

Due Diligence  
**Volcano View Property**  
Bagaces, Costa Rica



**Contracted by:**  
**Andy Usztan**

**Prepared by:**



**May, 2008**

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**Annexes**

1. Cadastral Plan
2. Aerial photograph and property photos

The Project Office was contracted to conduct the present due diligence Mr. Andy Usztan.

The report is intended to evaluate the characteristics of the property located in Bagaces, Costa Rica, where it could be developed as a residential, commercial and tourist project, and to determine the possible restrictions and/or limitations due to the physical, environmental and legal framework.

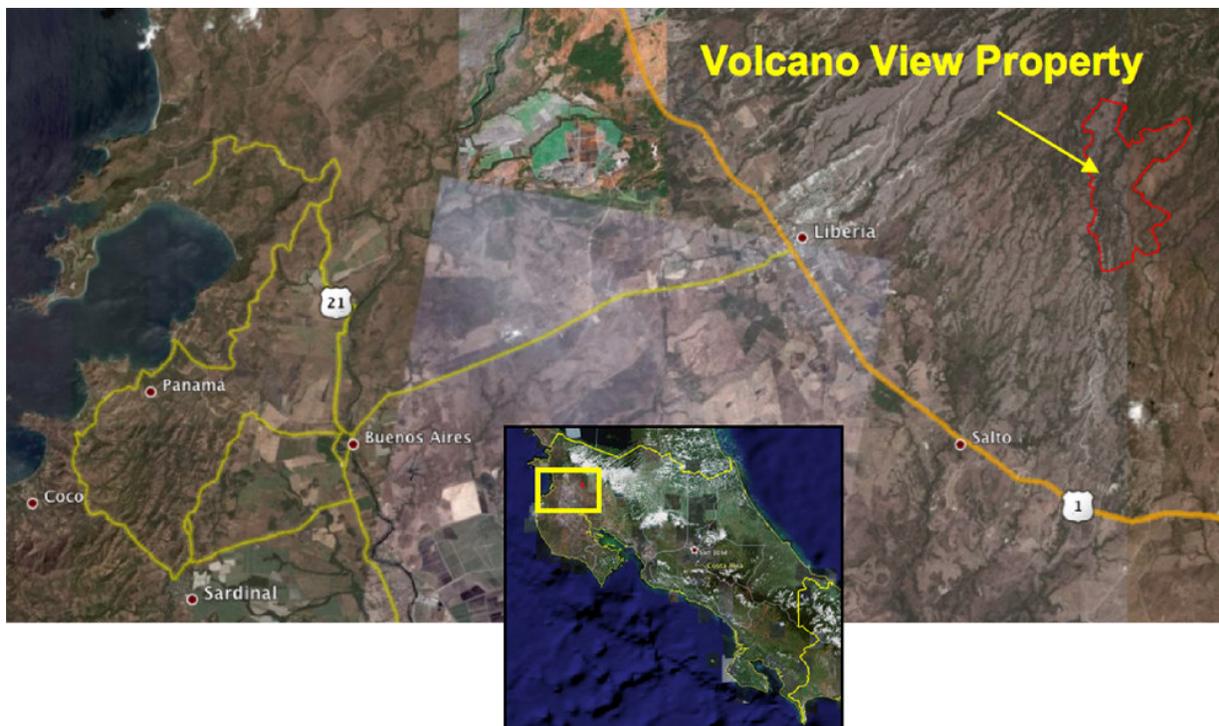
## 1. PROPERTY LOCATION

The estate is located in the Bagaces county, in the province of Guanacaste (see maps N°1 and N°2). It comprises an area of 1250 hectares 8645 sqm, and the following information corresponds to that of the cadastral plan (see Annex N°1):

Property	Plans to the name of	Area
Cadastral Plan No. G-262078-95	Ganadera Costeña Matapalo Limitada	1250 has 8645,44 m2

The property is located 9 km north of the town of Pijije, which is located along the Interamerican Highway, 14 kilometers south of the City of Liberia.

