UNIVERSIDAD NACIONAL DE INGENIERIA

COLLEGE OF PETROLEUM AND PETROCHEMICAL ENGINEERING

Senior Design Project

Integral Project: Hydrocarbons Exploration and Exploitation in the *San Jacinto* Oriental Field, *Marañon* Basin, *Loreto* Region, Amazon Jungle, Peru

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FACULTAD DE INGENIERÍA DE PETRÓLEO, GAS NATURAL Y PETROQUÍMICA

ESPECIALIDAD DE INGENIERÍA DE PETRÓLEO Y GAS NATURAL

Integral Project of Exploration and Exploitation of Hydrocarbons in the San Jacinto Oriental Field- Marañon Basin in the Loreto Region- Peru

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Good Job

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CAPSTONE COURSE:
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This research is lovingly dedicated to our parents who have been our constant source of inspiration. They have given us the drive and discipline to tackle a task with enthusiast and determination. Without their love and support this project would not have been made possible

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ABSTRACT

Currently, one of the main problems in the oil sector is the low national production of hydrocarbons and in the Peruvian jungle it is even more critical; this problem is compounded by the problems of oil transportation and social conflicts. In this context, it is important to develop new integrated hydrocarbon exploration and production projects.

The present project evaluates the feasibility of the Exploration and Exploitation of a new field San Jacinto Oriental, located in Block 192 of the Peruvian jungle. The objective is to increase oil production and thus ensure the sustainability of the country's hydrocarbon supply.

The methodology implemented was the formulation and evaluation of integral hydrocarbon exploration and exploitation projects, which considers strategic, technical, economic, legal, environmental, social and management aspects. Methods, processes, designs, equations, graphs, software, tools, international technical standards and Peruvian legislation were used at each stage of project development. All this by means of the knowledge learned during the university life.

As a fundamental part of the project, the possibility of taking advantage of the two types of crude oil (heavy and light) present in the reservoirs of the San Jacinto Oriental field to obtain crude oil for sale and for transportation through the Norperuano pipeline is studied.

Finally, it is concluded that the exploration and exploitation project of the San Jacinto Oriental field is economically viable.

INTRODUCTION.

Block 192 has the largest oil reserves in Peru. According to Perupetro S.A., the largest reserves in this block are comprised by the heavy oil existing in the Vivian formation. The fields which have heavy oil reserves are Jibaro, Jibarito, San Jacinto and Bartra and the last one has been closed since 2002 due to high production costs as it is a remote field in the block.

The San Jacinto analog field will allow us to extract information and correlate it with our San Jacinto Oriental field project. According to the information, this field would be a good prospect for oil exploitation. And it would have light crude and large volumes of heavy crude in the subsoil, belonging to the Vivian formation, which is a limiting factor for transportation by the Norperuano pipeline, since it transports crude greater than 18°API.

The project began with the development of the strategic analysis to have an overview, both internal and external, of the situation of the block and the San Jacinto Oriental field. Next, the geological study was developed to detect the oil formations. Then, the reservoir engineering study was carried out to estimate reserves and obtain production forecasts. Also, a drilling plan for exploratory, confirmatory and development wells was prepared, followed by the production system and surface facilities, storage and transportation until reaching the point of sale. In addition, a legal study was conducted and the impacts of the project on the environment and society were analyzed.

Finally, an economic study was carried out, estimating revenues, investments (CAPEX) and operating expenses (OPEX), which was useful for the cash flow, economic evaluation, and sensitivity and risk analysis of the project.

This type of project requires joint action by companies, government agencies, universities and civil society. These complex operations should be treated not as a problem but as an opportunity for development.

1. PROJECT

1.1.Problem Statement

How well do we know the hydrocarbon sector and its relevance for the country?

How important are oil investment projects?

According to information from the Peruvian Society of Hydrocarbons, in January 2021 Peru will spend 60 million soles (16.7 MM US$) per day on importing fuel to meet the country's demand.

In December 2020, oil production reached 31,625 BPD, a decrease of 45% in comparison with the previous year, that is explained by the drop in international prices, the effects of COVID19 and the social conflicts both in the facilities of the block and in the Norperuano pipeline. This further aggravates the oil deficit.

Consequently, the central problem is the low national production of hydrocarbons, the increase in oil demand, increase in import of hydrocarbons and the low investment in the exploration and exploitation of hydrocarbons.

1.2.Objective

1.2.1. General Objective

To increase national crude oil production, particularly in the Northern Jungle - Block 192, through the development of integral Exploration and Exploitation Projects for light and heavy hydrocarbons. This is the case of the San Jacinto Oriental Field and developing a methodology to formulate and evaluate integral hydrocarbon projects that promote investments in the oil sector.

1.2.2. Specific Objective

- Perform a strategic analysis to analyze our external and internal environment with useful tools such as the SWOT matrix, PESTEL analysis and PORTER forces to achieve our goals.
- -Identify and use the most efficient methods to geologically evaluate the presence of hydrocarbons.
- Define a project proposal based on reservoir management standards, in which the processes and tools for the development of each operation (drilling, production, transportation) are established.
- Combine vertical and directional drilling of wells in the San Jacinto Oriental field, in order to recover the greatest number of hydrocarbons economically.
- Improve the hydrocarbon recovery factor through new technologies such as automation in our production equipment.
- Maximize the use of resources expressed in time, cost and scope improvement in our operations such as transportation and oil production that allow an advantage over our competitors.
- Promote research with universities through agreements for the search of new alternatives to obtain oil, in such a way that a permanent alliance between companies and universities is established.

1.3.Justification

The importance of our project will lie in being convenient, relevant and having practical implications, which is how we establish that we must do it because it is of:

1. Importance for the country

It will ensure the sustainability of the country's energy supply with less imports because of its productive history, its great capacity and also its large reserves.

2. Attractive to private investments

It will allow a greater possibility of accessing project financing and the sector will be further developed.

3. Technical university

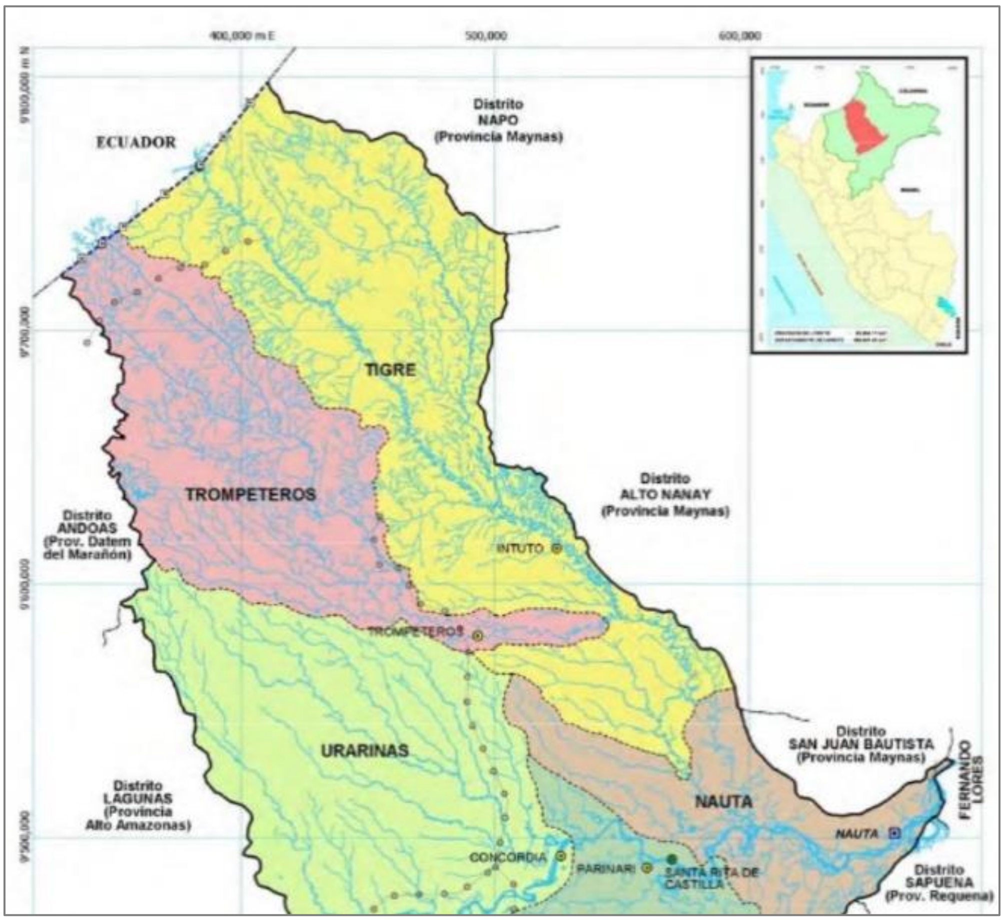
It will form a clear vision of techniques and operations applied in the development of these fields. Here with a very particular scenario where the innovation and/or competitiveness of the company will be required

2. PROJECT LOCATION

2.1.Location

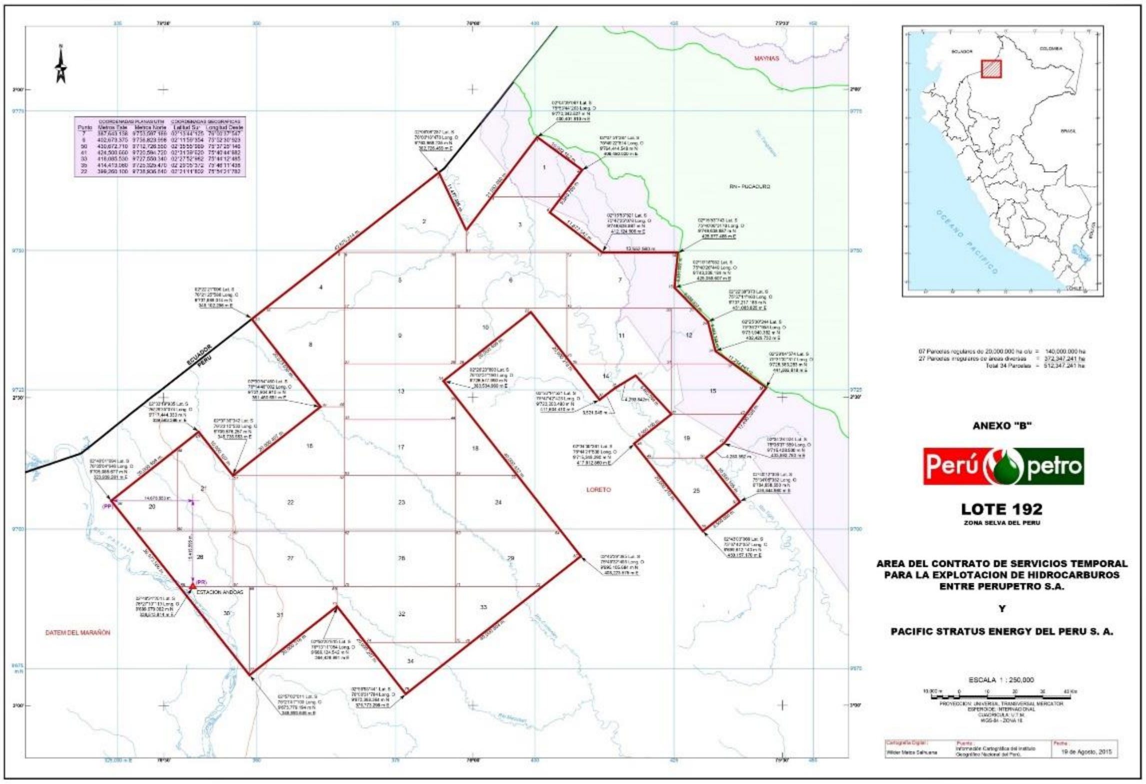
Block 192 (ex 1AB)-Field San Jacinto, the study of this Project is located in the Northern Jungle of Peru, within the Marañon oil basin. It is between the provinces of Datem Marañon and Loreto in the amazon jungle region. Districts: El Tigre, Andoas and Trompetereros. (Perupetro, Estadísticas, 2019)

Figura 1 Distribution of districts in the Loreto Region (Regional Government of Loreto)



Note: Location of main districts comprising block 192. (Gobierno Regional de Loreto, 2017)

Figura 2. Location of Block 192



Note: Map with limits for 192 blocks. (Perupetro, Estadísticas, 2019)

2.2.Overview about Block 192

Frontera Energy Corporation gets bid the operation of Block 192 on August 31,2015, through a Temporary Services Agreement.

Block 192 has a current Surface Area of 512,347,241 hectares. It is located on the Northern part of the Marañon Basin, a Basin of the foreland type. The oil produced comes mainly from the Upper Cretaceous reservoirs and comes from the Vivian and Chonta formations.

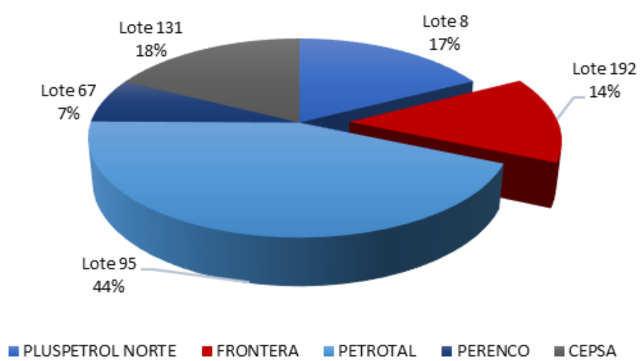
The average gravity of oil is 18°API, resulting from the mixture of the production of light oil reservoirs (30°- 40° API), heavy oil reservoirs (10.5°-16.5° API), and medium oil reservoirs (18°-22.5° API).

Proved oil reserves as of December 2019 were estimated at 691.8 MSTB, probable reserves were estimated at 21.8 MSTB, and possible reserves at 21.6 MSTB. In 2019, 2,836,669 Mbls have been produced. (Perupetro, Statistics, 2019)

2.3.General Statistical Data

- **Jungle Production in the year 2020**

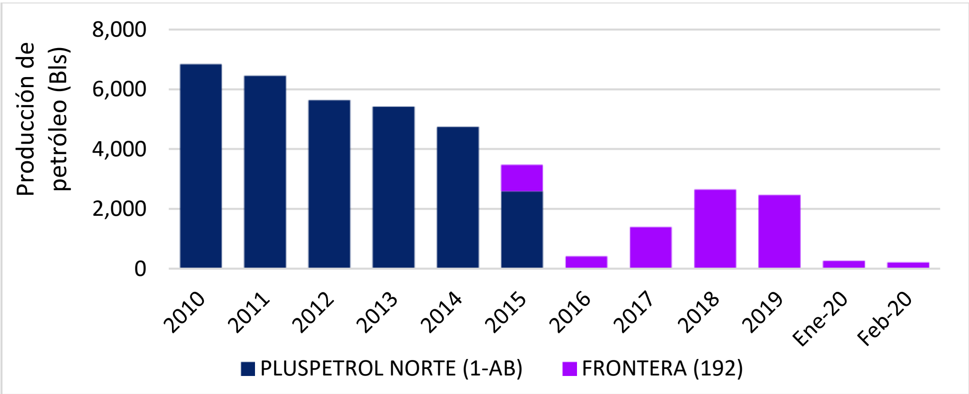
Figura 3. Oil production in the Selva area by block



Nota: Oil Production by Petroleum contractors in the Peruvian Jungle. (Perupetro, 2020)

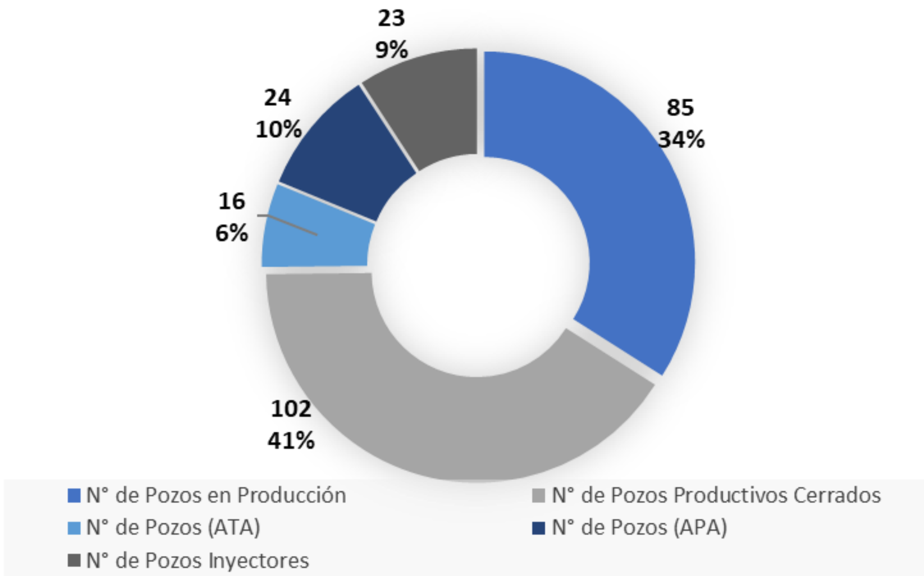
- **Production in the Block 192 during the year 2020**

Figura 4 Block 192 (Ex 1-AB) production since 2010



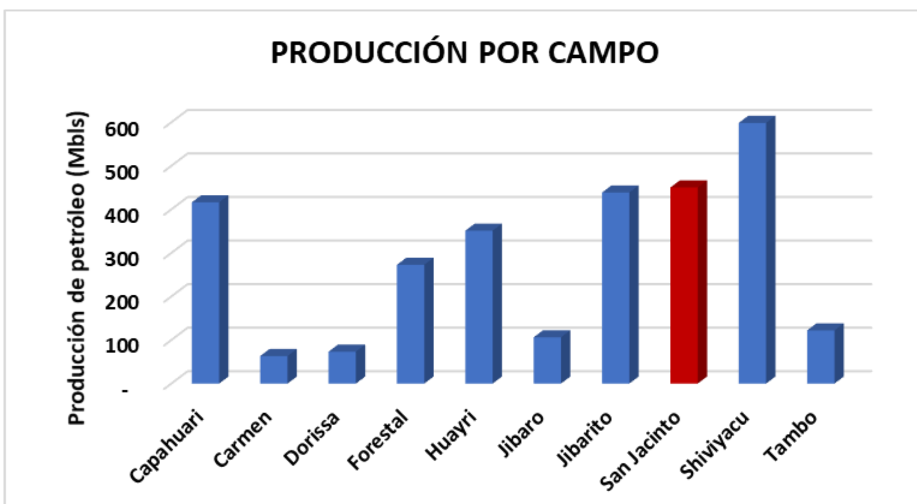
- **States of Wells during the year 2019**

Figura 5 Distribution of current wells according to their current status (Perupetro, Statistics, 2019)



- **Production by Field in 2019**

Figura 6. Block 192 production by field during 2019. (Perupetro, Estadísticas, 2019)



3. STRATEGIC ANALYSIS

3.1.ABOUT KYSPETROL

KYSPETROL is a private, independent and international company with more than 30 years of experience in oil exploration and exploitation. It was founded in 1987, starting its operation Northern Peru, developing its potential in areas of the Talara basin. A short time later KYSPETROL, extended its operations both within the country (Northern Jungle of Peru, Field Bretaña); as in the development of Fields located in different Latin American countries such as (Field Jacana) and Ecuador (Field Libertador). Our main purpose remains to contribute to the energy and sustainable development of the country allowing the economic growth of the sector. In our company we use creativity, innovation and responsibility to face the challenges that cover each operation, and we emphasize the development of the skills of the new generations.

Figura 7: Areas where operations are carried out

Tabla 1: General information about KysPetrol

NAME OF THE ENTERPRISE	KysPetrol S.A.
EXPERIENCE IN EXPLOITATION	33 years
COUNTRY	Perú
LISTED IN STOCK MARKET (Y/N)	N

3.1.1. Technical Capacity

Currently, KYSPETROL operates more than 300 wells of which 50 have been drilled in the last five years. KYSPETROL has developed a rigorous monitoring system for production facilities including wells, resulting in a technical efficiency of 95%. The key to this success is the frequent measurement of production volumes and reservoir and bottom pressures.

Current production is 200,000 bopd with plans to introduce new production technologies (horizontal wells, water sink), EOR (polymer flood) and other improvement projects.

With the aim of increasing reserves, as appraisal program was executed in 2018/2019 that resulted in an increase of 7.2 MMbbls.

In 2016, KYSPETROL began an exploration program in Colombia drilling more than 50 on shore exploration wells of which 20 have been drilled in the last four years. At the same time, KYSPETROL has also been active on the nearby coast through the acquisition of 2D and 3D seismic using transmission and OBC technologies. At the moment, KYSPETROL is about to begin 9 wells exploration drilling program in the Field Bretaña.

Tabla 2: Technical indicators

Annual Average Oil Production, bopd	(25000
Drilled exploratory wells	30
Recorded 2D Seismic Lines, Km	3176
Recorded 3D Seismic Lines, Km	2717
Drilled development wells	100
Proved Reserves (MMBOE)	50
Participation in contracts	+3

3.1.2. Economic Capacity

To support our economic capacity to receive the block, the Financial Statements for 2018, 2019, and 2020 are made known, within which we indicate that we have a Net income of 139.58 MMUSD, equity of 360.77 MMUSD, in addition to having liquidity of 1.4 MMUSD so far in 2020.

Tabla 3: Economic indicators

ECONOMIC INDICATORS	2020	2019	Last two years average
Assets	360.77 MMUSD	200.65 MMUSD	280.71 MMUSD
Current Assets	150.88 MMUSD	105.97 MMUSD	128.425 MMUSD
Operating Cash Flow	9.7 MMUSD	8.5 MMUSD	9.1 MMUSD

3.1.3. Legal Capacity

By submitting the KYSPETROL Charter and Statute, a copy of the International Certificate that supports the implementation and application of an Environmental Management System for oil exploration and production activities, KYSPETROL Certificate of Incorporation and certificate of connection, and sworn statement referring to the corporate purpose we support our legal existence, corporate validity and that we comply with the legal capacity to be able to exploit the field in question.

3.2.STRATEGIC FUNDAMENTALS

3.2.1. Mission

We are an international operating company committed to all our operations being developed with a social and environmental responsibility, taking into consideration sustainable development and contributing to the increase of national production.

3.2.2. Vision

Become a leading and reliable company in the Peruvian hydrocarbons industry, carrying out strategic activities to consolidate our national and international in the hydrocarbons sector within 20 years.

3.2.3. Values

- **Respect**

Aligns industry with law enforcement, promotes harmony with the environment, and recognizes the importance of human rights, freedom of religion.

- **Justice**

It is the conception that each and every member must work with equity and for the common good.

- **Responsibility**

It is a value that must be in the consciousness of people every moment, which allows them to reflect, manage, guide, and to assess the consequences of their actions always in favor of labor, social, cultural, and natural improvement.

- **Ethics**

The ethical principles of the company focus on healthy, transparent competition, and participation in businesses that are framed within the current legislation and applicable in Peru.

- **Innovation**

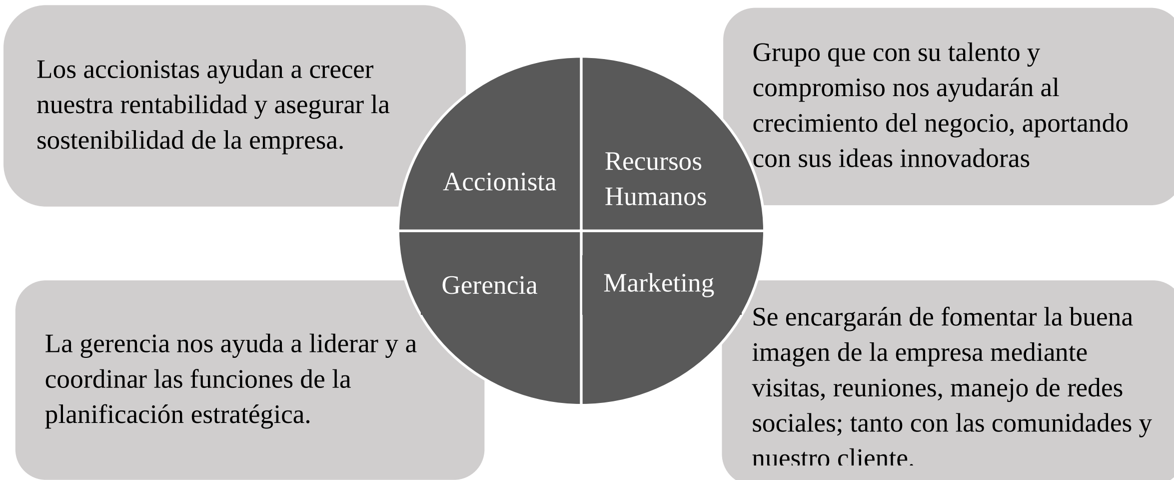
Think beyond possibilities and act despite uncertainty to capitalize on opportunities.

3.3.INTEREST GROUPS

Stakeholder analysis helps us to identify key points of interest to observe these needs and to integrate it into strategies.

3.3.1. Internal interest groups

Figura 8. Internal Stakeholders



3.3.2. External interest groups.

3.3.2.1. State regulatory and supervisory organization

- **Ministerio de Energía y Minas (MINEM)**

The Ministry of Energy and Mines formulates and evaluates national policies regarding the sustainable development of mining-energy activities, contributing to human development, as well as reducing environmental impact. (Minas, s.f.)

- **Ministerio del Ambiente**

The Ministry of the Environment is in charge of formulating, planning, directing, executing, supervising and evaluating the National Environmental Policy (PNA), as well as directing the National Environmental Impact Assessment System (SEIA). (Ambiente, s.f.)

- **Ministerio de Cultura**

The Ministry of Culture is a body of the Executive Power responsible for all cultural aspects of the country and exercises exclusive and exclusive competence with respect to other levels of management throughout the national territory. (Cultura, s.f.)

- **Perupetro S.A.**

Perupetro S.A. is the state company under private law that, on behalf of the Peruvian State, is in charge of promoting, negotiating, signing and supervising contracts for the exploration and exploitation of hydrocarbons in Peru. (S.A, s.f.)

- **Servicio Nacional de Certificación Ambiental para las Inversiones Sostenibles**

SENACE is a specialized technical public body, attached to the Ministry of the Environment. Its task is to review and approve the larger detailed Environmental Impact Studies (EIA-d) of public, private or mixed capital investment projects. (SENACE, s.f.)

- **Organismo de Evaluación y Fiscalización Ambiental – OEFA**

OEFA is a specialized public technical organization, attached to the Ministry of the Environment, in charge of environmental control and ensuring the proper balance between private investment in economic activities and environmental protection. The OEFA is also the governing body of the National System for Environmental Assessment and Enforcement (SINEFA). (OEFA, s.f.)

- **Organismo Supervisor de las Inversiones en Energía y Minería - OSINERGMIN**

It is the Supervisory Agency for Investment in Energy and Mining, a public institution in charge of regulating and supervising that companies in the electricity, hydrocarbon and mining sectors comply with the legal provisions of the activities they carry out. (OSINERGMIN, s.f.).

- **Comunidad Local y General**

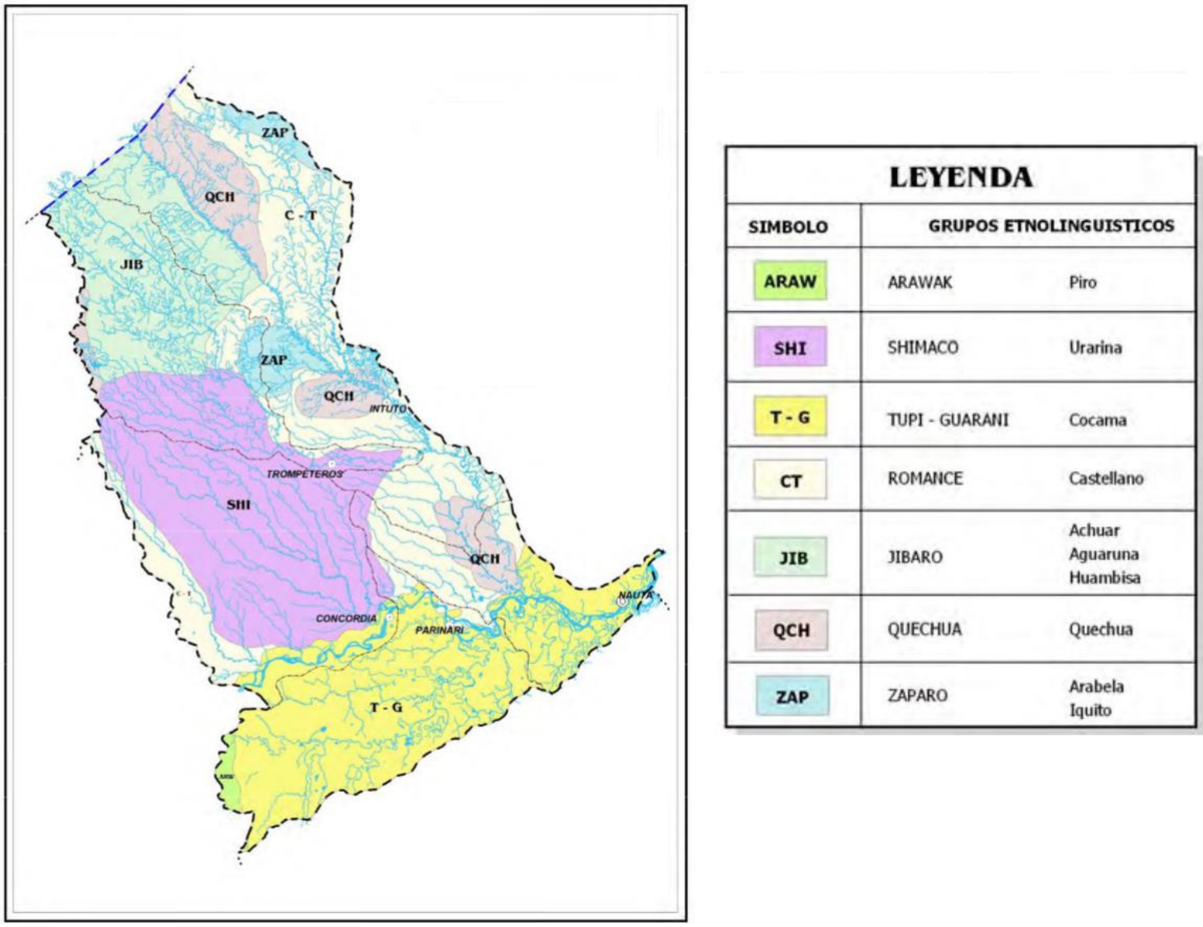
Different communities around the field of operations are very important in the feasibility analysis of a project. The PUINAMUDT platform is made up of four indigenous federations that group a total of 98 (NINETY-EIGHT) indigenous communities of Loreto that are within the scope of direct and indirect influence of the Lote 192.

- FEDIQUEP: Quechua Indigenous Federation of Pastaza
- FECONACOR: Federation of Native Communities of the Current
- OPIKAFPE: It brings together 4 Kichwa and Achuar communities from the Alto Tigre basin that are within the area of lot 192, the community closest to the San Jacinto field. (PUINAMUDT, s.f.).

Tabla 4 Indigenous communities in the province of Loreto

DISTRICT	NAME RECOGNIZED COMMUNITY	GROUP
TIGRE	28 DE JULIO	QUECHUA
TIGRE	ALFONSO UGARTE	QUECHUA
TIGRE	BELEN	ACHUAL
TIGRE	MARSELLA	QUECHUA
TIGRE	NUEVA JERUSALEN	ACHUAL
TIGRE	NUEVA JERUSALEN	ACHUAL
TIGRE	NUEVA VALENCIA	ACHUAL
TIGRE	NUEVO CANAAN	QUECHUA
TIGRE	PAICHE PLAYA	QUECHUA
TIGRE	PAMPA HERMOSA	ACHUAL
TIGRE	SAN ANDRES	QUECHUA DEL TIGRE
TIGRE	SAN JUAN	QUECHUA
TIGRE	SAN JUAN DE PAVAYACU	QUECHUA
TIGRE	SANTA ELENA	QUECHUA
TIGRE	PARAÍSO, SANTA CRUZ	QUECHUA
TIGRE	VISTA ALEGRE	QUECHUA
TIGRE	12 DE OCTUBRE	QUECHUA DEL TIGRE
TIGRE	SANTA FE	

Figura 9 Map of Indigenous Communities in the province of Loreto



3.3.2.2. AUTHORITIES

Tabla 5. Municipalities surrounding Block 192.

Gobierno Regional de Loreto-GOREL	Municipalidad Provincial de Loreto
Municipalidad Distrital de Tigre	Municipalidad Distrital de Trompeteros
Municipalidad Provincial de Datem del Marañón	Municipalidad Distrital de Andoas

3.3.2.3. SOCIAL ORGANITZATIONS

Tabla 6. Social organizations in Loreto

Asociación Interétnica para el Desarrollo de la Selva Peruana - AIDESEP	Organización Regional de Pueblos Indígenas del Oriente - ORPIO
Organización de Pueblos Indígenas Kichwas Amazónicos Fronterizos del Perú- Ecuador- OPIKAFPE	Federación de Comunidades Nativas del Corrientes - FECONACO
Federación de Indígenas Quechua del Pastaza - FEDIQUEP	Federación de Comunidades Nativas del Alto Tigre - FECONAT
Federación Indígena del Alto Pastaza - FEDINAPA	Organización Interétnica del Alto Pastaza - ORIAP

3.3.2.4. NGO AND OTHER INSTITUTIONS

Tabla 7. Institutions in Loreto

Derecho Ambiente y Recursos Naturales - DAR	Instituto de Defensa Legal – IDL
Instituto de Defensa Legal del Ambiente y del Desarrollo sostenible - IDLADS	Pueblos Indígenas Amazónicos Unidos en Defensa de sus Territorios - PUINAMUDT

3.3.2.5. CUSTOMERS

Petroperú will be our only client to purchase our products, since currently consumption exceeds daily national production.

3.3.2.6. SUPPLIERS

To carry out the project objective, we depend on raw materials and services. It is a fundamental group for the quality and realization of our product.

- Petrex
- Schlumberger
- Halliburton
- Baker Huges
- National OilWell Varco

3.3.2.7. UNIVERSITIES

We will promote the development of research in universities through university extension courses and project competitions, financing the best projects.

- Universidad Nacional de Ingeniería - UNI
- Universidad Nacional de Piura - UNP
- Universidad Nacional Autónoma del Alto Amazonas- UNAAA
- Universidad Nacional de la Amazonia Peruana- UNAP

3.4.INTERNAL ANALYSIS

In Peru, the oil sector is comprised of:

The Government, as a regulatory and supervisory entity through public companies; by operating companies, both private and state, and private equity services companies, generally.

Although Peru is not a purely oil country, it contributes large sums of money for royalties, Income Tax and the Canon to local regional governments (Government take), where its exploratory and extractive activities are carried out.

In Rumbo Minero TV, the president of the Perupetro board of directors, Seferino Yesquén, presented the topic "Urgent reactivation of the hydrocarbon sector", where he mentioned:

> In the 90s, there were 200 thousand barrels, in 2000 about 100 thousand BPD then about 60 thousand, 40 thousand, 25 thousand and now we are at 30 thousand BPD. In 2018, the turning point of the industry occurred, we went from 40 thousand BPD to what in February had reached 61,200 BPD thanks to the production of batch 95 in the jungle; situation currently halted by the taking of the oil pipeline by the native communities that prevents lots 8, 192 and 67 that together make 22 thousand barrels, continue to produce; the only batch it produces is 95.
>
> Peru imported 15 billion soles of fuel per year to what today is imported the equivalent of 21 billion soles per year; Peru consumes more and more energy. (Yesquén, 2020)

He pointed out that as a result of COVID-19, there are 12 thousand families who lost work in the jungle, in Talara with less impact, but also with casualties. This is because the importation does not pay royalties or generate work.

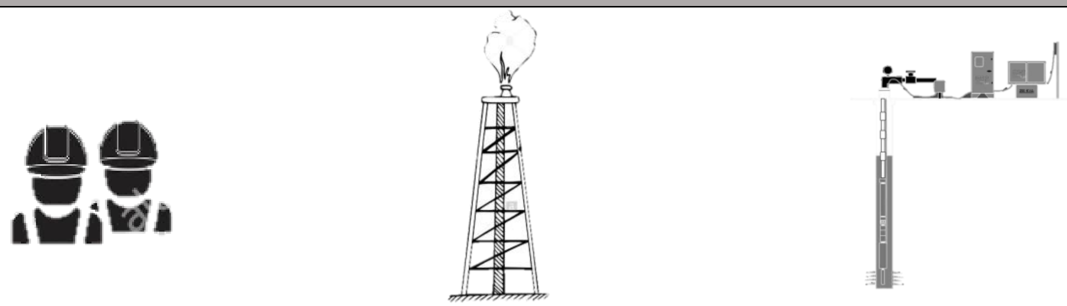
Today there is a whole political agenda to update that should focus on updating the Organic Law; royalties; the issue of rating companies; homologate the canon. In the same way, it is necessary to work in granting security and productive continuity of the Norperuano Pipeline; as well as addressing social gaps.

3.4.1. Value chain

It is an analysis and management tool that will allow us to describe the development of our activities as a company or organization, generating value for the final product, which through an internal analysis has the purpose of providing the highest quality of service and product to the client based on our competitive advantage.

Figura 10. Oil value chain

UPSTREAM



Exploration	Drilling Exploration Confirmatory and Development	Production

Note: Our enterprise KysPetrol, will focus on the upstream activity of the value chain. (Own Preparation)

We can see, a diagram of the company's value chain is presented, detailing the primary activities and the support / auxiliary activities:

Tabla 8. Diagram of the company's value chain, detailing the primary activities

PRIMARY ACTIVITIES			
Internal Logistics	**Operations**	**External Logistics**	**Sales**
- Material procurement and storage sites will be implemented - Data interpretation will enable better production	- Drilling and production operations will be performed - Production systems in heavy crude will be obtained with specialized lifting systems - Field reconnaissance for EIA preparation. - Maintenance and Control	Transportation of crude oil to the batteries and then to the sales and auditing point located at the Andoas station.	Meetings, agreements and negotiations with the client (**PERUPETRO**)

Note: Own Preparation

Tabla 9. Diagram of the company's value chain, detailing auxiliary activities

Auxiliar Activities	
	Company Infrastructure
	• Project Planning and Financing Area • Legal basis and quality control Area. • Administration and Finance Area.
	Human Resources Management
	• Recruitment of personnel and training of the work team • Sensitization and awareness programs. • Creation of job positions.
	Technology and Information Systems
	• Modeling, correlation, analysis and interpretation of electrical logs. • Use of production simulators. • Application of new data collection technologies.
	Purchases
	• Purchase of equipment, PPE, materials for exploration, drilling and production.

Note: Own Preparation

3.5.EXTERNAL ANALYSIS

3.5.1. Porter´s Forces

By owning a crude produced in the Peruvian jungle and under a license agreement, our product would have a single buyer, with whom we must comply with the established agreements regarding the parameters of the crude, such as BS&W, sulfur content, API, among others, which will give us a good reputation and image within the industry. On the other hand, the client's power is very strong in terms of product quality requirements, because they would not buy from us if we do not meet the minimum requirements; therefore, it is essential to satisfy our client.

The state operator (PETROPERÚ) will be our main client; since it has a high bargaining power when it comes to the product we offer, because it is the only buyer in the jungle.

3.5.1.1. Threats of potential entrants

Oil industry presents many barriers to entry; However, there are companies with great economic and technical capacity that find a good deal in the Peruvian market. That, before the approval of the new Organic Law, which seeks to encourage exploration in our country, new reserves could be found, which would attract new operators to our country. There are new companies interested in the hydrocarbon potential of Peru, for example:

- Viper Energy
- Norther Hydrocarbon S.A.
- Mquest International
- Interoil
- Upland Oil & Gas

3.5.1.2. Supplier Power

Among the main suppliers of the Sector are suppliers of technology, machinery, equipment, services and human resources consultancies. In the latter, there are those of highly qualified specialized personnel; raw material suppliers contemplate those of chemicals used, for example, for sludge design, additives to control thermal stability, etc. In our case, several clients of our suppliers coexist that can influence the costs of the products they offer us.

Among the main ones we have:

- Halliburton: Company in charge of cementing and competition activities, in addition to being a company with new technologies.
- Petrex: To fulfill the field development plan and in charge of drilling activities.
- Schlumberger: Company in charge of running logging.

3.5.1.3. Threats of substitutes

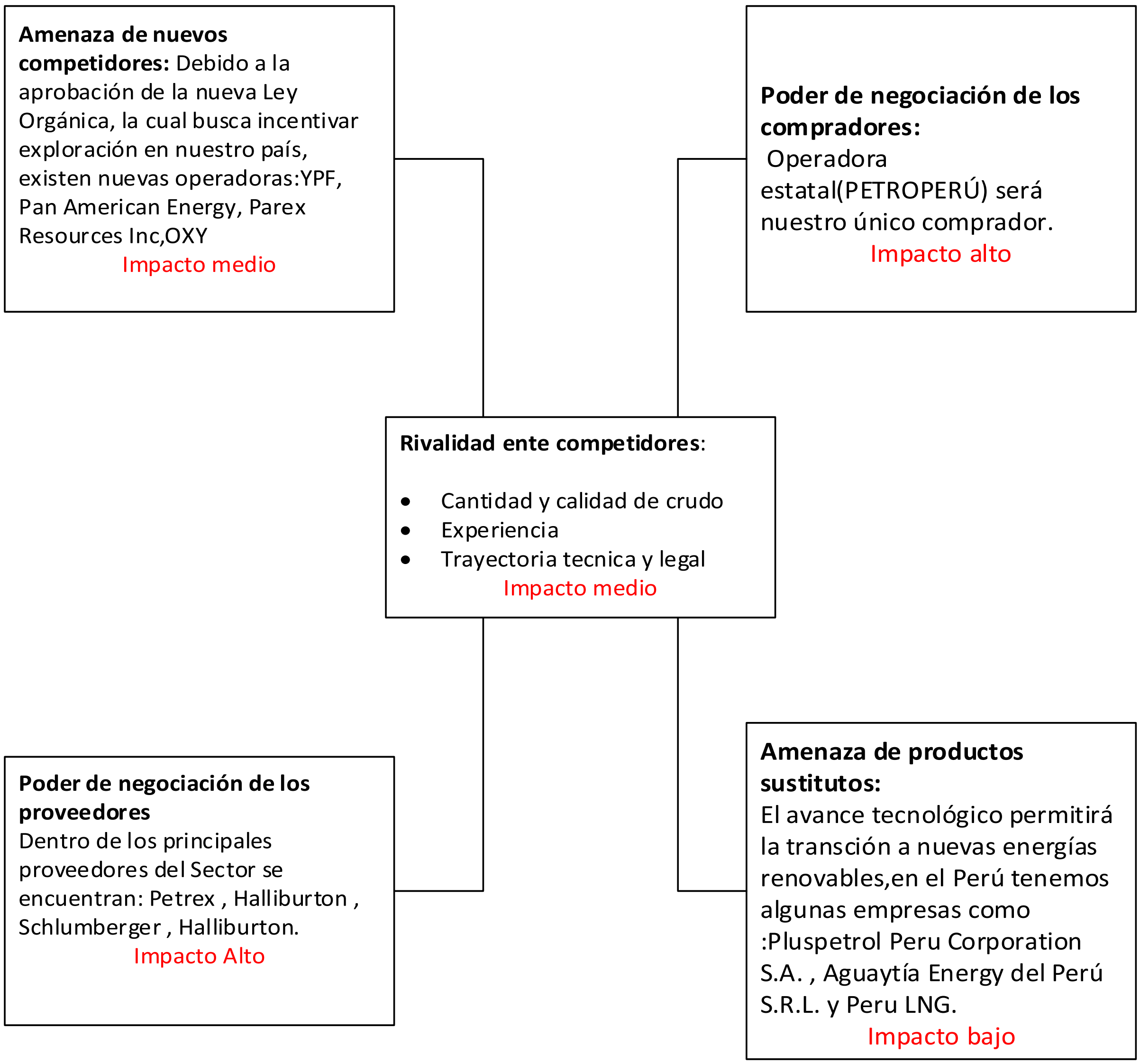
Oil can be stored and is not easily substitutable in the short or medium term. In our country it continues to be the main source of energy since the other sources are less developed and are being implemented slowly.

Thanks to technological progress, it allows the possibility of replacing it in the long term with other substitute energy sources (NG and NGL, solar, nuclear and geothermal energy, among others). Crude derivatives are used in almost all economic sectors, although mainly in industry (petrochemical, electrical, manufacturing, etc.), transportation, cooking and heating. Some companies provide alternative energies, such as: Pluspetrol Peru Corporation S.A., Aguaytía Energy del Perú S.R.L. and Peru LNG.

3.5.1.4. Competitive rivalry

The operators compete in rivalry in terms of achieving crude production objectives, since lot 192 is one of the main contributors to national production, in search of satisfying national consumption. Regarding the operations, each operator develops within the lot that corresponds to it without intervening outside of these. We have Pluspetrol, Perenco and PETROTAL as direct competitors since they use the pipeline as their main source of transportation. Another point to take into account would be a differentiation in the product since they are very similar which would not generate any strategy in our competitors.

Figura 11. Porter's 5 forces diagram.



3.5.2. PESTEL Analysis

This analysis will help us to know the environment of our organization by studying various factors including political, economic, social, technological, ecological, and legal, which may affect the development of the project.

Tabla 10. PESTEL Analysis

EXTERNAL FACTORS	OPPORTUNITIES	CHALLENGES
Political	Government proposed on November 23, 2020, to implement a better policy to boost investments in Peru. (Rumbo Minero, 2020) Progress in the Talara refinery at 97%. (Rumbo Minero, 2020)	Political instability, which makes future investments uncertain (unfinished governments). (BBC, 2020) Postponement of the new Organic Hydrocarbons Law.
Economic	Quarterly GNP growth by economic activities in the extractive sector of 1.3% from II-III quarter 2020 (INEI, PBI trimestral, 2020) Balance of payments (percentage in GDP) rose to 0.45% in III quarter 2020. (BCRP, Estadisticas, 2020) The Board of Directors of the Central Reserve Bank of Peru agreed to continue with its expansionary monetary policy, maintaining the benchmark interest rate at 0.25%. (BCRP, Programa monetario , nov. 2020)	44% drop in royalties from oil companies so far in 2020 compared to the previous year. (EconoJournal, 2020) Increase in annual inflation (November 2020) by 2.14%. (INEI, Variacion de los indicadores de los precios de la economia, nov. 2020) Current unemployment rate of 16.4%. (INVESTING, nov. 2020) High fiscal terms that discourage investment.
Social	The existence of Prior Consultation for a dialogue with indigenous federations and native communities. (Cultura, s.f.)	Incidents recorded at ONP stations by the Marañon Datem communities. (Gestion, Evacuacion de personal, 2020) Loreto comprises the highest number of social conflicts in the hydrocarbon sector. (OSINERGMIN, 2019) Pluspetrol and Frontera Energy do not assume responsibility for the damages occurred in the past, and their abandonment plan. (Gestion, 2020)
Technology	PERUPETRO promotes multi-client contracts that employ new exploration techniques. For example: Searcher, CGG, Searcher OFFSHORE. ONP resumed operations on August 1 under strict safety protocols. (Gestion, Oleoducto Norperuano reanuda sus operaciones bajo estrictos protocolos de seguridad, 2020)	Most of the spills in the Peruvian rainforest are caused by corrosion of pipelines and operational failures of companies. (Times, 2020)

Environment	Existence of Law N°28611 "General Environmental Law in Peru", according to which we are all obliged to contribute to an effective environmental management and to protect the environment. (MINAM, 2005)	During the State of Emergency, about eight oil spills have occurred in Block 192. (Wayka, 2020).
Legal	Existence of Law No. 26221 "Organic Hydrocarbons Law", which integrates all the regulations to which the industry must be subject. (PERUPETRO, s.f.)	Pluspetrol and OEFA in dispute over remediation of environmental liabilities of Block 192. (El Comercio, 2020)

3.6.SWOT Analysis

Tabla 11.SWOT Analysis

	STRENGTHS	WEAKNESSES
INTERNAL FACTORS	S1: We are a national operating company with several years of experience in oil exploration and production in the forest fields of Peru. S2: We have the financial backing to cover the contract. S3: Our company considers different technological advances related to the exploitation of heavy crude oil. S4: We have highly trained professionals with ease of negotiation and treatment. S5: Large reserves of heavy and light oil in the San Jacinto field.	W1: Dependence of the ONP to transport our products to the interior of the country. W2: Need to perform additional treatments to the oil to meet the required minimum standards of inspection. W3: We do not have personnel specialized in environmental and legal management about the current Peruvian regulations
	OPPORTUNITIES	**THREATS**
EXTERNAL FACTORS	O1: The end of the service contract with Frontera Energy will be the first quarter of 2021. O2: The high demand for fuel in Peru will force us to produce large quantities of oil. O3: The Iquitos refinery has easy access to our field for the treatment of heavy oil. O4: New generations of research-oriented human capital.	T1: Due to history, there is a high probability of ONP inactivity. T2: Disagreement in the Prior Consultation due to conflicts with the communities resulting from the oil activity. T3: High standards of qualification regarding technical, economic, and legal capacity. T4: Susceptibility to volatility in international crude oil prices T5: Delays in the approval of environmental studies. T6: Distance between the field and the inspection point.

3.7.STRATEGIES

Tabla 12. Strategies based on the SWOT analysis

	STRENGTHS	WEAKNESSES
OPPORTUNITIES	**S1/O5:** The experience in jungle fields and our highly trained workers make us a competitive company able to manage the proposal field. **S3/O2:** The knowledge of different software will allow us to make a better prediction of the recovery factor which could reduce the gap between supply and demand. **S1/O2:** Increase the production capacity by taking advantage of the large volume of reserves in San Jacinto field. **S1/O4:** Consolidate connection with suppliers which we have already worked with.	**W1/O4:** Our young and trained researchers allow us to determine other alternatives for the transportation of heavy oil reducing the dependance of the Norperuano pipeline. **W2/O2:** The profits obtained by the high production of the field will served to cover the expenses of the additional treatment for the crude oil. **W2/O3:** The installation of an equipment for pumping and receiving the diluent will be done thanks to the easy fluvial access of the refinery and our field.
THREATS	**S2/T1:** The high financial capital will serve to face any contingency. **S1/T2:** The previous experience in jungle fields will allow us to set better agreement with the communities. **S3/T6:** Install a pumping station in order to compensate the high pressure drop during the track of the pipeline.	**W1/T2:** Create a commission with the company and community to promote preventive measures in order to guarantee the safety of crude oil transportation to Andoas station. **W3/T5:** Request the support of a consultancy in order to get faster the environmental permissions and don’t have delays in the approval. This will be done in the first period of the project.

BALANCED SCORECARD

Balanced scorecard tracks all the important elements in a company's strategy, from continuous improvement and partnerships to teamwork and global scale. And that allows companies to achieve excellence. The Balance Scorecard allows you to analyze from four important perspectives. We ask four basic questions:

- How do customers see us? (Customer perspective)
- What can we be the best at? (Internal perspective of the company)
- Can we continue to improve and create value? (Innovation and learning perspective)
- How do we see ourselves in front of the shareholders? (Financial perspectives)

Tabla 13 Balanced Scorecard

OBJECTIVES	GOALS	INDICATORS	INITIATIVES
CUSTOMER PERSPETIVE **Be a referent in the oil and gas industry.**	Hydrocarbon production and delivery in an effective way. Maintain an ISO certification in HQSE.	Company Prestige. Certification: ISO 45001; 14001.	Increase Area production Maintain HQSE policies in our operations.
INSIDE PROCESS PERSPECTIVE **Be able to reach a recovery factor of 25% for Vivian and 40% for Chonta.**	Calculate theoretical recovery factor (RF) Perform EOR activities.	Dayli production. Well History. Original Oil in Place.	Identify exploratory prospects with high success probability. Production volumes tracing.
LEARNING AND INNOVATION PERSPECTIVE **Count with highly trained staff for Project development.**	Perform of training programs for our staff.	Trained and effective staff.	Efficient recruitment process.
FINANCIAL PERSPECTIVE **Increase profit and reduce costs.**	Increase production in 50% and reduce costs in 8 %.	Incomes. Cash Flow. Oil price.	Increase our profit margin in 30%.

4. TECHNICAL STUDY

4.1.LOCATION OF THE STUDY FIELD

4.1.1. Location of the study field

The area to develop in the current project is a twin field of the current San Jacinto field, which will be called San Jacinto Oriental field. It is in the northern part of block 192, specifically in the province of Loreto, in the Tigre District.

This block had been operated by Frontera Energy Company since August 31, 2015. This company negotiated with PERUPETRO through Temporary Services Contract. Currently PERUPETRO assumed the temporary administration of block 192 from February 6 until the completion of the process of prior consultation. PERUPETRO expects to sign a license contract for the exploitation of hydrocarbons in compliance with Law 30357. Its geology is developed within the Marañón Oil Basin, in the northern jungle of Peru.

Figure 12: Distribution of fields in Block 192. (PERUPETRO, Statistics, 2019)

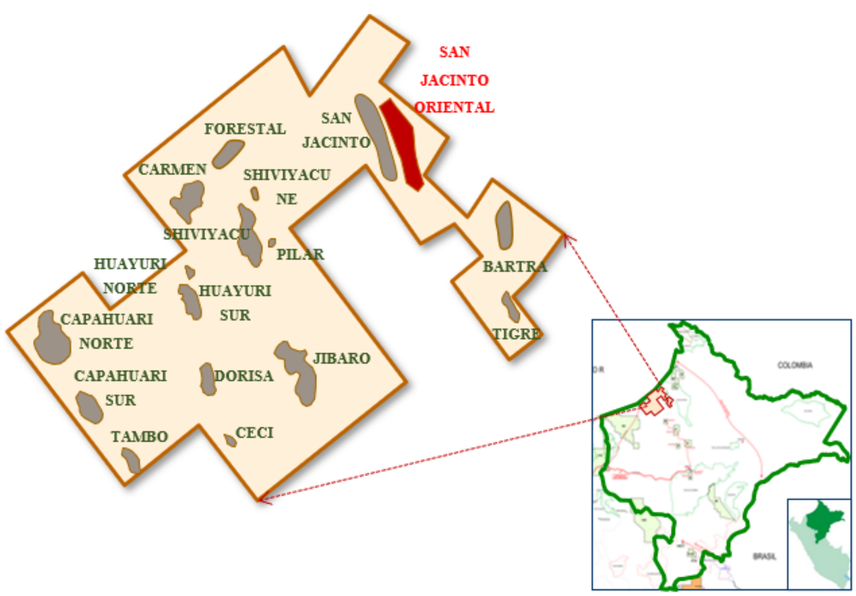


Figure 13 Location of San Jacinto Oriental field on the map. Source: Google Earth

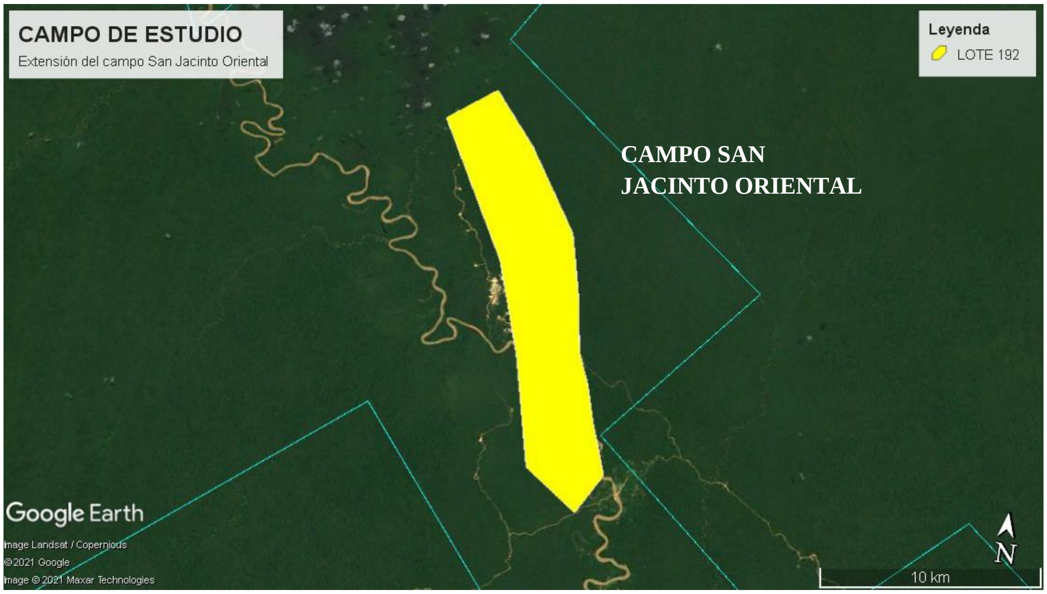


Tabla 14 Study Area Coordinates. Source: Google Earth

GEOGRAPHIAL COORDINATES	
South Latitude	West Longitude
2°14'40.54"S	75°52'25.47"O
2°13’38.22"S	75°52’37.60"O
2°14’57.56"S	75°51’31.38"O
2°16’38.53"S	75°50’2.67"O
2°18’38.55"S	75°49’48.26"O
2°19’58.28"S	75°49’34.45"O
2°20’48.28"S	75°49’16.19"O
2°21’40.75"S	75°49’2.69"O
2°22’56.94"S	75°48’34.99"O
2°23’56.94"S	75°49’10.44"O
2°23’1.59"S	75°50’30.61"O
2°20’18.54"S	75°51’11.79"O
2°117’33.13"S	75°52’22.36"O
2°14’33.54"S	75°53’51.89"O

area: 6’290 ha

4.1.2. Regional geological study

4.1.2.1. Identification of the area of interest

Surface geology analysis is the first part of geological exploration that is based on the investigation of alluvial deposits observed on the surface, on laboratory analyses of samples and on data obtained after travelling through the territory. For this reason, it is important to note data of outcrops on the slopes of the beds, river edges, and other topographic features.

It is worth mentioning that all this development is done with the types of rocks, composition, characteristics, inclination and direction of strata, ages of fossil remain that provide information for the manufacture of subsoil maps of the twin San Jacinto field.

The methods to be used are:

- Aerial photography
- Seismic method
- Gravimetric method

4.1.2.2. Natural characteristics of the study area:

The location of block 192 is in the Amazon plain of northern Peru, approx. 182 and 267 meters above sea level. In the classification of Pulgar Vidal, it corresponds to the altitudinal floor of Omagua or low forest (80-400 meters above sea level). Main characteristics for its extensive plain, subjected to a process of abrasion and destruction by the rivers that cross it, without major structural deformation, although there is a relief given by hills, hills and alluvial terraces, covered by a dense tropical forest. Tahuampas, restingas, altos and filos are the main geoforms that stand out from the block.

The climate is tropical, warm, humid, and rainy, having an average temperature above 25 degrees Celsius, in block 192 its annual average ranges from 24.2 to 25.2 degrees Celsius, the rains develop with great intensity between the months of December to May. The soils of the Amazon have little nitrogen, phosphorus, and potassium capacity. In addition, soils have abundant oxide and hydroxide of aluminum and hydrogen. Its vegetation of the block includes tropical forests, with dense cover and heterogeneity of tree species, Block 192 is in a region with a high forest power comprising the type of forests that can be used due to their accessibility and operational conditions.

4.2.GEOLOGY

4.2.1. Geology of the San Jacinto Oriental field

The field San Jacinto Oriental is located in the northern part of the Marañón Basin, the basin is of the type called as antepaís, located within elongated anticlinal structures within an extensive monoclinal that dives toward the southwest. The hydrocarbon potential comes mainly from the productive reservoirs to Basal Tertiary, Vivian, and the sands of the Chonta Formation. It is worth mentioning that the Tertiary Basal reservoir is productive only in the southern block where the oil has migrated to the fault plane of the Vivian reservoir.

- **VIVIAN RESERVOIR**

It is the most important reservoir of the field; it is a quartz white sandstone deposited in an environment of intertwined currents.

In the homologous San Jacinto field, Vivian produces heavy oil with an average of 11.5° API, having a depth of 2.408 m. It has an average porosity of 19.7% and net oil sand of 9.8 meters. It mainly produces by lower water drive in Vivian A, on the other hand, Vivian B produces by flank water drive generating greater recovery.

- **CHONTA RESERVOIR**

In the San Jacinto Oriental field, it comprises estuary deposits to shallow marine environments, resulting in an extremely heterogeneous deposit. In the San Jacinto Homologue field, the Chonta Sand reservoir produces light 28°API oil at a depth of 2,560 m. It has a porosity of 19.1% and oil sand with an average thickness of 3.4 meters.

4.2.2. Exploration Process

PLAY

A project associated with a prospective trend according to potentials, but that require more data acquisition and/or more evaluation to be able to define specific leads or prospects.

Activities:

- Regional studies

LEAD

A project associated with a potential accumulation that is currently poorly defined and requires more data acquisition and/or evaluation to be classified as a prospectus.

Activities:

- Superficial studies
- Laboratory analysis
- Geological and geophysical studies (gravimetry, geo-electric, magnetometry and thermometric)

PROSPECT

A project associated with potential accumulation that is sufficiently well defined to represent a viable drilling target.

Activities:

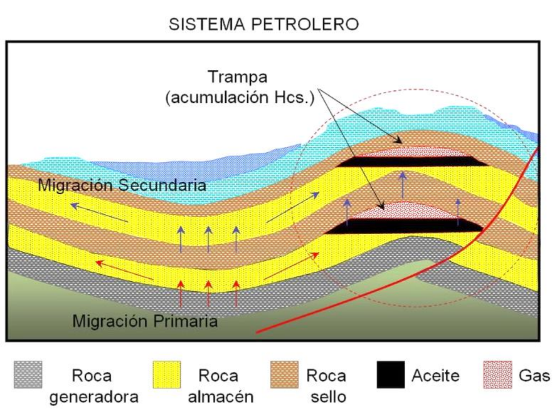
- 2D and 3D seismic.

4.2.3. Oil system

It is the system in which the hydrocarbon is produced that includes the geological processes essential for a reservoir of hydrocarbon to exist in nature in a given sedimentary basin. The Marañón Basin has 2 proven oil system, among the special elements of an oil system is:

- Source or parent rock
- Reservoir rock
- Seal rock
- Trap formation
- Expulsion, migration and accumulation
- Overburden (lithostatic load)

Figura 14: Oil System. Source: Olmec University, Exploration Geology



This process must be carried out at an appropriate time and temperature so that the chain of events causes the organic matter of the generating rock to be transformed into hydrocarbon, in the absence of one of the aforementioned elements the possibility of an oil system being eliminated, this process is carried out in millions of years, the oil systems of the Marañón Basin are Pucará and Chonta in which they became hydrocarbon generators at different times. In this report we are going to represent the oil system through a history of events graph.

4.2.3.1. Pucará oil system:

- **Source rock**

Belonging to the late Triassic, Jurassic around 157 million years, the Pucara formation extends from north to south with an increase of layer from east to west with its most prospective depocenters on the western stretch. The formation extends in the folded belt and in the basins of Santiago, Bagua and Huallaga and is subdivided into 3 units: the bottom part is held to Cambara, Arama chay, both with lime shale and calcareous shale and on top to Condorsinga is rich in siliclastics and has a reservoir facies.

- **Seal and reservoir rock**

Pucara fluid is found in potential reservoirs such as Cushabatay, Aguas Calientes, Chonta and Vivian, the latter two are the most developed at present. It has a quality of reservoir from good to excellent in this deposit. The shales of the Raya and Chonta Formation form the seal rock of the Cushabatay and Aguas Calientes reservoirs respectively. The shales of the lower tertiary Yahuarango form the seal to the reservoir Vivian.

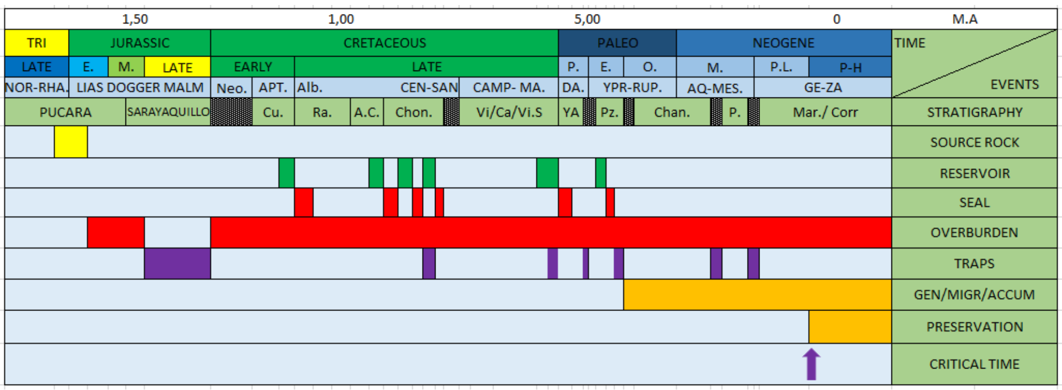
- **Traps**

The predominant style in the Cretaceous area of the Marañón Basin is structural which is based on the soft form of anticline are small closures in the late Tertiary era, Potential traps at the level of the Pucara reservoir that may have accumulations of Pucara oils are stratigraphic traps or combined stratigraphic-structural traps, it should be mentioned that traps can also function as side seals.

- **Generation and migration**

It originates in the Paleocene-Middle Miocene epoch from 63 to 12 million years and that of the gas during the Late Eocene-Miocene from 55 to 10 million years with which the oil would have migrated upwards and then to the east, this migration occurs over long distances approx. 150 miles from depocenters. (PERUPETRO, Cuenca Petroleras del Perú, s.f.)

Figura 15: Pucará oil system – graphic of events. Source: PARSEP, 2002



Note: Purple Bar - Chonta Geological Event

4.2.3.2. Chonta oil system:

- **Source rock**

The time of the late Cretaceous is the time of the source rock age in which the upper Chonta shales with greater extent to the east, but in lesser proportion so that the source (net pay) of the generating rock decreases towards the east. On the western side of the Marañón basin the base of the Chonta formation reached its oil window maturity instead, for the east side there is an early oil window.

- **Seal and reservoir rock**

The reservoir Vivian formed by quartz sandstones of medium to coarse grain, deposited in a fluvial environment, its seal is given by the shales of the lower tertiary Yahuarango. The Chonta reservoir is formed by glauconite sandstones, of coarse to fine grained quartz deposited in a marine environment.

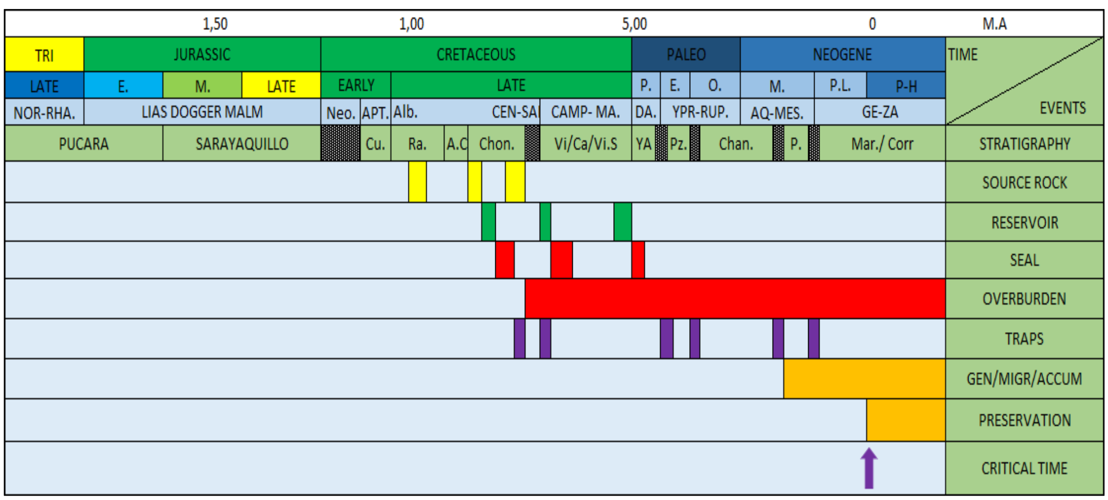
- **Traps**

Presents 3 types of structural traps. They are structural (anticline), stratigraphic and stratigraphic-structural which are much younger than those of Pucara, the faults are of short time, so the structures are partially filled (1/3 from the reservoir).

- **Generation and migration**

The ejection of oil from the Chonta Formation occurs during the Late Miocene to the present time around 8 million years, migrated to the younger late tertiary structures, a migration of up to 100 miles and lateral upwards due to the sandstones of Chonta and Vivian and vertical migration due to local faults.

Figura 16: Chonta oil system – graphic of events. Source: PARSEP, 2002



4.2.4. Structural Model of the Marañón Basin

This basin corresponds to a subsident flexural basin (foredeep depozone) of the Andean foreland system of the Amazon NW.

- **Location, orientation**

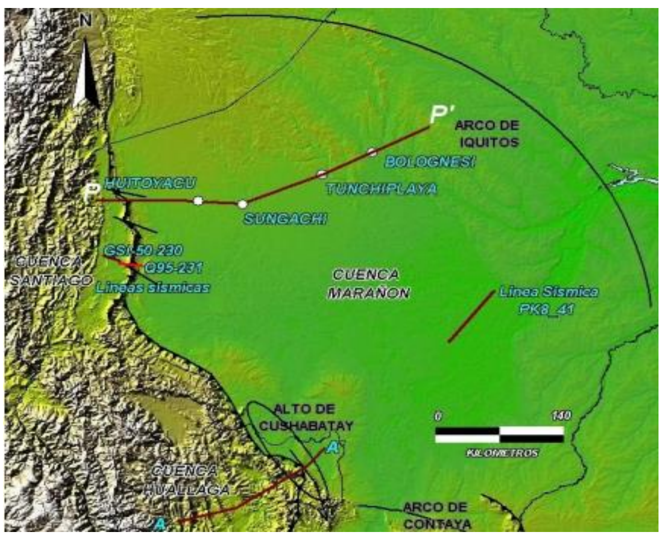
This basin is located between 2º and 7º South latitude with respect to the equator and 73º and 77º West longitude with respect to the Greenwich meridian.

It has a structural orientation NNW-SSE in the northern sector, and NW-SE in the southern sector.

- ***Limits***

It is bounded to the north by the East Equator basin, to the west by the sub-Andean zone (Santiago and Huallaga basins), to the NE by the arc of Iquitos, to the SW by the high of Cushabatay-Contaya, and to the south by the arc of Contaya that separates it from the Ucayali basin, on the east borders with the Craton of Brazil.

Figura 17: Visualization of some limits of the Marañón Basin. Source: PARSEP, 2002.



- **Geological events**

The substrate of this basin is deformed by rifting tectonics (called the zone of Earth's crust where faults and fissures appear because of the divergence of two tectonic plates) from the late Permian and early Triassic, which generated an alternating erosion of the Paleozoic section.

Subsidence or subsidence of the Upper Cretaceous and the Cenozoic is controlled by the tectonic load produced by the landslide systems (movement of earth or rocks along a slope) of the Eastern

Cordillera (mountainous alignment constituting the eastern branch of the Andes Mountain Range in Peru) and the sub-Andean zone.

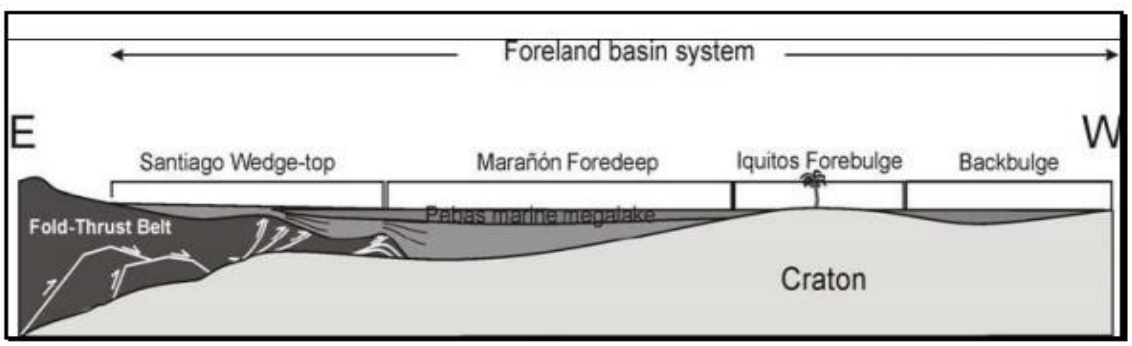
The inner part of the basin is deformed by tectonic inversions (occurs when the extensional faults that control a basin reverse the direction of its movements due to stresses) of extensive Paleozoic and Mesozoic faults, those investments were initiated during the Upper Cretaceous in a compressive stage called the "Peruvian phase" (called by the registration of several marine transgressions and compressive tectonic phases), which were then reactivated during the Neogene.

- ***Structures***

In the eastern direction, the Cenozoic sediments are minted on the arc of Iquitos (zone of the Forebulge).

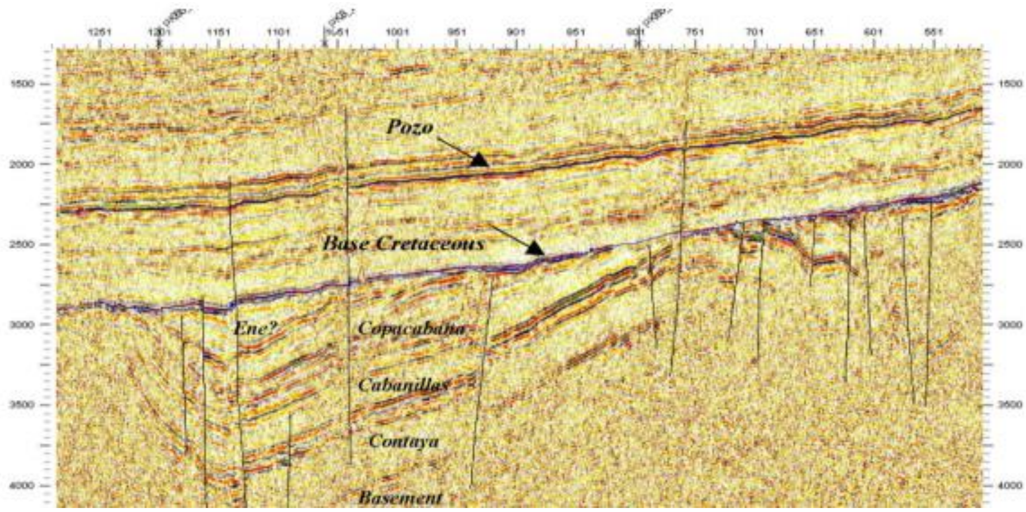
The sedimentological studies of the Miocene-Pliocene that emerge in the area of the arc of Iquitos show that its lifting controlled the sedimentation of the Marañón basin from the Upper Miocene.

Figura 18: Foreland basin system. Source: PARSEP, 2002



The seismic section below shows the alternating formation of some grabens and semigrabens, as well as a pronounced erosion at the base of the Cretaceous.

Figura 19 Seismic section results PK8_41. Source: PARSEP, 2002



Note: the figure shows an erosion surface at the base of the Cretaceous above graben and horst.

4.2.5. Structural Geology of the San Jacinto Field

Structural geology is defined as the branch of geology that studies the Earth's crust, its structures and its relationship to the rocks it contains. In addition, he studies the geometry of rock formations and the position in which they appear on the surface. In this project we will show 3 structural maps, corresponding to Chonta, Vivian and Tertiary Basal. In addition to their corresponding maps of net oil sands. All this as a basis for the study of reservoirs.

4.2.5.1. Structural maps of the San Jacinto Oriental Field

¿How was the process of obtaining structural maps carried out?

