CHAPTER IV.

POTENTIAL IMPACT ON ENVIRONMENT, HEALTH AND SAFETY

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4. CHAPTER IV: POTENTIAL IMPACT ON ENVIROMENT, HEALTH AND SAFETY

4. 1 IMPACT IDENTIFICATION AND EVALUATION

The evaluation of possible environmental impacts includes the area of influence, in which the general conditions of the area's biotic, abiotic and socioeconomic components are investigated in their unaltered states. The goal is to assess the impacts of oil well drilling on the different environmental components in the Palagua-Caipal field.

This chapter states three (3) evaluations. All are focused on identifying and characterizing impacts. These three (3) actions follow in order of their progression, and include the following: the environmental impact on the area to be directly influenced by activities during the drilling project in the Palagua-Caipal Field, the resulting outline with and without environmental measures, and an assessment of the industrial safety risks involved during drilling. It is important to note that the drilling activities in the Palagua Field will be carried out in the already existing oilfield area. This implies that no new areas will be used, thus, environmental components will not be significantly affected when compared to previous assessments. The results will establish measures and recommendations in the current Environmental Management Plan (EMP) in categories like Hygiene, Industrial Safety, Occupational Health and the Social Management Plan.

4.2 ENVIRONMENTAL ASSESSMENT

In the environmental assessment of the project "**DRILLING OF DEVELOPMENT WELLS AT THE PALAGUA-CAIPAL FIELD",** located in the municipality of Puerto Boyaca, Department of Boyaca, the possible impacts of activities that may develop during the project are identified and quantified. This includes control, protection, mitigation and compensation measures.

– 4.2.1 AFFECTED ENVIRONMENT

An affected environment is defined as one that has changed in one or more environmental, socioeconomic or biophysical characteristic over any length of time. Therefore, it is important to determine the most relevant environmental components in the area and for the specific project. The following is a description of the previously mentioned components.

The Environmental Impacts (EI) in this evaluation are those that may result from activities to be implemented during the project **DRILLING OF DEVELOPMENT WELLS AT THE PALAGUA-CAIPAL FIELD,** located in the municipality of Puerto Boyaca, Department of Boyaca, including changes to Geospheric, Atmospheric, Hydric, Biotic, Socioeconomic and Cultural components. The goal of this assessment is to establish and coordinate the control, mitigation and compensation measures in the Environmental Management Plan.

– 4.2.2 IDENTIFICATION OF IMPACT

It is necessary to establish the type and level of change that may occur in the Abiotic, Biotic and Socioeconomic environment as a result of well drilling activities. The impact is based on the profile of the affected area. The profile comes from the Environmental Base Line.

The method selected to detect and quantify the impact is based on a matrix design which compares the project, environment and socioeconomic component. This is to analyze the activities that trigger processes that change the environment of the project.

For this purpose, the sequence ACTION – EFFECT – IMPACT was used with the following definitions:

ACTION: An operation or task required to execute an activity of the project.

EFFECT: A physical, biotic, economic or social process that is activated, suspended or modified by the project's activities.

IMPACT: A change, whether beneficial, harmful or indifferent, that is generated by an action upon the environment or other component.

The following are activities forseen in the project that may affect the physical, biotic and social aspects, causing an impact.

4.3 IMPACT EVALUATION FOR ACTIVITIES TO BE EXECUTED

4.3.1. METHOD OF IMPACT EVALUATION

The following describes the method proposed by Vicente Conesa1, used to carry out the identification and assessment of possible impacts that may be generated in the drilling activities of the wells at Palagua – Caipal Field.

To identify, predict and evaluate impacts, the Environmental Base Line served as a profile. It is a framework for the analysis of how the project may modify the environment, including the population, its infrastructure and activities.

Also, this information was used to compare aspects of similar areas that are in the drilling stage and/or are neglected, so as to establish the consequences of specific actions.

The environmental assessment includes qualitative procedures, whose results will be analyzed for validity in the following scenarios:

- Scenario without project (S-WP)

[1] CONESA ,VICENTE. Methodological guide for the evaluation of environmental impact. (Methodological Guide To Evaluate Environmentla Impact). Editions. Muni Press. Barcelona-Spain 2000.

♦ Scenario with project

- Scenario with project (Without Environmental measures)

- Scenario with project (With Environmental measures)

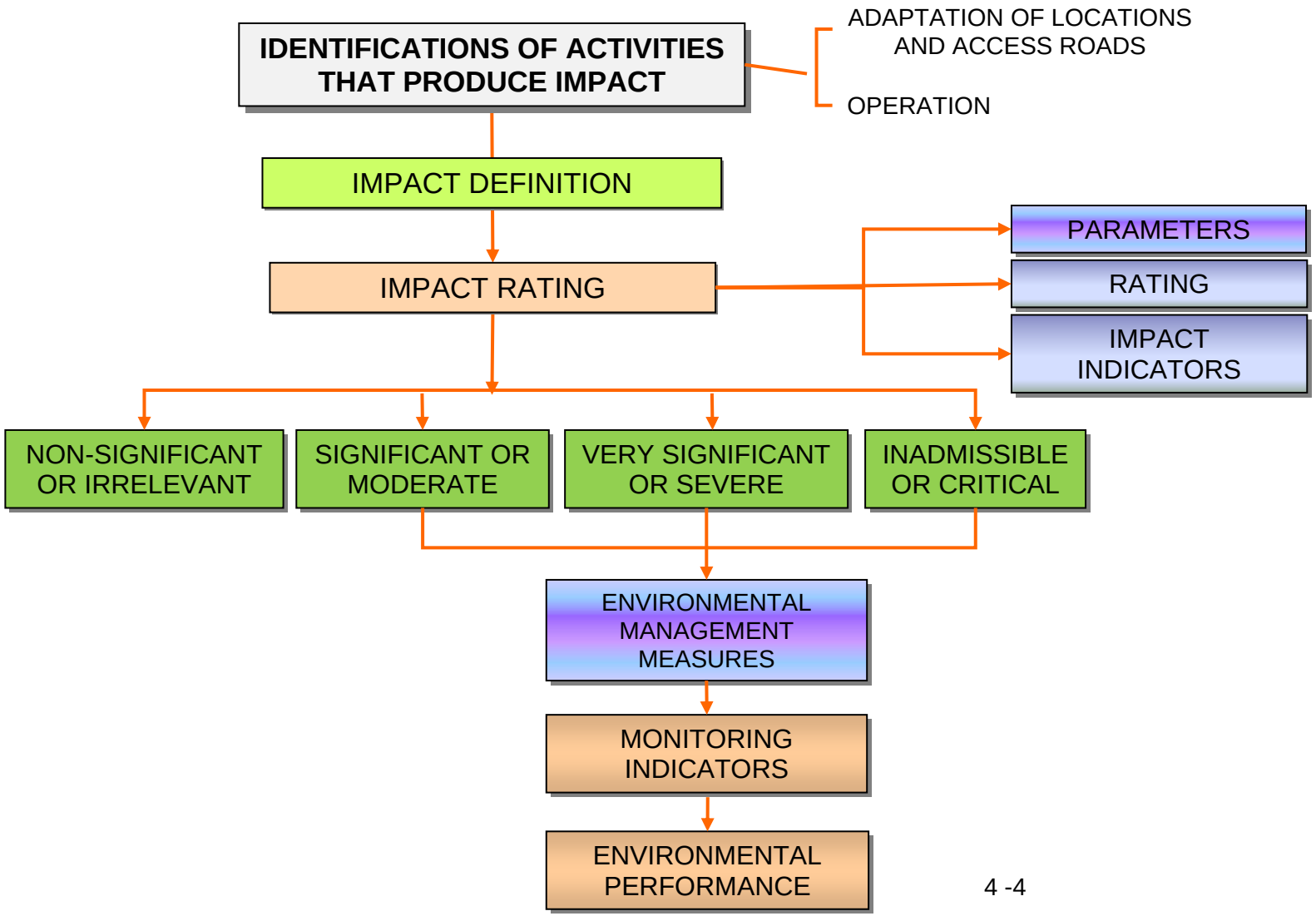
The Scenario Without Project is evaluated using the information contained in the Base Line. This includes the structure and dynamics of the current environmental area of study while not considering the activities of the project. In the other scenarios, (With Project, With and Without the Environmental Management Measures) the main impact of actions in the installation stage, adaptation of the area, drilling and dismantling and restoration of Palagua's field are considered both with management measures and without them.

The basic stages of impact evaluation proposed for the project are:

♦ Impact Identification.

♦ Qualitative Impact Assessment.

IMPACT ASSESSMENT METHODOLOGY



4.3.1.1 Impact Identification

First, the goal is to create a Cause – Effect matrix. This refines the number of situations possible in the project.

The preliminary identification and evaluation of potential environmental impacts was performed according to the following procedure:

- Identification of activities and events that can generate the greatest environmental impacts (Disintegration of the Project).
- Identification of systems, subsystems, environmental components and environmental factors susceptible of being affected.
- Identification of potential environmental impacts expected when comparing the environmental and project components in a simple matrix of interaction and relation (Cause – Effect).

In order to identify project activities that may generate impacts, the project was divided into three stages:

A. Installation and Area Adjustment Stage

This stage includes preliminary activities such as demarcation of the drilling area. Additionally, it includes any influence of the residential community in the area under the influence of Palagua Field.
This stage includes all activities in the Project Description that involve modification to the area under direct influence.

B. Operative – Drilling Stage

This stage corresponds to all the activities identified as well drilling of **PALAGUA-CAIPAL FIELD, LOCATED IN THE MUNICIPALITY OF PUERTO BOYACA, DEPARTMENT OF BOYACA.**

Included in the variables for the Preliminary phase are:

- **Manual Labor Recruitment**

This refers to the personnel requirements that a project may generate and the methods used for this recruitment.

- **Area Demarcation**

This refers to the physical demarcation of the work area with any kind of material or element that indicates a restriction for a passer-by or crossing vehicles, whether temporarily or permanently, or creates an access road or roads to the drilling areas.

- **Reforestation**

If the area where the drilling wells are located is covered with weed species, then it does not require reforestation at any of the stage of the project.

Once the activities and events of the project which generate the strongest impact are identified, then other environmental components and/or processes (of the physical, socioeconomic and cultural environment) that can be affected are identified. They are selected based on information from the environmental profile, including zoning of the area of influence.

The same format was used to establish the variables of the project and organize the collected information. The next step was to review, organize and sort out the information in order to find the variables that identify impact. Table 4.1 includes a list of the variables or environmental indexes used in the assessment.

Table 4-1 Environmental Factors

SYSTEM	SUBSYSTEM	ENVIRONMENTAL COMPONENT	AFFECTED ENVIRONMENTAL FACTORS
PHYSICAL ENVIRONMENT	INERT ENVIRONMENT	AIR	Air Quality
			Noise Levels
		WATER	Water Quality
		SOIL	Soil Quality
			Stabilization
	BIOTIC ENVIRONMENT	FLORA	Replanting
			Green Spaces
	PERCEPTUAL ENVIRONMENT	LANDSCAPE	Landscape Visual
SOCIOECONOMIC AND CULTURAL ENVIRONMENT	URBAN CENTERS ENVIRONMENT	LOTS	Tenure Type
	SOCIOCULTURAL ENVIRONMENT	SERVICES	Travelling Times and Costs
			Public Utilities
		HUMANS	Social Relations
			Inter-institutional Relations
			Accident Rate
			Risk and Safety
	ECONOMIC ENVIRONMENT	ECONOMY	Labor Supply
			Productive and Service Sector

The components susceptible to being affected are described in the profile done in the Environmental Base Line. The following is a description of each of them.

- **Air Quality – Impact: Increase in Atmospheric Emissions and Particulate Matter.**

This refers to the concentration of suspended particles, NOx, SOx, CO; other pollutants would be: hydrogen sulfide (H2S); volatile organic components (VOC); methane and ethane; benzene, ethylbenzene, toluene, and xylenes (BYEX); glycols; and polycyclic aromatic hydrocarbons (PAHS) present in the project area and that may produce risk, harm or discomfort to people; during installation or operation.

The greenhouse effect gas emissions (GEG) that are significant (>1000,000 tons of CO2 equivalent per year) from facilities and support activities must be quantified annually as aggregated emissions.

It is important to maximize energy efficiency. The global objective should be to reduce emissions into the air and assess cost effective options from a technical point of view to reduce emissions.

The facilities should be equipped with a dependable gas detection system that can isolate the source of the leakage and reduce the gas leaks. Equipment should be isolated or depressurized in order to reduce the system of pressure, thus reducing the overall flow of a leak. Gas detection mechanisms should also be used to authorize entry and authorize activities performed within confined spaces.

- **Noise Levels – Impact: Increase in Noise Levels**

Audio impacts are calculated via evaluations of noise in the developments near local population settlements. They are the acoustic pressure levels (L) measured in decibel units (dB), that are represented by (Leq), (Lmin), and (Lmax). The greatest impact would be in the sensitive areas. This may be controlled by implementing environmental management measures.

- **Water Quality – Impact: Water Quality Alteration.**

This refers to the physical – chemical changes of streams made by toxic substances, sediments, solids, or waste water produced by a project activity. It is considered unlikely to alter a water source, since they are located in areas away from the oil and gas field installation. However, formation water is produced when brought to the surface during hydrocarbon production. Due to its large volume, this stream of water might represent the largest waste product that the oil and gas industry has to manage and dispose of into the earth. The water produced contains a complex mixture of inorganic compounds (dissolved salts, metal traces, suspended particles) and organic compounds (disperse and dissolved hydrocarbons, organic acids) and, in many cases, waste chemical additives (e.g. scale and corrosion inhibitors) that may be added during the hydrocarbon production process.

