run in a natural way. They represent altered or very altered land cover with a low capacity to generate and supply environmental goods or services to the community or the surroundings (habitat for species of wildlife and native plants, hydric regulator, protector of soils, conservation of landscape, etc.). Therefore in response to severe alterations, its capacity is not altered to supply goods and services in the short term. In response to very severe alterations there is no variation in its potential to provide services.

Source: GEOCOL CONSULTORES S.A., 2017.

The land cover units and the sensitive wildlife present in the area of influence of the Rumichaca - Pasto Dual Carriageway Project, San Juan - Pedregal Segment, have been produced by the use and transformation of the structure of the ecosystems. Those alterations have been caused mainly by agricultural activities, which has produced alterations in the diversity of wildlife and plants, and by the ecological processes that occur in terrestrial and aquatic ecosystems. After analyzing the functionality of each type of land cover and the sensitive wildlife, categories were established according to the environmental importance of each one. The description and specialization can be seen in **Figure 6.5** and **Table 6.9**, respectively.

Table 6. 9 Environmental Sensitivity of Land Cover and Wildlife identified in the AI of the Highway Project, San Juan – Pedregal Segment.

Land Cover	Environmental Sensitivity	Description
ARTIFICIAL TERRITORIES: Continuous and discontinuous urban fabric; roadway network and associated territories; use of construction materials	LOW	This category includes areas without vegetation that are generally related to the direct impact of man and to areas with scant or no presence of vegetation coming from natural processes. Urban fabric is made up of buildings, roads, and infrastructure that form a part of urban areas in each municipality, plus the peripheral areas that are being incorporated into the city, that are continuously present, or that cover the territory in a scattered and discontinuous manner. The roadway network and associated territories do not constitute a type of land cover that can be altered or modified from biotic point of view, for which reason their environmental sensitivity is very low. Relative to the ecosystem services they can provide, despite providing the physical support for the movement of communities and the exchange of goods and services, commercial and cultural and other types of relations, it

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Land Cover	Environmental Sensitivity	Description
		<p>does not provide additional services in terms of supply, regulation, or support, and is considered to be of very low importance.</p> <p>This type of land cover is made up of species with wide distribution that are generalists in terms of their habits. Diversity is low because there are few habitats that provide optimum resources for the species. The constant presence of anthropogenic activities makes it hard for wildlife to get established. In addition, species are established that have adapted to living with man or that pass through temporarily to move toward other habitats. The dominant group in these areas are birds from the Columbidae and Psittacines orders.</p>
Pasture	LOW	<p>This type of land cover is represented by areas in which management activities have taken place (clearing, fertilization, planting), and is located in zones where there have been annual plantings that have been left fallow in order to, after a time, use them again in some type of cultivation. Since this is a coverage produced by human intervention, it has very good capacity for recovery in the short term.</p> <p>This type of land cover is related mainly to provisioning services, either because they have crops, or grass, or are being rotated and/or left fallow, and are important for the economic support of the communities as part of their livelihood and subsistence. However, apart from said provisioning service, this land cover does not provide regulating or supporting services, and it is therefore considered of low importance.</p> <p>It is associated with a low diversity of wildlife, predominantly species that are tolerant to anthropogenic intervention. It represents a habitat that is not well adapted as a refuge for species and has a low availability of resources.</p> <p>It is constituted of species with a wide distribution, that have generalist habits and are present in great abundance. The constant presence of anthropogenic activities such as preparing the land for crops makes it hard for wildlife to get established.</p>
Mosaic of crops and mosaic of pasture and crops	LOW	<p>Mosaics of grasses and crops are the most common land cover unit in the area of study. In the mosaic of crops, different fast-growing species are planted, including onion, peas, potatoes, corn, and tree tomatoes, among others. They are tolerant to disturbances and have a good capacity for recovery in the short run.</p> <p>In terms of services, this land cover represents one of the activities with the greatest relevance for the subsistence and livelihood of communities, because it provides the physical support for the establishment of productive self-consumption systems, bartering, or local trade. It is also worth mentioning that there are native varieties and species among those same crops, providing complementary food sources for wildlife and a place for them to sleep.</p> <p>There is a low diversity, however, of wildlife. Most are generalist species that are attracted by some resources produced sporadically. The constant presence of people scares off determined species that have a greater degree of restriction, and the ones that proliferate are more generalist and associated with man, such as foxes or doves. The lack of structural</p>

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Land Cover	Environmental Sensitivity	Description
		complexity generates a low supply of food resources and micro-habitats. Among the species present, the dominant group is birds, some of which are: the crested bobwhite (<i>Colinus cristatus</i>), the band-tailed pigeon (<i>Patagioenas fasciata</i>), the white-tipped Dove (<i>Leptotila verreauxi</i>), the eared Dove (<i>Zenaida auriculata</i>), the great thrush (<i>Turdus fuscater</i>), the tropical mockingbird (<i>Mimus gilvus</i>) and the black flowerpiercer (<i>Diglossa humeralis</i>); mammals include species such as the Armadillo (<i>Dasyopus novemcinctus</i>), the long-tailed weasel (<i>Mustela frenata</i>) and the red-tailed squirrel (<i>Sciurus granatensis</i>).
Forest Plantation	MEDIUM	<p>These are forest plantations with conifers such as cypress trees and <i>Pinus patula</i> and latifolias such as the eucalyptus. These plantations are established as protective reforestation and are found throughout the area of study. Considering that there are individuals that are tree size that can provide environmental services and can be affected by any alteration, the environmental sensitivity is medium, with a good recovery capacity in the short term. This land cover helps retain the earth in areas with slopes, helping prevent erosion and retaining water.</p> <p>This land cover corresponds to one of the main sources of ecosystem services in terms of provisioning, since the forest products are used as raw material for construction activities, as firewood, and for other domestic uses. The regulating services are also relevant as they relate to climate regulation and air quality.</p> <p>The diversity of fauna is from medium to low due to the fact that a single species predominates in each plantation, which takes away from the structural complexity and generates a moderate supply of food resources, with the potential as a refuge habitat for some species predominating. This land cover is used by the wildlife that lives there as a corridor for moving towards zones with better environmental conditions. They can also come to be a place of refuge for birds, mammals, and highly mobile reptiles.</p>
Low secondary vegetation	HIGH	<p>The low secondary vegetation in the area of study is characterized by having shrubs and grasses with a short cycle, with the occasional presence of trees. This land cover corresponds to the initial stages of succession after the deforestation of forests.</p> <p>It has a high diversity of wildlife, having a complex composition of plants that generates varied micro-habitats for multiple species. They constitute links in mobility corridors for species of wildlife. Sensitive wildlife include threatened and/or endemic species such as: the Rana marsupial de la Cocha frog <i>Gastrotheca espeletia</i> (EN and almost endemic) and the frog <i>Gastrotheca orophylax</i>, the lizards <i>Riama simotera</i> and <i>Pholidobolus montium</i> (NT and almost endemic), the fox <i>Cerdocyon thous</i>, the birds known as the Western Emerald Hummingbird <i>Chlorostilbon melanorhynchus</i>, the scrub Tanager <i>Tangara vitriolina</i>, the roadside Hawk <i>Rupornis magnirostris</i> and the tyrian metaltail Hummingbird <i>Metallura tyrianthina</i>.</p>