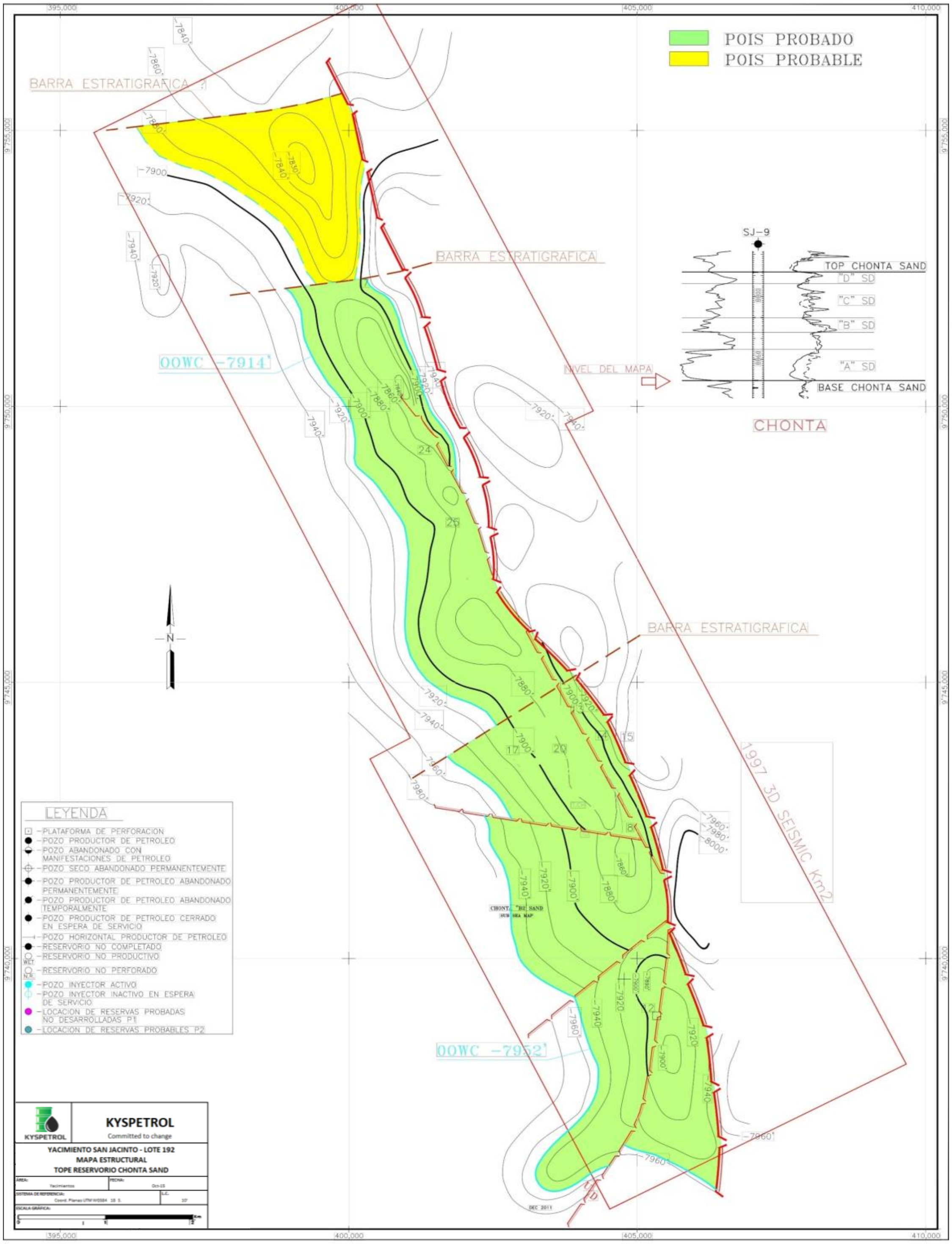
Generally, we know that a structural map shows the configuration of a horizon or stratum. Its construction refers to a baseline that is usually sea level. For that purpose, we require the following information:

- Exact location
- Depth of markers under the Surface
- Known composition of rocks
- Selected stratigraphic markers

- Construction:
    - Interpolation
    - Plotting (the interval between the curves depends on the elevation difference within the study area)
    - Interpretation (To show the geological structure. If no cores are available, well registers are used)

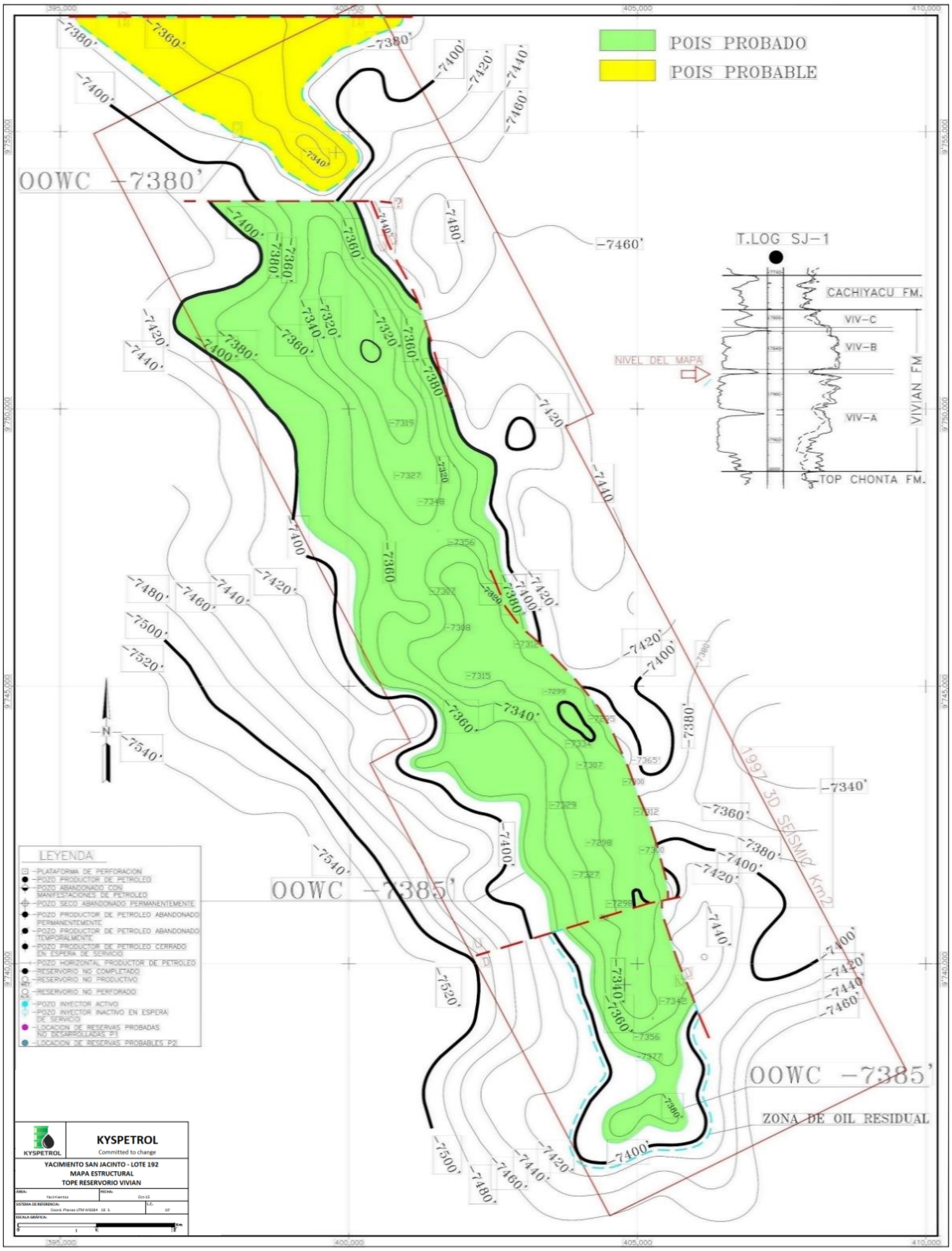
- **Structural Map of Chonta**

Figura 20: Structural map of Chonta - San Jacinto Oriental Field. Source: PERUPETRO, Data Bank.



- **Structural Map of Vivian**

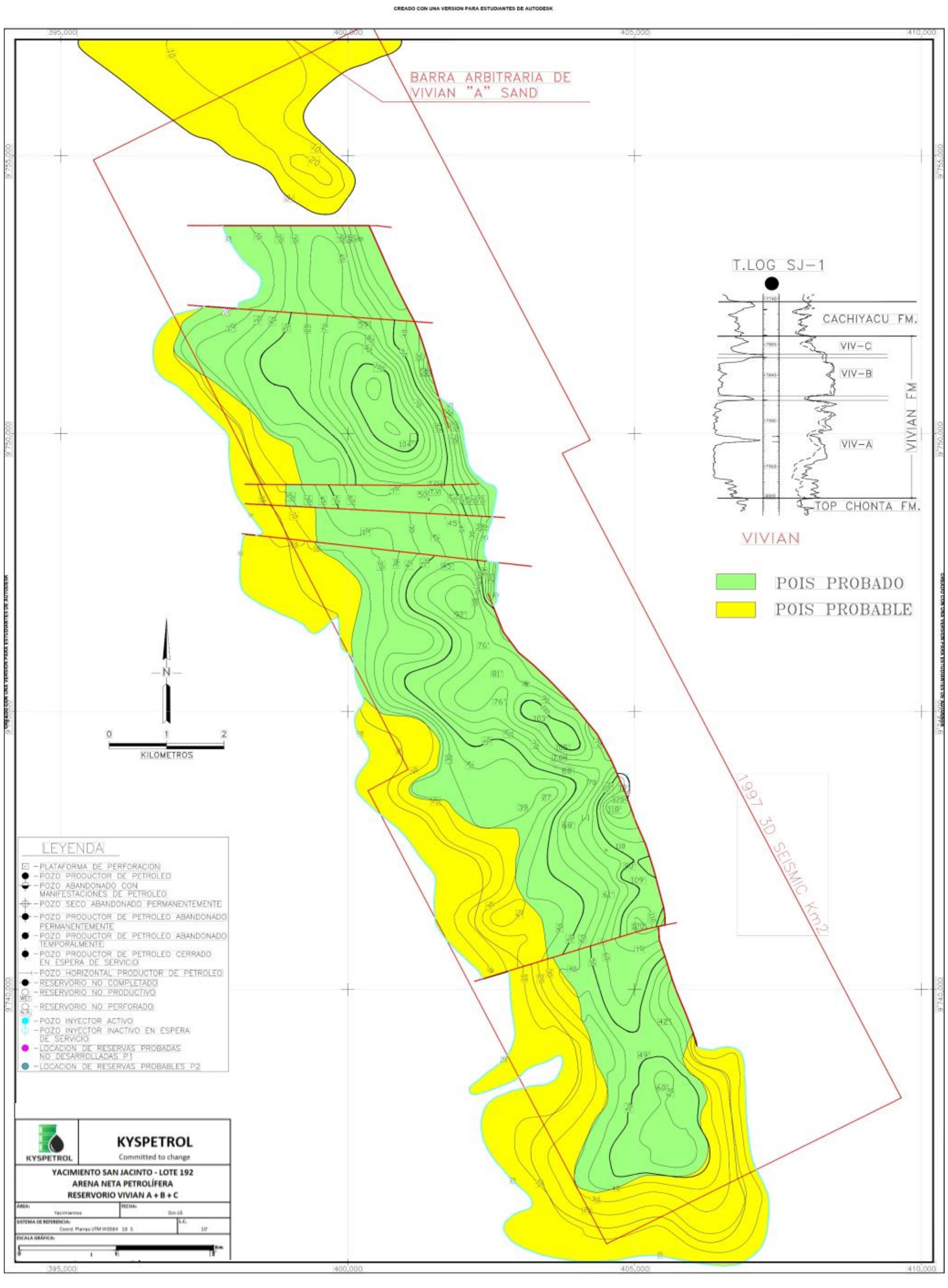
Figura 21: Structural map of Vivian - San Jacinto Oriental Field. Source: PERUPETRO, Data Bank.



4.2.5.2. Maps of the net oil sand at the San Jacinto Oriental Field

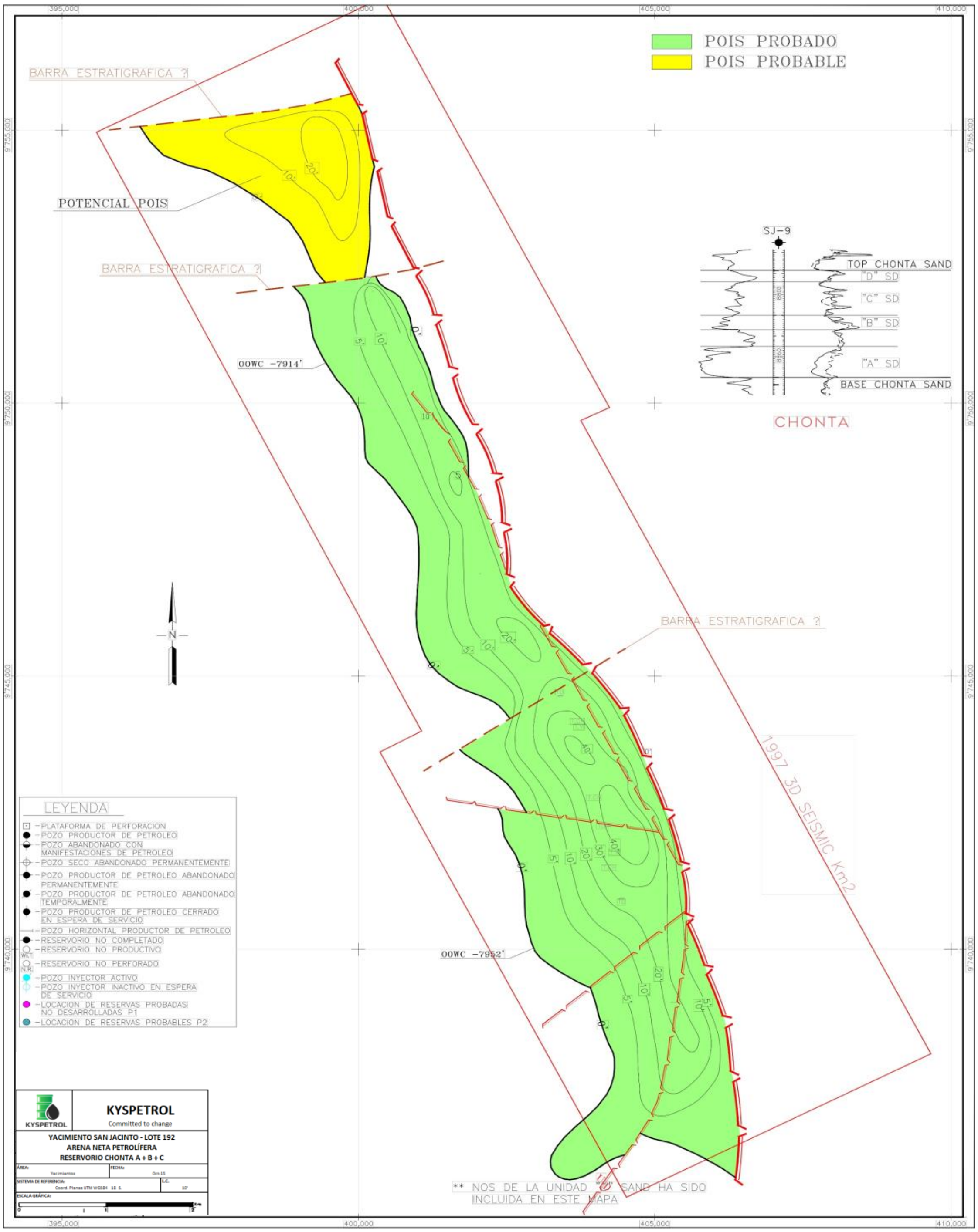
- **Oil Sand Map of Vivian Reservoir**

Figura 22: Oil Sand Map of Vivian Reservoir. Source: PERUPETRO, Data Bank.



- **Oil Sand Map of Chonta Reservoir**

Figura 23: Oil Sand Map of Chonta Reservoir. Source: PERUPETRO, Data Bank.



4.2.6. Stratigraphic Column of the Marañón basin

Figura 24: Stratigraphic column of the Marañón basin. Source: PARSEP, 2002.

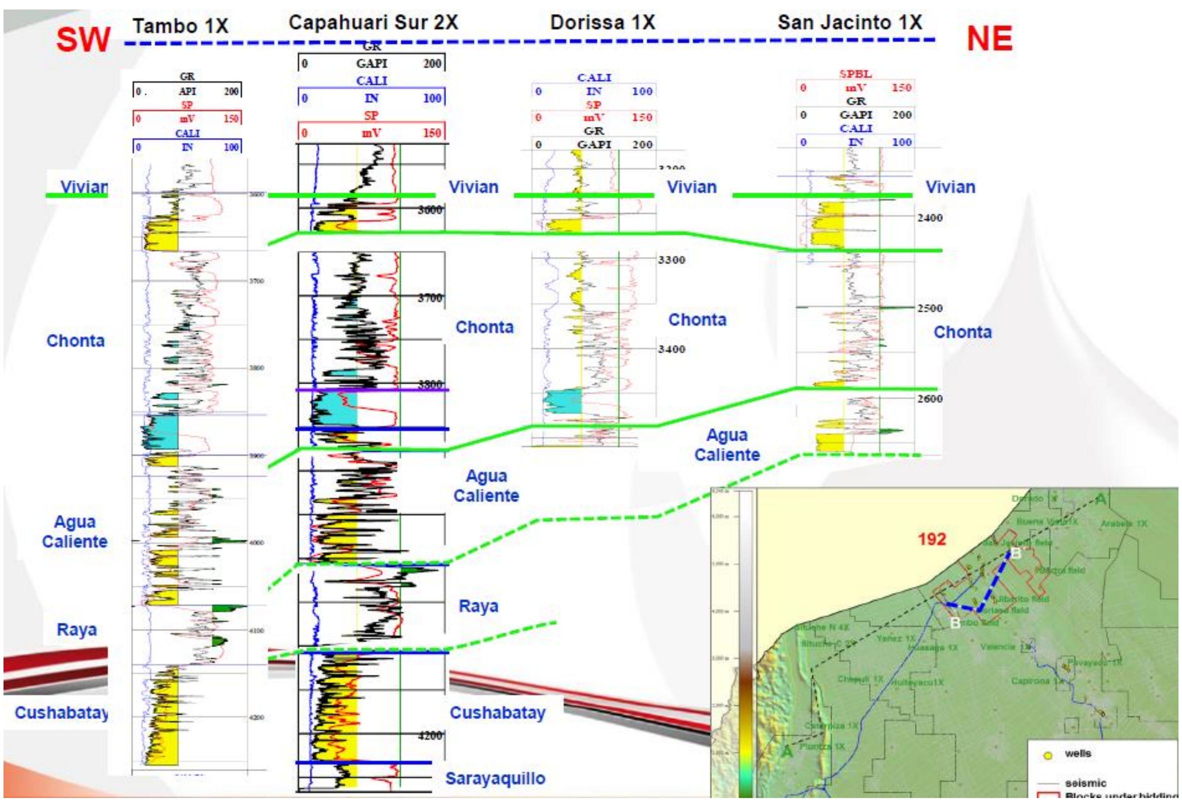
AGE	PARSEP NE PERU		MARAÑON OXY	MARAÑON PETROPERU	HUALLAGA	UCAYALI	SANTIAGO	
Q		Corrientes	Upper Red Beds	Corrientes	Capas Rojas Superiores			Nieva Upper Puca
TERTIARY		Marañon		Marañon		Ipuro		
		Pebas		Pebas				
		Chambira		Chambira		Chambira		
	POZO	Pozo Shale	Pozo Shale	Pozo Shale	Pozos	Pozo Shale	Lower Puca Pozo	Pozo Shale Pozo Sand
		Pozo Sand	Pozo Sand	Pozo Sand		Pozo Sand		Santiago SS
		Yahuarango	Lower Red Beds	Yahuarango	Capas Rojas Inferiores	Yahuarango		
Cretaceous	Vivian	Upper Vivian	Basal Tertiry	Upper Vivian	Cachiyacu	Casa Blanca		Cachiyacu
		Huchpayacu Cachiyacu	Cachiyacu	Huchpayacu		Huchpayacu		
				Cachiyacu		Cachiyacu		
		Lower Vivian	Vivian	Lower Vivian	Vivian	Vivian		Vivian
	Chonta	Upper Chonta	Chonta Shale	Pona	Chonta	Chonta		Chonta
				Lupuna				
				Upper Cetico				
		Chonta Lmst	Chonta Lmst	Caliza				
			Chonta Sand	Lower Cetico				
		Lower Chonta	Lower Chonta Sand					
			Basal Chonta Sand					
		Agua Caliente	Agua Caliente	Agua Caliente	Agua Caliente	Agua Caliente		
		Raya Cushabatay	Raya	Raya	Raya Cushabatay	Raya		
			Cushabatay	Cushabatay		Cushabatay		Cushabatay
Juras	Pucara Sarayaquillo	Red Beds Evaporitic Unit	Sarayaquillo	Sarayaquillo	Sarayaquillo	Sarayaquillo	Pucara Sarayaquillo	Red Beds
								Evaporitic Unit
TRIAS		Condorsinga	Pucará	Pucará	Pucará	Pucará		Condorsinga
		Aramachay						Aramachay
		Chambara						Chambara
		Mitu Ene	Mitu	Mitu	Mitu	Mitu		Mitu
PERM			Ene	Ene	Ene	Ene		Ene
		Copacabana	Copacabana	Copacabana	Copacabana	Copacabana /Tarma		Copacabana
CARB		Tarma	Tarma	Tarma				
DEV		Ambo Cabanillas	Ambo	Ambo	Ambo	Ambo		
			Cabanillas	Cabanillas		Cabanillas		
ORD		Contaya	Contaya	Contaya	Contaya	Contaya		
BASAMENT								

Note: Own Elaboration

4.2.7. Stratigraphic Geology of the San Jacinto Field

Stratigraphy is responsible for studying, interpreting, identifying and describing both the vertical and horizontal sequences of stratified rocks; it is also responsible for the mapping and correlation of these rock units, determining the order and timing of events in a given geological time in Earth's history. Based on the "Marañon Basin Technical Report" we will divide this description into four mega-sequences: Tertiary, Cretaceous, Late Triassic to Jurassic and Paleozoic. In the following image we can see the stratigraphic column of the Marañón basin, where for purposes of this project we will use the Oxy (Western) classification since our structural maps are based on this classification.

Figura 25: Comparison of Electrical Logging in Block 192. Source: PARSEP, 2002.



- **Paleozoic**

The Ordovician formations of Contaya and Cabanillas Devónicas are generally extremely mature, but still have moderate OCD values of the Marañón Basin. Ambo / Tarma-Copacabana formations consisting of shales and marine carbonates located in the southern part of the basin.

- **Jurassic to Triassic**

The Pucara Group represents a sedimentary sequence of economic importance that was deposited from the upper Triassic to the lower Jurassic. It is divided into three formations at the outcrops of the fold and thrust belt, which from major to minor are the Chambara, Aramachay and Condorsinga formations and the three are recognized throughout the northern and central Andes of Peru. The Pucara represents the maximum flood event of an important mega-sequence with the lower Chambara and Aramachay Formations forming the lower transgressive cycle and the upper Aramachay and Condorsinga/ Sarayaquillo Formations forming the upper regressive cycle.

- **Cretaceous**

Most of the industry-generated reports presented in the Marañón Basin focus on post-Cretacean structuring and, in particular, on post-Cretaceans and pre-Pozo structures for reasons of early trapping of hydrocarbons.

By examining any of the various cross-sections from west to east through the Cashew Basin, we see that the Cretaceous thickened dramatically to the west. In part, this is due to the continued sinking of the basin during the deposition west of the Hingeline fault of the Marañón basin. The other reason is the transgressive nature of the Cretaceous time. Within the section of the Chonta marker to the Cretaceous base, the Cretaceous transgressive sequence, the Cushabatay becomes younger from the west.

In the area of Campo Tambo, according to PARSEP studies, there are anomalous accumulations of carbonate associated with Chonta limestone. These anomalies are oval in shape, elongated and aligned approximately parallel to Basin Hingeline.

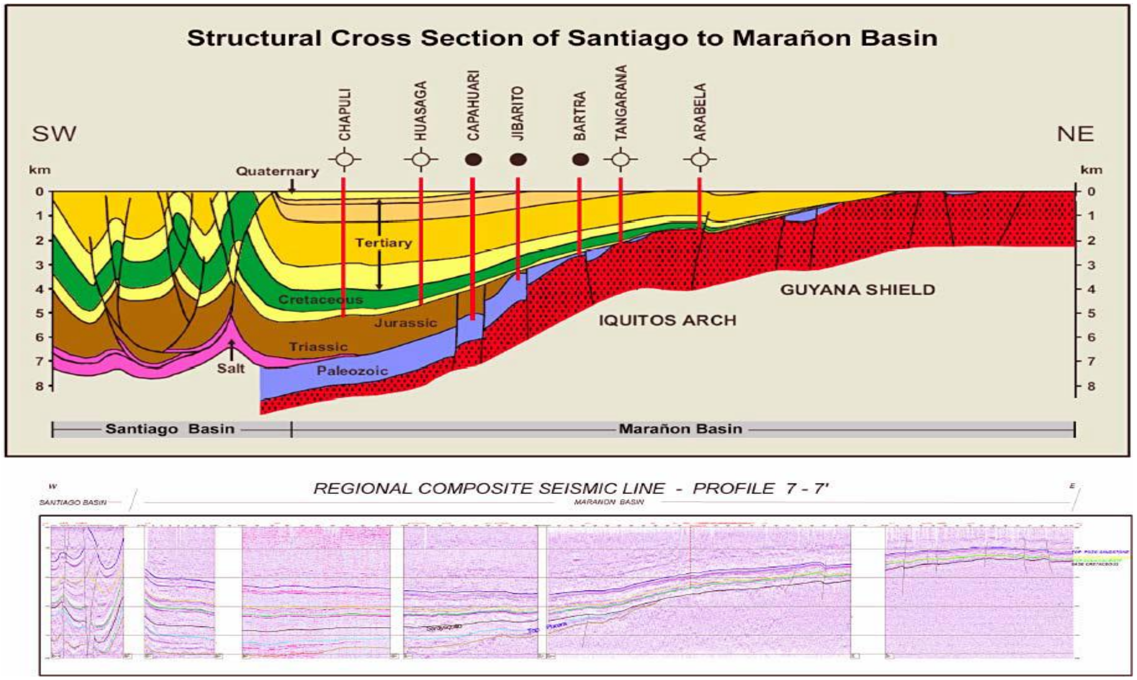
- **Tertiary**

This section contains very interesting formations such as Pozo Formation. The Pozo shale, a result of a regional Oligocene Sea flood, when combined with the underlying Pozo sandstone, forms one of the strongest seismic events in the Marañón basin.

Another topic that needs further discussion with respect to the Tertiary in the context of this study is that of the basal Tertiary and its contact with the Cretaceous. Occidental referred to the highest productive sand found as the Tertiary Basal. This nomenclature was then continued further northeast in the Dorado, Piranha and Paiche wells of Block 67 by Barrett Resources. Petroperu throughout the exploration and development of the Marañón Basin referred to the same interval as the Upper Vivian, implying a Cretaceous age.

The contact between the Cretaceous and the Tertiary is very ambiguous in the Peruvian sector of the great Marañón basin / Oriente.

Figura 26: Stratigraphic Court of the Marañón Basin. Source: PARSEP, 2002.



Lote 64: Lotes de crudo liviano, zona de los Campanianos. Estas zonas son levantadas producto que la cordillera de los Andas

Terciario
Terciario superior: son básicamente arcillas, rocas sellos.
Terciario Inferior, existen algunos reservorios para almacenar agua, tal es el caso del POZO SAND.
Terciario Inferior: Se encuentra el reservorio de mayor importancia por su capacidad de almacenamiento, Vivian

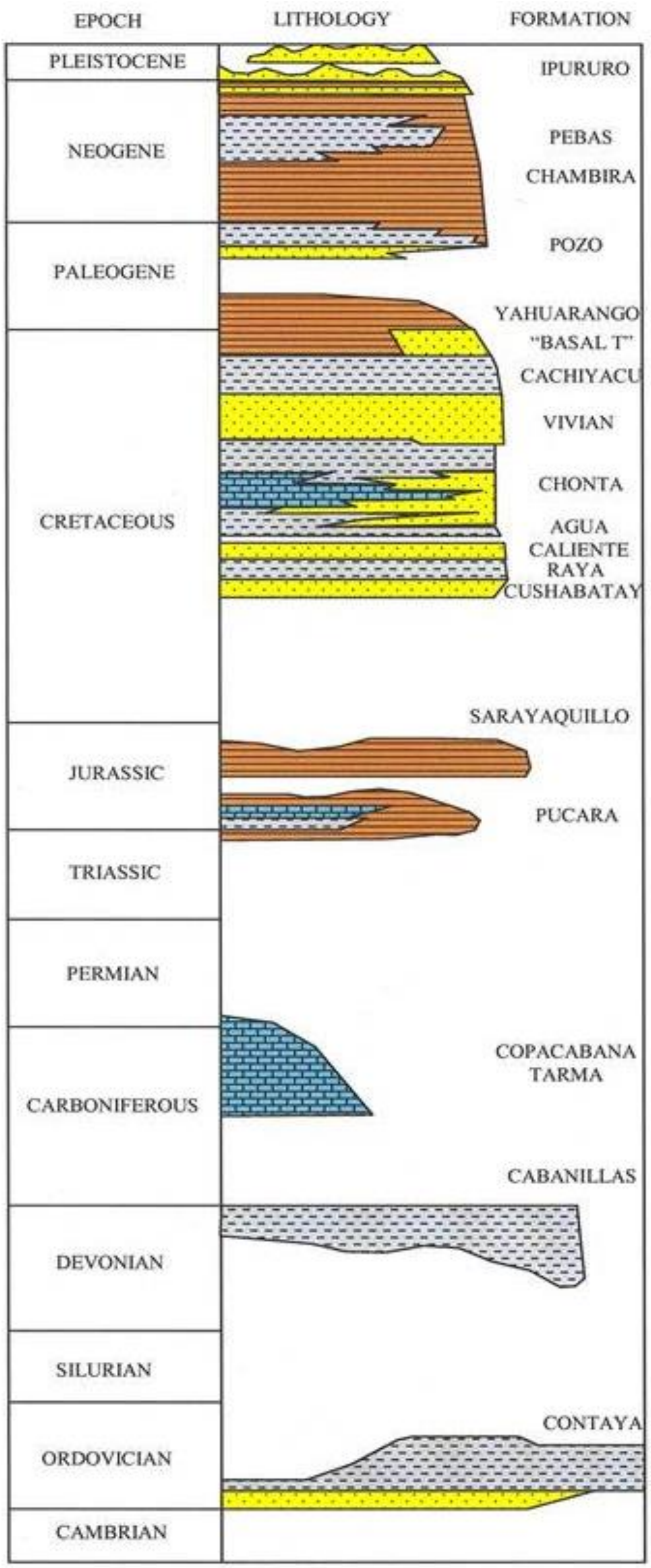
Cretáceo:
Contiene principalmente a la formación Chonta.
Es espeso en mayor proporción hacia el oeste debido a la naturaleza transgresora en el tiempo.
Además, existen acumulaciones anómalas de carbonato asociadas con la piedra caliza Chonta

Jurásico a triásico-
Son rocas básicamente madres.
El Grupo Pucará representa una secuencia sedimentaria de importancia económica que se depositó desde el Triásico superior hasta el Jurásico inferior.

Paleozoico
Son rocas básicamente madres.
Las formaciones Ordovícicas de Contaya y Cabanillas Devónicas son generalmente extremadamente maduros, pero aún tienen valores moderados de TOC de la Cuenca Marañón

4.2.8. Sedimentary cycles

Figura 27: Sedimentary cycles of the Marañón basin. Source: PARSEP, 2002.



Ciclo sedimentario terciario
Se encuentra lutitas rojas con entradas marinas en la cuenca Marañón, estas lutitas forman la roca sello para el ciclo Cretácico.

Ciclo sedimentario Cretáceo
El ciclo Cretáceo es un entorno de antepaís que representa un ciclo continuo. Es el más importante porque aquí se encuentran las estructuras, también, las principales rocas reservorios (Vivian y Chonta)

Ciclo triásico- jurásico:
Se encuentra Pucara que desarrolla calizas y lutitas que son rocas madres probadas de la cuenca Marañón. Por otra parte, Sarayaquillo es un sistema fluvial de areniscas rojas, de buenas características para ser roca reservorio, este es expectante a la exploración.

Ciclo Copacabana:
Es un ciclo del Pérmico- Carbonífero, aquí domina las rocas calizas. Copacabana podría ser una roca madre, sin embargo, no hay datos contundentes. Podría ser un reservorio no convencional

Ciclo Cabanillas
Roca madre, pero no hay evidencia de un crudo proveniente de Cabanilla. Cabanilla Ambo es la roca madre de Camisea. Desde el punto de vista litológico no es una roca madre potencial

Ciclo Ordovincico
Se encuentra la formación Contaya. No existe evidencia de presencia de hidrocarburos. Sin embargo, tiene presencia de TOC que indicaría que fue una roca madre antiguo.

4.3.RESERVOIR ENGINEERING

4.3.1. Petrophysical analysis:

To begin with the reservoir analysis, the petrophysical analysis for the reservoir characterization must be treated, we will evaluate the logs of the neighboring San Jacinto field since the San Jacinto Oriental field does not have logs, we are in the exploration stage, so we will use the modeling of a well for Vivian and a well for Chonta respectively.

The petrophysical analysis will be done for wells 19 and 13 for each of the formations respectively. We will use the Interactive Petrophysics 3.5 program, which will analyze the sands represented by different intervals and assisted with the structural map to confirm the tops and bases of the respective sands.

- **Vivian case:**

For this modeling we use the classic logs of well 19 that will help us determine the interval of interest and have the most appropriate parameters such as porosity, water saturation and permeability to detail with the help of the mentioned program. We generate GR, SP, Caliper, Density and Neutron curves with the histogram, then we select the P50 case for a higher degree of certainty.

The location of the 19 model well in the San Jacinto field is in the central part of the field, at around 7310 feet of depth.

Figura 28: Location well19 San Jacinto

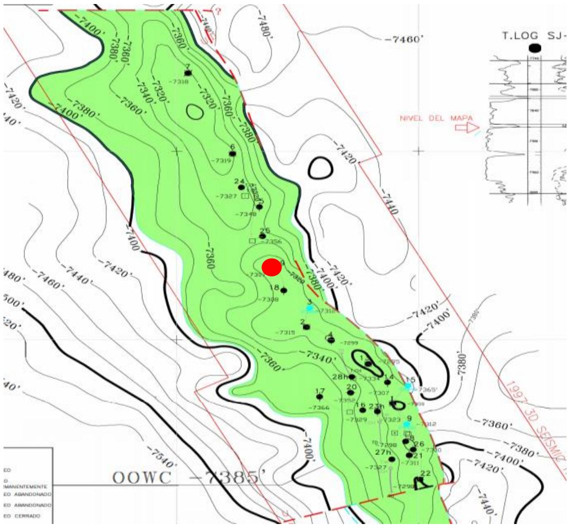
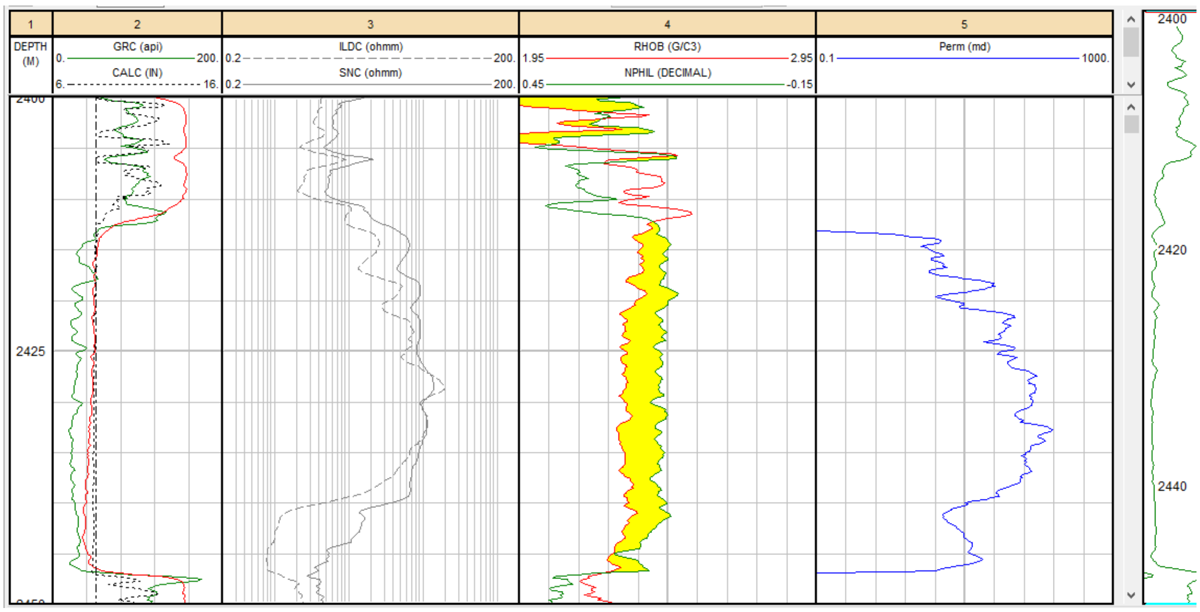
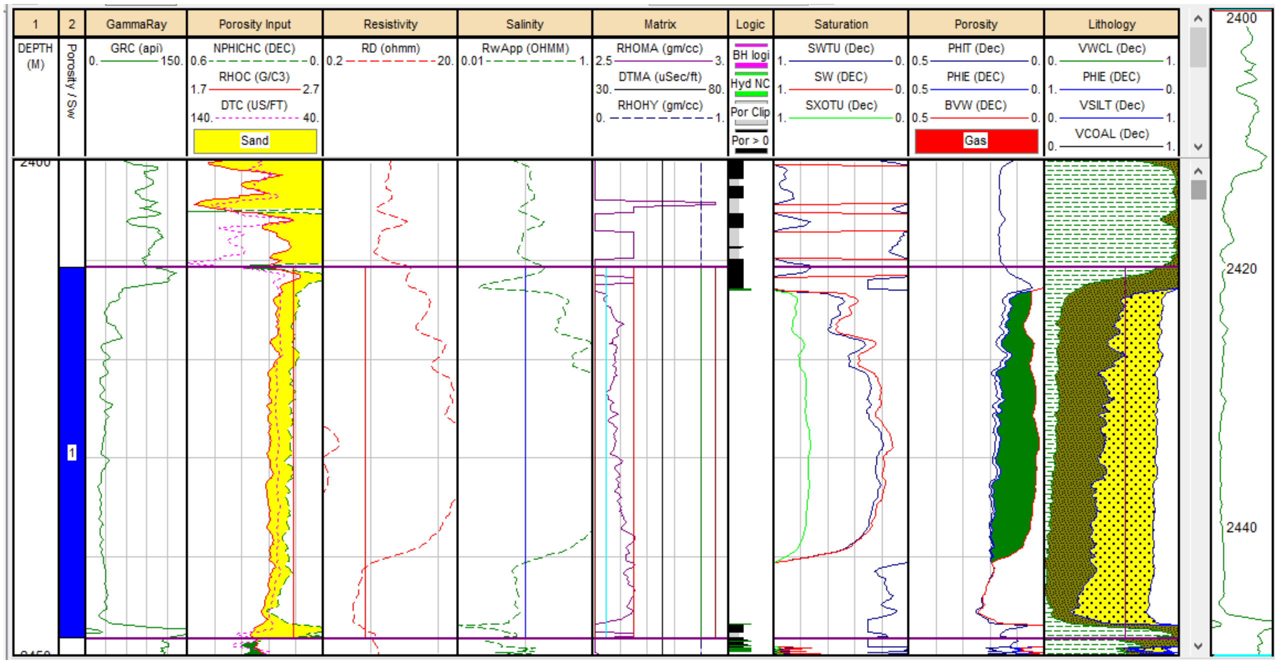


Figura 29: Analysis of logs for the Vivian reservoir



The parameters mentioned above, are used to obtain the well log analysis in representative values and the appropriate lithology will be obtained.

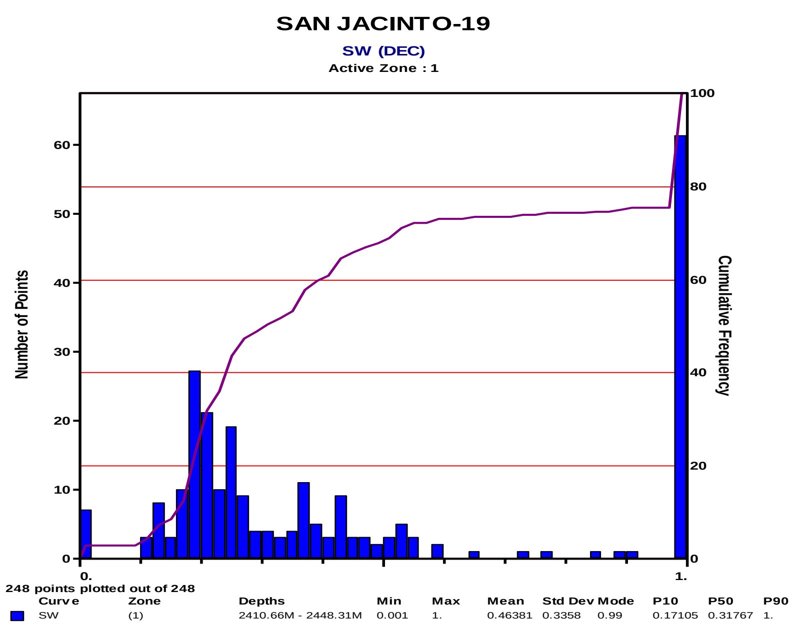
Figura 30: Analysis of logs for the Vivian reservoir



The following histograms are generated from the analysis performed.

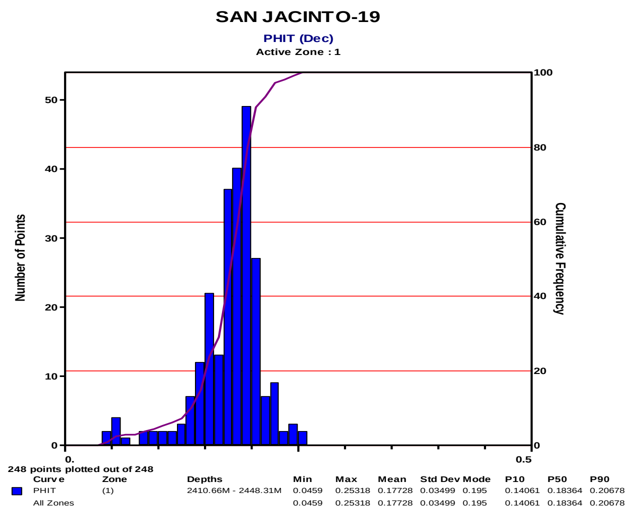
- **Water saturation**

Figura 31: Saturation Histogram of San Jacinto field - Vivian Reservoir - Well 19



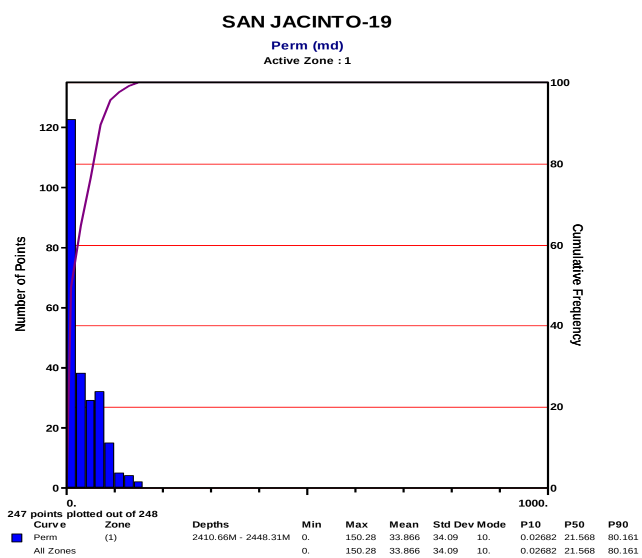
- **Porosity**:

Figura 32: Histogram Porosity of San Jacinto field - Vivian Reservoir - Well 19



- **Permeability**

Figura 33: Histogram Permeability of San Jacinto field - Vivian Reservoir - Well 19



- **Chonta case:**

The well logs GR, SP, Caliper, Density and Neutron were used to represent the clay volume, water saturation and porosity with the help of the histogram from the program, analyzing the interval 2635-2575 meters.

The location of well 13 in the San Jacinto field is situated in the central part of the field near to the east, in order to have a greater detail to the fact that Chonta is a poor sand at a depth of approximately 7900 ft.

Figura 34: Location well13 San Jacinto

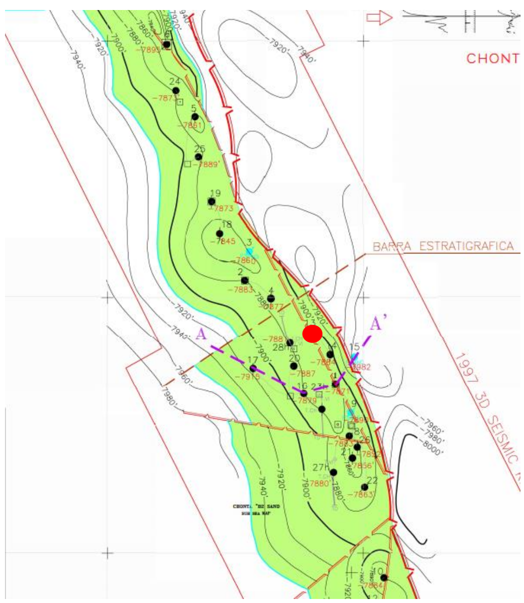
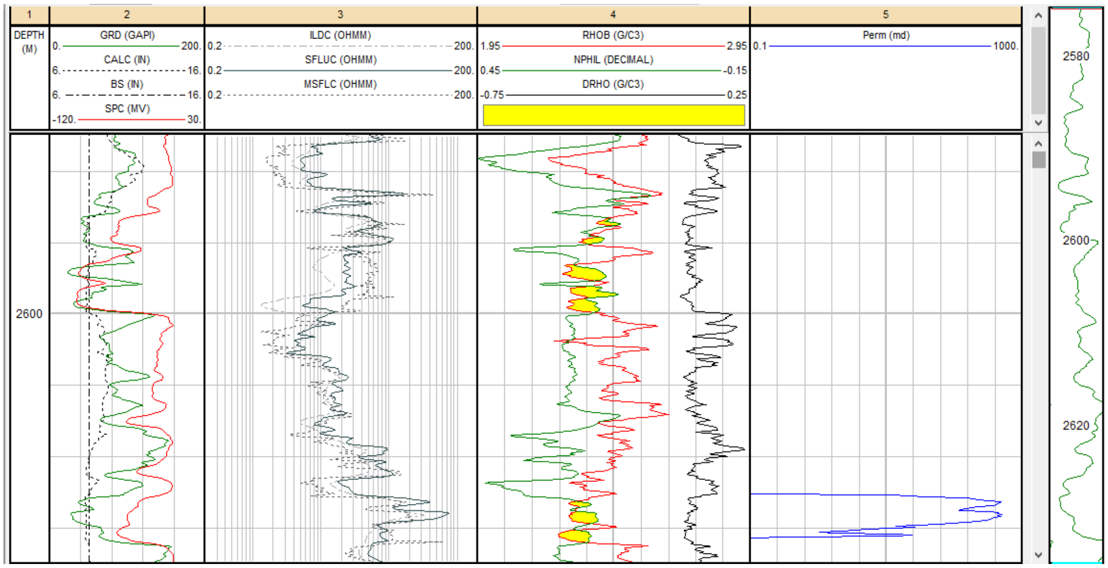
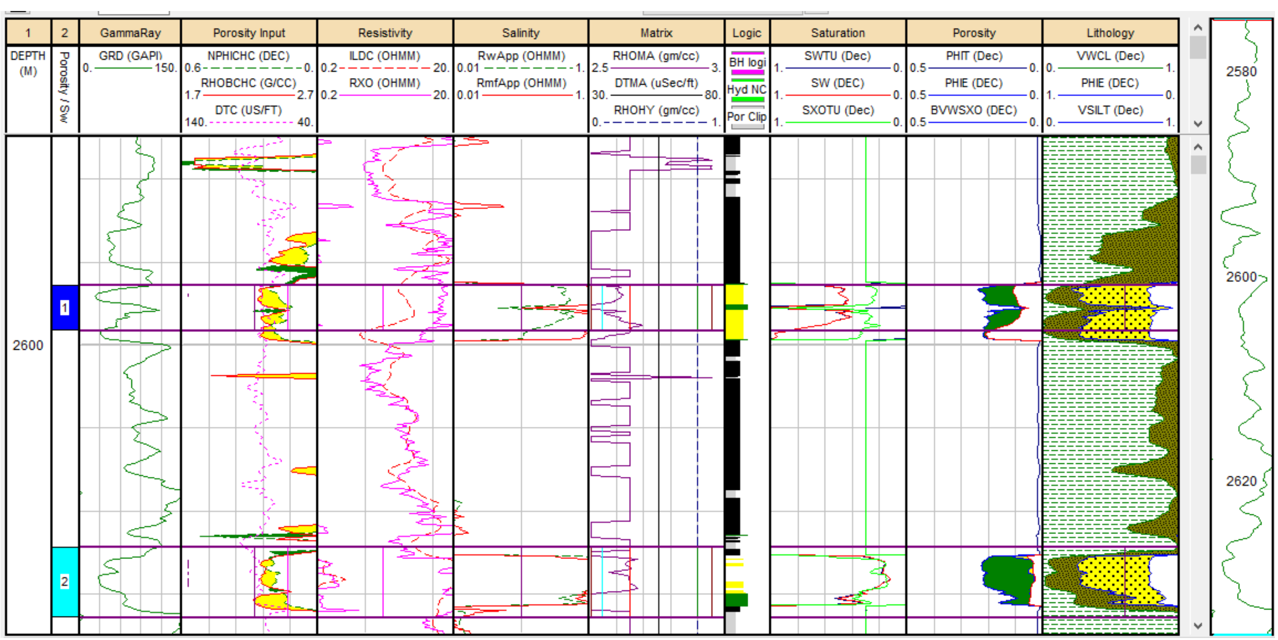


Figura 35: Analysis of logs for the Chonta reservoir



The parameters mentioned, are used to obtain the well log analysis in representative values and the appropriate lithology will be obtained.

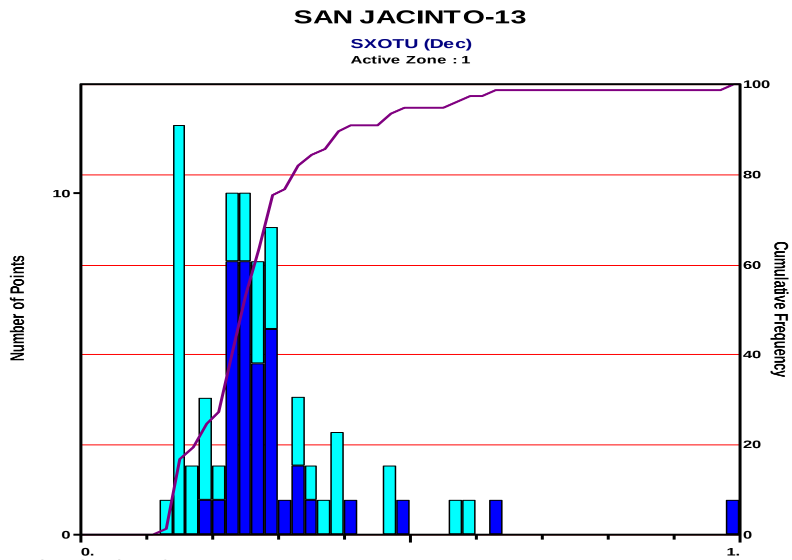
Figura 36: Result of logs analysis for the Chonta reservoir



The following histograms are generated from the analysis performed.

- **Water Saturation**

Figura 37: Water Saturation Histogram of San Jacinto field - Chonta Reservoir - Well 13

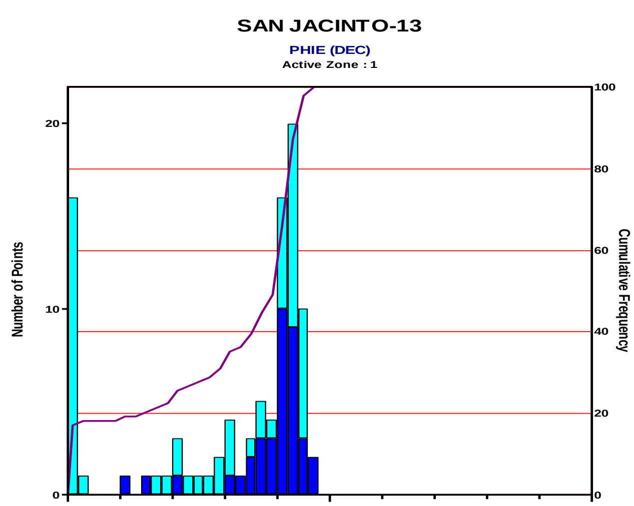


77 points plotted out of 94

Curve	Zone	Depths	Min	Max	Mean	Std Dev	Mode	P10	P50	P90
SXOTU	(1)	2592.78M - 2598.27M	0.19188	0.98513	0.30275	0.1405		0.22447	0.26742	0.34757
SXOTU	(2)	2624.33M - 2632.86M	0.13806	0.58333	0.2579	0.1189	0.15	0.14993	0.23172	0.39742
All Zones			0.13806	0.98513	0.27945	0.1308	0.15	0.15559	0.25718	0.39742

- **Porosity**

Figura 38: Histogram Porosity of San Jacinto field - Chonta Reservoir - Well 13

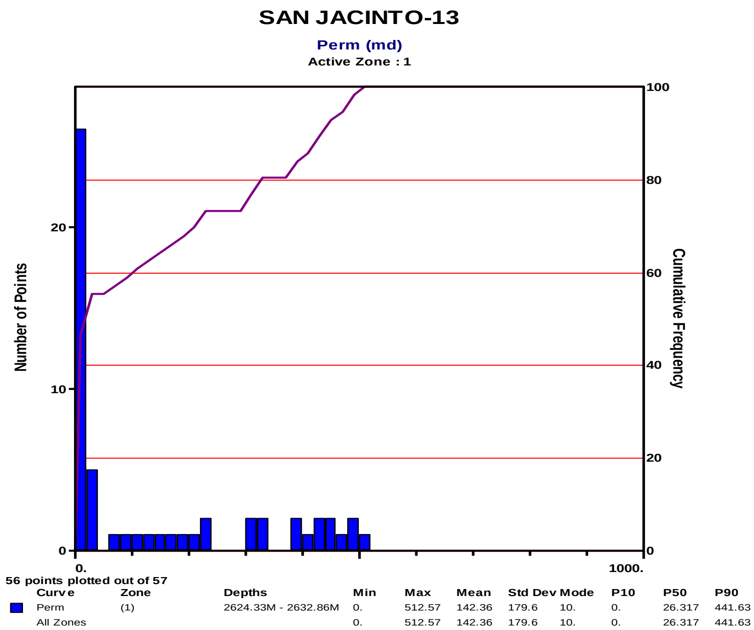


94 points plotted out of 94

Curve	Zone	Depths	Min	Max	Mean	Std Dev	Mode	P10	P50	P90
PHIE	(1)	2592.78M - 2598.27M	0.05188	0.23779	0.19451	0.03947	0.205	0.16016	0.20614	0.22087
PHIE	(2)	2624.33M - 2632.86M	0.0001	0.22457	0.13053	0.09246	0.005	0.0001	0.1572	0.22004
All Zones			0.0001	0.23779	0.15572	0.08209	0.215	0.0001	0.20152	0.22165

- **Permeability**

Figura 39: Histogram Permeability of San Jacinto field - Chonta Reservoir - Well 13



We realize that for the calculation of permeabilities, the use of the software equations such as the Timur correlation does not generate a correct value, that is why we will stay with the data provided by Perupetro which gives us a more representative result since it is based on a core analysis.

K Timur: 21.5 md Vivian

K Timur: 26.3 md Chonta

$$\mathbf{K = a * \frac{Phi^b}{Swi^c}}$$

$$\text{Timur} \quad :'a' = 8581 :'b' = 4.4 \ :'c' = 2$$

Results for project:

Tabla 15: Petrophysical values obtained with the Interactive Petrophysics software 3.5.

Reservoir	Sw	Porosity	a	m	n	K (md)	**Net Pay (ft)**	**Gross Interval (ft)**
Vivian	0.317	0.183	1	2	2	2000	100	7872-8036
Chonta	0.25	0.201	1	2	2	200	35	8446-8642

Net pay taken were 100 ft of Vivian and 35 ft of clean sand Chonta for petrophysical calculations; however, these are not the intervals to be perforated.

It is worth mentioning that for the petrophysical properties, we took the value of the best estimate in order to continue with the following studies, we concluded that we have very good characteristics in terms of porosity, greater than 15%, for each formation, and good permeability.

4.3.2. PVT fluid properties

4.3.2.1. Fluid properties using correlations

To find the main rock-fluid properties for the San Jacinto Oriental field we will make use of PVT correlations, with which we will analyze a static and dynamic model of the reservoir in order to have a better understanding of the fluids and their initial behavior.

A PVT model was constructed for each reservoir using the following correlations:

- **P_b: Al-Marhoun correlation**

$$p_b = 5.38088 \times 10^{-3} {R_{sb}}^{0.715082} {\gamma_\delta}^{-1.87784}\ {\gamma_o}^{3.1437} T^{1.32657}$$

- **R_s: Al-Marhoun correlation**

$$R_s = [185.84321 p {\gamma_\delta}^{1.87784}\ {\gamma_o}^{-3.1437} T^{-1.32657}]^{1.3984}$$

- **B_o: Al-Marhoun P_r correlation >P_b**

$$B_t = 0.314693 + 0.106253 \times 10^{-4} F + 0.18883 \times 10^{-10} F^2$$

$$F = R_s^{0.644516} \gamma_\delta^{-1.07934} \gamma_o^{0.724874} p^{-0.76191} T^{2.00621}$$

- **B_o: Standing correlation $P_b > P_r$**

$$B_{ab} = 0.9759 + 12 \times 10^{-5} F^{1.2}$$

$$F = R_{sb} \sqrt{\frac{\gamma_\delta}{\gamma_o}} + 1.25T$$

- **C_o: Petrosky correlation $P_r > P_b$**

$$C_O = 1.705 \times 10^{-7} R_s^{0.69357} \gamma_\delta^{0.1885} \gamma_{API}^{0.3272} T^{0.6729} p^{-0.5906}$$

- **C_o: McCain correlation $P_r < P_b$**

$$\ln c_o = -7.114 - 1.394 \ln p - 0.981 \ln T + 0.770 \ln \gamma_{API} + 0.446 \ln \gamma_\delta$$

Where C_o in lpc^{-1}, P in Psi and T in °R

- **μ_{od}: Beggs correlation - dead viscosity**

The correlation is as follows:

$$\mu_{od} = 10^x - 1$$

Where:

$x = yT^{-1.163}$
$y = 10^Z$
$z = 3.0324 - 0.02023\gamma_{API}$
$\mu_{od} = Viscosity\ of\ oil\ without\ gas\ at\ 1\ atm. y\ \ T\ cp.$
$\gamma_{API} = Oil\ gravity, °API$
$T = Reservoir\ temperature, °F$

- **μ_{ob}: Correlation for viscosity at the bubble point**

Beggs and Robinson correlation, J.R.[21]

$$\mu_{ob} = a(\mu_{od})^b$$

Where:

$a = 10.715(R_s + 100)^{-0.515}$

$b = 5.44(R_s + 150)^{-0.338}$

- **μ_o Vasquez correlation**

$$\mu_o = \mu_{ob}\left(\frac{p}{p_b}\right)^m$$

Where:

$m = 2.6p^{1.187}\exp\left(-11.513 - 8.98 \times 10^{-5}p\right)$

The PVT curves were developed using the reservoir temperature varying pressures, obtaining the curves of viscosity, compressibility, bubble pressure, formation volume factor and solubility ratio.

- **PVT VIVIAN: Pr=3450 psi**

Tabla 16: Table of Vivian Reservoir PVT Values

Pressure	Rs(scf/stb)	Uo(cp)	Bo	Co(1/psi)
4000	50	60.484	1.140	1.6462E-06
3800	50	57.760	1.143	1.6968E-06
3600	50	55.151	1.145	1.7519E-06
3400	50	52.660	1.148	1.812E-06
3200	50	50.287	1.151	1.8781E-06
3000	50	48.033	1.153	1.951E-06
2800	50	45.900	1.156	2.0322E-06
2600	50	43.889	1.159	2.1231E-06
2400	50	42.001	1.162	2.2259E-06
2200	50	40.237	1.165	2.3432E-06
2000	50	38.600	1.168	2.4789E-06
1800	50	37.094	1.172	2.6381E-06
1600	50	35.722	1.175	2.8281E-06
1400	50	34.490	1.178	3.0602E-06
1200	50	33.408	1.182	3.3519E-06
1000	50	32.490	1.185	3.733E-06
800	50	31.990	1.189	4.2588E-06
789	50	31.853	1.189	4.2938E-06
700	50	31.549	1.193	4.6083E-06

600	50	31.275	1.182	5.0475E-06
500	46.431	31.064	1.169	0.00056722
400	33.985	30.926	1.156	0.00077345
300	22.729	30.875	1.141	0.00115362
200	12.892	30.932	1.124	0.00202668
100	4.891	31.115	1.106	0.00531056

Figura 40: Bo plot of the Vivian reservoir

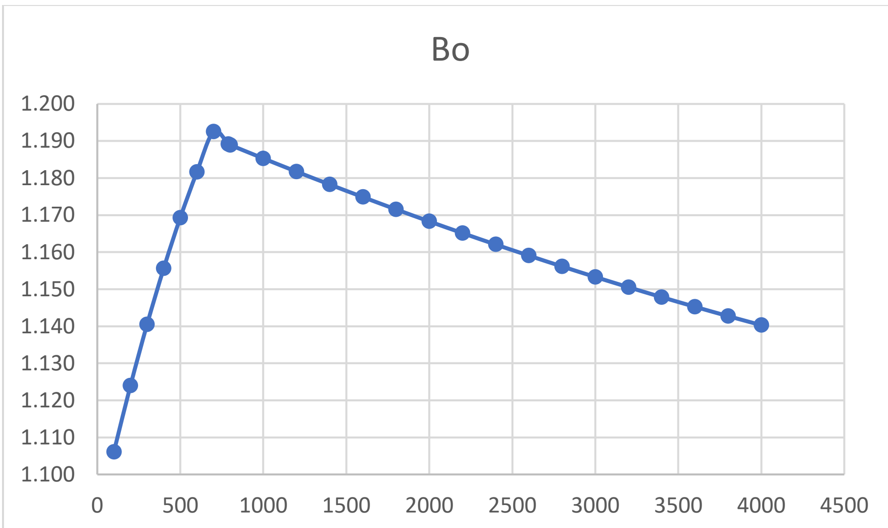


Figura 41: Rs plot of Vivian reservoir

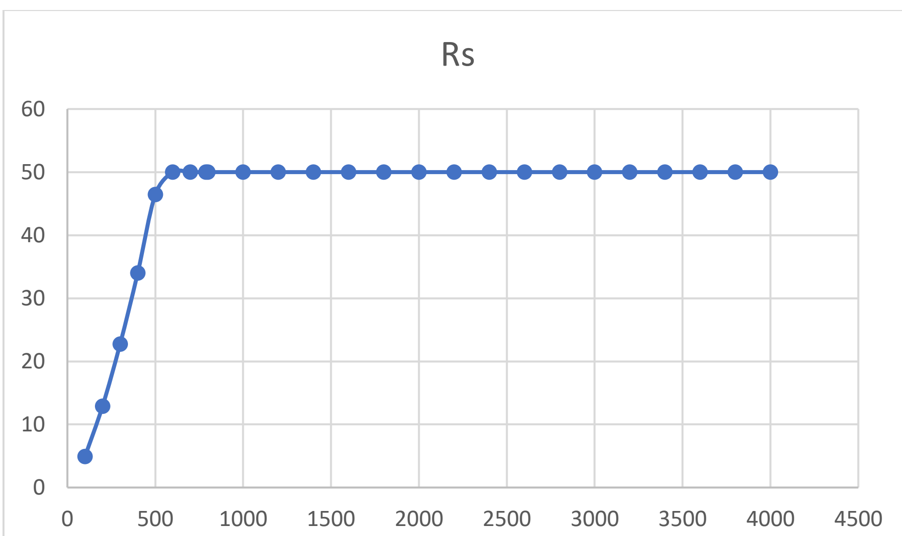


Figura 42: U_o plot of Vivian reservoir

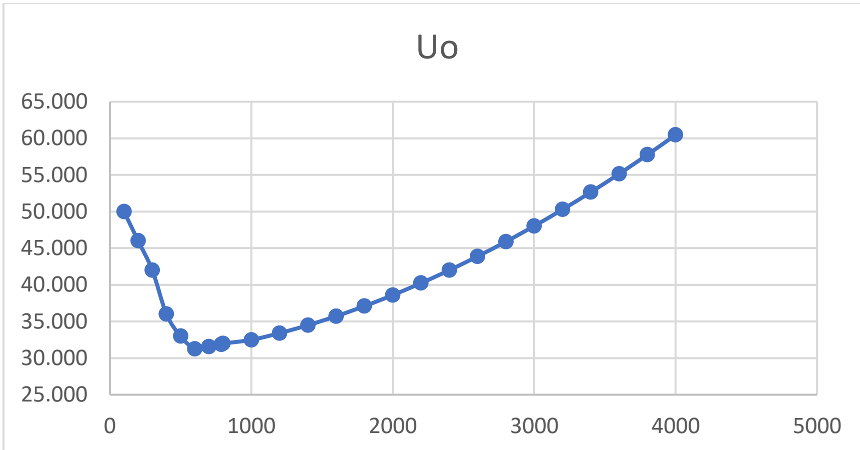


Figura 43: C_o plot of Vivian reservoir

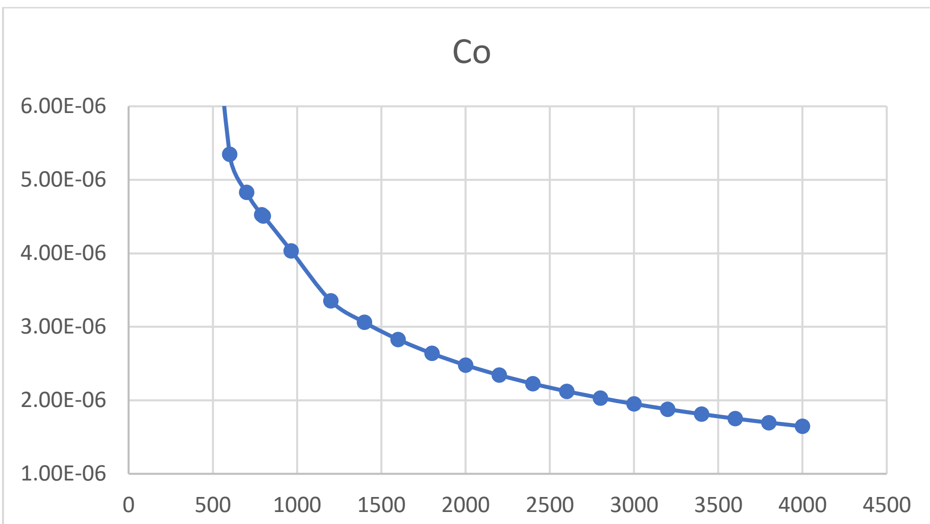


Tabla 17: Table of Vivian reservoir PVT values using correlations

Pr =3450 psi   T°= 225 F

Data	Average Data	
API @ 60°F	11.5	
Gas solubility (Rs)	50	SCF/STB
Bubble Pressure (Pb)	527	psia
Oil Volume Factor (βo)	1.146	bbl/STB
Oil density	60.5	lb/ft3
Oil viscosity (μo)	53	cp

- **PVT CHONTA: Pr= 3700 psi**

Tabla 18: Table of PVT values of Chonta Reservoir

Pressure	Rs(scf/stb)	Uo(cp)	Bo	Co(1/psi)
4281	185	1.426	1.137	0.000
4000	185	1.356	1.140	0.000
3800	185	1.308	1.143	0.000
3600	185	1.262	1.145	0.000
3400	185	1.218	1.148	0.000
3200	185	1.175	1.151	0.000
3000	185	1.135	1.153	0.000
2800	185	1.096	1.156	0.000
2600	185	1.060	1.159	0.000
2400	185	1.026	1.162	0.000
2200	185	0.994	1.165	0.000
2000	185	0.964	1.168	0.000
1800	185	0.937	1.172	0.000
1600	185	0.912	1.175	0.000
1400	185	0.890	1.178	0.000
1200	185	0.871	1.182	0.000
1058	185	0.863	1.184	0.000
900	147.629	0.849	1.162	0.001
800	125.210	0.844	1.151	0.001
700	103.883	0.839	1.141	0.001
600	83.739	0.836	1.131	0.001
500	64.893	0.835	1.122	0.001
400	47.499	0.834	1.114	0.002
300	31.766	0.836	1.106	0.002
250	24.617	0.838	1.103	0.003
200	18.019	0.840	1.100	0.004
100	6.835	0.848	1.095	0.011

Figura 44: Bo plot of Chonta reservoir

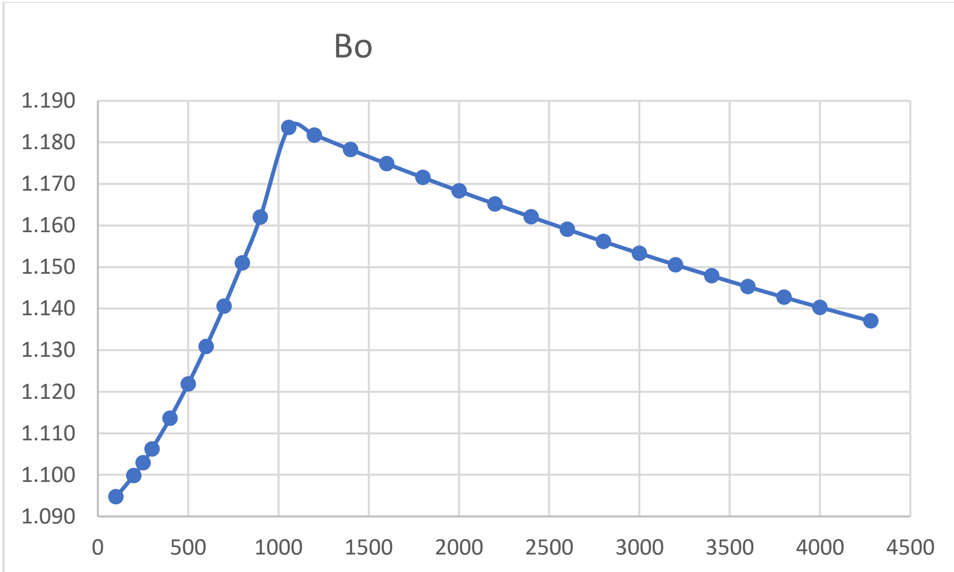


Figura 45: Rs plot of Chonta reservoir

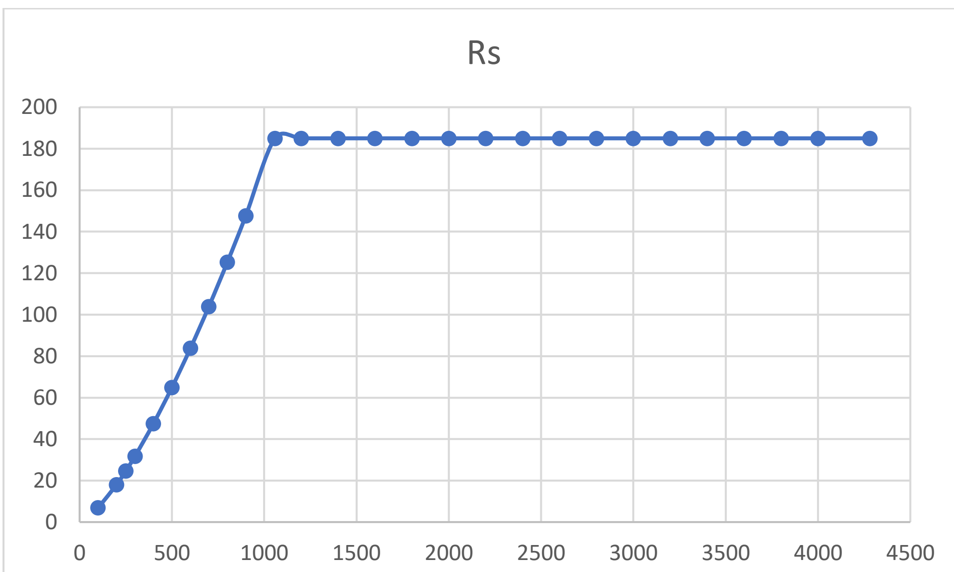


Figura 46: Uo plot of Chonta reservoir

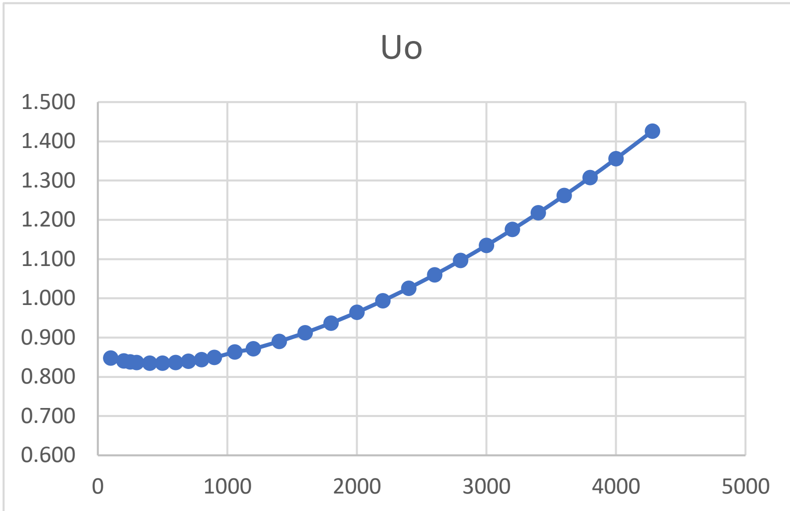


Figura 47: Co plot of Chonta reservoir

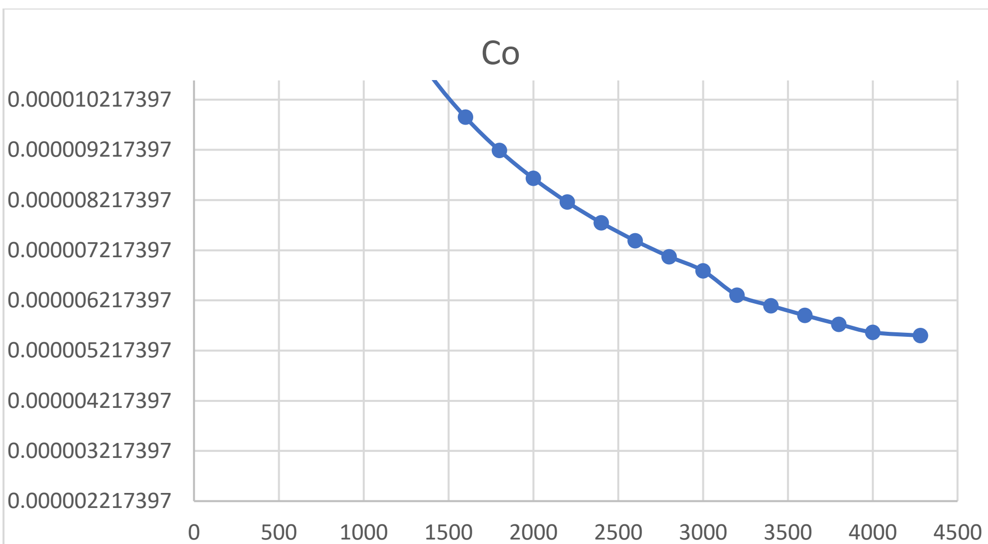


Tabla 19: Table of PVT values of the Chonta reservoir using correlations

Pr= 3700 psi   T°= 240 F

Data	Average Data	
API @ 60°F	31.4	
Gas solubility (Rs)	185	SCF/STB
Bubble Pressure (Pb)	1058	psia
Oil Volume Factor (βo)	1.13	bbl/STB

Oil density	53.6	lb/ft3
Oil viscosity (μo)	1.42	cp
PVT Results		

4.3.2.2. Fluid properties using Ecrin

Using the Ecrin software, we will calculate the properties of the fluids. The following data was obtained for the calculation of fluid properties.