- **Soil Quality – Impact: Soil Quality Alteration.**

This refers to possible changes in the chemical properties of the soil, like pH, Cation Exchange Capacity, salinity, nutrient content and organic matter or a reduction of the possibilities of life in the soil due to building waste (cement, iron, resins, etc.), lubricants, and fuel. In any case it is considered a low environmental impact.

- **Stability – Impact: Soil Stability Alteration.**

This refers to the possible soil changes resulting from oil mining and building activities that include seismic tracks, wells, and temporary facilities like base camps for workers, storage of material (pipes), workshops, and access roads. These impacts are considered of low environmental importance.

- **Replanting – Impact: Replanted Areas Intervention.**

This refers to the replanting of previously existing trees in the drilling areas. Since the existing tree species in the area will be preserved, there is no need to perform any type of forestry treatment.

- **Green Spaces – Impact: Green Spaces Intervention.**

As stated above, the drilling area will not significantly alter a large amount of green spaces, temporarily or permanently, while the installation and drilling activities take place. The permanent effects depend on the restoration of the affected area.

- **Landscape Visual – Impact: Landscape Visual Alteration.**

This includes all landscape components; in this case it refers to replanting, green spaces and use of the land with respect to nearness to a town, the number of potential observers, and accessibility to observation and communication points. Once the drilling activities end, it is expected that the effect on the visible landscape be positive.

- **Type of Ownership – Impact: Modification of Tenure Type.**

This factor only applies to the resident population of Palagua Field. Different areas will be impacted in different ways according to their type of tenure (owners, tenants, holders).

- **Public Utilities – Impact: Alteration in the Delivery of Public Utilities.**

This refers to the possibility of public utility interruption as a result of the installation or operation stage. It is expected to be minimal and not affect the population.

- **Social Relations – Impact: Absence or Presence of Conflict with the Population.**

This entails the reaction of the population located in the area under direct or indirect influence. This includes a favorable manifestation (absence of conflict) unfavorable manifestation (presence of conflict) or even indifference to the project.

It is suggested that conflict can be prevented, reduced or mitigated with proper implementation of recommendations made in the Social Management Plan.

- **Inter-institutional Relations – Impact: Absence or Presence of Conflict within Institutions.**

This refers to the communication between Institutions related to project development. Also, it refers to the connections established within entities and their activities in the building stage that may be assessed by the number of incidents, problems or difficulties registered in a determined period of time. An adequate arrangement should generate fewer conflicts and setbacks.

- **Accident Rate – Impact: Increase or Decrease in Accident Rate.**

This is found through the number of accidents or incidents (of various types) that may occur during the installation and drilling periods. The goal is to effectively establish measures proposed by the Environmental Management Plan.

- **Risk and Safety – Impact: Exposure to Risk Factors.**

This refers to the statistics of work accident and incident rates directly related to staff education, training, advisory and follow up as well implementation of strategies proposed in industrial safety plans, occupational health, emergency planning, etc. The above statistics are the baseline used to establish the behavior of this variable. If none are available, then records from other drilling projects within Palagua Field are to be used.

- **Labor Supply – Impact: Change in Employment and Unemployment Levels.**

This factor's purpose is to evaluate labor demand in the region and its effects on local labor supply. The measure proposed in the adaptation stage aims to observe statistics that evaluate the impact.

4.3.1.2 Identification of Cause – Effect Relations between Actions of the Project and Environmental Factors.

To identify impact, it has been proposed to carry out a simple matrix analysis to establish which relations Project-Environment are the most important in different scenarios and sectors which will be presented in depth in the following stages of the environmental assessment.

The identification matrix (found at end of chapter) shows the most relevant activities of the Project during the adaptation and operation stages that produce the highest impact in the columns. It shows the systems, subsystems and environmental factors that are more susceptible of being affected during the execution of the project in the rows. These environmental factors are organized into the physical, socioeconomic and cultural environments and the components air, soil, flora, landscape, services, humans, and economy.

The results of the impact identification are included in the corresponding tables. This creates the base of the other activities of the environmental assessment.

4.3.1.3 Qualitative Assessment of Environmental Impact.

According to the method proposed by Conesa (2000), the impact is qualified using Impact Importance (II) or an importance matrix that clarifies each impact in specific sectors and situations. The final results of the scenarios are used to make a comparison and thus either establish the effectiveness of considered measures or propose new environmental management and control options.

These matrices identify, prevent and communicate effects on the environment. The elements are: nature, intensity, extension, moment, permanency, reversibility, synergy, accumulation, effect, timing and recoverability (Conesa, 2000).

The parameters to be evaluated and the range described by Conesa (2000) are listed in **Table 4-2**.

Table 4-2 Criteria to develop the importance matrix

CRITERIA	SYMBOL	DESCRIPTION
INTENSITY	I	Frequency of an action on the element in the area of operation. Range: 1 -12, where 1 is minimal effect and12 is total destruction of the element or process in the environment in the area.
EXTENT	EX	Area of influence impacted, including project surroundings. Range: 1-8, where 1 is a localized effect in less than 50 m in the surrounding area, 2 is a partial impact when the extent reaches between 50 and 200 m of the work area, 4 is an extensive impact that reaches between 200 and 500 m of the work area, and 8 is when the effect does not admit a precise location at all within the project surroundings.
MOMENT	MO	The period that the impact is displayed refers to the time between the onset of an action (to) and the beginning of an effect (tj) on the environmental factor under consideration. Range: 1-4, where 1 is Long Term, when the effect takes longer than 5 years to manifest, 2 is Medium Term, a period between 1 and 5 years, and 4 is Immediate, when zero time has elapsed or Short Term, when it is less than a year.
PERMANENCY	PE	The period that the effect will supposedly last from the moment it appears to the moment the previous conditions return by natural means or as a result of corrective measures. Range: 1-4, where 1 is a fleeting effect that lasts less than one year, 2 lasts between 1 and 10 years, and 4 lasts more than 10 years.
REVERSIBILITY	RV	The possibility of reconstructing the element affected by the project. Range: 1-4, where 1 is a short term value, 2 is a medium term value, and 4 is an irreversible effect. The time periods definitions are the same as the previous parameter.
SINERGY	SI	The combination of two or more simple effects. The total impact of simple effects produced simultaneously is higher than the impact of simple effects carried out independently.
ACUMULATION	AC	The progressive increase in amount of the effect when the effect persists from the first manifestation and occurs again. Range: 1-4, where 1 does not produce cumulative effects (simple accumulation), and 4 is the highest accumulation.
EFFECT	EF	The cause – effect relationship, also known as consequences of an action. Range: 1-4, where 1 represents an indirect consequence of an action and 4 is a direct consequence of an action.
PERIODICITY	PR	The repetition of an effect in an unpredictable way (irregular effect), or constant in time (constant effect). Range: 1-4, where the effects are irregular or discontinuous, and 4 when the effects are constant.
RECOVERABILITY	MC	The possibility of a total or partial rebuilding of the environmental element or process affected by the project through the introduction of corrective measures. Range: 1-4, where 1 is completely and immediately recoverable, 2 if it is recoverable within a medium term and 4 if it is partial or if it is irrecoverable via natural actions but is recoverable by introducing compensatory measures.

The rating scales that are assigned to these criteria for the purpose of classifying the Environmental Importance in the process of assessment were taken from Conesa's method, and are presented in **Table 4-3**

Table 4-3 Impact Importance.

NATURE		INTENSITY (I)	Degree of Incidence
Beneficial Impact Harmful Impact	+ -	Low Medium High Very High Total	1 2 4 8 12
EXTENSION (EX)	Area of Influence	MOMENT (MO)	Term of Manifestation
- Punctual - Partial - Extensive - Total - Critical	1 2 4 8 (+4)	Long term Medium term Immediate Critical	1 2 4 (+4)
PERSISTENCY (PE)	Permanence of the effect	REVERSIBILITY (RV)	CHARACTER
- Fleeting - Temporal - Permanente	1 2 4	Short Term Medium term Irreversible	1 2 4
SYNERGY (SI)	Manifestation regularity	ACCUMULATION (AC)	Progressive increase
- Without synergism - Synergic - Very synergic	1 2 4	Simple Cumulative	 1 4
EFFECT (EF)	Cause/Effect Relation	PERIODICITY (PR)	Area of Influence
- Indirect (Secondary) - Direct	1 4	- Periodical - Continuous	1 2
RECOVERABILITY (MC)	Anthropic Rebuilding	IMPORTANCE (II)	
- Immediately recoverable - Recoverable at a medium term - Mitigable - Irrecoverable	1 2 4 8	I = (3I + 2EX+ MO+ PE+RV+SI+AC+EF+PR+MC)	

The importance of each identified impact for each scenario is established from the following equation proposed by (Conesa):

$$I = (3I + 2EX + MO + PE + RV + SI + AC + EF + PR + MC)$$

The Impact importance (I) according to the proposed equation ranges from 13 to 100. The intermediate values are between 40 and 60 including some of the following circumstances:

- Total intensity but minimal effect on remaining factors.
- Very high or high intensity with high or very high effect on remaining factors.
- High intensity, irrecoverable effect and very high effect on remaining factors.
- Medium or low intensity, irrecoverable effect and very high effect on at least two of the remaining factors.

The impacts with importance values lower than 25 are irrelevant. Impacts with a value of importance of between 25 and 50 are moderate. Impacts with a value between 50 and 75 are severe. Impacts with a value of more than 75 are critical.

IMPACT VALUE	IMPACT SIGNIFICANCE
<25	Irrelevant or compatible
25 – 50	Moderate
51 – 75	Severe
>75	Crítical

The environmental importance of project actions can be established using results from the matrix. By comparing the results of two different impacts, it can be stated what activities have a greater impact on envrionmental factors. Also, a score using the above factors can state whether an action is unfavorable, unacceptable, or if an action or modification must take place in order to reverse an unfavorable condition.

To obtain the Absolute Environmental Importance, each row has a weighted sum that indicates the largest incidences, changes or alterations. Each column has a weighted sum to indicate the activities that have the greatest capacity for affecting the environment.

Aspects of the project that generate the higest impacts are identified, evaluated, assessed and quantified. The environmental components and processes that may be affected (such as the physical, socioeconomic and cultural environments) are defined. They are selected based on the characteristics and environmental zoning of the area of influence.

An initial analysis was done with a primary and secondary review by a work group knowledgable and experienced in the development of this type of study. It was added to other operational information and presented by the Union Temporal IJP, in order to determine potential impacts and adjust the scope of the study, based on Impact Importance:

- The activities proposed in the Project do not cause very significant impact to the environment or natural resources.

- The Project does not require building of access roads to the locations of the new wells, since they will be drilled from existing locations that already have their respective access roads.

- For the drilling, an area of 50 m x 60 m approximately will be adapted on the existing location. To avoid enlarging the area, the only thing to be built will be an embankment with filling material so that it may hold its capacity with only surfacing material. This necessitates dragging material close to 500 m3 for a layer of pavement of 25 cm.

- The impacts are localized to the project area.

In conclusion, the preliminary assessment shows the impact of each project activity on the environment with the following results:

- The area of the location and the access roads are composed of sedimentary rocks intertwined with recent streams from the Magdalena River and its tributary rivers.

- Activities like mobilization of equipment and personnel for the project, as well as the use of machinery and heavy equipment may increase the concentration of particulates, noise and emissions temporarily affecting the air quality.

- The impact on vegetation is considered low since it is an area with vegetation cover considered as pasture and weed species on a hill landscape, with palms and isolated trees and intersperced natural forest relicts scattered in the area. In the low or lacustrine areas the dominant vegetation is made up of palms from the Palm Tree family, including: bijao Calathea lutea, Heliconia from the species Heliconia caribaea Lam, and graminea or poaceae from the species Poaceae Barnhard, among others. The impact on flora is considered temporary, reversible and of low consideration for the area to be used.

- The impacts on terrestrial fauna are imperceptible, since there will be no alteration in the habitats, nestlings, and the wild areas will not be altered in a way which may modify fauna behavior in the area.

- The socioeconomic and cultural impacts are low and temporary. This is the most important factor and of greatest relevance for the project, considering employment generation and the benefits that the population has received.

4.4 ENVIRONMENTAL ASSESSMENT WITHOUT THE PROJECT

In the Base Line of the present study the current state of each of the environmental components in the area of direct and indirect influence is established. The assessment scenario defines the environmental supply and demand in the area.

The assessment without the project, defined as the diagnosis of the area, provides parameters of environmental susceptibility and degrees of intervention that have to be taken into account in the environmental management measures proposed in the Management Plan.

- The area is tectonically complex, which makes it attractive for the development of hydrocarbon projects.

- The area is characterized by low hills with moderate slopes

- The soil has some water erosion due to rainfall and mild to severe laminar erosion. In some sectors there are erosion gullies

- No prevalent species of fauna and flora were identified. The representative species of fauna is iguana. The vegetation is mostly in the low area, which has abundant palms, bijao platanillo

and yarumo trees, rubber and mata palo. For the most part, it is an area of pastures with some scattered relicts of intersperced forest in the region

- The population in the rural areas has moved to urban areas, decreasing the population of the farmlands. This is because they do not have access to basic public utilities and services, improvement and automation of agricultural and livestock production, or to increasing productive employment rates. The project tends to slightly improve employment rates in a temporary and localized way.