The property under study is very well located, between the city of Liberia and the city of Bagaces, close to the Interamerican Highway and with many natural attractions in its surroundings, such as the Rincon de la Vieja National Park and Miravalles Volcano.



## 2. GEOLOGICAL & HYDROGEOLOGICAL STUDY

### 2.1. Geology

The terrain at Volcano View varies between 390 meters above sea level down to 160 m.a.s.l. The area is thus a transitional system between the higher elevations and the lowlands and plains to the South of the Highway. This transition zone is also reflected by the resulting vegetation which facilitates

The rock formations in the area are volcanic in origin, the Bagaces Formation is a grayish tuff or ignimbrite of dacitic composition. This rock type is visible on the Interamerican Highway between Cañas and Bagaces. The Liberia Formation partially covers the former and is generally known as a white tuff of rhyolitic composition. This formation is observed along the highway between the Rio Salto and approximately four km. past the City of Liberia, after this point the Bagaces Fm. Continues all along the Highway to a few kilometers before the Nicaraguan border.

The origin and mode of deposition of the materials results in a homogeneous rocktype, well-graded and sorted as a function of distance from the emitting source or crater.

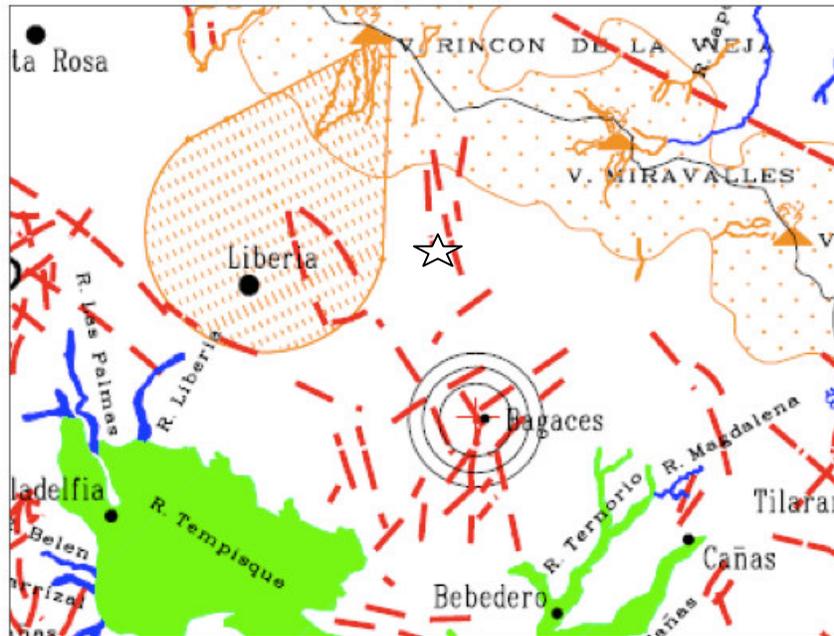
The tuff resulted from volcanic eruptions from the Rincon de La Vieja complex or the Miravalles complex of cones and craters. The Rincon de la Vieja most recently erupted in November, 1995, and is being monitored closely by geoscientists in Costa Rica.

This eruptive episode was similar to previous phreatic eruptions, producing lahar avalanches to the north but contained no juvenile magma. The Miravalles Volcano has only presented fumarolic activity in historic times.

The pyroclastic flows cover many square kilometers and typically give rise to a hummocky topography with occasional small lagoons between the slopes of the arched or elongated hills. Weathering tends to round out all edges and soften linear features. The observed rock in-situ and in hand sample shows flow lineations within some of the welded and stratified volcanic glass and ash.

### 2.2. Natural Hazards

**Volcanic hazard** evaluations are often based on detailed geologic and geochronologic studies of a volcano's past activity, using the assumption that future eruptions will be of similar eruptive style and volume. The modern topography of the volcano is also an important consideration.



Map 1: Comisión Nacional de Emergencias Map including Project area.