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Land Cover	Environmental Sensitivity	Description
Open rocky grassland	VERY HIGH	<p>This land cover corresponds to an area dominated by natural grass-type vegetation (<i>Epidendrum</i> sp.1- Guamilche, <i>Pterocaulon virgatum</i> – Frailejón and <i>Monnina aestuans</i> - Uvilán), that grow on rocky and gravelly substrates, with the presence of a wide variety of epiphytes, such as <i>Parmotrema andinum</i>, <i>Heterodermia</i> sp., <i>Lobariella pallida</i>, <i>Bryum</i> sp., <i>Plagiochila adianthoides</i>, <i>Bryum billarderi</i>, <i>Frullania ericoides</i> and <i>Bryum</i> sp..</p> <p>Open rocky grassland is a natural land cover, and is not very common in the area of study, which increases its sensitivity, it being considered to have very high environmental importance. Because it is a habitat with very particular conditions, it does not host a great diversity of wildlife, but it does provide refuge and food supply for some specific species of fauna, including, just as in forests, species that are threatened or endemic, such as: <i>Anolis heterodermus</i> (Flat Andes Anole), <i>Stenocercus angel</i> (lizard), <i>Stenocercus guentheri</i> (lizard), <i>Riama simotera</i> (lizard), and <i>Lesbia nuna</i> (the green-tailed trainbearer).</p>
Dense High Andes Forest and Riparian Forest	VERY HIGH	<p>The dense high Andean forest in the study area is represented by small isolated fragments that are not interconnected and have plant species of great ecological importance (<i>Styrax</i> sp. - Storax-, <i>Cestrum buxifolium</i> –tinto- and <i>Aegiphila odontophylla</i> –cedrillo-). The riparian forests correspond to land cover consisting of trees located on the banks of permanent or temporary water courses (e.g. <i>Weinmannia cochensis</i> -encenillo-, <i>Lafoesia acuminata</i> -guayacán).</p> <p>In the project's area of influence, this land cover is very intervened due to nearness to urban areas and it is not very common. It is therefore considered to have a very high environmental sensitivity and importance.</p> <p>This land cover is one of the most important sources for ecosystem services for the area of influence, because these areas provide supporting and regulating services such as regulation of water, the climate, and air quality, the retention and purification of soils, flood control, supply and maintenance of habitat, and cultural services related to enjoying the beauty of the landscape and the presence of sites of historical and cultural interest located there.</p> <p>In addition, a few patches were identified of forest land cover found in the Lower montane dry forest (bs-MB) life zone, which puts priority on the importance of the land cover in the area of study, with it being understood that dry forest is one of the most degraded and threatened ecosystems across the nation.</p> <p>It had the greatest diversity of wildlife, also putting in evidence a complex composition and structure of plants that generates varied micro-habitats for multiple species. It was also the main corridor for the mobility of wildlife, and the concentration of animals is due to the fact that it is a unique habitat with the best supply of resources in the zone. Within the composition there are several threatened and endemic animals such as the frogs <i>Pristimantis buckleyi</i> (Rana de lluvia), <i>Pristimantis curtipes</i> (Rana de lluvia), <i>Pristimantis leoni</i> (Rana de lluvia), <i>Gastrotheca argenteovirens</i> (Rana marsupial), and <i>Gastrotheca espeletia</i> (Rana marsupial de la Cocha), and the lizards <i>Pholidobolus montium</i>, <i>Riama simotera</i>, <i>Stenocercus angel</i>, and <i>Stenocercus guentheri</i>. There are also <i>Colibri coruscans</i> (sparkling violetear), <i>Metallura tyrianthina</i> (<i>Tyrian metaltail</i>), <i>Eriocnemis derbyi</i> (Black-thighed puffleg),</p>

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Land Cover	Environmental Sensitivity	Description
		<i>Patagioenas fasciata</i> (band-tailed pigeon), <i>Setophaga fusca</i> (Blackburnian warbler) and <i>Leopardus pajeros</i> (Pampas cat).
High secondary vegetation	VERY HIGH	<p>This land cover is characterized by being tree-like vegetation with an irregular canopy due to its intermediate stage of succession, with the presence of some bush-type specimens, lianas and vines. This class generally arises after the stage of low secondary vegetation, which in turn develops after deforestation processes in forests.</p> <p>The areas with this land cover are sensitive to disturbances and have capacity for recovery in the long-term, for which reason, management measures must be adopted.</p> <p>This land cover has very high importance because it hosts numerous provisioning services (wood and firewood), regulating services (water, climate, soil retention, and flood control), supporting services (habitat maintenance), and cultural services (beauty of the landscape).</p> <p>It has a high diversity of wildlife, having a structure and composition of plants that favors the presence of varied micro-habitats for multiple species. This is the land cover that gives continuity to wildlife corridors in the area of study. There are some threatened animals included in this composition, such as the Rana marsupial de la Cocha <i>Gastrotheca espeletia</i> (EN and almost endemic), the lizards <i>Riama simotera</i> and <i>Pholidobolus montium</i> (NT and almost endemic), the Andean fox <i>Lycalopex culpaeus</i>, the Pampas cat <i>Leopardus pajeros</i>, the birds known as the Western Emerald Hummingbird <i>Chlorostilbon melanorhynchus</i>, the Scrub Tanager <i>Tangara vitriolina</i>, the roadside hawk <i>Rupornis magnirostris</i> and the Tyrian metaltail hummingbird <i>Metallura tyrianthina</i>.</p>
Rivers (50m)	VERY HIGH	<p>The Guaitara River is in the biotic area of influence of the Highway project, which is part of the great basin of the Patia River. This basin has an area of 17.9 ha (0.45% of the area of intervention).</p> <p>This land cover is a very important source of ecosystem services for the project's area of influence, because it has relevance for provisioning, regulating water and climate, the supply and maintenance of habitat, and the cultural services related to enjoying the beauty of the landscape and the use of sites for recreation and relaxation.</p> <p>Its diversity is low in comparison with other land covers, but its biological importance comes from the fact that it provides habitats for species associated with water resources (e.g. <i>Caenolestes fuliginosus</i> (dusky caenolestid), <i>Basiliscus galeritus</i> (Western basilisk), <i>Merganetta armata</i> (Torrent duck), <i>Actitis macularius</i> (Spotted sandpiper), <i>Sayornis nigricans</i> (Black phoebe), <i>Cinclus leucocephalus</i> (White-capped dipper), <i>Zonotrichia capensis</i> (Rufous-collared sparrow) and <i>Setophaga fusca</i> (Blackburnian warbler)); it is also the support for certain animals as a source of continuous hydration in dry periods. The associated vegetation provides different types of micro-habitats and specific associated wildlife. These are important areas for the concentration and reproduction of amphibians, birds, mammals, and aquatic reptiles. They are the main corridor for the movement of species. Their channels generally contain vegetation that serves as a bridge for connecting isolated areas.</p>