- The area has medium archeological potential, but specifically the area of the wells does not affect this component. There have been no formal studies for this region of the country. So, there have not been any findings in the last fifty years of activity in the area. It is important to point out that impacts on cultural heritage refer to the harm done by direct intervention of people with the intention to rob tombs, or do irreversible damage to an archeological site is irreversible.

4.5 ASSESSMENT WITH PROJECT

The assessment with the project takes place after the impacts associated with the different activities are made during the execution of the project and identified.

For the physical component six (6) impacts were identified, 100% of them occur during stages 1 and 2, and 50% continued into stage 3. 50% of the impacts identified affect the geospheric component, 17% the hydrospheric and 33% the atmospheric.

For the biotic component, two (2) impacts were identified, which are present during the three stages of the project. 100% of these impacts relate to terrestrial ecosystems due to the effect on the atmospheric component. It is important to make clear that no impacts were identified in aquatic ecosystems as there are no lotic or lentic bodies within the area of influence of the project.

Finally, for the socioeconomic and cultural factor five (5) impacts were identified, occurred during the development of the three stages of project and are related to economic and productive activities and to institutional participation and presence. **Table 4-4** presents a consolidation of the results that were obtained.

Table 4-4 Environmental Assessment Results

IMPACT		1	2	3
1. Destabilization of slopes		L	L	-
2. Change in use of the land		L	L	-
3. Change in the structure of the soil biota		L	L	-
4. Increased demand of groundwater		L	L	L
5. Increase in sound pressure levels		L	L	L
6. Pollution from COx, NOx,SOx, particles and VOC's		L	L	L
7. Temporary alteration of the habitat		L	L	L
8. Temporary migration of fauna		L	L	L
9. Increased demand of services		L	L	L
10. Change in traditional productive activity		L	L	L
11. Temporary employment generation		L	L	L
12. Increased demand of goods and services		L	L	L
13. Increased inter-institutional relations and activities		L	L	L
TOTAL	H	**0**	**0**	**0**
	• M	**0**	**0**	**0**
	L	**13**	**13**	**10**
	H + M + L	**13**	**13**	**10**

Impact of high environmental importance H
Impact of medium environmental importance M
Impact of low environmental importance L

* Stages:
1 –Buildings and adaptations
2 – Drilling
3 – Dismantling and restoration

Source: XIJMA LTDA.- MODIFIED PEREZ S.-2007

According to the previous assessment, we find that 100% of the identified impacts occur during stages one and two. 83% occur during the dismantling and restoration stages.

It is important to emphasize that no impacts of high and/or medium environmental importance occur, which is in accordance with the preliminary assessment and with the characteristics of the project.

The impacts identified in the socioeconomic and cultural aspect are qualified as positive as they improve conditions in the region; only bad management would classify them as negative.

No dismantling and clearing, cutting, leveling or major earthwork activities will be carried out. The only excavation that will take place will be of the drilling rig, which is within the respective existing location built many years ago.

Though the area has a tradition of oil extraction, there have been no projects for a few years. Therefore, the community usually exaggerates the project and its scope. Often a community does not know the selection system of non-qualified personnel, the number of vacancies available or the wage level. This can create false expectations that lead to an increase in the cost of goods and services as well as the movement of people from nearby rural areas in search of better job opportunities. Therefore, recruitment is an activity of special treatment because there is currently no clarity to the community about these factors.

During drilling, the most critical aspect is domestic and industrial liquid and solid waste management. The operation of engines and equipment required for drilling generate atmospheric emissions and noise. Atmospheric emissions are considered of low importance, since in other wells has been proven that the level of affectation of the air quality is low, due to the characteristic of the sources of the emissions and to their temporary nature.

During the dismantling stage, the most important impact is social. The staff is layed off and settlements are made for those who must then return to their agricultural and livestock activities with lower wages. At the Palagua Field, this impact has as an aggravating factor which is the potential increase of the economically active population in the area of influence. After the drilling activities end, and once new families settle in the area, the rural area of Palagua must absorb the increased unemployment rate in the working age population.

4.6 ENVIRONMENTAL INDICATORS

The list of indicators included in **Table 4-5** is shown as model that may serve as reference at the time of defining follow-up indicators for processes directly related to the activity and whose duration is comparable to the duration of the project. It is recommended to begin building based on the information from the environmental management information and completion of the list mentioned.

Table 4-5 Proposed indicators for Environmental Follow-up and Assessment

IMPACT	ENVIRONMENTAL INDICATOR	
	NAME / DESCRIPTION	UNIT
PHYSICAL COMPONENT		
Geospheric		
1. Change in soil structure	Soil Loss	%
2. Increase or production of erosion	Erosion (Soil Loss) Area affected by erosion	m^3/Ha/Year Ha
3. Destabilization of slopes	Number of Events Affected Area	Unit Ha
4. Natural landscape modification of landforms	Fragmentation of Coverage	Ha/Unit
5. Change in land use	Change in Use Capability	Class IV – VIII
6. Change in the structure of the soil biota	Change in the Value of the MO	%
Surface water / Ground water		
7. Change in the use of surface water	Current Flow Use	m^3/s %
8. Aquifer Modification	Current Flow – year average	m^3/s
Atmospheric		
9. Increase in sound pressure levels	Sound Pressure	dB(A)
10. Pollution: COx, NOx, SOx, particles and VOC's	Pollutant Concentration	ppm - ppb - gr/sec
BIOTIC COMPONENT		
Terrestrial Fauna and Fauna		
11. Structural Change in the Flora	Loss of Vegetation Cover	m^3/Ha/year
12. Decrease in Vegetation Cover	Type Area Affected x 100 / total area of project	% type area
13. Habitat Alteration	Alteration of Vegetation Cover	% of cover
14. Fauna Migration	Decrease of Species	Nº Organisms Per Area Unit
15. Change of Food Chain	Decrease of Species	Nº Organisms Per Area Unit

IMPACT	ENVIRONMENTAL INDICATOR	
	NAME / DESCRIPTION	UNIT
SOCIOECONOMIC AND CULTURAL COMPONENT		
Population and Demography		
16. Creation of Community Expectations	Workshops	Number of participants
Public Utilities and Social Services Infrastructure		
17. Increased demand for public services and health	Demand in healthcare attention in the local healthcare centers	% Local consultations / month
Economic and Productive Activities		
18. Temporary Employment Generation	Demand of Non-Qualified Labor Force in the Region	Contracts Tot / month
19. Increased Demand of Goods and Services	Creation of establishments of various services of purchase and sale of food and basic necessities	% new establishments in 6 months
20. Economic Change in Land Use	Area to execute the project and all activities within it	Total of Has. used
Institutional Participation and Presence		
21. Creation of expectations in the institutions	Different proceedings of the Municipal authorities to apply for benefits or claims from project	# claims presented
22. Increased Inter-institutional Relations	Contacts between local and regional entities and companies involved in the project.	Total entities related
Conflicts		
23. Existence of complaints and / or claims	Rights to petition or requests of information regarding the project	# of requests
Archeological Areas		
24. Alteration of cultural and historic registry	Archeological findings	# of findings

Source: XIJMA LTDA- MODIFIED PEREZ S. R.

To construct reliable and useful indicators five main aspects must be taken into account:

1. **Sustainable Development:** This concept implies the relationship of socioeconomic, cultural and environmental factors in time and space dimensions. Therefore, "sustainable development" must be defined for each scenario according to its characteristics.

2. **Environmental Information:** It is ideal to have an environmental information system that provides an integrated and organized data set to allow the improvement and efficiency of the processes of exchange, dissemination and communication of this information.

3. **Pyramid of Information:** In the decision making process there are three clearly differentiated levels to define the concept of indicators and indexes: Information to aid the managerial process, Information to assign a higher value, and Information to reduce the volume of data by identifying particular variables that have a special significance.

4. **Decision Making Cycle:** It is a dynamic process composed of four stages: identification of problems, formulation of policies and strategies, implementation of policies and actions, and evaluation of policies, strategies and actions. In the previous steps, the indicators allow the synthesis and analysis of technical information, taking specific actions on priority issues, identification of problems, setting development objectives and goals, measuring and reporting of trends, developments and state of the environment.

5. **Conceptual Model and Framework.** The Model PRESSURE – STATE – RESPONSE (PSR) (OCDE, 1991, 1993) is accepted worldwide given its simplicity, its ease of use and the possibility it offers to be applied at different levels, scales and human activities.

Additionally, the building of indicators depends on: the availability and quality of information, the different conditions at the region (physical, biotic, socioeconomic and cultural) and the project to be developed. Any scoring that is intended to be defined will inevitably contain a degree of partiality.

4.7 ENVIRONMENTAL IMPACT SENSITIVITY ANALYSIS

The sensitivity analysis determines the change in environmental conditions, while attempting to correct the subjectivity of the evaluation team in the allocation of values to attributes qualified in the evaluation. The intention of this analysis is to assess the sensitivity of the qualitative attributes defined in the method and rated by the interdisciplinary team, by comparing the evaluated scenario under the following circumstances:

- Optimistic Scenario: evaluates the attributes likely to change, assigning them favorable values as compared to the assessed situation.

- Pessimistic Scenario: assigns values to the above attributes under adverse conditions and therefore assigning them move degrading values as compared to the assessed situation.

This analysis is presented through the matrixes for the scenario without Environmental measures and the scenario With Environmental measures (Matrixes attached). The range of variability of the importance of the impact on each of the relationships between the scenario of assessment and the sensitivity scenarios should not exceed 20%, which is the margin of error that is allowed to be corrected regarding the subjectivity of the evaluation exercise.

4.7.1 EVALUATION RESULTS

4.7.1.1 Without Project Scenario Assessment

The scenario "Without Project" is evaluated using the information in the Base Line Study regardless of the project activities, the results are shown below:

❖ **Air Quality:** studies and monitoring have been done on air quality in the Palagua field, which establish concentrations of particulate matter, nitrogen oxides, sulfur oxides, carbon monoxide and hydrocarbons, as stated in Base Line of this study. The places where emissions are evident are within the project site and the largest contribution of air emissions comes from automotive traffic flowing through the drilling sites.

❖ **Noise Levels:** In the Palagua field, high levels of noise are associated with vehicular traffic and the operation of machinery and equipment. However, these levels are considered non permanent and undetectable because they don´t exceed the permitted limits for noise levels.

Noise pollution is one of the factors that have a greater impact on the working population in terms of occupational diseases derived from industries. Ordinary citizens are also affected by this pollution, which is reflected in the physical and mental health of people with increased levels of aggression, decreased job performance and decreased intellectual performance, sleep disturbance, increased stress and fatigue and loss of hearing.

The human ear has the ability to perceive sounds in a wide range of frequencies through a delicate noise receiver system. Noise is defined as the unpleasant sensation of sound that goes beyond the hearing thresholds of ear pain, this threshold is between 120 and 140 decibels (dB). Below is a scale of intensity in decibels of some of the most common sounds. Observe Table 4.6.

Table 4-6 Sound Intensity

Intensity (db)	Sound sensation
0	Hearing threshold
15 – 20	whisper
40 – 50	Normal conversation
80	Intense traffic
100	Upsetting
120 – 130	Air plane – Pain threshold

Although the activities taking place in the Palagua field correspond to industrial work, impact by SPL Sound Pressure Levels is low. The Company has taken the preventive and control measures to avoid the problems due to varying degrees of hearing loss. The company carries out periodical epidemiological surveillance, as well as occupational health prevention programs.

❖ **Reforestation:** In the Palagua-Caipal field, there are many individual trees. The plantings are distributed amongst bush, tree and shrub sizes. The most common species are found in **Table 4-7.**

Table 4-7 Vegetation Profile of Palagua-Caipal field.

COMMON NAME	SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME
Hobo/Java plum	*Spondias mombin*	Iguá/Cadeno	*Pseudosamanea guachapele*
Mango	*Mangifera indica*	Dormidera/Humble plant	*Mimosa* sp.
Marañón/Cashew	*Anacardium occidentale*	Matapalo, caucho/Popenoe fig	*Ficus* sp.
Gusanero/Tigerwood	*Astronium* sp.	Dinde/Fustic tree	*Chlorophora tinctoria*
Anón de monte/Golden Sugar Apple	*Annona* sp.	Cucharo/Myrsine	*Rapanea guinensis*
Palo Seco/Monkey Pepper	*Xylopia aromatica*	Guayabo (dulce)/Guava	*Psidium guajava*
Palma de vino/Yagua palm	*Scheelea butyraceae*	Sapán	*Lathropopis* sp.
Palma de lata/Lata palm	*Bactris minor*	Vara santa/Ant tree	*Triplaris americana*
Palma nolí, corozo/American Oil Palm	*Elaeis oleifera*	Guásimo, Guácimo/Bay Cedar	*Guazuma ulmifolia*
Palma de coco/Coconut palm	*Cocos nucifera*	Teca/Teak	*Tectona grandis*
Totumo/Calabash Tree	*Crescentia cujete*	Tuno	*Miconia* sp.
Gualanday	*Jacaranda* sp.	Dormidera/Humble plant	*Mimosa* sp.
Flor morado, Guayacán/Trumpet tree	*Tabebuia rosea*	Mastranto/Bolita	*Hyptis brachyata*
Balso/Balsa	*Ochroma lagopus*	Palma iraca/Panama Hat Plant	*Carludovica palmata*
Yarumo o guarumoPumpwood	*Cecropia* sp.	Platanillo/Flase Bird of Paradise	*Heliconia* sp.
Palma iracaPanama Hot Plant	*Carludovica palmata*	Bihao	*Calathea* sp.
Almendro/Almond	*Terminalia* sp.	Pasto guinea/Guinea Grass	*Panicum maximum*
Lechero	*Sapium marmieri*	Carimagua/Gamba Grass	*Andropogon gayanus*
Matarratón/Mouse Killer	*Gliricidia sepium*	Pasto alemán/German Grass	*Echinochloa polystachya*
Abarco or Chibugá	*Cariniana pyriformis*	Pasto puntero/Jaragua Grass	*Hyparhenia rufa*
Ciruelo or Cafe	*Bunchosia* sp.	Braquiaria, pasto alambre/Surinam Grass	*Brachiaria decumbens*
Cedro/Cedar	*Cedrela odorata*	Helecho/Ferns	*Acrostichum* sp.
Guamo	*Inga* sp.	Samán/Rain Tree/Monkey Pod	*Samanea saman*
Payandé, gallinero/Madras thorn	*Pithecellobium dulce*		

SOURCE: Palagua Field Observations

❖ **Green Areas:** The green areas are constituted mainly by weeds distributed throughout the field.