- **PVT VIVIAN Pr=3450 psi**

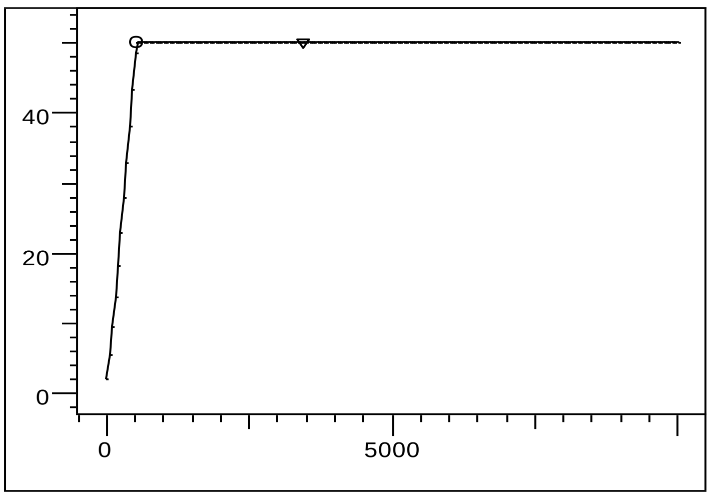
Tabla 20 : Table of PVT data for the Vivian reservoir obtained from Ecrin

Pressure(psia)	Rs(scf/stb)	Bo(B/stb)	Co(psi-1)	Uo(cp)	Rho(g/cc)
14.6959	2.126	1.082	1.082	69.015	0.915
64.6959	5.630	1.083	1.083	68.535	0.915
114.696	9.579	1.085	1.085	68.033	0.914
164.696	13.833	1.087	1.087	67.532	0.913
214.696	18.325	1.089	1.089	67.043	0.912
264.696	23.015	1.091	1.091	66.573	0.911
314.696	27.873	1.093	1.093	66.123	0.911
364.696	32.880	1.095	1.095	65.695	0.910
414.696	38.021	1.098	1.098	65.290	0.909
464.696	43.283	1.100	1.100	64.907	0.908
514.696	48.657	1.103	1.103	64.545	0.907
564.696	50	1.102	1.102	64.486	0.907
614.696	50	1.101	1.101	64.525	0.909
664.696	50	1.100	1.100	64.569	0.910
714.696	50	1.099	1.099	64.616	0.910
764.696	50	1.098	1.098	64.666	0.911
814.696	50	1.097	1.097	64.720	0.912
864.696	50	1.096	1.096	64.777	0.912
914.696	50	1.096	1.096	64.837	0.913
964.696	50	1.095	1.095	64.900	0.913
1014.7	50	1.095	1.095	64.967	0.914
1064.7	50	1.094	1.094	65.035	0.914
1114.7	50	1.094	1.094	65.107	0.914

1164.7	50	1.093	1.093	65.181	0.915
1214.7	50	1.093	1.093	65.258	0.915
1264.7	50	1.093	1.093	65.338	0.915
1314.7	50	1.092	1.092	65.420	0.915
1364.7	50	1.092	1.092	65.505	0.916
1414.7	50	1.092	1.092	65.592	0.916
1464.7	50	1.092	1.092	65.681	0.916
1514.7	50	1.092	1.092	65.773	0.916
1564.7	50	1.091	1.091	65.867	0.916
1614.7	50	1.091	1.091	65.964	0.917
1664.7	50	1.091	1.091	66.063	0.917
1714.7	50	1.091	1.091	66.164	0.917
1764.7	50	1.091	1.091	66.267	0.917
1814.7	50	1.090	1.090	66.373	0.917
1864.7	50	1.090	1.090	66.481	0.917
1914.7	50	1.090	1.090	66.591	0.917
1964.7	50	1.090	1.090	66.703	0.917
2014.7	50	1.090	1.090	66.818	0.918
2064.7	50	1.090	1.090	66.934	0.918
2114.7	50	1.090	1.090	67.053	0.918
2164.7	50	1.090	1.090	67.174	0.918
2214.7	50	1.090	1.090	67.297	0.918
2264.7	50	1.089	1.089	67.422	0.918
2314.7	50	1.089	1.089	67.550	0.918
2364.7	50	1.089	1.089	67.679	0.918
2414.7	50	1.089	1.089	67.811	0.918
2464.7	50	1.089	1.089	67.944	0.918
2514.7	50	1.089	1.089	68.080	0.918
2564.7	50	1.089	1.089	68.218	0.918
2614.7	50	1.089	1.089	68.358	0.918
2664.7	50	1.089	1.089	68.500	0.919
2714.7	50	1.089	1.089	68.644	0.919
2764.7	50	1.089	1.089	68.790	0.919
2814.7	50	1.089	1.089	68.938	0.919
2864.7	50	1.089	1.089	69.089	0.919
2914.7	50	1.089	1.089	69.241	0.919
2964.7	50	1.088	1.088	69.395	0.919
3014.7	50	1.088	1.088	69.552	0.919

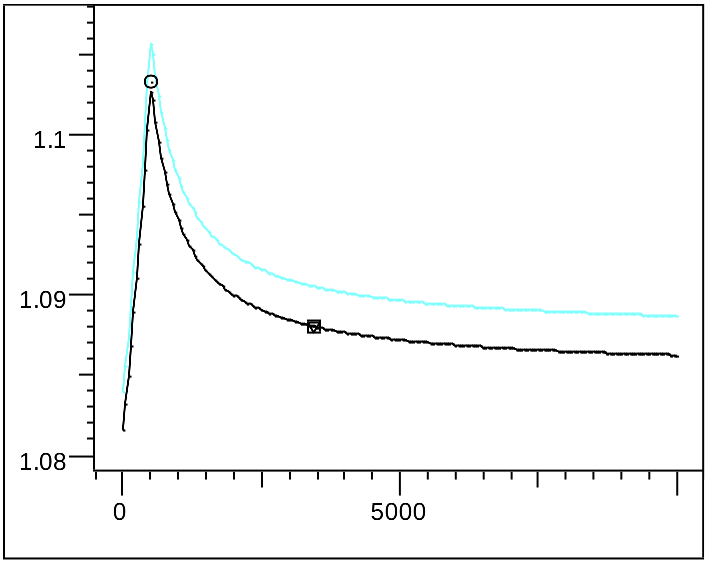
3064.7	50	1.088	1.088	69.710	0.919
3114.7	50	1.088	1.088	69.871	0.919
3164.7	50	1.088	1.088	70.034	0.919
3214.7	50	1.088	1.088	70.198	0.919
3264.7	50	1.088	1.088	70.365	0.919
3314.7	50	1.088	1.088	70.534	0.919
3364.7	50	1.088	1.088	70.704	0.919
3414.7	50	1.088	1.088	70.877	0.919
3464.7	50	1.088	1.088	71.052	0.919

Figura 48 : Rs plot of Vivian reservoir using Ecrin



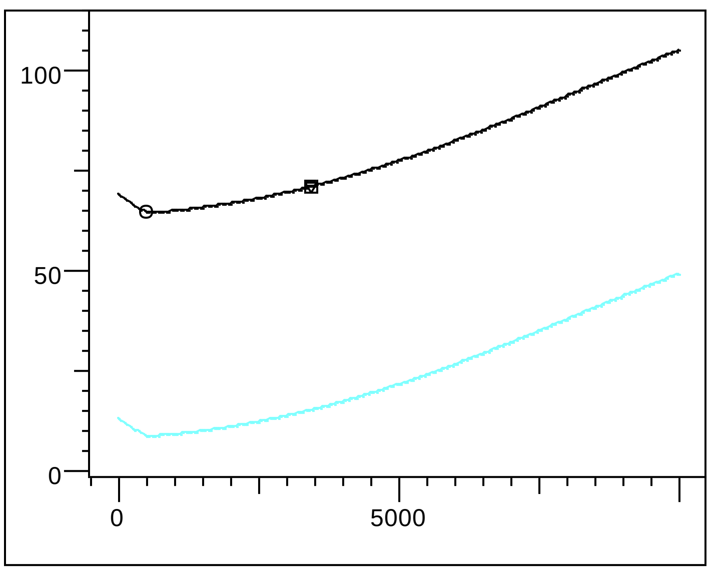
Gas/Oil Ratio [scf/stb] vs Pressure [psia]

Figura 49: Bo plot of Vivian reservoir using Ecrin



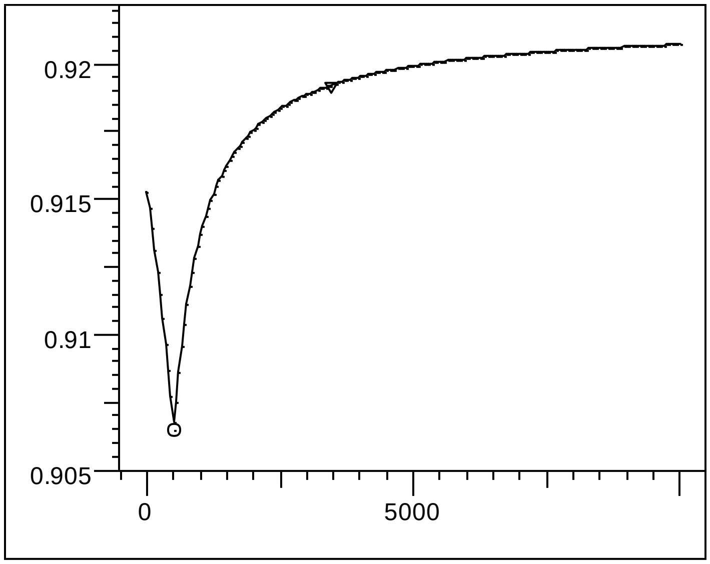
Reservoir to SC liquid volume ratio [B/STB] vs Pressure [psia]

Figura 50: Uo plot of Vivian reservoir using Ecrin



Viscosity [cp] vs Pressure [psia]

Figura 51: Oil density (Rho) plot of Vivian reservoir using Ecrin



Density [g/cc] vs Pressure [psia]

- **PVT CHONTA Pr=3700 psi**

Figura 52: Table of PVT data for the Chonta reservoir obtained from Ecrin

P(psia)	Rs(scf/stb)	Bo(B/stb)	Co(psi-1)	Uo	Rho(g/cc)
14.6959	3.9851	1.0879	0.0339	1.5043	0.7991
64.6959	10.5538	1.0907	0.0040	1.4459	0.7982
114.6960	17.9562	1.0938	0.0017	1.3861	0.7971
164.6960	25.9312	1.0972	0.0010	1.3279	0.7960
214.6960	34.3522	1.1008	0.0007	1.2723	0.7948
264.6960	43.1424	1.1046	0.0005	1.2198	0.7935
314.6960	52.2499	1.1086	0.0004	1.1705	0.7922
364.6960	61.6367	1.1127	0.0003	1.1243	0.7909
414.6960	71.2737	1.1169	0.0003	1.0811	0.7895
464.6960	81.1379	1.1212	0.0002	1.0407	0.7880
514.6960	91.2108	1.1257	0.0002	1.0028	0.7866
564.6960	101.4770	1.1302	0.0002	0.9674	0.7851
614.6960	111.9220	1.1349	0.0002	0.9342	0.7836
664.6960	122.5370	1.1396	0.0001	0.9030	0.7820

714.6960	133.3100	1.1444	0.0001	0.8738	0.7805
764.6960	144.2330	1.1494	0.0001	0.8462	0.7789
814.6960	155.2990	1.1544	0.0001	0.8203	0.7773
864.6960	166.5010	1.1595	0.0001	0.7958	0.7756
914.6960	177.8320	1.1646	0.0001	0.7726	0.7740
964.6960	185.0000	1.1699	0.0000	0.7507	0.7723
1014.7000	185.0000	1.1721	0.0000	0.7406	0.7718
1064.7000	185.0000	1.1706	0.0000	0.7446	0.7728
1114.7000	185.0000	1.1693	0.0000	0.7487	0.7737
1164.7000	185.0000	1.1680	0.0000	0.7531	0.7746
1214.7000	185.0000	1.1668	0.0000	0.7577	0.7753
1264.7000	185.0000	1.1658	0.0000	0.7625	0.7760
1314.7000	185.0000	1.1648	0.0000	0.7675	0.7767
1364.7000	185.0000	1.1639	0.0000	0.7727	0.7773
1414.7000	185.0000	1.1631	0.0000	0.7781	0.7779
1464.7000	185.0000	1.1623	0.0000	0.7837	0.7784
1514.7000	185.0000	1.1616	0.0000	0.7895	0.7789
1564.7000	185.0000	1.1609	0.0000	0.7954	0.7793
1614.7000	185.0000	1.1602	0.0000	0.8016	0.7798
1664.7000	185.0000	1.1596	0.0000	0.8079	0.7802
1714.7000	185.0000	1.1591	0.0000	0.8143	0.7805
1764.7000	185.0000	1.1585	0.0000	0.8210	0.7809
1814.7000	185.0000	1.1580	0.0000	0.8278	0.7812
1864.7000	185.0000	1.1576	0.0000	0.8348	0.7816
1914.7000	185.0000	1.1571	0.0000	0.8419	0.7819
1964.7000	185.0000	1.1567	0.0000	0.8492	0.7822
2014.7000	185.0000	1.1563	0.0000	0.8566	0.7824
2064.7000	185.0000	1.1559	0.0000	0.8642	0.7827
2114.7000	185.0000	1.1555	0.0000	0.8720	0.7829
2164.7000	185.0000	1.1552	0.0000	0.8799	0.7832
2214.7000	185.0000	1.1548	0.0000	0.8880	0.7834
2264.7000	185.0000	1.1545	0.0000	0.8962	0.7836
2314.7000	185.0000	1.1542	0.0000	0.9045	0.7838
2364.7000	185.0000	1.1539	0.0000	0.9130	0.7840
2414.7000	185.0000	1.1536	0.0000	0.9217	0.7842
2464.7000	185.0000	1.1534	0.0000	0.9304	0.7844
2514.7000	185.0000	1.1531	0.0000	0.9394	0.7846
2564.7000	185.0000	1.1528	0.0000	0.9484	0.7848
2614.7000	185.0000	1.1526	0.0000	0.9576	0.7849

2664.7000	185.0000	1.1524	0.0000	0.9670	0.7851
2714.7000	185.0000	1.1522	0.0000	0.9765	0.7852
2764.7000	185.0000	1.1519	0.0000	0.9861	0.7854
2814.7000	185.0000	1.1517	0.0000	0.9958	0.7855
2864.7000	185.0000	1.1515	0.0000	1.0057	0.7856
2914.7000	185.0000	1.1513	0.0000	1.0158	0.7858
2964.7000	185.0000	1.1512	0.0000	1.0259	0.7859

Figura 53: Rs plot of Chonta reservoir using Ecrin

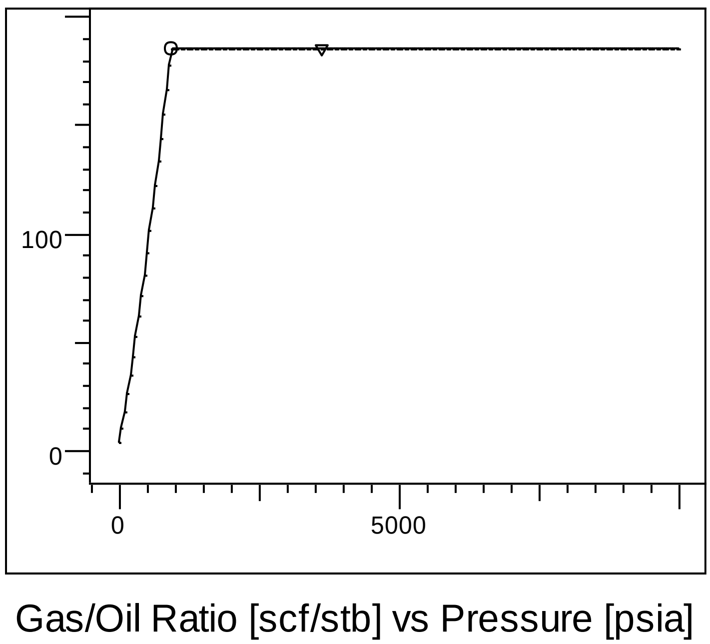
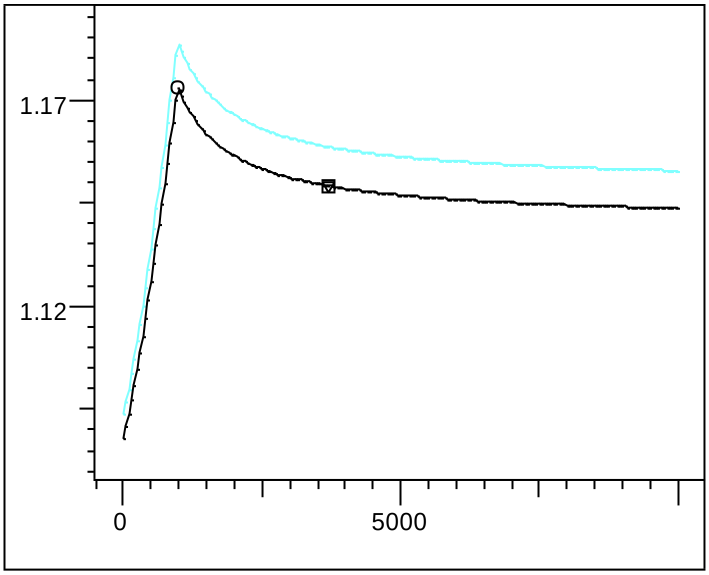
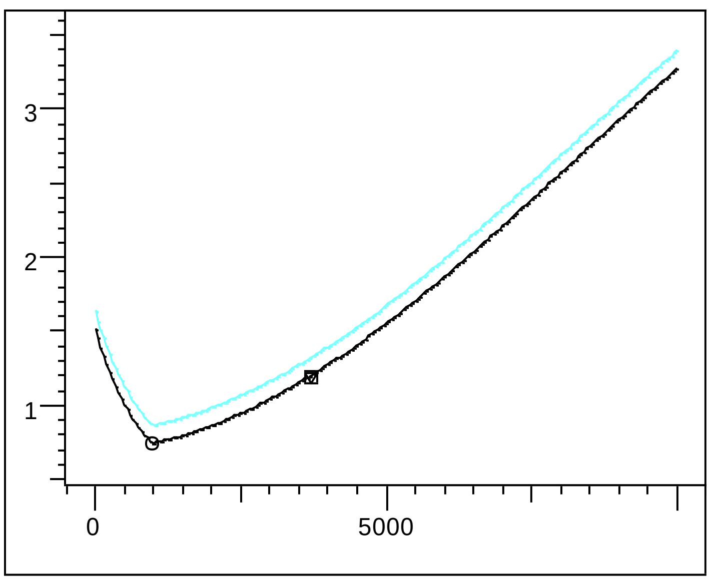


Figura 54: Bo plot of Chonta reservoir using Ecrin



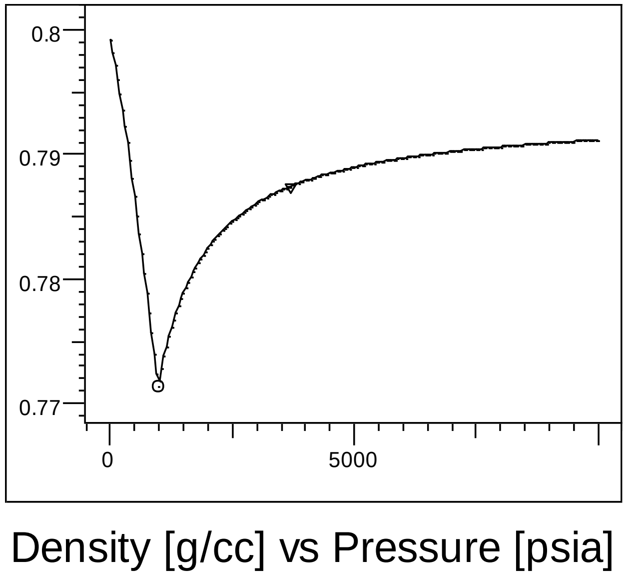
Reservoir to SC liquid volume ratio [B/STB] vs Pressure [psia]

Figura 55: Uo plot of Chonta reservoir using Ecrin



Viscosity [cp] vs Pressure [psia]

Figura 56: Oil density (Rho) plot of Chonta reservoir using Ecrin



- **Comparison of results using Ecrin and Correlations**

Tabla 21: Comparative table of data obtained using Correlations and Ecrin for Vivian reservoir

VIVIAN RESERVOIR			
	CORRELATIONS	**ECRIN**	
API @ 60°F	11.5	11.5	
Gas solubility (Rs)	50	50	(SCF/STB)
Bubble Pressure (Pb)	527	540	(Psia)
Oil Volume Factor (βo)	1.15	1.088	(bbl/STB)
Oil density	60.5	57.3456	(lb/ft3)
Oil viscosity (μo)	60	71.052	(Cp)

Tabla 22: Comparative table of data obtained using Correlations and Ecrin for Chonta reservoir

CHONTA RESERVOIR			
	CORRELATIONS	**ECRIN**	
API @ 60°F	31.4	31.4	
Gas solubility (Rs)	185	185	*(SCF/STB)*
Bubble Pressure (Pb)	1058	978	*(Psia)*
Oil Volume Factor (βo)	1.13	1.149	*(bbl/STB)*
Oil density	53.6	57.3456	*(lb/ft3)*
Oil viscosity (μo)	1.42	1.41	*(Cp)*

The viscosity determined for both reservoirs is at reservoir conditions and in the production stage the bottom-to-surface viscosity plot will be made by means of an appropriate correlation.

It should be noted that we keep the PVT properties found by the Ecrin program because it can be readjusted with a field test value and be able to analyze in a better way the corresponding machining.

4.3.3. Reserve Estimates

4.3.3.1. Calculation of Reserves by Analogy

To estimate reserves by analogy we use the regional, geographic and geological similarities of other fields, based mainly on the nature of their formation.

For this purpose, we use information from fields of the same block that present similarities in certain characteristics:

- **Analogy by geographic extension:**

We locate fields close to the field of study, in this case we compare with the Forestal and Bartra field:

Forestales	
Area (ha)	**POES (MMBbl)**
1851	161.2
7111	**619.28**

Bartra	
Area (ha)	**POES (MMBbl)**
2647	242.4
7111	**651.19**

According to this analysis, there would be an average reserve estimate of 635 MMbbl adding the Chonta and Vivian reservoirs.

- **Analogy by gross thickness:**

Vivian formation

We also conducted a study by gross thickness, comparing the Shiviyacu and Jibarito fields.

Shiviyacu	
Gross interval, ft	**POES**
114	331.5
189	**549.59**

Jibarito	
Gross interval, ft	**POES**
139	315.4
189	**428.85**

According to this data, there would be an estimated reserves of 489 MMbbl in the Vivian formation.

Chonta formation

According to their similarity we compare with the formations of the Shiviyacu and Forestal fields.

Shiviyacu	
Gross interval (ft)	**POES**
44	37.3
91	**77.14**

Forestal	
Gross interval (ft)	**POES**
44	32.6
91	**67.42**

According to this relationship, there would be an estimated 72 MMbbl in the Chonta formation.

- **Analogy by Area:**

Vivian formation

For this part we carried out a study by area, comparing the Forestal and Jibaro fields.

Forestal	
Area (acre)	**POES**
3484.9	123.2
11000	**388.88**

Jibaro	
Area (acre)	**POES**
5190.2	214.6
11000	**454.82**

According to this data, there would be an estimated reserves of 489 MMbbl in the Vivian formation.

Chonta formation

According to their similarity we compare with the Capahuari Norte and Pilar field formations.

Capahuari Norte	
Area (acre)	**POES**
4152.9	26.3
8521	**53.96**

Pilar	
Area (acre)	**POES**
461	3.5
8521	**64.69**

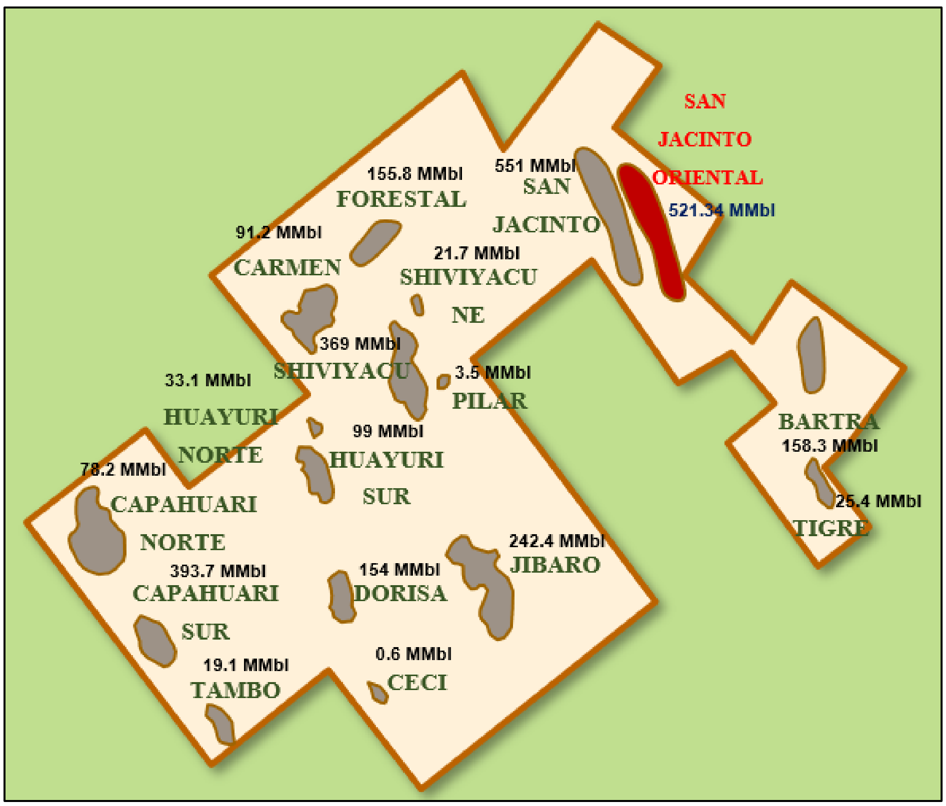
According to this relationship, there would be an estimated 59 MMbbl in the Chonta formation.

- **CONCLUSION**

Tabla 23: Consolidated results for the San Jacinto Field reservoirs

	VIVIAN	CHONTA	TOTAL
Extension			**619.28**
			651.19
Gross interval	549.59	77.14	**626.74**
	428.85	67.42	**496.28**
Area	388.88	53.96	**442.84**
	454.82	64.69	**519.51**
Average	**455.54**	**65.81**	**521.34**

Figura 57: Location of reservoirs in Block 192 for calculation of reserves by analogy



4.3.3.2. VOLUMETRIC METHOD

The estimation of reserves by this method consists of considering the properties of the rock, in this case properties of the twin field to our field of study will be used, in this case the San Jacinto field, and in this way determine a representative OOIP for the San Jacinto Oriental field.

4.3.3.2.1. DETERMINISTIC METHOD

To estimate the volume of oil in situ using the deterministic method, we use the following equation:

$$N = \frac{7758 * A * h * \emptyset * (1 - S_{wi})}{B_{oi}}$$

Where:

A: Area (acres)

h: Net oil thickness (feet)

Ø: Effective formation porosity (fraction)

Swi: Initial water saturation (fraction)

Boi: Formation Volume Factor (RB/SB)

To determine the area and thickness we used the net thickness maps, taken to AutoCAD, which helped us to determine more quickly the areas of each thickness taking as a reference the distribution used in the map.

- **CHONTA OOIP**

Using the net sand map of the Chonta formation with which we obtained the following results to find the in-situ volume of the formation:

Tabla 24: In situ volume calculation using Chonta net sand mapping

DEPTH (ft)	AREA (acres)	NET PAY (ft)	Ai+1/Ai	METHOD	VOLUME (acre. ft)
0	8415.02	5	0.59	Trapezoidal	33365.22
5	4931.07	5	0.68	Trapezoidal	12368.12
5	16.18	2.5		Spherical	23.49
10	3336.04	10	0.39	Pyramidal	33502.62
20	1290.00	10	0.50	Trapezoidal	6829.65
20	75.93	5		Spherical	202.91
20	90.77	5		Spherical	240.02
20	57.62	5		Spherical	157.15
30	648.60	10	0.33	Pyramidal	4168.55
40	34.82	5		Spherical	100.15
40	83.13	5		Spherical	220.92
40	95.58	5		Spherical	252.03
				TOTAL VOLUME	91430.85

The in-situ volume of oil was calculated using the equation mentioned before:

Tabla 25: Chonta's OOIP using the deterministic method

VOLUME	91430.85	*acre. ft*
PHI	0.2	*%*
Swi	0.25	*%*
Boi	1.149	*Bls/STB*
POES	92.60	*MMbbls*

- **VIVIAN OOIP**

We determined the in-situ volume using Vivian's net sand map.

Tabla 26: In situ volume calculation using Vivian net sand mapping

DEPTH (ft)	AREA (acres)	NET PAY (ft)	Ai+1/Ai	METHOD	VOLUME (acre. ft)
0	2714.229	10	1.36	Trapezoidal	32073.98
10	3700.566	10	4.63	Trapezoidal	104219.28
20	17143.289	10	0.64	Trapezoidal	140432.64
30	10943.240	10	0.65	Trapezoidal	55187.41
30	94.242	8		Spherical	410.48
40	7074.820	10	0.78	Trapezoidal	36182.25
40	161.630	6		Spherical	503.74
50	5495.409	10	0.68	Trapezoidal	46191.71
60	3742.934	10	0.68	Trapezoidal	29207.51
60	2098.569	6		Spherical	6314.56
70	2555.968	10	0.65	Trapezoidal	12890.20
70	22.072	8		Spherical	121.80
70	51.354	8		Spherical	238.93
80	1660.540	10	0.65	Trapezoidal	8590.71
80	57.601	8		Spherical	263.92
90	1084.330	10	0.65	Trapezoidal	8932.30
100	702.130	10	0.16	Pyramidal	5149.71
100	84.391	6		Spherical	272.02
110	114.927	10	0.59	Trapezoidal	617.65
110	8.603	8		Spherical	67.92
110	40.804	8		Spherical	196.73
110	19.300	8		Spherical	110.71
120	67.240	10	0.42	Pyramidal	696.52
130	28.380	8		Spherical	147.03
			TOTAL VOLUME		489019.69

The in-situ volume of oil was calculated using the equation mentioned before:

Tabla 27: Vivian's OOIP using the deterministic method

VOLUME	489019.69	*acre. ft*
PHI	0.183	*%*
Swi	0.317	*%*
Boi	1.088	*Bls/STB*
POES	435.83	*MMbbls*

4.3.3.2.2. PROBABILISTIC METHOD

With the use of the Crystal Ball software, a distribution is generated for the properties of the OOIP calculation, 10000 tests are simulated for the probabilities, obtaining the percentiles P10, P50, P90, and to have a range of values for the calculation of the in-situ volume of the reservoir.

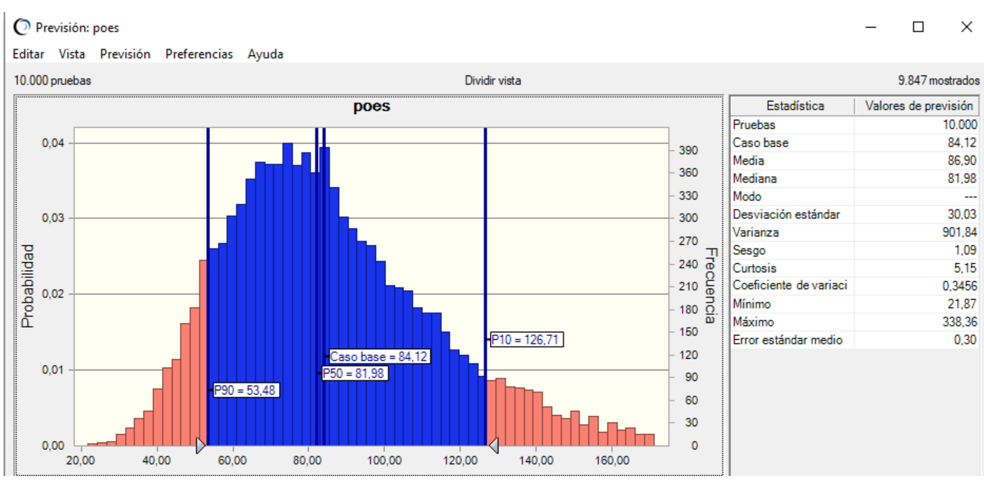
- **Calculation of the OOIP for Chonta:**

10,000 tests were generated with different distributions in order to have a margin of less than 5%.

Tabla 28: Type of distribution for each petrophysical property - Chonta Reservoir

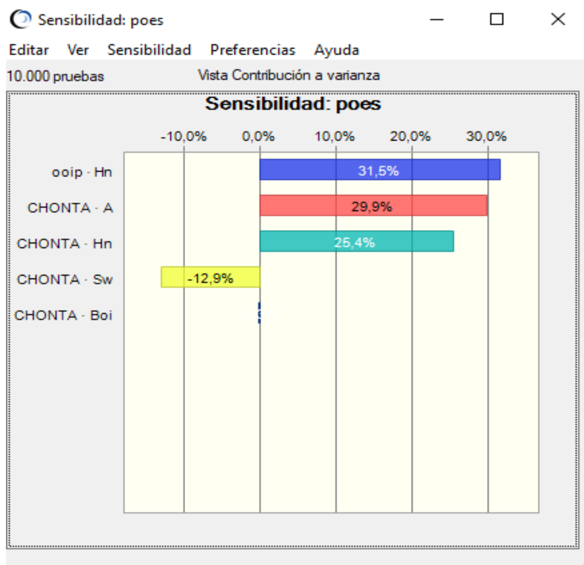
PARAMETERS	DISTRIBUTION
Ø	Normal Logarithmic
Sw	Normal Logarithmic
A	Beta pert
Hn	Normal Logarithmic
Boi	Uniform

Figura 58: OOIP Estimate - Chonta reservoir



- **Sensibility**:

Figura 59:Sensibility - Chonta reservoir



Results:

The results for Chonta are presented and the P50 will be taken as the most certain result for the calculation of OOIP and for future analysis:

Tabla 29: Data obtained for different percentiles - Chonta Reservoir

POES Chonta	
P90	53.48 MMbls
P50	81.98 MMbls
P10	126.71 MMbls

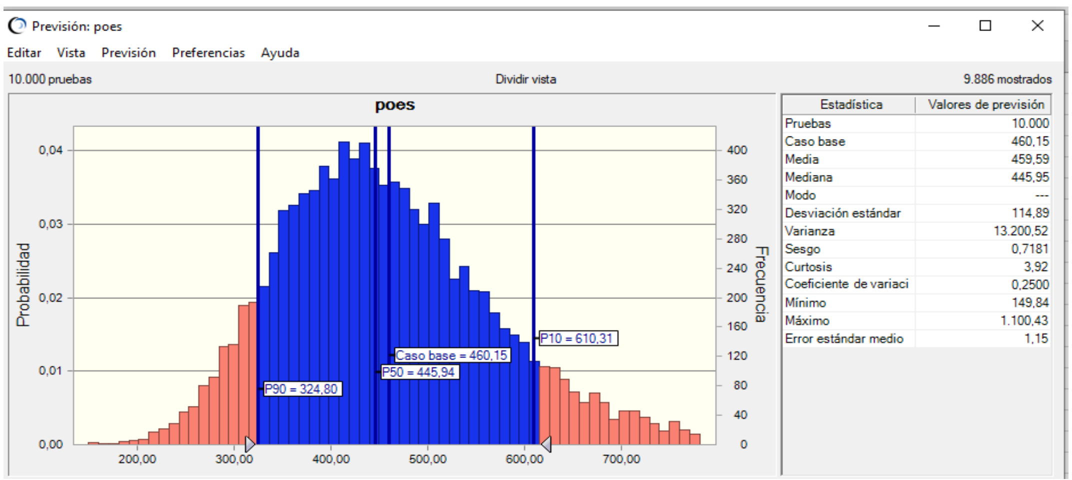
Vivian POES calculation

10000 tests were generated in the Crystal Ball software using the following distributions:

Tabla 30: Type of distribution for each petrophysical property - Vivian Reservoir

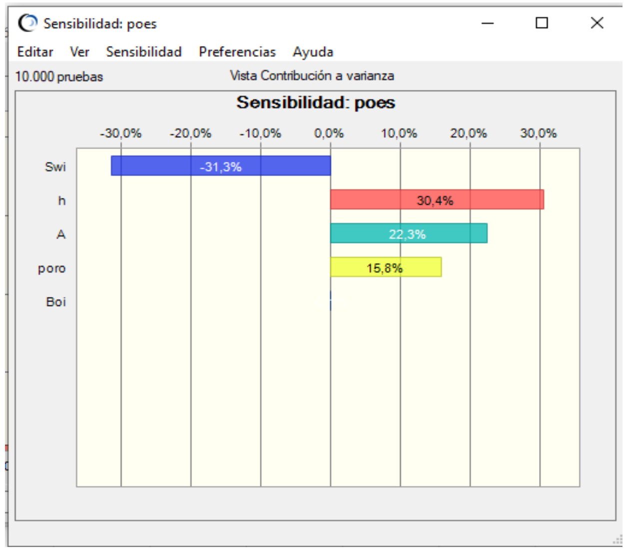
PARAMETER	DISTRIBUTION
Ø	Normal Logarithmic
Sw	Normal Logarithmic
A	Beta pert
Hn	Normal Logarithmic
Boi	Uniform

Figura 60: OOIP Estimate - Chonta reservoir



- **Sensibility**:

Figura 61: Sensibility - Vivian reservoir



Results:

The results for Vivian are presented and the P50 will be taken as the most certain result for the calculation of OOIP and for future analysis:

Tabla 31: Data obtained for different percentiles - Vivian Reservoir

POES Vivian	
P90	324.80 MMbls
P50	**445.94 MMbls**
P10	610.31 MMbs

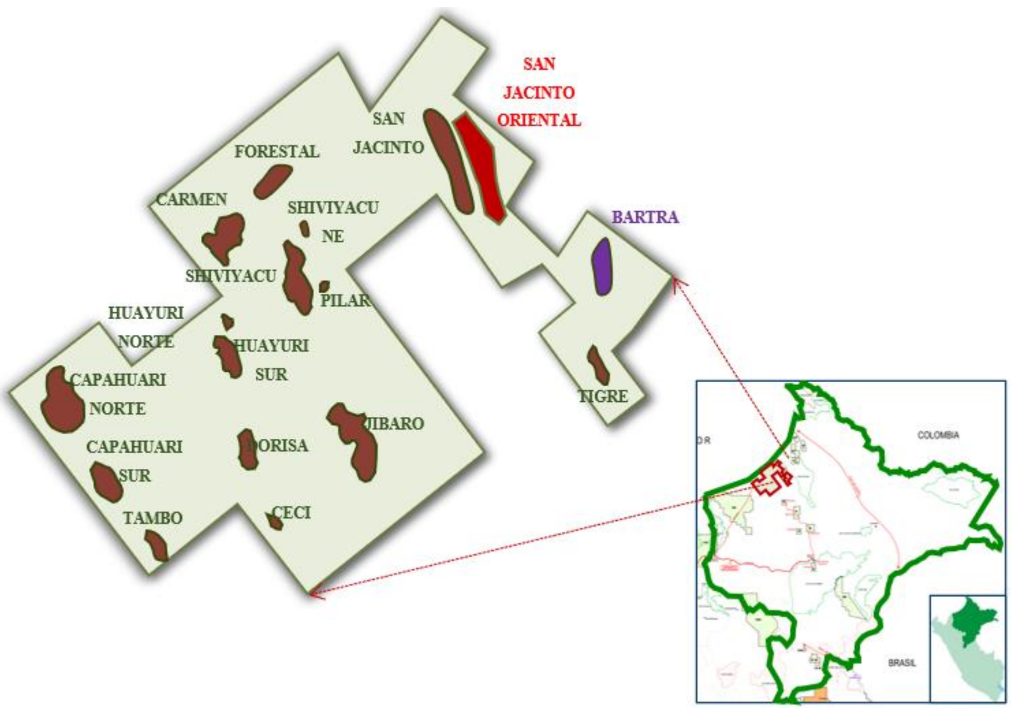
4.3.4. Calculation of the recovery factor and selection of the number of wells

4.3.4.1. Calculation of the Recovery Factor using Wegel's Equation

Since the reservoir is a heavy crude oil reservoir, the correlations for the calculation of the recovery factor are not well known, that is why we rely on a calculation from relative permeabilities, supporting ourselves from the results of the relative permeabilities of a field close to the San

Jacinto Oriental field, which is the Bartra field and having this permeability data, we apply a water cut-off limit of 98% in the Wegel correlation because it is a virgin field.

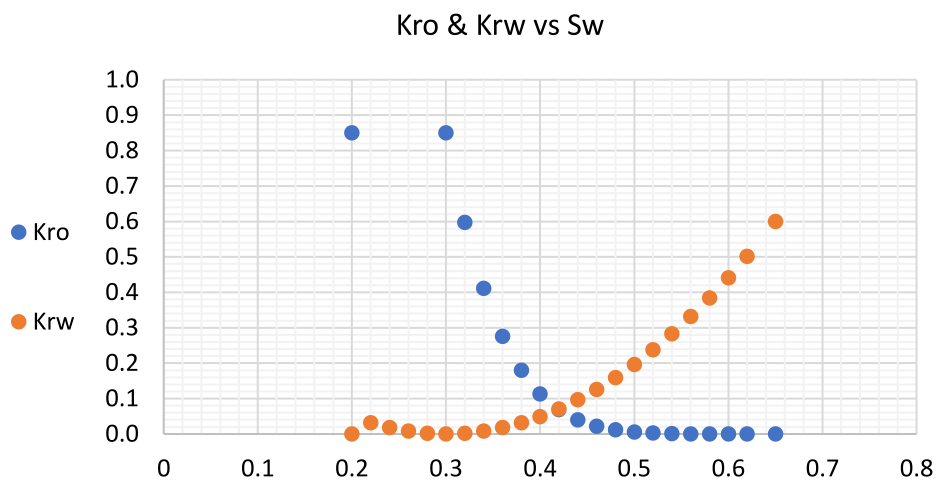
Figura 62: Location of the Bartra field for the reference recovery factor



Relative permeabilities to be used for R.F. calculation:

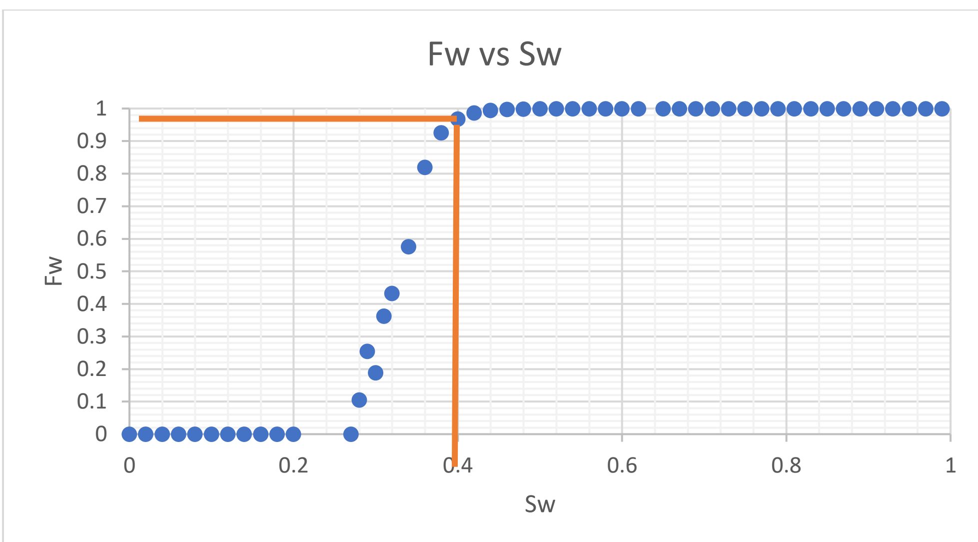
Recall that the development of this method was based on disregarding the capillary pressure gradient with respect to the flow direction. But this hypothesis is acceptable for intermediate or high-water saturations.

Figura 63 : plot Kro- Krw vs Sw



- **98% limit for virgin field, Vivian case:**

Figura 64: Water saturation vs. fractional flow for Vivian reservoir



Calculation of the Recovery Factor for the Vivian reservoir, San Jacinto Oriental field:

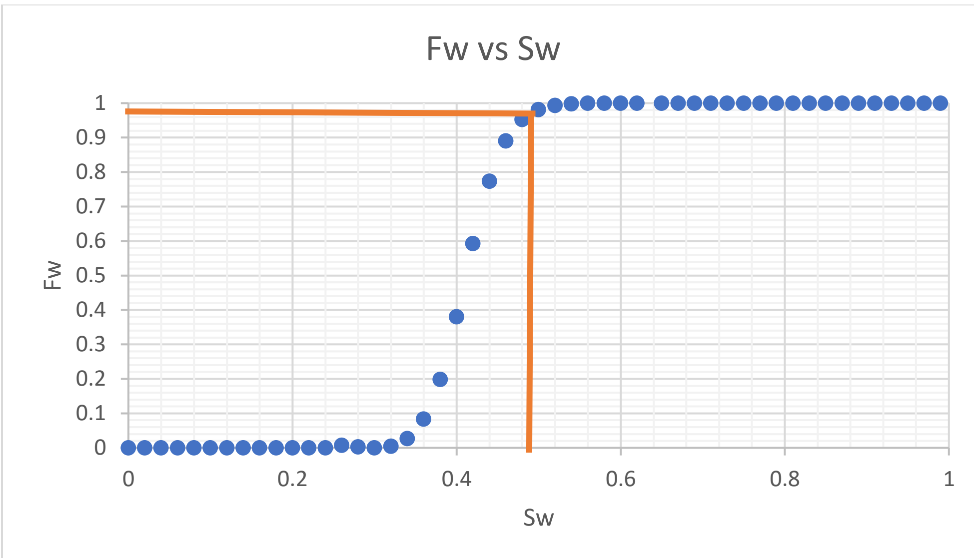
$$F_r = \frac{\bar{S}_w - S_{wc}}{1 - S_{wc}}$$

Tabla 32: Recovery factor for Vivian *reservoir*

uo	71
uw	1
swc	0.3
Fr	25.7%

- **98% limit for virgin field, Chonta case:**

Figura 65: Water saturation vs. *fractional flow for the* Chonta *reservoir*



$$F_r = \frac{\bar{S}_w - S_{wc}}{1 - S_{wc}}$$

Tabla 33: Recovery factor for Chonta *reservoir*

Uo	1.41
Uw	1
Swc	0.3
Fr	40.00%

4.3.5. *Basic Production Forecast Model*

- **DETERMINATION AND EVALUATION OF FIELD PRODUCTION DECLINE**

To determine the productive behavior of the San Jacinto Oriental field, it will be based on the neighboring fields of the field under study, for this we will build a decline model with the first wells drilled in the field for both formations and other characteristics.

To evaluate the behavior, the hyperbolic decline model will be used, being the one that best fits our model.

$$q = \frac{q_i}{(1 + b * D_{mi} * t)^{1/b}}$$

Formula 2: Hyperbolic declination model

- **VIVIAN FORMATION**

To analyze Vivian, we took into account two scenarios, the main one in which we considered the wells with a low water cut, which were the first wells to be developed, and a second group which started with a high water cut, some at the beginning of the field development and others evaluated over time.

Tabla 34: Groups of wells according to water cut-off

GROUP 1 – Low Water Cut	
WELL	**WC (%)**
SANJ-01X: V	(13-71)
SANJ-02C: V	(0-58)
SANJ-06: V	(0-48)
SANJ-13: V	(18-76)
SANJ-22C: V	(29-38)
SANJ-03D: V	(0-48)

GROUP 2 – High Water Cut	
WELL	**WC (%)**
SANJ-05D: V	(73-83)
SANJ-16D: V	(68-87)
SANJ-24D: V	(57-93)

Some wells had to be excluded due to their short production period and the fact that their distribution is very unstable.

- Group 1:

The parameters of the production decline were determined for each of the following:

Tabla 35: Declination parameters for each well

Well	Qi BPD	Di $Month^{-1}$	b	EUR MBls
SANJ-01X: V	1600	0.025	0.920	6,191
SANJ-02C: V	1450	0.023	0.910	5,487
SANJ-06: V	1600	0.023	0.930	6,676
SANJ-13: V	1350	0.026	0.890	4,367
SANJ-22C: V	1740	0.021	0.910	7,374
SANJ-03D: V	1280	0.090	0.900	1,238

We determine the statistical data of the flow rate and the EUR, to determine both the standard deviation and its distribution.

Figura 66: Statistical distribution of flow rates - Group 1

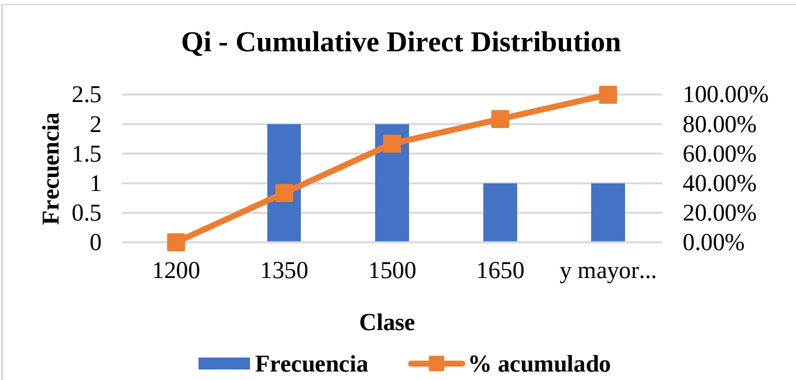
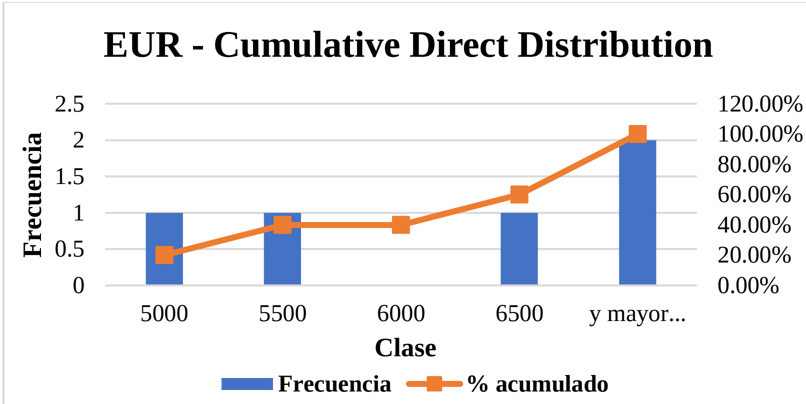


Figura 67: Statistical distribution of EUR - Group 1



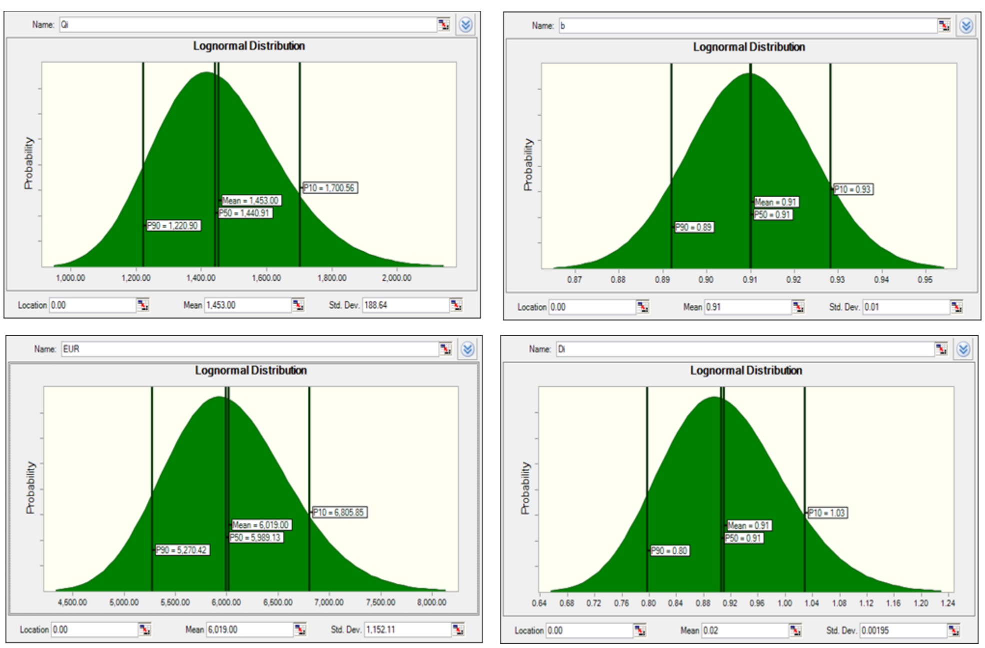
We determine the following data to perform a probability distribution.

Tabla 36: Declination parameters for the probabilistic distribution method

	Qi	Di	b	EUR
Mean	1453	0.024	0.910	6,019
# Wells	6	5	6	6
Standard Deviation	188.64	0.00195	0.01414	1152.11
Distribution	1400	0.024	0.91	6019

We performed the distribution of the parameters; in this case a Lognormal distribution was used.

Figura 68. Log normal distribution of parameters used to evaluate decline



A test with 10000 cases was run to determine the P10, P50 and P90 flow rates at zero time.

Figura 69: Probabilistic flow distribution

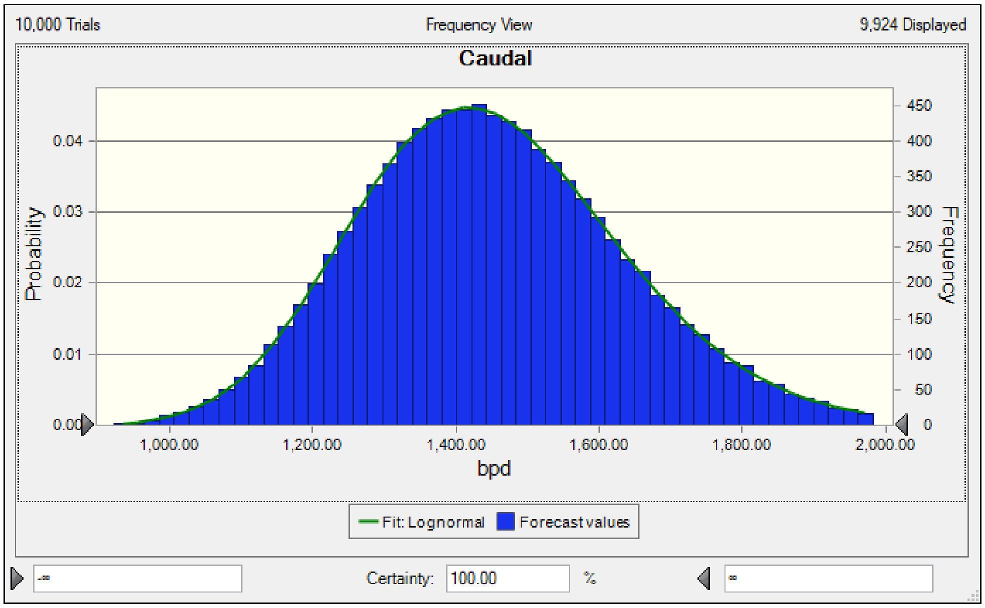


Tabla 37: Distribution of flow rate percentiles

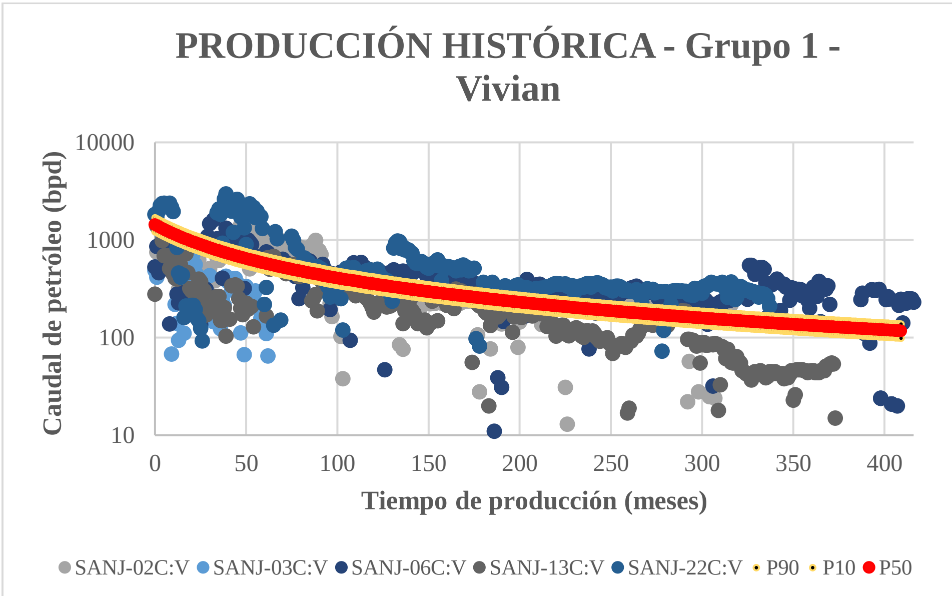
Percentiles	Fit: Lognormal
P100	0
P90	1,220.81
P80	1,292.31
P70	1,346.45
P60	1,394.50
P50	1,440.96
P40	1,488.97
P30	1,542.11
P20	1,606.71
P10	1,700.81
P0	∞

In addition, with the run we determine the parameters of the deterministic hyperbolic declination model:

Qi	1400
Di	0.024
b	0.91

Then, we perform the forecast on the production history of the wells, which results in the following chart:

Figura 70: Probabilistic type curve with the hyperbolic declination model



- <u>Group 2:</u>

The parameters of the production decline were determined for each well:

Tabla 38: Declination parameters for each well

Wells	Qi BPD	Di Month-1	b	EUR MBls
SANJ-05D:V	750.000	0.009	0.870	5,600
SANJ-16D:V	640.000	0.011	0.960	4,231
SANJ-24D:V	900.000	0.018	0.890	3,513

We determine the statistical data of the flow rate and the EUR, to determine the standard deviation and its distribution.

Figura 71: Statistical distribution of flow rates - Group 2

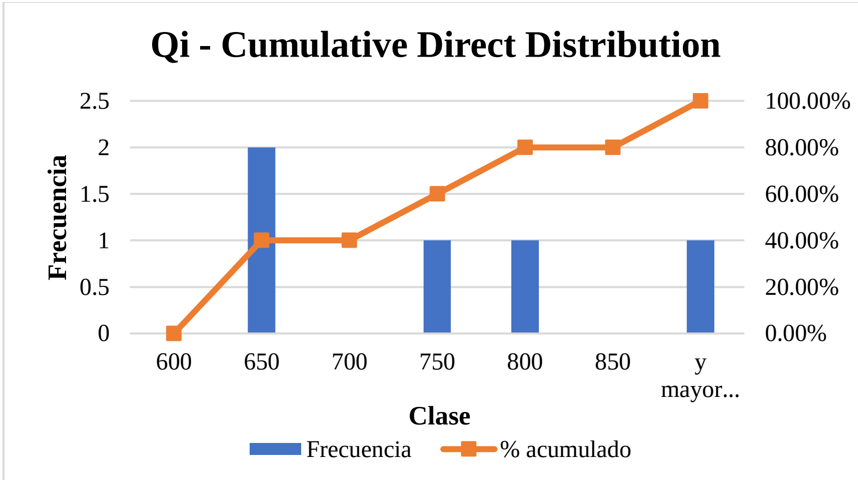
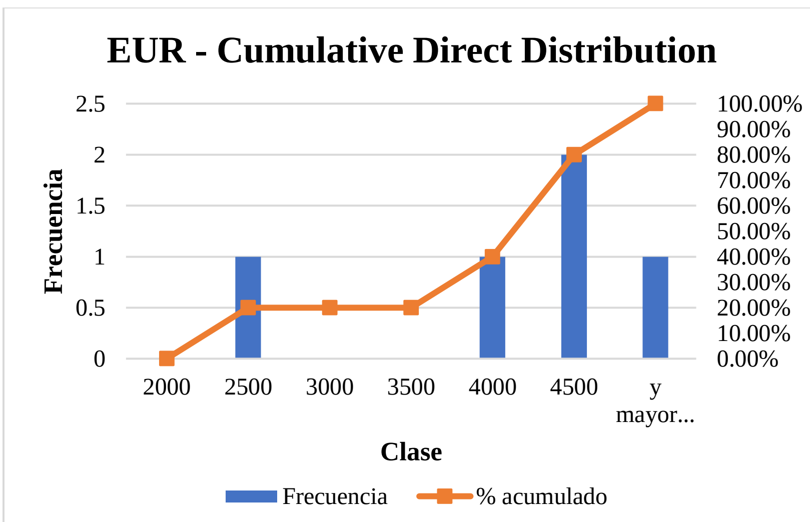


Figura 72: Statistical distribution of EUR - Group 2



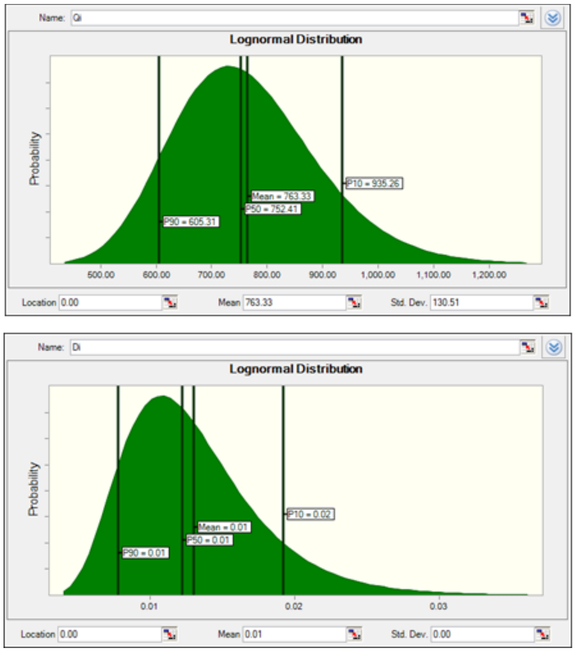
We determine the following data to perform a probability distribution.

Tabla 39: Declination parameters for the probabilistic distribution method

	Qi	Di	b	EUR
Mean	763.333	0.013	0.91	4,448
# Wells	3	3	3	3
Standard Deviation	130.51	0.00473	0.04726	1060.29
Distribution	748	0.92	0.015	4448

We performed the distribution of the parameters; in this case a log normal distribution was used.

Figura 73. Lognormal distribution of the parameters used to evaluate the declination



A test with 10000 cases was run to determine the P10, P50 and P90 flow rates at zero time.

Figura 74: Probabilistic flow distribution

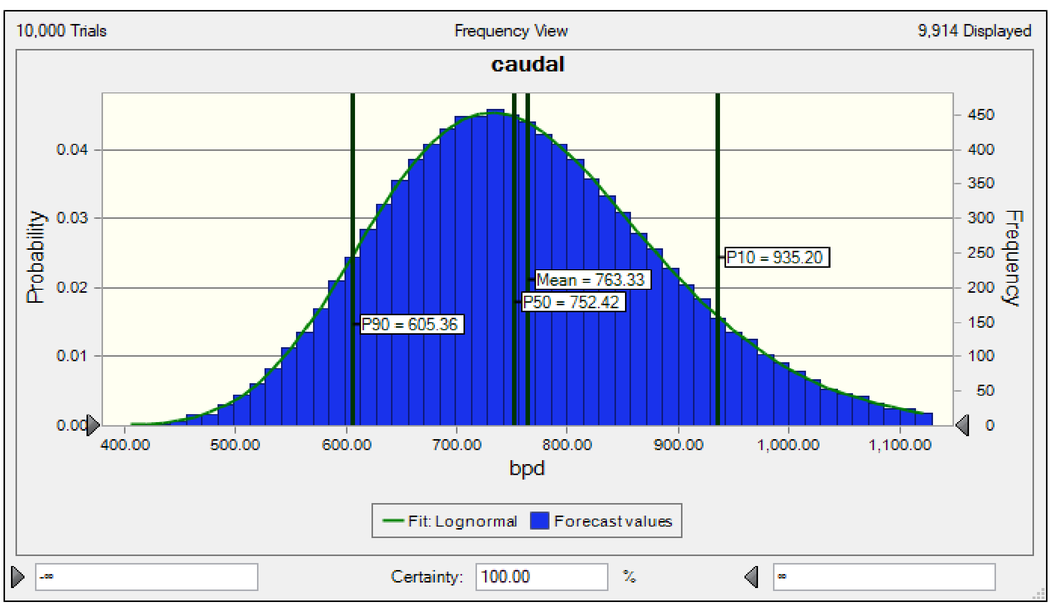


Tabla 40: Distribution of flow rate percentiles

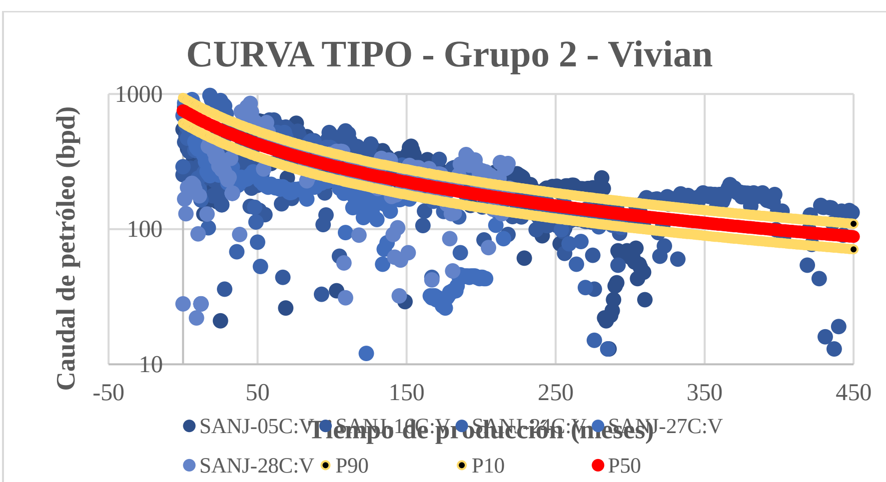
Percentiles	Fit: Lognormal
P100	0
P90	605.36
P80	652.28
P70	688.35
P60	720.76
P50	752.42
P40	785.47
P30	822.44
P20	867.92
P10	935.2
P0	∞

In addition, with the run we determine the parameters of the deterministic hyperbolic declination model:

Qi	748
Di	0.015
b	0.92

Then, we perform the forecast on the production history of the wells, which results in the following chart:

Figura 75: Decline using the probabilistic distribution method for group 2 - Vivian Reservoir



○ CHONTA FORMATION

To analyze the Chonta formation, we performed a similar analysis to that performed for Vivian, the two groups are as follows:

Tabla 41: Groups of wells according to water cut-off

GROUP 1 – Low Water Cut	
POZO	**WC (%)**
SANJ-01X:C	(19-56)
SANJ-20D:C	(8-42)
SANJ-12:C	(4-39)
SANJ-13:C	(12-64)
SANJ-14D:C	(26-53)
SANJ-18D:C	(46-70)
SANJ-22D:C	(23-60)

GROUP 2 – High Water Cut	
POZO	**WC (%)**
SANJ-02C:C	(76-88)
SANJ-10D:C	(82-91)
SANJ-16D:C	(72-90)
SANJ-24D:C	(70-91)

Some wells had to be excluded due to their short production period and the fact that their distribution is very unstable.

- <u>Group 1:</u>

The parameters of the production decline were determined for each of the following:

Tabla 42: Declination parameters for each well

Wells	Qi BPD	Di Month-1	b	EUR MBls
SANJ-01X:C	2750	0.086	0.870	3,039
SANJ-20D:C	3000	0.070	0.730	3,232
SANJ-12:C	2400	0.067	0.820	3,041
SANJ-13:C	1600	0.054	0.830	2,352
SANJ-14D:C	1500	0.076	0.815	1,518
SANJ-18D:C	2000	0.070	0.790	2,231
SANJ-22D:C	2500	0.095	0.85	2,374

- **Chonta min Water cut**

We determine the statistical data of the flow rate and the EUR, to determine both the standard deviation and its distribution.

Figura 76: Statistical distribution of flow rates - Group 1

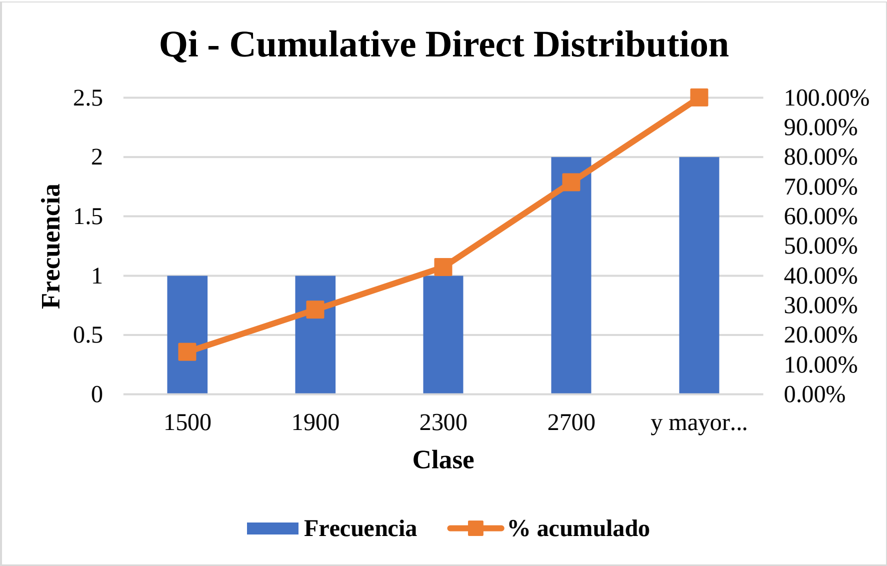
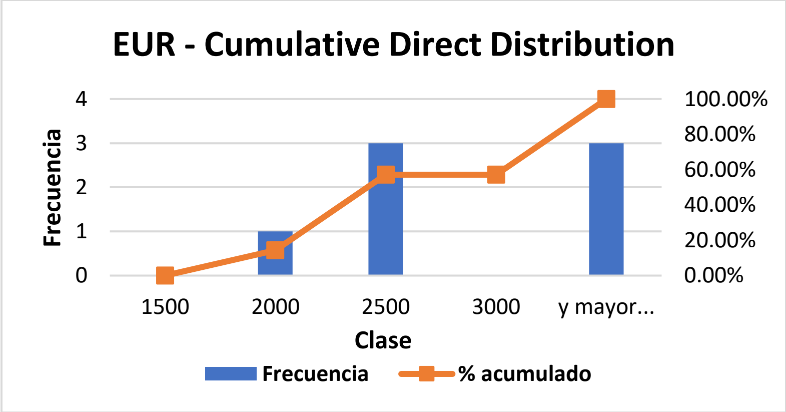


Figura 77: Statistical distribution of EUR - Group 1



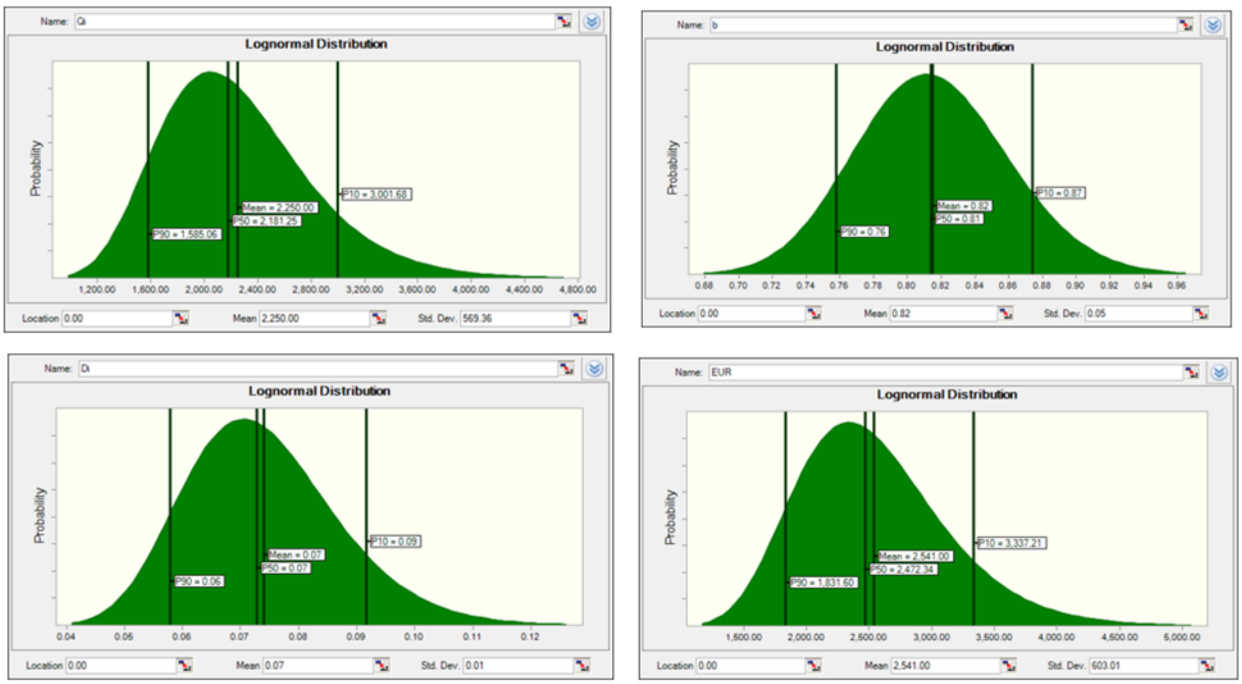
We determine the following data to perform a probability distribution.

Tabla 43: Declination parameters for the probabilistic distribution method

	Qi	Di	b	EUR
Mean	2250	0.074	0.815	2,541
# Wells	6	5	6	6
Standard Deviation	569.356	0.013354	0.04537	603.0097
Distribution	2250	0.074	0.815	2541

We performed the distribution of the parameters, in this case a Lognormal distribution.

Figura 78. Lognormal distribution of the parameters used to evaluate the declination



A test with 10000 cases was run to determine the P10, P50 and P90 flow rates at zero time.