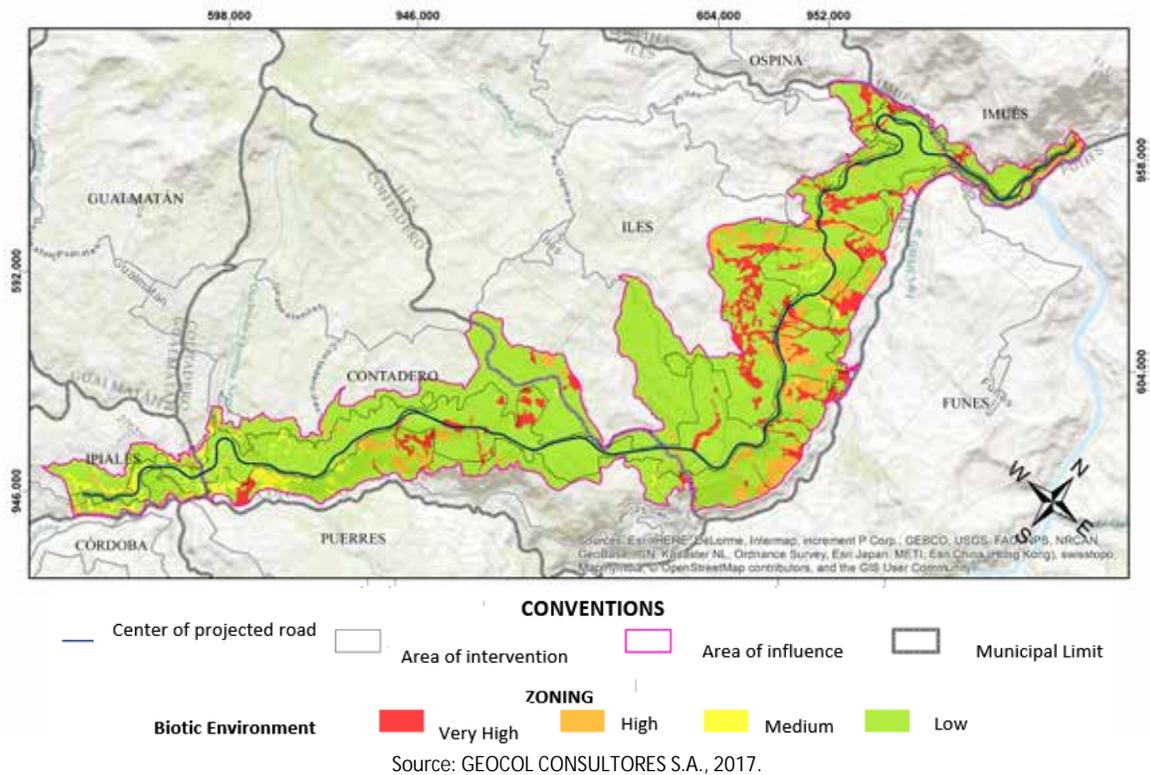
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Source: GEOCOL CONSULTORES S.A., 2017.

6.2.1 Results of Biotic Zoning

The resulting map of the environmental sensitivity of land covers and sensitive wildlife is the biotic zoning map. It provides information on the sensitive and important areas, from a biotic point of view, located in the area of influence defined for the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment (see Figure 6.5 and Map Attachment, Map No. 28 Biotic Environment Zoning).

Figure 6. 5 Biotic Zoning Map for the Area of Influence of the Rumichaca – Pasto Dual Carriageway Project, San Juan - Pedregal Segment.



Taking into account the valuation of the land cover units identified in the area of influence for the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment, percentages and zones were established for each category of sensitivity, thereby determining the zoning for the biotic environment as shown in Table 6.10. It was found that in the area of study there is a predominance of areas with LOW sensitivity, constituting 80.2% of the area of influence and 83.5% of the area of intervention. These values are attributed to the dominance of land cover such as Mosaic of crops and Mosaic of grasses and crops, which are the largest areas. This is followed by areas with VERY HIGH sensitivity, constituting 8.7% of the area of influence, and then areas

with HIGH sensitivity, constituting 7.2% of the area of intervention. These percentages are the result of the presence of natural land cover such as dense forests and riparian forests, which are key elements for maintaining the diversity in the region (Table 6.10; Figure 6.6).

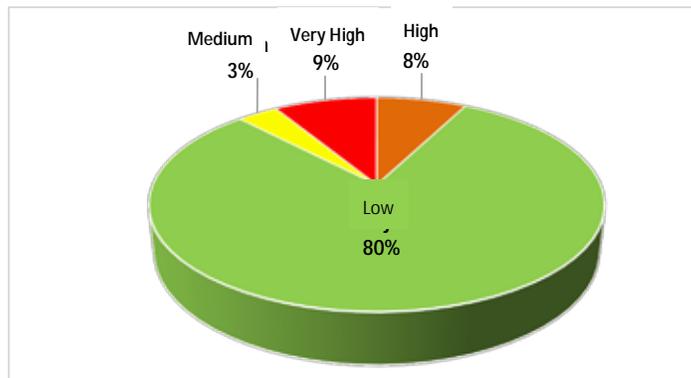
Table 6. 10 Environmental Zoning for the Biotic Component of the Area of Influence defined for the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment.

Level of sensitivity/ importance	Area of influence		Area of Intervention	
	Area (ha)	%	Area (ha)	%
VERY HIGH	353.2	8.7	105.2	6.5
HIGH	308.4	7.6	117	7.2
MEDIUM	139.9	3.5	47.3	2.9
LOW	3239.3	80.2	1359.7	83.5
TOTAL	4040.7	100	1629.2	100

Source: GEOCOL CONSULTORES S.A., 2017.

Biotic sensitivity helps identify special ecological processes and conditions in the region, providing orientation for management activities and decision-making relative to the intervention involved in project activities. In general terms, it can be concluded that inside the area of influence defined for the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment the predominant land cover is Mosaic of crops and Mosaic of grasses and crops, which are associated with low levels of sensitivity and importance. The following describes each category of sensitivity according to the characteristics defined for the project’s area of influence.

Figure 6. 6 Percentages for Sensitivity Categories for the Biotic Component for the Area of Influence of the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment.



Source: GEOCOL CONSULTORES S.A., 2017.

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6.3 ZONING OF THE SOCIOECONOMIC AND CULTURAL ENVIRONMENT

The environmental zoning of the socioeconomic environment refers to the regional expression of different social processes and characteristics of the communities that at a given time live in or have an influence in an area or region. This is illustrated on a map. For that reason, the zoning of the socioeconomic and cultural environment of the area of influence presents and divides into sectors the intrinsic and exogenous characteristics that indicate the degree of sensitivity for the communities that live there to any alteration or modification of their pre-existing conditions. In the same way, those elements are shown and scored that are considered to be an asset or connected with the provision of a social, environmental, economic, or cultural service.

This zoning is illustrated in each fraction of land or area of influence, taking into account not only the political and administrative divisions, but also divisions that can be differentiated using the variables to be considered.¹

In this case, the variables for division into sectors are the ones related to economic activity and spaces inhabited, community organization and arenas for participation, land distribution, presence of ethnic groups, and archaeological potential (Figure 6.7), with their respective valuations.

Figure 6. 7 Variables established for Zoning the Abiotic Environment



Source: GEOCOL CONSULTORES S.A., 2017.