❖ **Soil:** According to the soil study of developed in the area, there are:

The Palagua production field is located in the Middle Magdalena Valley, where there is a basin of tectonic origin. The boundary on the East is made of the faults of the foothills of the Cordillera Oriental and to the boundary on the West is made of the faults of the central cordillera. A tectonic depression is molded throughout the area, mainly by Tertiary rocks, which have verticalised thrusts and dips at the higher parts and are leaning toward the east in depth.

Environmental factors, such as tenure type, time and travel costs, utilities, social relationships, inter-institutional relationships, accidents, labor supply, risk and safety are identified as factors affected by the "With Environmental measures Project and Without Environmental measures Project" scenarios. They are not discussed in the "Without Environmental Measures scenario" since the impact on these environmental factors occurs because of the project and there is no baseline data. These environmental factors will be evaluated in the scenario "with project" and measured during the implementation of the project activities through the indicators proposed in the Environmental Management Plan.

4.8 RESULTS ANALYSIS WITH PROJECT SCENARIO

After defining the affected environmental factors and the project activities, they were compared using the impact identification matrix which outlines 64 relationships that reflect the environmental effects. These are indicated in the corresponding matrix.

Of all the relationships established or identified impacts, there were 14 positive relationships, which represent 31.8% of all relationships. The 30 remaining relationships (68.2%) were negative, indicating that at the level of impact identification the proposed activities for this sector exert some adverse changes which obviously have to be prevented, controlled, mitigated or compensated.

Having identified the relationships their importance is determined for each of the impacts for the scenarios "Without Environmental Measures" and "With Environmental Measures". Each of the 64 established relationships were described using qualitative attributes: Intensity (I), Extension (EX), Moment (MO), frequency (PE), reversibility (RV), Synergy (SI), Accumulation (AC), Effect (EF), frequency (PR), Recoverability (MC).

The parameter values of identified impacts show which impacts are the most important and also some characteristics and behaviors of them in order to establish how and through what measures they can be controlled, which is that what arises in the scenario " With Environmental Measures. "

- ***Preliminary Stage***

For this stage, 19 relationships were evaluated; of which 36.8% (8) are positive in their nature and the remaining 63.2% are negative. In the scenario "Without Environmental measures" 15.8% generate a severe impact and 47.4% (a moderate one), the remaining data (36.8%) are positive impacts, therefore do not apply. While the scenario "With environmental measures" has no existing link that generates a severe impact, 47.4% (9 relationships) generate a moderate impact and 15.8% (3 relations) are regarded as irrelevant or compatible impacts, the remaining (36.8%) did not apply.

***Negative impacts*:** The results of impact assessment conclude that during the preliminary stage of the project, the action that generates greatest negative impact on the scenarios "Without Environmental measures" and "With Environmental measures" is corporate management, which is related to the factor of employment opportunity because of the expectations generated by community regarding the exploitation of new wells in the area.

With respect to the forestry intervention activity, the project plans to be developed in areas free of tree plantations, where there are only weeds. Since it is not necessary to build access roads, the impact will be minimal. However, the excavation material extracted will be used in the capping of the areas around the wells as a mitigation measure. Low impact will be controlled during these Project activities.

It is important to note that the reported forest species, correspond to existing paths in the area of influence of the wells, therefore, they are not considered an itemized list or an inventory of species.

The use of existing infrastructure facilities in the area moderately affected air quality. It occurs immediately, generating a direct effect on the environment. The intensity degree is low because the impact was generated by communities. The other drilling well facilities and their operations did not generate any negative environmental impact. The scenario with Environmental measures considered the importance value irrelevant or compatible.

***Positive impacts*:** The action that generates the greatest positive impact in the scenario without measures is the temporary sign posting about environmental factors, social relations, and relations between institutions; this is a preventive activity that aims to anticipate any environmental and social event. In the scenario "with measures" it is more important when applied to social relations as it is a preventive measure, it should cover more than 500 m. This same action when applied to inter institutional relations specifically refers to the degree of participation of related institutions in the region; they should continue to participate during different stages of the project.

The action that generates the least positive impact at this preiminary work stage is the relationship between the fencing of the project and the accident risk factor, which has a transitory impact generated in a limited area. It generates a direct effect on the environment with short-term reversibility and simple progressive increase. The impact on the environment is low. Other qualitative attributes qualified for this ratio correspond to lower values.

In the scenario "with measures," it is encouraged to recruit labor contracts from previous projects in the area. This will help estimate the percentages of those hired, which will aid in building statistics that can be used in other projects.

- ***Stage of Adaptation of access roads to Wells***

For this stage, 13 relationships were evaluated, since there is already an access road, some areas should be adapted. With the evaluation we have that:

***Negative impacts*:** During this stage the action of the project that generates greatest negative impact on the scenario "Without environmental measures" is material handling resulting from leveling of the road. It relates to the environmental factor of air quality with a value of 38 on a scale of 1 to 100. This impact manifested immediately, with a total coverage area of approximately 500 m, generating a low level of impact. It is a cumulative impact as the generation of particulate matter during the development of this activity occurs on a continuous or repeated basis, generating a direct impact on air quality. The reconstruction of the affected factor (air quality) requires mitigation measures. On the scenario "With Environmental Measures" it decreased by 6.5% but frequency remains very low.

The following are the measures that constitute the best tools to prevent the occurrence of minor or severe injuries among the population that works in the project or those that remain outside the area in the vicinity: maintaining a preventive attitude regarding the procedures of this action, slowing down vehicular traffic through the roads both internally and externally, maintaining signs posting information about the quality of Palagua field.

In a scenario "Without Environmental Measures" the operation of machinery and equipment is related to the environmental risk and safety factor, which generates a significant impact, manifested directly on the human environmental component. It has an average frequency rate that spans a large spectrum, because the worker is permanently exposed to exogenous and endogenous risks. In the scenario "With Environmental measures" this impact decreases by 7.46% because the level of frequency goes from very low to medium if measures are implemented and a preventive attitude is maintained regarding the procedures and operation of this equipment.

Timely, accurate and sufficient information, together with adequate training on the use of Personal Protective Elements and adequate procedures to maintain personal safety, become the ideal tools to prevent the occurrence of mild or serious accidents among the population working on the project or those that remain outside the area but still in the vicinity.

The activity called Informative sign posting generates an impact on the environmental risk and safety factor. It directly affects the human component and manifests itself immediately in a large area of over 500 meters, generating a high frequency rate by exposure of workers to both endogenous and exogenous risk factors.

In the scenario "With Environmental measures" the impact passes from being medium to being a moderate impact. Environmental measures to be taken are preventive.

In the scenario "Without Environmental measures" the operation of machinery and equipment related to the accident factor generates a moderate impact. The impact value barely qualifies, which is why preventive environmental measures must be taken to lower the value of impact. At the moment that an accident occurs, which is caused by the operation of machinery and equipment, that impact will manifest itself immediately, generating a direct effect on the human component.

In the scenario "With Environmental measures" preventive measures should be implemented, such as strict compliance with the procedures set for the operation of machinery and equipment. This would make the frequency of the impact go from medium to medium low decreasing the value of the impact by 5.39% while retaining its moderate nature.

One of the activities that generates less impact in the stage of installation and operation is related to the social factor. It generates a moderate impact as this activity is paired with functions of the Company that has been in operation since 2001. The extensión of this impact does not exceed 50 continuous meters, and its effect would be recovered in the short term with the installation of new wells and the regularity of the manifestation of the impact is considered irregular because it is expected that the degree of impact on the factor to be low. Other activity with less impact is excavation, which is associated with stability factors, adaptation of the area.

With the adoption of environmental measures, the impact generated by the stage of installation and operation, concerning the stability factor decreases by 11.11% becoming irrelevant or a compatible impact. In this case, environmental measures are incorporated into the stages of the project through compensation by leveling the neighboring land. There will be no removal of material from the area, because it will be used in shaping the field, which is favored by the characteristics of the soil in the area.

The operation activities in the field and in offices go from being a moderate impact to irrelevant or compatible with the adoption of preventive environmental measures in anticipation of any environmental or social event that compromises the proper environmental management of the Project. This implies that the activity has to be timely in the identification of abnormal situations and has to have appropriate measures such as those stated in the Environmental Management Plan.

***Positive impacts*:** The activity of shaping or grading, allows for the project to keep the landscape component as relates to environmental factors, visual landscape, tree planting, social relations and inter-institutional relationships. This generates a positive impact in both scenarios because the development of this activity gives uniformity to the area, without affecting the current conditions of the soil, improves the visual landscape, consolidates and ensures the continuity of landscape and scenic part through the labor of installing the wells and, at the same time creates and consolidates areas for plants to regrow which will result in improving the quality of the biota of the area.

- ***Operation Phase***

12 relationships were evaluated on this stage where 75% (9) of them are positive in nature and the remaining 25% are negative. Regarding those with negative character of the impact generated, 33.33% of them are moderate and 66.67% are Low. In the scenario with

environmental measures, 100% of the relationships with negative impacts generated are moderate.

Negative impacts: At this stage the activity of the Project that generates greater negative impact on the stage "Without environmental measures" is the activity of drilling to extract and transport oil.

The service has two particular characteristics, the first derived from the typical drilling operating conditions and the second derives from the circumstances required for channeling the product, which in some cases depend on the facilities and existing connections. This aspect is particularly relevant in light of the development strategy of the production system. This impact appears immediately in a large area, and is reversible, once this stage is completed.

Positive Impacts*:* The operation for oil drilling and conduction in the Palagua field related to environmental factors, visual landscape, social relations, accident rate, changes in current use, and job opportunities, generates a positive impact in both scenarios. The above taking into account that in the operation phase the landscape design (which is kept) and the operating system have already been implemented. Thus, the development of this activity gives uniformity to the area by improving the visual landscape, favoring the population by improving their quality of life with Company educational programs, and upkeep of access roads to the area.

4.9 RESULTS OF THE SENSITIVITY ANALYSIS

The results obtained in the sensitivity analysis are included under the following scenarios:

In the optimistic scenario "With project Without Environmental Measures" the relationship that showed the greatest variation in the assessment was the operational stage with positive social relations that are scarcely within the range established for the development of a sensitivity analysis value with an amount of 20%. This changes the impact from medium to moderate. Next is the use of machinery and equipment in the installation area. It requires the adaptation and geo-conformation of the surrounding areas, due to the variation in impact, the general impact changed from medium to low, the latter being the truer representation of the impact.

The stable filling action has an overall positive nature, since it changes the impact on the environment from medium to low.
In the pessimistic scenario the highest value was in material, machinery and equipment management. The impact changed from high to medium because there was no variation in qualitative factors.

The accident rate in machinery and equipment operation changed from high to very high. As above, the variation ranges resulted from the change in the impact due to extension.

In the optimistic scenario “With Environmental measures” Informative sign posting was the only relation whose value went from medium to low. As in the scenario “without Environmental measures” the relations between the optimistic and pessimistic scenarios varied by impact value.

In the pessimistic scenario As happened with the installations and operations in other fields, the impact on field or office operation in social relations changed from medium to low with internal and external sign postings for circulation and drilling areas.

The implementation of new wells did not result in any change with inter-institutional relations in the pessimistic scenario since it is a singular activity and generates a medium degree of incidence on the human component.

Looking at the sensitivity analysis, the intensity and extension factors create the higest variation since they are the most significant in the environmental impact importance calculation. The remaining factors can generate no more variation than 10%.

4.10 ENVIRONMENTAL INDEXES OR INDICATORS

– 4.10.1 ENVIRONMENTAL QUALITY INDEXES (EQI)

The Environmental Quality Indexes quantify the measurements in the Base Line and include the variations between the situations With and Without project to monitor and follow up on each of the environmental fators.

These indexes are calculated using measurable physical environmental factors during diagnostic activities. They establish current conditions so they may be used for future extrapolation or comparison with regulation values.

No global impact on an environmental factor can be given as the selected parameters are in heterogeneous units. Therefore, the different units need to be homogenized. An alternative is to obtain the environmental quality indexes (EQI) of each environmental parameter.

In order to establish environmental quality values to different impacts, relative transformation curves from previous projects can be used. Every previous project has a variation between 0 and 1. Alternatively, if no comparison curve exists, then the current situation can be compared to previous situations, thereby establishing possible changes and ranges of variations. This makes it easy to assign a situation to an index or comparison.