The above map by the CNE or “National Emergency Commission” shows the known potential hazards for the region. It is interesting to note that the property (STAR), corresponds with a “calm” (blank) zone between the Town of Bagaces and the City of Liberia. The red fault lines are absent here and the property is a few kilometers east of the Rincon’s expected cone of influence of volcanic ash and tephra, should a major eruption occur.

No apparent faulting was observed during the field visit, this would seem to corroborate that there are no known active faults on the property. A more detailed fieldwork could reconfirm this. It is possible that the trace of old faults was covered by the Pleistocene (newer) ignimbrites and tuffs. If they remain hidden or unidentified it is because of lack of activity during so many years which is also a good thing.

As the last major eruption at the Rincon de La Vieja Volcano involving juvenile magma, the interpretation of the Rio Blanco Tephra Deposit is crucial for predicting the style of future eruptions. Since the Rio Blanco tephra eruption, explosive phreatic and phreatomagmatic eruptions from the Active Rincon de La Vieja Crater have only deposited minor amounts of tephra and ash in the vicinity of the Active Crater.

Numerous calderas have been identified near the axis of the Miravalles – Rincón de La Vieja Volcanoes. These are volcanic depressions ranging from 1.5 to 100 km diameter resulting from the collapse of pre-existing volcanic structures. Sometimes the caldera floor is impermeable and a lagoon is formed as in the case of the Mogote Lagoon in Guayabo of Bagaces. After each eruption the calderas increasingly collapse inwardly. The Alcántara / Guachipelin caldera is believed to have originated the major deposits of ignimbrite reaching Liberia and the project location.

Within the property, the rock-types observed throughout the terrain show very limited spatial

variation. Undifferentiated ignimbrites and pyroclastic flows are visible throughout the property. A hummocky topography has resulted as erosion and weathering penetrates past the upper layers. Some lineation due to flow are seen at or near the horizontal. Cooling fractures are also occasionally present as sub-vertical planes.

### 2.3. Seismic Hazard

Along the Volcanic Cordillera of Guanacaste there are three areas which reached an intensity of VIII. One of these three is related to the August 1<sup>st</sup> 1935 Bagaces earthquake which was perceived as a M 5.5 Modified Mercalli Scale, (this scale goes up to 12). On December 6<sup>th</sup>, 1941 there was another earthquake considered a M 6.0 Nevertheless, faulting and seismic activity in historic times has been a period presenting low activity.

The level VIII Mercalli intensity is, by definition, one in which the following occurs: Driving a vehicle becomes difficult. Concrete work is damaged considerably. Elevated structures may tumble. Some tree branches may fall. Water wells reflect a change in flow and in temperature. Humid or sloping terrain may develop cracks.

The stratigraphy points to relatively thick sequences, up to 50 meters, of volcanic tuff welded in place over previous events of ash and minor pumice.

In terms of geomorphology, we can divide the property into two units. The bulk of the property corresponds to Unit A which are the local highlands or plateaus, these areas range from fairly flat to gentle slopes. Unit B is covered by medium grade slopes connecting the plateaus and the creek or river bottoms.

A much smaller Sub-unit B1 covers a portion of the property in the form of canyon rims, these areas add an important scenic value to the property and may be exploited accordingly.



Photo No. 1: View of the highlands and slopes with the Miravalles Volcano in the background.

The property has a high percentage of land suitable for development. A series of acreage or “quintas” could be designed with views across the valleys and some steeper slopes leading down to the creek beds with a buffer zone around these. There are also large sections of level land atop the plateaus. Some sections of the plateaus end in abrupt rims rather than gentle slopes. Nevertheless there are no signs of ongoing instability and these drop-offs may serve as scenic look-out points.

The exact location of any building sites should be selected in such a way as to avoid any geological weak points which could be locally present, i.e.: geological contacts, lenses of pumice or clay, erosion prone slopes, slumps or slides planes etc.