Figura 79: Probabilistic flow distribution

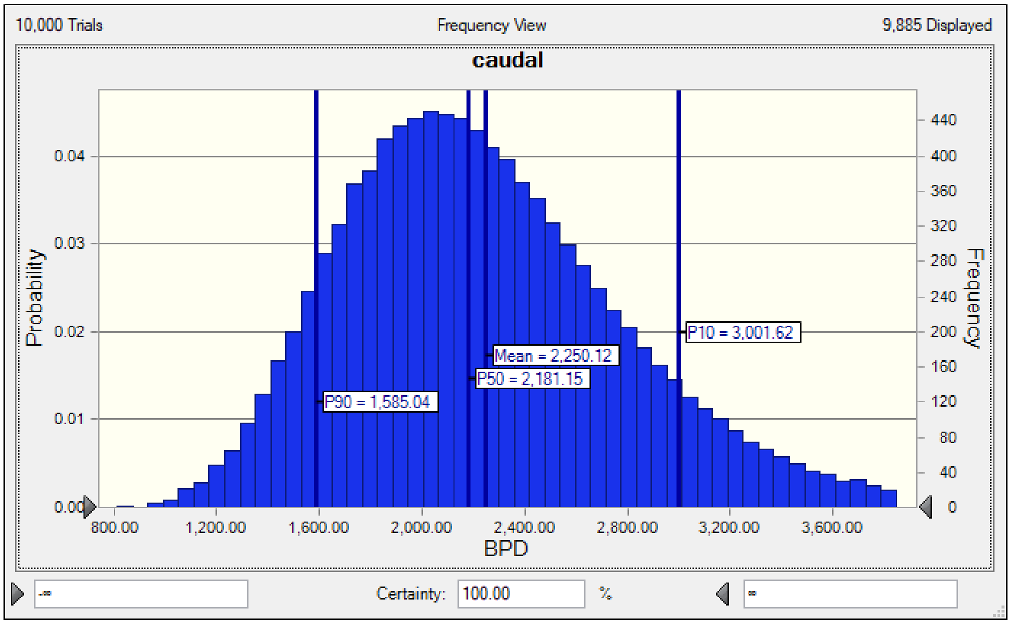


Tabla 44: Distribution of flow rate percentiles

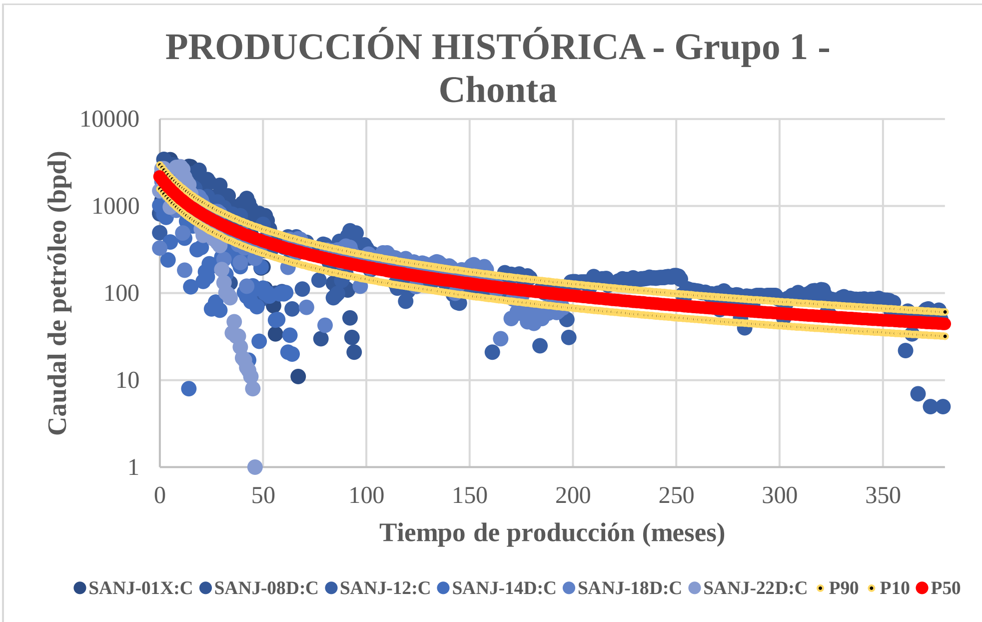
Percentiles	Forecast values
P100	815.87
P90	1,585.04
P80	1,768.56
P70	1,914.09
P60	2,047.79
P50	2,181.15
P40	2,323.02
P30	2,485.62
P20	2,689.59
P10	3,001.62
P0	5,412.76

In addition, with the run we determine the parameters of the deterministic hyperbolic declination model:

Qi	2250
Di	0.074
b	0.815

Then, we perform the forecast on the production history of the wells, which results in the following chart:

Figura 80: Probabilistic type curve with the hyperbolic declination model



- <u>Group 2:</u>

The parameters of the production decline were determined for each well:

Tabla 45: Declination parameters for each well

Wells	Qi BPD	Di $Month^{-1}$	b	EUR MBls
SANJ-02C:C	900	0.065	0.915	1,078
SANJ-10D:C	1300	0.120	0.720	780
SANJ-16D:C	1150	0.076	0.820	1,133
SANJ-24D:C	850	0.100	0.850	628

We determine the statistical data of the flow rate and the EUR, to determine the standard deviation and its distribution.

Figura 81: Statistical distribution of flow rates - Group 2

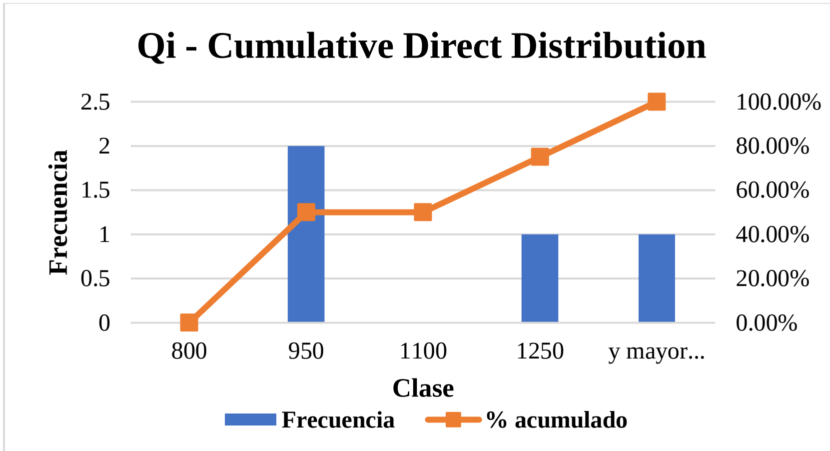
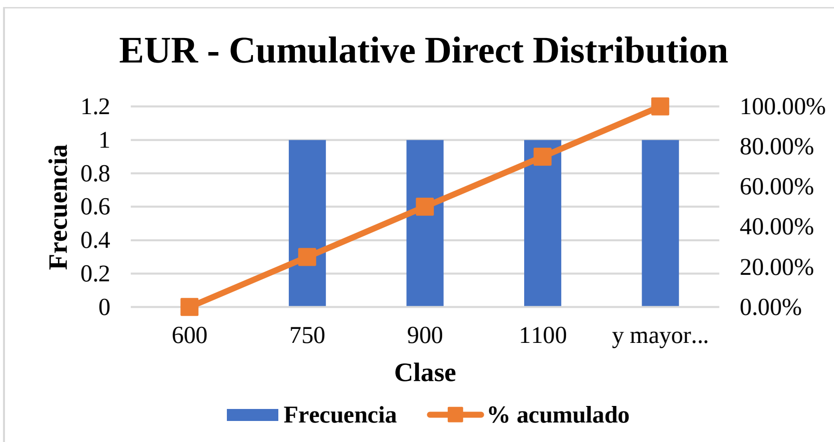


Figura 82: Statistical distribution of EUR - Group 2



We determine the following data to perform a probability distribution:

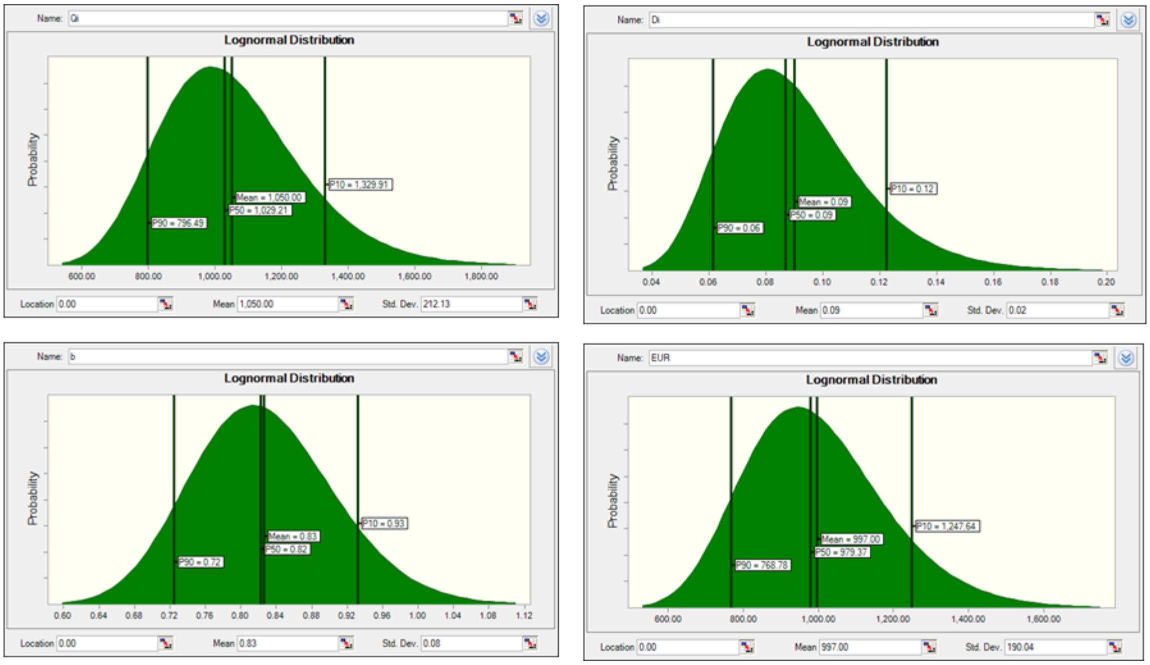
Tabla 46: Declination parameters for the probabilistic distribution method

	Qi	Di	b	EUR
Mean	1050	0.090	0.826	997
# Wells	4	4	4	3
Standard Deviation	212.132	0.024636	0.081176	190.04131
Distribution	1030	0.08	0.837	1030

We performed the distribution of the parameters; in this case a log normal distribution was used.

A 10000-test run was performed to determine the P10, P50 and P90 flow rates at zero time.

Figura 83: Lognormal distribution of the parameters used to evaluate the declination



A test with 10000 cases was run to determine the P10, P50 and P90 flow rates at zero time.

Figura 84: Probabilistic flow distribution

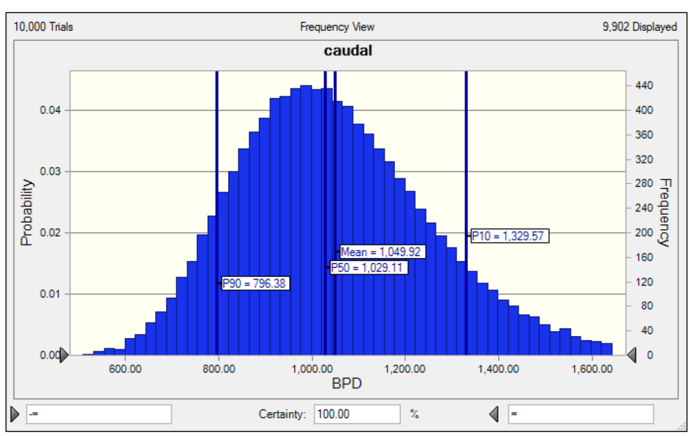


Tabla 47: Distribution of flow rate percentiles

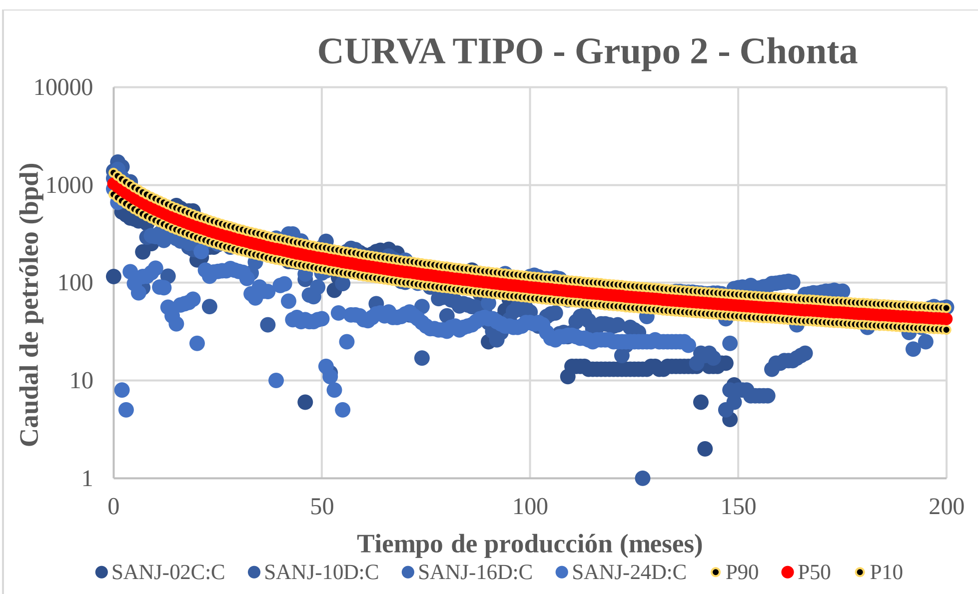
Percentiles	Fit: Lognormal
P100	0
P90	796.78
P80	869.96
P70	926.86
P60	978.42
P50	1,029.20
P40	1,082.61
P30	1,142.84
P20	1,217.59
P10	1,329.41
P0	∞

In addition, with the run we determine the parameters of the deterministic hyperbolic declination model:

Qi	1030
Di	0.08
b	0.837

Then, we perform the forecast on the production history of the wells, which results in the following chart:

Figura 85: Probabilistic method for group 2- Chonta Reservoir



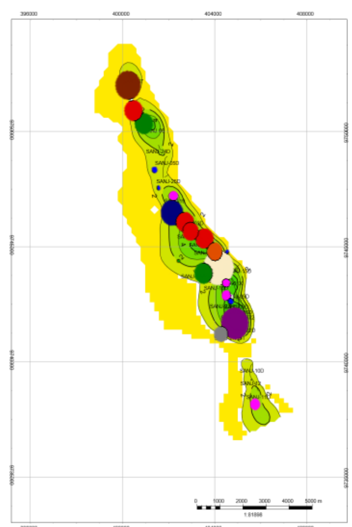
- **DRAINAGE RADIUS OF THE WELLS**

The methodology to be used to determine the drainage area will be by a statistical analysis taking into account the drainage radius history of the wells of the San Jacinto field.

- **VIVIAN FORMATION**

Using OFM software we can calculate and visualize the drainage area of the wells.

Figura 86: Distribution of Vivian drainage areas



We see that the radius is approximately between 1111 ft to 1389 ft, to determine a more accurate value, we will use a probabilistic analysis.

Tabla 48: Drainage radius history

WELLS	Drainage radius (ft)
SANJ-01X: V	2097
SANJ-02C: V	1534
SANJ-04D: V	1245
SANJ-05D: V	1269

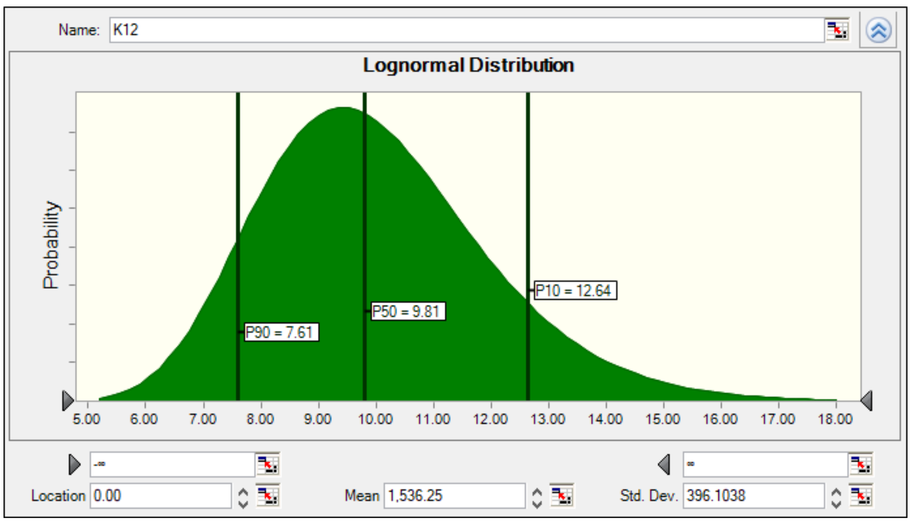
Then, we obtain:

Tabla 49: Statistical analysis

STATISTICS	
Mean	1536.25
Standard Error	198.051
Median	1401.5
Standard deviation	396.103
Sample variance	156898.25
Kurtosis	1.55319
Skewness coefficient	1.421
Range	852
Minimum	1245
Maximum	2097
Sum	6145
Count	4

The mean and standard deviation values are used to perform a log normal probability distribution:

Figura 87: Statistical distribution



In percentiles we have:

Tabla 50: Drainage radius percentiles-Vivian

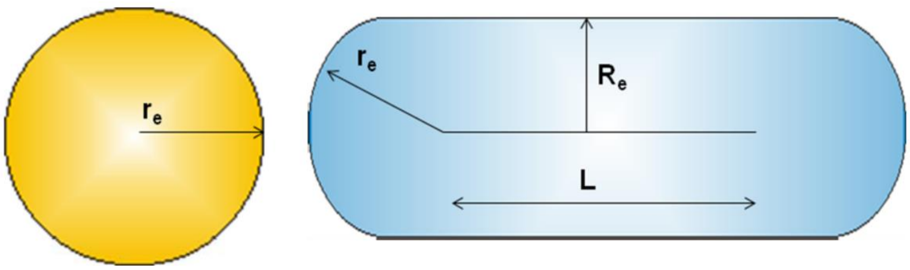
DRAINAGE RADIUS (ft)	
Mean	1536.25
P10	2059.15
P50	1487.6
P90	1074.69

The drainage radius to be used will be 1487.6 ft, thus the drainage area will be 160 acres.

Drainage Area (acres)	160

In the case of drainage radiuses in horizontal wells, the following relationship is applicable:

Figura 88: Relationship between the drainage area of a horizontal and vertical well



From which we consider approximately the following parameters:

r_e (ft)	1490
Re (ft)	1500
L (ft)	2500

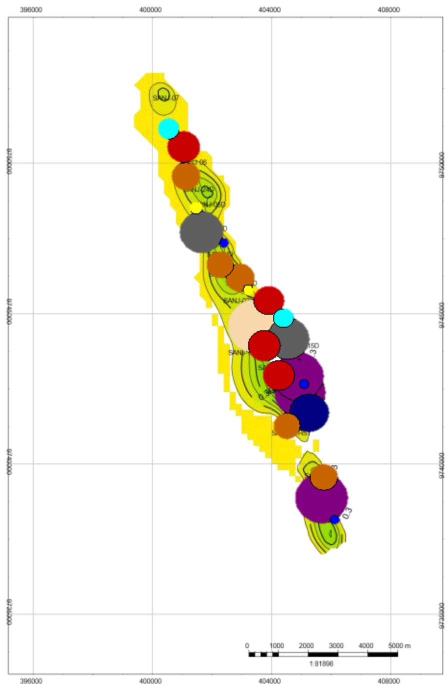
Therefore, the drainage area of the horizontal well will be:

Drainage Area (acres)	246

- **CHONTA FORMATION**

Using OFM software we can calculate and visualize the drainage area of the wells.

Figura 89: Distribution of Chonta drainage areas



We see that the radius is approximately between 1149 ft to 1478 ft, to determine a more accurate value, we will use a probabilistic analysis.

Tabla 51: Drainage radius history

WELLS	Drainage radius (ft)
SANJ-01X:C	1877
SANJ-02C:C	1198
SANJ-04D:C	1281
SANJ-05D:C	1447
SANJ-10D:C	1226

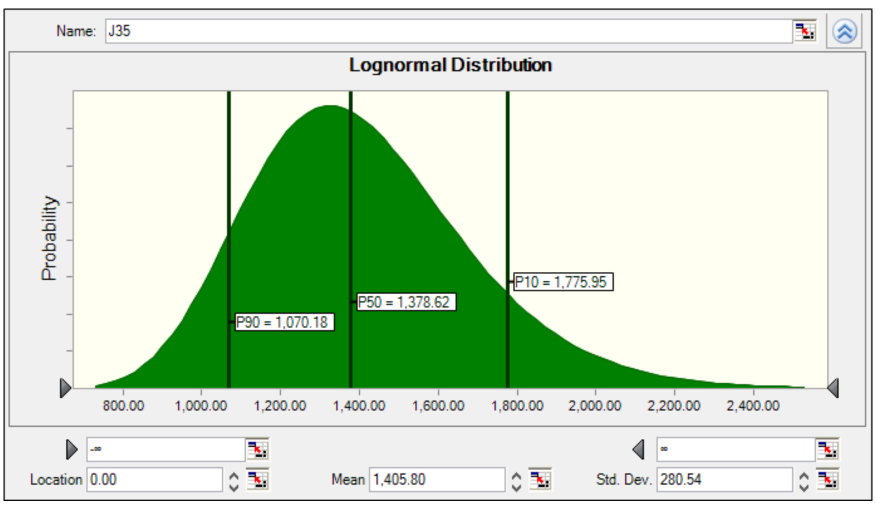
Then, we obtain:

Tabla 52: Statistical analysis

STATISTICS	
Mean	1405.8
Standard Error	125.5
Median	1281
Standard deviation	280.5
Sample variance	78702.7
Kurtosis	2.59
Skewness coefficient	1.66
Range	679
Minimum	1198
Maximum	1877
Sum	7029
Count	5

The mean and standard deviation values are used to perform a log normal probability distribution:

Figura 90: Statistical distribution



In percentiles we have:

Tabla 53: Drainage radius percentiles-Chonta

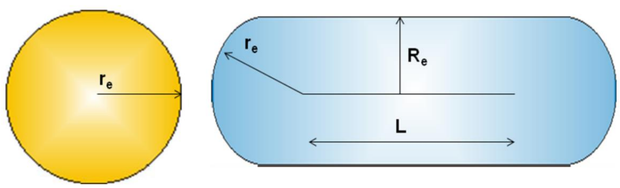
DRAINAGE RADIUS (ft)	
Media	1405.8
P10	1775.95
P50	1378.62
P90	1070.18

The drainage radius to be used will be 1378.6 ft, thus the drainage area will be 137 acres.

Drainage Area (acres)	137

In the case of drainage radiuses in horizontal wells, the following relationship is applicable:

Figura 91: Relationship between the drainage area of a horizontal and vertical well



From which we consider approximately the following parameters:

r_e (ft)	1380
Re (ft)	1400
L (ft)	1500

Therefore, the drainage area of the horizontal well will be:

Drainage Area (acres)	185

PRODUCTION FORECAST

The following points were taken into consideration to make the forecast of this project.

- **a.** The company will operate the field for 30 years base on Peruvian laws. The first 5 years will be taken for the exploration phase.
- **b.** The reservoirs in this Project does not have a simulation model so the forecast will be done with the hyperbolic declination model using the calculations of P50 from the previous section, this is shown in the following table:

Figura 92: Declination parameters divided in two groups: High and low water cut for Vivian and Chonta

	VIVIAN		CHONTA	
	Group1	Group2	Group1	Group2
Qo	1700	940	3000	1300
Di	0.0200	0.0150	0.0740	0.0800
b	0.9100	0.9200	0.8150	0.8370

The results show two different scenarios in each formation.

c. The horizontal wells were study in the same way and we determinate a relationship between its recovery factor and the recovery factor of a vertical well.

- **VIVIAN**

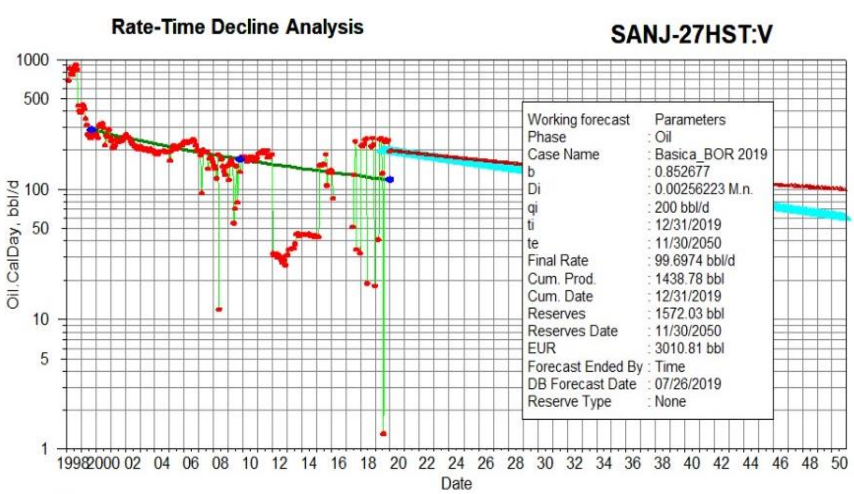
The following table shows the wells taken to analyzed Vivian.

Tabla 54: Comparison between two wells.

VIVIAN FORMATION						
WELLS	**API**	**Re (ft)**	**Water Production (bbl/d)**	**Top (ft)**	**Water cut (%)**	**WOR**
SANJ-16D: V	11	428	5506	7318	98	41
SANJ-27HST: V	11.7	321	8275	7300	98	42

We determined the parameters that are necessary to analyze the production of the well.

Figura 93: Forecast of the horizontal well- Vivian Reservoir



The results of the study of 25 years from the vertical and horizontal wells are shown in the following table:

Tabla 55: Comparison between vertical and horizontal Wells.

	SANJ-16D: V	SANJ-27H: V
Qi	186	799
b	0.9871	0.9695
Dmi	0.0118	0.0448
EUR(Mbls)	716.18	1411.11

In that way we can determined this relationship:

EUR Horizontal well _Vivian = EUR Vertical well _Vivian 1.97*

- **CHONTA**

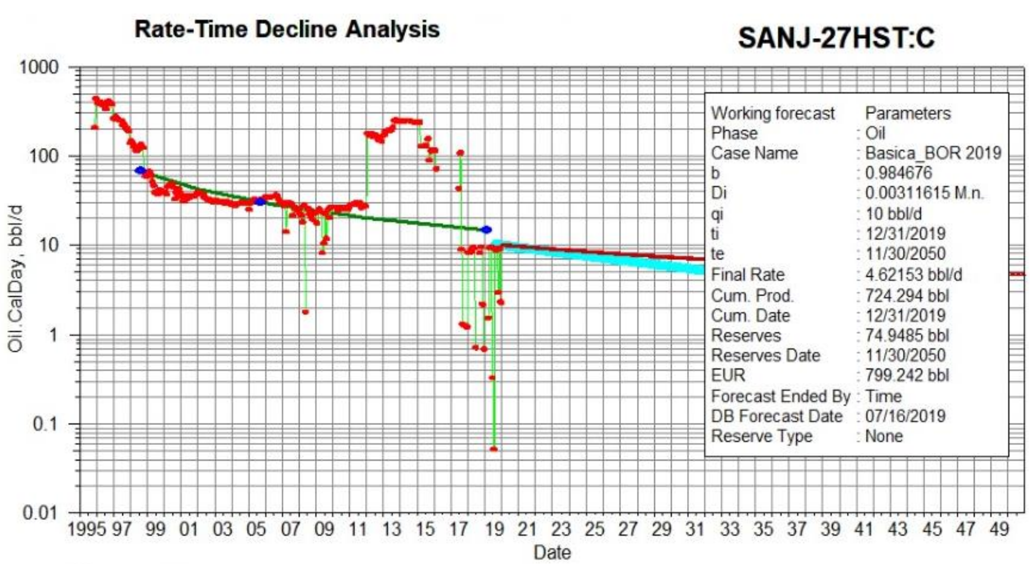
The following table shows the wells taken to analyzed Chonta.

Tabla 56: Comparison between two fields.

CHONTA FORMATION						
WELLS	**API**	**Re (ft)**	**Water production (bbl/d)**	**Top (ft)**	**Water cut (%)**	**WOR**
SANJ-16D: V	24	277	229	7318	87	7
SANJ-27HST: V	30	227	551	7308	100	237

We determined the parameters that are necessary to analyze the production of the well.

Figura 94: Forecast for a horizontal well. Chonta Reservoir



The results of the study of 25 years from the vertical and horizontal wells are shown in the following table:

Tabla 57: Comparison between the vertical and horizontal well

	SANJ-16D: C	SANJ-27H: C
Qi	116	520
b	0.9349	0.9364
Dmi	0.0111	0.1225
EUR(Mbls)	455.12	438.89

In that way we can determined this relationship:

Chonta Horizontal well _Chonta= EUR Vertical well _Chonta 0.96*

The result of this study shows that drill a horizontal well for Chonta formation does not have a good production in comparison of the vertical well. So that for the rest of the project, we considered just the vertical Wells for Chonta formation. However, more studies should be done in the future if we want to evaluate the drill of horizontal wells.

In base of that study, we did the following scenarios:

- **VIVIAN FORMATION**
  - **Scenario 1 – base:**

In this scenario, we consider the history of the field that shows that at least there is one well with a high water cut in all campaigns. So, we considered 23 vertical wells with a low initial water cut and 1 with a high initial water cut.

EUR-VG1 x well	4802.77	*Mbls*
EUR-VG2 x well	3134.60	*Mbls*
EUR-HG1 x well	12909.81	*Mbls*
EUR-HG2 x well	8888.48	*Mbls*

Tabla 58: Numbers of Wells for Vivian reservoir

SCENARIO	V - G1	H - G1	V- G2	H - G2	TOTAL	RF (%)
1	22	0	1	0	113598.28	24.4

As we can see in the table, theoretically just 25 percent of the oil in place will be produce so this is not the best scenario to develop for our 30 years of contract.

- **Other scenarios**

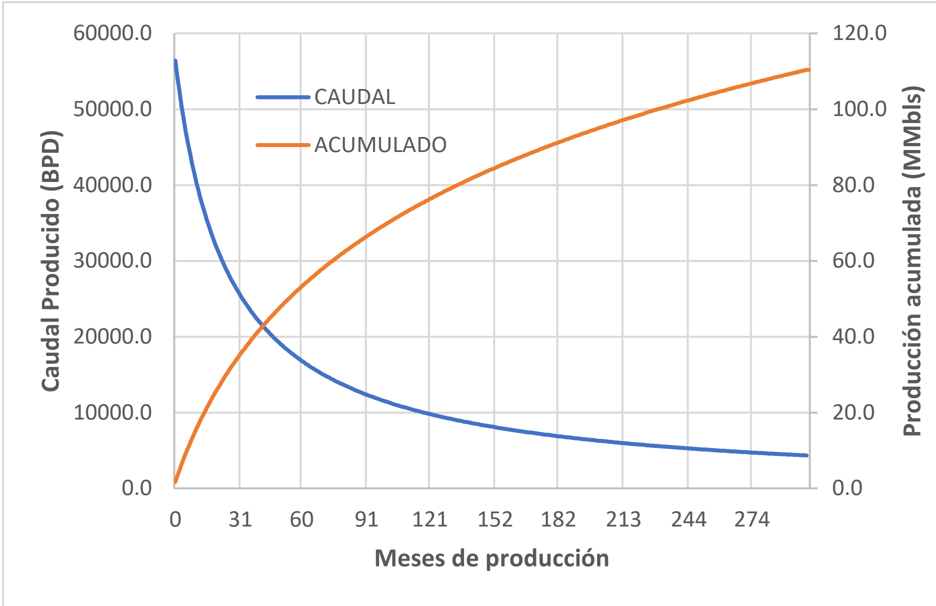
The following scenarios are done to consider the drill of horizontal wells.

Tabla 59: Different scenarios to determine R.F-Vivian reservoir

SCENARIO	V - G1	H - G1	V- G2	H - G2	TOTAL	RF (%)
1	22	0	1	0	108795.51	24.40
2	0	7	0	1	103278.48	23.16
3	5	6	0	1	110361.18	24.75

The results of this study say that in order to develop Vivian efficiently it is necessary to drill 5 vertical wells and 6 horizontal wells with low water cut, in addition we also consider that 1 horizontal well will have a high initial water cut. Taken into consideration all the previous points we determined that the Recovery Factor will be 24.75 %. To simplify the calculations and know how many wells we need, we will consider that all the wells can be drilled at the same time, but this won´t be done to our final study.

Figura 95: Graphic representation of the monthly production and cumulative production before the Drilling schedule



- **CHONTA FORMATION**
  - **Scenario 1 – base:**

In this scenario, we consider the history of the field that shows that at least there is one well with a high water cut in all campaigns. So, we considered 8 vertical wells with a low initial water cut and 1 with a high initial water cut.

EUR-VG1 x well	3255.10	*Mbls*
EUR-VG2 x well	1359.33	*Mbls*

Tabla 60: Number of Wells for Chonta Reservoir

SCENARIO	V - G1	V- G2	TOTAL	RF (%)
1	5	4	21712.838	26.49

Theoretically we estimated that our recovery factor is 40 % so, having 26% in this first scenario is not the best scenario to develop for our 30 years contract.

- **Other scenarios**

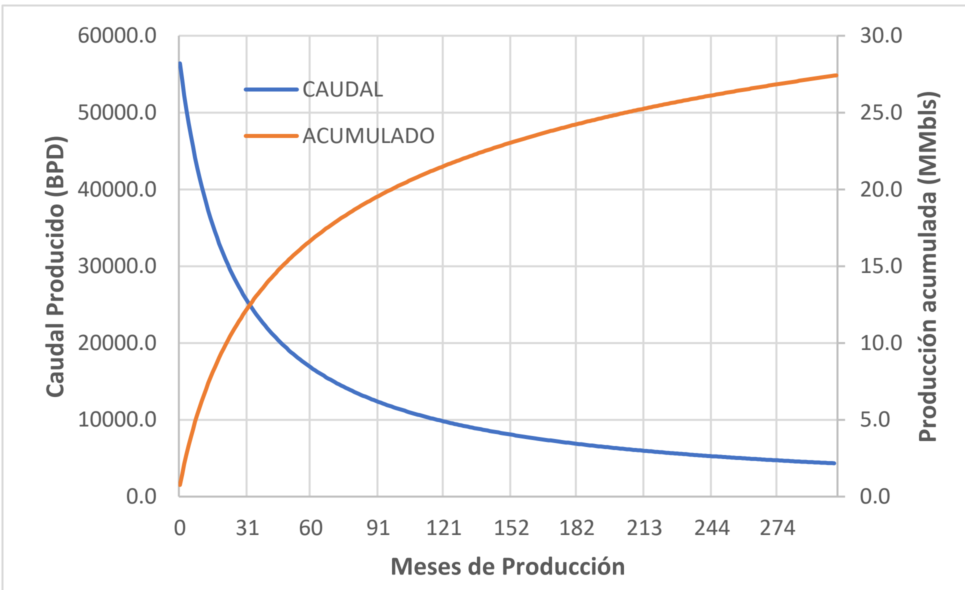
The following scenarios are done to consider the drill of horizontal wells.

Tabla 61: Different scenarios to determine the optimum R.F-Chonta Reservoir

SCENARIO	V - G1	V- G2	TOTAL	RF (%)
1	5	4	21712.838	26.49
2	8	1	27400.141	33.42
3	9	2	32014.576	39.05

We determined that Chonta reservoir can be develop efficiently with 11 vertical wells. We are considering that 2 of them will have high water cut. So, in this way we can have 39% as the recovery factor in this scenario with 25 years of exploitation.

Figura 96: Graphic representation of the monthly production and cumulative production before the Drilling schedule



DRILLING SCHEDULE

In this section we present the Drilling Schedule considering the time lapse of the drilling operation. We can estimate that our drilling campaign of wells will be finished in 3 years.

Figura 97: Drilling Schedule

POZO	TIPO	PERFORACIÓN	OBJETIVO Principal	OBJETIVO Secundario	2026 Ene	2026 Feb	2026 Mar	2026 Abr	2026 May	2026 Jun	2026 Jul	2026 Ago	2026 Set	2026 Oct	2026 Nov	2026 Dic	2027 Ene	2027 Feb	2027 Mar	2027 Abr	2027 May	2027 Jun	2027 Jul	2027 Ago	2027 Set	2027 Oct	2027 Nov	2027 Dic	2028 Ene	2028 Feb	2028 Mar	2028 Abr	2028 May	2028 Jun	2028 Jul	2028 Ago	2028 Set	2028 Oct	2028 Nov	2028 Dic	CAMPAÑA
SJN-X01: C	Exploratorio	Vertical	Chonta		X	X	X																																		
SJN-C02: C	Confirmatorio	Vertical	Chonta							X																															
SJN-C03: C	Confirmatorio	Vertical	Chonta								X																														
SJN-R01											O																														
SJN-H04: V	Desarrollo	Horizontal	Vivian													X	X																								1° CAMPAÑA
SJN-VS1:C	Desarrollo	Vertical	Chonta														X																								1° CAMPAÑA
SJN-H05: V	Desarrollo	Horizontal	Vivian														X	X																							1° CAMPAÑA
SJN-H06: V	Desarrollo	Horizontal	Vivian															X	X																						1° CAMPAÑA
SJN-H07: V	Desarrollo	Horizontal	Vivian																X	X																					1° CAMPAÑA
SJN-D01																					O																				1° CAMPAÑA
SJN-D02																																									1° CAMPAÑA
SJN-G08: C	Desarrollo	Comingle	Chonta																						X																2° CAMPAÑA
SJN-G08: V	Desarrollo	Comingle		Vivian																					X																2° CAMPAÑA
SJN-VS2:C	Desarrollo	Vertical	Chonta																						X																2° CAMPAÑA
SJN-G09: C	Desarrollo	Comingle	Chonta																							X															2° CAMPAÑA
SJN-G09: V	Desarrollo	Comingle		Vivian																						X															2° CAMPAÑA
SJN-H10: V	Desarrollo	Horizontal	Vivian																								X	X													2° CAMPAÑA
SJN-H11: V	Desarrollo	Horizontal	Vivian																									X	X												2° CAMPAÑA
SJN-H12: V	Desarrollo	Horizontal	Vivian																										X	X											2° CAMPAÑA
SJN-D03																															O										2° CAMPAÑA
SJN-D04																															O										2° CAMPAÑA
SJN-G13: C	Desarrollo	Comingle	Chonta																																X						3° CAMPAÑA
SJN-G13: V	Desarrollo	Comingle		Vivian																															X						3° CAMPAÑA
SJN-G14: C	Desarrollo	Comingle	Chonta																																	X					3° CAMPAÑA
SJN-G14: V	Desarrollo	Comingle		Vivian																																X					3° CAMPAÑA
SJN-G15: C	Desarrollo	Comingle	Chonta																																		X				3° CAMPAÑA
SJN-G15: V	Desarrollo	Comingle		Vivian																																	X				3° CAMPAÑA
SJN-V16: C	Desarrollo	Vertical	Chonta																																			X			3° CAMPAÑA
SJN-D05																																							O		3° CAMPAÑA
SJN-D06																																									3° CAMPAÑA

FORECAST

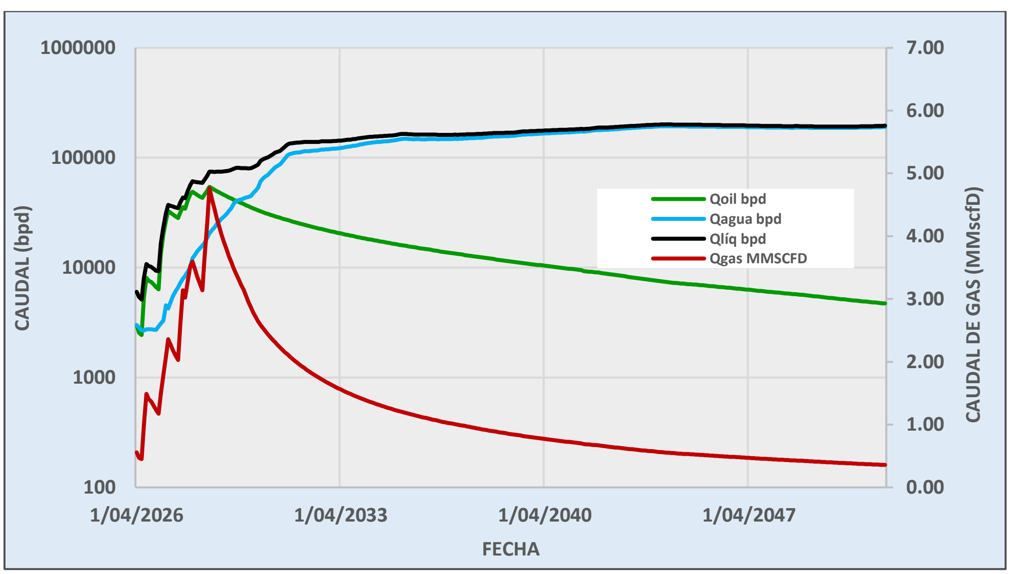
The analysis done by reservoir engineering shows the following rates for each formation and condition.

Tabla 62: Initial rates in group wells

		VIVIAN				CHONTA	
		VERTICAL		HORIZONTAL		VERTICAL	
		LOW	HIGH	LOW	HIGH	LOW	HIGH
FLOWING	Qi	1700	940	7310	4042	3000	1300
	b	0.9100	0.9200	0.9695	0.9695	0.8150	0.8370
	Dmi	0.0200	0.0150	0.0448	0.0448	0.0740	0.0800
ESP	Qi	1700		7310	4042	3000	1300
	b	0.9300		0.9790	0.9790	0.8340	0.8550
	Dmi	0.0110		0.0365	0.0365	0.0580	0.0760

The production forecast is done taken into consideration the Schedule of the drilling wells determined in the previous section.

Figura 98: Oil production forecast



CUMULATIVE OIL	143.64 MMbls
CUMULATIVE GAS	11.35 BCF

MINIMUM WORK PLAN (MWP)

The term of the contract is 30 years, counted from the Date of subscription of the Contract.

Tabla 63: Schedule of the development activities.

STAGE	TERM	ACTIVITIES
PREVIOUS STAGE	2 months	- Deadline to carry out operations. - Permit obtainment - Data acquisition
EXPLORATION	58 months	- Seismic studies - Geophysics - Core acquisition - Basic Geochemistry - Conditioning and installation of equipment for the operation of the inspection point. - Facilities - Measurement and analysis of reservoir fluids. - Drilling of exploratory well.
EXPLOITATION	25 years	- Development of drilling program. - Drilling of development wells. - Monitoring of production systems. - Reservoir simulation. - Equipment maintenance. - Recondition work. - EOR work feasibility studies. - Development of the Abandonment Plan.
TIME OF CONTRACT	**30 years**	

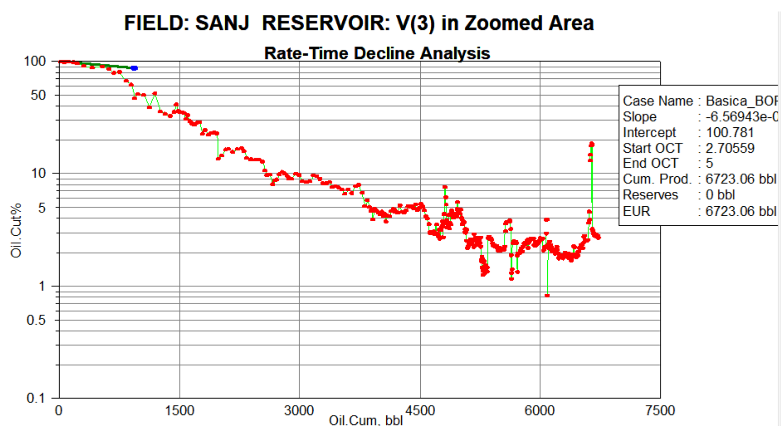
4.3.6. Aquifer Model

The studies show that both reservoirs, Vivian and Chonta, behave according to the water influx. So, in order to characterize the production of the water and have all the information necessary to do the facilities we did an aquifer model.

- **Vivian Aquifer Model**

The aquifer model was done with the diagnostic of Oil cut semi log vs Oil cumulative and we observe in the wells form all the field a point when the water irruption started. We analyzed 3 wells from San Jacinto field and that study show as the behavior of the oil cut before the irruption of the water.

Figura 99: Cumulative Oil vs Oil cut – Vivian Reservoir

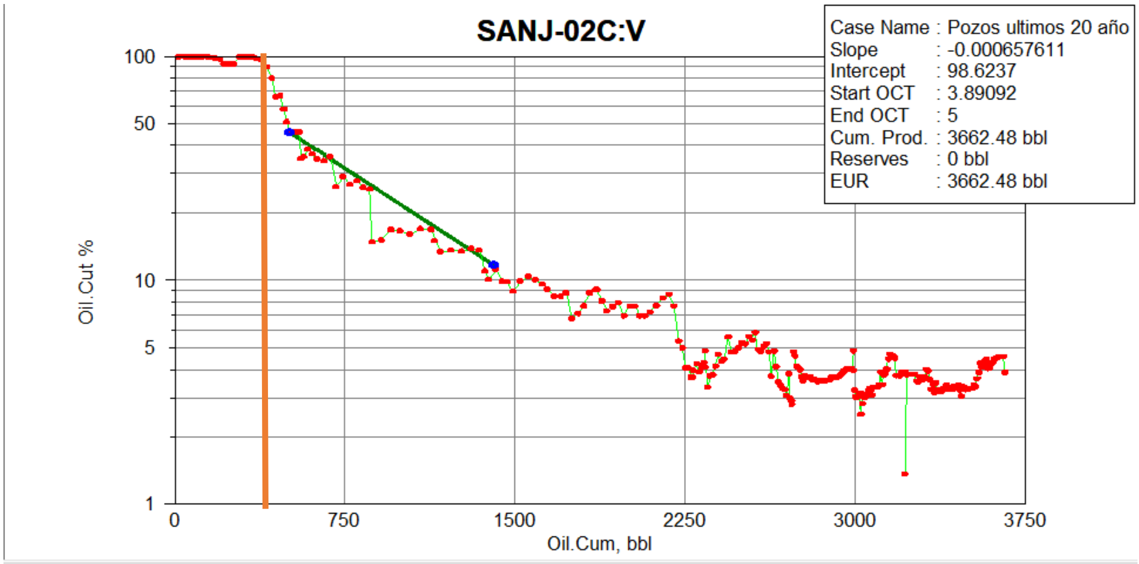


The Forecast analysis was done with the following equation that shows the behavior of the oil cut before the water irruption.

$$\log(\text{Oil. Cut}) = -6.56943e\text{-}005 * \text{Oil. Cum} + 2.00338$$

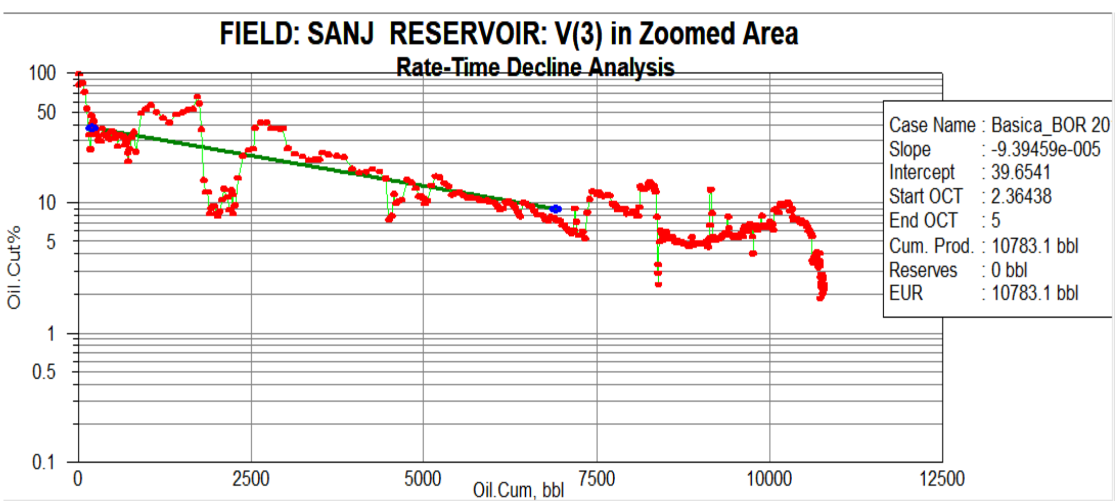
For a specific analysis, we analyzed Vivian's well 2, which at the beginning of its productive life has a 100% cut in crude oil.

Figura 100: Oil cumulative vs Oil cut for the well 2 from Vivian Reservoir



The analysis of the oil cut after the water irruption was analyzed in the wells with high production, initial oil cut lower than 100% and wells that have a good performance for a long time. The wells 4, 16 and 22 of Vivian reservoir were analyzed and the analysis show an equation of the behavior after the water irruption.

Figura 101: Cumulative oil vs. oil cut for wells 4, 16 and 22 of Vivian reservoir

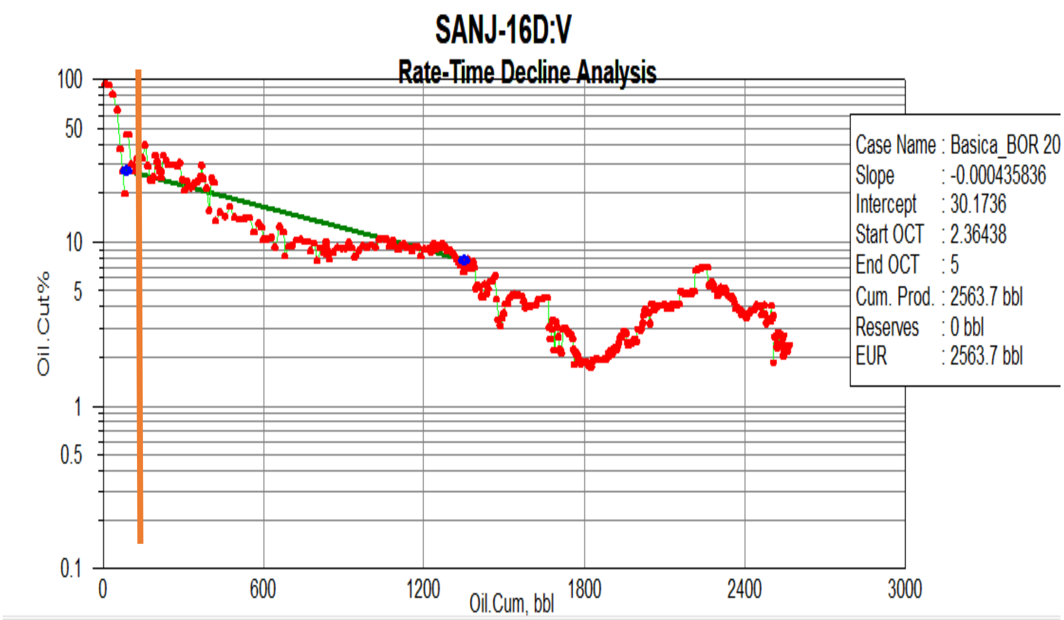


The Forecast analysis was done with the following equation that shows the behavior of the oil cut after the water irruption.

log (Oil. Cut) = -9.39459e-005 * Oil. Cum + 1.59829

The analysis was done based on the well 16 that has 50% of oil cut in its initial productive life and this oil cut decreases with the production of the well.

Figura 102 Oil cumulative vs Oil cut for the well 16- Vivian Reservoir



We determined the critic rate with 2 formulas, and we used correlation, after that, if the software does not give us a good behavior, we will use those analysis to determine the critic rate.

- **Meyer and Garder Method**

$$q_c = \frac{0.001535(\rho_w - \rho_o)k(h^2 - D^2)}{\mu_o B_o \ln\left(\frac{r_e}{r_w}\right)}$$

Qc	3.250259793
dw	1
do	0.98
k	2000
h	189
D	45
uo	71
bo	1.088
re	1258
rw	0.34

Qc= 3.25 BOPD

- **Kuo and Desbrisay Method**

A	8.51
B	0.81
C	0.76
Qc	5.31

$$q_c = (A)(B)(C)$$

$$A = \frac{(\rho_w - \rho_o) k (h^2 - D^2)}{2049 \mu_o B_o} \qquad C = \left(\frac{h}{r_e}\right)^{0.14}$$

$$B = 0.432 + \frac{\pi}{\ln\left(\frac{r_e}{r_w}\right)}$$

Qc= 5.8 BOPD

We realize that as soon as the productive life of a well in the Vivian reservoir begins, it will be affected by the aquifer, but working at a flow rate of 5.8 BOPD would not pay for the investment. Interpretation from the production graphic of the Oil cut variation:

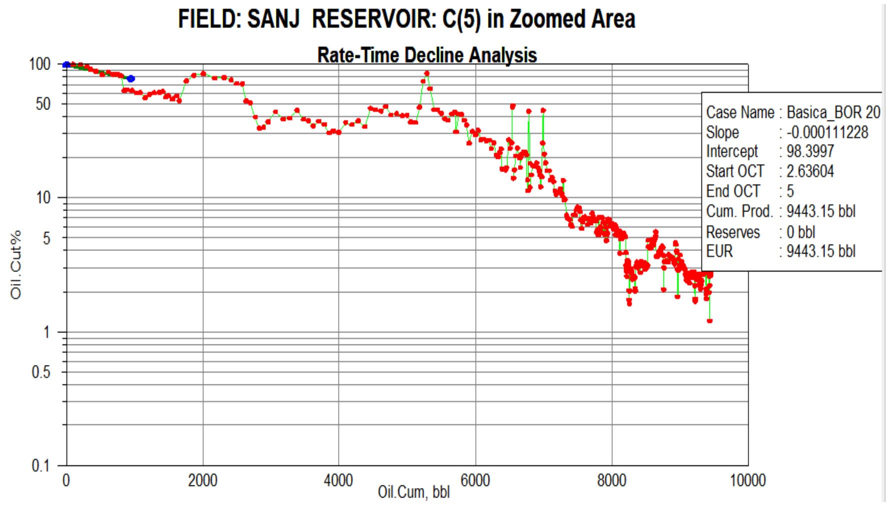
Oil cut (100 %)	From	To
	15/01/1981	15/06/1982

It is preferred to handle volumes of water, that is, try not to stop the coning, as it is uneconomical. Because by doing that the rate of oil is decreased. Water management is profitable with the oil production proposal.

- **Chonta aquifer Model**

We analyzed the wells from Chonta reservoir that has a representative oil cut before the water irruption. These wells are well 8, 11, 12, 13 and 20. After that, we did the forecast.

Figura 103: Oil cumulative vs Oil cut for wells 8, 11, 12, 13 and 20 – Chonta reservoir

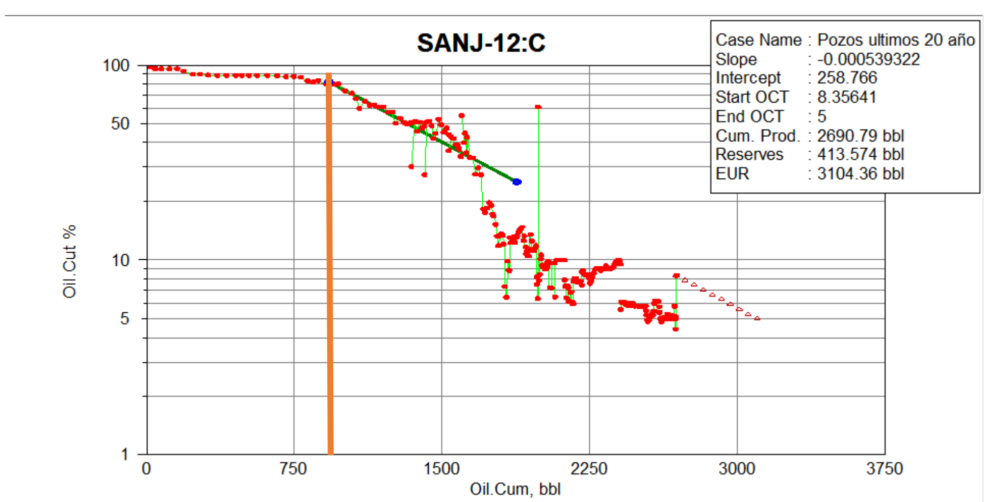


The Forecast analysis was done with the following equation that shows the behavior of the oil cut before the water irruption.

log (Oil. Cut) = -0.000111228 * Oil. Cum + 1.99299

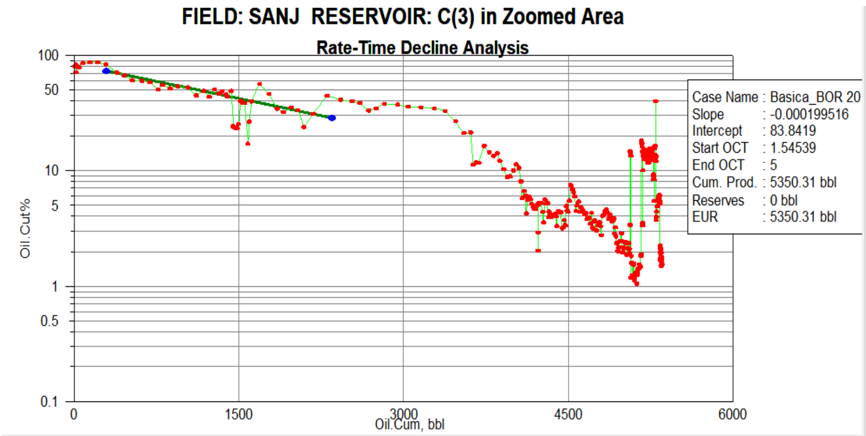
For a specific analysis, we analyzed Chonta's well 12, which at the beginning of its productive life has a 100% cut in crude oil. The study of the oil cut forecast vs the oil cumulative shows that the production of water will not delay too long.

Figura 104: Oil cumulative vs Oil cut for Well 12 – Chonta Reservoir



The analysis of the oil cut after the water irruption was analyzed in the wells with high production, initial oil cut lower than 100% and wells that have a good performance for a long time. All the wells from Chonta were studied and the analysis show an equation of the behavior after the water irruption.

Figura 105: Oil cumulative vs Oil cut for Well 3 – Chonta Reservoir

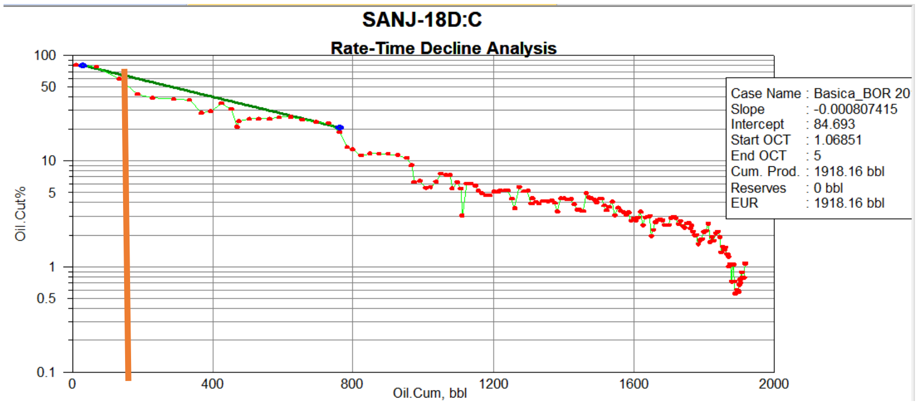


The Forecast analysis was done with the following equation that shows the behavior of the oil cut after the water irruption.

$$\log(\text{Oil. Cut}) = -0.000199516 * \text{Oil. Cum} + 1.92346$$

The analysis was done based on the well 18 that has 50% of oil cut in its initial productive life and this oil cut decreases with the production of the well.

Figura 106: Oil cumulative vs Oil cut for Well 18 – Chonta Reservoir



We determined the critic rate with 2 formulas, and we used correlation, after that, if the software does not give us a good behavior, we will use those analysis to determine the critic rate.

An extra analysis was done in order to determine a critic rate:

Meyer and Garder Method

$$q_c = \frac{0.001535(\rho_w - \rho_o)k(h^2 - D^2)}{\mu_o B_o \ln\left(\frac{r_e}{r_w}\right)}$$

Qc= 26.34 BOPD

Qc	26.34
dw	1
do	0.86
k	200
h	91
D	11
uo	1.41
bo	1.149
re	1258
rw	0.34

Kuo and Desbrisay Method

$$q_c = (A)(B)(C)$$

$$A = \frac{(\rho_w - \rho_o)k(h^2 - D^2)}{2049\mu_o B_o}$$

$$C = \left(\frac{h}{r_e}\right)^{0.14}$$

$$B = 0.432 + \frac{\pi}{\ln\left(\frac{r_e}{r_w}\right)}$$

A	68.82
B	0.814
C	0.69
Qc	38.8

Qc= 38.8 BOPD

Interpretation from the production graphic of the Oil cut variation:

	From	To
Oil cut (100 %)	15/01/1980	15/09/1980

Chonta reservoir will not have problems related with the water production in approximately the first 8 months of operations.

It is preferred to handle volumes of water, that is, try not to stop the coning, as it is uneconomical. Because by doing that the rate of oil is decreased. Water management is profitable with the oil production proposal.

4.3.6.1. MECHANISM TO DETECT THE EXCESICE WATER PRODUCTION.

The experience of the development of wells in the Peruvian jungle shows that these wells tend to have high water cut in its lifetime. There are many problems related to it, such as coning, canalization of multilayers and canalization near the well. The identification of these problems would be important to understand the rate of production and plan different services related to water control.

The studies related to water control and the identification of water problems in the wells were done based on the paper named Water Control Diagnostic Plots. This method is based on the plot of Time vs WOR (water oil ratio), the derivation of the WOR and the comparison of it with a graphic of the behavior of some problem related with water.

The wells 12 and 8 were used to characterize the water problems in Chonta reservoir and the well 2 was used to characterize the water problems in Vivian reservoir. We chose these wells because the location of them and their history production make them the most representative. The comparison of these wells with Chan diagnostic are shown in the following lines.

Chan Diagnostic for Chonta reservoir- San Jacinto

Figura 107: WOR and WOR', well 12,Chonta

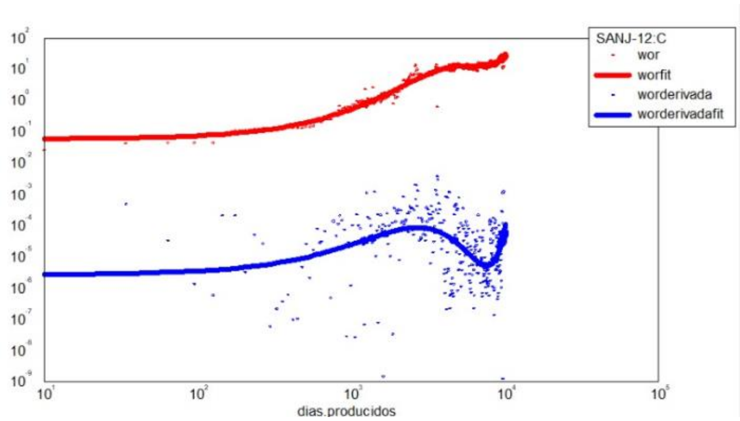


Figura 108: WOR and WOR' of Chan diagnostic

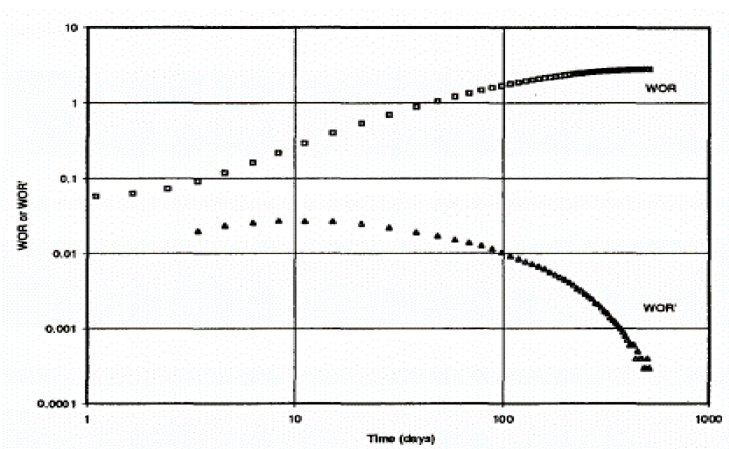


Figura 109: WOR and WOR' well 1, Chonta reservoir

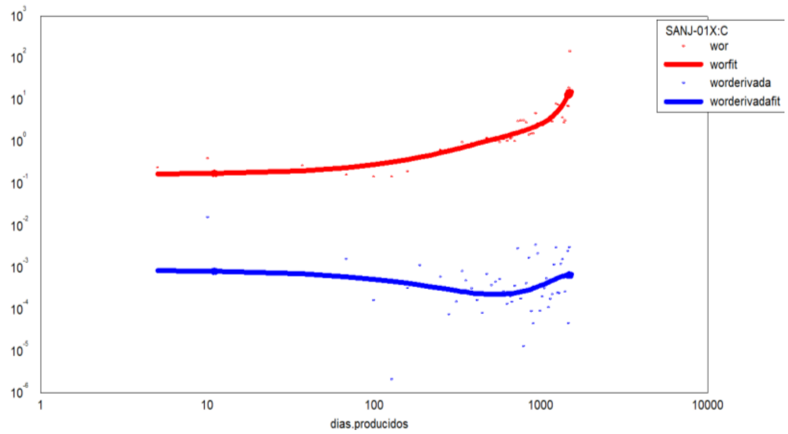


Figura 110: WOR and WOR' of Chan diagnostic

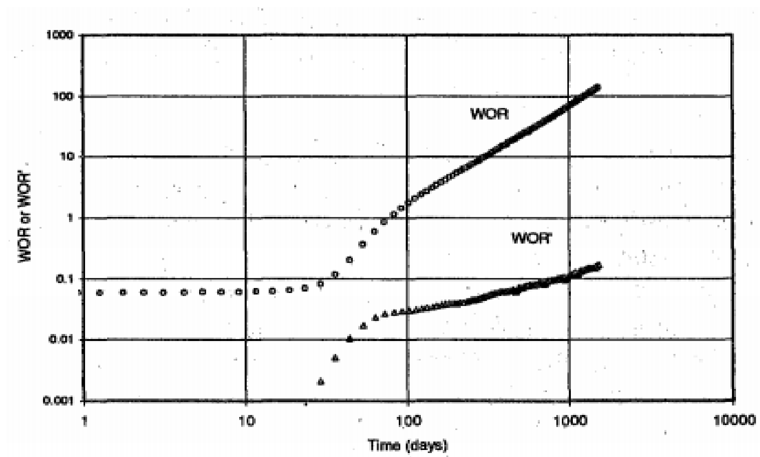


Figura 111: WOR y WOR' well 19, Chonta reservoir

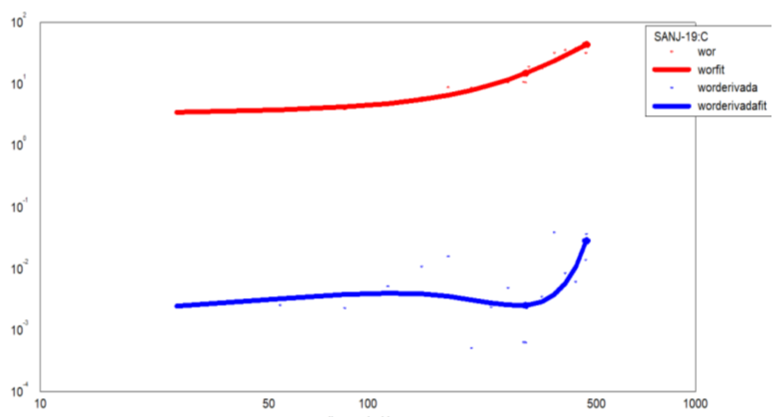


Figura 112: WOR and WOR’ of Chan diagnostic

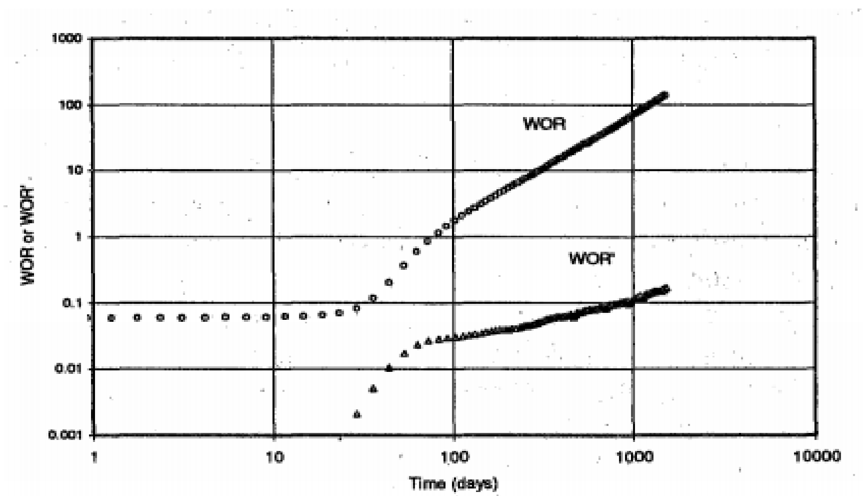


Figura 113: WOR y WOR’ well 10, Chonta reservoir

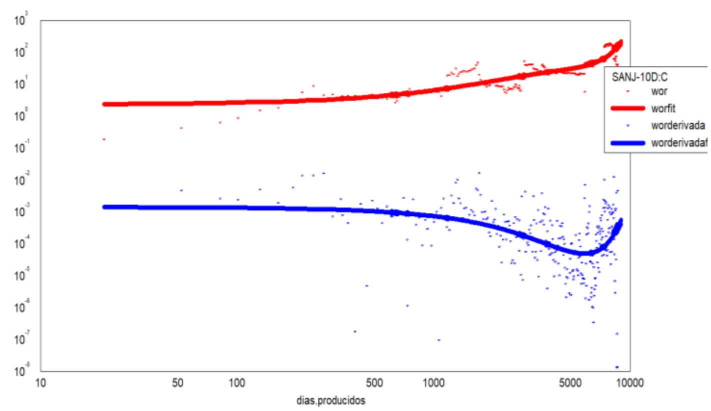
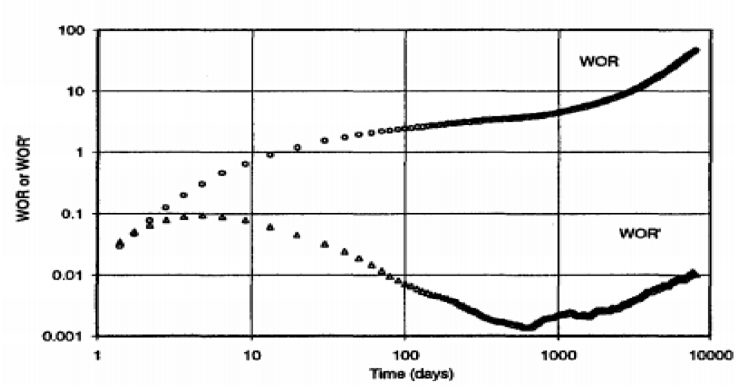


Figura 114: WOR and WOR’ of Chan diagnostic



According with Chang interpretation, we can infer that the zone near of the wells 12, 1, 19 and 10 for Chonta reservoir has aquifer problems in flanks.

Chan Diagnostic for Vivian reservoir- San Jacinto

Figura 115: WOR and WOR'well 02- Vivian reservoir

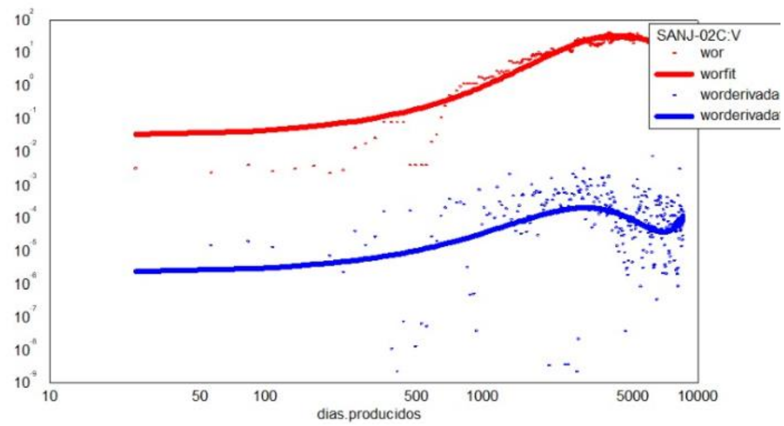


Figura 116: WOR and WOR' of Chan diagnostic

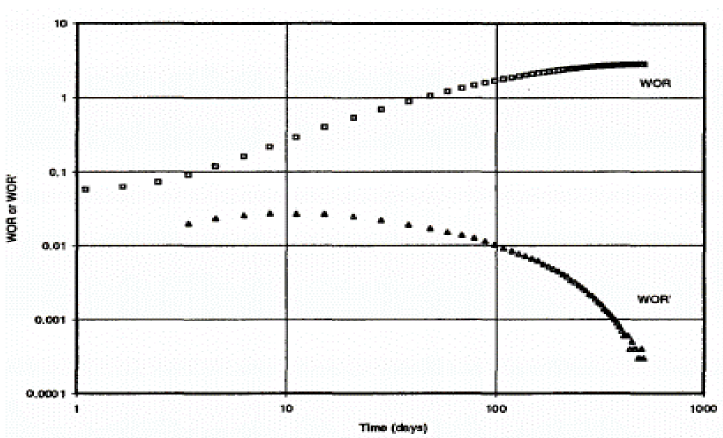


Figura 117: WOR and WOR'well 01- Vivian reservoir

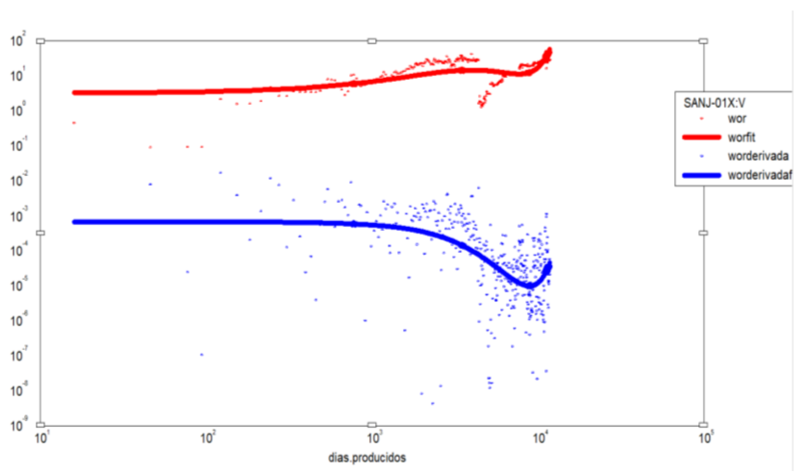
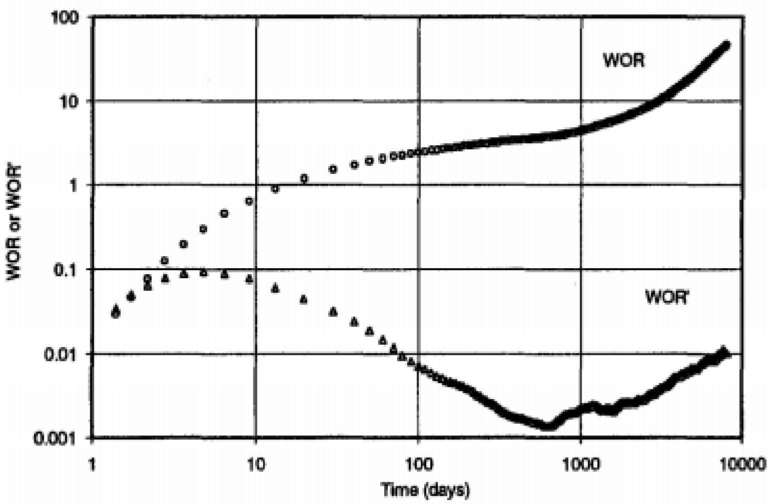


Figura 118: WOR and WOR' of Chan diagnostic



According with Chang interpretation, we can infer that the zone near of the wells 01 and 02 for Vivian reservoir has aquifer problems in flanks.

4.3.7. Inflow Relationship Performance

In this section we chose a representative well in Vivian and Chonta reservoirs and we used Excel to determine the Inflow Performance Relationship (IPR). This analysis is important because it helped us to determine a better forecast production for each reservoir. We did the study considering 4 IPR's curves, 2 of them for Vivian the others two for Chonta. These two curves are divided into well of vertical and horizontal behavior.