6.3.1 Economic Activity

This refers to the use (utilization) that human beings make of the land and the space they inhabit. It is also related to the management and modification of the natural environment to make it a built environment (planted fields, pastures, and human settlements). Therefore, it will take into account the units of land cover and land use defined on the map, which show the different economic activities developed in each sector or district of the area of study.

The score for the economic activity was focused taking into account the sensitivity criteria for each one of the different rural districts and the importance in terms of the economic activities that take place in them. The valuation for the importance of each territorial unit defined for the zoning was determined taking into account the current specialized land use units for each one, for which a score was established as shown below:

¹ Adapted from the Guideline for preparing environmental studies, Appendix 3. Environmental Zoning in Petroleum Areas of Interest. 2015

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- **Zones of Intensive Use:** Areas with the greatest concentration of population, dedicated to homes and industrial, agricultural, or livestock production in an intensive or technical manner.
 - ü Settlement and Transportation (4)
 - ü Agriculture (semi-intensive annual crops = subsistence crops) mosaics of grasses and crops. (3)
 - ü Mining (3)
- **Zones of Semi-intensive Use:** Areas dedicated to free-range ranching.
 - ü Ranching (2)
- **Zone of Low Use:** Areas in which no significant direct economic benefit is obtained and that are not directly connected with the market.
 - ü Conservation (1)
 - ü Natural bodies of water (1)

Table 6.11 shows the different economic activities that take place in the minor territorial units. The main economic activities that take place are concentrated in the primary sector, with agriculture for self-consumption, such as yuca, citric fruits, plantain, corn, fruit trees, and for trade, such as potatoes, beans, blackberries, onion, broad beans, and peas. There is also ranching and fish farming. The production is used for self-consumption and trade in a 10-90 proportion, respectively.

Table 6. 11 Zoning of Economic Activities.

MAJOR TERRITORIAL UNIT	MINOR TERRITORIAL UNIT	ECONOMIC ACTIVITY	SENSITIVITY SCORE
Contadero	Aldea de María	Settlement and transportation	4
	El Capulí	Agriculture	3
	El Culantro	Settlement and transportation	4
	El Juncal	Agriculture	3
	El Manzano	Agriculture	3
	IP Ospina Pérez	Agriculture	3
	Iscuazan	Settlement and transportation	4
	La Providencia	Settlement and transportation	4
	Las Cuevas	Agriculture	3
	Las Delicias	Agriculture	3
	San Andrés	Agriculture	3
	San Francisco	Agriculture	3
	San José de Quisnamuez	Agriculture	3
Iles	Alto del Rey	Agriculture	3
	Capulí	Agriculture	3
	El Porvenir	Agriculture	3
	El Rosario	Agriculture	3
	La Esperanza	Agriculture	3
	Loma Alta	Agriculture	3
	Tablón Alto	Agriculture	3
	Tablón Bajo	Agriculture	3
Tamburán	Agriculture	3	

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MAJOR TERRITORIAL UNIT	MINOR TERRITORIAL UNIT	ECONOMIC ACTIVITY	SENSITIVITY SCORE
	Urbano	Agriculture	3
	Yarqui	Agriculture	3
Imués	Pilcuán La Recta	Agriculture	3
	Pilcuán Viejo	Agriculture	3
	Silamag	Agriculture	3

Source: GEOCOL CONSULTORES S.A. Baseline socioeconomic environment. 2017.

The land use in the minor territorial units of the municipality of Contadero, is concentrated in agriculture (**Photograph 6.1**); only in 4 territorial units of this municipality is the land use mainly human settlements (Aldea de María, Iscuazán, El Culantro, and La Providencia). In the El Juncal district there is mining for gravel.

Photograph 6. 1 Agricultural Sector of the Municipality of Contadero



Source: GEOCOL CONSULTORES S.A., 2017.

In the eleven districts studied in Iles, the predominant land use is defined as agriculture. The main productive activity developed in the minor territorial units of Iles is agriculture, producing mainly potatoes, onions, peas, and kidney beans. The production is of a traditional type. In addition, in the district of Capulí, there is industrial land use related to mining, extracting construction materials, and land use for the purpose of tourism. This situation is directly related to the productive activities developed in the zone.

The land use in the districts of Pilcuán La Recta and Pilcuán Viejo is concentrated in agriculture, trade, and tourism.

The land cover and land use units were redrawn and, according to the new version, new units were defined that take into account the economic activities.

6.3.2 Spatial

This refers to the degree of development or coverage of basic household utilities, education, and healthcare in the area. These factors are used to determine a weighted index of the supply of these services in the

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communities inside the area of influence. This index refers to the sectors that have different degrees of supply or coverage, and is expressed in the following levels:

- **Low (1):** Areas with less than 50% coverage of basic household utilities (water, electricity, sewage). Deficient availability of education at the primary level, and few health posts for primary care.
- **Medium (2):** Areas where between 50% and 80% of the total population are covered by basic household utilities (water, electricity, sewage). Deficient availability of education at the intermediate level, and sufficient provision in terms of health posts.
- **High (3):** Areas where more than 80% of the total population are covered by basic household utilities (water, electricity, sewage). Good provision of education at the intermediate level and good provision in terms of health posts.

In the districts in the project’s area of influence, the predominant quality of life index is LOW (1). In 21 of the 27 territorial units registered, the coverage of the main basic public and social services is not sufficient (absence of services related to human waste, water mains, solid waste products, domestic natural gas, healthcare centers, and others).

Ninety-three percent of the minor territorial units have community water mains, with coverage varying between 90 to 100%. In general, the systems are classified as good, and include water purification processes. Currently, only 15% of the territorial units have sewage systems. This situation can unleash contamination of water for human consumption, because liquid waste products, if not channeled, filter into the soil, and can contaminate groundwater. In addition, people are exposed to contagious diseases that can be produced by the lack of basic sanitation.

Seventy-six percent of the territorial units have a septic system to properly manage the wastewater produced by the different homes, but they tend to get backed up, or not fulfil their function when they are not maintained in a timely manner. Electricity has the greatest coverage in the minor territorial units, attaining 100%. The company in charge of guaranteeing the provision of the service is Centrales Eléctricas de Nariño S.A. ESP-Cedenaar-.

Educational coverage in the minor communities is 85%. Only four (4) territorial units do not have schools, and they are El Manzano, El Capulí, Las Cuevas and La Esperanza, in which case the school-aged children need to travel to nearby schools. All of the schools have a cafeteria.

In the particular case of the minor territorial units in the area of influence, only two territorial units (I.P Ospina Pérez and Pilcuán Viejo) have a healthcare Centre. The people from the remaining areas must travel to the closest healthcare centers, or turn to traditional practices to deal with any discomfort or illness. For personalized attention, they need to go to the municipality of Pasto, located at an average distance of 2 hours.

The data on quality of life was calculated using the information on services, with which a Weighted Quality of Life Index was calculated for the rural areas and towns. The Unsatisfied Basic Needs (UBN) index was also used for the same purpose, which corresponds to the percentage of people versus households over the total population versus total households that have at least one unsatisfied basic need. In Colombia, the following UBN are considered: critically overcrowded homes, with physical conditions inappropriate for human lodging, inadequate utilities, high level of economic dependence, or school-aged children that do not attend school.