The absence of fault planes and slide planes, based on the first field visit, is also a favorable characteristic of the property. There was no visible scarring of the land by landslides, this points to a high level of surficial stability which would also be reflected in reduced development costs.

## 2.4. Hydrogeology

The surface network of drainages consists of sub-parallel rivers flowing in a North to South direction and tributary creeks flowing in a Southwesterly or Southeasterly direction. There is evidence of at least two intermittent shallow lagoons on the central plateau of the property.

The Potrero River is one of the main rivers cutting the property right down the middle. The Potrero tributaries are the Quebrada Triangulo, Nisperos and Maria. The other main river flowing from North to South is the Rio Salto which is also a property boundary. The main tributaries are Quebrada Agua Gata, Quebrada Cuesta Blanca.

The existing files on the wells indicated on Map only indicate that the two top ones were completed and that the bottom well was supposedly yet unfinished. The information kept by SENARA besides being incomplete is most likely outdated.

Regarding potential water-well drilling locations, four tentative locations have been selected - by Hydrogeologist Julio Elizondo - taking into account ease of access in addition to greatest expected hydrologic potential. These are listed below; based on existing literature one could expect an acceptable water volume between 60 to 80 meters below the surface.

Point	Coordinates N	Coordinates W	Potential
A	291.440	389.325	1
B	293.480	389.100	2
C	295.200	389.600	3
D	290.000	391.000	4

Table 1: Recommended water well sites (Map 5)

As observed in the following Map of Groundwater Resources the property, (STAR), falls within zone 4, meaning the underlying aquifer is of small to moderate potential. Between 40 and 4,000 l/min. are possible within zone 4. There may be localized significant variations to the amount of groundwater available. It is important to note that the vegetation during the first week of May, at the end of the dry season, is observed to be relatively green.