4.3.7.1. Vivian case

- **Vertical Inflow Relationship Performance**

We analyzed flowing wells with 0% of water cut.

h	100 ft
K	2000 md
uo	71 cp
Bo	1.088 (Bbls/STB)
rw	0.708 ft
re	1488 ft

Formula:

$$J = \frac{Qo}{Pr - Pwf}$$

$$J = \frac{0.00708xKxH}{UoxBox[\left(Ln\frac{re}{rw}\right) - 0.75 + s]}$$

$$= 2.65\frac{STB}{day}/psi$$

Figura 119 : IPR of the First Well – Vivian reservoir

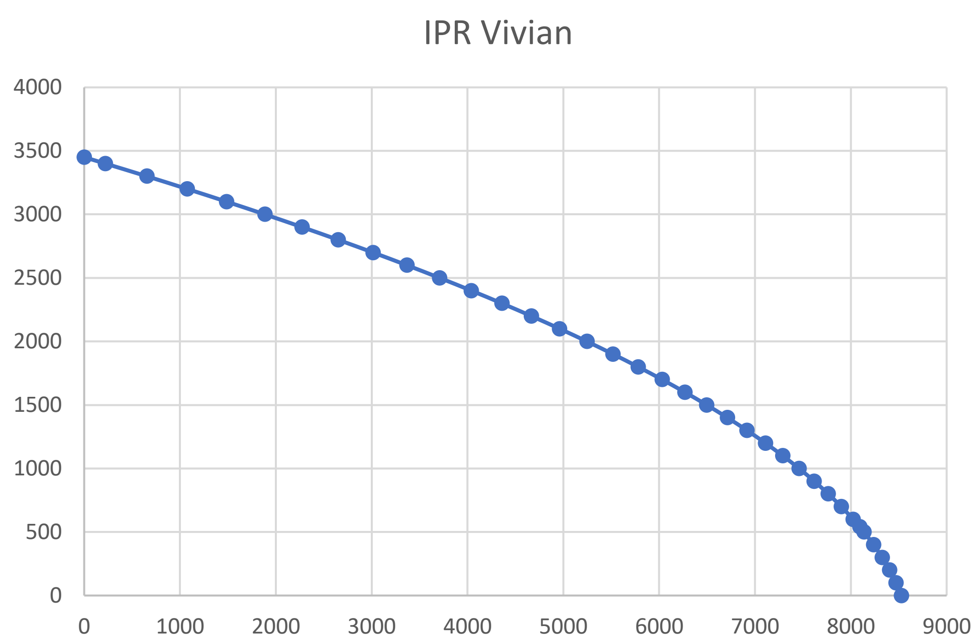


Tabla 64: IPR values of the First Well – Vivian reservoir

Pwf(psi)	Q(STB/day)
3450	0
3400	132.820616
3300	398.461849
3200	664.103082
3100	929.744314
3000	1195.38555
2900	1461.02678
2800	1726.66801
2700	1992.30924
2600	2257.95048
2500	2523.59171
2400	2789.23294
2300	3054.87418
2200	3320.51541
2100	3586.15664
2000	3851.79787
1900	4117.43911
1800	4383.08034
1700	4648.72157
1600	4914.3628
1500	5180.00404
1400	5445.64527
1300	5711.2865
1200	5976.92773
1100	6242.56897
1000	6508.2102
900	6773.85143
800	7039.49266
700	7305.1339
600	7570.77513
540	7730.15987
500	8136.6395
400	8237.65347
300	8327.20486
200	8405.29367
100	8471.91991
0	8527.08357

- **Horizontal Inflow Relationship Performance**

We predicted the behavior of the horizontal wells with Joshi correlations that helps us to compare the behavior of vertical and horizontal wells.

We analyzed flowing wells with 0% of water cut.

Kh	2000 md
uo	71 cp
Bo	1.088 (Bbls/STB)
Reh	2000.18056 ft
L	2500 ft
h	300 ft
rw	0.708 ft
B	1386.17

Formulas:

$$Jh = \frac{0.00708xHxKh}{UoxBo[\ln(R) + (\frac{B^2h}{L})\ln(\frac{h}{2rw})}$$

$$A = \frac{pixaxb}{43560}$$

$$Reh = \sqrt{\frac{43560xA}{pi}}$$

$$B = \sqrt{\frac{Kh}{Kv}}$$

$$R = \frac{a + \sqrt{a^2 - (\frac{L}{2})^2}}{(L/2)}$$

$$J = 4.427\frac{STB}{day}/psi$$

Figura 120: IPR of the second well – Vivian reservoir

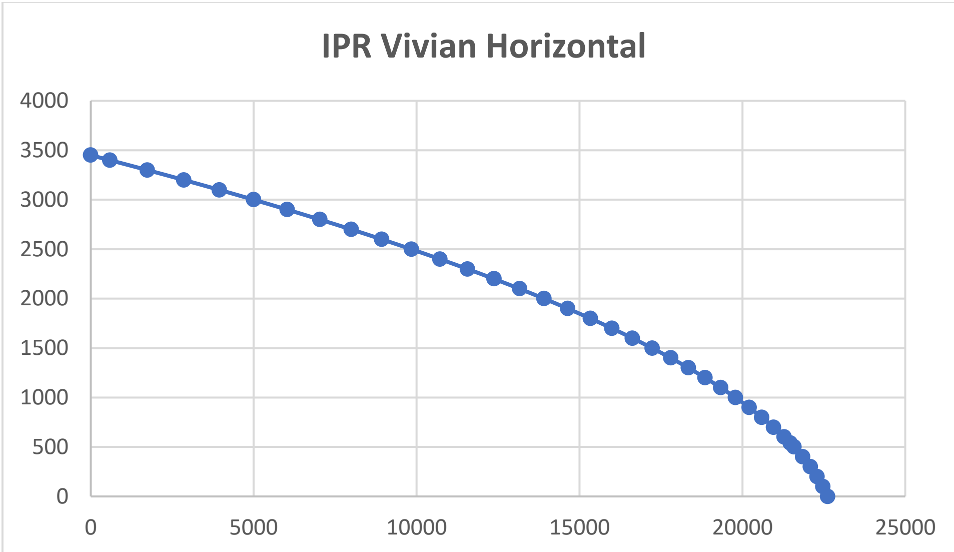


Tabla 65: IPR values of the second well – Vivian reservoir

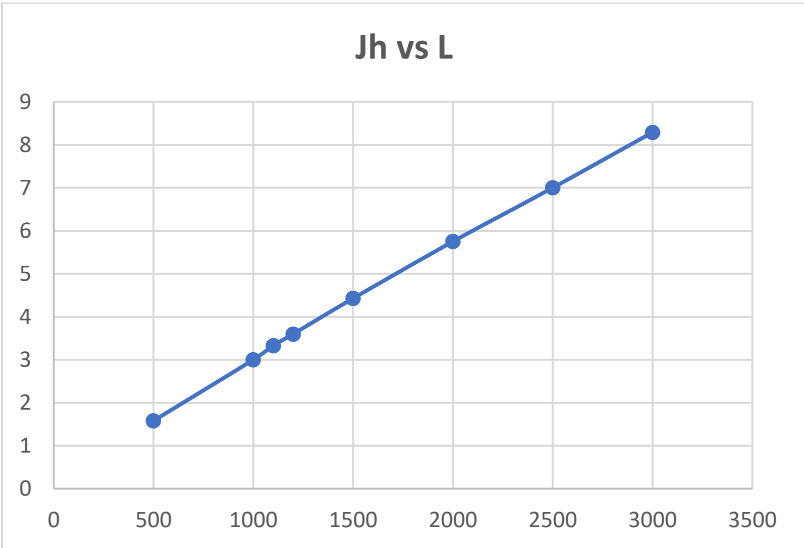
Pwf(psi)	Q(STB/day)
3450	0
3400	352.293259
3300	1056.87978
3200	1761.4663
3100	2466.05282
3000	3170.63933
2900	3875.22585
2800	4579.81237
2700	5284.39889
2600	5988.98541
2500	6693.57193
2400	7398.15845
2300	8102.74497
2200	8807.33149
2100	9511.918
2000	10216.5045
1900	10921.091
1800	11625.6776
1700	12330.2641
1600	13034.8506
1500	13739.4371
1400	14444.0236
1300	15148.6102
1200	15853.1967
1100	16557.7832
1000	17262.3697
900	17966.9562
800	18671.5428
700	19376.1293
600	20080.7158

540	21465.9292
500	21581.6138
400	21849.5432
300	22087.0692
200	22294.1919
100	22470.9112
0	22617.2273

We made a model with the productivity index vs length in order to have a good result for the horizontal well extension.

L(ft)	Jh
500	1.45
1000	2.31
1100	2.46
1200	3.6
1500	4.427
2000	5.75
2500	7
3000	8.29

Figura 121 Jh vs L Diagram



We used a length of 1000 ft because the good results of these wells in previous studies, this value shows that the productivity index does not change so much.

4.3.7.2. Chonta case

- **Vertical Inflow Relationship Performance**

We analyzed flowing wells with 0% of water cut.

H	70 ft
K	200 md
Uo	1.41 cp
Bo	1.149 (Bbls/STB)
Rw	0.708 ft
Re	1379 ft

$$J = \frac{Qo}{Pr - Pwf}$$

$$J = \frac{0.00708xKxH}{UoxBox[\left(Ln\frac{re}{rw}\right) - 0.75 + s]}$$

$$J = 12.807\frac{STB}{day}/psi$$

Figura 122: IPR vertical well Chonta

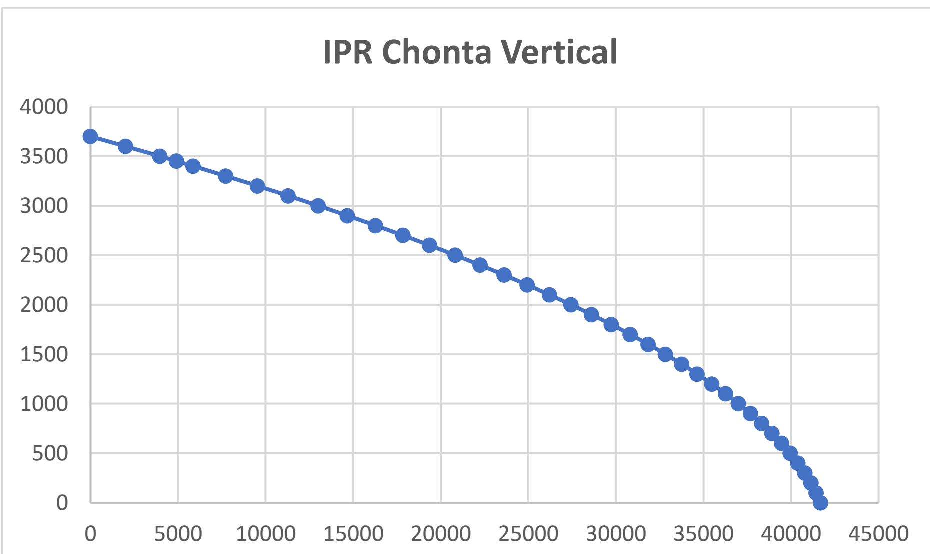


Tabla 66: IPR values of vertical well Chonta

Pwf(psi)	Q(STB/day)
3700	0
3600	1280.73136
3500	2561.46271
3450	3201.82839
3400	3842.19407
3300	5122.92543
3200	6403.65678
3100	7684.38814
3000	8965.1195
2900	10245.8509
2800	11526.5822
2700	12807.3136
2600	14088.0449
2500	15368.7763
2400	16649.5076
2300	17930.239
2200	19210.9704
2100	20491.7017
2000	21772.4331
1900	23053.1644
1800	24333.8958
1700	25614.6271
1600	26895.3585
1500	28176.0899
1400	29456.8212
1300	30737.5526
1200	32018.2839
1100	33299.0153
1000	34579.7466
900	37692.9394
800	38332.5255
700	38923.3812
600	39465.5065
500	39958.9015
400	40403.5661
300	40799.5003
200	41146.7042
100	41445.1777
0	41694.9208

- **Horizontal Inflow Relationship Performance**

We predicted the behavior of the horizontal wells with Joshi correlations that helps us to compare the behavior of vertical and horizontal wells.

We analyzed flowing wells with 0% of water cut.

$$Jh = \frac{0.00708xHxKh}{UoxBo[\ln(R) + (\frac{B^2h}{L})\ln(\frac{h}{2r})}$$

$$A = \frac{pixaxb}{43560}$$

$$Reh = \sqrt{\frac{43560xA}{pi}}$$

$$B = \sqrt{\frac{Kh}{Kv}}$$

$$R = \frac{a + \sqrt{a^2 - (\frac{L}{2})^2}}{(L/2)}$$

$$J = 21\frac{STB}{day}/psi$$

We used a length of 2500 ft because the good results of these wells in previous studies, this value shows that the productivity index does not change so much.

4.3.8. Well Location

During the beginning of the development of our field, we proposed a first solution in the selection of the number of wells to be drilled, which consisted in the drilling of vertical wells because it is economically but socially unviable since we are located in the Peruvian jungle and making the drilling operations in different location can cause problems with people living in that area. For that reason, we evaluate a better solution in the extraction of oil in our field with the location of horizontal wells, which will be able to extract much crude and reduce the number of wells, making more economically viable this alternative solution.

In addition to these parameters to consider, we located the first 3 wells that goes through the two formations, the first well is an exploratory well and wells 2 and 3 are confirmatory wells to take more exact measurements of our reservoirs, thus making more economical the development of the reservoirs and their subsequent study.

Tabla 67: Reservoir Data

San Jacinto Oriental	V-G1	H-G1	V-G2	H-G2	TOTAL	RF (%)
Vivian	5	6	0	1	110361.182	24.75
Chonta	9	0	2	0	32014.5756	39.05

Tabla 68. Number of wells predicted – Vivian Reservoir.

# Wells	12

Tabla 69. Number of wells predicted – Chonta Reservoir.

# Wells	11

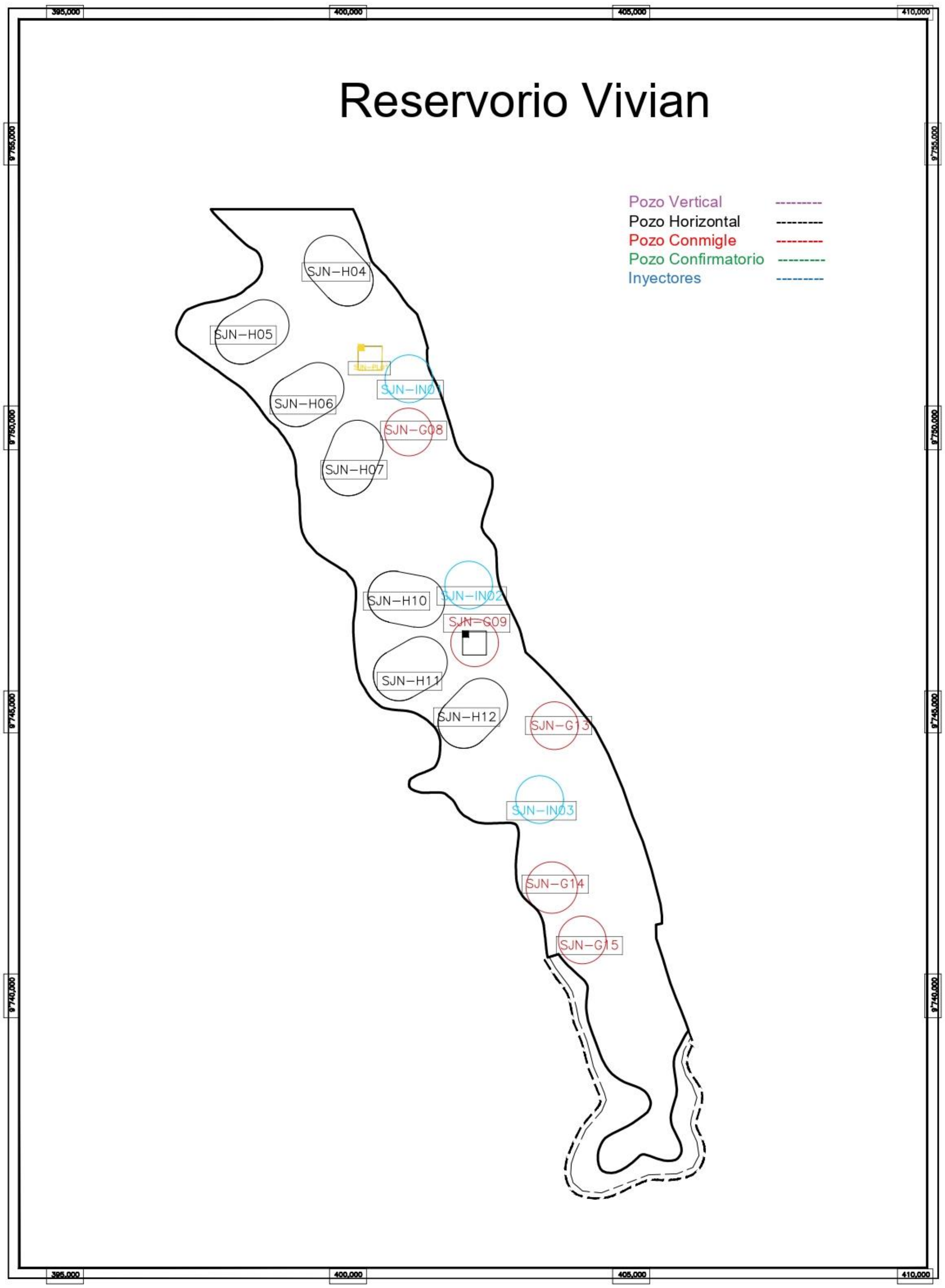
We used the previous calculations, the drainage radius for vertical and horizontal wells and the stratigraphic maps to locate the best place to drill the wells.

- **Vivian Formation:**

Tabla 70: Vivian formation coordinates

GEOGRAPHIC COORDINATES			
WELL	LATITUDE	LONGITUDE	ELEVATION
SJN-H04	2°14'50.10"S	75°52'8.63"O	189
SJN-H05	2°15'12.23"S	75°52'52.07"O	198
SJN-H06	2°15'49.33"S	75°52'23.67"O	191
SJN-H07	2°16'20.18"S	75°52'1.56"O	199
SJN-G08	2°16'15.51"S	75°51'36.62"O	199
SJN-G09	2°18'16.48"S	75°51'2.36"O	200
SJN-H10	2°17'52.83"S	75°51'30.92"O	199
SJN-H11	2°18'25.05"S	75°51'29.21"O	202
SJN-H12	2°18'50.29"S	75°50'56.07"O	192
SJN-G13	2°19'4.79"S	75°50'20.59"O	197
SJN-G14	2°20'37.74"S	75°50'21.95"O	177
SJN-G15	2°21'6.39"S	75°50'5.83"O	172

Figura 123: Well distribution – Vivian Formation

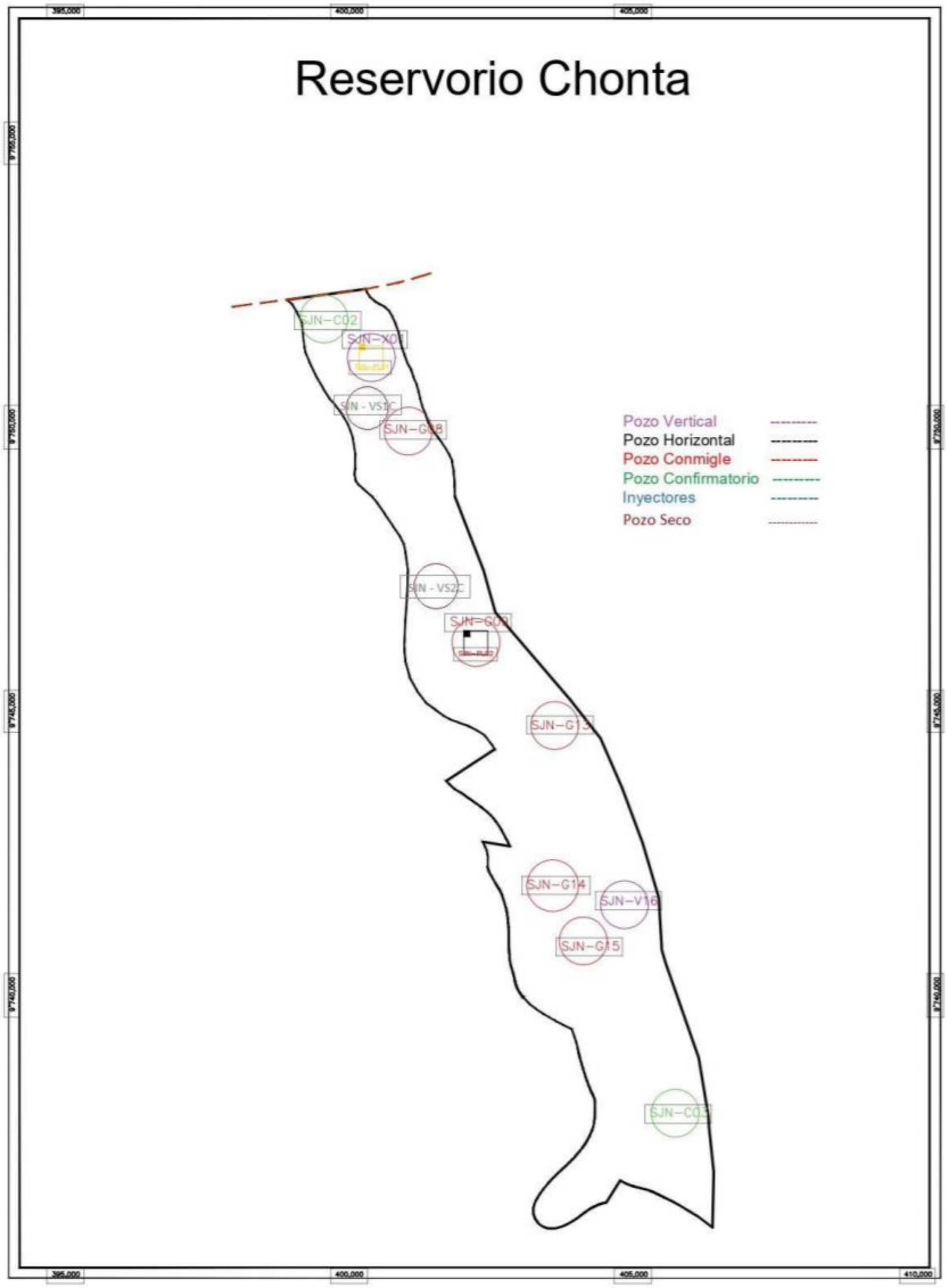


- **Chonta Formation**

Tabla 71: Chonta Formation Coordinates

WELL	SOUTH	WEST	ELEVATION (m)
SJN-X01	2°15'34.17"S	75°51'56.72"O	194
SJN-C02	2°15'12.47"S	75°52'21.18"O	202
SJN-C03	2°22'46.77"	75°49'18.37"O	172
SJN-VS1C	2°16'15.51"S	75°50'30.18"O	185
SJN-G08	2°16'12.34"S	75°51'36.62"O	199
SJN-VS2C	2°17'5.45"S	75°51'26.22"O	191
SJN-G09	2°18'16.48"S	75°51'2.36"O	200
SJN-G13	2°19'4.79"S	75°50'20.59"O	197
SJN-G14	2°20'37.74"S	75°50'21.95"O	177
SJN-G15	2°21'6.39"S	75°50'5.83"O	172
SJN-V16	2°20'47.62"S	75°49'44.66"O	190

Figura 124: Well distribution – Chonta Formation



4.3.9. Reservoir Simulation

The simulation has to be done through a static and dynamic model, so we are going to prioritize the modeling of a small reservoir to see the purpose of how these wells act with the petrophysical, rock-fluid properties, but it is not the modeling of the San Jacinto field. Oriental because we do not have the modeling of a structural map in the CMG program, nor the porosity and thickness that gives a specific value of each cell of the field, so we worked with a simulation model of 14 * 6 * 3 orthogonal.

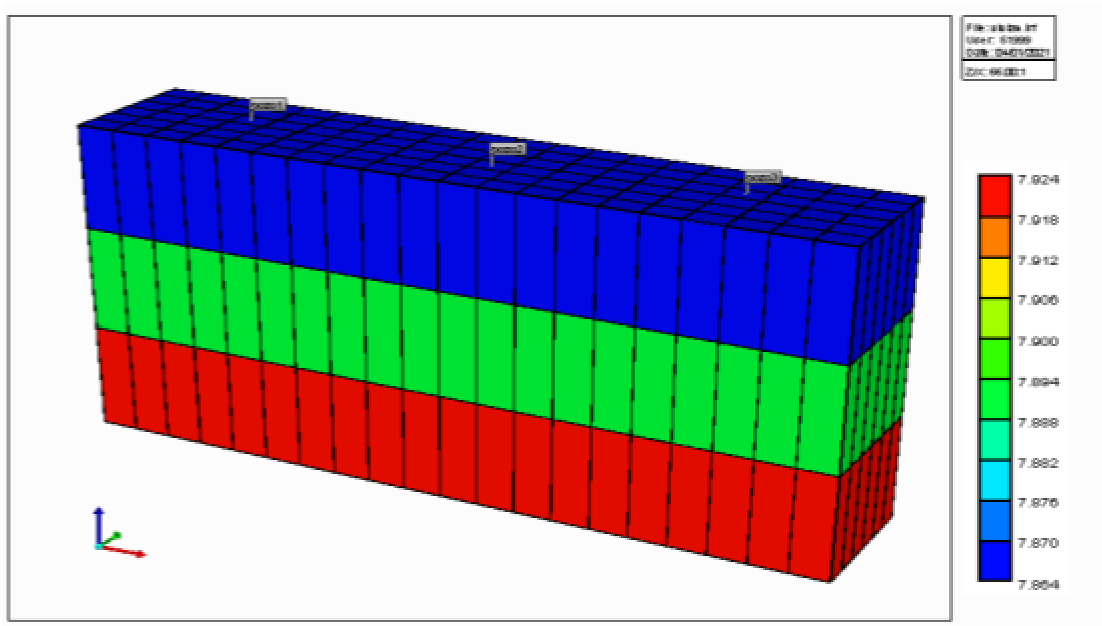
VIVIAN CASE:

The 3 wells of Vivian case were modeled base on the petrophysical properties and correlations for relative permeabilities. We used the CMG simulator to analyze different situation and the behavior of the future wells to be drilled.

Tabla 72: Model Data of Vivian

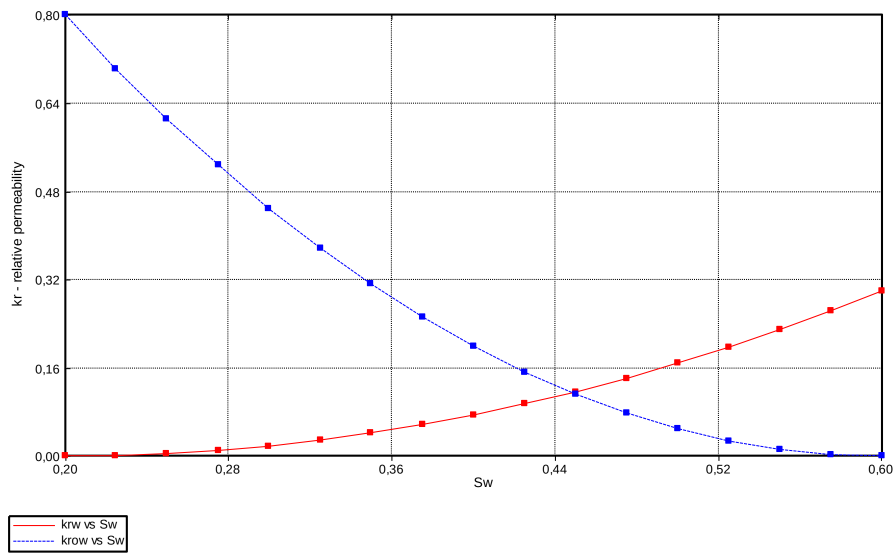
Top	7788 ft
Bottom	7977 ft
Net pay	45 ft
Reservoir pressure	3450 psi
Temperature	225 F
Porosity	0.183
Swi	0.317
Permeability	2000 md

Figura 125 Grid top model developed for Vivian reservoir



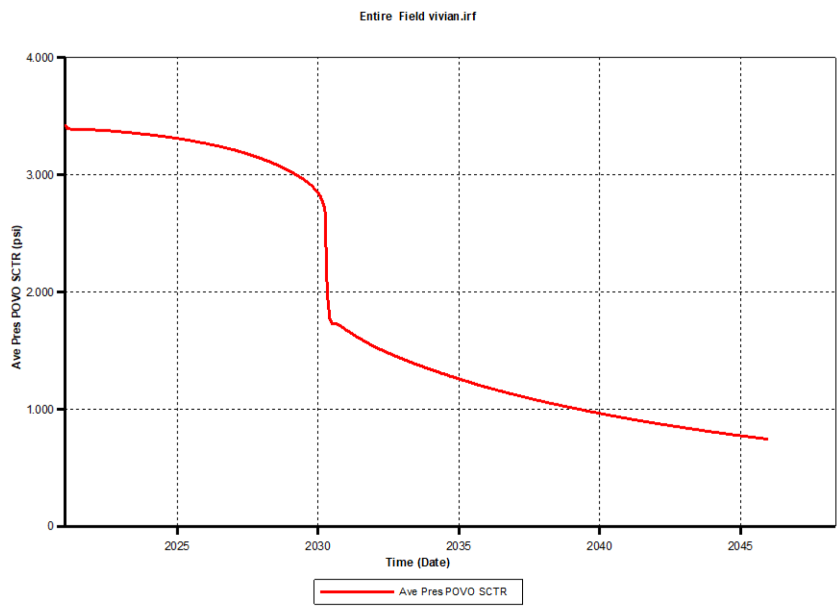
Design of relative permeability:

Figura 126: Relative permeability for Vivian formation



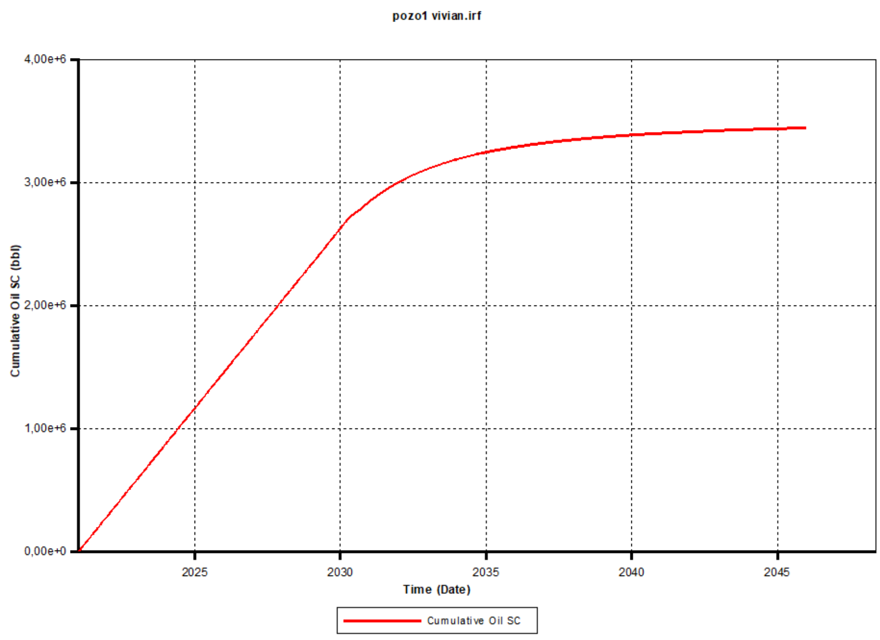
In this case we develop 3 wells for 25 years with an aquifer model that is located in the bottom of the reservoir, in the following lines we show one representative well of the model.

Figura 127: 25 years declination graphic of Vivian reservoir



The result of the simulation for the Well 1 in Vivian gives a number of 3.5 MMbls as the cumulative production in 25 years.

Figura 128: Oil cumulative – Vivian reservoir



CHONTA CASE:

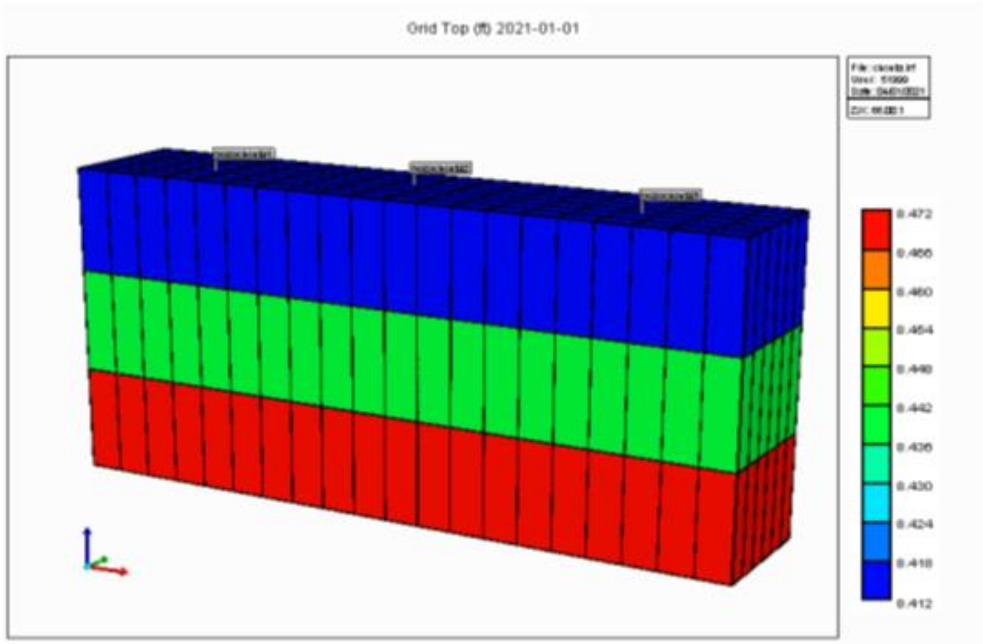
The model for Chonta was done in the same way as Vivian with an orthogonal grid of 14*6*3 with 3 wells in it which produce for 25 years and have a bottom aquifer behavior according the Chang curve analysis.

Tabla 73: Model Data for Chonta

Top	8412 ft
Bottom	8503 ft
Net pay	12 ft
Reservoir pressure	3700 psi
Temperature	240 F
Porosity	0.2
Swi	0.25
Permeability	200 md

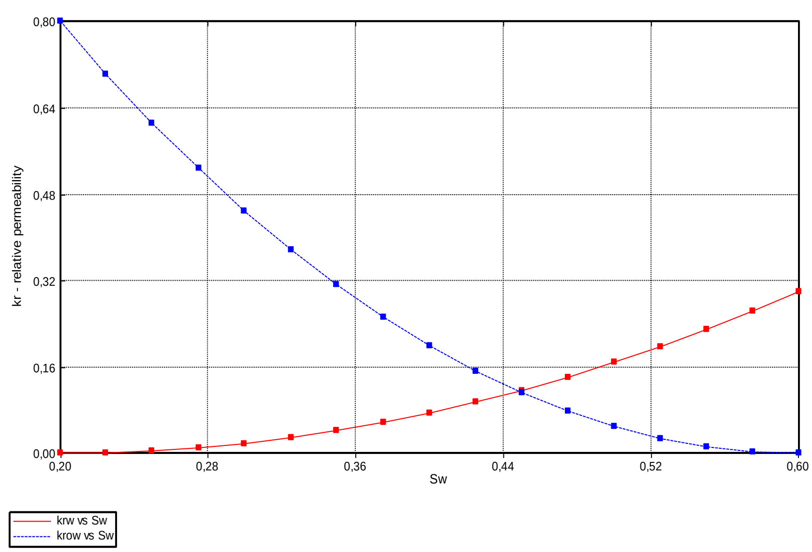
The simulation model of Chonta reservoir was done just as an example for the wells that produce from this reservoir.

Figura 129 Grid top – Chonta reservoir



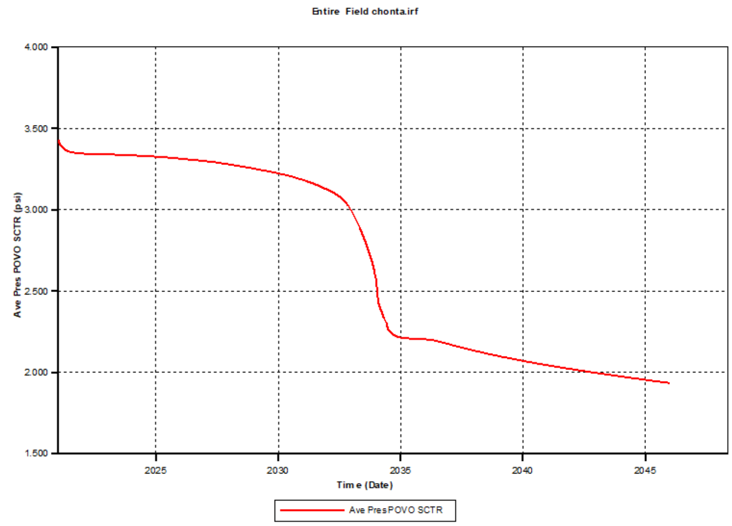
Design of relative permeability with correlations:

Figura 130: Relative permeability plot for Chonta reservoir



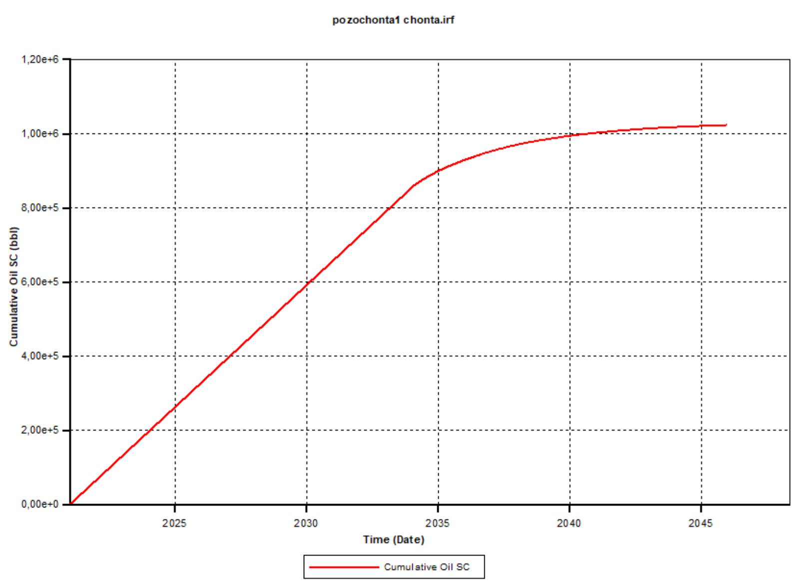
In this case we develop 3 wells for 25 years with an aquifer model that is located in the bottom of the reservoir, in the following lines we show one representative well of the model.

Figura 131: 25 years declination graphic of Chonta reservoir



The result of the simulation for the Well 1 in Chonta gives a number of 1.05 MMbls as the cumulative production in 25 years.

Figura 132: Cumulative Oil – Chonta reservoir



The simulation in this section was done just for an example case and won't be representative since there is not a static and dynamic model prepared for Vivian and Chonta reservoir. The simulation model will be a proposal to be done for a better understanding of the reservoirs.

4.3.10. Reserves Classification

4.3.10.1. Valorization of Hydrocarbon fields

Investors, operators, and the government have an interest in the valuation of properties, so the valorization (Appraisal) is carried out in two basic ways:

Reserves and Cash Flow

Figura 133: Properties valorization

Source: PRMS / own elaboration

Which leads to the question: How much oil and gas will be produced and how much money am I going to make? Reason why a definition of RESERVES is necessary with the following premises. Most of the parameters that define a reservoir's reserves cannot be measured directly and must be determined indirectly through analysis and interpretation of reservoir geology and engineering. Leading to the estimation of reserves that has an associated uncertainty. The Definitions of Reserves were designed to promote uniformity and a standardized measure of the asset, promoting a structure to quantify risk and uncertainty through its categorization.

4.3.10.2. Reserves and resources definition

Figura 134: Reserves and resources definition

Figura 135: Yacimiento – Resources - Reserves

Source: PRMS / Own Elaboration

Tabla 74: Project Maturity Stage

Maturity stage of a Project
1.- Exploration:
1.1.- Before exploratory well
a) Play
b) Lead
1.2.- After exploratory
a) Prospect
b) Not viable development
c) Not clear development
d) Pending development
2.-Development Stage:
2.1.- Justified for Development
2.2.- Approved for Development
3.- Production

Fuente: PRMS / Own Elaboration

4.3.10.3. Reserves

They are the amounts of hydrocarbon that are expected to be commercially recovered from a given date. Like all estimates in reserves, there is a certain degree of uncertainty, which will depend mainly on the quantity and quality of the geological and engineering information available when making the estimates, and on the interpretation of the information.

The quantity of reserves depends on:

- Complexity of reservoirs.
- Development stage.
- Degree of depletion.
- Amount of data available.
- Economic and regulatory conditions.

4.3.10.4. Resources

Estimated volumes of potentially recoverable hydrocarbons. They may be:

4.3.10.4.1. Contingent Resources:

Potentially recoverable volumes of known accumulations, but to date are not considered commercially recoverable.

4.3.10.4.2. Prospective Resources:

Potentially recoverable volumes of undiscovered accumulations.

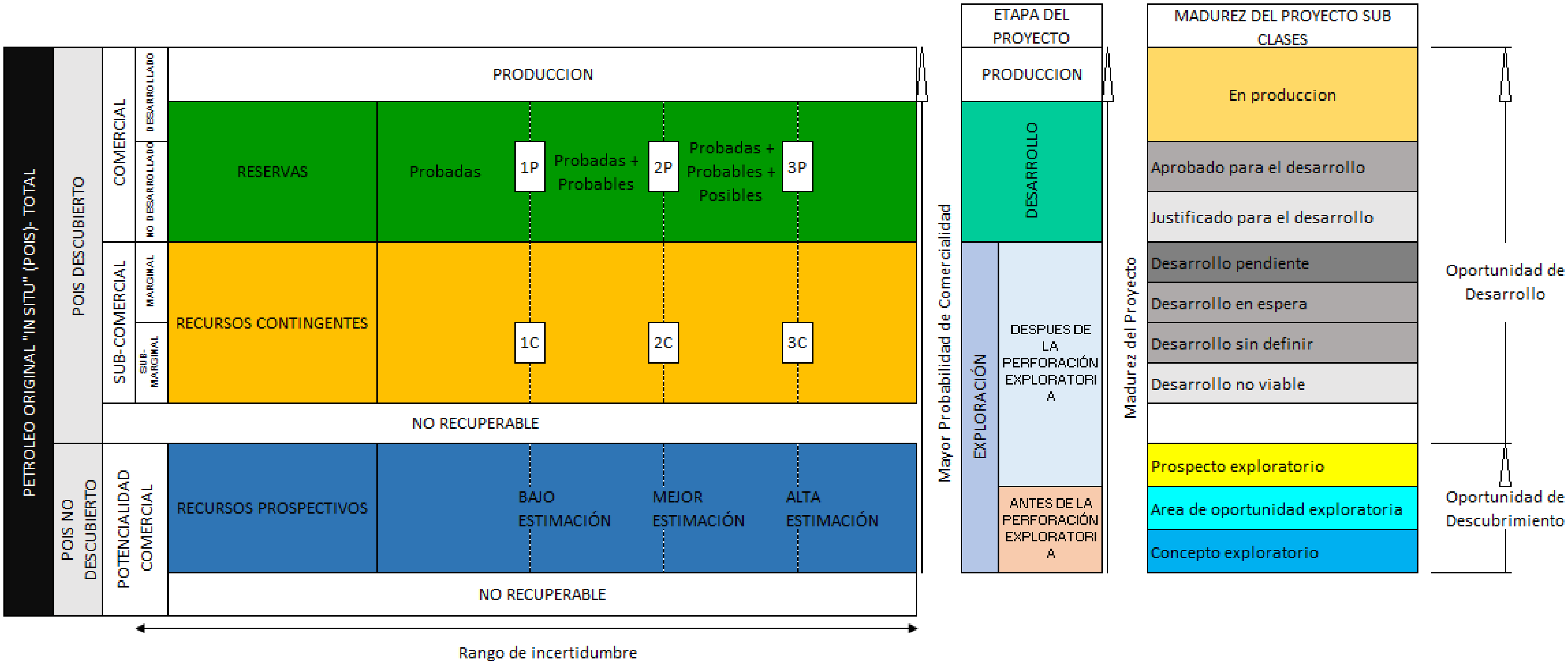
4.3.10.5. SPE Classification

Figura 136: SPE classification for Hydrocarbon resources

Source: PRMS / Own elaboration

4.3.10.6. Categorization and maturity of the project

Figura 137: Categorization and maturity of the project



Source: PRMS / Own elaboration

4.3.10.7. Proved Reserves

They are those quantities of oil that, through the analysis of geological and engineering information, can be estimated with reasonable certainty; as well as commercially recoverable from known reservoirs as of a given date and under current economic conditions, with existing operating methods and current government regulations.

These can be divided into developed or undeveloped reserves.

- They must have at least a 90% probability that they will be produced.
- Based on current production evidence or highly reliable information.
- They can be reported to various agencies, shareholders, and the general public.
- Like all probabilistic calculations, they are "estimated" and can change over time.

4.3.10.7.1. Proved Developed Reserves

Recovery is expected through existing wells, with existing equipment, and through current operating methods. Wells currently in production, those that are awaiting minor investments to connect them to the points of sale, or to complete, puncture or stimulate them, would be examples of areas with developed Proved reserves, since most of the investments to develop the reservations have already been made.

4.3.10.7.2. Proved Reserves Developed in Production

It is expected to recover from completed intervals that are open and in production as of the estimate date.

4.3.10.7.3. Proved Reserves Developed in No Production

The closed ones ("shut in") and those behind the casing ("behind pipe") are included.

Reserve "shut in"

It is expected to recover from completed intervals that are open at the date of estimation but that have not yet begun to produce, wells temporarily closed for market reasons or connections to pipelines, wells that cannot produce for easily solvable mechanical reasons.

Reserve "behind pipe"

It is expected to recover from unopened reservoirs in existing wells; Although completion or re-completion work will be required, the cost involved should be small compared to that of the well.

4.3.10.7.4. Proved Undeveloped Reserves

Undeveloped oil and gas reserves are those that are expected to be recovered from new wells in an undrilled area, or from existing wells where a significant investment is required for their determination.

Volumes attributable to enhanced recovery techniques cannot be classified as Proved undeveloped reserves, until the effectiveness of the technique has been proven in that reservoir or in an analogous one within the same geological formation in the immediate area.

4.3.10.8. Unproved Reserves

The geological and / or engineering information used to determine unproven reserves is similar to that used for estimates of proven reserves; However, in the case of unproven reserves, there are technical, contractual, economic, or regulatory doubts that prevent these reserves from being classified as proven.

Unproven reserves can be subdivided into probable reserves and possible reserves.

These can be estimated considering future economic conditions different from those existing at the time the estimate is made. The effect of possible improvements in economic conditions and possible technological advances in the future can be reflected by classifying reserves as either probable or possible.

4.3.10.8.1. Probable Reserves

They are those unproved reserves whose geological and technical analysis suggests that there is a greater probability that they can be recovered.

In this context, when probabilistic methods are used, there should be at least a 50% probability that the quantities recovered will be equal to or greater than the total proven reserves plus the estimated probable reserves.

4.3.10.8.2. Possible Reserves

They have less certainty than the Probable ones; They can be defined as those Unproved reserves, which, according to what the analyzes of the geological or engineering data suggest, are more likely not to be recovered than, if they are, to the specified economic conditions. (SPE, s.f.)

4.3.10.9. San Jacinto Oriental field Reserves

From the numerical simulation in conjunction with the volumes of hydrocarbons recoverable through primary methods; using the calculation of the theoretical recovery factor for each reservoir; we can infer a resource classification for each reservoir formation.

As we are in a prospective zone, today all calculated volumes will be classified as Prospective Resources; But once our first well is discovered and this in turn reaches its final depth, it is expected to discover the accumulations of hydrocarbons calculated and detailed lines below to classify them as contingent reserves and resources, according to the maturity of the OOIP. These values are:

VIVIAN RESERVOIR

Figura 138: Reserves and resources classification- San Jacinto Oriental field- Vivian formation

	Recovery factor	
Formation	**Theory**	**Forecast**
Vivian	0.2570	0.2475
Chonta	0.4000	0.3905

Probabilistic data		Units
P10	324.8	MMBBL
P50	445.94	MMBBL
P90	610.31	MMBBL

Reserves and resources classification- San Jacinto Oriental field- Vivian formation							
ORIGINAL OIL "IN PLACE" (OOIP)- TOTAL	POIS DISCOVERED	COMERCIAL	PRODUCTION				
			RESERVES	P10 324.8	Proved	Proved + Probable	Proved + Probable+ Possible
					80.39	110.37	151.05
		NOT-COMERCIAL	CONTINGENT RESOURCES	P50 445.94	1C	2C	3C
				P90 610.31	3.09	4.24	5.80
	UNRECOVERABLE				241.33	331.33	453.46
	OOIP NOT DISCOVERED		PROSPECTIVE RESOURCES		1U	2D	3D
			UNRECOVERABLE				

Source: PRMS / Own elaboration

CHONTA RESERVOIR

Figura 139: Reserves and resources classification- San Jacinto Oriental field- Chonta formation

Probabilistic data		Units
P10	53.48	MMBBL
P50	81.98	MMBBL
P90	126.71	MMBBL

<table>
<tr><th colspan="8">Reserves and resources classification- San Jacinto Oriental field- Vivian formation</th></tr>
<tr><td rowspan="10">ORIGINAL OIL "IN PLACE" (OOIP)- TOTAL</td><td rowspan="5">POIS DISCOVERED</td><td rowspan="3">COMERCIAL</td><td colspan="5">PRODUCTION</td></tr>
<tr><td rowspan="2">RESERVES</td><td rowspan="4">P10 53.48
P50 81.98
P90 126.71</td><td>Proved</td><td>Proved+ Probable</td><td>Proved + Probable + Possible</td></tr>
<tr><td>20.88</td><td>32.01</td><td>49.48</td></tr>
<tr><td rowspan="2">NOT-COMERCIAL</td><td rowspan="2">CONTINGENT RESOURCES</td><td>1C</td><td>2C</td><td>3C</td></tr>
<tr><td>0.51</td><td>0.78</td><td>1.20</td></tr>
<tr><td colspan="4">UNRECOVERABLE</td><td>32.09</td><td>49.19</td><td>76.03</td></tr>
<tr><td colspan="2" rowspan="2">OOIP NOT DISCOVERED</td><td colspan="2">PROSPECTIVE RESOURCES</td><td>1U</td><td>2U</td><td>3U</td></tr>
<tr><td colspan="5">UNRECOVERABLE</td></tr>
</table>

Source: PRMS / Own elaboration

CONCLUSION:

Reserves and uncertainty.

- Uncertainty: Lack of precise knowledge, doubt.
- Estimates of reserves and economics in the industry are inherently uncertain.
- We must think that we are talking about hydrocarbons buried hundreds, or thousands of meters below the surface, in reservoirs from which we can only obtain indirect and very specific measurements.
- According to the literatures, if we could obtain cores in all the wells of a typical reservoir, only 1 / 1e + 6 of the total volume of the reservoir would have been measured.
- If profiles and fluid measurements are also obtained, a sampling of 1/1000 of the total volume could be achieved.
- In addition to the variation of the parameters themselves, there are also errors in the sampling, measurement, and calculation methods.

In E&P there are at least 3 types of uncertainties:

- Techniques (existence, size and quality of reserves).
- Economic / Market (prices, costs, regulations).
- Strategic (actions of other firms: drilling, tenders, swaps, etc.)

4.4.Drilling Engineering

4.4.1. San Jacinto field Background

From reservoir engineering and geology areas is known that San Jacinto field is divided into two zones, North Zone (1), and South Zone (2). Every zone counts with different poral pressure gradient calculated from reservoir pressure.

Tabla 75 Total Wells for San Jacinto field

Drilling Program	
TOTAL WELLS	25
Exploratory Wells	1
Confirmatory Wells	2
Development Wells	15
+ Injector Wells	6
Cutoff Wells	1

5 wells – Verticals (Comingle)
9 wells – Verticals (Chonta)
6 wells – Horizontals (Vivian)

During exploratory stage (7 years) in 2021 will be constructed 3 platforms, one for exploratory well and the rest for confirmatory well. Development stage (around 30 years) requires 2 drilling platforms, the first will be constructed in 2027 and will contain 9 wells, and the second in 2028, the last 10 wells.

4.4.2. Drilling Program

Drilling program is a document prepared to give technical and economical parameters to develop a well drilling project in an effective way.

4.4.2.1. Well Details

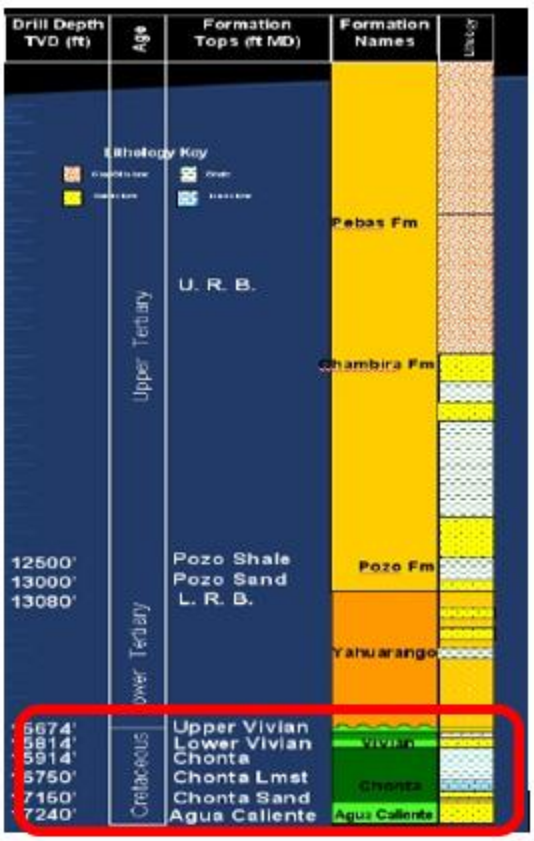
First is necessary define location and some characteristics of the well. The well selected for the development of this essay is the exploratory well SJN-X01.

Tabla 76 SJN-X01 Well Information

BASIC WELL DATA	Details
Well name	SJN01
Location	Marañon Basin
Coordinates	75°51'56.72"O" 2°15'34.17"S
Elevation	194 m
Block	192
Well Type	Vertical Well
Well depth	9800 ft
Type of fluid	Oil

4.4.2.2. Drilling Geology

4.4.2.2.1. Stratigraphic Column



4.4.2.2.2. Geological Objectives

The geological objectives in the field are called "Vivian" and "Chonta", rocks with proven conditions and characteristics to be the productive formations.

Reservoir Engineering established top and base estimated for productive formation.

Tabla 77 SJN-X01 Objectives

FORMATION	TOP	BOTTOM
Upper Vivian	2231.7 m / 7320 ft	2255.52 m/7400 ft
Upper Chonta	2390.2m / 7840ft	2412.8m / 7914ft

4.4.2.3. Poral Pressure Gradient Estimation

Poral pressure gradient is a value obtained from reservoir pressure for every productive formation, in this case, Vivian and Chonta. For gradient estimation reservoir pressure is divided into datum depth.

Tabla 78 Estimated Reservoir Pressure

FORMATION	INITIAL PRESSURE (psi)
Upper Vivian	3450
Upper Chonta	3700

Tabla 79 Estimated depth - Vivian formation

	FORMATION	TOP	BOTTOM	AVERAGE DEPTH (ft)
Zona 1	Upper Vivian	7320	7400	7360
Zona 2		7300	7380	7340

Tabla 80 Estimated depth - Chonta formation

	FORMATION	TOP	BOTTOM	AVERAGE DEPTH (ft)
Zona 1	Upper Chonta	7840	7914	7877
Zona 2		7860	7952	7998

Tabla 81 Poral Pressure Gradient

	Zone 1	Zone 2
FORMATION	Poral Gradient 1 (psi/ft)	Poral Gradient 2 (psi/ft)
Upper Vivian	0.469	0.470
Upper Chonta	0.470	0.463

4.4.2.4. Fracture Pressure Gradient Prediction

From drilling engineering literature are known empirical equations for fracture pressure gradient prediction.

4.4.2.4.1. Hubbert and Willis

$$Fmín = \frac{1}{3}(1 + \frac{2P}{D})$$

$$Fmáx = \frac{1}{2}(1 + \frac{P}{D})$$

Tabla 82: Fracture pressure gradient prediction using Hubbert and Willis's equation

	Zone 1	Zone 2
FG Minimum	0.6462	0.6442
FG Maximum	0.7346	0.7332
Fracture Gradient	0.6904	0.6887

4.4.2.4.2. Mathews and Kelly

$$F = \frac{Ki}{D} + \frac{P}{D}$$

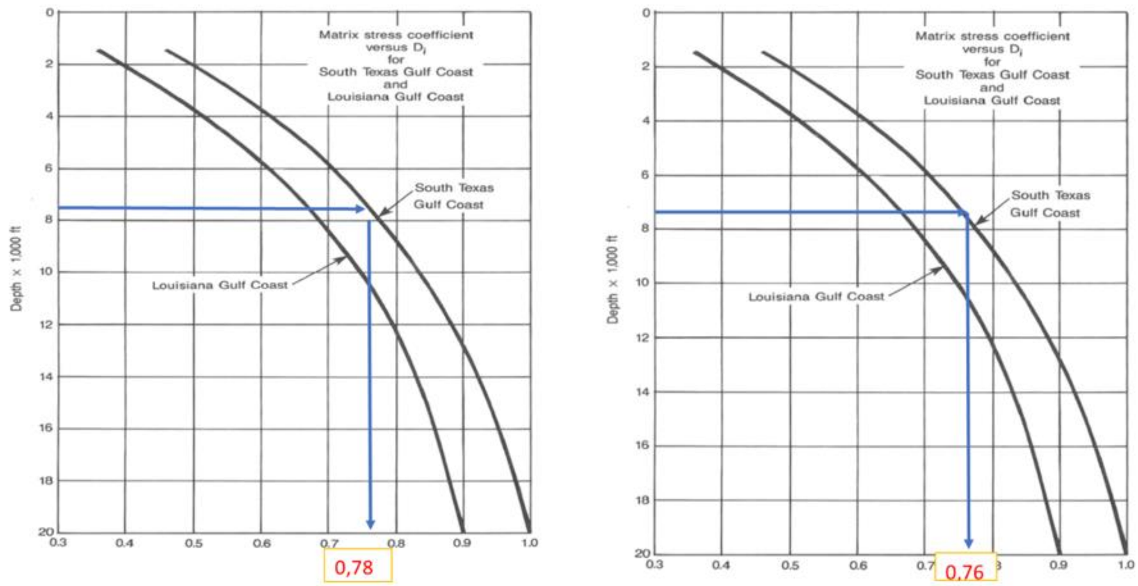
$$\frac{S}{D} = \frac{\sigma}{D} + \frac{P}{D}$$

Where:

$\frac{P}{D}: Poral\ Pressure\ Gradient$ $\frac{S}{D}: Overburden\ Gradient$

Ki estimation

Figura 140 Ki estimation



Finally fracture gradient is calculated

Tabla 83 Fracture pressure gradient prediction using Mathews and Kelly´s equation

	Ki	Overburden Gradient	Poral Gradient	Fracture Gradient
ZONE 1	0.78	**0.95**	0.4692	0.8442
ZONE 2	0.76	**0.95**	0.4663	0.8339

4.4.2.4.3. Ben Eaton

$$cp = 0.0645 x \ln(D) - 0.0673$$

$$Pf = Pp + \left(\frac{cp}{1 - cp}\right)(S(D) - Pp)$$

Where:

Cp.: Poisson Coefficient
D: Depth (ft)

Tabla 84 Fracture pressure gradient prediction using Ben Eaton´s equation

	Zone 1	Zone 2
cp	0.4326	0.4330
Fracture Gradient	**0.8358**	**0.8357**

Tabla 85 Fracture Pressure Gradient

	Poral Gradient (PG)	Over Burden Gradient (Ob)	Fracture Gradient (FG)	Fracture Gradient (FG)	Fracture Gradient (FG)
	(psi/*ft*)	***psi/ft***	**Hubbert and Willis (psi/ft)**	**Mathews and Kelly (psi/ft)**	**Ben Eaton (psi/ft)**
Zone 1	0.469	1	0.690	0.844	0.836
Zone 2	0.466	1	0.689	0.834	0.836

4.4.2.5. Drilling Operative Window (DOW)

From results obtained in previous section is possible construct a drilling operative window. A DOW is a safety operation area between poral and fracture pressure usually used to establish the drilling mud weight.

Tripping operations could generate more or less pressure in the well, a dangerous condition that could cause an influx or fracture and to avoid this is necessary to apply a safety margin of 0.5 ppg for poral and fracture pressure.

Figura 141 Drilling Operative window (ppg vs depth)

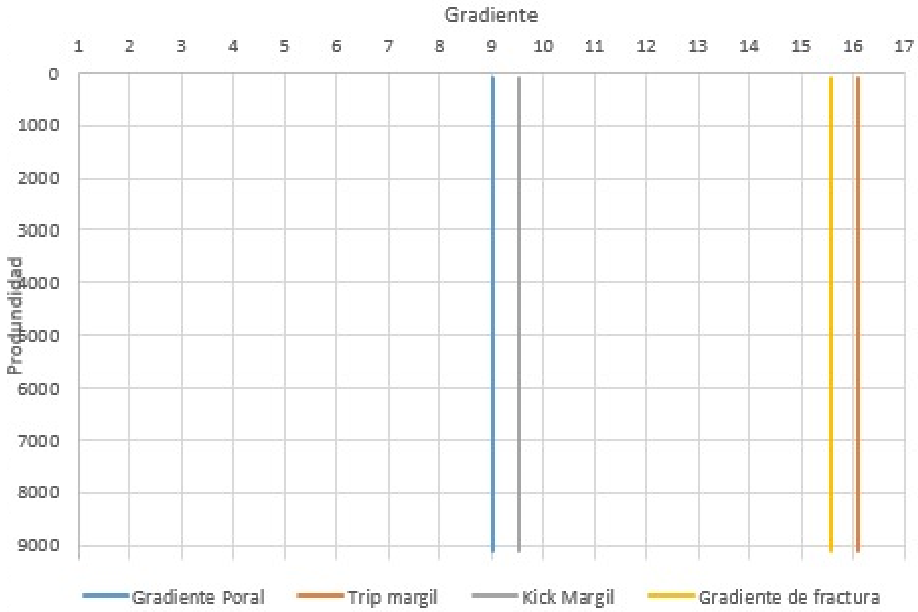
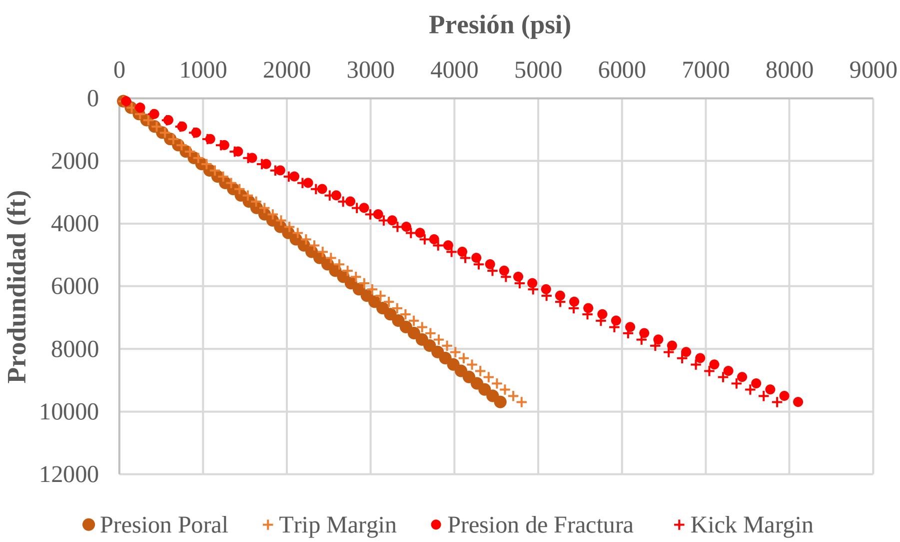


Figura 142: Drilling operative window (psi vs depth)



4.4.2.6. Drilling Fluids Program

Based on drilling fluids program from offset wells mud weight for SJN-X01 well was determined. Mud weight works as first well barrier during conventional drilling operations and it varies in every section (surface, intermediate, production) because needs to fit with drilling operation window. Usually, mud weight is a little bit greater than poral pressure to maintain overbalance in well and avoid damage in productive formation.

Mud primary functions

- Balance formation pressure.
- Carry cuttings to the Surface.
- Clean, cool and lubricate the bit.
- Seal permeable formations.
- Stabilize borehole.
- Transmit hydraulic power to the bit.

26 in section (Conductor)

Figura 143 Fluid description for SJN-X01 well 26 in section

	From
Fluid	Water
Depth	100 ft

17-1/2 in section (Surface)

Figura 144 Fluid properties for SJN-X01 well 17-1/2 in section

	From	To
Type of fluid	SPUD MUD	SPUD MUD
Depth	100 ft	3200 ft
Density (ppg)	8.9	8.9
Funnel viscosity (sec)	38	45
PV (cp)	10	17
YP (lb/100ft2)	13	22
% Sand	<0.3	
PH	8.5	9.5
Sludge volume.	930 bbls	

12-1/4 in section

Figura 145 Possible operational problems during SJN-X01 well 12-1/4 in section

Posibles problemas en Pozo	
PROBLEMA	**RECOMENDACIONES**
Formación Gumbo ▪ **Taponamiento del "flow line" con arcilla.** ▪ **Levantamiento de la mesa rotaria por arcilla pegajosa.** ▪ **Incremento de presión.**	Limpiar El hueco con píldoras que usen Súper Sweep o goma xántica. El uso de estos deberá ser supervisado por Cía. Lodos en los momentos que requiera el pozo. Tener cuidado de no echar píldoras cada stand y sin necesidad.
Perdidas de circulación durante la cementación	Controlar velocidad de bajada de casing a 70 segundos por tubo en la formación Pozo Sand. Agregar material puenteante en Pozo Sand.

Drilling detergent/Drill Con DS use must be from the beginning to avoid possible operational problems related with gumbo like flowline plugging, also walnut use will help with fluid loss. It´s recommended to pump disperse pills as a good practice to maintain hole cleaning.

Figura 146 Fluid properties for SJN-X01 well 12-1/4 in section

	From	To
Type of fluid	QDRILL	QDRILL
Depth	3200 ft	8530 ft
Density (ppg)	11	11
Funnel viscosity (sec)	12-17	12-17
PV (cp)	13-22	13-22
YP (lb/100ft2)	9	10
% Sand	6-10	6-10
Volume of mud.	1261 bbls	

8-1/2" section

Figura 147 Possible operational problems during SJN-X01 well 12-1/4 in section

Posibles problemas en Pozo	
PROBLEMA	**RECOMENDACIONES**
Inestabilidad de Lower Red Beds	Perforar con caudales menores a 500 gpm
Pérdida total dentro de los primeros 30 a 60 m de formación Chonta	Adicionar material puente antes recomendado por CIA de lodos y perforar con galonagés entre 320 y 380 gpm material puenteante en Pozo Sand.

Torque y arrastre en chonta	Suministrar al lodo agentes lubricantes

Figura 148 Fluid properties for SJN-X01 well 8-1/2 in section

	From	To
Tipo de fluido	MAXDRILL	MAXDRILL
Profundidad	8530 ft	9800 ft
Densidad (ppg)	11.5	11.5
PV (cp)	10	15
Dial a 3 rpm	13	18
YP ($lb/100ft^2$)	20	40
Calcio ++, ppm	100	150
PH	9.0	9.5
Perdida de filtrado (cc/30 min)	5	7
Volume of mud	776 bbls	

4.4.2.7. Well Design

4.4.2.7.1. Casing Design

Security factors for casing selection

Casing design is the selection of the best casing characteristics for a particular string. The design is based on the resistance of the tubular good against the collapse, burst and tension forces that are acting over tubular body and connection. The use of security factors for casing design responds the necessity to maintain well integrity and safety operations.

Is important to note that casing drift must be greater than next hole diameter to allow the pass of the bit and another drilling tool.

Security factors used for this design are presented in Peruvian law, specifically in DS 032-2004 called “Reglamento para actividades de exploración y explotación de hidrocarburos”.

Tabla 86 Security factors used for SJN-X01 well casing design

Design Factor	
Collapse	1.125
Tension	1.8
Tension	2
Burst	1.1

$$P_{burst} = \nabla Poral * Depth * F_{burst}$$

$$P_{Colapsse} = 0.052 * MW * Depth * F_{colapsse}$$

$$Tension = Lenght * Weight * F_{burst}$$

Conductor Casing

Conductor setting Depth is around 100 ft and is not necessary to develop a string design because at this level pressure and tension are very low.