This situation can be used on variables such as air quality, noise levels, landscape visuals, green spaces, accident rate, among others. Social and community situations are less likely to have a transformation curve, as they have less information.

– 4.10.2 DETERMINATION OF THE ENVIRONMENTAL QUALITY INDEXES (EQI)

No global impact on an environmental factor can be given as the selected parameters are in heterogeneous units.

Once the impact values for each project activity have been determined, the different units need to be homogenized to obtain the EQI.

Each environmental component with an Environmental Quality Index must have a definition, which has to be dynamic, representative, reproducible and if possible quantifiable.

In the expressed transformation function, each environmental factor is seen as a value between 0 and 1, where 1 is assigned to the optimal or favorable Environmental quality situation and 0 to the most unfavorable. This defines the status of Environmental Quality.

This function can be linear or curved, with a positive or negative slope, or may have a maximum or intermediate minimum point, or other kind of shape according to the ratio Quality – Magnitude.

To develop the present assessment the following indexes were studied and analyzed for the current operation scenarios:

- Air Quality **(EQI-1)**
- Noise Levels **(EQI-2)**
- Establishment of the soil **(EQI-3)**
- Green Areas **(EQI-4)**
- Visual Landscape **(EQI-5)**
- Social Affairs **(EQI-6)**
- Accident Rate **(EQI-7)**

The measurements of noise fulfill following standards:

- **IEC 61672-1 (2003)** (2002-05) - Electroacoustics, Sound level meters, Specifications and Pattern evaluation tests.
- **IEC 61260 (1995-08)** - Electroacoustics, Octave-band and fractional-octaveband filters.
- **ANSI S1.11-2004** - American National Standard "Specification for Octave- Band and Fractional-Octave-Band Analog and Digital Filters."
- **ANSI S1.4-1983 (R2001)** - American National Standard "Specification for Sound Level Meters."
- **ANSI S1.43-1997 (R2002)** - American National Standard "Specifications for Integrating Averaging Sound Level Meters."
- **Earlier standards** - IEC 60651 and IEC 60804.

The water measurements are in accordance with the **Standard Methods for the Examination of Water and Wastewater** of the **APHA, AWWA and WEF** in the latest version.

The values for each environmental component are in their respective matrixes. For landscape visuals, the values were obtained by assigning a scale value and broken up into different categories. This proposed method uses a scale of absolute values (Av) that are determined by assigning values to the variables Green Spaces and Land Use; this highlights that the hydrical component for the project is of low importance since there are no still or running waters in the area to be disturbed.

$$Av = GS + LU$$

The addition of these landscape or scenic components will define the values of the indexes (EQI-5) according to the ranges indicated in the following table:

Character	Value
Spectacular	16 to 25
Superb	8 to16
Distinguished	4 to 8
Nice	2 to 4
Simple	1 to 2
Unpleasant	0 to 1

The value obtained from Av is corrected for closeness to human settlements, to internal and external roads and the traffic in them, to the potential population of observers, and the accessibility of the observation points obtaining a relative value.

Finally, the value of the landscape is determined (Lv) through the following equation:

$$L_v = K * Av$$

where: $$K = 1.125 * [P / d * Ac * S]^{1/4}$$

P = Average size of the population close by (inhabitants in the Area).
d = Average distance in Km, to the closest town,
Ac= Accessibility to observation points or visual basin (Immediate = 4, Good = 3, Medium = 2, Bad = 1 and Inaccessible = 0).
S = Surface from which the visual basin is perceived (Very big = 4, Big = 3, Small = 2 and Very small = 1).

The values of **P** and **d** are established according to the following figures:

Inhabitants	P	Distance (Km)	d
1-1000	1	0-1	1
1000-2000	2	1-2	2
2000-4000	3	2-4	3
4000-8000	4	4-6	4
8000-16000	5	6-8	5
16000-50000	6	8-10	6
50000-100000	7	10-15	7
>100000	8	>15	8

For the operation stage was determined using the same method, taking into account the affectation data of the green spaces and the area of social influence.

4.11 IMPACTS FROM RISKS OF INDUSTRIAL SAFETY AND OCCUPATIONAL HEALTH

There is a wide range of impacts of Industrial Safety and Occupational Health risks. This range is directly connected to determining eventual situations that may occur between variables of the project. These variables are considered part of the impact assessment in the installation and operation stage of the project. The risk factors can be divided into two categories: endogenous and exogenous

The first category, endogenous, comes from factors inherent to project activities. The latter, exogenous, comes from external factors and have nothing to do with the project, but may still generate very significant problems and impacts.

For the purpose of assessing impacts resulting from Industrial Safety and Occupational Health, matrices were developed in which the columns are the selected variables and the rows are the risk variables separated among endogenous containing 8 risk factors, as follows:

- Physical
- Chemical
- Biological
- Physical load
- Psychosocial
- Mechanical
- Electrical
- Basic Sanitation

There are 7 exogenous variables. They vary greatly since they are necessarily outside of any established pattern, as follows:

- Terrorist Attacks
- Social Demonstrations
- Common Delinquency
- Thunderstorms
- Earthquakes
- Flooding
- Damage of public property

Risk assessment is the process for estimating the magnitude of unavoidable risks, obtaining the necessary information for making an appropriate decision on the need for preventive measures and, if so, the type of measures that should be taken.

The risk assessment is composed of the following stages:

- Risk Analysis, through which danger is identified
- Risk Estimation, assessing the probability and the consequences as a whole if the danger manifests.

The risk analysis will provide the range of magnitude of the risk.

- **Risk Assessment,** Considering the risk value and the tolerable risk, a judgment can now be issued on the tolerability of the risk involved.

If the risk is determined to be unacceptable, it is necessary to control the risk by adopting preventive measures:

- Eliminate or reduce the risk through preventive measures at the source or within the organization, using collective protection, individual protection or training and information for workers.

- Periodically check and control the conditions, the organization and work methods and state of health of the workers.

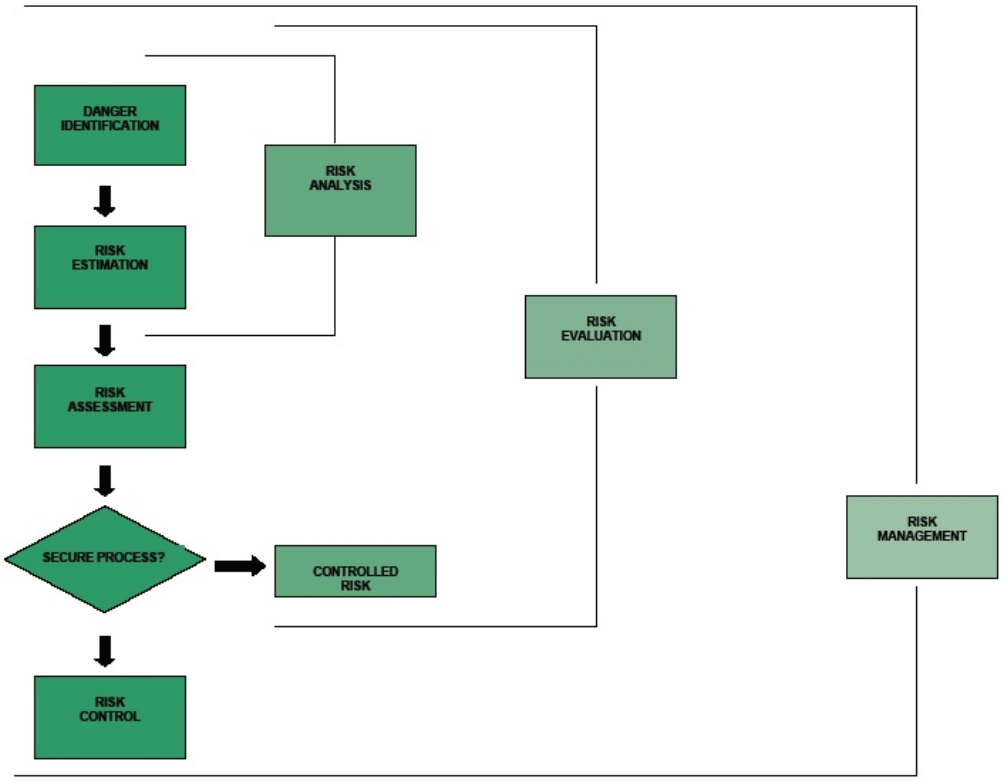


Figure 4-1 Risk Assessment

The only variables selected were those that have significant risk factors. The rest were discarded, creating a more realistic scenario that highlights only the most important risks.

The considered factors are Consequence (**C**), Exposure (**E**), and Probability (**P**). Each is assigned a value between 1 and 10, and the product between establishes the Danger Level (**DL**) with the following equation:

$$DL = C * E * P$$

The "**Danger Level**" on a scale of 1 to 1,000 has a resulting range of:

Low	1 to 200
Medium	201 to 600
High	601 to 1,000

In the lower part of the matrices this scale appears as a reference.

The results from the risk assessment, the average for each risk factor, and the average for the different variables of the project are in the attached matrix. The averages for each risk factor are in the final columns and the variables for the project are in the final row. The specific qualifications and assessments for each selected factor are also in the attached tables.

The list below demonstrates the level of the assessed, identified and averaged risks. The risks are listed by degree of repercussion, in descending order, with the highest risk at the top of the list.

Social Demonstrations
Terrorist Attacks
Electrical
Mechanical
Thunderstorms
Flooding
Physical
Physical Load
Psychosocial

The project activities prone to risks to Industrial Safety and Occupational Health are the following, also in order of importance from greatest to least:

Machinery and Equipment Operation
Conductivity Systems
Vehicular Operation
Adaptation of areas of intervention
Geo-conformation of surrounding areas
Maintenance of the internal and external access roads

All the risks defined in this assessment are included in the different environmental management and control proposals included in the Environmental Management Plan (EMP) but especially in the proposals that relate to Safety, Machinery and Equipment and Contingencies, among others.

4.11.1 RISK ASSESSMENT MATRIX

RISK SCENARIO - RISK ASSESSMENT MATRIX (RAM)

SAFETY CONDITIONS											
RISK FACTOR	UNSAFE CONDITION OR ACTION	SOURCE	POSSIBLE ACCIDENT	POSSIBLE INJURIES	CONTROL MEASURES	CONSEQUENCES	EXPOSITION	PROBABILITY	DEGREE OF DANGER	% EXPOSED	DEGREE OF REPERCUSSION
Mechanical	Presence of vehicular flow internal and external to work areas.	Condition directly related to the type of process.	Hit by, run over by, collision against, trapped between, third party injuries (vehicular flow)	Traumas, musculoskeletal injuries, wounds, fractures, death.	Signaling and isolation of the work area with reflective elements. Installation of preventive and regulatory signals.	6	6	4	126	4	304
	Presence of machinery and equipment in the work area.	Condition directly related to the type of process (land leveling, drilling activity)	Hit by, run over by, collision against, trapped between	Traumas, musculoskeletal injuries, wounds, fractures, death.	Keeping away from the excavator turning area, signaling of the work area, reverse gear alarm in the dump trucks and other equipment where may apply, use of reflective vests, pre-operational inspection of vehicles and machinery.	8	9	8	176	4	704
	Objects on the floor	Lack of order	Falls on the same level	Traumas, musculoskeletal injuries, wounds, fractures.	Order and cleanliness in the work area	6	4	4	96	4	384
	Unloading of pipes	Pipes to be installed	Hit by, trapped between	Traumas, musculoskeletal injuries, wounds, fractures, death.	The unloading of pipes at the installation points will be coordinated, and if needed with the use of mechanical aids, it is forbidden to use ramps and roll the pipes from the platter of the dump truck to the floor, the download must be lifted on rigging tubes that are in good shape and resistant.	9	7	6	214	4	856
	Storage of pipes	Pipes to be stored	Trapped between, trapped by, hit by, third party injuries	Traumas, musculoskeletal injuries, wounds, fractures, death.	The pipeline will be minted and stored separately at least 1 m from the heads of neighboring properties. Access to third parties will be restricted. The pipes will be stockpiled and supported with wood studs in the cases where they will be kept for a long time to prevent the movement of the pipe into the surrounding area.	8	6	8	384	3	1152
	Loading of dump trucks with pipes.	Pipes falling from dump trucks, resulting from not securing pipes at loading or when overloading.	Hit by falling objects, third party injuries	Traumas, musculoskeletal injuries, wounds, death.	Use of helmet, secure pipes to the dump area of the truck or to the platform of the vehicle or dump truck, in case of overhanging, place a DANGER LONG LOAD signal, the dump truck should not exceed a speed of 30 km per hour on the road	4	6	6	144	4	576
	Suspended loads.	Lifting and moving of pipes.	Hit by falling objects	Traumas, musculoskeletal injuries, wounds, death.	Use of helmet, not standing beneath the suspended load, pre-operational inspection of machinery, slings and gear used to lift pipes.	8	6	6	288	3	864
	Presence of machinery such as excavators and dump trucks in the work area.	Condition directly related to the type of process (loading and unloading of debris, pipes and construction materials and equipment installation)	Hit by, run over by, trapped between	Traumas, musculoskeletal injuries, wounds, fractures, death.	Keep away from the mobilization area of the excavator, signaling of work area, reverse alarm on the dump truck and other incumbent equipment, use of reflective vests, pre-operational inspection of vehicles and machinery.	4	5	7	140	4	560