Map No. 2: Estimated Groundwater Resources



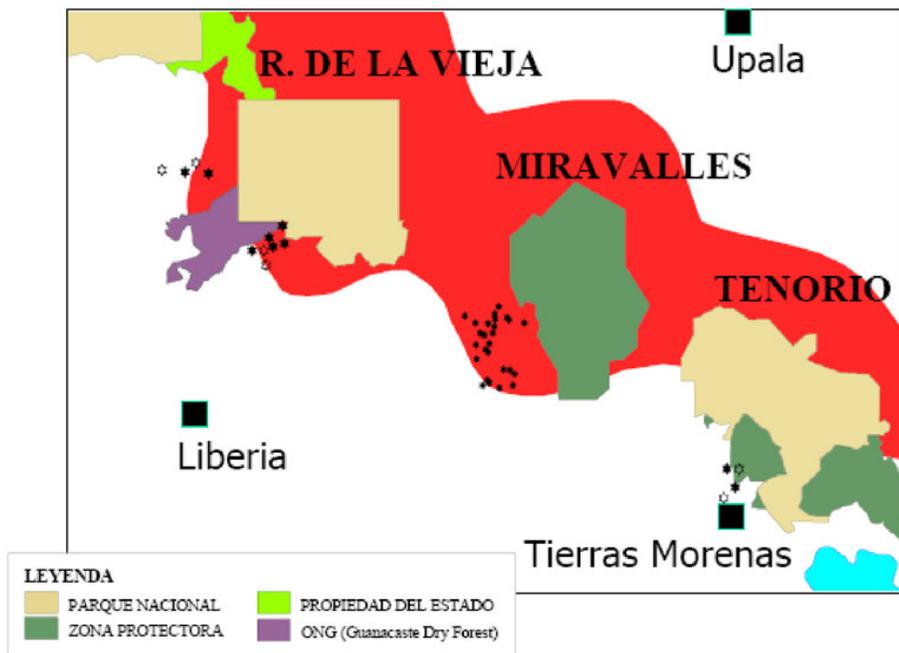
**GROUND WATER RESOURCES**

- FRESH WATER GENERALLY PLENTIFUL**
- Map Unit  
**1** Moderate to large quantities from highly porous volcanic breccias and fractured lavas in Pleistocene to Recent age volcanic aquifers in the Meseta Central (Central Valley). Depth to water is 40 to 105 m.
- 2** Moderate to large quantities from Miocene and Quaternary age alluvial aquifers in Valle de Tempisque, Limon, and Puntarenas. Depth to water is 8 to 40 m in Tempisque aquifer, 3.6 to 12 m in La Bomba aquifer near Limon, 27 to 32 m in Barranca aquifer, and 44 to 48 m in El Roble aquifer near Puntarenas.
- 3** Small to moderate quantities from Eocene to Quaternary age volcanic and sedimentary aquifers. Volcanic mud flow deposits in Llanura de San Carlos, and volcanic breccias, sandstones, and marine carbonate rocks in Valle del General, may form regional aquifers with many smaller perched zones.
- FRESH WATER LOCALLY PLENTIFUL**
- 4** Small to moderate quantities from Pleistocene volcanic aquifers near Valle de Tempisque. Moderate quantities from volcanic breccias, ignimbrites of the Bagaces aquifer; and small quantities from the Liberia aquifer of fluviolacustrine deposits with interbedded rhyolite and pumice. Depth to water averages 100 m in the Bagaces aquifer and 20 m in the Liberia aquifer.
- 5** Very small to small quantities from discontinuous aquifers in undifferentiated Tertiary and Cretaceous volcanic and sedimentary rocks in Peninsula de Nicoya, Peninsula de Osa, and Cordillera de Talamanca. Depth to water is less than 200 m.
- FRESH WATER SCARCE OR LACKING**
- 6** Meager to small quantities from Recent basalt and andesite lava flows, agglomerates, and pyroclastics on active volcanic cones in Cordillera de Guanacaste and Cordillera Central.
- 7** Meager to large quantities of brackish to saline water from unconsolidated alluvium underlying coastal plain swamps and mangroves. Depth to water is less than 20 m.

Note: Map unit numbers refer to entries in table 2.