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In Colombia, the population census establishes whether the homes visited have any UBN, for example: if the home is mobile, is a bridge, does not have walls, or the walls are made of fabric or recycled materials, or has an earthen floor; if there are more than three people per room, excluding the bathroom, kitchen, and garage; if they do not have a toilet or sewage system; if there are more than three people per occupied family member, and also if the head of the household has a maximum of two years education; or if there is at least one child between the ages of 6 and 12 that does not attend a formal school. Once the number of homes with UBNs is established, the percentage is determined corresponding to this total number of households.

To calculate the UBN, the characteristics of the home are assessed and it is classified as a home with or without UBNs. Once this has been done, it is assumed that all the people/households that live in the home have the unsatisfied basic needs detected in said home.

An individual or household is regularly defined as being poor if there is an UBN. If there are two or more UBN, the individual/household is considered to be living in deprivation. What is more, census results can be used to calculate not only the percentage of people/households with UBN, but also the reason why they are classified in said category. For example, the percentage of people/households can be calculated that are living in deprivation with inadequate homes, critical overcrowding, inadequate utilities, high level of economic dependence, or with school-aged children that do not attend school. Moreover, comparing the UBN index with the poverty line, an interesting classification for households can be obtained, for example: households with inertial poverty (with UBN), households with recent poverty (below the poverty line but without UBN), and households with chronic poverty (below the poverty line and with UBN).

The following is the score for each one of the project's territorial units (**Table 6.12**), according to the quality of life evaluation. The previously mentioned percentage of unsatisfied basic needs was taken into account for this purpose, along with the characterization of the spatial dimension.

Table 6. 12 Score of the Quality of Life Variable (% UBN) and Access to Public and Social Utilities Identified in the Baseline.

Major Territorial Unit	Minor Territorial Unit	% UBN	Water Supply Network	Sewage	Electricity	School	Healthcare Centre	Sensitivity Score
Contadero	Aldea de María	68.94%	X		X	X		1
	El Capulí	68.94%	X		X			1
	El Culantro	68.94%	X		X	X		1
	El Juncal	68.94%	X	X	X	X		2
	El Manzano	68.94%			X			1
	IP Ospina Pérez	68.94%	X		X	X	X	2
	Iscuazan	68.94%	X		X	X		1
	La Providencia	68.94%			X	X		1
	Las Cuevas	68.94%	X		X			1
	Las Delicias	68.94%	X		X	X		1
	San Andrés	68.94%	X		X	X		1
	San Francisco	68.94%	X		X	X		1
San José de Quisnamuez	68.94%	X		X	X		1	
Iles	Alto del Rey	66.55%	X		X	X		1
	Capulí	66.55%	X	X	X	X		2
	El Porvenir	66.55%	X	X	X	X		2
	El Rosario	66.55%	X		X	X		1

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Major Territorial Unit	Minor Territorial Unit	% UBN	Water Supply Network	Sewage	Electricity	School	Healthcare Centre	Sensitivity Score
	La Esperanza	66.55%	X		X			1
	Loma Alta	66.55%	X		X	X		1
	Tablón Alto	66.55%	X		X	X		1
	Tablón Bajo	66.55%	X		X	X		1
	Tamburán	66.55%	X		X	X		1
	Urbano	66.55%	X		X	X		1
	Yarqui	66.55%	X		X	X		1
Imués	Pilcuán La Recta	57.50%	X	X	X	X		2
	Pilcuán Viejo	57.50%	X	X	X	X	X	3
	Silamag	57.50%	X		X	X		1

Source: GEOCOL CONSULTORES S.A. Baseline socioeconomic environment. 2017. DANE, Official Census. 2005.

6.3.3 Community Organization and Arenas for Participation

Based on a perspective that focuses on the social aspects of the minor territorial unit, in other words, the rural districts and the towns, each minor territorial unit is given a weighting in accordance with the community organizations they have and their arenas for participation. Based on this, the quantity and/or diversity is determined of the community organizations and the arenas for participation established by the communities that live in said territorial units.

Based on this, it is necessary to look for the following aspects:

- **Community Action Boards:** These are considered to be the most traditional and main form of community organization, both in the rural sector and in the urban sector.
- **Other district or neighborhood community organizations.** During the characterization, the presence of other types of organizations is determined, such as Housewives Clubs, Parents Associations, Work Committees, Cooperatives and other forms of organization whose jurisdiction continues to be the rural district unit (minor territorial unit).
- **Associations of community organizations.** This unit permits verifying the presence of organizations that transcend the rural district unit (minor territorial unit) or neighborhood and, at the same time, represents associations that extend across two or more organizations of neighborhood or rural district community (minor territorial unit).

In addition, the look at arenas for participation has considered mainly three (3) arenas and/or components:

- **Community development:** This refers to the diverse actions and work done by organizations to improve infrastructure, access to utilities, and other dimensions that are included in rating quality of life.
- **Environmental Work:** This refers to the involvement of communities in processes to plan and execute environmental management plans, both those related to the activities of projects, and also those based on community or institutional initiatives.

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- **Municipal and/or regional development:** This refers to the involvement of communities in arenas for participation for planning and managing the development projects of the municipalities or of the Department.

Based on the valuation of these items, the situation is reviewed of the territorial unit under analysis, in other words for the rural district or town, giving a point for the presence of each type of organization, exercising participation in each one of the arenas defined. Once all of the variables considered are identified and recorded, the units are thus classified that have been analyzed, to thereby define the Index for Diversity of Organizations and Arenas for Community Participation, as follows:

- **Low (1):** Describes the minor territorial unit where there are no or few community organizations, and these organizations are present in one or a maximum of two arenas for participation.
- **Medium (2):** Describes the minor territorial unit where two or more community organizations are located that participate in at least two of the arenas defined.
- **High (3):** Describes the minor territorial unit where there is a broad diversity of social organizations, including those that represent associations of those organizations, and that are involved or participate in the three arenas for participation defined.

In all the minor territorial units of the project, Community Action Boards are constituted, recognized according to Law 743/5 June 2002. Community action is a joint and organized social expression of civil society whose purpose is to promote comprehensive, sustainable, and supportable development based on the exercise of participatory democracy, in the management of community development. The following is the score for each one of the project's territorial units, according to the evaluation of participation and organization (**Table 6.13**):

Table 6. 13 Zoning by Community Organizations and Arenas for Participation

Major Territorial Unit	Minor Territorial Unit	Description of organizations and associations	Sensitivity Score
Contadero	Aldea de María	Community Action Board	1
	El Capulí	Community Action Board	1
	El Culantro	Community Action Board	1
	El Juncal	Community Action Board	1
	El Manzano	Community Action Board	1
	IP Ospina Pérez	Community Action Board	1
	Iscuazan	Community Action Board	1
	La Providencia	Community Action Board	1
	Las Cuevas	Community Action Board	1
	Las Delicias	Community Action Board Rural Women's Association	2
	San Andrés	Community Action Board	1
San Francisco	Community Action Board Rural Women's Association Peasant Progress Association	2	
San José de Quisnamuez	Community Action Board	1	
Iles	Alto del Rey	Community Action Board	1
	Capulí	Community Action Board	1
	El Porvenir	Community Action Board	1
	El Rosario	Community Action Board	1

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Major Territorial Unit	Minor Territorial Unit	Description of organizations and associations	Sensitivity Score
	La Esperanza	Community Action Board	1
	Loma Alta	Community Action Board	1
	Tablón Alto	Community Action Board	1
	Tablón Bajo	Community Action Board	1
	Tamburán	Community Action Board	1
	Urbano	Community Action Board	1
	Yarqui	Community Action Board	1
Imués	Pilcuán La Recta	Community Action Board Oversight Committee for the Rumichaca Pasto Project	2
	Pilcuán Viejo	Community Action Board Oversight Committee for the Rumichaca Pasto Project	2
	Silamag	Community Action Board	1

Source: GEOCOL CONSULTORES S.A. Baseline socioeconomic environment. 2017.