SAFETY CONDITIONS											
RISK FACTOR	UNSAFE CONDITION OR ACTION	SOURCE	POSSIBLE ACCIDENT	POSSIBLE INJURIES	CONTROL MEASURES	CONSEQUENCES	EXPOSITION	PROBABILITY	DEGREE OF DANGER	% EXPOSED	DEGREE OF REPERCUSSION
Mechanical	Entry and exit of vehicles	Equipment transportation	Collided against, run over by, trapped between, trapped by, third party injuries.	Traumas, musculoskeletal injuries, wounds, fractures, death.	Responsibility and prudence of the drivers of machinery and equipment used in the activity, daily check of the dump trucks' state of the brakes, lights, reverse alarm and rearview mirrors.	6	8	6	288	3	864
	Loading of materials and equipment.	Falling objects or elements or tools.	Hit by falling objects.	Traumas, musculoskeletal injuries, wounds, death.	Use of protective helmet, carry out training activities.	6	4	6	144	3	432
	Management and mobilization of machinery and equipment.	Condition related to the type of stage of the project.	Hit by, trapped by, trapped between, run over by.	Traumas, musculoskeletal injuries, wounds, death, third party accidents.	Technical-mechanical inspection of vehicles and machinery that execute the activity. For the mobilization of machinery will be complied with what is established in the Safety Proceedings.	6	6	6	216	4	864
	Unsafe stacking.	Stockpiling of pipes, materials and diverse elements.	Entrapment	Traumas, wounds, musculoskeletal injuries, death.	Stockpiles secured with structures. Install signage and control third party access to the stacking area.	8	6	6	288	3	864
	Handling of materials	Handling of materials and abrasive elements.	Contact with	Abrasions, dermatitis	Use of leather work gloves when handling abrasive elements like steel bars.	6	8	6	288	2	576
	Handling of steel bars	Handling of irons	Hit by and contact with abrasive elements	Abrasions, wounds, traumas, fractures.	Use of leather gloves, and steel-toed boots.	4	8	6	192	2	384
Physical	Particulate matter	Loading of excavated material to level the area, which generates particles in the atmosphere as result from the wind.	Projection of particles in the eyes.	Foreign bodies in eyes, eye injuries.	Protection by using safety goggles when by weather conditions (summer or strong winds) there is presence of particulate matter in the work area.	4	6	4	96	4	384

SAFETY CONDITIONS											
RISK FACTOR	UNSAFE CONDITION OR ACTION	SOURCE	POSSIBLE ACCIDENT	POSSIBLE INJURIES	CONTROL MEASURES	CONSEQUENCES	EXPOSITION	PROBABILITY	DEGREE OF DANGER	% EXPOSED	DEGREE OF REPERCUSSION
Biological	Exposure to fungi, viruses, bacteria	Lack of care when there is contact with items or substances that may affect workers.	Dermatitis, fungal skin alterations, and viral deseases.		Check on safety inspections, epidemiological surveillance program for possible viral diseases.	6	4	4	96	4	384
Ergonomic	Dynamic loads: efforts to lift, carry or drop loads.	Handling of steel reinforcements, metal formworks, etc.	Lumbar hernia, lumbar discopathy, lumbar tears.		Use of mechanical aids for load handling, training in load management. No person is allowed to handle loads heavier than 30 kg of weight. The installation of signals that weigh more than 25 kg should be done in coordination with other people.	6	8	8	384	2	768
Chemical	Exposure to gases like Co, Nox, Co2 and Sox.	Vehicular, machinery and drilling equipment traffic.	Diseases in the respiratory system (airways and lungs), occupational pneumoconiosis, effect on carboxyhemoglobin formation.		Use of respiratory protection according to the gas found which exceeds the TLV (threshold limit value), training of machinery operators in environmental and safety issues, training will be done bimonthly.	6	8	4	192	4	768
	Exposure to particulate matter.	Removal of material and leveling produce particulate matter in the atmosphere.	Diseases in the respiratory system (airways and lungs), occupational pneumoconiosis, fibrosis.		Use of respiratory protection.	4	4	4	64	4	256

SAFETY CONDITIONS											
RISK FACTOR	UNSAFE CONDITION OR ACTION	SOURCE	POSSIBLE ACCIDENT	POSSIBLE INJURIES	CONTROL MEASURES	CONSEQUENCES	EXPOSITION	PROBABILITY	DEGREE OF DANGER	% EXPOSED	DEGREE OF REPERCUSSION
Locative	Presence of personnel foreign to the project in the work area.	Works in areas of low susceptibility of presence of personnel foreign to the project.	Run over by machinery and dump trucks	Traumas, wounds, musculoskeletal injuries, death.	Prevent access of people foreign to the project activities, keep signaling.	6	4	4	96	2	192
	Objects on the floor.	Lack of order	Falls on the same level	Traumas, musculoskeletal injuries, wounds, fractures.	Removal of material not used in the work area, and if necessary, at this place of stockpiling, a place to store material and work elements will be specified in this storage area.	4	6	6	144	4	576
Public	Presence of vehicular traffic.	Lack of signaling warning the pedestrian of the entry or exit of vehicles.	Run over by vehicles	Traumas, musculoskeletal injuries, wounds, fractures, death.	Install preventive and informative signaling.	6	4	4	96	4	384

4.11.2 IMPACT ASSESSMENT MATRIX

IMPACT ASSESMENT MATRIX

DRILLING CAMPAIGN OF DEVELOPMENT WELLS
PALAGUA - CAIPAL FIELD, PUERTO BOYACA MUNICIPALITY (BOYACA)

SYSTEM	SUB-SYSTEM	ENVIRONMENTAL COMPONENT	ENVIRONMENTAL FACTORS AFFECTED	PHASE OF THE PROJECT												
				PRELIMINARY PHASE OR PREOPERATIVE				PREPARATION ACTIVITIES		INSTALLATION ACTIVITIES			OPERATION, CLOSE AND ABANDONMENT			
				Payment of real property	Topographic assesment of the platform	Civil work design	Presentation of the EPM (PMA in spanish)	Access roads preparation	Drilling site (platforms) preparation	Equipment transportation	Assembling and installation of equipment	Production Tests	Operation of Machinery and Equipment	Machinery and Equipment Maintenace	Follow up and monitoring	Site recovery
PHYSICAL ENVIRONMENT	INERT MEDIA	AIR	AIR QUALITY					N	N	N						
			NOISE LEVELS									P	N			
		WATER	WATER QUALITY													
		SOIL	SOIL QUALITY					P	P							P
			STABILITY					P	P							P
		FLORA	FOREST INTERVENTION													
			GREEN SPACES						N							P
	VISUAL MEDIA	SITE	LANDSCAPE VISUAL					P	P							P
SOCIO-CULTURAL AND ECONOMIC ENVIRONMENT	POPULATION GROUP	PRECINT	TENURE TYPE	P												
	SOCIO-CULTURAL ENVIRONMENT	SERVICES	TIME AND COSTS OF DISPLACEMENT					P		P						
			PUBLIC UTILITIES					P								
		HUMAN	SOCIAL SERVICES				P			P	P	N				
			INTERINSTITUTIONAL RELATIONS				P				N	N				
			ACCIDENT RATE			P	P			P						
			RISK AND SAFETY			P	P	N			N					
	ECONOMIC ENVIRONMENT		JOBS OFFERED-LABOR SUPPLY		P					P	P					
			PRODUCTIVE AND SERVICE SECTOR	N		N				P						

N: Negative
P: Positive

DRILLING CAMPAIGN OF DEVELOPMENT WELLS
PALAGUA - CAIPAL FIELD, PUERTO BOYACA MUNICIPALITY (BOYACA)

IMPORTANCE AND QUALITATIVE VALORIZATION OF THE ENVIRONMENTAL IMPACT

SCENARIO: PROJECT WITHOUT ENVIRONMENTAL MEASURES

RELATIONS Ai Pi	I	EX	MO	PE	RV	SI	AC	EF	PR	MC	II	CHARACTER	IMPACT SIGNIFICANCE
PRELIMINARY PHASE													
Precinct Management; Type of Tenure	2	2	4	4	2	1	1	4	1	2	29	P	N/A
Services Management	2	4	2	4	2	2	1	2	1	2	30	P	N/A
Job offer and labor supply	8	8	6	2	1	1	1	6	2	0	59	P	Relevant
Green Areas	2	2	4	2	1	2	1	4	1	2	27	N	Moderate
Visual Impact	2	4	2	2	1	2	4	4	1	1	31	N	Moderate
Accident rate	4	2	8	1	1	1	1	4	1	0	33	N	Moderate
Risk and Safety	4	2	4	1	1	2	4	4	1	0	33	N	Moderate
Social Relations	8	4	8	2	1	1	4	4	4	0	56	P	Relevant
Interinstutional Relations	4	2	8	2	1	2	4	4	4	0	41	P	Relevant
Forest intervention	0	0	0	0	0	0	0	0	0	0	0		N/A
SITE PREPARATION PHASE													
Excavations: Air Quality	4	2	4	2	1	2	4	4	2	2	37	N	Moderate
Excavations: Noise Levels	2	2	8	1	1	1	4	4	2	2	33	N	Moderate
Excavations: Water quality	2	1	8	1	1	1	1	1	2	4	27	N	Moderate
Excavations: Stability	4	1	8	1	1	1	1	4	2	4	36	N	Moderate
Excavations: Public Utilities	4	1	8	1	1	1	1	4	2	4	36	N	Moderate
Landfill, Air Quality	4	2	8	1	1	2	4	4	2	2	40	N	Moderate
Landfill, Water Quality	1	2	8	1	1	1	4	4	2	2	30	N	Moderate
Landfill, Stability	2	1	8	4	1	2	1	1	2	0	27	P	N/A
Devegetation; Air Quality	2	2	8	1	1	2	4	4	1	1	32	N	Moderate
Devegetation: Green Areas	2	4	4	2	1	1	1	4	4	4	35	N	Moderate
Machinery and equipment operation:Air quality	2	8	8	1	1	2	4	4	1	1	44	N	Moderate
Machinery and equipment operation:Noise levels	8	2	8	1	1	1	4	4	1	1	49	N	Moderate
Machinery and equipment operation: Soil quality	2	2	4	2	1	1	4	4	2	4	32	N	Moderate
Machiney and equipment operation: Social Relations	2	4	4	2	1	2	1	4	2	2	32	N	Moderate
Machinery and equipment operation: Accident rate	4	8	8	1	1	1	1	4	2	4	50	N	Moderate
Machinery and equipment operation; Risk and Safety	8	8	8	1	1	1	1	4	4	4	64	N	Critic
Complementary activities: Risk and Safety	2	1	8	1	1	1	1	4	2	4	30	N	Moderate
Site component; Revegetation	4	8	4	4	2	2	1	4	1	0	46	P	N/A
Site component; Visual Impact	4	8	4	4	2	2	1	4	4	0	49	P	N/A
Site componnet; Social Relations	4	8	2	4	2	1	1	4	4	0	46	P	N/A
Site component; Interinstitutional relations	4	4	4	4	2	1	1	4	4	0	40	P	N/A
OPERATION PHASE													
Machinery and equipment operation: Visual Impact	4	8	2	2	2	2	1	4	4	0	45	P	N/A
Vehicles operation; Social Relations	2	8	4	2	2	1	1	4	4	0	40	P	N/A
Machinery and equipment operation: Jobs offered	2	1	2	4	2	1	1	4	1	0	23	P	N/A
Maintenance of the road; Social Relations	4	2	2	2	2	1	1	4	4	0	32	P	N/A
Machinery and equipment maintenance; Risk and safety	4	2	8	1	1	1	1	4	2	4	38	N	Moderate
ABANDOMENT AND RECOVERY OF THE AREA PHASE													
Machinery and equipment operation: Visual Impact	4	8	2	2	2	2	1	4	4	0	45	P	N/A
Vehicles operation; Social Relations	2	8	4	2	2	1	1	4	4	0	40	P	N/A
Machinery and equipment operation: Jobs offered	2	1	2	4	2	1	1	4	1	0	23	P	Moderate
Site component	4	2	2	2	2	1	1	4	4	0	32	P	Relevant
Recovered green areas	4	2	8	1	1	1	1	4	2	4	38	N	Relevant

II = (3 I + 2 EX + EF + PR + MC)

I=INTENSITY EX= EXTENSION EF= EFFECT
PR= PERIODICITY MC= RESILIENCY II= IMPORTANCE INDEX

DRILLING CAMPAIGN OF DEVELOPMENT WELLS
PALAGUA - CAIPAL FIELD, PUERTO BOYACA MUNICIPALITY (BOYACA)