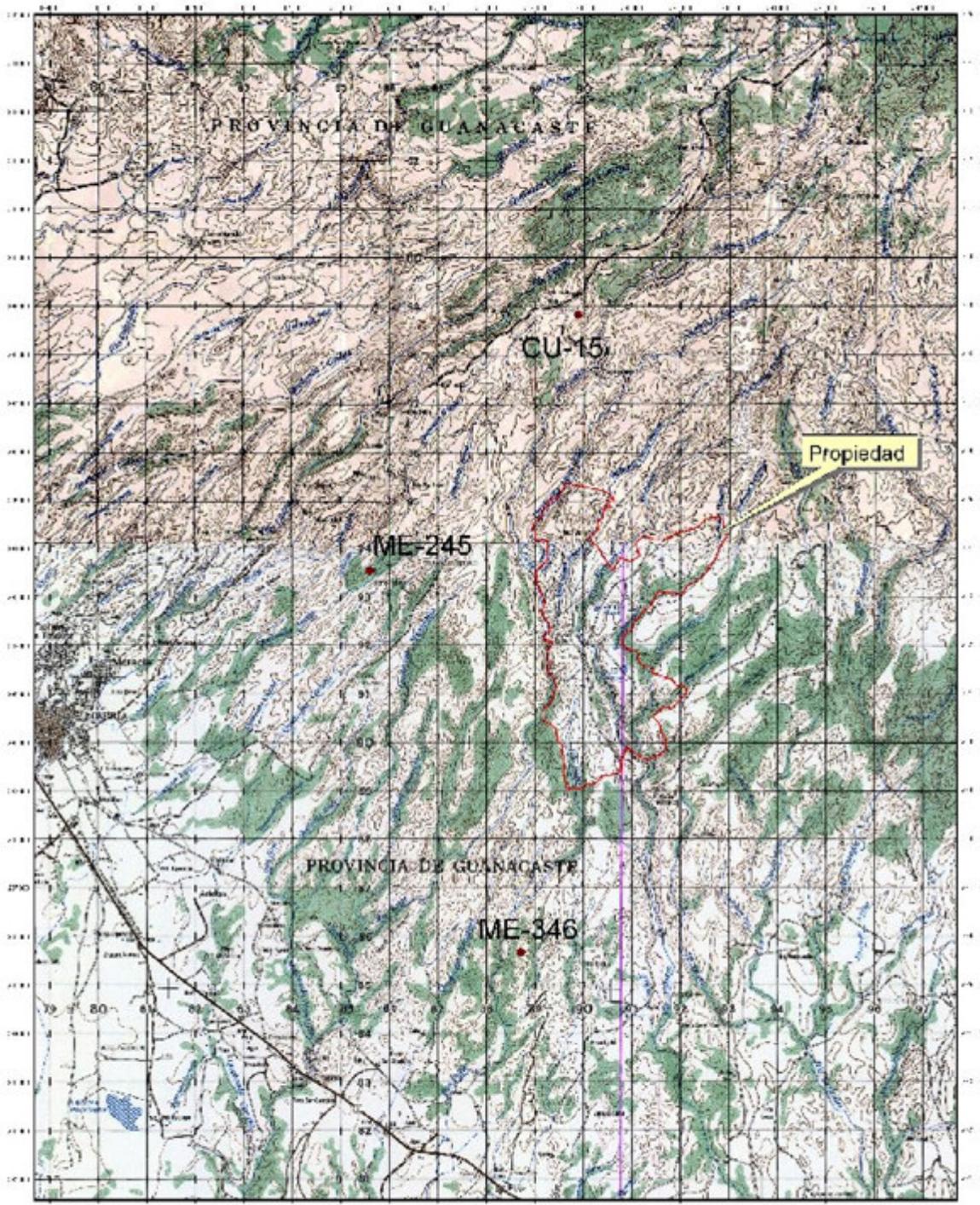
**QUANTITATIVE TERMS:**  
 Enormous = >400,000 liters per minute (L/min) (100,000 gallons per minute (gal/min))  
 Very large = >40,000 to 400,000 L/min (10,000 to 100,000 gal/min)  
 Large = >4,000 to 40,000 L/min (1,000 to 10,000 gal/min)  
 Moderate = >400 to 4,000 L/min (100 to 1,000 gal/min)  
 Small = >40 to 400 L/min (10 to 100 gal/min)  
 Very small = >4 to 40 L/min (1 to 10 gal/min)  
 Meager = ≤4 L/min (1 gal/min)

Map No. 3: Protected lands upstream from property



From the above maps we see that the rivers flowing south from the volcanic cordillera (in red) originate in protected zones, the arbitrary boundary drawn for the groundwater potential zones indicates the property is near the Map Unit 1 of moderate to large quantities of groundwater. No springs were observed during the site visit, it is possible they may exist as intermittent or permanent springs near the creek / river beds. If any springs are found, the law states a buffer zone of 100 m radius is necessary for conservation purposes.

Map No. 4: Known water wells within a 4km. radius of the project area. Source: Deppat, 2008. (Geographer Karen Morales M.)



Based on data from the SENARA (Groundwater Authority) there are only three registered water wells within a 4 km radius of the property, these are presented below.



### 3. EVALUATION OF THE VEGETATION DISTRIBUTION AND DENSITY

The property in study is an old cattle ranch; decades ago it used to be covered mostly by pastures with small remnants of native vegetation along the creeks and over steep slope terrain. Since the cattle activity was significantly reduce a couple of decades ago, a large extent of the property has been under a natural process of regeneration. Nowadays, the vegetation on the property is composed by a complex mosaic of areas under natural regeneration of different stages, and other areas where this process has not been allowed.

In spite of this very complex distribution of different vegetation units, we can ideally categorized the property under four types of vegetation, as follows (see map 6):

#### **Forestry plantation:**

A small area (no more than one hectare) of teak (*Tectona grandis*) planted beside the house of the property keeper in the central area.