Surface Casing

Tabla 87 Data and results obtained for SJN-X01well surface casing design

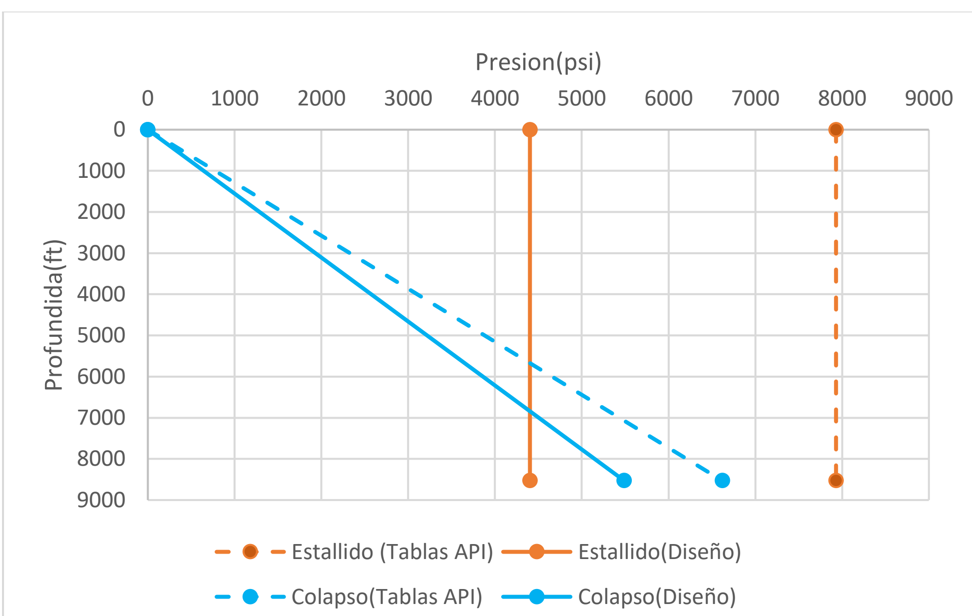
Depth (ft)	3200
Mud weight(ppg)	8.9
Pore Gradient (psi/ft)	0.469

Design Factors	
Collapse	1.125
Tension	1.8
Burst	1.1

Design Factors	
Collapse (psi)	1666.08
Burst (psi)	1651.71
Tension	391680.00

Comparison		
	Design	Tables API
Collapse(psi)	1965.6	2220
Burst (psi)	1651.71	4710
Tension	391680	1458000

Figura 149 Burst and collapse loading scenario for SJN-X01well surface casing



Intermediate Casing

Tabla 88 Data and results obtained for SJN-X01 intermediate casing design

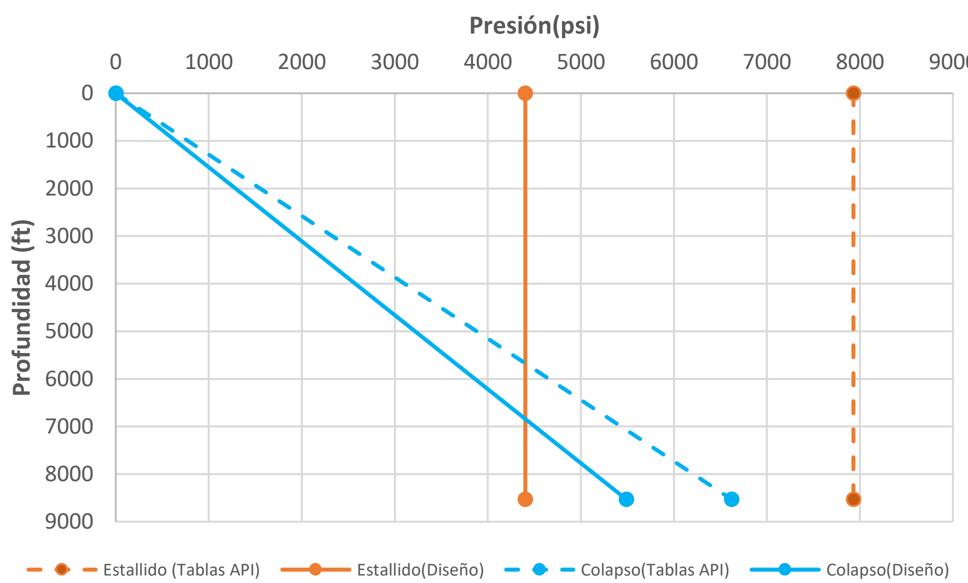
Depth (ft)	8530
Mud Weight(ppg)	11
Pore Gradient (psi/ft)	0.469

Design Factors	
Collapse	1.125
Tension	1.8
Burst	1.1

Design Factors	
Collapse (psi)	5489.1
Burst (psi)	4402.8
Tension	821439.0

Comparison		
	Design	Tables API
Collapse(psi)	5489.1	6620
Burst (psi)	4402.8	7930
Tension	821439	1244000

Figura 150 Burst and collapse loading scenario for SJN-X01well intermediate casing



Production Linner

Tabla 89: Data and results obtained for SJN-X01 production liner design

Depth (ft)	9800
Mud Weight(ppg)	11.5
Pore Gradient (psi/ft)	0.469

Design Factors	
Collapse	1.125
Tension	1.8
Burst	1.1

Design Factors	
Collapse (psi)	6592.95
Burst (psi)	5058.36
Tension	81954.00

Comparison		
	Design	Tables API
Collapse(psi)	6593.0	7020
Burst (psi)	5058.4	8160
Tension	81954	676000

Figura 151 Burst and collapse loading scenario for SJN-X01well production liner

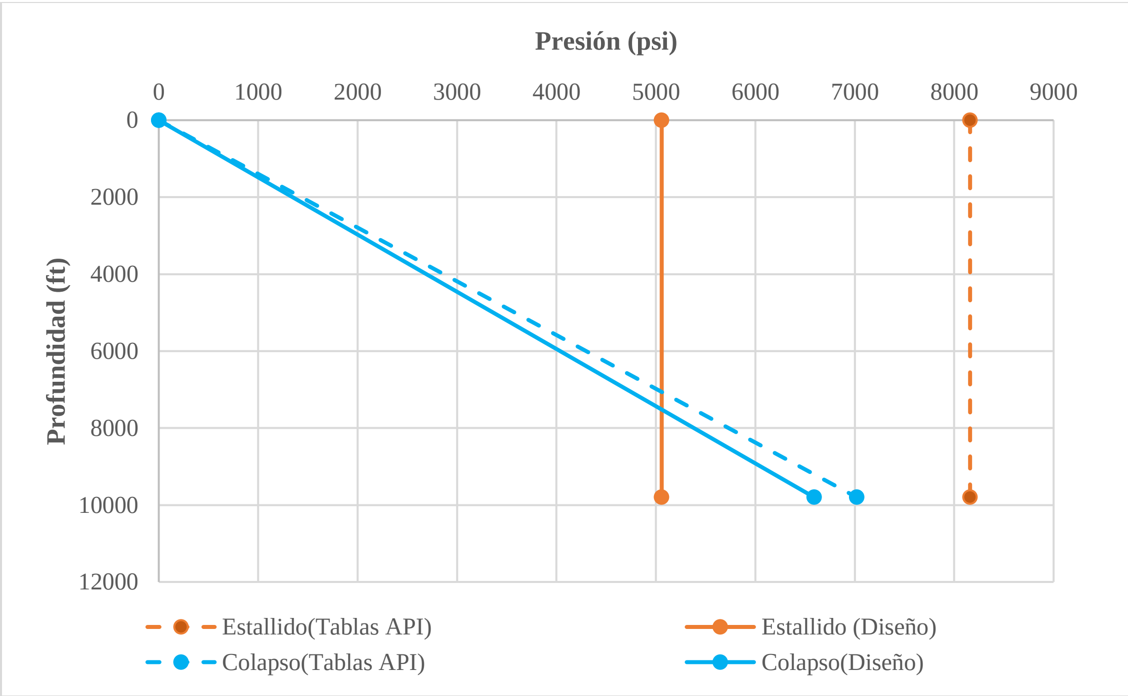


Tabla 90 Results obtained from SJN-X01 well casing design

Casing Type	Outer Diameter (in)	Nominal Weigh (lb/ft)	Grade	Depth
Conductor	20	94	H-40	100
Surface	13 3/8	68	K-55	3200
Intermediate	9 5/8	53.5	L-80	8530
Linner	7	29	L-80	8230-9800

API tables for casing selection

Figura 152 API table for surface casing design

TABLE 7.6—MINIMUM PERFORMANCE PROPERTIES OF CASING (cont.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
																			*Joint Strength—1,000 lbf							
												**Internal Pressure Resistance, psi							Threaded and Coupled							
															Buttress Thread						Buttress Thread					
					Threaded and Coupled			Extreme Line							Regular Coupling		Special Clearance Coupling								Extreme Line	
Size Outside Diameter (in.)	Nominal Weight Threads and Coupling (lbm/ft)	Grade	Wall Thickness (in.)	Inside Diameter (in.)	Drift Diameter (in.)	Outside Diameter of Coupling (in.)	Outside Diameter Special Clearance Coupling (in.)	Drift Diameter (in.)	Outside Diameter of Box Powertight (in.)	Collapse Resistance (psi)	Pipe Body Yield Strength (1,000 lbf)	Plain End or Extreme Line	Round Thread Short	Round Thread Long	Same Grade	Higher Grade	Same Grade	Higher Grade	Round Thread Short	Round Thread Long	Regular Coupling	Regular Coupling Higher Grade†	Special Clearance Coupling	Special Clearance Coupling Higher Grade†	Standard Joint	Optional Joint
10¾	51.00	C-90	0.450	9.850	9.694	11.750	11.250	9.694	11.460	3,400	1,310	6,590	6,590	—	6,590	—	4,150	—	692	—	1,287	—	1,112	—	1,465	—
	55.50	C-90	0.495	9.760	9.604	11.750	11.250	9.604	11.460	4,160	1,435	7,250	6,880	—	7,250	—	4,150	—	771	—	1,409	—	1,112	—	1,595	—
	51.00	C-95	0.450	9.850	9.694	11.750	11.250	9.694	11.460	3,480	1,383	6,960	6,880	—	6,960	—	4,150	—	927	—	1,354	—	1,151	—	1,529	—
	55.50	C-95	0.495	9.760	9.604	11.750	11.250	9.604	11.460	4,290	1,515	7,660	6,880	—	7,450	—	4,150	—	1,032	—	1,483	—	1,151	—	1,675	—
	51.00	P-110	0.450	9.850	9.694	11.750	11.250	9.694	11.460	3,660	1,602	8,060	7,860	—	7,450	7,450	4,150	4,150	1,080	—	1,594	1,594	1,370	1,594	1,820	—
	55.50	P-110	0.495	9.760	9.604	11.750	11.250	9.604	11.460	4,610	1,754	8,860	7,860	—	7,450	7,450	4,150	4,150	1,203	—	1,745	1,745	1,370	1,745	1,993	—
	60.70	P-110	0.545	9.660	9.504	11.750	11.250	9.504	11.460	5,880	1,922	9,760	7,860	—	7,450	7,450	4,150	4,150	1,338	—	1,912	1,912	1,370	1,754	2,000	—
	65.70	P-110	0.595	9.560	9.404	11.750	11.250	—	—	7,500	2,088	10,650	7,860	—	7,450	7,450	4,150	4,150	1,472	—	2,077	2,077	1,370	1,754	—	—
11¾	42.00	H-40	0.333	11.084	10.928	12.750	—	—	—	1,040	476	1,980	1,980	—	—	—	—	—	307	—	—	—	—	—	—	—
	47.00	J-55	0.375	11.000	10.844	12.750	—	—	—	1,510	737	3,070	3,070	—	3,070	3,070	—	—	477	—	807	807	—	—	—	—
	54.00	J-55	0.435	10.880	10.724	12.750	—	—	—	2,070	850	3,560	3,560	—	3,560	3,560	—	—	568	—	931	931	—	—	—	—
	60.00	J-55	0.489	10.772	10.616	12.750	—	—	—	2,660	952	4,010	4,010	—	4,010	4,010	—	—	649	—	1,042	1,042	—	—	—	—
	47.00	K-55	0.375	11.000	10.844	12.750	—	—	—	1,510	737	3,070	3,070	—	3,070	3,070	—	—	509	—	935	935	—	—	—	—
	54.00	K-55	0.435	10.880	10.724	12.750	—	—	—	2,070	850	3,560	3,560	—	3,560	3,560	—	—	606	—	1,079	1,079	—	—	—	—
	60.00	K-55	0.489	10.772	10.616	12.750	—	—	—	2,660	952	4,010	4,010	—	4,010	4,010	—	—	693	—	1,208	1,208	—	—	—	—
	60.00	C-75	0.489	10.772	10.616	12.750	—	—	—	3,070	1,298	5,460	5,460	—	5,460	—	—	—	869	—	1,361	—	—	—	—	—
	60.00	L-80	0.489	10.772	10.616	12.750	—	—	—	3,180	1,384	5,830	5,820	—	5,830	—	—	—	913	—	1,399	—	—	—	—	—
	60.00	N-80	0.489	10.772	10.616	12.750	—	—	—	3,180	1,384	5,830	5,820	—	5,830	—	—	—	924	—	1,440	1,440	—	—	—	—
	60.00	C-90	0.489	10.772	10.616	12.750	—	—	—	3,360	1,557	6,550	5,820	—	6,300	—	—	—	1,011	—	1,517	—	—	—	—	—
	60.00	C-95	0.489	10.772	10.616	12.750	—	—	—	3,440	1,644	6,920	5,820	—	6,300	—	—	—	1,066	—	1,596	—	—	—	—	—
	60.00	P-110	0.489	10.772	10.616	12.750	—	—	—	3,610	1,903	8,010	5,820	—	6,300	6,300	—	—	1,242	—	1,877	1,877	—	—	—	—
13⅜	48.00	H-40	0.330	12.715	12.559	14.375	—	—	—	740	541	1,730	1,730	—	—	—	—	—	322	—	—	—	—	—	—	—
	54.50	J-55	0.380	12.615	12.459	14.375	—	—	—	1,130	853	2,730	2,730	—	2,730	2,730	—	—	514	—	909	909	—	—	—	—
	61.00	J-55	0.430	12.515	12.359	14.375	—	—	—	1,540	962	3,090	3,090	—	3,090	3,090	—	—	595	—	1,025	1,025	—	—	—	—
	68.00	J-55	0.480	12.415	12.259	14.375	—	—	—	1,950	1,069	3,450	3,450	—	3,450	3,450	—	—	675	—	1,140	1,140	—	—	—	—
	54.50	K-55	0.380	12.615	12.459	14.375	—	—	—	1,130	853	2,730	2,730	—	2,730	2,730	—	—	547	—	1,038	1,038	—	—	—	—
	61.00	K-55	0.430	12.515	12.359	14.375	—	—	—	1,540	962	3,090	3,090	—	3,090	3,090	—	—	633	—	1,169	1,169	—	—	—	—
	68.00	K-55	0.480	12.415	12.259	14.375	—	—	—	1,950	1,069	3,450	3,450	—	3,450	3,450	—	—	718	—	1,300	1,300	—	—	—	—
	68.00	C-75	0.480	12.415	12.259	14.375	—	—	—	2,220	1,458	4,710	4,550	—	4,710	—	—	—	905	—	1,496	—	—	—	—	—
	72.00	C-75	0.514	12.347	12.191	14.375	—	—	—	2,600	1,558	5,040	4,550	—	4,930	—	—	—	978	—	1,598	—	—	—	—	—
	68.00	L-80	0.480	12.415	12.259	14.375	—	—	—	2,260	1,556	5,020	4,550	—	4,930	—	—	—	952	—	1,545	—	—	—	—	—
	72.00	L-80	0.514	12.347	12.191	14.375	—	—	—	2,670	1,661	5,380	4,550	—	4,930	—	—	—	1,029	—	1,650	—	—	—	—	—
	68.00	N-80	0.480	12.415	12.259	14.375	—	—	—	2,260	1,556	5,020	4,550	—	4,930	4,930	—	—	963	—	1,585	1,585	—	—	—	—
	72.00	N-80	0.514	12.347	12.191	14.375	—	—	—	2,670	1,661	5,380	4,550	—	4,930	4,930	—	—	1,040	—	1,693	1,693	—	—	—	—
	68.00	G-90	0.480	12.415	12.259	14.375	—	—	—	2,320	1,750	5,650	4,550	—	4,930	—	—	—	1,057	—	1,683	—	—	—	—	—
	72.00	G-90	0.514	12.347	12.191	14.375	—	—	—	2,780	1,869	6,050	4,550	—	4,930	—	—	—	1,142	—	1,797	—	—	—	—	—
	68.00	C-95	0.480	12.415	12.259	14.375	—	—	—	2,330	1,847	5,970	4,550	—	4,930	—	—	—	1,114	—	1,772	—	—	—	—	—
	72.00	C-95	0.514	12.347	12.191	14.375	—	—	—	2,820	1,973	6,390	4,550	—	4,930	—	—	—	1,204	—	1,893	—	—	—	—	—
	68.00	P-110	0.480	12.415	12.259	14.375	—	—	—	2,330	2,139	6,910	4,550	—	4,930	4,930	—	—	1,297	—	2,079	2,079	—	—	—	—
	72.00	P-110	0.514	12.347	12.191	14.375	—	—	—	2,890	2,264	7,400	4,550	—	4,930	4,930	—	—	1,402	—	2,221	2,221	—	—	—	—

Tabla 91 API table for intermediate casing design

1	2	3	4	5	6	7	8	9	10	11	12
					Threaded and Coupled			Extreme Line			
Size Outside Diameter (in.)	Nominal Weight Threads and Coupling (lbm/ft)	Grade	Wall Thickness (in.)	Inside Diameter (in.)	Drift Diameter (in.)	Outside Diameter of Coupling (in.)	Outside Diameter Special Clearance Coupling (in.)	Drift Diameter (in.)	Outside Diameter of Box Powertight (in.)	Collapse Resistance (psi)	Pipe Body Yield Strength (1,000 lbf)
8 5/8	36.00	C-95	0.400	7.825	7.700	9.625	9.125	7.700	9.120	4,350	982
	40.00	C-95	0.450	7.725	7.600	9.625	9.125	7.600	9.120	6,020	1,098
	44.00	C-95	0.500	7.625	7.500	9.625	9.125	7.500	9.120	7,740	1,212
	49.00	C-95	0.557	7.511	7.386	9.625	9.125	7.386	9.120	9,710	1,341
	40.00	P-110	0.450	7.725	7.600	9.625	9.125	7.600	9.120	6,390	1,271
	44.00	P-110	0.500	7.625	7.500	9.625	9.125	7.500	9.120	8,420	1,404
	49.00	P-110	0.557	7.511	7.386	9.625	9.125	7.386	9.120	10,740	1,553
9 5/8	32.30	H-40	0.312	9.001	8.845	10.625	—	—	—	1,370	365
	36.00	H-40	0.352	8.921	8.765	10.625	—	—	—	1,720	410
	36.00	J-55	0.352	8.921	8.765	10.625	10.125	—	—	2,020	564
	40.00	J-55	0.395	8.835	8.679	10.625	10.125	8.599	10.100	2,570	630
	36.00	K-55	0.352	8.921	8.765	10.625	10.125	—	—	2,020	564
	40.00	K-55	0.395	8.835	8.679	10.625	10.125	8.599	10.100	2,570	630
	40.00	C-75	0.395	8.835	8.679	10.625	10.125	8.599	10.100	2,990	859
	43.50	C-75	0.435	8.755	8.599	10.625	10.125	8.599	10.100	3,730	942
	47.00	C-75	0.472	8.681	8.525	10.625	10.125	8.525	10.100	4,610	1,018
	53.50	C-75	0.545	8.535	8.379	10.625	10.125	8.379	10.100	6,350	1,166
	40.00	L-80	0.395	8.835	8.679	10.625	10.125	8.599	10.100	3,090	916
	43.50	L-80	0.435	8.755	8.599	10.625	10.125	8.599	10.100	3,810	1,005
	47.00	L-80	0.472	8.681	8.525	10.625	10.125	8.525	10.100	4,760	1,086
	53.50	L-80	0.545	8.535	8.379	10.625	10.125	8.379	10.100	6,620	1,244
	40.00	N-80	0.395	8.835	8.679	10.625	10.125	8.599	10.100	3,090	916
	43.50	N-80	0.435	8.755	8.599	10.625	10.125	8.599	10.100	3,810	1,005
	47.00	N-80	0.472	8.681	8.525	10.625	10.125	8.525	10.100	4,760	1,086
	53.50	N-80	0.545	8.535	8.379	10.625	10.125	8.379	10.100	6,620	1,244
	40.00	C-90	0.395	8.835	8.679	10.625	10.125	8.599	10.100	3,250	1,031
	43.50	C-90	0.435	8.755	8.599	10.625	10.125	8.599	10.100	4,010	1,130
	47.00	C-90	0.472	8.681	8.525	10.625	10.125	8.525	10.100	5,000	1,221
	53.50	C-90	0.545	8.535	8.379	10.625	10.125	8.379	10.100	7,120	1,399
	40.00	C-95	0.395	8.835	8.679	10.625	10.125	8.599	10.100	3,320	1,088
	43.50	C-95	0.435	8.755	8.599	10.625	10.125	8.599	10.100	4,120	1,193
	47.00	C-95	0.472	8.681	8.525	10.625	10.125	8.525	10.100	5,090	1,289
	53.50	C-95	0.545	8.535	8.379	10.625	10.125	8.379	10.100	7,340	1,477
	43.50	P-110	0.435	8.755	8.599	10.625	10.125	8.599	10.100	4,420	1,381
	47.00	P-110	0.472	8.681	8.525	10.625	10.125	8.525	10.100	5,300	1,493
	53.50	P-110	0.545	8.535	8.379	10.625	10.125	8.379	10.100	7,950	1,710

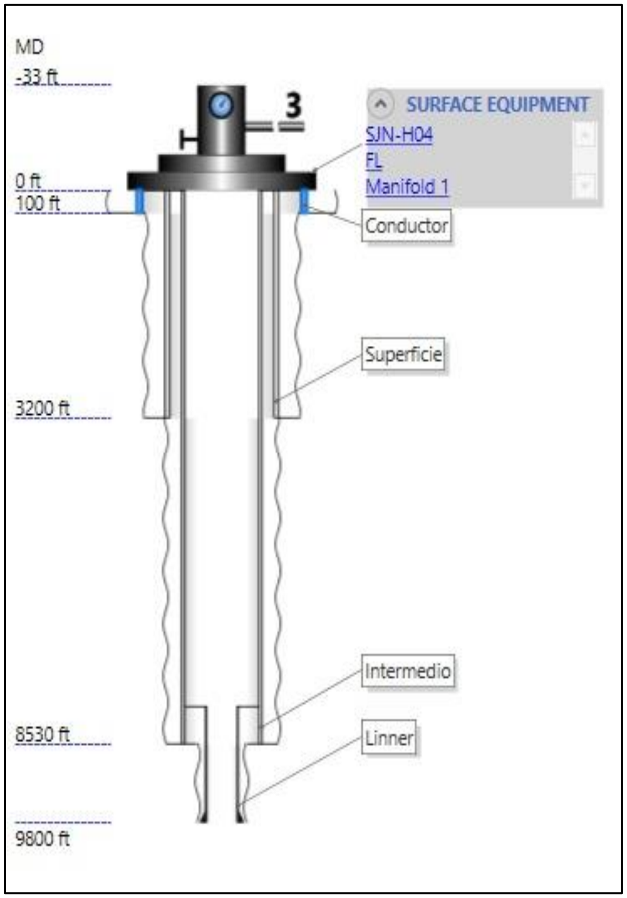
1	2	3	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
										*Joint Strength—1,000 lbf							
			**Internal Pressure Resistance, psi							Threaded and Coupled							
						Buttress Thread						Buttress Thread				Extreme Line	
				Round Thread		Regular Coupling		Special Clearance Coupling		Round Thread							
Size Outside Diameter (in.)	Nominal Weight Threads and Coupling (lbm/ft)	Grade	Plain End or Extreme Line	Short	Long	Same Grade	Higher Grade	Same Grade	Higher Grade	Short	Long	Regular Coupling	Regular Coupling Higher Grade†	Special Clearance Coupling	Special Clearance Coupling Higher Grade†	Standard Joint	Optional Joint
8 5/8	36.00	C-95	7,710	—	7,710	7,710	—	6,340	—	—	789	976	—	927	—	963	936
	40.00	C-95	8,670	—	8,670	8,670	—	6,340	—	—	904	1,092	—	927	—	1,042	979
	44.00	C-95	9,640	—	9,640	9,640	—	6,340	—	—	1,017	1,206	—	927	—	1,113	979
	49.00	C-95	10,740	—	10,380	10,740	—	6,340	—	—	1,144	1,334	—	927	—	1,113	979
	40.00	P-110	10,040	—	10,040	10,040	10,040	6,340	6,340	—	1,055	1,288	1,288	1,103	1,288	1,240	1,165
	44.00	P-110	11,160	—	10,380	11,160	11,160	6,340	6,340	—	1,186	1,423	1,423	1,103	1,412	1,326	1,165
	49.00	P-110	12,430	—	10,380	11,230	11,230	6,340	6,340	—	1,335	1,574	1,574	1,103	1,412	1,326	1,165
9 5/8	32.30	H-40	2,270	2,270	—	—	—	—	—	254	—	—	—	—	—	—	—
	36.00	H-40	2,560	2,560	—	—	—	—	—	294	—	—	—	—	—	—	—
	36.00	J-55	3,520	3,520	3,520	3,520	3,530	3,520	3,520	394	453	639	639	639	639	—	—
	40.00	J-55	3,950	3,950	3,950	3,950	3,950	3,660	3,950	452	520	714	714	714	714	770	770
	36.00	K-55	3,520	3,520	3,520	3,520	3,520	3,520	3,520	423	489	755	755	755	755	—	—
	40.00	K-55	3,950	3,950	3,950	3,950	3,950	3,660	3,950	486	561	843	843	843	843	975	975
	40.00	C-75	5,390	—	5,390	5,390	—	4,990	—	—	694	926	—	926	—	975	975
	43.50	C-75	5,930	—	5,930	5,930	—	4,990	—	—	776	1,016	—	934	—	975	975
	47.00	C-75	6,440	—	6,440	6,440	—	4,990	—	—	852	1,098	—	934	—	1,032	1,032
	53.50	C-75	7,430	—	7,430	7,430	—	4,990	—	—	999	1,257	—	934	—	1,173	1,053
	40.00	L-80	5,750	—	5,750	5,750	—	5,140	—	—	727	947	—	934	—	975	975
	43.50	L-80	6,330	—	6,330	6,330	—	5,140	—	—	813	1,038	—	934	—	975	975
	47.00	L-80	6,870	—	6,870	6,870	—	5,140	—	—	893	1,122	—	934	—	1,032	1,032
	53.50	L-80	7,930	—	7,930	7,930	—	5,140	—	—	1,047	1,286	—	934	—	1,173	1,053
	40.00	N-80	5,750	—	5,750	5,750	5,750	5,140	5,140	—	737	979	979	979	979	1,027	1,027
	43.50	N-80	6,330	—	6,330	6,330	6,330	5,140	5,140	—	825	1,074	1,074	983	1,074	1,027	1,027
	47.00	N-80	6,870	—	6,870	6,870	6,870	5,140	5,140	—	905	1,161	1,161	983	1,161	1,086	1,086
	53.50	N-80	7,930	—	7,930	7,930	7,930	5,140	5,140	—	1,062	1,329	1,329	983	1,229	1,235	1,109
	40.00	C-90	6,460	—	6,460	6,460	—	5,140	—	—	804	1,021	—	983	—	1,027	1,027
	43.50	C-90	7,120	—	7,120	7,120	—	5,140	—	—	899	1,119	—	983	—	1,027	1,027
	47.00	C-90	7,720	—	7,720	7,720	—	5,140	—	—	987	1,210	—	983	—	1,086	1,086
	53.50	C-90	8,920	—	8,460	8,920	—	5,140	—	—	1,157	1,386	—	983	—	1,235	1,109
	40.00	C-95	6,820	—	6,820	6,820	—	5,140	—	—	847	1,074	—	1,032	—	1,078	1,078
	43.50	C-95	7,510	—	7,510	7,510	—	5,140	—	—	948	1,178	—	1,032	—	1,078	1,078
	47.00	C-95	8,150	—	8,150	8,150	—	5,140	—	—	1,040	1,273	—	1,032	—	1,141	1,141
	53.50	C-95	9,410	—	8,460	8,460	—	5,140	—	—	1,220	1,458	—	1,032	—	1,297	1,164
	43.50	P-110	8,700	—	8,700	8,700	8,700	5,140	5,140	—	1,106	1,388	1,388	1,229	1,388	1,283	1,283
	47.00	P-110	9,440	—	9,440	9,160	9,160	5,140	5,140	—	1,213	1,500	1,500	1,229	1,500	1,358	1,358
	53.50	P-110	10,900	—	9,670	9,160	9,160	5,140	5,140	—	1,422	1,718	1,718	1,229	1,573	1,544	1,386

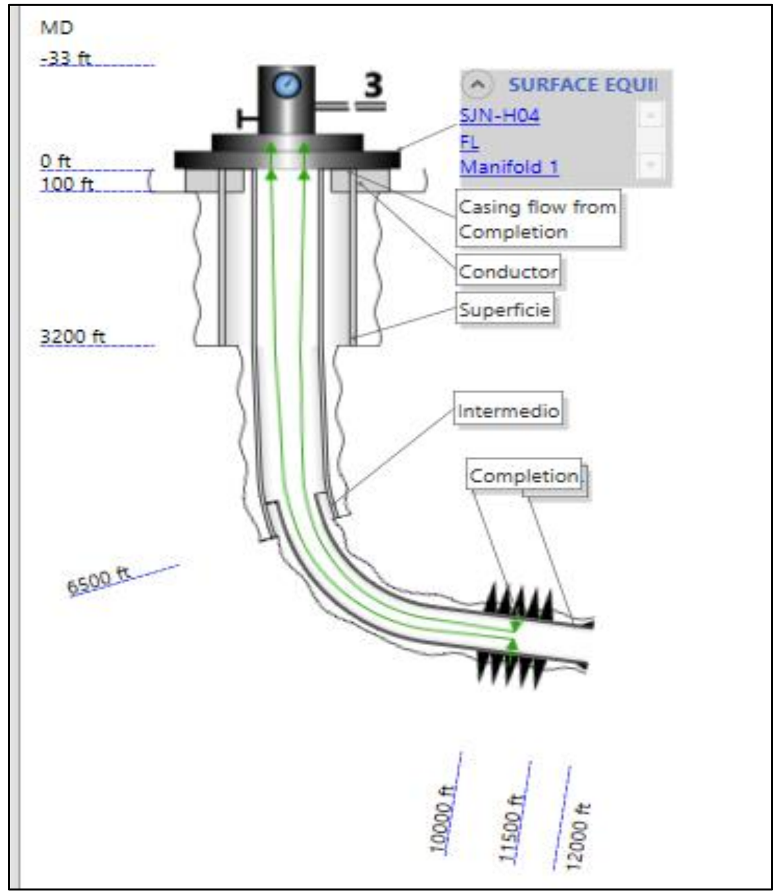
Tabla 92 API table for production liner design

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
																			*Joint Strength—1,000 lbf							
					Threaded and Coupled			Extreme Line				**Internal Pressure Resistance, psi							Threaded and Coupled							
															Buttress Thread						Buttress Thread					
													Round Thread		Regular Coupling		Special Clearance Coupling		Round Thread						Extreme Line	
Size Outside Diameter (in.)	Nominal Weight Threads and Coupling (lbm/ft)	Grade	Wall Thickness (in.)	Inside Diameter (in.)	Drift Diameter (in.)	Outside Diameter of Coupling (in.)	Outside Diameter Special Clearance Coupling (in.)	Drift Diameter (in.)	Outside Diameter of Box Powertight (in.)	Collapse Resistance (psi)	Pipe Body Yield Strength (1,000 lbf)	Plain End or Extreme Line	Short	Long	Same Grade	Higher Grade	Same Grade	Higher Grade	Short	Long	Regular Coupling	Regular Coupling Higher Grade[1]	Special Clearance Coupling	Special Clearance Coupling Higher Grade[1]	Standard Joint	Optional Joint
7	17.00	H-40	0.231	6.538	6.413	7.656	—	—	—	1,420	196	2,310	2,310	—	—	—	—	—	122	—	—	—	—	—	—	—
	20.00	H-40	0.272	6.456	6.331	7.656	—	—	—	1,970	230	2,720	2,720	—	—	—	—	—	176	—	—	—	—	—	—	—
	20.00	J-55	0.272	6.456	6.331	7.656	—	—	—	2,270	316	3,740	3,740	—	—	—	—	—	234	—	—	—	—	—	—	—
	23.00	J-55	0.317	6.366	6.241	7.656	7.375	6.151	7.390	3,270	366	4,360	4,360	4,360	4,360	4,360	3,950	4,360	284	313	432	432	421	432	499	499
	26.00	J-55	0.362	6.276	6.151	7.656	7.375	6.151	7.390	4,320	415	4,980	4,980	4,980	4,980	4,980	3,950	4,980	334	367	490	490	421	490	506	506
	20.00	K-55	0.272	6.456	6.331	7.656	—	—	—	2,270	316	3,740	3,740	—	—	—	—	—	254	—	—	—	—	—	—	—
	23.00	K-55	0.317	6.366	6.241	7.656	7.375	6.151	7.390	3,270	366	4,360	4,360	4,360	4,360	4,360	3,950	4,360	309	341	522	522	522	522	632	632
	26.00	K-55	0.362	6.276	6.151	7.656	7.375	6.151	7.390	4,320	415	4,980	4,980	4,980	4,980	4,980	3,950	4,980	364	401	592	592	533	561	641	641
	23.00	C-75	0.317	6.366	6.241	7.656	7.375	6.151	7.390	3,750	499	5,940	—	5,940	5,940	—	5,380	—	—	416	557	—	533	—	632	632
	26.00	C-75	0.362	6.276	6.151	7.656	7.375	6.151	7.390	5,220	566	6,790	—	6,790	6,790	—	5,380	—	—	489	631	—	533	—	641	641
	29.00	C-75	0.408	6.184	6.059	7.656	7.375	6.059	7.390	6,730	634	7,650	—	7,650	7,650	—	5,380	—	—	562	707	—	533	—	685	674
	32.00	C-75	0.453	6.094	5.969	7.656	7.375	5.969	7.390	8,200	699	8,490	—	8,490	7,930	—	5,380	—	—	633	779	—	533	—	761	674
	35.00	C-75	0.498	6.004	5.879	7.656	7.375	5.879	7.530	9,670	763	9,340	—	8,660	7,930	—	5,380	—	—	703	833	—	533	—	850	761
	38.00	C-75	0.540	5.920	5.795	7.656	7.375	5.795	7.530	10,680	822	10,120	—	8,660	7,930	—	5,380	—	—	767	833	—	533	—	917	761
	23.00	L-80	0.317	6.366	6.241	7.656	7.375	6.151	7.390	3,830	532	6,340	—	6,340	6,340	6,340	5,740	6,340	—	435	565	—	533	—	632	632
	26.00	L-80	0.362	6.276	6.151	7.656	7.375	6.151	7.390	5,410	604	7,240	—	7,240	7,240	7,240	5,740	7,240	—	511	641	—	533	—	641	641
	29.00	L-80	0.408	6.184	6.059	7.656	7.375	6.059	7.390	7,020	676	8,160	—	8,160	8,160	8,160	5,740	7,890	—	587	718	—	533	—	685	674
	32.00	L-80	0.453	6.094	5.969	7.656	7.375	5.969	7.390	8,610	745	9,060	—	9,060	8,460	9,060	5,740	7,890	—	661	791	—	533	—	761	674
	35.00	L-80	0.498	6.004	5.879	7.656	7.375	5.879	7.530	10,180	814	9,960	—	9,240	8,460	9,960	5,740	7,890	—	734	833	—	533	—	850	761
	38.00	L-80	0.540	5.920	5.795	7.656	7.375	5.795	7.530	11,390	877	10,800	—	9,240	8,460	10,800	5,740	7,890	—	801	833	—	533	—	917	761
	23.00	N-80	0.317	6.366	6.241	7.656	7.375	6.151	7.390	3,830	532	6,340	—	6,340	6,340	6,340	5,740	6,340	—	442	588	588	561	588	666	666
	26.00	N-80	0.362	6.276	6.151	7.656	7.375	6.151	7.390	5,410	604	7,240	—	7,240	7,240	7,240	5,740	7,240	—	519	667	667	561	667	675	675
	29.00	N-80	0.408	6.184	6.059	7.656	7.375	6.059	7.390	7,020	676	8,160	—	8,160	8,160	8,160	5,740	7,890	—	597	746	746	561	702	721	709
	32.00	N-80	0.453	6.094	5.969	7.656	7.375	5.969	7.390	8,610	745	9,060	—	9,060	8,460	9,060	5,740	7,890	—	672	823	823	561	702	801	709
	35.00	N-80	0.498	6.004	5.879	7.656	7.375	5.879	7.530	10,180	814	9,960	—	9,240	8,460	9,960	5,740	7,890	—	746	876	898	561	702	895	801
	38.00	N-80	0.540	5.920	5.795	7.656	7.375	5.795	7.530	11,390	877	10,800	—	9,240	8,460	10,800	5,740	7,890	—	814	876	968	561	702	965	801
	23.00	C-90	0.317	6.366	6.241	7.656	7.375	6.151	7.390	4,030	599	7,130	—	7,130	7,130	—	6,450	—	—	447	605	—	561	—	666	666
	26.00	C-90	0.362	6.276	6.151	7.656	7.375	6.151	7.390	5,740	679	8,150	—	8,150	8,150	—	6,450	—	—	563	687	—	561	—	675	675
	29.00	C-90	0.408	6.184	6.059	7.656	7.375	6.059	7.390	7,580	760	9,180	—	9,180	9,180	—	6,450	—	—	648	768	—	561	—	721	709
	32.00	C-90	0.453	6.094	5.969	7.656	7.375	5.969	7.390	9,380	839	10,190	—	9,520	9,520	—	6,450	—	—	729	847	—	561	—	801	709
	35.00	C-90	0.498	6.004	5.879	7.656	7.375	5.879	7.530	11,170	915	11,210	—	9,520	9,520	—	6,450	—	—	809	876	—	561	—	895	801
	38.00	C-90	0.540	5.920	5.795	7.656	7.375	5.795	7.530	12,820	986	12,150	—	9,520	9,520	—	6,450	—	—	883	876	—	561	—	965	801
	23.00	C-95	0.317	6.366	6.241	7.656	7.375	6.151	7.390	4,140	632	7,530	—	7,530	7,530	—	6,810	—	—	505	636	—	589	—	699	699
	26.00	C-95	0.362	6.276	6.151	7.656	7.375	6.151	7.390	5,880	717	8,600	—	8,600	8,600	—	6,810	—	—	593	722	—	589	—	709	709
	29.00	C-95	0.408	6.184	6.059	7.656	7.375	6.059	7.390	7,830	803	9,690	—	9,520	9,690	—	6,810	—	—	683	808	—	589	—	757	744
	32.00	C-95	0.453	6.094	5.969	7.656	7.375	5.969	7.390	9,750	885	10,760	—	9,520	10,050	—	6,810	—	—	768	891	—	589	—	841	744
	35.00	C-95	0.498	6.004	5.879	7.656	7.375	5.879	7.530	11,650	966	11,830	—	9,520	10,050	—	6,810	—	—	853	920	—	589	—	940	841
	38.00	C-95	0.540	5.920	5.795	7.656	7.375	5.795	7.530	13,440	1,041	12,820	—	9,520	10,050	—	6,810	—	—	931	920	—	589	—	1,013	841
	26.00	P-110	0.362	6.276	6.151	7.656	7.375	6.151	7.390	6,230	830	9,960	—	9,520	9,960	9,960	7,480	7,480	—	693	853	853	702	853	844	844
	29.00	P-110	0.408	6.184	6.059	7.656	7.375	6.059	7.390	8,530	929	11,220	—	9,520	11,220	11,220	7,480	7,480	—	797	955	955	702	898	902	886
	32.00	P-110	0.453	6.094	5.969	7.656	7.375	5.969	7.390	10,780	1,025	12,460	—	9,520	11,640	11,790	7,480	7,480	—	897	1,053	1,053	702	898	1,002	886
	35.00	P-110	0.498	6.004	5.879	7.656	7.375	5.879	7.530	13,020	1,119	13,700	—	9,520	11,640	11,790	7,480	7,480	—	996	1,096	1,150	702	898	1,118	1,002
	38.00	P-110	0.540	5.920	5.795	7.656	7.375	5.795	7.530	15,140	1,205	14,850	—	9,520	11,640	11,790	7,480	7,480	—	1,087	1,096	1,239	702	898	1,207	1,002

DESIGN OF HORIZONTAL AND VERTICAL WELLS

Figura 153: Design of horizontal and vertical wells.





4.4.2.7.2. *Wellhead design*

Figura 154: Wellhead - SJN-X01 well

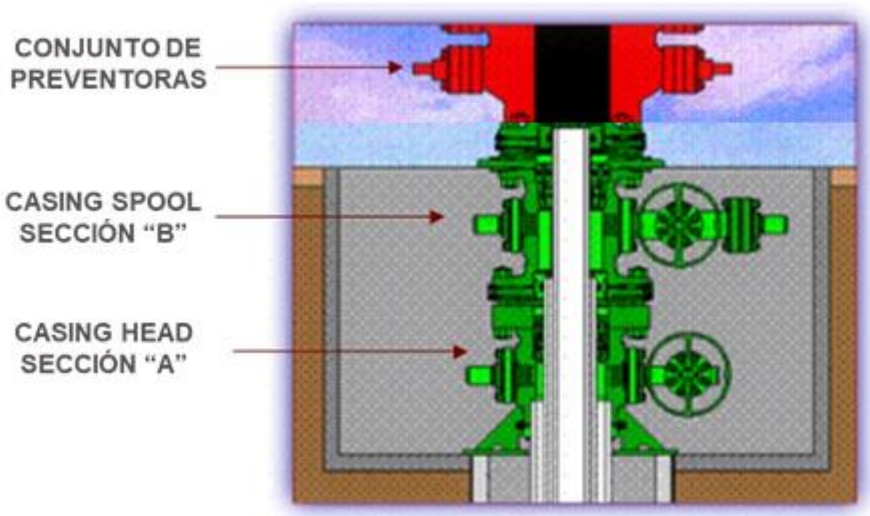


Tabla 93: BOP Description

SECTION	DESCRIPTION
"A"	20" Tipo Slip-Lok 20 ¾", 3M x 21 ¼ x 5M Braden Head con 2 1/16", 3M studded outlets and a base plate of 30" de O.D.
"B"	21 ¼ x 5M x 13 5/8", 10M Casing Spool con 2-1/16", 10 M studded outlets.

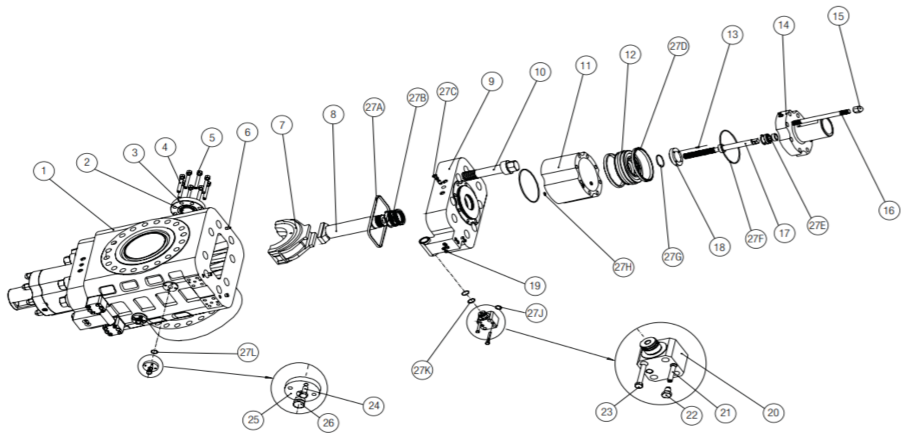
4.4.2.7.3. *BOP Requirements*

BOP selection is based on offset wells drilling programs.

- Integrated Equipment 13 5/8": 8000 psi (5M), Double RAM BOP 10000 psi (10M) and Individual RAM BOP de 10000 psi (10M).

Based in 139° article of DS-032-2004 was proposed a pressure testing program for BOP once a time every two weeks after a drilling or cementing operation.

Figura 155. 13 5/8 BOP RAM Spare parts



Item	Qty	Description
1	1	Body (Single)
1A	1	Body (Double)
2	1	Gasket
3	1	Blind flange
4	8	Bolt
5	8	Nut
6	2	Cone pin
7	1	Ram assembly
8	2	Ram shaft
27A	2	Seal ring, bonnet
27B	2 pair	Ram shaft seal
27C	2 pair	Secondary seal
9	1	Right bonnet
9A	1	Left bonnet
10	16	Bolt, bonnet
11	2	Cylinder
12	2	Piston
27D	4	Seal ring, piston
13	4	Screw
14	1	Right cylinder head
14A	1	Left cylinder head

Item	Qty	Description
15	16	Nut
16	16	Bolt
27E	2 pair	Locking shaft seal
17	2	Locking shaft
27F	4	O –ring
18	2	Piston locking head
27G	2	O-ring
27H	4	O-ring
19	1	Plug R1/2
27J	4	O-ring
20	4	Hinge bracket
21	8	Locating pin
22	8	Screw
23	16	Screw
27K	8	O-ring
27L	2	O-ring
24	8	Screw
25	2	Oil pipe bracket
26	12	Plug MPT
27	1	Repair Kit
28	2 set	Manual control assembly

BOP Characteristics

BOP selection was made taking in count possible reservoir pressure and safety factors for exploratory, confirmatory and development wells. The selected BOP is capable to support 10000 psi, a pressure resistance that make it enough for drilling the SJN-X01 well.

Figura 156 Selected BOP Characteristics (Integrated Equipments)

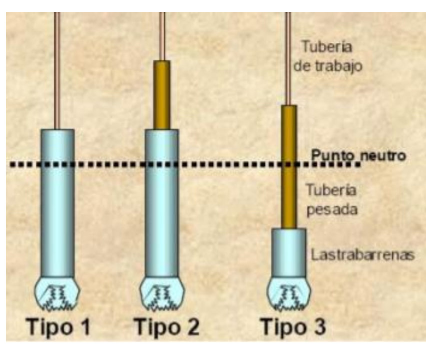
		10,000 Double Ram		10,000 Single Ram	
Bore Size		13 5/8 in	346.1 mm	13 5/8 in	346.1 mm
Pressure Rating		10000 psi	69 MPa	10000 psi	69 MPa
End Connections		Studded top and flanged bottom			
Test Pressure		Per API 16A			
Operating Pressure		1500 psi	10.4 MPa	1500 psi	10.4 MPa
Hydraulic Fluid	Open	7.6 gal	28.3 liters	7.6 gal	28.3 liters
	Close	8.8 gal	33.3 liters	8.8 gal	33.3 liters
Piston Stroke		13.39 in	340 mm	13.39 in	340 mm
Weight		30,400 lbs	13,820 kg	12,620 lbs	5737 kg
Ring Joint		BX-159	BX-159	BX-159	BX-159
Width		43.7 in	1110 mm	43.7 in	1110 mm
Height		58.5 in	1485 mm	37.8 in	960 mm
Length		105.12 in	2672 mm	105.12 in	2672 mm

4.4.2.8. Drill string Design

The drill string is an arrangement of tools and tubulars that is mainly responsible for transmitting the rotation generated on the surface, by the rotary table or the top drive and allowing the circulation of fluids in the well.

Neutral point is where compression forces begin to change into tension forces and has an important consideration during drilling operations because it must be present in a thick wall tubular to avoid stress fatigue in the drill pipe.

Figura 157: Neutral point on BHA



To determine BHA height is necessary to use the present equation

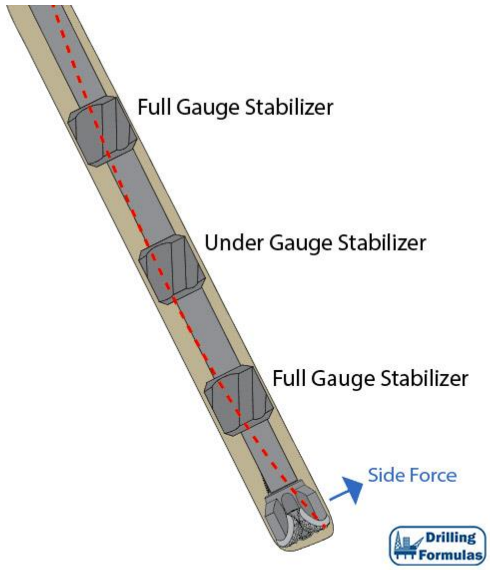
$$Pn = \frac{WOB}{FfxPlbx1.49}$$

$$Pn = Neutral\ point\ height$$

$$WOB = Weight\ On\ Bit$$

An important part of the drill string is the BHA because this is the part that exert weight on the bit. For SJN-X01 well will be use a packed BHA to maintain a vertical trajectory and avoid deviations during operation.

Figura 158 Packed BHA (Drilling Formulas)

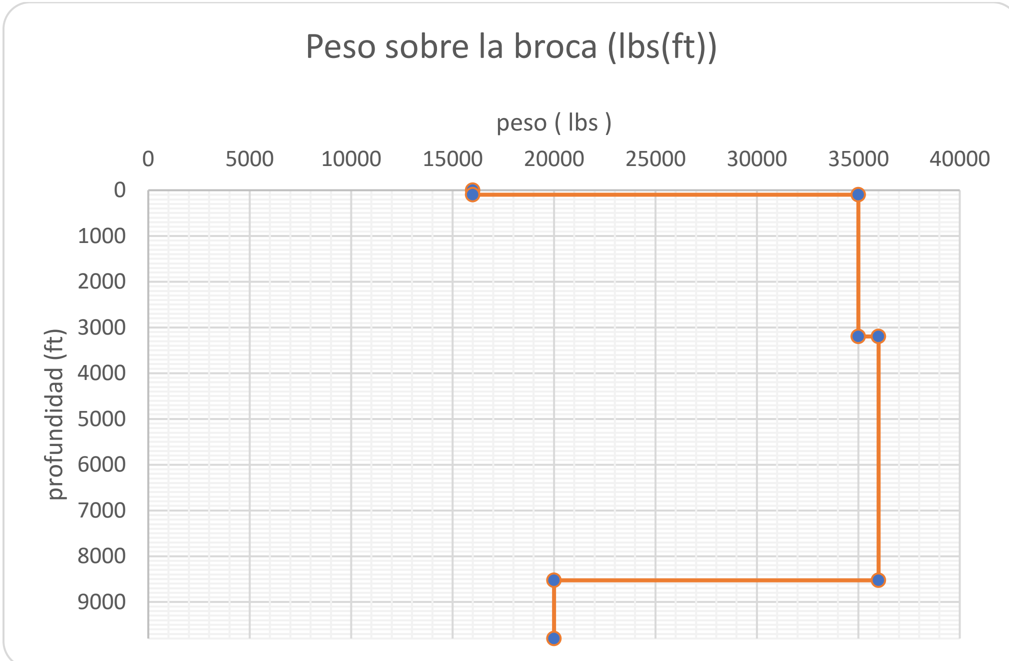


From rock strength data was determined the estimated weight on bit necessary to drill SJN-X01 well in an effective way. It´s important to apply the correct weight on bit to reach optimal ROP.

Tabla 94: Weight on Bit – SJN-X01 well

Weight(lb.)	Depth(ft)
16000	0
16000	100
35000	100
35000	3200
36000	3200
36000	8530
20000	8530
20000	9800

Figura 159: Weight On Bit vs Depth



4.4.2.8.1. Conductor section

The first drill string will be conformed only by drill collar and bit because is the shortest section in well (100 ft).

4.4.2.8.2. Surface section

Figura 160 Data for drill string #2 design

Section	0-3200 ft
mud density	8.9 ppg
Buoyancy factor	0.8534
WOB	40000 lb
Safety factor	0.8
Drill collar	6 ½´´ ;90.61 lb/ft; II ;31.5 ft
Heavy weight	5´´ ;57.93 lb/ft; II ;31 ft
Drill pipe	5´´ ;24.11 lb/ft; II; 31.5 ft

1. Buoyancy factor

$$Ff = 1 - \frac{MW}{62.4}$$

$$Bf = 0.8573$$

2. Drill collar length

$$Dcl = \frac{WOB}{0.8xFfxWdc}$$

$$Dcl = 792\ ft$$

$$\#\ Drillcollar = 20$$

3. Neutral point will be located at 80% of drill collar length

$$Dcl = 792x0.8 = 633\ ft$$

4. HWDP required weight

$$Whw = WDcxLDcx0.2$$

$$Whw = 14353.7\ lbs$$

$$Cantidad\ de\ Whw = 8$$

5. Drill pipe length

$$Ldp = 2250ft$$

$$\#\ Drillpipe = 72$$

Tabla 95 Drill string #2

Quantity	Component	Length(ft)	Length Cumulative ft)
1	Bit	1	1
1	NBS	5.5	6.5
1	Mud motor	-	6.5
2	6 1/2 DC	63	69.5
1	MWD	-	69.5
1	STB	5.5	75
18	6 1/2 DC	567	642
1	Collar	-	-
3	5´´ HWDP	93	735
1	JAR	30	765
3	5´´ HWDP	93	858
1	ACELERATOR	30	888
2	5´´ HWDP	62	950

4.4.2.8.3. Intermediate section

Tabla 96 Data for drill string #3 design

Section	0-8530 ft
Mud Weight	11 ppg
Buoyancy Factor	0.85
WOB	50000 lb
Safety Factor	0.8
Drill collar	6 ½´´ ;90.61 lb/ft; II ;31.5 ft
Heavy weight	5´´ ;57.93 lb/ft; II ;31 ft
Drill pipe	5´´ ;24.11 lb/ft; II; 31.5 ft

1. Buoyancy factor

$$Ff = 1 - \frac{MW}{62.4}$$

$$Bf = 0.823$$

2. Drill collar length

$$Dcl = \frac{Psb}{0.8xFfxWdc}$$

$$Dcl = 811.12\ ft$$

$$Cantidad\ de\ Dcl = 21$$

6. Neutral point will be located at 80% of drill collar length

$$Dcl = 811.12x0.8 = 648.9\ ft$$

3. HWDP required weight

$$Whw = WDcxLDcx0.2$$

$$Whw = 14699.28\ lbs$$

$$Cantidad\ de\ Whw = 8$$

4. Drill pipe length

$$Ldp = 7548.5ft$$

$$\#\ Drillpipe = 240$$

Tabla 97 Drill string #3

Quantity	Component	Length(ft)	Total length (ft)
1	Bit	1	1
1	NBS	5.5	6.5
1	Mud motor	-	6.5
2	6 1/2 DC	63	69.5
1	MWD Tool	-	69.5
1	STB	5.5	75
19	6 1/2 DC	598.5	673.5
3	5´´ HWDP	93	766.5
1	JAR	30	796.5
3	5´´ HWDP	93	889.5
1	ACELERATOR	30	919.5
2	5´´ HWDP	62	981.5

4.4.2.8.4. Production section

Tabla 98 Data for drill string #4 design

Section	**8230-9800 ft**
Mud Weight	**11.5 ppg**
Buoyancy Factor	**0.84427**
WOB	**34000 lb**
Safety Factor	**0.8**
Drill collar	**6 ½´´ ;90.61 lb/ft; II ;31.5 ft**
Heavy weight	**5´´ ;57.93 lb/ft; II ;31 ft**
Drill pipe	**5´´ ;24.11 lb/ft; II; 31.5 ft**

Calculation and Results

1. Buoyancy factor

$$Ff = 1 - \frac{Dlodo}{62.4}$$

$$Ff = 0.82$$

2. Drill collar length

$$Dcl = \frac{Psb}{0.8xFfxWdc}$$

$$Dcl = 555.557\ ft$$

$$Cantidad\ de\ Dcl = 14$$

7. Neutral point will be located at 80% of drill collar length

$$Dcl = 811.12x0.8 = 444.44\ ft$$

3. HWDP required weight

$$Whw = WDcxLDcx0.2$$

$$Whw = 10067.8\ lbs$$

$$Cantidad\ de\ Whw = 6$$

4. Drill pipe length

$$Ldp = 9101ft$$

$$Cantidad\ de\ Dp = 289$$

Tabla 99: Drill string #4

Quantity	Component	Length(ft)	Length total(ft)
1	Drill Bit	1	1
1	NBS	5.5	6.5
1	Mud motor	-	6.5
2	6 1/2 DC	63	69.5
1	MWD Tool	-	69.5
1	STB	5.5	75
12	6 1/2 DC	378	453
2	5´´ HWDP	62	515
1	JAR	30	545
2	5´´ HWDP	62	607
1	ACELERATOR	30	637
2	5´´ HWDP	62	699

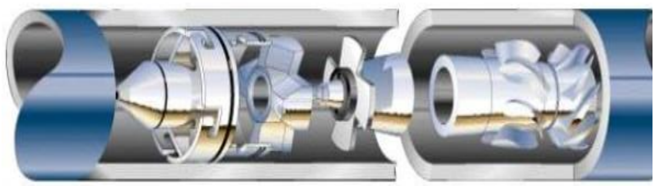
Note: For this well in San Jacinto field is planned to use Spiral drill collar to reduce stuck pipe by differential pressure having less contact area (around 40%) between drill collar and formation.

4.4.2.8.5. Considerations of performance improvement

The use of mud motor and MWD system is not exclusive for directional and horizontal wells, in this case we use these tools to improve the drilling performance, mud motor helps to increase rpm, torque and rate of penetration (ROP) reducing drilling time and cost, on the other hand, the MWD system measure the deviation in well and transmit important data of rpm, wob, torque and pressure from downhole to surface helping to take actions to maintain the vertical trajectory in vertical wells.

Figura 161: Mud motor (Downhole motor)

Figura 162: MWD system



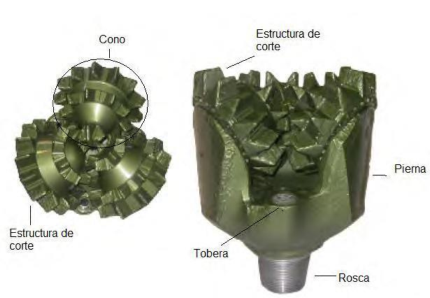
4.4.2.9. Bit Selection

Conductor section (26 inches)

The conductor section will be drilled using a IADC 115 steel tooth tricone bit because shallow formation presents low compression strength also it helps to maintain stability and achieve more rate of penetration.

The nozzle distribution used for this section improve the cuttings transport and the bit and hole cleaning.

Figura 163 Bit selection for conductor section

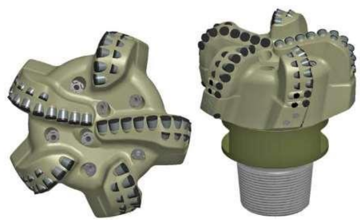


Surface section (17-1/2 inches)

Surface section presents formation with low compressive strength a IADC S322 PDC bit with downhole motor are a good selection because is possible to achieve high ROP and maintain a stable trajectory during drilling operation.

The bit uses 19 mm primary cutters and have 7 nozzles to improve hydraulics and cleaning in well.

Figura 164 Bit selection for surface section



Intermediate Section (12-1/4 inches)

Intermediate section is the longest in the well and requires more drilling time, also rock compressive strength is bigger than past section. A tricone bit possibly fail during operation and requires replace the bit, and to avoid this situation and optimize times an IADC S322 PDC bit is selected as the best option for this section.

Figura 165 Bit selection for intermediate section

Production Section (8-1/2")

The last Section in well requires an IADC M323 PDC bit. A matrix body pdc bit is required for this section because it will drill across Vivian and Chonta formations, productive formation conformed mainly by sandstone and recognized as an erosive formation. In this environment a steel body bit could fail suffering excessive damage.

Tabla 100 Recommended bit for every section in SJN-X01 well

N°	Size	Drill bit type	IADC	Weight over bit	GPM	Depth	Brand
1	26	T11	115	10-50 klb	250	100	National Oilwell Varco
2	17.5	RSR519M	S322	50 klb	1100	3200	National Oilwell Varco
1	12.25	RSX192HFGSW	S322	5-49 klb	600	8530	National Oilwell Varco
1	8.5	DSR619M	M323	34 klb	600	9800	Baker Hughes

4.4.2.10. Drilling Hydraulics

Hydraulics are very important for drilling operations. In this section is necessary to establish the correct flow rate to maintain a laminar fluid flow regime in the annular to avoid formation erosion and achieve a good hole cleaning.

For every Section in the well is necessary to calculate fluid velocity and pressure loss in pipe, annular and bit.

4.4.2.10.1. Surface section

- **Annular pressure loss**

<u>Velocity in pipe</u>

$$V = \frac{q}{2.448(d_2^2 - d_1^2)}$$

<u>Pressure loss</u>

$$\frac{d_{pf}}{d_L} = \frac{\mu v}{1500\left(d_2^2 - d_1^2 - \frac{d_2^2 - d_1^2}{\ln \frac{d_2}{d_1}}\right)}$$

- v = velocidad media de flujo ft/s
- μ = viscosidad cp
- dpf /dL = gradiente de presión friccional psi/ft
- d_1 = diámetro externo del tubo interior Pulg.
- d_2 = diámetro interno del tubo exterior. Pulg.

<u>Cuttings slip velocity</u>

$$Vdescenso_{\left(\frac{ft}{seg}\right)} = \frac{2 * grav * D^2 * (\rho_{rec} - MW)}{0.145454 * \mu_{lodo}}$$

- **Cuttings slip velocity**

Tabla 101 Cuttings slip velocity in surface section

Velocity cuttings descent	
Gravity(ft/s2)	32.2
Diameter of cuttings (ft)	0.00833333
Cutting density (lb/ft3)	162.24
Mud density (lb/ft3)	66.576402
Viscosity (cp)	13.5
Descent velocity (ft/s)	0.21787603

Tabla 102 Annular pressure loss in surface section

Loss of pressure in the annulus	
Depth(ft)	3200
Viscosity(cp)	13.5
Mud density(ppg)	8.9
Casing inside diameter (in)	12.415
Outer diameter of string (in)	5.00
Q(gpm)	800
Average annular velocity (ft/s)	2.749
Frictional pressure gradient (psi/ft)	0.00192443
Frictional pressure drops in annulus (psi)	6.158

- **Pipe pressure loss**

Reynolds number

$$Nre = \frac{928p\ v\ d}{u}$$

Friction factor

$$f = \frac{0.0791}{Ne^{0.25}}$$

Pressure loss

$$\frac{Dpf}{Dl} = \frac{f\ p\ v^2}{25.8\ d}$$

Tabla 103 Pipe pressure loss in surface section

Friction loss in the pipeline	
Depth(ft)	3200
Viscosity(cp)	13.5
Mud density(ppg)	8.9
String inside diameter (in)	4.276
Q(gpm)	800
Average drill pipe velocity (ft/s)	18.0911
Reynolds number	47326.8026
Friction factor(f)	0.0053629
Pressure drops(psi)	453.1

- **Bit pressure loss**

$$\Delta p_{bit} = \frac{8.311 * 10^{-5} * MW * Q}{c_d^2 * A_t^2}$$

Tabla 104 Bit pressure loss in surface section

Loss of friction on drill bit	
TFA	0.884
Mud density	8.9
Q(gpm)	800
ct	0.95
Pressure drops	671.230253

4.4.2.10.2. Intermediate section

Every section uses the same formulas for drilling hydraulics, the only difference is the change in tubular and hole diameter.

- **Cuttings slip velocity**

Tabla 105 Cuttings slip velocity in intermediate section

Velocity cuttings descent	
Gravity(ft/s2)	32.2
Diameter of cuttings (ft)	0.00833333
Cutting density (lb/ft3)	162.24
Mud density (lb/ft3)	82.2854407
Viscosity (cp)	14.5
Descent velocity (ft/s)	0.16953983

- **Annular pressure loss**

Tabla 106 Annular pressure loss in intermediate section

Loss of pressure in the annulus	
Depth(ft)	8530
Viscosity(cp)	14.5
Mud density(ppg)	11
Casing inside diameter (in)	8.535
Outer diameter of string (in)	5.00
Q(gpm)	500
Average annular velocity (ft/s)	4.44
Frictional pressure gradient (psi/ft)	0.001030616
Frictional pressure drops in annulus (psi)	8.79

- **Pipe pressure loss**

Tabla 107 Pipe pressure loss in intermediate section

Friction loss in the pipeline	
Depth(ft)	8530
Viscosity(cp)	14.5
Mud density(ppg)	11
String inside diameter (in)	4.276
Q(gpm)	500
Average drill pipe velocity (ft/s)	11.340
Reynolds number	34137.79
Friction factor(f)	0.005819258
Pressure drops(psi)	636.51

- **Bit pressure loss**

Tabla 108 Bit pressure loss in intermediate section

Loss of friction on drill bit	
TFA	0.4601
Mud density	11
Q(gpm)	500
ct	0.95
Pressure drops	1196.284013

4.4.2.10.3. Production section

Tabla 109: Descent speed in section IV

Velocity cuttings descent	
Gravity(ft/s2)	32.2
Diameter of cuttings (ft)	0.00833333
Cutting density (lb/ft3)	162.24
Mud density (lb/ft3)	86.025688
Viscosity (cp)	12.5
Descent velocity (ft/s)	0.18746622

- **Annular pressure loss**

Tabla 110: Annular pressure loss in production section

Loss of pressure in the annulus	
Depth(ft)	9800
Viscosity(cp)	12.5
Mud density(ppg)	11.5
Casing inside diameter (in)	6.184
Outer diameter of string (in)	5.00
Q(gpm)	300
Average annular velocity (ft/s)	9.44
Frictional pressure gradient (psi/ft)	0.001603687
Frictional pressure drops in annulus (psi)	15.7

- **Pipe pressure loss**

Tabla 111 Pipe pressure loss in production section

Friction loss in the pipeline	
Depth(ft)	9800
Viscosity(cp)	12.5
Mud density(ppg)	11.5
String inside diameter (in)	4.276
Q(gpm)	300
Average drill pipe velocity (ft/s)	6.890
Reynolds number	25152.91
Friction factor(f)	0.006281009
Pressure drops(psi)	304.60

- **Bit pressure loss**

Tabla 112 Bit pressure loss in production section

Loss of friction on drill bit	
TFA	0.574
Mud density	11.5
Q(gpm)	300
ct	0.95
Pressure drops	289.2828162

4.4.2.10.4. Hydraulics results

Tabla 113 Drilling hydraulics results

	Results		
	Superficial	Intermediate	production
Annular friction pressure loss (psi)	6.16	8.79	15.72
Pressure loss (psi)	453.12	636.51	304.60
Drill bit pressure loss (psi)	671.23	1196.28	289.28
Total pressure loss	1130.51	1841.58	609.60
Power	527.658	537.217	106.697

- **Mud volume in well**

Tabla 114 Mud volume per section

	SUPERFICIAL	INTERMEDIATE	PRODUCTION
	Section 17.5	Section 12 1/4 8530	Section 8 1/2 9800
Tb	DP + HWDP + DC	DP + HWDP + DC	DP + HWDP + DC
bbl	930	1261	776

4.4.2.11. Cementing Program

The cementing program have as an objective

- Assure potential for optimal production
- Contribute to efficient well development
- Assure an efficient installation in operability and costs (PERUPETRO, Programa de perforación 1X - BLOCK 8323, 2020)

4.4.2.11.1. Initial Data

Realize a correct cementing calculation required some data and considerations.

Tabla 115: SJN-X01 well data

DRILL BITS	DIAMETER	TYPES
Conductor	26”	Tricónica
Surface	17 ½”	PDC
Intermediate	12 ¼”	PDC
Production Liner	8 ½”	PDC

Tabla 116: SJN-X01 well depth data

CASING	DIAMETER	DEPTH (ft)
Conductor	20”	100
Surface	13 3/8”	3200
Intermediate	9 5/8”	8530
Production Liner	7”	8230 - 9800

4.4.2.11.2. Required parameters

- **Cement slurry density**

Determine density of slurry require some data

  - API class for oil well cement
  - Water Requirement table
  - Physical properties of cement and additives

Cement slurry density

$$\rho l = \frac{Wl}{Vl}$$

Where:

- ✓ *ρl: Cement slurry density (ppg)*
- ✓ *Wl: Slurry weight (lb)*
- ✓ *Vl: Slurry volume(gl)*
  - Slurry performance

$$R = \frac{Vl}{7.48}$$

Where:

- ✓ *R = Cement slurry performance (ft3/Sx)*
- ✓ *Vl = Cement slurry volume (gal)*

- **Cement volume in well**
  - Annular capacity

$$Va = \frac{(D_1^2 - D_2^2)}{1029.4}$$

Donde:

- ✓ *Va: Annular capacity (Bbl/ft)*
- ✓ *D1: Larger diameter (in)*
- ✓ *D2: Shorter diameter (in)*

- Pipe capacity

$$Vt = \frac{(ID^2)}{1029.4}$$

Donde:

- ✓ *Vt: Pipe capacity (Bbls/ft)*
- ✓ *ID: Tubing inside diameter (in)*

- Cement sacks required

$$Sx = \frac{Vc}{r}$$

Donde:

- ✓ *Sx: Cement sacks*
- ✓ *Vc: Cement slurry volume (ft3)*
- ✓ *r: Slurry performance (ft3/Sx)*

- **Water required**

  Water properties for analysis

  - Reynolds number = 1000
  - Plastic viscosity = 1.6 cp
  - Annular velocity

$$v = \frac{Nre * u_p}{928 * \rho * 0.8165 * (D1 - D2)}$$

- ✓ *v: Annular velocity (ft/seg).*
- ✓ *Nre: Reynolds number.*
- ✓ *up: Plastic viscosity (cp)*
- ✓ *ρ: Wash fluid density (ppg).*
- ✓ *De: Equivalent diameter (in)*

- Wash fluid height

$$hfl = v * t$$

- ✓ *Hfl: Wash fluid height (ft)*
- ✓ *V: Annular velocity (ft/seg)*
- ✓ *T: Removing time (seg)*

- Wash fluid volume

$$Vfl = hfl * (\frac{D_1^2 - D_2^2}{1029.4})$$

- ✓ *hfl: Wash fluid height (ft)*
- ✓ *D1: External diameter (in)*
- ✓ *D2: Internal diameter (in)*

- Slurry water requirements

$$Vh2o = \frac{Requirement * \#sx}{42}$$

- ✓ *Vh2o: Slurry water requirement*
- ✓ *#sx: Cement Sacks*

- **Friction pressure**
  - For Newtonian fluids
    - Reynolds number

$$Nre = \frac{928 * p * v * 0.8165\ (D2 - D1)}{\mu}$$

Donde:

- ✓ *Nre: Reynolds number*
- ✓ *ρl: Density (ppg)*
- ✓ *v: Fluid velocity (ft/seg)*
- ✓ *D2: External diameter (in)*
- ✓ *D1: Internal diameter (in)*

- Friction factor

$$f = \frac{16}{Nre}$$

Where:

- ✓ *f: Friction factor*
- ✓ *Nre: Reynolds number*

- Friction pressure

$$Pf = \frac{0.039 * pl * L * v^2 * f}{0.8165 * (D2 - D1)}$$

Where:

- ✓ *Pf: Friction pressure (psi)*
- ✓ *ρl: Cement Slurry density (ppg)*
- ✓ *f: Friction factor*
- ✓ *v: Fluid velocity (ft/seg)*
- ✓ *D2: External diameter (in)*
- ✓ *D1: Internal diameter (in)*
- ✓ *L: Length (ft)*

- For Bingham's plastic fluids
  - μ_p = 24.7 cp
  - τ = 11 lb/100ft2
  - Reynolds number

$$Nre = \frac{928 * p * v * 0.8165\ (D2 - D1)}{\mu p + \dfrac{5 * \tau y * (D2 - D1)}{v}}$$

Where:

- ✓ *Nre: Reynolds number*
- ✓ *ρl: Density (ppg)*
- ✓ *v: Velocity (ft/seg)*
- ✓ *D2: External diameter (in)*
- ✓ *D1: Internal diameter (in)*
- ✓ *τ: Elastic limit (lb/100ft2)*

- Friction factor

$$f = \frac{16}{Nre}$$

- ✓ *f: Friction factor*
- ✓ *Nre: Reynolds number*

- Friction pressure

$$Pf = \frac{0.039 * pl * L * v^2 * f}{0.8165 * (D2 - D1)}$$

- ✓ *Pf: Friction pressure (psi)*
- ✓ *ρl: Cement slurry density (ppg)*
- ✓ *f: Friction factor*
- ✓ *v: Fluid velocity (ft/seg)*
- ✓ *D2: External diameter (in)*
- ✓ *D1: Internal diameter (in)*
- ✓ *L: Length (ft)*

- For pseudo-plastic fluids
  - K’ = 0.0642
  - n’ = 0.323
  - Reynolds number

$$Nre = \frac{2.28 * \rho * v^{2-n'} * (D2 - D1)^{n'}}{144^{n'} * K' * (\frac{2n' + 1}{3n'})^{n'}}$$

- ✓ *Nre: Reynolds number*
- ✓ *ρl: Density (ppg)*
- ✓ *v: Fluid velocity (ft/seg)*
- ✓ *D2: External diameter (in)*
- ✓ *D1: Internal diameter (in)*
- ✓ *n’: Adimensional factor*
- ✓ *k’: lb/100ft2*

- Friction factor

$$f = \frac{16}{Nre}$$

- ✓ *f: Frictio factor*
- ✓ *Nre: Reynolds number*

- Friction pressure

$$Pf = \frac{0.039 * pl * L * v^2 * f}{0.8165 * (D2 - D1)}$$

- ✓ *Pf: Friction pressure (psi)*
- ✓ *ρl: Cement slurry density (ppg)*
- ✓ *f: Friction factor*
- ✓ *v: Velocity (ft/seg)*
- ✓ *D2: External diameter (in)*
- ✓ *D1: Internal diameter (in)*
- ✓ *L: Length (ft)*

- **Operation time**
  - Flow rate

$$Q = \frac{v * \pi * (D_2^2 - D_{1)}^2}{4 * 13.476}$$

- ✓ *Q: Flow rate (BPM)*
- ✓ *v: Flow velocity (ft/seg)*
- ✓ *D1: Larger diameter (in)*
- ✓ *D2: Shorter diameter (in)*

  - Operation time

$$t = \frac{Va + Vt + Vfl}{Q}$$

- *t: Operation time (min)*
- *Va: Annular volume (Bbl)*
- *Vt: Pipe volume (Bbs)*
- *Vfl: Wash fluid volume (Bbl)*
- *Q: Flow rate (BPM)*

4.4.2.11.3. *Cementing calculation*

Cement Slurry Densities

- **Lead cement slurry**

Tabla 117 Lead cement slurry density

Materials	*W*	*Ṽ*	*V*	*Yield*
	Lib	*(gal/lib)*	*(gal)*	
Cement G	94.00	0.0382	3.59	5.0
Bentonite (12%)	11.28	0.0453	0.51	7.8
Water	106.62		12.80	
	211.90		**16.90**	**12.8**

Slurry density	12.54	*lb/gal*
Slurry Yield	2.26	*ft3/sx*

- **Tail cement slurry**

Tabla 118 Tail cement slurry density

Materials	*W*	*Ṽ*	*V*	*Yield*
	Lib	*(gal/lib)*	*(gal)*	
Cement G	94.00	0.0382	3.59	5.0
Silica Fluor (17%)	15.98	0.0456	0.73	0.8
Water	48.31		5.80	
	158.29		**10.12**	**5.8**

Slurry density	15.64	*lb/gal*
Slurry Yield	1.35	*ft3/sx*

Cement slurry volume

Tabla 119: Cement slurry volume for conductor section

CONDUCTOR CASING		
Main slurry		
ØDrill bit	26	*in*
Øcsg	20	*in*
Depth	100	*ft*
C26"-20"	0.26812	*bls/ft*
Volume	26.81	*Bls*
Volume	150.54	*ft3*
Sacks	66.62	*sx*

Tabla 120: Cement slurry volume for surface section

SUPERFICIAL CASING								
Main slurry			Fill slurry					
ØDrill bit	17 1/2	*in*	**ØDrill bit**	17 1/2	*in*	**Øcsg1**	19 5/8	*in*
Øcsg	13 3/8	*in*	**Øcsg**	13 3/8	*in*	**Øcsg2**	13 3/8	*in*
Profundidad	500	*ft*	**Depth**	2500	*ft*	**Depth**	200	*ft*
C17 1/2"-13 3/8"	0.1237	*bls/ft*	**C**17 1/2"-13 3/8"	0.12372	*bls/ft*	**C**20"-13 3/8"	0.20036	*bls/ft*
Volume	61.86	*Bls*	**Volume**	309.30	*Bls*	**Volume**	40.07	*Bls*
Volume	347.32	*ft3*	**Volume**	1736.62	*ft3*	**Volume**	224.99	*ft3*
Sacks	256.73	*sx*	**Sacks**	768.55	*sx*	**Sacks**	99.57	*sx*

Tabla 121: Cement slurry volume for intermediate section

INTERMEDIATE CASING					
Main slurry			Fill slurry		
ØDrill bit	12 1/4	*in*	**ØDrill bit**	12 1/4	*In*
Øcsg	9 5/8	*in*	**Øcsg**	9 5/8	*In*
Depth	700	*ft*	**Depth**	1800	*Ft*
C17 1/2"-13 3/8"	0.05578	*bls/ft*	**C**17 1/2"-13 3/8"	0.05578	*bls/ft*
Volume	39.05	*Bls*	**Volume**	100.41	*Bls*
Volume	219.24	*ft3*	**Volume**	563.75	*ft3*
Sacks	162.05		**Sacks**	249.49	

Tabla 122: Cement slurry volume for production section

PRODUCTION LINER					
Main slurry					
ØDrill bit	8 1/2	*in*	**Øcsg**	9	*in*
Øliner	7	*in*	**Øliner**	7	*in*
Depth	1270	*ft*	**Depth**	300	*ft*
C17 1/2"-13 3/8"	0.02259	*bls/ft*	**C**17 1/2"-13 3/8"	0.03110	*bls/ft*
Volume	28.68	*Bls*	**Volume**	9.33	*Bls*
Volume	161.05	*ft3*	**Volume**	52.39	*ft3*
Sacks	119.04	*sx*	**Sacks**	38.73	*sx*

Tabla 123: Required cement slurry volume

	MAIN SLURRY		FILL SLURRY	
	Volume (Bls)	**Sacks (sx)**	**Volume (Bls)**	**Sacks (sx)**
CONDUCTOR CASING	26.81	66.62		
SUPERFICIAL CASING	61.86	256.73	349.38	868.12
INTERMEDIATE CASING	39.05	162.05	100.41	249.49
LINER	38.02	157.77		
TOTAL	**166**	**644**	**450**	**1117.61**

Water required

- **Wash fluid**

Tabla 124: Wash fluid volumen for intermediate section

INTERMEDIATE CASING		
WASH FLUID		
Nre	10000	
Viscosity	1.6	*cp*
Velocity	1.0	*ft/Seg*
Hfl	637.4	*ft*
Volume	35.6	*bls*

Tabla 125: Water required for section

CONDUCTOR CASING		
Water for mixture		
Main volume	9.200	*Bls*

SURFACE CASING		
Water for mixture		
Main volume.	35.453	*Bls*
Fill volume	264.571	*Bls*

INTERMEDIATE CASING		
Water for mixture		
Main volume	22.379	*Bls*
Fill volume	76.035	*Bls*

LINER		
Water for mixture		
Main volume.	16.439	*Bls*
Fill volume	11.802	*Bls*

Tabla 126: Total water required volume

	Total volume (Bls)
CONDUCTOR CASING	9.2
SURFACE CASING	300.02
INTERMEDIATE CASING	133.97
LINER	28.24
TOTAL	472

Friction pressure

Tabla 127: Friction pressure in conductor section

CONDUCTOR CASING		
MAIN MIXTURE		
Viscosity	24.7	*cp*
ty	11	*lb/100ft2*
Nre	187.42	
f	0.0853686	
Pf	1.98	*psi*

Tabla 128 Friction pressure in surface section

SURFACE CASING					
MAIN MIXTURE			**FILL MIXTURE**		
Viscosity	24.7	*cp*	**K'**	0.0642	
ty	11	*lb/100ft2*	**n'**	0.323	
Nre	181.85		**Nre**	233.10	
f	0.0879843		**f**	0.0686393	
Pf	7.43	*psi*	**Pf**	31.30	*psi*

Tabla 129 Friction pressure in intermediate section

INTERMEDIATE CASING								
MAIN MIXTURE			**FILL MIXTURE**			**WASH FLUID**		
Viscosity	24.7	*cp*	**K'**	0.0642		**Viscosity**	1.6	*Cp*
ty	11	*lb/100ft2*	**n'**	0.323		**Density**	8.33	*lb/gal*
Nre	172.47		**Nre**	201.44		**Nre**	10000.00	
f	0.0927674		**f**	0.0794284		**f**	0.00903389	
Pf	17.24	*psi*	**Pf**	37.95	*psi*	**Pf**	4.32	*psi*

Tabla 130 Friction pressure in production section

LINER		
MAIN MIXTURE		
Viscosity	24.7	*cp*
ty	11	*lb/100ft2*
Nre	155.90	
f	0.1026324	
Pf	74.85	*psi*

Operation time

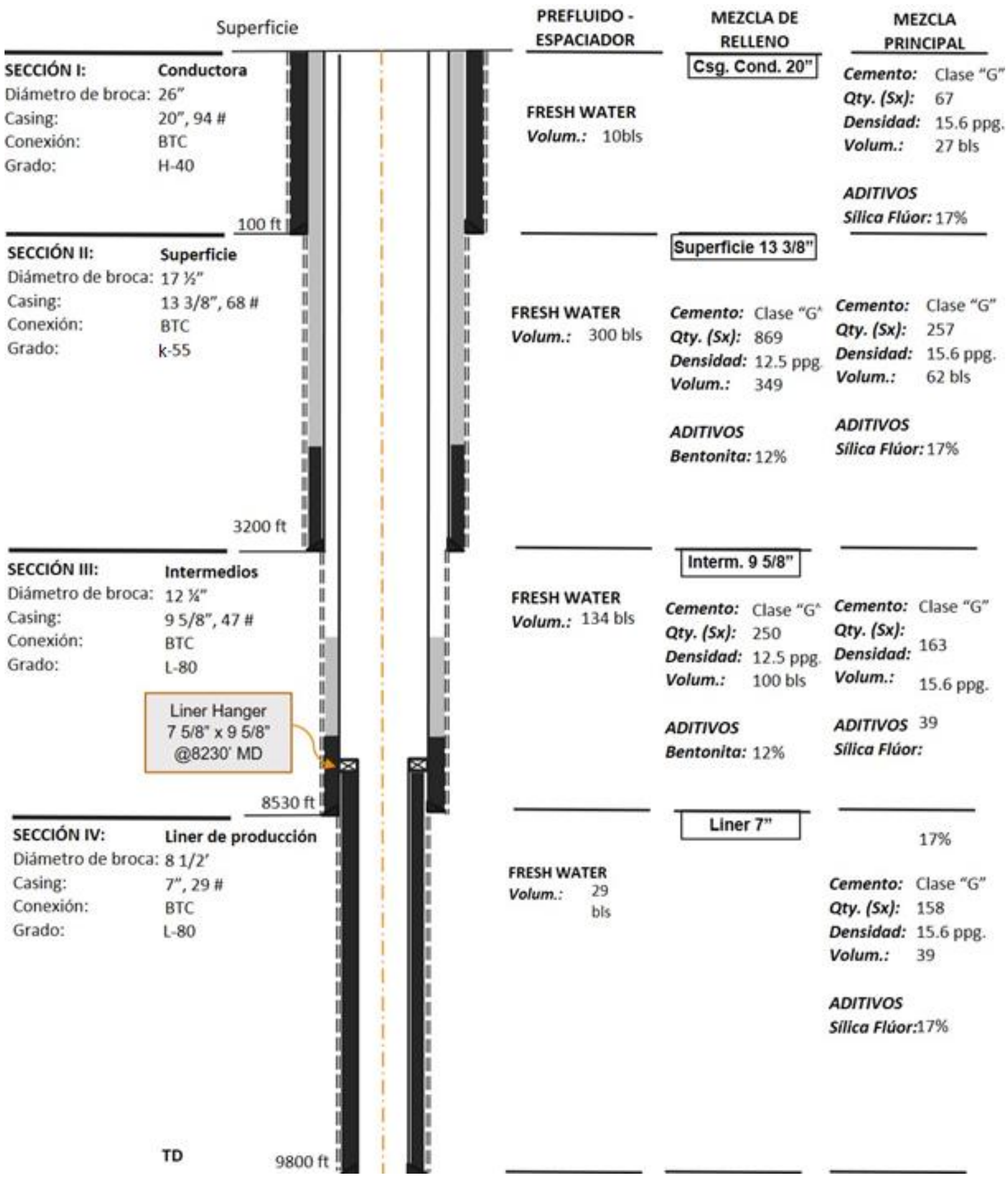
Tabla 131: Operation time for every section

CONDUCTOR CASING		
SET TIME		
Q	15.533863	*BPM*
C20"	0.35072664	*bls/ft*
V F. D	35.07	*Bls*
tf	3.9838	*min*
Hours	0.066397	*Hrs*

SURFACE CASING		
SET TIME		
Q	7.16805463	*BPM*
C13 3/8"	0.15705384	*bls/ft*
V F. D	494.719602	*Bls*
tf	126.388174	*min*
Hours	2.10646957	*Hrs*

INTERMEDIATE CASING		
SET TIME		
Q	3.23182441	*BPM*
C9 5/8"	0.07979208	*bls/ft*
V F. D	676.6369	*Bls*
tf	252.5173	*min*
Hours	4.2086	*Hrs*

LINER DE PRODUCCIÓN		
SET TIME		
Q	1.30855911	*BPM*
C7"	0.04152462	*bls/ft*
V F. D	404.865	*Bls*
tf	309.4386	*min*
Hours	5.15731	*Hrs*



Superficie
PREFLUIDO - ESPACIADOR
MEZCLA DE RELLENO
MEZCLA PRINCIPAL
SECCIÓN I: Conductora
Diámetro de broca: 26"
Casing: 20", 94 #
Conexión: BTC
Grado: H-40
100 ft
Csg. Cond. 20"
FRESH WATER
Volum.: 10bls
Cemento: Clase "G"
Qty. (Sx): 67
Densidad: 15.6 ppg.
Volum.: 27 bls
ADITIVOS
Sílica Flúor: 17%
SECCIÓN II: Superficie
Diámetro de broca: 17 ½"
Casing: 13 3/8", 68 #
Conexión: BTC
Grado: k-55
Superficie 13 3/8"
FRESH WATER
Volum.: 300 bls
Cemento: Clase "G"
Qty. (Sx): 869
Densidad: 12.5 ppg.
Volum.: 349
ADITIVOS
Bentonita: 12%
Cemento: Clase "G"
Qty. (Sx): 257
Densidad: 15.6 ppg.
Volum.: 62 bls
ADITIVOS
Sílica Flúor: 17%
3200 ft
SECCIÓN III: Intermedios
Diámetro de broca: 12 ¼"
Casing: 9 5/8", 47 #
Conexión: BTC
Grado: L-80
Interm. 9 5/8"
FRESH WATER
Volum.: 134 bls
Cemento: Clase "G"
Qty. (Sx): 250
Densidad: 12.5 ppg.
Volum.: 100 bls
ADITIVOS
Bentonita: 12%
Cemento: Clase "G"
Qty. (Sx): 163
Densidad: 15.6 ppg.
Volum.: 39
ADITIVOS
Sílica Flúor: 17%
Liner Hanger
7 5/8" x 9 5/8"
@8230' MD
8530 ft
SECCIÓN IV: Liner de producción
Diámetro de broca: 8 1/2'
Casing: 7", 29 #
Conexión: BTC
Grado: L-80
Liner 7"
FRESH WATER
Volum.: 29 bls
Cemento: Clase "G"
Qty. (Sx): 158
Densidad: 15.6 ppg.
Volum.: 39
ADITIVOS
Sílica Flúor: 17%
TD
9800 ft

4.4.2.12. Rig Sizing

Drilling operation development of San Jacinto field requires a rig with enough technical capacity to reach the geological objective and construct the wells.