IMPORTANCE AND QUALITATIVE VALORIZATION OF THE ENVIRONMENTAL IMPACT

SCENARIO: PROJECT WITH ENVIRONMENTAL MEASURES

RELATIONS Ai Pi	I	EX	MO	PE	RV	SI	AC	EF	PR	MC	II	CHARACTER	IMPACT SIGNIFICANCE
PRELIMINARY PHASE													
Social Management	8	2	4	4	1	1	1	4	1	8	52	N	Severe
Precinct Management	8	4	4	2	2	2	1	4	1	2	50	N	Moderate
Service Management	2	8	4	2	1	1	1	4	2	0	37	P	N/A
Jobs offered	1	2	4	2	1	2	1	4	1	2	24	N	Irrelevant or compatible
Green areas	1	4	2	2	1	2	4	4	1	1	28	N	Moderate
Visual Impact	4	2	8	1	1	1	1	4	1	0	33	P	N/A
Accident rate	4	2	8	1	1	2	4	4	1	0	37	P	N/A
Risk and Safety	2	4	8	2	1	2	4	4	4	2	41	N	Moderate
Social Relations	1	2	8	2	1	1	1	4	1	2	27	N	Moderate
Interstitutional Relations	8	4	8	2	2	2	4	4	4	0	58	P	N/A
Forest Intervention	4	2	8	2	2	2	4	4	4	0	42	P	N/A
SITE PREPARATION PHASE													
Excavations: Air Quality	2	2	4	2	1	2	4	4	2	2	31	N	Moderate
Excavations: Water Quality	1	2	8	1	1	1	4	4	2	2	30	N	Moderate
Excavations: Stability	1	1	8	1	1	1	1	1	2	4	24	N	Irrelevant or compatible
Excavations: Risk and Safety	2	1	8	1	1	1	1	4	2	4	30	N	Moderate
Excavations: Pubic Utility	2	1	8	1	1	1	1	4	2	4	30	N	Moderate
Landfill: Air Quality	2	2	8	1	1	2	4	4	2	2	34	N	Moderate
Landfill; Water Quality	1	1	8	1	1	1	4	4	2	2	28	N	Moderate
Landfill, Stability	4	1	8	4	1	2	1	1	2	0	33	P	N/A
Devegation: Air quality	2	2	8	1	1	1	4	4	1	2	32	N	Moderate
Devegation: Green areas	4	1	8	1	1	1	1	4	1	1	32	N	Moderate
Machinery and equipment operation:Air quality	1	2	8	1	1	1	4	4	1	2	29	N	Moderate
Machinery and equipment operation:Noise levels	2	2	4	2	1	2	1	4	1	2	27	N	Moderate
Machinery and equipment operation: Soil quality	2	1	4	2	1	1	1	4	1	2	24	N	Irrelevant or compatible
Machiney and equipment operation: Social Relations	1	1	8	1	1	1	1	4	1	4	26	N	Moderate
Machinery and equipment operation: Accident rate	4	1	8	1	1	1	1	4	1	4	35	N	Moderate
Operación de maquinaria y equipos; Riesgo y seguridad.	1	2	8	1	1	2	4	4	1	1	29	N	Moderate
Complementary activities: Risk and Safety	2	2	4	2	1	1	1	4	4	4	31	N	Moderate
Site component; Revegetation	4	8	8	1	1	2	4	4	4	4	56	N	Severe
Site component; Visual Impact	1	4	8	2	1	2	4	4	1	2	35	N	Moderado
Maintenance of the road; Social Relations	2	2	8	2	1	1	1	4	2	2	31	N	Moderado
Site component; Interinstitutional relations	2	2	8	2	1	1	1	4	2	2	31	N	Moderado
OPERATION PHASE													
Machinery and equipment operation: Visual Impact	4	8	4	4	2	2	1	4	4	0	49	P	N/A
Vehicles operation; Social Relations	4	8	4	2	2	1	1	4	4	0	46	P	N/A
Machinery and equipment operation: Jobs offered	8	8	8	2	2	1	1	4	4	0	62	P	N/A
Maintenance of the road; Social Relations	4	1	2	4	2	1	1	4	1	0	29	P	N/A
Machinery and equipment maintenance; Risk and safety	8	2	2	2	2	1	1	4	4	0	44	P	N/A
ABANDOMENT AND RECOVERY OF THE AREA PHASE													
Machinery and equipment operation: Visual Impact	1	2	8	1	1	2	4	4	1	1	29	N	Moderate
Vehicles operation; Social Relations	2	2	4	2	1	1	1	4	4	4	31	N	Moderate
Machinery and equipment operation: Jobs offered	4	8	8	1	1	2	4	4	4	4	56	N	Moderate
Site component	1	4	8	2	1	2	4	4	1	2	35	N	Severe
Recovered green areas	2	2	8	2	1	1	1	4	2	2	31	N	Severe

II = (3 I + 2 EX + EF + PR + MC)

I=INTENSITY EX= EXTENSION EF= EFFECT
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DRILLING CAMPAIGN OF DEVELOPMENT WELLS IN PALAGUA - CAIPAL FIELD

SENSIBILITY ANALYSIS

SCENARIO: PROJECT WITH ENVIRONMENTAL MEASURES

														OPTIMISTIC SCENARIO														PESIMISTIC SCENARIO													
RELATIONS Ai Pi	I	EX	MO	PE	RV	SI	AC	EF	PR	MC	II	CHARACTER	IMPACT SIGNIFICANCE	I	EX	MO	PE	RV	SI	AC	EF	PR	MC	II	CARÁCTER	SIGNIFICADO DEL IMPACTO	%	I	EX	MO	PE	RV	SI	AC	EF	PR	MC	II	CHARACTER	IMPACT SIGNIFICANCE	%
PRELIMINAR PHaSE																																											
Social Management	4	4	4	4	1	1	1	4	1	2	38	P	Moderate	4	2	4	4	1	1	1	4	1	2	34	N	Moderate	10.53	4	8	4	4	2	1	1	4	1	2	47	N	Moderate	19.15
Precinct Management	8	4	4	2	2	2	1	4	1	2	50	P	Moderate	8	2	4	2	2	2	1	4	2	1	46	N	Moderate	8.00	8	4	4	4	2	2	1	4	1	2	52	N	Severe	3.85
Service Management	2	8	4	2	1	1	1	4	2	0	37	P	N/A	4	8	4	2	1	1	1	4	2	0	43	P	N/A	13.95	1	8	4	2	1	1	1	4	2	0	34	P	N/A	8.11
Jobs offered	1	2	4	2	1	2	1	4	1	2	24	N	Irrelevant or compatible	1	1	4	2	1	2	1	4	1	2	22	N	Irrelevant or compatible	8.33	2	2	4	2	1	2	1	4	1	2	27	N	Moderate	11.11
Green areas	1	4	2	2	1	2	4	4	1	1	28	N	Moderate	1	2	2	2	1	2	4	4	1	1	24	N	Irrelevant or compatible	14.29	2	4	2	2	1	2	4	4	1	1	31	N	Moderate	9.68
Visual Impact	4	2	8	1	1	1	1	4	1	0	33	P	N/A	4	4	8	1	1	1	1	4	1	0	37	P	N/A	10.81	4	1	8	1	1	1	1	4	1	0	31	P	N/A	6.06
Accident rate	4	2	8	1	1	2	4	4	1	0	37	P	N/A	4	4	8	1	1	2	4	4	1	0	41	P	N/A	9.76	4	1	8	1	1	2	4	4	1	0	35	P	N/A	5.41
Risk and Safety	2	4	8	2	1	2	4	4	4	2	41	P	Moderate	2	2	8	2	1	2	4	4	4	2	37	N	Moderate	9.76	4	4	8	2	2	2	4	4	4	2	48	N	Moderate	14.58
Social Relations	1	2	8	2	1	1	1	4	1	2	27	P	Moderate	1	2	8	1	1	1	1	4	1	2	26	N	Moderate	3.70	2	2	8	2	1	1	1	4	1	2	30	N	Moderate	10.00
Interstitutional Relations	8	4	8	2	2	2	4	4	4	0	58	P	N/A	8	8	8	2	2	2	4	4	4	0	66	P	N/A	12.12	8	4	8	2	1	1	4	4	4	0	56	P	N/A	3.45
Forest Intervention	4	2	8	2	2	2	4	4	4	0	42	P	N/A	4	4	8	2	2	2	4	4	4	0	46	P	N/A	8.70	4	2	8	2	1	2	4	4	4	0	41	P	N/A	2.38
PREPARATION PHASE																																											
Excavations: Air Quality	2	2	4	2	1	2	4	4	2	2	31	N	Moderate	2	1	4	2	1	2	4	4	2	2	29	P	Moderate	6.45	4	2	4	2	1	2	4	4	2	2	37	N	Moderate	16.22
Excavations: Noise Levels	1	2	8	1	1	1	4	4	2	2	30	N	Moderate	1	1	8	1	1	1	4	4	2	2	28	P	Moderate	6.67	2	2	8	1	1	1	4	4	2	2	33	N	Moderate	9.09
Excavations: Water quality	1	1	8	1	1	1	1	4	2	4	27	P	N/A	1	1	8	1	1	1	1	1	2	4	24	P	Irrelevant or compatible	11.11	2	1	8	1	1	1	1	4	2	4	30	N	Moderate	10.00
Excavations: Stability	2	1	8	1	1	1	1	4	2	4	30	P	Moderate	1	1	8	1	1	1	1	4	2	4	27	P	Moderate	10.00	4	1	8	1	1	1	1	4	2	4	36	N	Moderate	16.67
Excavations; Risk and Safety	2	1	8	1	1	1	1	4	2	4	30	N	Moderate	1	1	8	1	1	1	1	4	2	4	27	P	Moderate	10.00	4	1	8	1	1	1	1	4	2	4	36	N	Moderate	16.67
Excavations; Public Utilities	2	2	8	1	1	2	4	4	2	2	34	N	Moderate	1	2	8	1	1	2	4	4	2	2	31	P	Moderate	8.82	4	2	8	1	1	2	4	4	2	2	40	N	Moderate	15.00
Landfill, Air Quality	1	1	8	1	1	1	4	4	2	2	28	N	Moderate	1	1	8	1	1	1	4	4	1	2	27	N	Moderate	3.57	1	2	8	1	2	1	4	4	2	2	31	N	Moderate	9.68
Landfill, Water Quality	4	1	8	4	1	2	1	1	2	0	33	P	N/A	4	2	8	4	1	2	1	1	2	0	35	P	N/A	5.71	2	1	8	4	1	2	1	1	2	0	27	P	N/A	18.18
Landfill, Stability	2	2	8	1	1	1	4	4	1	2	32	N	Moderate	1	2	8	1	1	1	4	4	1	2	29	N	Moderate	9.38	4	2	8	1	1	1	4	4	1	2	38	N	Moderate	15.79
Devegetation; Air Quality	4	1	8	1	1	1	1	4	1	1	32	P	Moderate	2	1	8	1	1	1	1	4	1	1	26	N	Moderate	18.75	4	1	8	2	1	1	1	4	1	1	33	N	Moderate	3.03
Devegetation: Green Areas	1	2	8	1	1	1	4	4	1	2	29	N	Moderate	1	1	8	1	1	1	4	4	1	2	27	P	Moderate	6.90	2	2	8	1	1	1	4	4	1	2	32	N	Moderate	9.38
Machinery and equipment operation:Air quality	2	2	4	2	1	2	1	4	1	2	27	N	Moderate	2	1	4	2	1	2	1	4	1	2	25	P	Irrelevant or compatible	7.41	2	2	4	2	2	2	1	4	1	2	28	N	Moderate	3.57
Machinery and equipment operation:Noise levels	2	1	4	2	1	1	1	4	1	2	24	N	Irrelevant or compatible	1	1	4	2	1	1	1	4	1	2	21	P	Irrelevant or compatible	12.50	2	2	4	2	1	1	1	4	1	2	26	N	Moderate	7.69
Machinery and equipment operation: Soil quality	2	1	8	1	1	1	1	4	1	4	29	P	Moderate	1	1	8	1	1	1	1	4	1	4	26	P	Moderate	10.34	4	1	8	1	1	1	1	4	1	4	35	N	Moderate	17.14
Machiney and equipment operation: Social Relations	4	1	8	1	1	1	1	4	1	4	35	P	Moderate	2	1	8	1	1	1	1	4	1	4	29	P	Moderate	17.14	4	1	8	1	1	1	1	4	2	4	36	N	Moderate	2.78
Machinery and equipment operation: Accident rate	1	2	8	1	1	2	4	4	1	1	29	P	Moderate	1	1	8	1	1	2	4	4	1	1	27	P	Moderate	6.90	2	2	8	1	1	2	4	4	1	1	32	N	Moderate	9.38
Machinery and equipment operation; Risk and Safety	2	2	4	2	1	1	1	4	4	4	31	P	Moderate	1	2	4	2	1	1	1	4	4	4	28	P	Moderate	9.68	4	2	4	2	1	1	1	4	4	4	37	N	Moderate	16.22
Complementary activities: Risk and Safety	4	8	8	1	1	2	4	4	4	4	56	P	Relevant	2	8	8	1	1	2	4	4	4	4	50	P	Moderate	10.71	8	8	8	1	1	2	4	4	4	4	68	N	Severe	17.65
Site component; Revegetation	1	4	8	2	1	2	4	4	1	2	35	P	Moderate	1	2	8	2	1	2	4	4	1	2	31	P	Moderate	11.43	2	4	8	2	1	2	4	4	1	2	38	N	Moderate	7.89
Site component; Visual Impact	2	2	8	2	1	1	1	4	2	2	31	P	Moderate	1	2	8	2	1	1	1	4	2	2	28	P	Moderate	9.68	2	4	8	2	1	1	1	4	2	2	35	N	Moderate	11.43
Site componnet; Social Relations	2	2	8	2	1	1	1	4	2	2	31	P	Moderate	1	2	8	2	1	1	1	4	2	2	28	P	Moderate	9.68	4	2	8	2	1	1	1	4	2	2	37	N	Moderate	16.22
Site component; Interinstitutional relations	1	1	8	2	1	1	1	4	4	4	30	P	Moderate	1	1	8	2	1	1	1	1	4	4	27	P	Moderate	10.00	2	1	8	2	1	1	1	4	4	4	33	N	Moderate	9.09
OPERATION PHASE																																											
Machinery and equipment operation: Visual Impact	4	8	4	4	2	2	1	4	4	0	49	P	N/A	8	8	4	4	2	2	1	4	4	0	61	P	N/A	19.67	4	8	4	2	2	2	1	4	4	0	47	P	N/A	4.08
Vehicles operation; Social Relations	4	8	4	2	2	1	1	4	4	0	46	P	N/A	8	8	4	2	2	1	1	4	4	0	58	P	N/A	20.69	2	8	4	2	2	1	1	4	4	0	40	P	N/A	13.04
Machinery and equipment operation: Jobs offered	8	8	8	2	2	1	1	4	4	0	62	P	N/A	8	8	8	4	2	1	1	4	4	0	64	P	N/A	3.13	4	8	8	2	2	1	1	4	4	0	50	P	N/A	19.35
Maintenance of the road; Social Relations	4	1	2	4	2	1	1	4	1	0	29	P	N/A	4	2	2	4	2	1	1	4	1	0	31	P	N/A	6.45	2	1	2	4	2	1	1	4	1	0	23	P	N/A	20.00
Machinery and equipment maintenance; Risk and safety	8	2	2	2	2	1	1	4	4	0	44	P	N/A	8	2	4	2	2	1	1	4	4	0	46	P	N/A	4.35	4	4	2	2	2	1	1	4	4	0	36	P	N/A	18.18
ABANDONMENT AND AREA RECOVERY PHASE																																											
Machinery and equipment operation: Visual Impact	2	2	8	1	1	1	1	4	2	4	32	N	Moderate	2	1	8	1	1	1	1	4	2	4	30	N	Moderate	6.25	4	2	8	1	1	1	1	4	2	4	38	N	Moderate	15.79
Vehicles operation; Social Relations	2	2	8	1	1	1	1	4	2	0	28	P	N/A	4	2	8	1	1	1	1	4	2	0	34	P	N/A	17.65	2	1	8	1	1	1	1	4	2	0	26	P	N/A	7.14
Machinery and equipment operation: Jobs offered	4	8	4	4	2	2	4	4	4	0	52	P	N/A	8	8	4	4	2	2	4	4	4	0	64	P	N/A	18.75	4	8	4	2	2	2	4	4	4	0	50	P	N/A	3.85
Site component	4	8	4	4	2	2	1	4	4	0	49	P	N/A	8	8	4	4	2	2	1	4	4	0	61	P	N/A	19.67	4	8	4	2	2	2	1	4	4	0	47	P	N/A	4.08
Recovered green areas	2	8	8	4	2	1	1	4	2	4	48	P	Moderate	2	8	8	4	2	1	1	4	1	4	47	P	Moderate	2.08	4	8	8	4	4	1	1	4	2	4	56	N	Severe	14.29
Relocation of public transportation; Interinstitutional Relations	2	4	8	4	2	1	1	1	2	4	37	P	Moderate	2	4	8	4	2	1	1	1	1	4	36	P	Moderate	2.70	4	4	8	4	4	1	1	1	2	4	45	N	Moderate	17.78