#### **Pastures:**

This are the areas with the highest level of human disturbance, correspond to open areas still used for cattle grazing. A few species of grass and some herbaceous plants, with scattered trees of medium height, compose the dominant vegetation. This unit is located mainly on the top and slope of hills on the east side of the property.

#### **Bushes and small trees:**

This unit is located in areas that used to be pastures no more than 15 years ago and right now are covered by vegetation of young second growth. Dense bushes five meters tall dominate the vegetation, with some medium height (15 meters) trees of native species such as chicle tree (*Manilkara zapota*), nance (*Byrsonima crassifolia*) and peine de mico (*Apeiba tibourbou*). This unit is scattered along most of the property.

#### **Secondary forest:**

This unit includes the area with least disturbed vegetation in the property, it correspond with the areas along the rivers and creeks and over steep slope terrain, where the native vegetation was kept in a state of secondary growth, after most of the valuable trees were extracted for its wood. Nowadays, the vegetation is typical of secondary forest, with trees up to 20 meters tall and 60 cm wide.

As to the restrictions for development, the areas of forestry plantation and pastures have no restrictions regarding cutting of trees and land used change.

The areas of secondary forest has restriction for cutting of trees due to the forestry law, because it is prohibited in the protection zone of creeks and rivers (a strip 15 meters wide along each side of the creek) and in the areas classify as forest by the Forestry Administration (MINAE), that is the sectors with more than 60 trees per hectare with 15 cm of diameter at chest height.

The areas of bushes and small trees could not be classify as forest today, but due to the process of natural regeneration, it is estimated that if this process continues some sectors could be classify as forest in a period of five to ten years.



Photo 2: it shows the three most common vegetation units on the property, the front trees belong to secondary forest and the hill top is covered by pastures and surrounded by bushes.

## Map 6. Classification of forest

## 4. RESTRICTIONS OF THE PROPERTY

### 4.1. Protection Zones of Creeks and Rivers

According to information given by SENARA (National System of Irrigation and Drainage), and the site visit, there is not any natural spring or well inside the farm to be protected, because of that there is not any restriction on this matter. Regarding streams, the farm is crossed by creeks, and rivers which have different protection legal status, according Forestry Law.

From the point of view of the assessment of surface waters, the bed of the Salto River was identified to the west boundary of the farm. This river is the most important body of water there, having water throughout the entire year, although its flow rate increases during the rainy season. The Salto River water can be taken, to supply water for irrigation, as well as potable use if its quality allows.

Another creeks with the presence of water are located within the property and in the eastern boundary. Most of them are not permanent creeks, but requires protection, according to the Law.

The protection zone of bodies of water is established by the INVU, institution in which the corresponding procedures have to be carried out for the establishment of the appropriate protection.

However, considering the existing legal framework, we have prepared our own interpretation and possible resolution from INVU. According to the Forestry Law (N° 7575), in Section 33.-Protection Areas, the following are declared as protection areas:

- *A belt of fifteen meters in rural areas or ten meters in urban areas, measured horizontally to both sides, from the shores of rivers, creeks and streams, if the terrain is flat, or fifty meters horizontally if the terrain is steep.*

For the case in study, 15 meters will have to be considered as protection zone, since the area is located in a rural zone, as well as a belt of 50 m in the areas where the slope is greater than 40%.

It is important to mention that according to the legal framework, only the creeks or rivers declared as *water of public domain* require the protection zones mentioned in the Forestry Law.

In this matter, it has to be requested to the Water Department, the declaration of which creeks within the farm are declared as water of public domain.

## **4.2. Protection Zones of Springs**

As was indicated, it was not possible to find the presence of springs within the property in study. But it is important to mention that because of the size of property and the lack of internal roads, it was very hard to see most of it, therefore, we can not say that we are 100% sure of the no presence of springs.