6.3.4 Distribution of the Land

It is important to consider the social sensitivity of the area based on the response to or consequence produced by any alteration or impact. It could be said that in the majority of cases, this will be more conspicuous on small properties, than on those who hold large properties. Based on this, and taking into account the distribution of the land, the following levels or categories have been considered, based on the size of the properties:

- Micro property: properties between 0 and 3 ha in size. (4)
- Mini property: properties that are between 3 and 10 ha in size. (3)
- Small property: properties that are between 10 and 20 ha in size. (2)
- Medium-sized property: properties that vary between 20 and 200 ha in size. (1)
- Large property: Properties greater than 200 ha in size. (0)

Based on the above information, it was concluded that in terms of distribution of the land the micro properties are the most common in the districts studied, and the land is held under the mode of property ownership. The territorial units in lles are characterized by a distribution of the land predominated by micro properties, followed by mini properties. Most properties are held under the mode of property ownership, with some cases of rental and sharecropping. According to the information gathered in the field, it was established that 100% of the properties located in the minor units of the municipality of Imués are classified as micro properties, with less than 3 ha.

The following is the score for each one of the project's territorial units, according to the evaluation of the distribution of the land (Table 6.14):

Table 6. 14 Zoning by Land Distribution.

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Major Territorial Unit	Minor Territorial Unit	Land Distribution	Sensitivity Score
Contadero	Aldea de María	MICRO PROPERTIES	4
	El Capulí	MICRO PROPERTIES	4
	El Culantro	MICRO PROPERTIES	4
	El Juncal	MICRO PROPERTIES	4
	El Manzano	MICRO PROPERTIES	4
	IP Ospina Pérez	MICRO PROPERTIES	4
	Iscuazan	MICRO PROPERTIES	4
	La Providencia	MICRO PROPERTIES	4
	Las Cuevas	MICRO PROPERTIES	4
	Las Delicias	MICRO PROPERTIES	4
	San Andrés	MICRO PROPERTIES	4
	San Francisco	MICRO PROPERTIES	4
San José de Quisnamuez	MICRO PROPERTIES	4	
Iles	Alto del Rey	MICRO PROPERTIES	4
	Capulí	MICRO PROPERTIES	4
	El Porvenir	MICRO PROPERTIES	4
	El Rosario	MICRO PROPERTIES	4
	La Esperanza	MICRO PROPERTIES	4
	Loma Alta	MICRO PROPERTIES	4
	Tablón Alto	MICRO PROPERTIES	4
	Tablón Bajo	MICRO PROPERTIES	4
	Tamburán	MICRO PROPERTIES	4
	Urbano	MICRO PROPERTIES	4
Yarqui	MICRO PROPERTIES	4	
Imués	Pilcuán La Recta	MICRO PROPERTIES	4
	Pilcuán Viejo	MICRO PROPERTIES	4
	Silamag	MICRO PROPERTIES	4

Source: GEOCOL CONSULTORES S.A. Baseline socioeconomic environment. 2017.

6.3.5 Archaeological Potential

Based on a region's archaeological and/or cultural potential in the area of influence of this EIA, the following levels of sensitivity were established:

- **High archaeological and/or cultural potential (4).**-Areas with high potential for the effective presence of sites, pieces, or collections of archaeological, historical and/or cultural value or interest to the national community (sites for getting together or recreation, or with a high potential in terms of landscape).
- **Moderate archaeological and/or cultural potential (2).**-Areas where the landscape permits supposing with moderate likelihood that sites, pieces, or collections of archaeological, historical and/or cultural value or interest exist for the departmental community. There could be decontextualized and/or unstratified archaeological evidence.
- **Low archaeological and/or cultural potential (1).**-Areas without archaeological evidence or where the characteristic of the surroundings (acidity of the soil, high water table, and other factors) do not facilitate the preservation of the same. From a cultural point of view the presence of sites of cultural importance is not demonstrated.

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6.3.6 Presence of Ethnic Groups

Taking into account that the existence of indigenous, Afro Colombian, or Rom groups can be reported in these areas, it is important to define the degree of sensitivity of this type of territory or sector. This is because, regardless of the environmental zoning obtained in the prior consultation, it is relevant to consider the territories of communities that have not yet been recognized. Therefore, the sensitivity comes from the state of recognition at the time the corresponding study is done, with the greatest sensitivity determined for those communities that have already been recognized legally and are constituted as a reservation, relative to others that have not yet been recognized.

- Legally recognized Reservations and Town Councils: Areas with reservations or town councils that have been legally constituted by the Ministry of the Interior. High capacity to supply cultural goods and services, especially based on the need to go through the prior consultation process. (3)
- Town councils recognized or in the process of recognition: Areas or sectors with town councils that are legitimate or recognized or in the process of recognition by the regional institutions or the Ministry of the Interior. Moderate capacity to provide cultural goods and services, given that they do not need to be consulted and that their cultural ancestors have yet to be demonstrated. (2)
- No presence reported: Areas or sectors that are outside of territories belonging to ethnic minorities. (1)

The ethnic communities established according to the stipulations of Writ 948 on March 28, 2017, "To define an alternative for the project called "Divided Highway between the towns of San Juan and Pilcuán Viejo, in the Rumichaca – Pasto Divided Highway Project," in the Department of Nariño," in the area of influence of the approved layout are: Indígena Colonial de San Juan, Parcialidad Indígena Aldea de María and Cabildo Indígena de Iles.

6.3.7 Levels of Sensitivity

The scores for socioeconomic sensitivity are presented below in **Table 6.15** according to the sum of the different variables taken into account. **Figure 6.8** and the **Map Appendix, Map No. 30 Zoning of the Socioeconomic Environment** present the socioeconomic sensitivity map for the physical biotic area of influence. Due to the fact that variables such as land-use, necessary for determining the main economic activities, are restricted only to this area of influence. Therefore, the comparison of the variables and the total percentage for socioeconomic sensitivity cover only the physical and biotic area of influence.