A drilling rig must have

- A motor capable of rotating all the given string configuration according to the area to be drilled.
- A drilling tower capable of safely supporting the entire WOB of the string in the lifting, docking, and string lowering processes.
- An adequate mud pumping system with pumps capable of removing debris from the bottom to the surface.
- An adequate BOP with the ability to control bottom pressures during drilling with an adequate safety margin to prevent possible abnormal pressures that make drilling work difficult.

Currently hydraulic rig can reach only depths around 10000 ft and this the reason why the equipment selected for drilling operations in San Jacinto field is a conventional rig.

Tabla 132 Drilling Rig Characteristics

Components	Technical specifications
Mast structure	
Height	Pyramidal 185 pies height, 46 x 54 pies base
Nominal capacity	680 TM
Draw work	
Engine	3000 HP
Drum	Para cable 1-314’
Compensator of Movement	250 TM operando (580 TM static)
Top Drive System	590 TM
Rotary Table	49.5’ open
Drill movement	Hydraulic - Semiautomatic
Mud engine	Triple of 120 spm y 1,600 HP pumps
Shale shaker	3 vibrators
(BOP)	2 x 18-314’de 1OE000 lblpulg3 y double rams 18-314’ de 5,000 lb pulg3 for annular control 10,000 lb/pulg3 well connector
(Diverter)	14-inch output
Control system	Multiple system
Drill and drill	95 drill bit x 21 inch de x 75 ft by tube
Elevator tensioner	726 TM Maximum capacities of tension
Cable guide tensioner.	4 x 9.07 TM

Choke	10,000 lb/pulg3; 2 x manually adjustable y2 x remote controlled valves
Power distribution	General Electric system
Crane	2x80 ft x35 TM a 20 fts;2x 12O ft x47 T M tp 25 ft
Impeller	6 x 2,500 HP each one
Propulsers	2 x helices de 8,000 HP each one

Figura 166 Conventional drilling rig layout

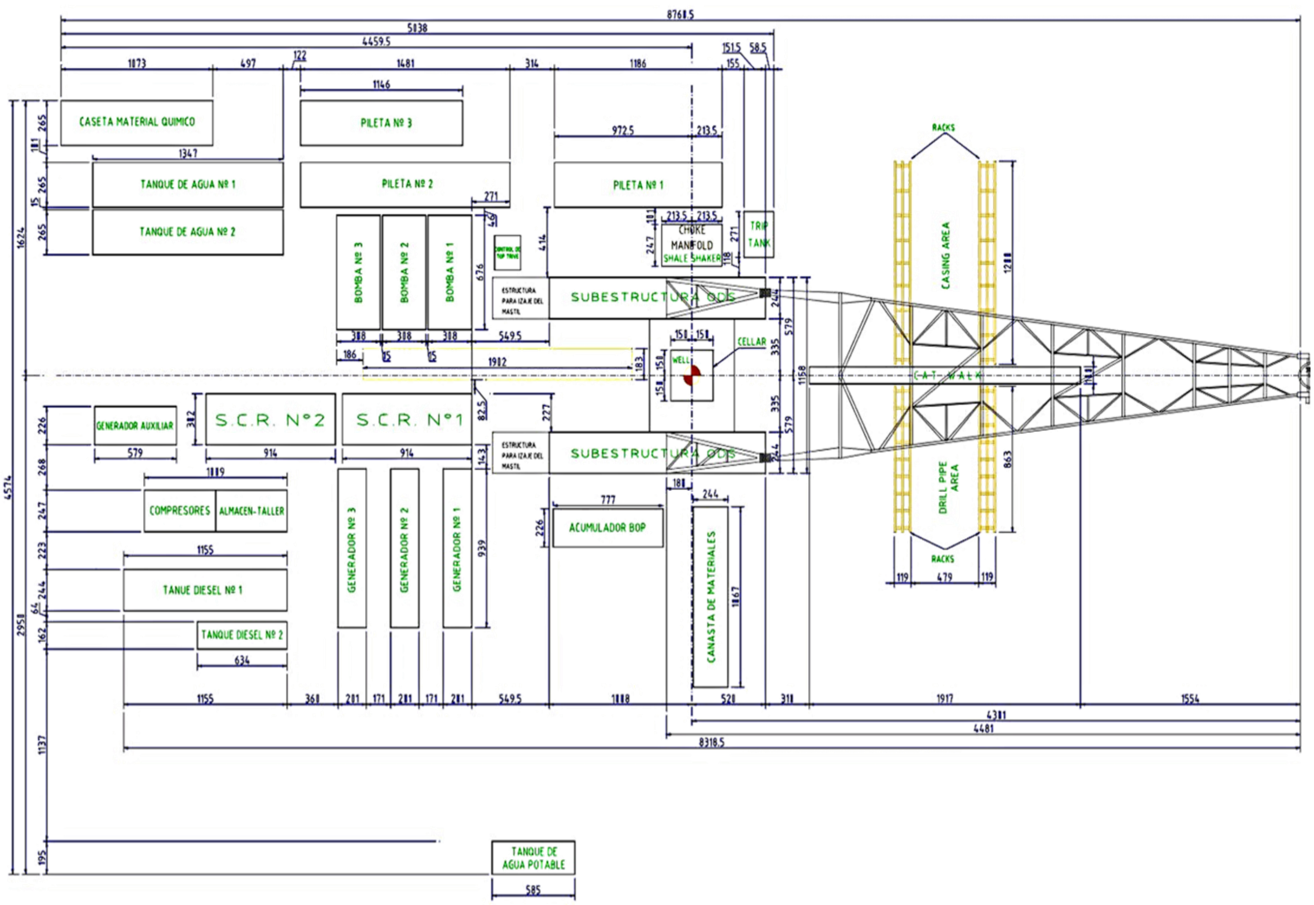
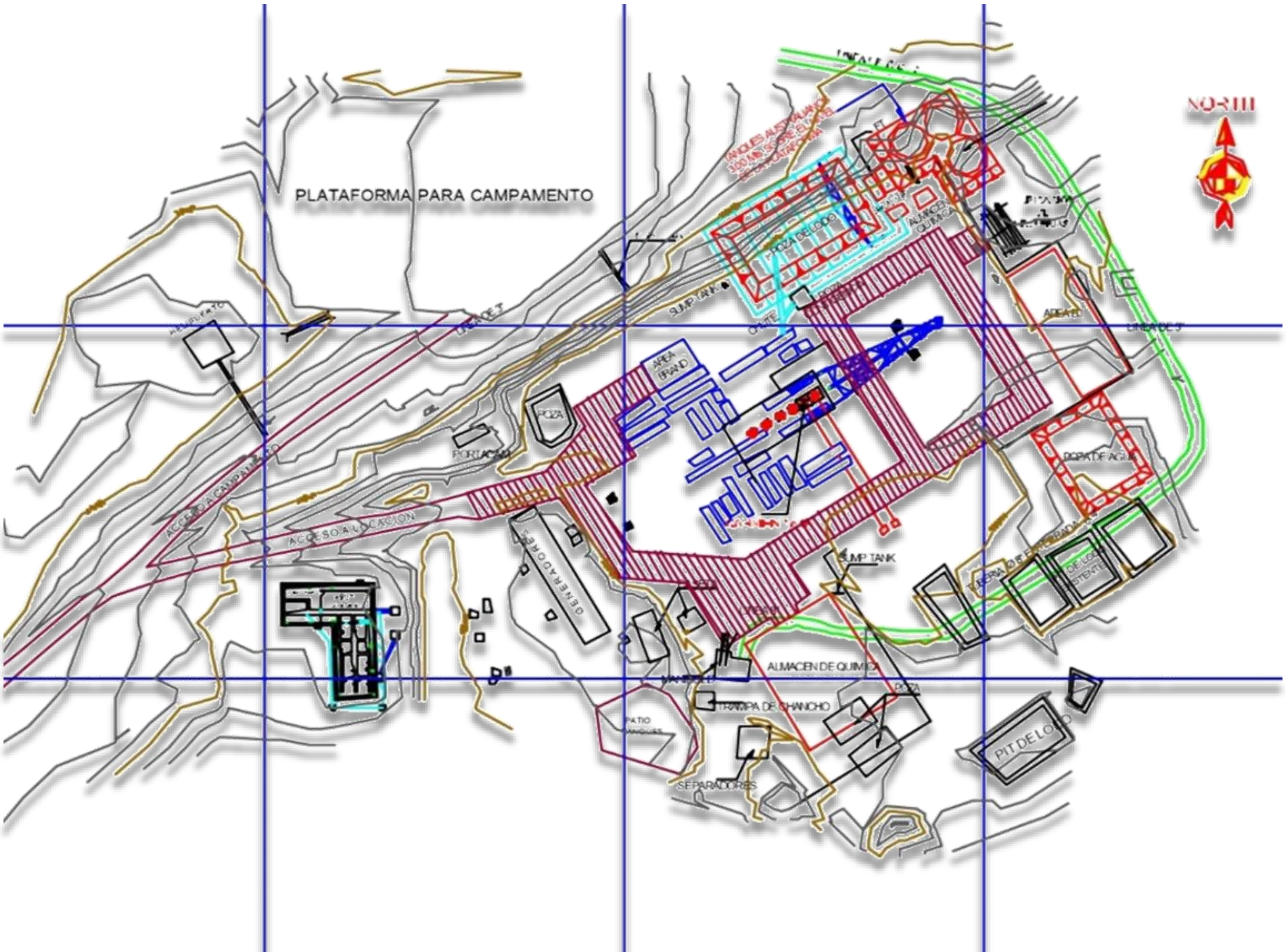


Figura 167 View of drilling rig in SJN-X01 well platform



4.4.2.13. Well Logs Program

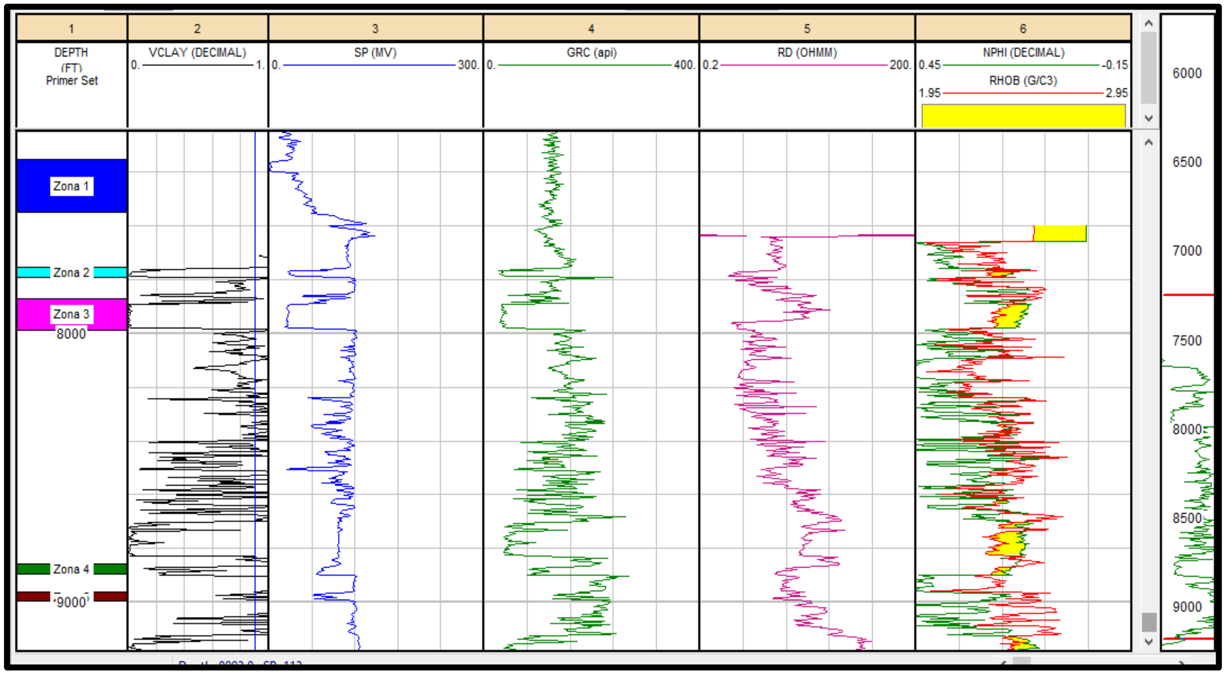
Tabla 133 Well logs program for exploratory well

EXPLORATORY WELLS
SP Log
Gamma Ray Log
Porosity Logs *(Sonic, neutron, density)*
Well Testing *(Buildup, Drawdown, Isochronal)*
Core Tests

Tabla 134 Well logs program for development wells

DEVELOPMENT WELLS
Caliper Log
Gamma Ray Log
Casing Collar Locater
Production Logging Tool
Injection Logging Tool

Figura 168 Productive formation well log



4.4.2.14. Drilling Time Projections

Tabla 135: Drilling time projection for SJN-X01 well

	ACTIVITIES	**Depth**	Hours	Days	Accumulated days
1	Assembling the drilling rig up	0	0		0
2	Drill conductor hole (26" drill bit)	100	19.2	0.8	0.8
3	Setting and cement conductor casing and install diverter (20" casing, 94#/ft)	100	31.2	1.3	2.1
4	Drill surface hole (17 1/2" drill bit)	3200	120	5	7.1
5	Setting and cement surface casing (casing 13 3/8", 68#/ft)	3200	110.4	4.6	11.7
6	Wellhead" A" set + BOPs	3200	16.8	0.7	12.4
7	Drill intermediate hole (12 1/4" drill bit)	8530	480	20	32.4
8	Setting and cement intermediate casing (casing 9 5/8", 47#/ft)	8530	60	2.5	34.9
9	FIT test	8530	31.2	1.3	36.2
10	Unsetting BOPs, casing "A" setting, install section "B" + BOPs	8530	16.8	0.7	36.9
11	Drill production hole (8 1/2" drill bit)	9800	888	37	73.9
12	Setting and cement production liner (Casing 7", 29#/ft)	9800	48	2	75.9
13	Abandonment	9800	31.2	1.3	77.2

Figura 169 SJN-X01 well drilling curve

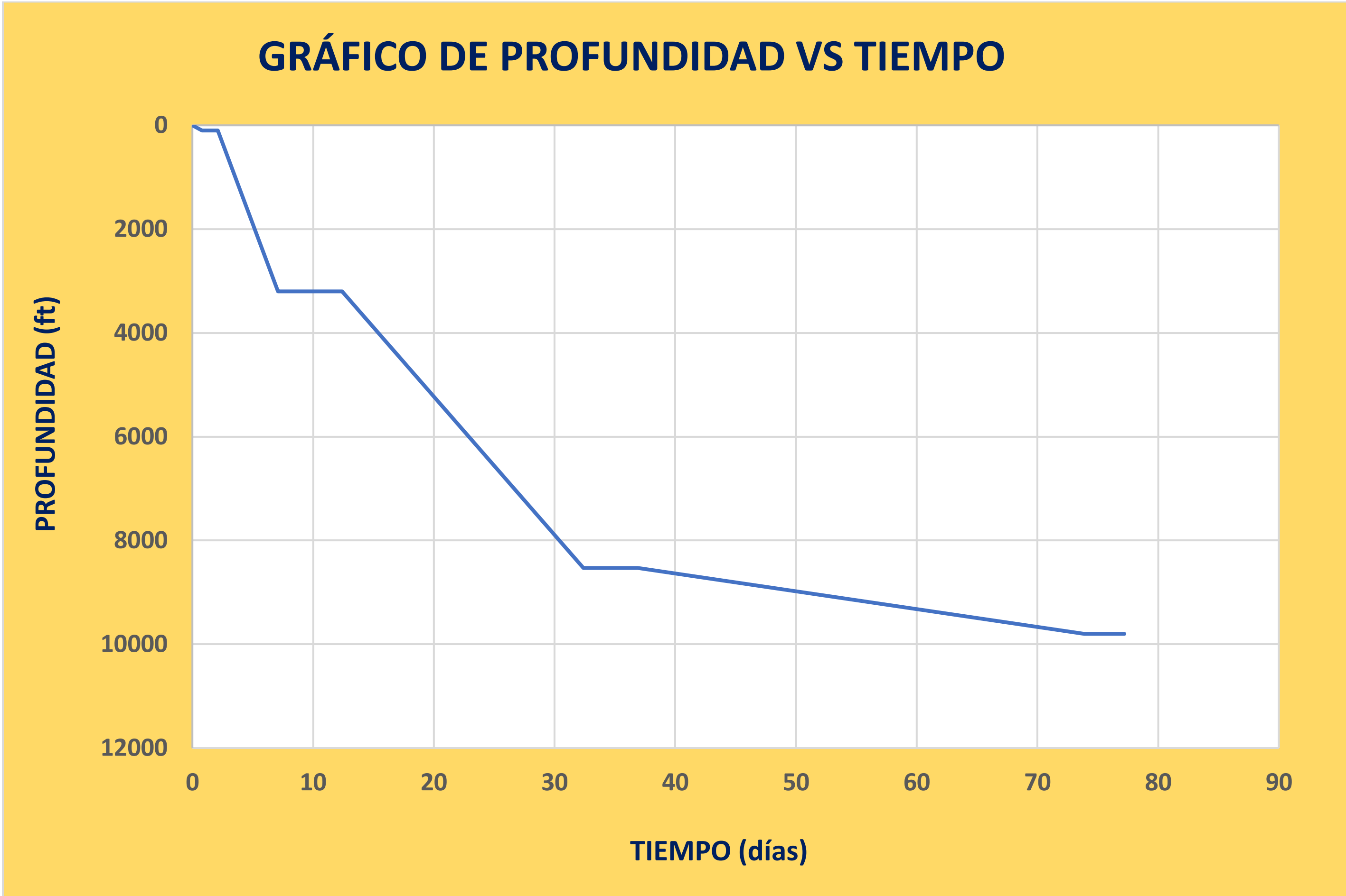
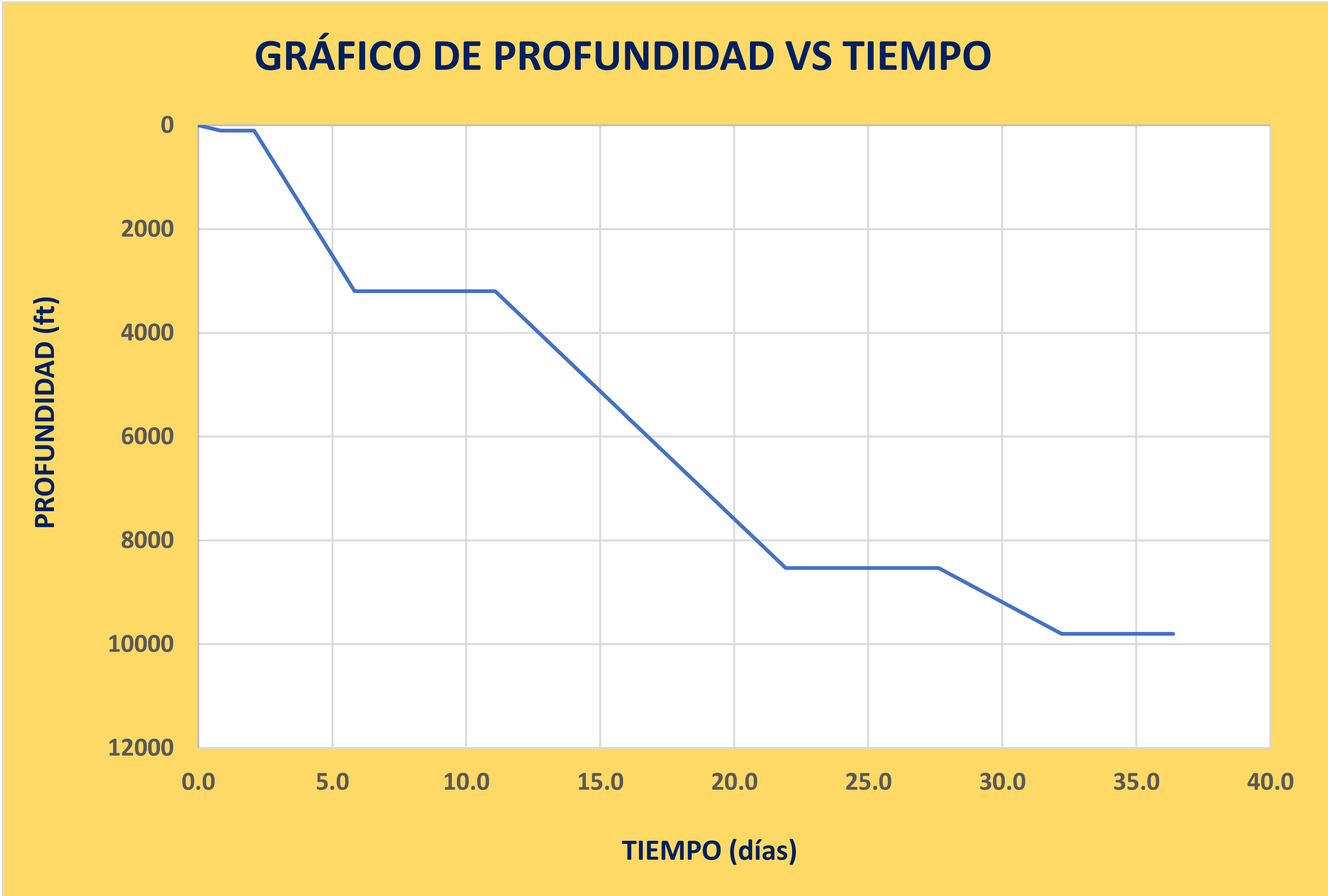


Tabla 136 Drilling time projection for SJN-CO2 well (Confirmatory)

	ACTIVITIES	**Depth**	Hours	Days	Accumulated days
1	Assembling the drilling rig up	0	0	0.0	0.0
2	Drill conductor hole (26" drill bit)	100	20	0.8	0.8
3	Setting and cement conductor casing and install diverter (20" casing, 94#/ft)	100	30	1.3	2.1
4	Drill surface hole (17 1/2" drill bit)	3200	90	3.8	5.8
5	FIT test Setting and cement surface casing (casing 13 3/8", 68#/ft)	3200	110	4.6	10.4
6	Wellhead" A" set + BOPs	3200	16	0.7	11.1
7	Drill intermediate hole (12 1/4" drill bit)	8530	260	10.8	21.9
8	Setting and cement intermediate casing (casing 9 5/8", 47#/ft)	8530	90	3.8	25.7
9	FIT test	8530	31	1.3	27.0
10	Unsetting BOPs, casing "A" setting, install section "B" + BOPs	8530	16	0.7	27.6
11	Drill production hole (8 1/2" drill bit)	9800	110	4.6	32.2
12	Setting and cement production liner (Casing 7", 29#/ft)	9800	100	4.2	36.4

Figura 170 SJN-CO2 well drilling curve



4.5.PRODUCTION ENGINEERING

4.5.1. Stimulation

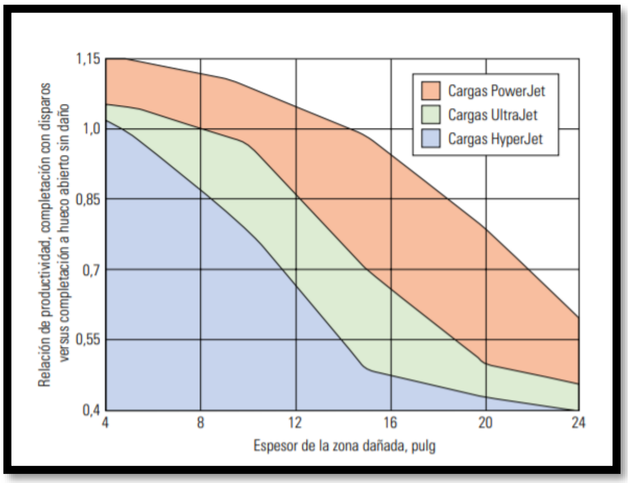
For achieve communication between the oil zone and the well, it is necessary open holes with the use of gun and the most efficient methods. Even today, perforation design plays a very important role in well production.

4.5.1.1. Perforation design

For perforation design, we interpreted the logs of the San Jacinto field, which will detail the areas of interest. We use Gamma Rey, Resistivity, CCL, VDL logs to select the intervals to be shoot applying the technology “Power Jets”.

Power Jets are characterized by their high performance, they have been designed and manufactured to overcome by at least 20-30% performance that in other charges in consolidated sandstones. For the use of these explosives, high density pulverized material liners were used that generate discharge length and higher impact pressures in terms of penetration.

Figura 171: Graph productivity vs damage



Taking into consideration, the most important factors in a perforating design for a high productivity are:

- Shooting dimension
- Shot density
- Phase angle
- Shot damage

4.5.1.1.1. Selection criteria for perforating method and technique

In order to obtain the production of hydrocarbons from the formation and for a good operation during perforating, the following should be considered:

- The properties of fluids.
- The lithology of the interval of interest.
- Termination type.
- The specific characteristics of the shots.

Factors that affect the quality of the shot are:

- Shot plugging.
- Differential pressure effect.
- Shot density.
- Shooting performance.

Figura 172: Perforation parameters

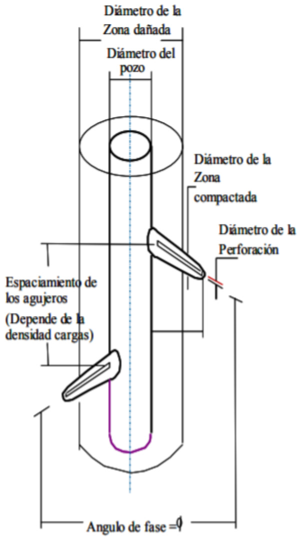
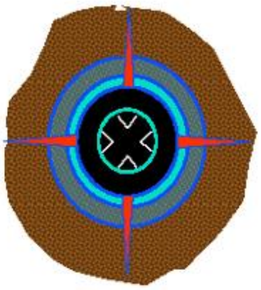


Figura 173: Shot density assembly

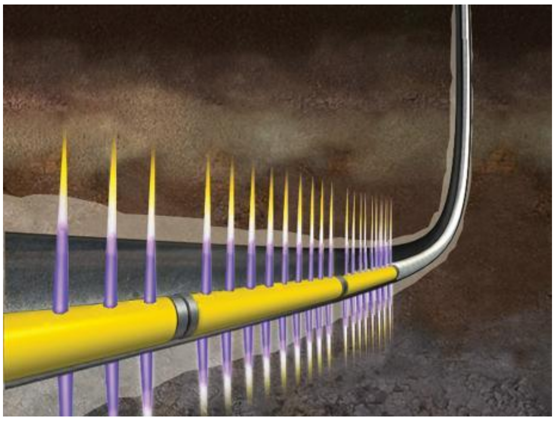


Due to issues of permeability, productivity index, porosity and extraction capacity. TCP technique (Tubing conveyed perforating) will be implemented using the Underbalance method.

4.5.1.1.2. TCP Technique

This technique is very helpful because it allows the guns to be positioned through the pipe with packers, this will generate a better job in perforating operations. This technique produces greater penetration, high shoot density, larger diameters guns and it is the best option for horizontal and directional wells.

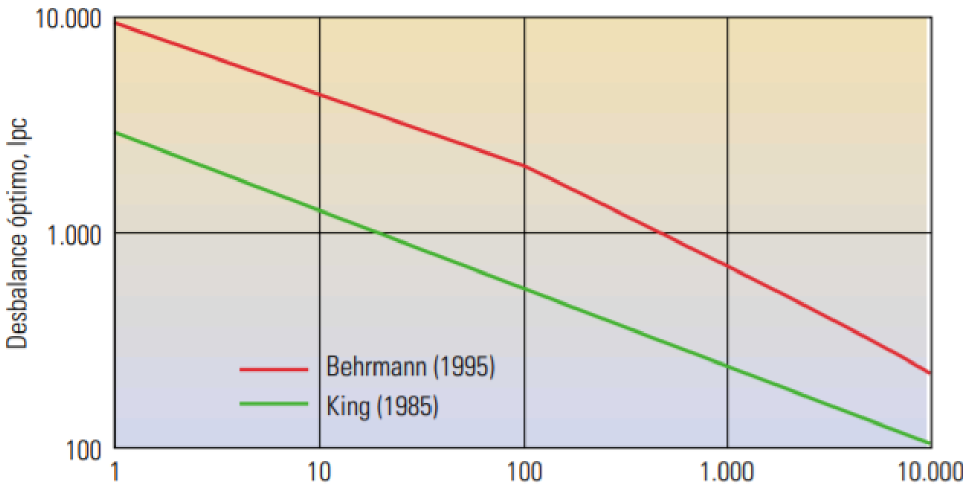
Figura 174: TCP Horizontal Well



4.5.1.1.3. Underbalance method

The benefits of perforating underbalance (conditions favorable to the reservoir, P reservoir> P hydrostatic) will be minimize damage to the formation from debris. The pressure difference must be sufficient to generate a sudden initial flow to carry the debris.

Figura 175: Berhmann and King's Graph



$$Underbalance\ King\ Chonta = 600\ psi$$

$$Underbalance\ King\ Vivian = 300\ psi$$

$$Underbalance\ Behrmann\ Chonta = 1200\ psi$$

$$Underbalance\ Behrmann\ Vivian = 800\ psi$$

The following table shows the productive intervals obtained from the San Jacinto field logs. Additionally, some specifications of the perforating operation are shown.

Tabla 137: Perforation distribution in San Jacinto Oriental – Vivian formation

TUBING CONVEYED PERFORATING UNDERBALANCE| TECHNIQUE					
Field	Perforated diameter (in)	Well	DPP	Interval	Penetration (in)
SAN JACINTO ORIENTAL VIVIAN	0.44	SJN-04H	6	300 ft <7954-8000>ft	55.72
	0.44	SJN-05H	6	300 ft <7954-8000> ft	55.72
	0.44	SJN-06H	6	300 ft<7954-8000> ft	55.72
	0.44	SJN-07H	6	300 ft <7954-8000> ft	55.72
	0.44	SJN-10H	6	300 ft <8036-8081> ft	55.72
	0.44	SJN-11H	6	300 ft <8036-8081> ft	55.72
	0.44	SJN-12H	6	300 ft<8036-8081> ft	55.72
	0.44	SJN-G08	6	7934-8034 ft	55.72
	0.44	SJN-G09	6	7857-7957 ft	55.72
	0.44	SJN-G13	6	8316-8416 ft	55.72
	0.44	SJN-G14	6	8240-8340 ft	55.72
	0.44	SJN-G15	6	8240-8340 ft	55.72

Charge description:

Through API RP 19 the characteristics of the explosive charge will be shown.

Tabla 138: API RP 19. Description

GUN PARAMETERS	
Explosive Weight	39 gr
Gun type	SDP
Explosive type	HMX
Part number	X3920SDP
Phase	60 °

In the same way, the logs will be analyzed to get the productive intervals for the case of the formation Chonta.

Tabla 139: Perforation distribution in San Jacinto Oriental – Chonta formation

TUBING CONVEYED PERFORATING UNDERBALANCE| TECHNIQUE					
Field	**Perforated diameter (pulg)**	**Well**	**DPP**	**Interval**	**Penetration (pulg)**
SAN JACINTO ORIENTAL CHONTA	0.43	SJN-X01	6	8566-8666 ft	46.3
	0.43	SJN-C02	6	8566-8666 ft	46.3
	0.43	SJN-C03	6	8943.7-9043.7 ft	46.3
	0.43	SJN-G08	6	8500.4-8600.4 ft	46.3
	0.43	SJN-G09	6	8936-9036 ft	46.3
	0.43	SJN-G13	6	8464-8564 ft	46.3
	0.43	SJN-G14	6	8850-8950 ft	46.3
	0.43	SJN-G15	6	8950-9050 ft	46.3
	0.43	SJN-V16	6	8848-8948 ft	46.3

Charge description:

Through API RP 19 the characteristics of the explosive charge will be shown.

Tabla 140: API RP 19. Description

GUN PARAMETERS	
Explosive Weight	26 gr
Gun type	SDP
Explosive type	HMX
Part number	X2620SDP
Phase	60 °

In the reservoir analysis, a thickness of 72.5 ft was estimated for the net oil thickness, but 100 ft will be perforating because on the production stage we will get a more detailed estimate of net oil thickness. In case of excessive water production problems, the use of squeeze or relative permeability modifiers will develop.

4.5.1.2. Stimulation design

The application of relative permeability modifiers is already a study carried out in our country, so we will take these documents as a reference. (B., 2019)

Tabla 141: Application reference of RPM.

SOURCE	BLOCK	APLICATION	CONDITIONS
UNIVERSIDAD NACIONAL DE PIURA, *Improvements in primary cementing of wells with water invasion and/or water impulsion problems.*	1-AB	Chonta-Vivian Formations	- Oil crude (10-35°API) - Water drive mechanisms - Bubble pressure of 527 psia - GOR between 50 and 200 SCF/STB - Initial pressure of 4500 psi

San Jacinto Oriental field, the object of our current project, presents conditions of high temperatures and flow rates, therefore, the polymer to be used must be resistant for these conditions. In that sense, we will use ZoneTROL XT polymer. This polymer will be prepared in the laboratory and then be injected to the formations. (García, 2016)

Tabla 142: Polymer characteristics

ZONETROL XT POLYMER
Environmentally friendly
Does not require large areal surface area
Selective flow restriction of aqueous fluids
Can be applied in a wide range of concentrations
Effective at temperatures between (220°F-250°F)

The effect of this stimulation is to reduce the flow relative to the water between 5 to 10 times. In the oil case it has values less than 2 times.

Considerations for the injection:

- The application of the MPR's must be in undamaged wells.
- The location system, cleaning pipes and surface equipment to be used.
- The treatment is temporary, it can be used for up to 2 years.
- After having pumped the MPR, we cannot inject fluid with a pH lower than 3 because it will affect the properties of the polymer. (Merino, 2019)

Determination of treatment volume

Perforated interval = 45 ft

Penetration = 8 ft

Porosity = 18.3 %

Required volume/well = 295 bls

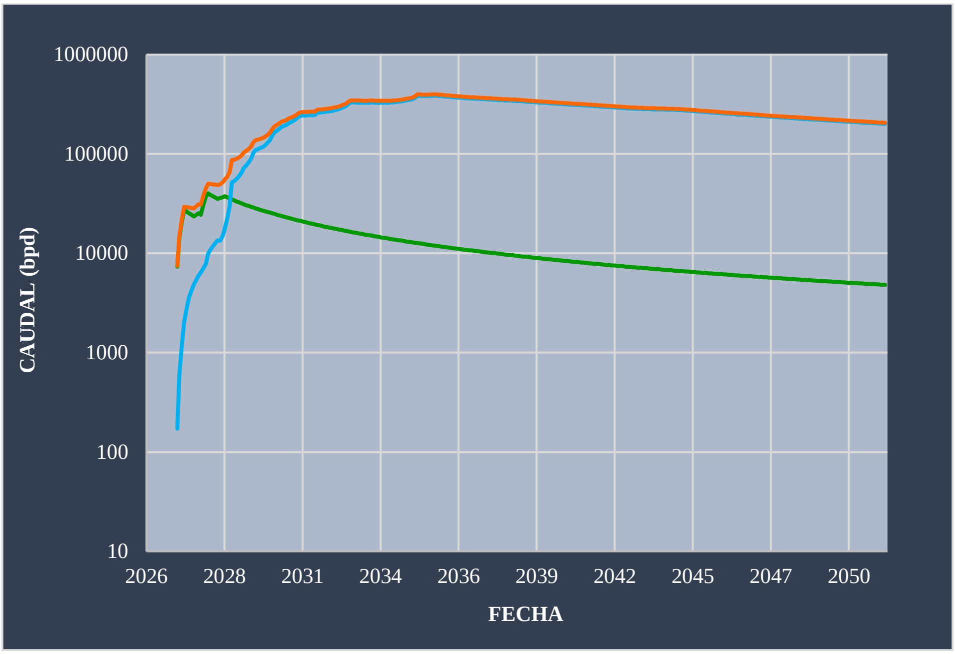
In addition, squeeze processes will be applied to the lower areas of the formation. In order to this, rigorous study will be made to avoid isolation of the oil zone.

We carry out the following analysis to determine which formations we would apply this stimulation method to:

- **VIVIAN FORMATION**

According to the results obtained from the reservoir area, we can make a forecast of the fluids coming from the well:

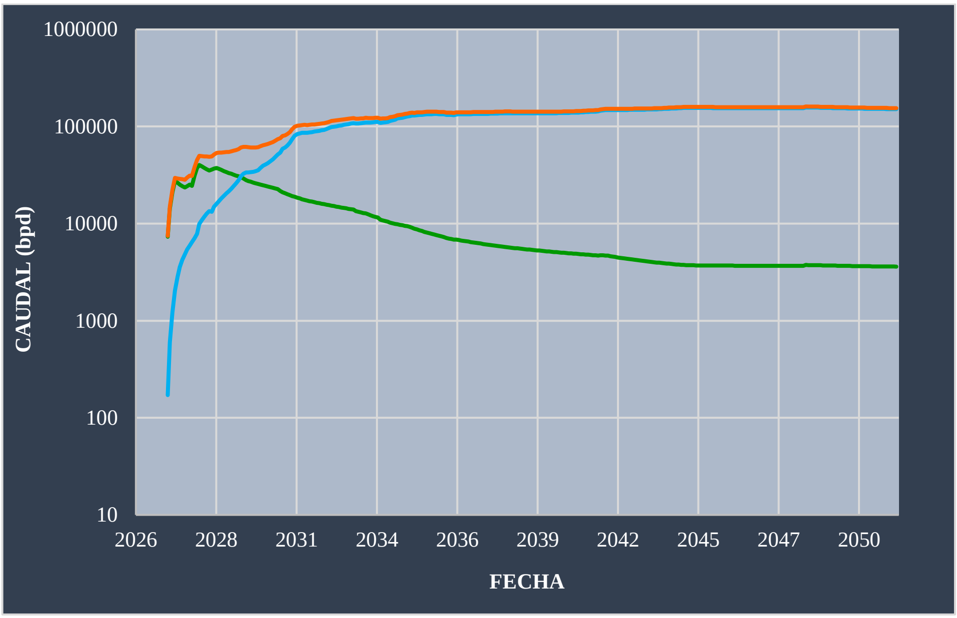
Figura 176: Type curve of fluids.



We see that water flows are too high, reaching volumes that our artificial lifting system would not endure, for this reason we set a limit of 15,000 bpd. From this we propose an alternative that will allow us to control this excess water.

The solution is to reduce the oil flow because producing large amounts of oil leads us to produce large amounts of water, therefore, by decreasing the oil production it would also decrease water production.

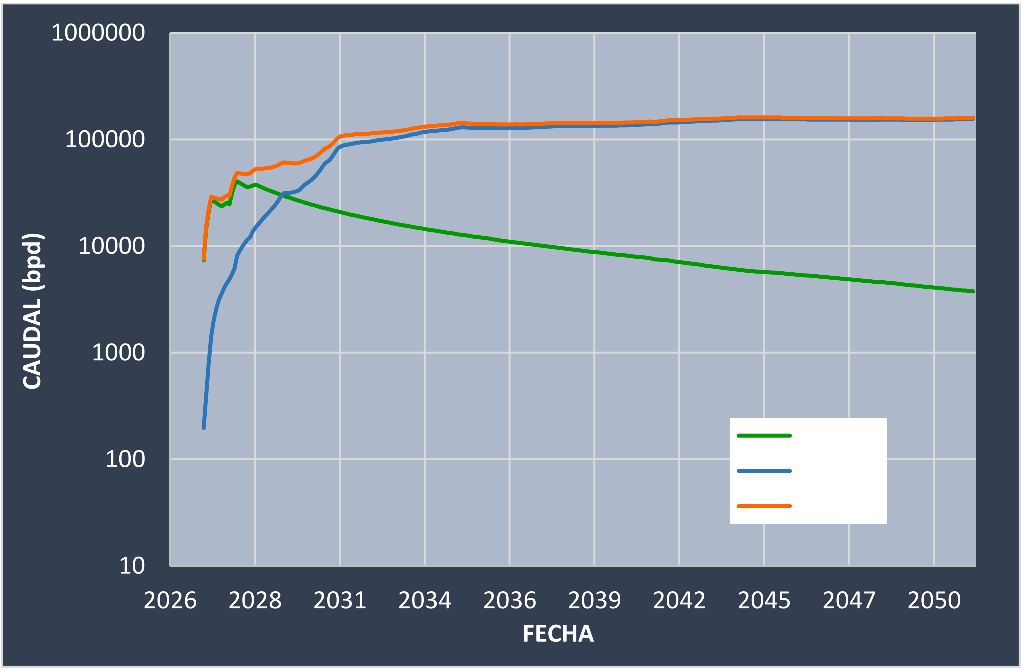
Figura 177: Flow rate of fluids after decrease oil production



This alternative shown us that oil production would be decreasing and therefore our recovery factor, so another alternative would be evaluated.

From reference documents it is shown that the use of "relative permeability modifiers" presents good results in block 192, so we would evaluate this alternative.

Figura 178: Production curve after applying RPM's



By way of conclusion, the following recovery factors are seen:

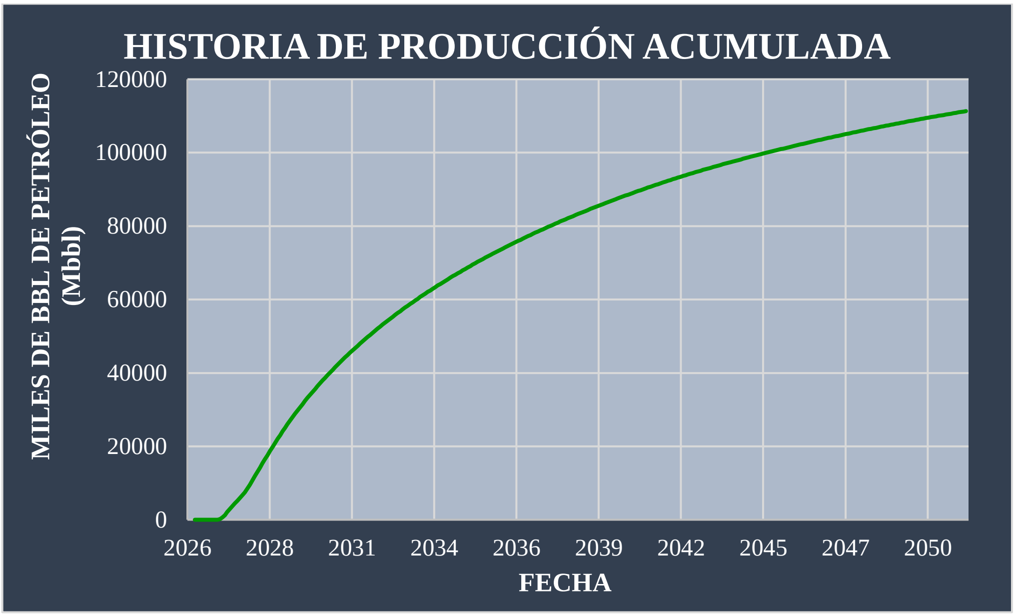
Tabla 143: Recovery Factor by different ways

	THEORY	REAL	OPTIMIZED RATE	MPR's Application
RF (%)	25.7	25.66	21.74	24.96

From this we see that although it is true that the recovery factor decreases, this is because the RPM's do not have an ideal water restriction, but this also restricts the oil flow from the well. However, better values are obtained than the other alternatives.

Therefore, the following results would be obtained:

Figura 179: Accumulated production history



There is the following recovery factor:

	Np (MMbbl)	Recovery Factor (%)
VIVIAN	111.33	24.96%

The application periods would be the following:

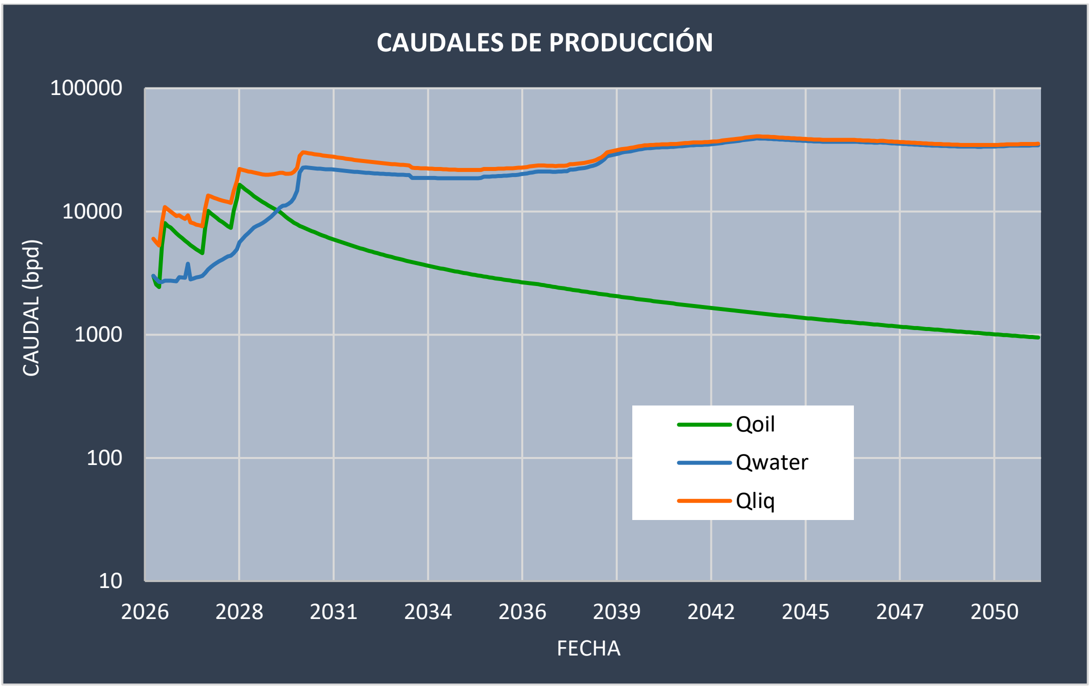
Tabla 144: Naphtha application periods

	FIRST PERIOD		SECOND PERIOD	
SJN-H04	1/12/2030	1/11/2032	1/08/2038	1/07/2040
SJN-H05	1/03/2034	1/02/2036	1/08/2043	1/07/2045
SJN-H06	1/12/2033	1/11/2035		
SJN-H07	1/02/2032	1/01/2034	1/04/2037	1/03/2039
SJN-G09	1/04/2035	1/03/2037		
SJN-H11	1/05/2035	1/04/2037		
SJN-H12	1/08/2029	1/07/2031		

- **CHONTA FORMATION**

In the same way, the following analysis is carried out in the reservoir section, obtaining the following results:

Figura 180: Production rate..



In the case of the Chonta reservoir, we see that there is no problem with the production of water, therefore, there would be no need to apply the RPMs. Obtaining the following recovery:

	Np (MMbbl)	Recovery factor (%)
CHONTA	31.52	38.45%

4.5.2. Well Testing

Pressure tests are of vital importance for the knowledge of the productivity of the wells, for that the interpretations should be used to the maximum and it will help us to increase the recovery factor for the companies.

Build Up Test:

For the process of a pressure test, it must be taken into consideration that the well must be producing for a period at a constant rate and then it will be closed. Finally, the pressure versus time at the bottom of the hole will be recorded.

It is possible to estimate: Formation permeability, current drainage area pressure, damage, heterogeneities, and reservoir boundaries.

Figura 181: General closure test

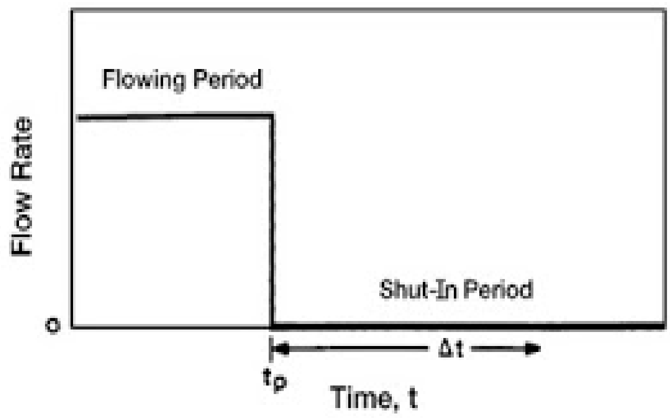
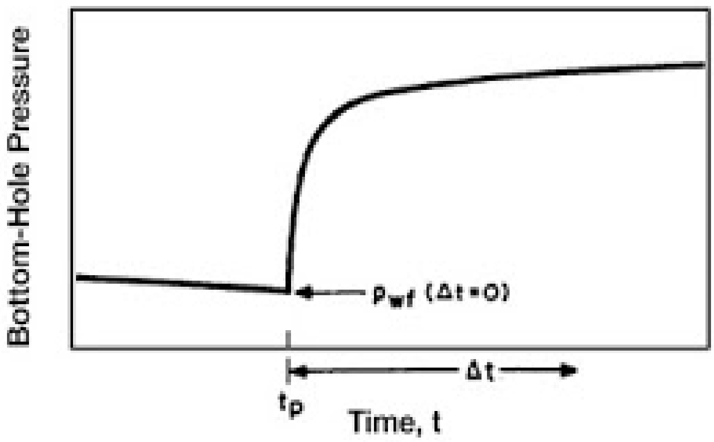


Figura 182: Pressure behavior



Fall Off Test:

It allows find conditions of the reservoir around of the injector well by injecting water. The process is very similar to the closure test, it is performed by closing the injection well and viewing the pressure at the bottom of the well as a function of time at a constant injection rate.

Some parameters will be determined from the test: Effective permeability of the reservoir to the injected fluid, damage caused by swelling of the clays, plugging, precipitates, average reservoir pressure, reservoir burst pressure (injection regime).

Figura 183: Fall off test

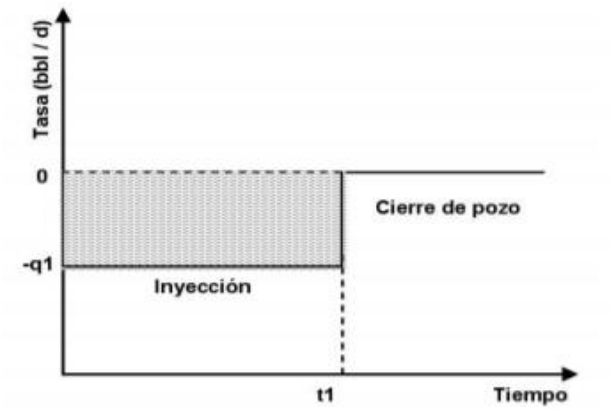
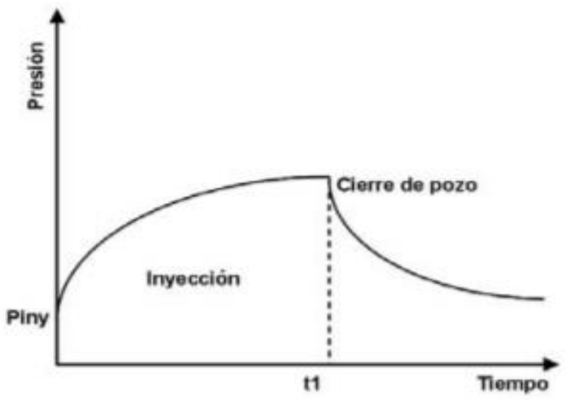


Figura 184: Behavior of Fall off test



Basic procedure of a well test analysis:

- Development and obtaining of downhole data: Smoothing and trimming of data.
- Obtaining information of the reservoir and well.
- Obtaining the mechanical state of the well and sequence of events in the test.
- Development of production history and well pressure.
- Use of derivative and diagnostic graphs.
- Well modeling through the use of programs.
- Detailed calculation of the different parameters.

4.5.3. Artificial lift design

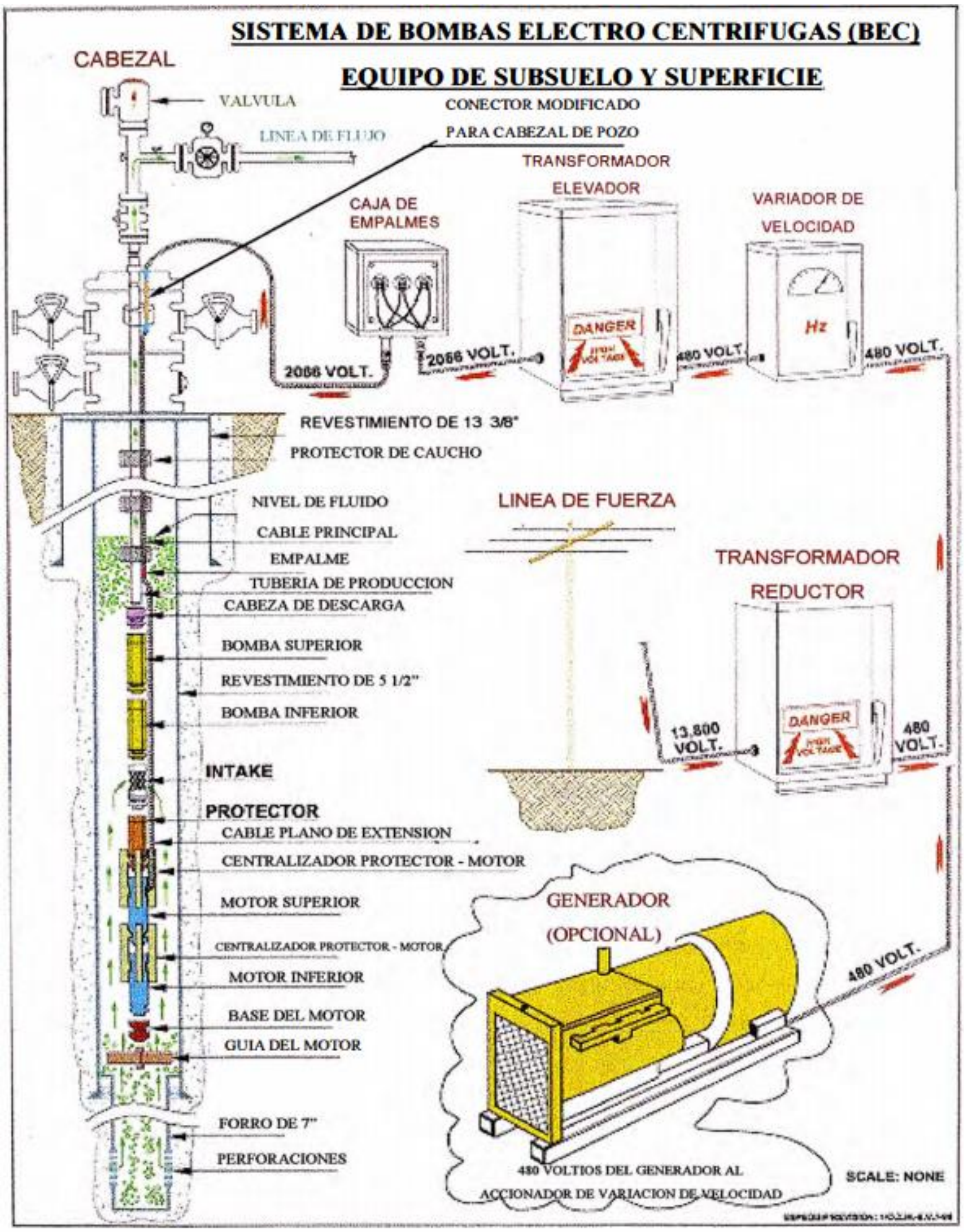
The fields of Block 192 are characterized by having a high water cut in a short period when production begins, so knowing how to control water production will be necessary for the recovery of the hydrocarbon.

For Vivian and Chonta cases from Campo San Jacinto Oriental of block 192, we have developed a design using electrical submersible pumping system because we are going to work with high flow rates to have the best possible optimization.

Electrical Submersible Pumping System:

It operates in conditions of submerged in the well fluid and it grasps the production pipes, the pump setting depth will depend on the design. Among its downhole components are: pump, seal, motor, cable and gas separator. The surface components are: Junction box, variable speed drive, transformers and surface cables.

Figura 185:Electrical Submersible Pumping System. Author: Wilfredo Dioses, tesis Bec



For design an ESP system, certain parameters must be taken into consideration:

- Well productivity
- Density, viscosity, gas content, abrasive action
- Diameters and depths of the Casing and Tubing
- Depths of perforations
- Available pumps, diameter, and power of the motors
- Factors affecting the ESP design:
- Geometry of the well
- Flow capacity

$$\mathrm{Pr}\, y\ Pwf > Pb$$

$$Ip = \frac{q}{Pr - Pwf}$$

- Effects of viscosity
- Engine cooling
- Total dynamic load, TDH

Equations to use for ESP design:

1. Reservoir barrels, BPD

$$QrBPD = STBD = [(1 - Wc)Bo + WcxBw]$$

2. Gradient of fluid in formation

$$Grad.f = Grad.aceite + Grad.agua$$

$$Gradf = 0.433x(1 - WC) * \frac{Box141.5}{131.5 + API} + SGWxWcxWcx0433/Bw$$

3. Total dynamic load

$$TDH = Nivel\ de\ fluido + fricción + Descarga$$

$$TDH = FL + Ft + PD$$

FT: Friction loss in tubing

FL: Expressed in vertical depth

PD: Discharge pressure in the pipe

$$Descarga = \frac{Pt}{Gradf}$$

4. Bottom Flowing Pressure: Pwf

$$Pwf = [Perf - Suc]xGradf + [Suc - FL]xGrad + Pc + Pg$$

5. Productivity Index

$$Pi = \frac{STBD}{PS - Pwf}$$

Calculations for design:

1. Find fluid gradient, mixture, and oil gradient
2. Calculate the flowing pressure
3. Find the static fluid level
4. PI 1 to 4, 5000 ft pump, PI more than 4, 4000-5000 ft
5. Estimate QSTBD knowing the PI
6. Convert QSTBD to reservoir conditions
7. Find dynamic load TDH
8. Plot the pump performance curves.
9. We find the sequence at different parameters
10. We find the number of stages and the required power

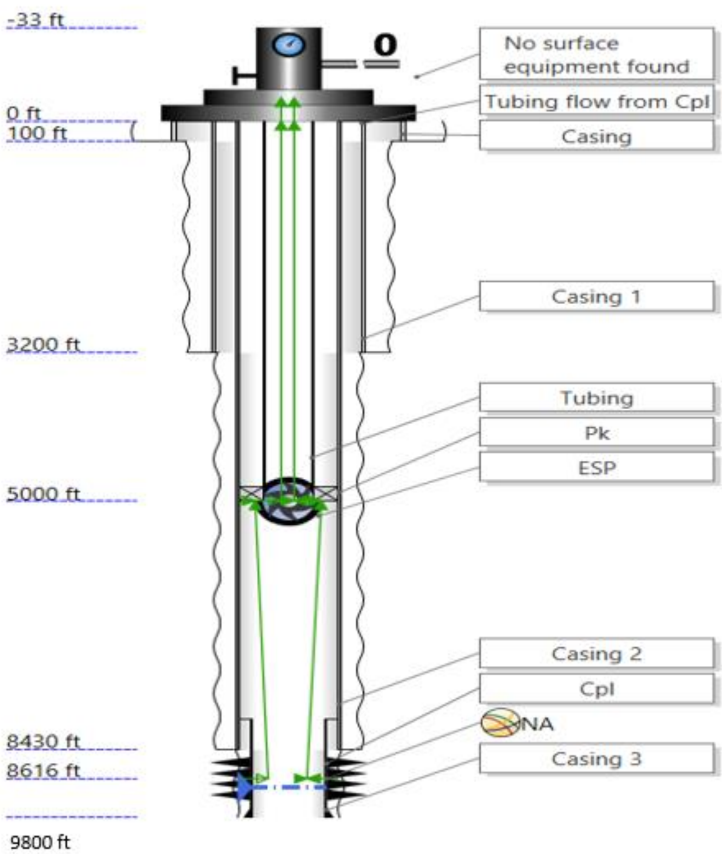
Case: Chonta Vertical well X01

Tabla 145: Chonta vertical well X01 - Parameters

ELECTRIC SUBMERSIBLE PUMP DESIGN							
OPERATOR		KysPetrol		**WELL**			
COUNTRY		Perú		**FORMATION**		CHONTA	
FIELD		San Jacinto Oriental					
WELL							
	ID (in)	**OD (in)**	**Weight(lb/ft)**	**FROM (ft)**	**TO (ft)**	**PERFORATED INTERVAL**	
Casing	19.124	20	94	0	100	-	-
Casing	12.415	13.375	68	0	3200	-	-
Casing	8.535	9.625	53.5	0	8430	-	-
Liner	6.184	7	29	8330	9800	100 ft	
Tubing	3.958	4.5	12.6	0			
SURFACE INFORMATION							
THP	150	Psi		**VOLTAGE**	-	V	
WHT	240	F		**FREQUENCY**	60	Hz	
CHP	0	Psi					
FLUID PROPERTIES							
API		32		Bubble Pressure		978	Psi
Gas gravity		0.895		**Salinity**		33800	Ppm
Water gravity		1.05					
RESERVOIR CHARACTERIZATION							
PRESSURE TEST				**PRODUCTION TEST**			
		MD	**TVD**				
Datum		7843	7843	Oil rate		300	Bopd
Static Pressure		3250	psi	**Water rate**		7000	Bwpd
Temperature		240	F	Liquid rate		7300	Bfpd
IP		12.807	stb/psi	**BSW**		97%	
K		200	md	**GOR**		185	scf/bbl
DESIGN PARAMETERS							
				MD	TVD	UNITS	
Setting depth				5000	5000	Ft	
Rate design				8000		Bpd	

- ➢ We will present the electrical submersible pumping diagram of well X01:

Figura 186: ESP Diagram – PIPESIM 2017

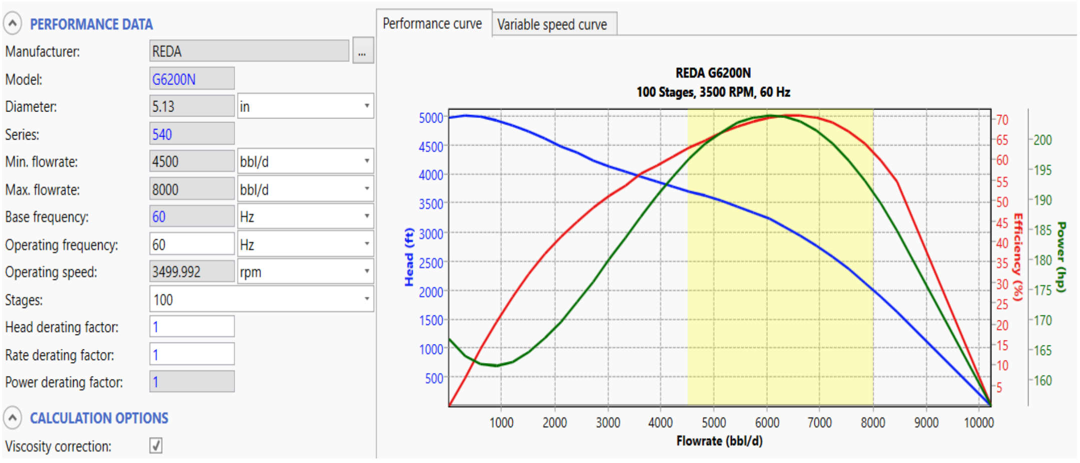


The selected pump with the PipeSim2017 program:

- GEDA G6200N
- 100 stages
- 3500 RPM
- 60 Hz

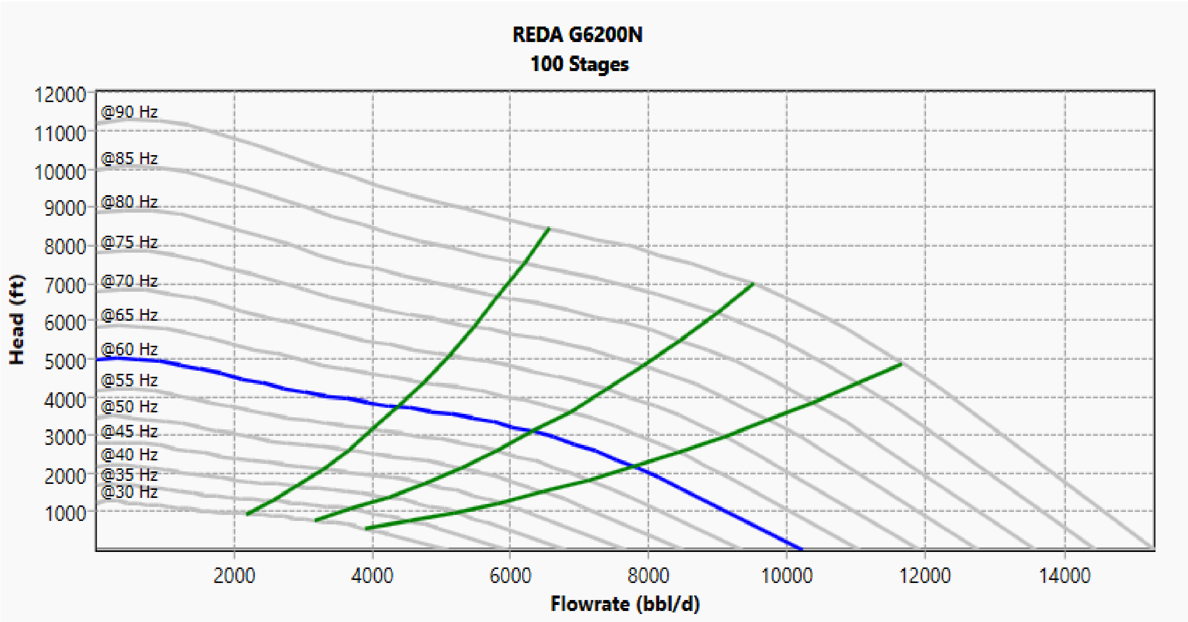
- ➢ Pump Performance curve @ 60 Hz

Figura 187: Performance Curve REDA G6200N



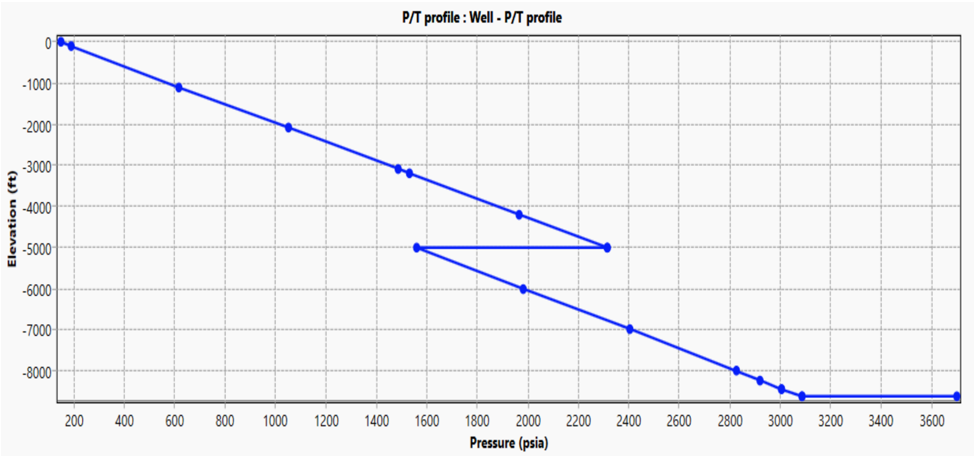
- Curve performance

Figura 188: Optimal working range REDA G6200N



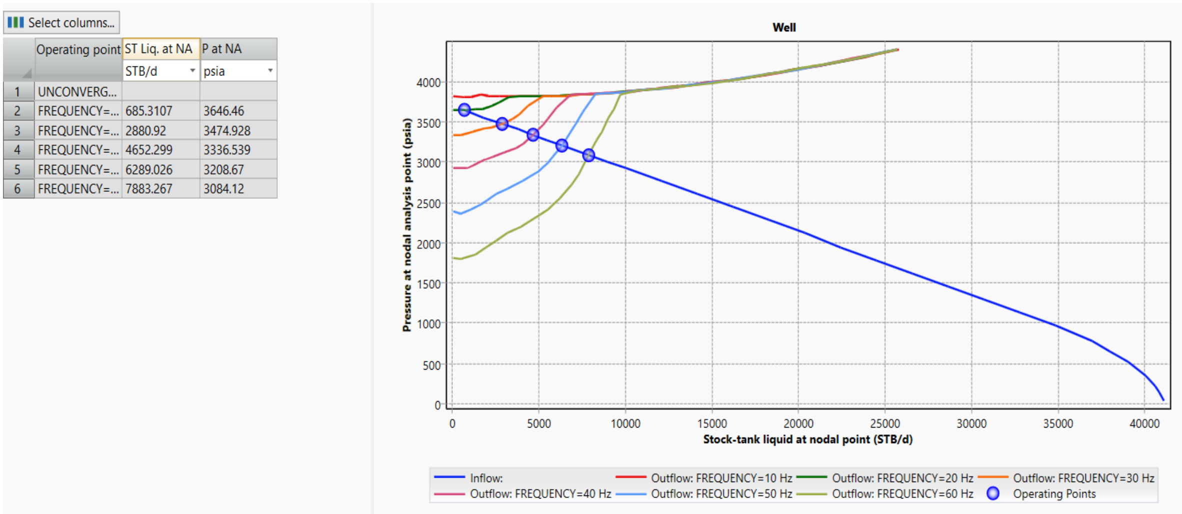
- Pressure profile:

Figura 189: Elevation vs Pressure



- Nodal Analysis

Figura 190: Nodal analysis at different frequencies



	Operating point	ST Liq. at NA	P at NA
		STB/d	psia
1	UNCONVERG...		
2	FREQUENCY=...	685.3107	3646.46
3	FREQUENCY=...	2880.92	3474.928
4	FREQUENCY=...	4652.299	3336.539
5	FREQUENCY=...	6289.026	3208.67
6	FREQUENCY=...	7883.267	3084.12

The graph is presented at the beginning of production and at the end of Production.

Tabla 146: Production using ESP System

BFPD	WC	Yo	API	HZ	PWF	PC	IP	Mixture gradient	H	PIP	Pdesc	Ppump	Hfriction	TDH	n liquid
3000	0.03843316	0.86544343	32	60	3465.625	150	12.8	0.376976234	5577.218798	2102.47894	2143.62523	41.1462897	36.02	543.070638	2000
5624.17112	0.05951369	0.86544343	32	60	3260.61163	150	12.8	0.378204449	5005.293691	1893.02434	2150.07336	257.049015	115.20	1191.47168	2000
5293.16076	0.07817725	0.86544343	32	60	3286.47182	150	12.8	0.379291844	5048.757411	1914.95251	2155.78218	240.829673	102.98	1133.39499	2000
4999.65599	0.09590816	0.86544343	32	60	3309.40188	150	12.8	0.3803249	5085.512515	1934.14704	2161.20572	227.058686	92.66	1084.07382	2000
4737.83501	0.11227646	0.86544343	32	60	3329.85664	150	12.8	0.381278566	5117.395837	1951.15335	2166.21247	215.059125	83.88	1041.34538	2000
4503.00831	0.126962	0.86544343	32	60	3348.20248	150	12.8	0.38213419	5145.850068	1966.40525	2170.7045	204.29925	76.36	1003.51496	2000
4291.3583	0.14108186	0.86544343	32	60	3364.73763	150	12.8	0.382956855	5170.205521	1979.96565	2175.02349	195.057843	69.85	970.885065	2000
4099.74718	0.15383768	0.86544343	32	60	3379.70725	150	12.8	0.383700047	5192.201285	1992.24788	2178.92525	186.67737	64.19	941.638586	2000
3925.57332	0.16617946	0.86544343	32	60	3393.31458	150	12.8	0.384419116	5211.122383	2003.25506	2182.70036	179.445299	59.24	916.230608	2000
4182.48342	0.1968645	0.86544343	32	60	3373.24348	150	12.8	0.386206919	5118.290656	1976.71926	2192.08632	215.36706	66.61	1012.64586	2000
4052.17533	0.2234554	0.86544343	32	60	3383.4238	150	12.8	0.387756184	5109.647556	1981.29744	2200.21997	218.922528	62.82	1014.2472	2000
3931.04606	0.2500463	0.86544343	32	60	3392.88703	150	12.8	0.38930545	5099.23126	1985.15852	2208.35361	223.195092	59.39	1018.00607	2000

The calculations are attached in the Production Spreadsheet.