Based on that, following we summarize the applicable Law to the protection of springs, in case later in the planning phase, springs are found in the property.

The Forestry Law #7575, chapter IV, article 33, declares as protection zone the land surrounding permanent springs, with a protection area of a radius of one hundred meters measured horizontally.

Also, the Law of Water #276, chapter IX, article 149, establishes the prohibition to destroy the trees located in an area closer to 70 meters of the springs located in the hills, and in an area closer to 50 meters in flat land.

Finally, it is important to mention that any spring can be harnessed and take advantage of its flow for consumption as potable water. To do that, it is necessary to obtain a permit or a concession to use that water from the Department of Water of the Ministry of Environment.

## **4.3. Urban and environmental restrictions**

The following table summarize the main aspects to be taken under consideration, to plan a development of the property under study.

**Table 1  
Volcano View Property Due Diligence  
Urban, and Environmental Restrictions**

<b>Law</b>	<b>Restriction</b>	<b>Condition</b>	<b>Action to Take</b>
Forestry Law	Rivers and creeks Protection Zones (15 and 50 meters to both sides)	There are several creeks at the estate, a few of them with sections in rough terrain, but most of them in terrains with low slopes.	Submit to the INVU a countor lines map with the location of the creeks to obtain the official alignment of the protection zone
Forestry Law	Land use in forest terrains cannot be changed	Only small sections of the property have forest, mainly related to the protection zones of creeks and the river Salto.	Protect the areas of forest identified in the Vegetation map.
Urban Planning Law	Urban Regulatory Plan establishes land use and controls density, height, coverage, etc.	There is no valid Urban Regulatory Plan for the area under study (Bagaces County)	None
General Law on Public Roads	Establishes a right of ways for public roads	The property is crossed by a road that might be qualify as public, and therefore, the right of way and set backs have to be identified.	Request to the Municipality of Bagaces and the Ministry of Public Works and Transportation, if the road within the property is public. In case it is, find out its right of way and setbacks for construction.
Environmental Organic Law	Environmental Feasibility Certificate is required for new projects	Once there is a Master Plan for the project, the Environmental Evaluation Document (D1) must submitted at the SETENA in order to continue with the process of obtaining the Environmental Feasibility Certificate from that institution.	To prepare the D1 based on the project's Master Plan, and file it at SETENA.

Construction Law	Establishes construction set-backs from farm borders	The corresponding municipality will issue a statement on alignment and setbacks from public roads. The estimated setback is 3 m from the farm's boundary.	To observe the setback established by the municipality for the location of buildings.
Water Law	Requires a concession for the use of groundwater in case of obtaining water from a well, to use water from a creek or river.	It is possible that the project will have to be supplied by its own means through the drilling of wells, or getting water from the Salto river.	To request the concession for obtaining the drinking water supply based on the volumes obtained at the drilled wells in the farm, or from the Salto River.

## 5. CONCLUSIONS AND RECOMMENDATIONS

The Volcano View property has good potential for a variety of projects. Some land-use options will be more sensitive to availability of water in larger quantities than others. A low-density development is definitely feasible with existing water resources and higher density use will be subject to number of wells drilled and capacity results.

The geology and terrain are stable, the topography is mostly gentle and varied, and these characteristics favor development options. The water well information is practically non-existent for this region, any drilling executed will generate new data. A favorable aquifer will consist of highly fractured rock with an elevated permeability. The existence of a favorable rock type is quite possible in the form of a fractured lava flow.

The proposed well locations have been selected in a way to minimize depth of drilling to the water table, and are expected to produce adequate results. Though there is uncertainty regarding the production capacity of said locations the ease of drilling in the underlying rock type is a big advantage. Therefore there will definitely be adequate water for lower density land uses.

As a final conclusion, it is noteworthy that the estate under study possesses excellent conditions in terms of landscape and location for the development of a touristic or residential project. The identified restrictions will not place future development at risk because of the extensive acreage available for development of all project components, such as a golf course, equestrian estates, condominiums, etc.