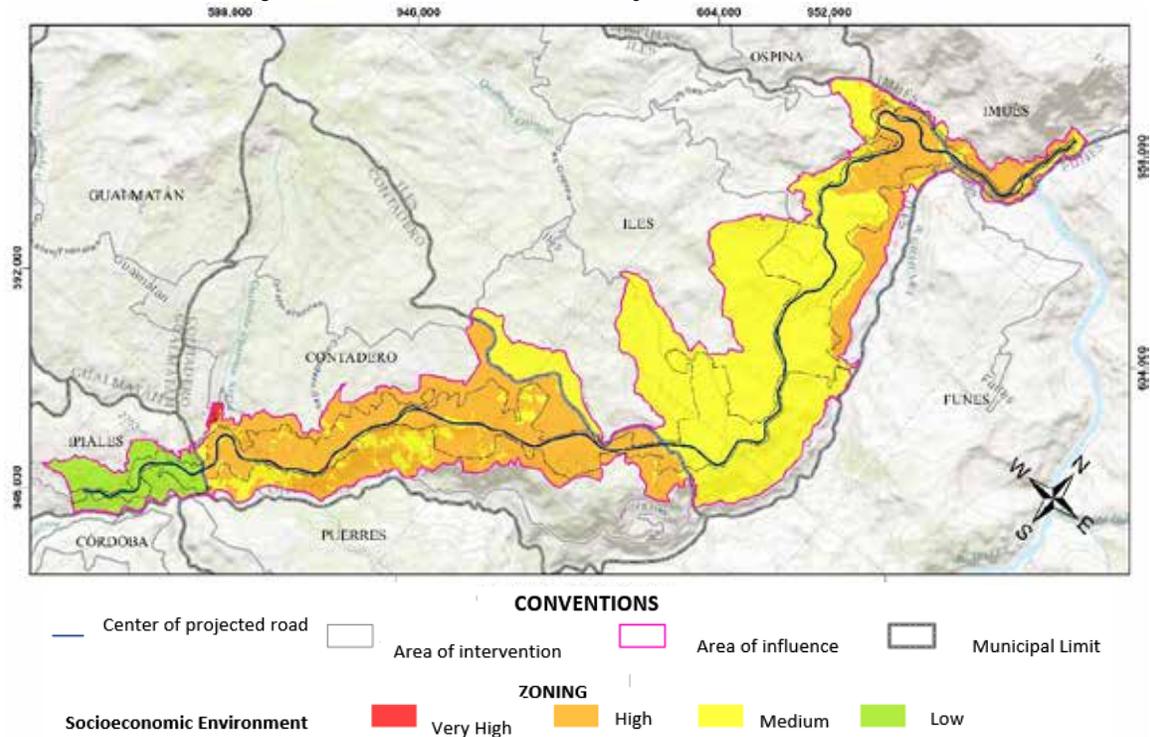
It is important to bear in mind that the zones that have a low sensitivity in the territorial units of San Juan, El Rosario and Boquerón in the San Juan Reserves, do not have all the necessary information gathered to be able to score each one of the variables of the component. Therefore, the score given corresponds only to the economic activity determined by the identification of the land use, for which reason the sensitivity of this area is low, since it does not contain the sum of all of the variables of the component.

Table 6. 15 Levels of Socioeconomic Sensitivity

Socioeconomic Sensitivity	Numeric
Very High	19-24
High	13-18
Medium	7-12
Low	1-6

Source: GEOCOL CONSULTORES S.A., 2017.

Figure 6. 8 Socioeconomic Sensitivity of the Area of Influence



Source: GEOCOL CONSULTORES S.A., 2017.

6.4 ENVIRONMENTAL ZONING

The environmental zoning is the product of the environmental description and characterization of a determined area, through which a synthesis is obtained of the diagnosis of the baseline for the study and an overall vision of the conditions of the ecosystems and natural resources found there. Environmental zoning basically consists of overlaying thematic layers obtained from the environmental characterization, analyzing and scoring each component separately to subsequently categorize and prioritize those factors that

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determine the sensitivity of a place. That zoning determines the degree of environmental sensitivity in each one of the ecosystems in a determined area.

It is obtained by overlaying the different homogeneous units both in abiotic, biotic, and social aspects. These are analyzed and grouped according to the criteria, categories, and scores described above, to then define possible uses and restrictions, according to the activity or project to be executed (type of intervention).

Taking those variables into account, the project's environmental sensitivity will be defined by the following expression established in the referenced methodology guideline:

$$S = f \{ \{ \sum A, B, S \} \}$$

Where:

A= variables from the physical environment, including the general stability of the terrain (**Es**), potential land-use (**Ups**), hydrogeological vulnerability (**Vh**) and the degree of the slope of the terrain (**Pd**).

$$A = \sum \{ Es, Ups, Vh, Pd \}$$

Note: The variables considered are cumulative, given that they can occur simultaneously at a same site or place.

B= Variables from the biotic environment, including the score given to each site based on the land cover identified in the survey of the baseline for the area of study. The following communities of vegetation will be considered for the minimum categories to be taken into account: Artificial territories (**Ta**), Pastures (**P**), Mosaics (**M**), Forest Plantations (**Pf**), Grasses (**H**), Forests (**B**), Secondary Vegetation (**Vg**) and Rivers (**R**)

$$B = \{ Ta; P; M; Pf; H; B; Vg; R \}$$

Note: The variables considered are mutually exclusive. In other words a place classified as Dense High Andean Forest and Riparian Forest (**B**) cannot be considered at the same time to be another type of plant community.

S= Variables in the socioeconomic environment, demonstrated in the score defined for the aspects of economic activity (**Ae**), spatial (**E**), community organizations and arenas for participation (**Oc**), distribution of the land (**Dt**), archaeological potential (**Pa**) and presence of ethnic groups (**Pe**).

$$S = \sum \{ Ae, E, Oc, Dt, Pa, Pe \}$$

Note: The variables considered are cumulative, given that they can occur simultaneously at a same site or place.

6.4.1 Definition of the Environmental Sensitivity of the Areas

The ranges for the score for environmental sensitivity were established according to the methodology described, and they are presented in **Table 6.16**:

Table 6. 16 Ranges for the Score for Environmental Sensitivity

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ENVIRONMENTAL SENSITIVITY	RANGE
Low	3-4
Medium	5-7
High	8-10
Very High	11-12

Source: GEOCOL CONSULTORES S.A., 2017.

Based on the above, the areas with a very high restriction are included in the range between 11 and 12 points, in other words, with **VERY HIGH SENSITIVITY**, while the areas with a high restriction are defined to have an environmental sensitivity between 8 and 10 points, which corresponds to **HIGH SENSITIVITY** or between 5 and 7 points corresponding to **MEDIUM SENSITIVITY**. Lastly, **LOW SENSITIVITY** will be defined as being between 3 and 4 points.

6.4.1.1 Special Areas in Environmental Zoning

These are established based on their particularity in the area of the project or based on legal or special restrictions they may have. In other words, they have a **VERY HIGH SENSITIVITY**. The score for sensitivity for the area of influence of the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment, takes into account the presence of areas for preservation and conservation, either by means of administrative orders or by particular or private organizations, or based on their importance for the area of study at the regional or national level.

- **Priority areas for conservation and/or legal restrictions.**

The following areas were identified in the area of influence of the project:

- **Areas that are sensitive or have environmental importance.** The project's area of influence has forest land cover in the lower montane dry forest (bs-MB) life zone. These units have an area of 1,245 ha and 1,313 ha, respectively, but they are located outside of the area of intervention of the highway project.

Some characteristics that are prevalent in the dry forest are the presence of species with important adaptive strategies, as a response mainly to seasonal climates. These include the presence of deciduous species (Murphy and Lugo 1986). Their arboreal stratum, basal areas, and index of biodiversity are low compared to moist and very moist forests (Murphy and Lugo 1986, Gentry 1995). The dry forest, however, has high degrees of endemism and speciation (Pennington et al. 2006).