4.12 SOCIAL COMPONENT - SOCIAL MANAGEMENT

UT IJP is an enterprise involved with the integral social responsibility in the area of influence for the operation of the Palagua – Caipal Field and clearly knows all the implications of its actions on the community in the area of influence. So, they encourage social management to satisfy the needs and expectations of the community of the Palagua- Caipal Rural Area and of those who profit from its economic activity, in addition to the care and preservation of the surrounding area.

Social management is conducted so as to encourage business social responsibility under different scenarios of action:

- ***Normative:*** Compliance with the requirements demanded by the environmental entities (MAVDT and CORPOBOYACA) and the Environment Management Plan for the Palagua – Caipal Field Operation.

- ***Operational:*** The factors that allow the UT IJP to produce goods and render services according to the corporate purposes.

- ***Social:*** To link the actions to be taken by UT IJP with the social context in which it acts in a way that it allows to contribute to the quality of life and the well being of the community of the area of influence.

4.12.1 SOCIAL MANAGEMENT RESPONSIBILITIES AND ACTIVITIES

- ***The Palagua-Rural Area School, in the Municipality of Puerto Boyacá, is fully enclosed with reinforced fencing.***

- ***Fencing is also reinforced at the vehicle gate and pedestrian gate areas.***

- ***Palagua- School on the hill with Hatchery Area below.***

- ***Community Awareness Program on the Nursery and Hatchery Areas with technical support and follow up.***
-

- ***Training Events: Industrial Security Risks Associated to the Oil Industry Workshop***

- ***Training Events: Emergency fire equipment training***

-

- ***Training Events: Weekly Fire Safety Tests***

- **Hiring of non qualified labour force.**

The Community Action Board of the Palagua Rural Area contributes a the list of eligible workers guaranteeing the achievement of generating employment for 94% of the labor force hired in the Palagua Rural Area; this includes hiring of female head-of-household for the support of the family group.

- ***Technical Training on: Production Facilities with the Technical Institute of Petroleum in the facilities of the Palagua Field and the Dynamic Measuring Course supported by PROASEM.***

- ***Securing of the main routes of the Palagua - Rural Area Highway***

Inspections on the main and secondary routes of the Field are carried out periodically in order to schedule the maintenance and secure that the roads are kept in good condition. This ensures minimizing the impacts (generation of dust) or injuries (vehicle accidents) that could generate holes or faults in the road.

- ***Donation of supplies to develop the first "National Nautical-Motor Competition" in Puerto Boyacá, an event in the Palagua Lake.***

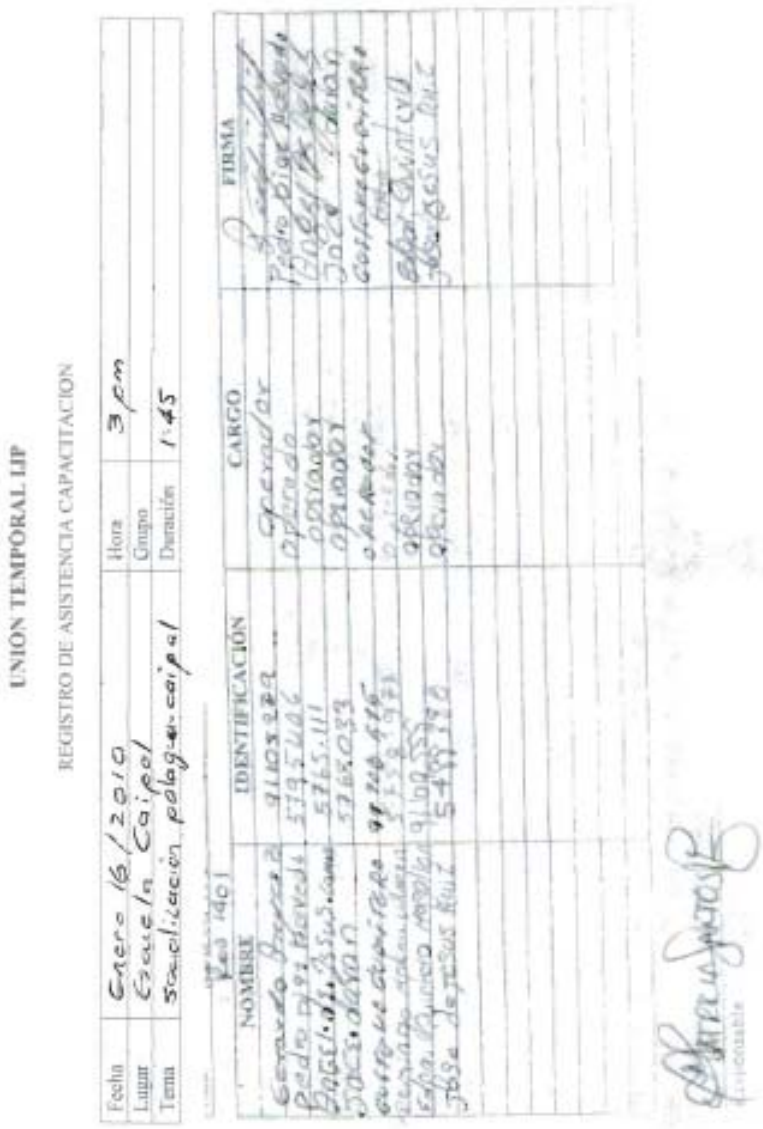
- ***Socialization with the Palagua School students – Alliance in values, video among other subjects.***

- ***Children's Day celebration and Celebration of Peasants Day***

- ***Recognition of Superior Students of the Palgua School, with day of shopping for school clothes, shoes and backpacks.***

- ***Christmas gifts for 120 children of the Palagua Rural Area.***

- ***Records of Meetings for the Public Awareness of the Environmental Management Plan***



UNION TEMPORAL LIP

REGISTRO DE ASISTENCIA CAPACITACION

Fecha	Enero 16/2010	Hora	3pm
Lugar	Escuela Caipal	Grupo	
Tema	Sensibilización palagua caipal	Duración	1:45

NOMBRE	IDENTIFICACIÓN	CARGO	FIRMA
Gerardo Bogota	91105229	Operador	
Pedro Diaz Heredia	5795406	Operador	
Angel David Sanchez	5765.111	operador	
Jorge Olaya	5765053	operador	
Guillermo Quintero	98.140.416	Ayudante	
Fernando Valenzuela	5758993	operador	
Edwin Quintero Morales	91100553	operador	
Jesus Antonio Ruiz	5485112	operador	

SATELITA SANTOS
Ecopetrol

UNION TEMPORAL UP

REGISTRO DE ASISTENCIA CAPACITACION

Fecha	Dia 12/2007	Hora	3pm
Lugar	Escuela Caipal	Grupo	
Tema	Sensibilizacion Palagua - Caipal	Duración	1:50

NOMBRE	IDENTIFICACIÓN	CARGO	FIRMA
[illegible]	[illegible]	[illegible]	[illegible]
Jhoslin Daza	91068887	[illegible]	[illegible]
Orlando Hoyos	91069544	inspector [illegible]	[illegible]
[illegible]	91023770	[illegible]	[illegible]
[illegible]	9707 2922	[illegible]	[illegible]
Mauricio [illegible]	91136025	Conductor [illegible]	[illegible]
[illegible]	5141143	Conductor Grua	[illegible]
[illegible]	91065411	Conductor [illegible]	[illegible]
[illegible]	91085604	[illegible]	[illegible]
[illegible]	91069 8898	Conductor [illegible]	[illegible]
[illegible]	13641 958	conductor de [illegible]	[illegible]
[illegible]	91088680	Conductor mecanico	[illegible]
[illegible]	5622134	Operador [illegible]	[illegible]
[illegible]	4076522	[illegible]	[illegible]
[illegible]	73636025	[illegible]	[illegible]
[illegible]	91041905	[illegible]	[illegible]

Harold Sarquis

UNION TEMPORAL UP

REGISTRO DE ASISTENCIA CAPACITACIÓN

Fecha	Diciembre 5/2009	Hora	3 pm
Lugar	Escuela Caipal	Grupo	
Tema	Social-Inducción Palagua-Caipal	Duración	1:20

NOMBRE	IDENTIFICACIÓN	CARGO	FIRMA
Fancy Romero	91.076.666	Operador	
Vicente Arias	91.116.815	Operador	
Wilson Pachón	1.088.204.483	Aux. de mantenimiento	
Wilinton Niño	91.087.115	Mantenimiento	
Reinaldo Díaz Espinosa	91.089.248	Operador	
Aldair José Díaz	7.437.020	Electricista	
Rodolfo Montero	Operador		
Fabio Triana	91.015.994	CONDUCTOR	Fabio Triana

PATRICIA SANTOS
ESTUDIANTE

UNION TEMPORAL LIP

REGISTRO DE ASISTENCIA CAPACITACION

Fecha	Noviembre 21/2009	Hora	3 pm
Lugar	Escuela Caipal	Grupo	
Tema	socialización palagua-caipal	Duración	2:00

NOMBRE	IDENTIFICACIÓN	CARGO	FIRMA
Jairo Giraldo	74245564		Jairo Giraldo
Diego Torres Velasco	1.056.029.011	Guadañador	Diego Torres Velasco
Hoberto Pastrana	1.056.029.616	Guada Dador	Hoberto Pastrana
[illegible]	[illegible]	[illegible]	[illegible]
Juan José Torres	7304212	Obros	Juan José Torres
[illegible]	79.326224	Guadañador	[illegible]
Pedro Rodríguez	7127007	Guadañador	Pedro Rodríguez

Patricia Santos
Responsable

UNION TEMPORAL LIP

REGISTRO DE ASISTENCIA CAPACITACION

Fecha	Noviembre 14 de 2009	Hora	3 pm
Lugar	Escuela Caipal	Grupo	
Tema	Soc. ed. 2010-01 Hsy, Palagua-Caipal	Duración	1.30

NOMBRE	IDENTIFICACION	CARGO	FIRMA
Wilder Bogoya F	3242203	Operador	
José Emilio Vásquez G	245836	Conductor	
Víctor Manuel Pedraza R	74163192	Operario	
Gonzalo Pinzón C	3220302	Almacenista	
Mario Rodríguez F	245.036	Operario	
Pedro Pablo Pinzón	74162400	Operario	
José Eduardo Rodríguez	245.285	Recepto Legal	
David Alejandro Bonilla	74168397	Trabajador	