In terms of conservation, the dry forest is one of the most degraded and threatened ecosystems (Janzen 1988, Miles et al. 2006), because it occurs as patches or fragments in almost all of the neotropical region. Most of them are immersed in landscapes dominated by crops and areas dedicated to ranching (Fajardo et al. 2005). This, in addition to the presence of good quality timber species, has led to their intense transformation (Ceballos 1995, Fajardo et al. 2005).

- **Headwaters and their Protective Buffer Zone** According to letter a of article 3 of Decree 1449 of 1977, an area of at least 100 m around the headwaters of water sources, measured from their periphery, is considered to be protective forest area. For that reason these areas cannot be intervened (very high sensitivity). In addition, these are environmentally fragile components, and constitute a type of potential water source for supplying communities.

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6.4.2 Interpretation of the Results

As previously mentioned, the elements classified as areas of **VERY HIGH SOCIO-ENVIRONMENTAL SENSITIVITY** are located in the fragments of dry forest mentioned above, and at headwaters and their protective buffer zone, with the purpose of ensuring their protection during the execution of the project.

With respect to the zones considered as having a **HIGH SENSITIVITY**, these are areas that have environmental and/or legal limitations. Carrying out projects, works, or activities is not definitively excluded in these areas; through reaching a consensus, engaging in consultations, and proper management they can be used to execute projects. These type of terrains include the following:

Social infrastructure (municipal seats, towns, scattered homes, health posts, and community meeting rooms), infrastructure for the provision of water, hand-dug wells, productive infrastructure associated with homes, infrastructure corresponding to the generation of income and providing subsistence to the town, and areas for recreational use.

Protective forest areas on lands that may or may not have a forest aptitude, constituted in forests, that are an integral part of and support biological, ethnic, and environmental biodiversity, where knowledge of the forests and their management must be safeguarded under the principles of sustainability and that should be continuously conserved with forest; areas that are the headwaters of many rivers that flow out in different directions (*estrellas fluviales*), water production, forests in areas that supply urban or rural water systems, and buffer zones around creeks.

Buffer zones for rivers and creeks, where the buffer zones for water courses are strips of land parallel to the creeks and rivers, that have the purpose of isolating and protecting the water currents. Due to their importance, a strip of 30 m is taken on each side of the maximum contour line for flooding by the body of water.

The zones corresponding to mosaics of crops and pasture, artificial territory, etc., are considered to have **MODERATE TO LOW SENSITIVITY**. These elements have environmental and socioeconomic conditions that can be used for the development of the project, through the implementation of environmental management measures, in accordance with the impacts generated by the intervention and the negotiations carried out with the owners of these areas. Likewise, those elements were considered in the intermediate zoning (physical, biotic, and social) that are presented in **Table 6.17 and Figure 6.9**.

The overlay of the different homogeneous units for abiotic, biotic, and social aspects was analyzed, and groups were made according to the criteria, categories, and scores described above. The possible uses and restrictions were then defined according to the type of intervention. Taking those variables into account, the project's environmental sensitivity will be defined by the map presented in **Figure 6.9** (Also see **Map Appendix, Map No. 31 Total Environmental Zoning**). The environmental zoning is thus obtained, considering the degree of sensitivity of each element present in the area of influence of the Rumichaca – Pasto Divided Highway Project, San Juan - Pedregal Segment.

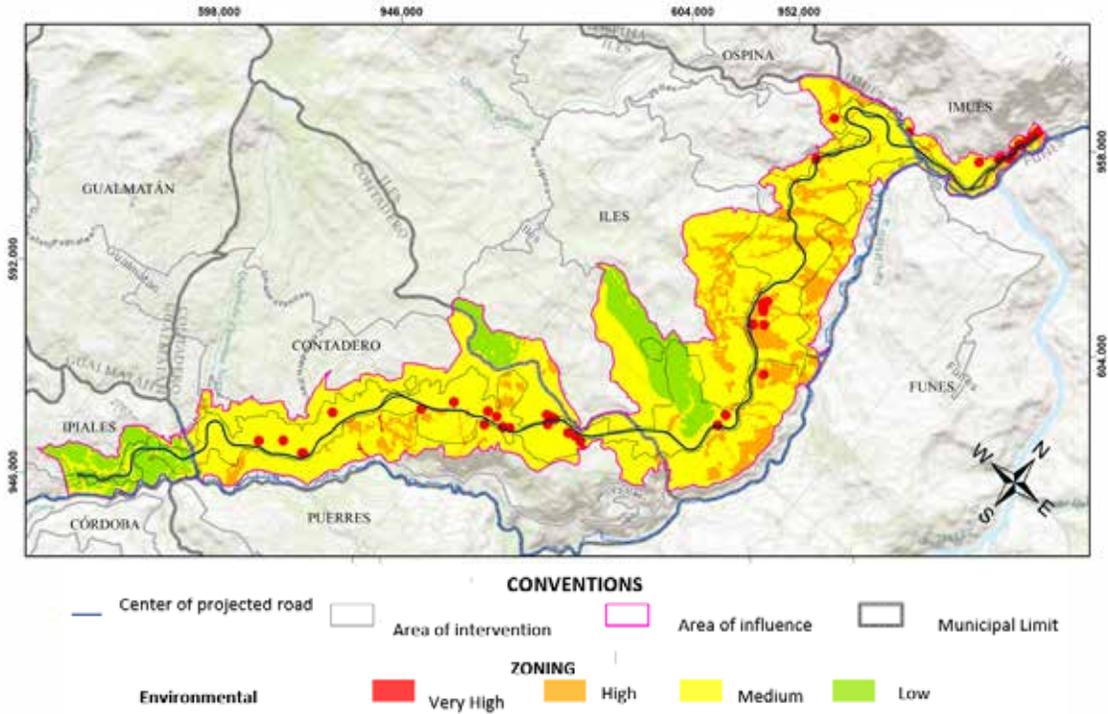
Table 6. 17 Environmental Zoning for the Area of Influence and Intervention of the Rumichaca – Pasto Duel Carriageway Project, San Juan - Pedregal Segment.

Environmental Sensitivity	Area of influence		Area of Intervention	
	Area (ha)	%	Area (ha)	%
VERY HIGH	114.39	2.8	75.81	4.7
HIGH	546.07	13.5	181.11	11.1
MEDIUM	2.898.50	71.7	1207.49	74.1
LOW	481.69	11.9	164.27	10.1
TOTAL	4040.66	100	1628.68	100

Source: GEOCOL CONSULTORES S.A., 2017.

The percentages for the different degrees of sensitivity determined in the consolidated environmental zoning for the project’s area of intervention showed that **74.1%** (1207.49 ha) is made up of zones of **Medium Sensitivity**, **11.1 %** (181.11 ha) of the area consists of zones of **High Sensitivity**, **10.1%** (164.27 ha) of **Low Sensitivity**, and **4.7%** (75.81 ha) are zones with **Very High Sensitivity**.

Figure 6. 9 Environmental Zoning for the Area of Influence and Intervention of the Rumichaca – Pasto Duel Carriageway Project, San Juan - Pedregal Segment.



Source: GEOCOL CONSULTORES S.A., 2017.

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