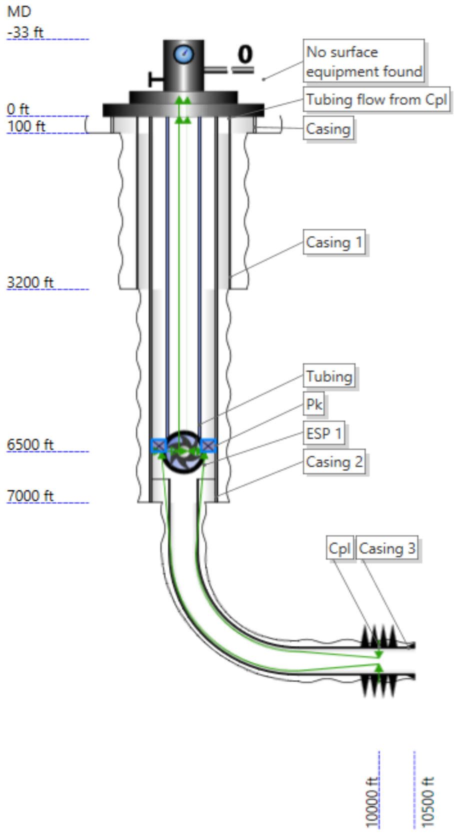
Case: Vivian horizontal well H10

Tabla 147 Vivian horizontal well H10 - Parameters

ELECTRIC SUBMERSIBLE PUMP DESIGN							
OPERATOR		KysPetrol		**WELL**			
COUNTRY		Perú		**FORMATION**		VIVIAN	
FIELD		San Jacinto Oriental					
WELL							
	ID (in)	**OD (in)**	**Weight(lb/ft)**	**FROM (ft)**	**TO (ft)**	**PERFORATED INTERVAL**	
Casing	19.124	20	94	0	100	-	-
Casing	12.415	13.375	68	0	3200	-	-
Casing	8.535	9.625	53.5	0	7000	-	-
Liner	6.184	7	29	6750	10500	300 ft	
Tubing	3.958	4.5	12.6	0			
SURFACE INFORMATION							
THP	150	Psi		**VOLTAGE**	-	V	
WHT	225	F		**FREQUENCY**	60	Hz	
CHP	0	Psi					
FLUID PROPERTIES							
API		11.5		Bubble Pressure		540	psi
Gas gravity		0.975		**Salinity**		42500	ppm
Water gravity		1.05					
RESERVOIR CHARACTERIZATION							
PRESSURE TEST				**PRODUCTION TEST**			
		MD	TVD				
Datum		7843	7843	Oil rate		14142	bopd
Static Pressure		3250	psi	**Water rate**		289	bwpd
Temperature		240	F	Liquid rate		14431	bfpd
IP		4.427	stb/psi	**BSW**		97%	
K		2000	md	**GOR**		50	scf/bbl
DESIGN PARAMETERS							
				MD	TVD	UNITS	
Setting depth				6500	6500	ft	
Rate design				15000		bpd	

We will present the electrical submersible pumping diagram of well H10:

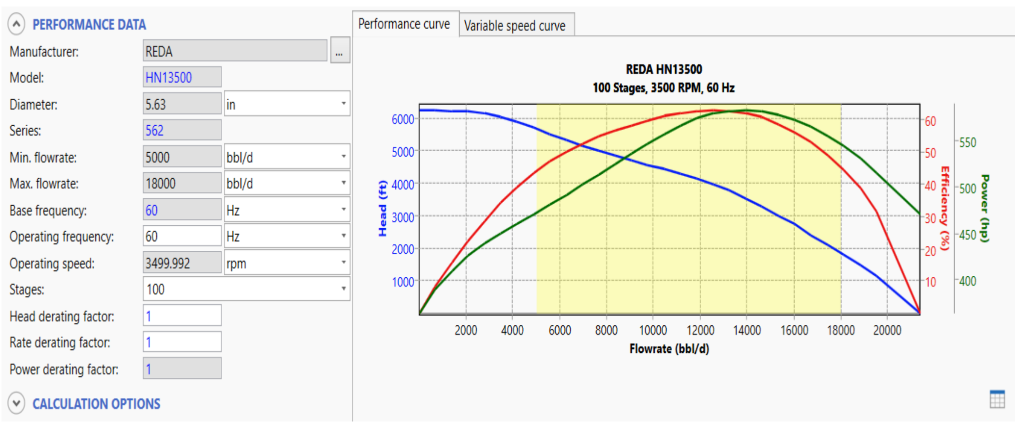
Figura 191: ESP diagram for Horizontal well



The selected pump with the PipeSim2017 program:

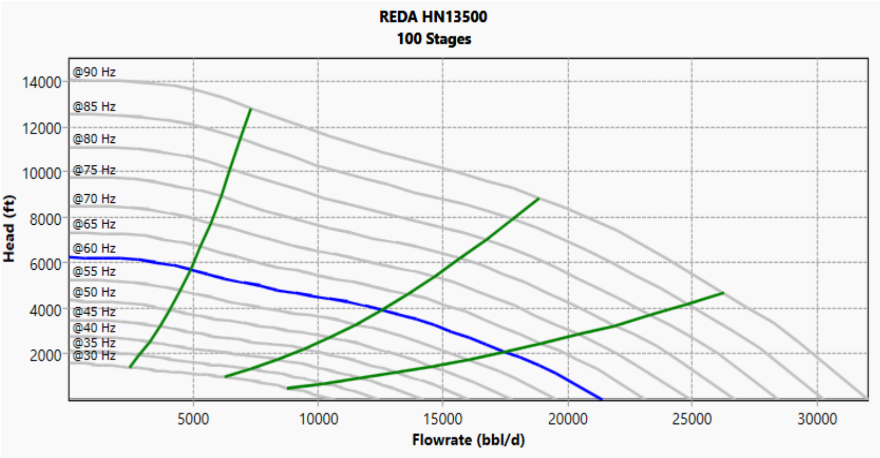
- REDA HN13500 N
- 100 stages
- 3500 RPM
- 60 Hz
- Pump performance curve @ 60 Htz

Figura 192: Performance curve REDA HN13500



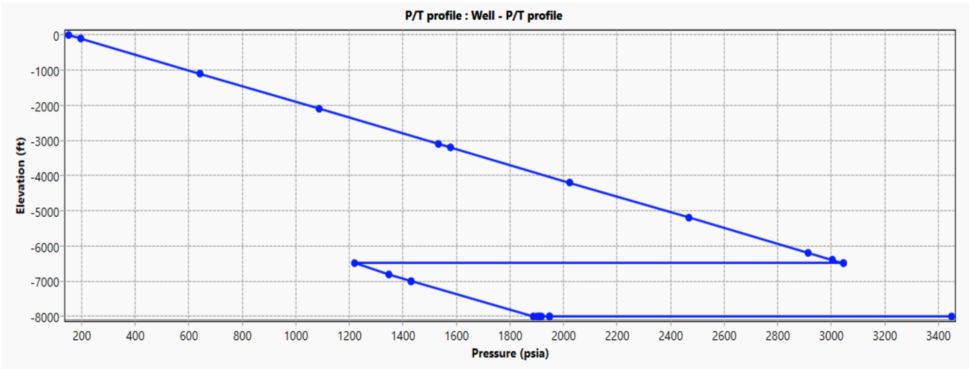
- ➢ Performance curve

Figura 193: Optimal working range REDA HN13500



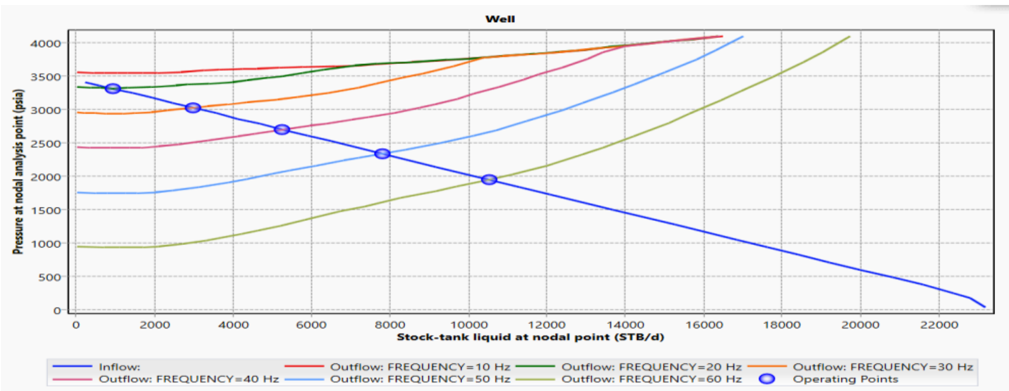
- ➢ Pressure profile:

Figura 194: Elevation vs Pressure



- ➢ Nodal Analysis

Figura 195: Nodal analysis at different frequencies



The graph is presented at the beginning of production and at the end of production

Tabla 148:Production using ESP System

BFPD	WC	Yo	API	HZ	PWF	PC	IP	Mixture gradient	H	PIP	Pdesc	Ppump	Hfriction	TDH
7506.27312	0.02614788	0.98951049	11.5	60	2327.67527	150	7	0.4285768	1626.34147	3089.53669	1463.19522	255.469945	4019.54491	2000
7417.66956	0.05561878	0.98951049	11.5	60	2340.33292	150	7	0.42871066	1638.78008	3090.45026	1451.67018	249.91918	3985.93586	2000
7348.46264	0.08493263	0.98951049	11.5	60	2350.21962	150	7	0.4288438	1648.4489	3091.35895	1442.91005	245.622559	3960.052	2000
7275.34025	0.11138884	0.98951049	11.5	60	2360.66568	150	7	0.42896397	1658.69832	3092.17906	1433.48074	241.120072	3932.52744	2000
7212.33469	0.13695145	0.98951049	11.5	60	2369.66647	150	7	0.42908007	1667.50912	3092.97148	1425.46236	237.271244	3908.99237	2000
7145.53909	0.16013833	0.98951049	11.5	60	2379.2087	150	7	0.42918538	1676.87901	3093.69024	1416.81123	233.221988	3883.88506	2000
7087.77716	0.18264685	0.98951049	11.5	60	2387.46041	150	7	0.42928762	1684.96342	3094.38798	1409.42456	229.746204	3862.33308	2000
7032.31946	0.20382715	0.98951049	11.5	60	2395.38293	150	7	0.42938382	1692.72852	3095.04455	1402.31602	226.431654	3841.64947	2000
6973.28396	0.22316077	0.98951049	11.5	60	2403.81658	150	7	0.42947163	1701.01847	3095.64387	1394.6254	222.927601	3819.49905	2000
6921.99693	0.24203993	0.98951049	11.5	60	2411.1433	150	7	0.42955738	1708.20486	3096.2291	1388.02423	219.903853	3800.38999	2000
6867.27866	0.25933471	0.98951049	11.5	60	2418.96019	150	7	0.42963593	1715.89322	3096.76522	1380.872	216.698739	3779.88305	2000
6819.61615	0.27627972	0.98951049	11.5	60	2425.76912	150	7	0.42971289	1722.5762	3097.29049	1374.71429	213.924544	3762.14085	2000
6773.57597	0.2923651	0.98951049	11.5	60	2432.34629	150	7	0.42978595	1729.03381	3097.78912	1368.75531	211.260379	3745.00852	2000
6714.84694	0.30619149	0.98951049	11.5	60	2440.73615	150	7	0.42984875	1737.32091	3098.21772	1360.89682	207.884238	3722.83412	2000

If it is not possible to work with a 100-stage pump, it will be necessary to work with more than one pump or, on the contrary, to work with larger pumps that are limited to the size of the well drift.

The calculations are attached in the Production Spreadsheet.

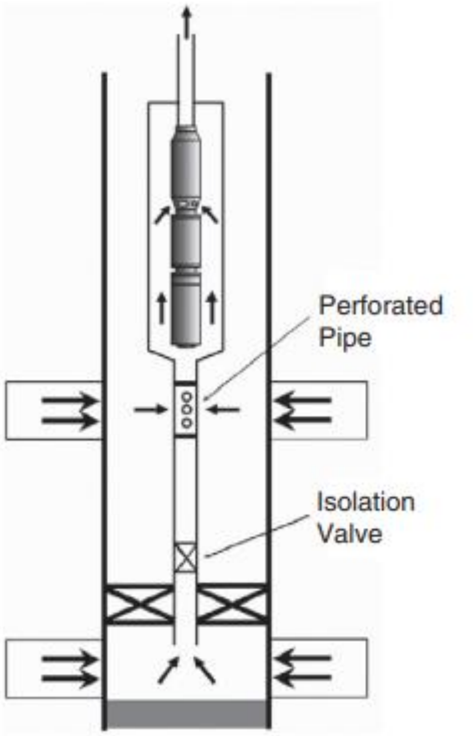
Case: Commingled vertical well G08

Tabla 149: Commingled vertical well G08 - Parameters

ELECTRIC SUBMERSIBLE PUMP DESIGN							
OPERATOR		KysPetrol		**WELL**			
COUNTRY		Perú		**FORMATION**		VIVIAN - CHONTA	
FIELD		San Jacinto Oriental					
POZO							
	ID (in)	**OD (in)**	**Weight(lb/ft)**	**FROM (ft)**	**TO (ft)**	**PERFORATED INTERVAL**	
Casing	19.124	20	94	0	100	-	-
Casing	12.415	13.375	68	0	3200	-	-
Casing	8.535	9.625	53.5	0	8530	-	-
Liner	6.184	7	29	8230	9800	300 ft	100 ft
Tubing	3.958	4.5	12.6	0			
SURFACE INFORMATION							
THP	150	Psi		**VOLTAGE**	-	V	
				FREQUENCY	60	Hz	
WHT	225	F					
CHP	0	Psi					
FLUID PROPERTIES							
API		Mix		Bubble Pressure		978 y 540	Psi
Gas gravity		0.975		**Salinity**		mix	Ppm
Water gravity		1.05					
RESERVOIR CHARACTERIZATION							
PRESSURE TEST				**PRODUCTION TEST**			
		MD	**TVD**				
Datum		7843	7843	**Oil rate**		14602	Bopd
Static Pressure		3250	psi	**Water rate**		298	Bwpd
Temperature		240	F	**Liquid rate**		14900	Bfpd
IP		15.4	stb/psi	**BSW**		98%	
K		2000 y 200	md	**GOR**		185	scf/bbl
DESIGN PARAMETERS							
				MD	**TVD**	**UNITS**	
SETTING DEPTH				5000	5000	ft	
RATE DESIGN				15000		bpd	

We will present the electrical submersible pumping diagram of well G08:

Tabla 150: Conventional ESP diagram. source: Gabor Takacs

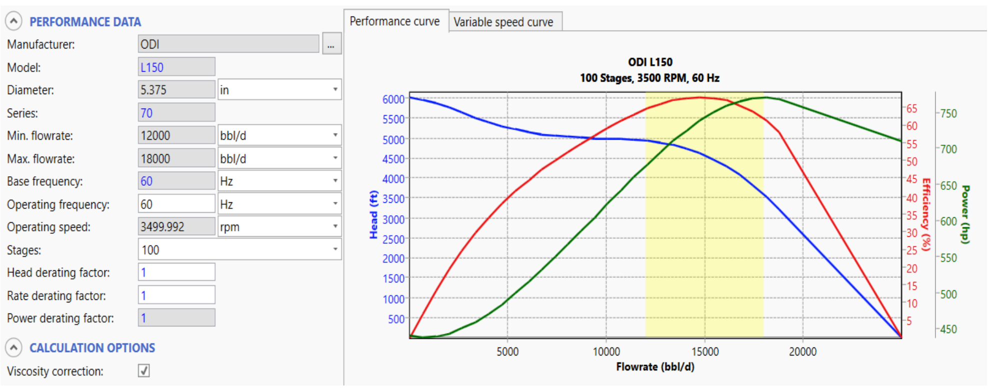


The selected pump with the PipeSim2017 program:

- ODI L150
- 100 stages
- 3500 RPM
- 60 Hz

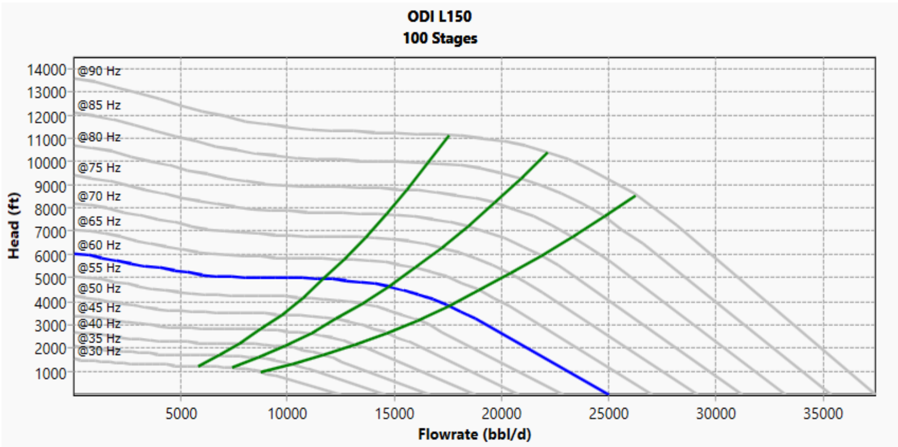
➢ Pump performance curve @ 60 Hz

Figura 196: Performance curve ODI L150



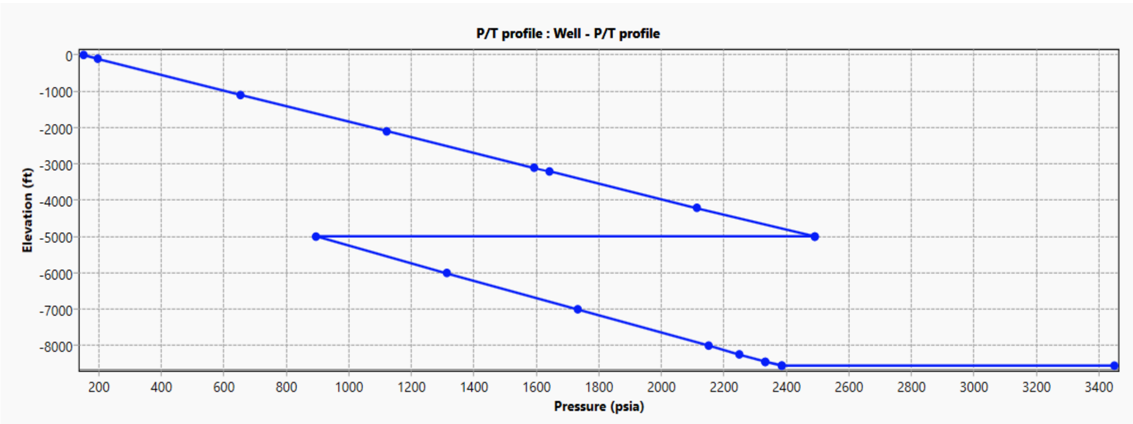
- Performance curve

Figura 197: Optimal working range ODI L150



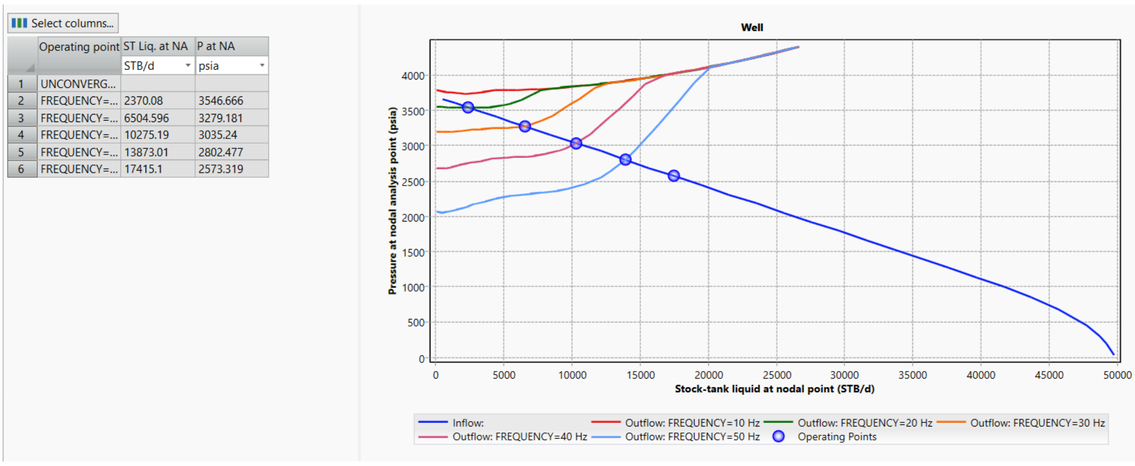
- Pressure profile

Figura 198: Elevation vs Pressure



- Nodal Analysis

Figura 199: Nodal Analysis at different frequencies



The graph is presented at the beginning of production and at the end of production.

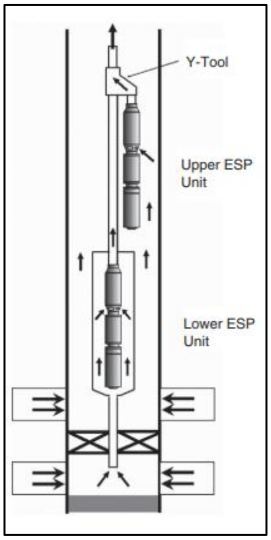
Tabla 151: Production using ESP System

BFPD	WC	BOIL	BFPD	WC	BOIL	BFPDT	WCT	Yo	Yo	Yot	Api average	Bovivivan	Bochonta	Bo prom	Hz
13789	0.972	383.2	2795.6	0.93	182.61	16584.18	0.97	0.99	0.87	0.95	17.53	1.09	1.15	1.11	60
13950	0.973	379.1	2803.2	0.94	181.60	16753.08	0.97	0.99	0.87	0.95	17.55	1.09	1.15	1.11	60
14121	0.973	375.1	2811.0	0.94	180.60	16932.21	0.97	0.99	0.87	0.95	17.57	1.09	1.15	1.11	60
14303	0.974	371.1	2819.2	0.94	179.61	17122.22	0.97	0.99	0.87	0.95	17.60	1.09	1.15	1.11	60
14496	0.975	367.2	2827.6	0.94	178.63	17323.83	0.97	0.99	0.87	0.95	17.62	1.09	1.15	1.11	60
14701	0.975	363.4	2836.4	0.94	177.66	17537.85	0.97	0.99	0.87	0.95	17.64	1.09	1.15	1.11	60
14920	0.976	359.6	2845.4	0.94	176.69	17765.15	0.97	0.99	0.87	0.95	17.66	1.09	1.15	1.11	60
14874	0.976	358.5	2854.8	0.94	175.74	17728.80	0.97	0.99	0.87	0.95	17.65	1.09	1.15	1.11	60
14856	0.976	358.1	2864.5	0.94	174.80	17720.42	0.97	0.99	0.87	0.95	17.63	1.09	1.15	1.11	60
14838	0.976	357.6	2874.5	0.94	173.86	17712.72	0.97	0.99	0.87	0.95	17.62	1.09	1.15	1.11	60
14821	0.976	357.2	2884.8	0.94	172.94	17705.70	0.97	0.99	0.87	0.95	17.60	1.09	1.15	1.11	60
14804	0.976	356.8	2895.5	0.94	172.02	17699.36	0.97	0.99	0.87	0.95	17.58	1.09	1.15	1.11	60

Pwf	PC	IP	Mixture gradient	H	PIP	Pdesc	Ppump	Hfriction	TDH	n liquid
2627.08	150	15.46	0.43	2349.71	1015.67	2433.83	1418.16	851.72	4479.59	4000
2616.15	150	15.46	0.43	2324.26	1004.70	2433.89	1429.20	867.83	4521.14	4000
2604.56	150	15.46	0.43	2297.28	993.06	2433.96	1440.90	885.08	4565.34	4000
2592.27	150	15.46	0.43	2268.67	980.72	2434.02	1453.30	903.54	4612.39	4000
2579.22	150	15.46	0.43	2238.32	967.63	2434.09	1466.46	923.32	4662.50	4000
2565.38	150	15.46	0.43	2206.12	953.74	2434.16	1480.42	944.53	4715.89	4000
2550.67	150	15.46	0.43	2171.93	938.99	2434.23	1495.24	967.31	4772.83	4000
2553.02	150	15.46	0.43	2177.34	941.33	2434.24	1492.90	963.65	4763.76	4000
2553.57	150	15.46	0.43	2178.55	941.86	2434.25	1492.39	962.81	4761.70	4000
2554.06	150	15.46	0.43	2179.67	942.35	2434.27	1491.92	962.03	4759.81	4000
2554.52	150	15.46	0.43	2180.68	942.79	2434.28	1491.49	961.33	4758.09	4000
2554.93	150	15.46	0.43	2181.59	943.19	2434.30	1491.10	960.69	4756.54	4000

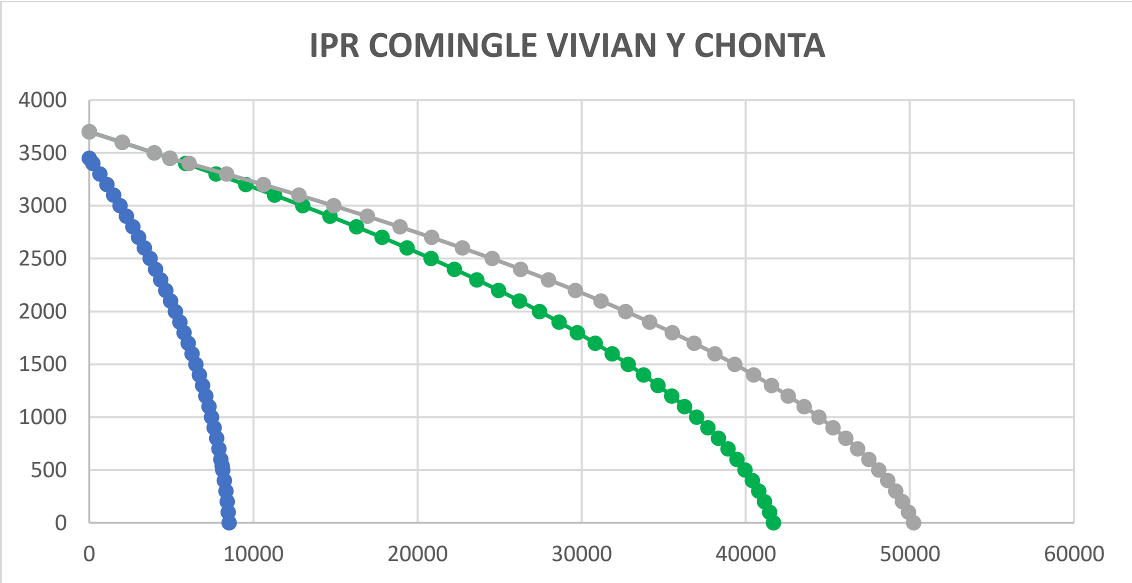
We will present the diagram of electrical submersible pumping of wells G09, G13, G14 and G15:

Figura 200: Commingled Production of two zones with two ESPs. Source: Gabor Takacs



We will select the pumps related to the Vivian and Chonta vertical well for the calculation and the IPR curve will be the sum of the two.

Figura 201: IPR – Commingled well



And the IPR curve would be the sum of the 2, reaching a maximum of 17 IP, for more information the respective calculations will be attached in an Excel file.

4.5.4. Surface Facilities

4.5.4.1. Flow Lines

4.5.4.1.1. Flow Line design

The flow of fluids in pipes generates a pressure drop due to the interaction between the roughness of the pipe walls and the fluid itself, this pressure drop is calculated as follows:

PRESSURE LOSS IN THE FLOW LINES

$$\Delta P_T = \Delta P_e + \Delta P_f$$

$$\Delta P_e = 0.433 * \gamma_L * \Delta h \qquad \Delta P_f = 0.06056 * f * \frac{\gamma_L * q^2 * L}{D^5}$$

ΔP_e: Pressure losses due to elevation
ΔP_f: Pressure losses due to friction

We have the friction losses generated by the friction of the pipe walls and the liquids while the lifting losses only depend on the difference in levels. Darcy-Weisbach experimentally deduced an equation to calculate shear losses ("Friction"), in a tube with permanent flow and constant diameter, in the proposed equation all the data were known except one which was called "friction factor" (f).

$$hf = f * \frac{L}{D} * \frac{V^2}{2g}$$

where:

hf: friction loss(m).
f: friction loss factor
g: gravity (m2/s)
D: diameter (m)
L: length (m)
V: average velocity (m/s)

Friction factor can be calculated according to the type of flow regime in the pipes.

- Poiseuille-1846 proposed the following equation to calculate the friction factor in a **laminar flow regime**:

$$f = \frac{64}{Re}$$

- In **turbulent regime**, the Colebrook-White equation is normally used.

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{\varepsilon}{3.7 * D} + \frac{2.51}{N\,\mathrm{Re}^{*}\sqrt{f}}\right)$$

The existence of viscosity causes a resistance to movement between two contiguous layers of fluid to appear, this dynamic influence of viscosity in movement is defined by the Reynolds number (DÁVILA J., PAJÓN P.)

Laminar flow

- $Si\ N_{Re} < 2300 \rightarrow f = \frac{64}{N_{\mathrm{Re}}}$

$$N_{\mathrm{Re}} = 92.2 * \frac{q * \gamma_L}{D * \mu}$$

Turbulent flow

- $Si\ N_{Re} > 4000 \rightarrow \frac{1}{\sqrt{f}} = -2\log\left(\frac{\varepsilon}{3.7 * D} + \frac{2.51}{N\,\mathrm{Re}^{*}\sqrt{f}}\right)$

ε: pipe roughness

The friction factor (f) can also be calculated using the Mood Diagram. However, for our calculations we will use the following iteration:

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{\varepsilon}{3.7 * D} + \frac{2.51}{N\,\mathrm{Re}^{*}\sqrt{f}}\right)$$

Taking into consideration the following premises:

- When calculating pressure losses, the viscosity of the fluid should be used at SURFACE conditions, not the same as it is at reservoir conditions.
- If a design wellhead pressure has been used for the "ESP" of 150 psi, it will ensure that the pressure losses do not exceed the following difference:

$$\text{Drop Pressure} \leq \text{Well head Pressure} - \text{separator pressure}$$

- In case they have a lot of pressure loss, a larger diameter pipe will be selected.

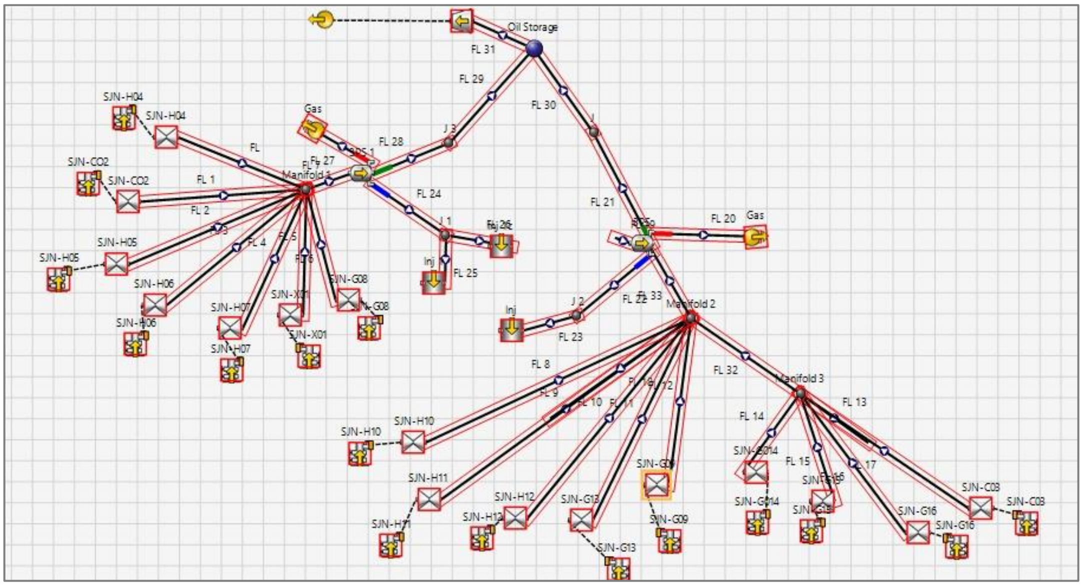
Tabla 152:Surface pressure and pipe diameter data available

Properties	Data
Separator pressure	60
Wellhead pressure	150
ΔP (P. Wellhead-Separator pressure)	90

Tubing diameters available
4.5
5
6
8
10

A diagram of the producing wells, disposal wells, flow lines, manifolds and batteries are shown.

Figura 202: Scheme of surface facilities



We can also see the production of water, gas and oil that will be processed by each of the batteries considered for the production system.

Figura 203 Production - Battery # 1

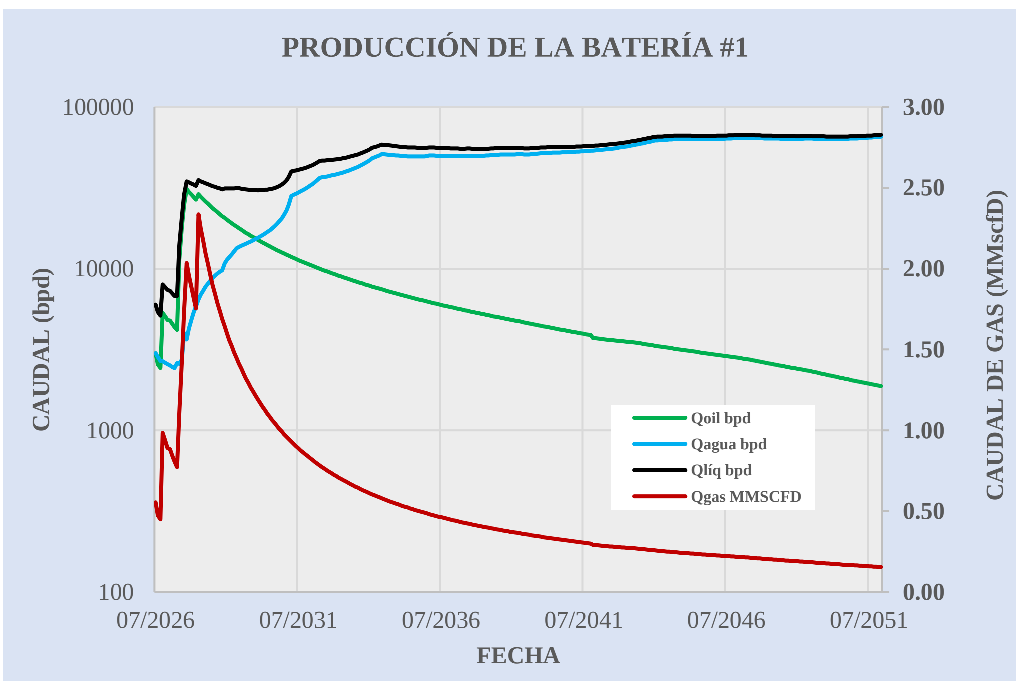


Figura 204: Production - Battery # 2

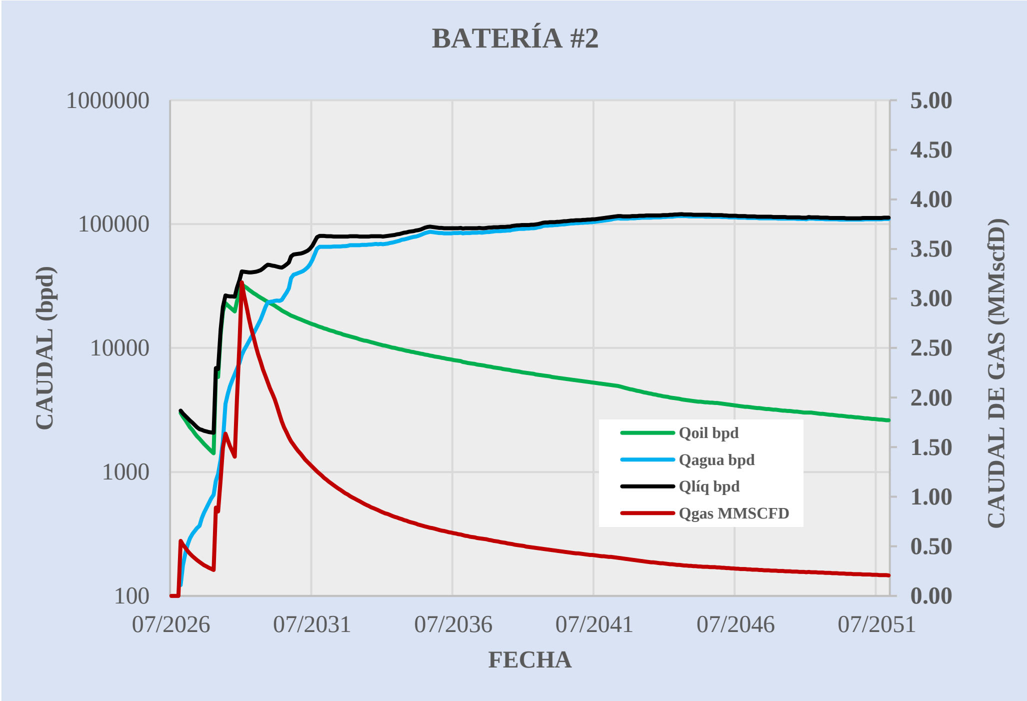
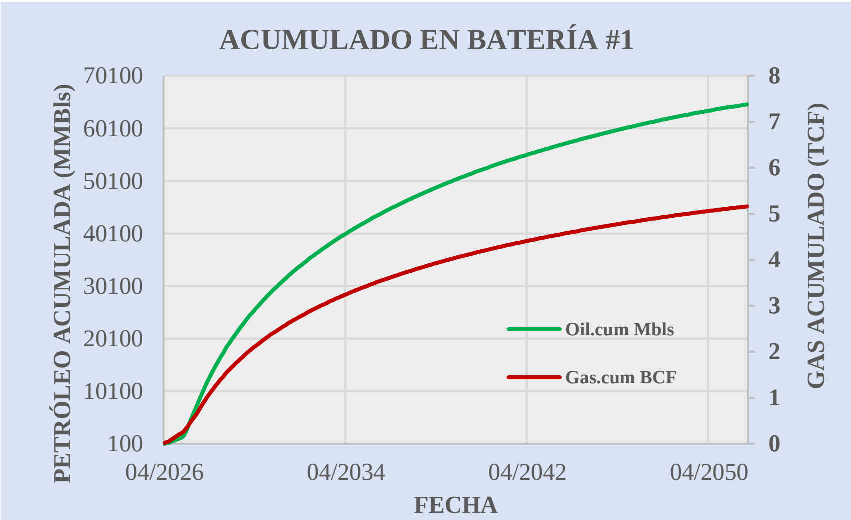
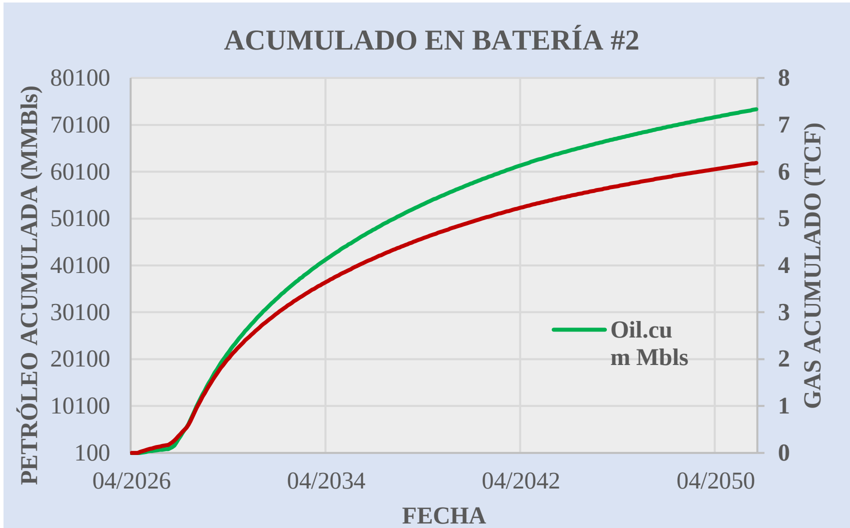


Figura 205: Cumulative Oil and Gas Production in Battery # 1



HYDROCARBON	CUMULATIVE PRODUCTION
Oil	64.672 MMbl
Gas	5.16 BCF

Figura 206 Cumulative Oil and Gas Production in Battery # 2



HYDROCARBON	CUMULATIVE PRODUCTION
Oil	73.414 MMbl
Gas	6.19 BCF

Tabla 153: Pressure loss in pipeline

Production Battery	Well	Length (Km)	**Elevation (m)**	Manifold Elevation(m)	Q (bbl/day)	ID (inch)	Length(miles)	Sp.gr (fluíd)	Viscosity(cp)	N Reynold	Flow
AL MANIFOLD N° 1 (m)	SJN-X01	0,707	194	186	3119,91	10	0,439	0,865	6	4147,0	turbulent
	SJN-C02	1,503	202	197	4215,4	10	0,934	0,865	6	5603,2	turbulent
	SJN-H04	2,065	189	186	14974,68	10	1,283	0,989	689	198,2	laminar
	SJN-H05	2,097	198	186	14704,51	10	1,303	0,989	689	194,6	laminar
	SJN-H06	0,745	191	186	14890	10	0,463	0,989	689	197,1	laminar
	SJN-H07	0,718	199	186	14935,18	10	0,446	0,989	689	197,7	laminar
	SJN-G08	0,94	199	186	18818,34	10	0,584	0,9333	13,68	11837,2	turbulent
AL MANIFOLD N° 2 (m)	SJN-C03	8,57	172	186	3985,05	10	5,325	0,865	6	5297,0	turbulent
	SJN-G09	1,023	200	197	29154,55	10	0,636	0,9333	13,68	18338,9	turbulent
	SJN-H10	2,109	199	197	14774,97	10	1,310	0,989	689	195,5	laminar
	SJN-H11	1,416	202	197	14782,1	10	0,880	0,989	689	195,6	laminar
	SJN-H12	0,25	192	197	14986,45	10	0,155	0,989	689	198,3	laminar
	SJN-G13	1,029	197	197	21748,45	10	0,639	0,933	13,68	13675,9	turbulent
	SJN-G14	4,1	177	197	20511,01	10	2,548	0,933	13,68	12897,7	turbulent
	SJN-G15	5,13	172	197	22728,46	10	3,188	0,933	13,68	14292,1	turbulent
	SJN-V16	4,91	190	197	2603,64	10	3,051	0,865	6	3460,8	turbulent

TURBULENT				LAMINAR			
e	**e/D**	**f***	**f**	**f**	**Pf Loss(psi)**	**Pe Loss (psi)**	**Total Loss**
0,001	0,00010000	0,03959	0,03959	0,01543	0,09	-9,830577742	-9,74
0,001	0,00010000	0,03631	0,03631	0,01142	0,32	-6,14	-5,83
0,001	0,00010000	0,12086	0,12086	0,32293	55,65	-4,21	51,44
0,001	0,00010000	0,12189	0,12189	0,32887	55,50	-16,86	38,64
0,001	0,00010000	0,12118	0,12118	0,32477	19,96	-7,02	12,94
0,001	0,00010000	0,12101	0,12101	0,32379	19,30	-18,26	1,03
0,001	0,00010000	0,02971	0,02971	0,00541	3,47	-17,24	-13,76
0,001	0,00010000	0,03689	0,03689	0,01208	1,63	17,20	18,84
0,001	0,00010000	0,02665	0,02665	0,00349	8,14	-3,98	4,16
0,001	0,00010000	0,12162	0,12162	0,32730	56,08	-2,81	53,27
0,001	0,00010000	0,12159	0,12159	0,32714	37,67	-7,02	30,65
0,001	0,00010000	0,12082	0,12082	0,32268	6,74	7,02	13,77
0,001	0,00010000	0,02865	0,02865	0,00468	4,90	0,00	4,90
0,001	0,00010000	0,02907	0,02907	0,00496	17,60	26,51	44,11
0,001	0,00010000	0,02833	0,02833	0,00448	26,36	33,14	59,49
0,001	0,00010000	0,04177	0,04176	0,01849	0,45	8,60	9,05

4.5.4.2. Separation

In the first instance, to separate the crude oil in oil, water and gas we must have a separator, the separators vary according to the number of phases (two-phase and three-phase) and according to the type of fluid to be separated (horizontal, vertical and spherical) being the most used horizontal separators for the process of liquid with little gas as it will be in our case, and the vertical separators for fluid with a greater quantity of gas.

These devices work at a certain pressure and separate fluids through 4 fundamental processes: momentum or quantity of movement, the force of gravity and coalescence. Any separation can employ one or more of these principles, but the fluid phases must always be immiscible and of different densities for separation to occur.

- **Primary separation section:** If a phase stream changes direction abruptly, the particles of the light phase will change direction or move faster than those of the higher density or heavier fluid, this change in momentum produces separation of the phases.
- **Secondary separation section:** The liquid droplets separate from the gaseous phase when the force of gravity acting on the liquid droplets is greater than the drag force of the gas.
- **Mist extraction section:** For the smallest drops of liquid, which form a kind of mist or drizzle that is dragged by the gaseous phase, and which cannot be separated by gravity, a coalescer mechanism is used. These means are demister, mist eliminators, or meshes, which cause the small drops to collide, forming larger drops that, due to their greater size and weight, cause them to precipitate by gravity.
- **Liquid storage section:** The liquid separated from the gas stream is stored and discharged. Some components are the controller, a level indicator, a float, and a dump valve.

Three-phase separator components:

- **Flow Diverter:** It consists of a device that is installed at the inlet of the separator.
- **Defoaming plates:** These helps break up the foam bubbles. They are installed at the gas / liquid interface of the corresponding separator.
- **Mist extractor:** They are installed in the gas discharge of the corresponding separator and constitute the main element of the coalescence section.
- **Vortex breaker:** Located at the oil and water outlets. Its function is to counteract the swirling effect that can occur when oil and water leave the separator. These devices prevent gas particles from escaping through the liquid lines.
- **Baffle:** Located at the bottom of the separator, it divides the separator into two compartments: oil and water. It only allows the oil to overflow into the oil compartment.

Figura 207. Three phase Separator

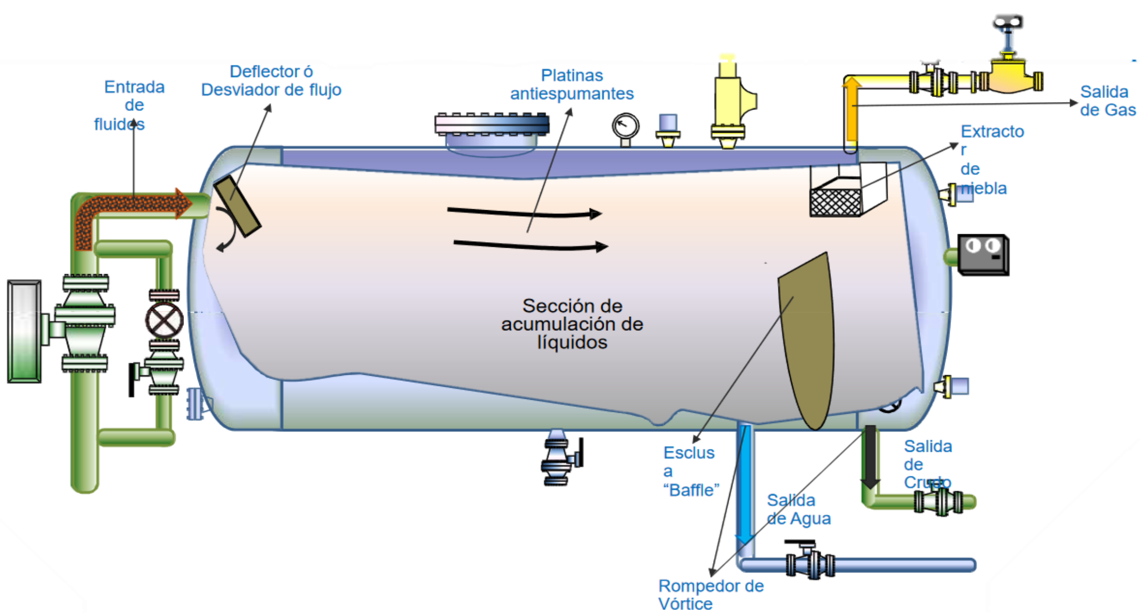


Tabla 154: North Battery

EQUIPMENT	CAPACITY	QUANTITY
Manifold		1
Production separator	35000 bpd	3
Test separator	10000 bpd	1
Total Tank	25000 bbl	4
Gun barrel	26200 bbl	5
Test tank	5000 bbl	2
Volumeter		2
Gun barrel	25000 bbl	3
pump tank	25000 bbl	3
storage tank	25000 bbl	4

Tabla 155: South Battery

EQUIPMENT	CAPACITY	QUANTITY
Manifold		2
Production separator	35000 bpd	4
Test separator	10000 bpd	1
Total Tank	25000 bbl	3
Gun barrel	26200 bbl	6
Test tank	5000 bbl	2
Volumeter		2
Gun barrel	25000 bbl	4

4.5.4.3. Fluid Treatment

During oil production, characterization tests will be taken in accordance with standards such as ASTM and API in order to determine the following characteristics:

- API gravity
- Water and sediment content
- Salt content
- Sulfur content

The characteristics of the oil must be within the required specification, since an out-of-specification crude oil has a very small commercial value, this due to the high levels of water and sediment, salts and sulfur, making it difficult to process.

On the other hand, we must inject the high volumes of formation water produced, so the design of the battery will ensure a correct separation, treatment and transport of the fluids.

Among the treatments to be carried out in our crude oil we have:

Demulsification: The crude received at the refineries contains small amounts of produced water (0.1% and 1.5%) that cannot be economically removed in the field. The water or brine produced with crude oil is salty and contains water-soluble impurities: sodium and calcium.

- Gravity treatment
- Heat treatment
- Chemical demulsifiers treatment (polyesteramides and their mixtures)
- Electrical treatment.

Desalination operation

This process is necessary to remove the salts in crude oil, which are detrimental to refining process. This treatment consists of washing the crude with steam in which the salt dissolves. This process is carried out in desalination equipment with an efficiency of 95% due to the cost and the delay time it has when decanting by gravity, since it is only 95% effective, it is mixed with a $NaOH$ solution to convert it to $NaCl$, thus reducing corrosion to the desalination unit.

- Separation by electrical coalescence.

- Chemical use: The chemicals used are generally demulsifiers that have strong attraction at the oil / water interfaces. The purpose of this chemistry is to improve the water / brine contact, flocculation and / or wettability of solids.
- Electrostatic dehydrator.

Foam presence (Foam occurs when pressure and temperature are reduced as oil flows from the well to the surface and gas is enveloped as small bubbles through the oil).

- Defoamer chemistry (Silicone-based defoamers are the most efficient in controlling foaming crudes.)

Water Clarification

Chemistry of reverse demulsifiers (The reverse demulsifiers used are polyelectrolytes which are totally organic chemicals, highly efficient at low doses and function as both coagulants and reverse emulsion breakers).

Paraffins and Asphaltenes

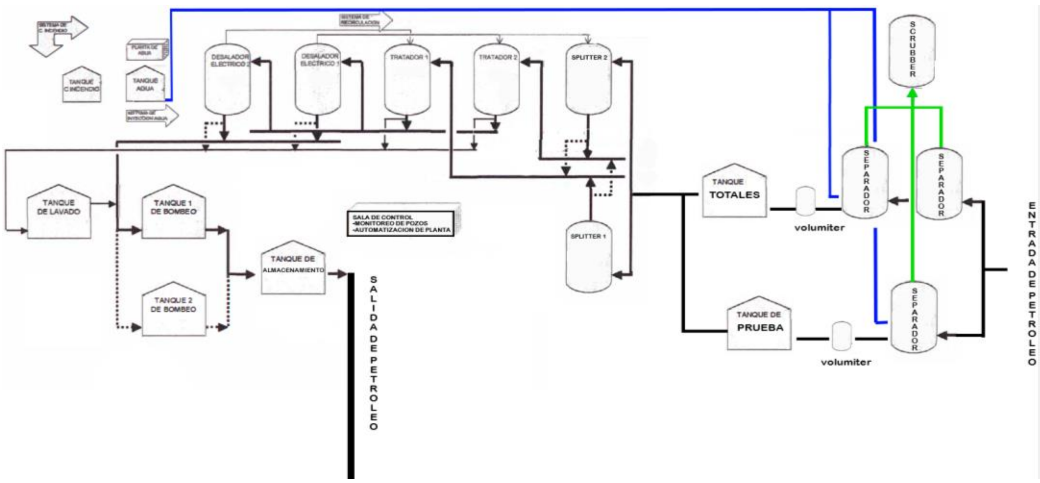
The presence of paraffin and asphaltenes in downhole and surface equipment are major problems in production operations.

Methods to remove paraffins and asphaltenes

- Mechanical: use of scrapers and pipe cutters for paraffin.
- Solvents: use of condensate, kerosene, or diesel for paraffins and toluene with surfactant for asphaltenes.

- Heat: hot oil or water for paraffin.
- Dispersants: water soluble dispersants.

Figura 208: Fluid separation scheme



Treatment of crude oil with Naphtha

Cracked naphtha is a product obtained from the catalytic cracking unit of petroleum refineries. It has physicochemical properties (low kinematic viscosity, low pour point, etc.) which, when mixed with heavy crude oil, improve the physicochemical properties of the mixture.

In recent years, the use of petroleum derivatives as diluents has increased. Oil refining has been able to produce hydrocarbons with a high degree of purity, achieving the manufacture of industrial diluents with properties required by the industry.

Some disadvantages of diluting with Naphtha would be:

- Accessibility since some heavy crude oil reserves are located in areas that are difficult to access.
- High costs.
- Decrease in volume of the flow of crude produced, since the naphtha will occupy a fraction of the mixture that will flow through the pipeline.

Determination of the optimum diluent percentage:

It depends mainly on the viscosity of the mixture and the flow regime. The objective is to transport a greater flow of crude with the lowest percentage of diluent possible (Naphtha) and to achieve the operational requirements of the North Peruvian Pipeline to pump the crude.

Fluids Properties:

Basic fluid	API (60°F)	cP (70°F)
San Jacinto Oriental	15.81	238.33
Naphtha	50	3.5

Dilution: San Jacinto Oriental crude / Naphtha

Crudo (% V/V)	API (60 F)	cP (70 F)
8	18.1	168

Iquitos refinery

The Iquitos refinery is located on the left bank of the Amazon River, 14 kilometers from the city of Iquitos, capital of the Maynas province, Loreto department. The Iquitos refinery produces fuels that supply hard-to-reach places in the Peruvian jungle.

Figura 209: Iquitos refinery

REFINERÍA IQUITOS	
Owner	PETROPERU
Start operations	15 de October de 1982
Location	Left bank of the Amazon River, 14 km from the city of Iquitos, Province of Maynas, Department of Loreto.
Full capacity	
Processing capacity	
Primary distillation unit	10500 bpd
Derivative production capacity	

NAPTHA	62.4 MBls
Electric Generation Unit	
2550 kW Nominal power	

Source: Ministerio de Energía y Minas

The diluent will be supplied by river through the Amazon and Marañón rivers. They will be received at a terminal and then transferred to our production fields where the diluent will be mixed and treated with the crude produced.

In the event that the Iquitos refinery does not have the necessary amounts of naphtha to treat our crude, we will use the services of other refineries such as:

Tabla 156:Refinery Capacity

	REFINERIES	ANNUAL NAPHTHA REFINING CAPACITY
PERU	Refinería de Talara	294.2 MBls
BRAZIL	Refinería Duque de Caxias (REDUC)	5692 MBls
BRAZIL	Refinería Paulínia (REPLAN)	5874 MBls

Equipment for pumping and receiving the diluent:

- Storage tanks for diluent
- Pumping equipment.
- Measuring equipment and other equipment for the diluent transport system.

Cost of facilities

Tabla 157:Cost of facilities

Description	Unit	Quantity	Cost	Total Cost
M US $				
Fluvial Terminal	unit	1	30770	30.8
Pumping system and diluent measurement.	unit	1	4000	4.0
Storage (100 Mbl Tanks)	unit	3	4000	12.0
TOTAL				**46.8**

Barge transportation

Transport capacity per barge

The barges to be used will have a volume capacity of 9,500 barrels of diluent and the navigation speed of the barges will be 5.6 knots on average. It is considered to make the trips with a configuration of 1 tug and 2 barges. Likewise, for navigation by waterway, no information on any restriction was found, so navigation is considered daytime and nighttime.

Considerations:

Excerpted from "Registros Hábiles de medios de transporte lacustre, marítimo y fluviales – OSINERGMIN", considering a safety factor of 0.8 to the total registered capacity.

- The Amazon River Navigation Study presents vessels such as barges loaded with 500 tons and a draft of 2ft that can navigate at speeds of up to 6 to 8 knots in the Napo River, assigning a safety factor of 0.8, we consider an average navigation speed of 5.6 knots.

- Navigability Study of the Amazon River Final Report

Using the distance to travel and the navigation speed, we obtain the navigation time:

- Distance to travel / Navigation speed = Navigation time
- 578 km / (5.6 knots * 1,852 km / knot * 24 hours) = 2.32 days.
- Total Navigation Time (578 km) = 2.32 days.

We obtain that navigating the 578 km requires 2.32 days, additionally it is considered 2 days for loading and unloading of transported fluid, which gives us a total of 6.64 round trip days.

From the above, we have a total of 6.64 days to transfer 19,000 barrels of diluent. In other words, each configuration of a tugboat and 2 barges provides us with a transport capacity of 1,032.6 bpd.

Cost of barges and tugs

Acquiring a new barge with the appropriate characteristics for the transport of diluent required by the project has an approximate cost of $ 1,500 million USD. Taking into consideration the cost of the barge, it is considered that the cost of the tugboat will be higher due to the greater equipment it will have, we estimate a cost of $ 2,000 M USD.

Tabla 158:Volumen and Number of Barges

YEAR	TRANSPORTED VOLUME (BLS)	NUMBER OF BARGES	NUMBER OF TUGGERS
2	679212	10.761	5.380

It was estimated that in year 2 the highest volume of diluent will be needed, so taking into consideration the capacity of the tank and the number of days of transport, 11 barges and 5 tugs will be needed.

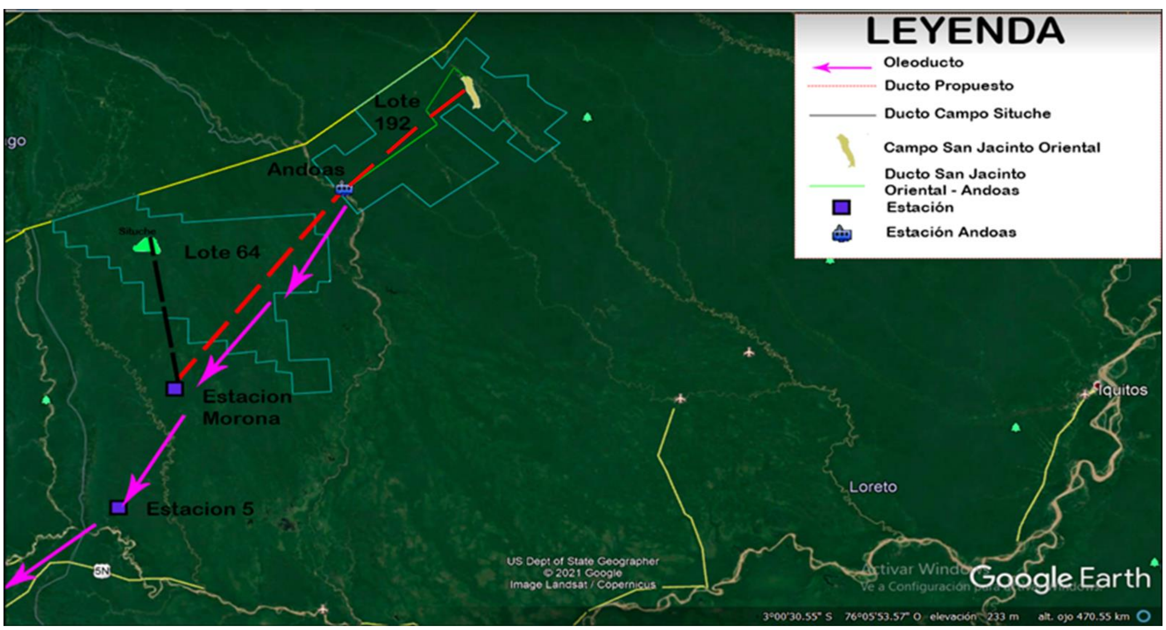
Source: Technical-economic study for the installation of new process units at the Iquitos Refinery to cover the demand for high-octane gasoline in the jungle region.

Analysis and comparison of the transport of diluted crude oil by barge and by pipeline, in the northern jungle of Peru

Light Crude Treatment

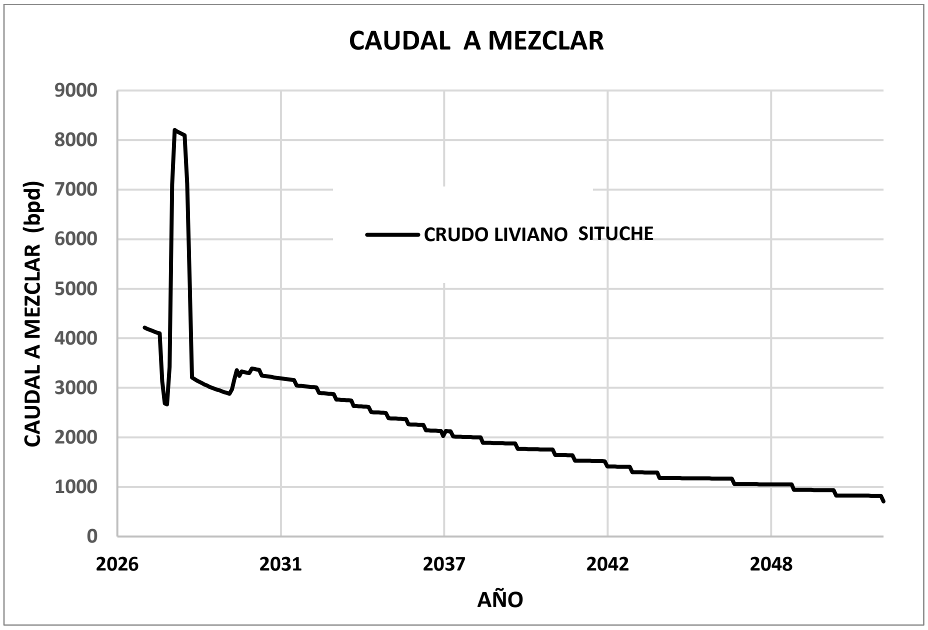
For the treatment with light crude oil, it is chosen to use crude from Block 64, specifically the "Situche" field, currently inoperative, which has reserves in the order of 41 MM Bls. From Block 64, it will be transported to the "Morona" station and then to the San Jacinto Oriental surface facilities for its respective mixing to reach the minimum parameters for later audit.

Figura 210: Proposed Oil pipeline



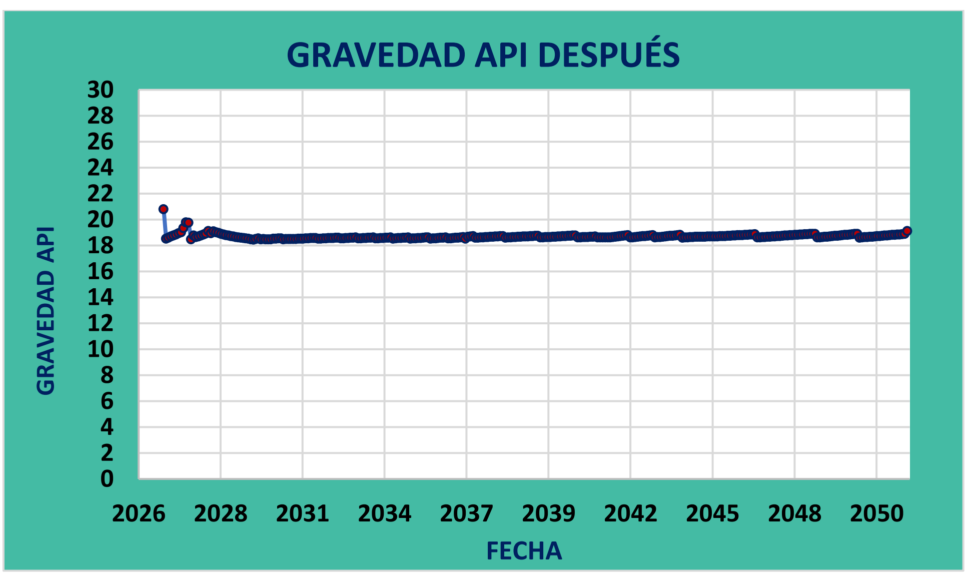
The graph of the flow rate to be mixed along time is presented below.

Figura 211: Production rate from Situche field



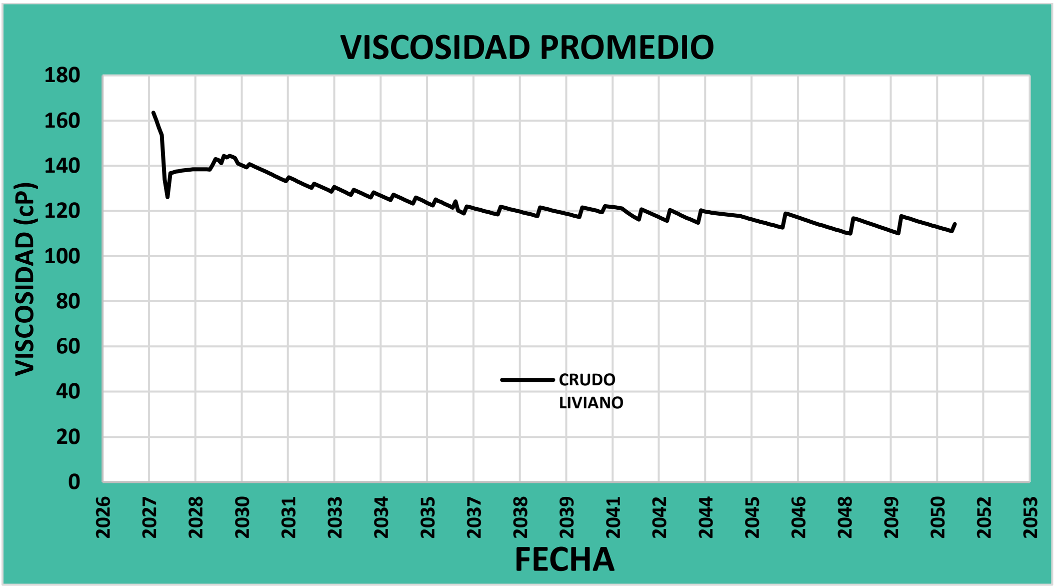
The graph of the API gravity of the mixture is shown, which at all times is above the minimum parameters required by the Pipeline (18° API)

Figura 212:API gravity



Likewise, the graph referring to the viscosity of the mixture is presented below.

Figura 213: Average viscosity



4.5.4.4. Storage and Measurement

For the storage of fluids, the maximum flows that will be processed in our field must be taken into consideration. For the North battery and South battery will be 86 and 129 Mbbl respectively. Using the estimated flow rates, the following production facilities are presented for each Battery.

Tabla 159 Proposed facilities for each Battery

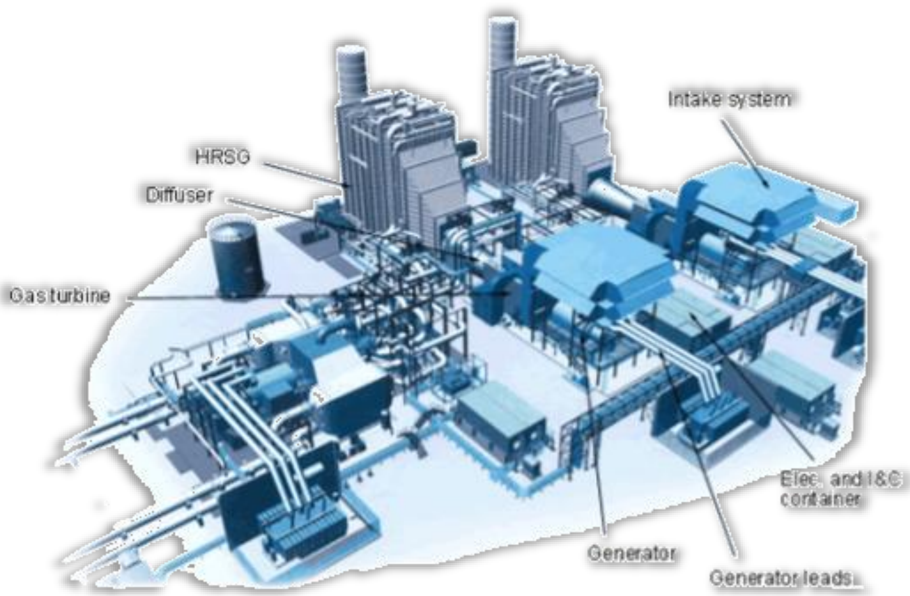
		ZONA NORTE	ZONA SUR
EQUIPMENT	CAPACITY	QUANTITY	QUANTITY
MANIFOLD		1	2
PRODUCTION SEPARATOR	35000 bpd	3	4
TEST SEPARATOR	10000 bpd	1	1
TOTAL TANK	25000 bbl	4	3
GUN BARREL	25000 bbl	5	6
TEST TANK	5000 bbl	2	2
VOLUMETER		2	2
GUN BARREL	25000 bbl	3	4
PUMP TANK	25000 bbl	3	
STORAGE TANK	25000 bbl	4	

4.5.5. Gas fired Power Plant

Features:

- ❖ Outdoor facilities.
- ❖ Infrastructure is housed in modules.
- ❖ Compact type.
- ❖ It does not require a large infrastructure to host it.
- ❖ Assembly is relatively quick

Figura 214: Gas fired Power Plant

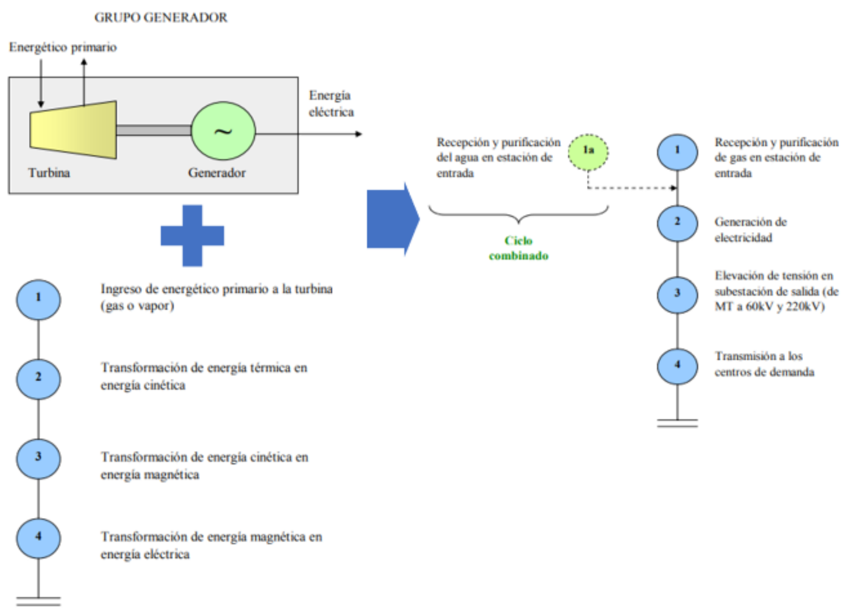


Infrastructure

- ❖ Gas turbine module
- ❖ Steam turbine module
- ❖ Water treatment and storage plant module
- ❖ Natural gas reception system module
- ❖ Electrical substation module
- ❖ Building for auxiliary equipment and operations control
- ❖ Office building, warehouse, maintenance workshop

Flowchart

Figura 215: Flowchart – Gas fired Power Plant



INFORMATION OF MANUFACTURERS OF GAS TURBINES (TG) AND STEAM TURBINES (TV).

OPERABILITY

Figura 216: Cycle

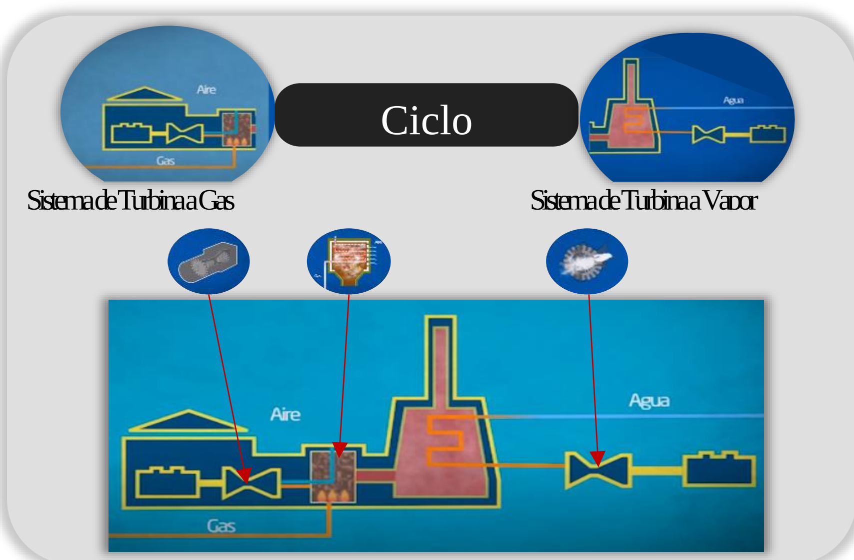


Tabla 160: Consumption data and requirement for the plant

	Operational Water Consumption + Additional non-operational (L/s)	Total annual NG requirement (Mm3)
Simple cycle stage	2.5	36.20
Combined cycle stage	3.0	72.40

Using Steam Turbine, 50% of everything produced with the Gas Turbine is obtained.

ENERGY-USING GAS TURBINE (TG):

Natural gas will be measured in cubic meters, so a conversion factor is needed to transform them into kilowatt hours (kWh), and in this way calculate the energy produced.

Enagás company uses the conversion factor by calculating the calorific value of the gas.
Where:

"1 m3 natural gas <> Superior calorific power (PCS) of 11,70 kWh approximately"

Our total gas production: **11.35BCF in 26 years**

Conversions:

1**BCF** = 28316846.59 **m^3**
1 **m^3 =** 11,70 **kWh** ***approximately***
11.35**BCF** = 321396208.82 **m^3** = 3760335643.194 **kWh** ***approximately***

“"This represents a production of **144 628 294 kWh** of energy approximately per year"”

ENERGY-USING STEAM TURBINE (TV):

50% of energy using gas turbine TG = 72314146.9845 **kWh**

Total Energy per year: 216942440.9535 **kWh**

4.5.6. Audit and Sale of Point

4.5.6.1. Oil Pipeline Design

- **Pipeline Route**

First, it is important to establish the following points for pipeline design:

- Location of the initial point, which determines the starting point of the pipeline, this part of the San Jacinto Oriental field, specifically in the tank of the treatment plant that receives the crude from Battery No. 1
- Location of the end point, which determines the point of arrival of the pipeline, this will be located at the Andoas station, specifically in the inspection tank of the KysPetrol company.
- The route of the pipeline is carried out taking into consideration the following points:
    - The pipeline must not exceed the limits of Block 192.
    - The pipeline must not cross neighboring fields located within Block192.
    - The route of the pipeline must not have high slopes.
    - Shorter lengths should be preferred to reduce costs.

Figura 217: Route of oil pipeline

Tabla 161: Starting and ending points of the pipeline route

REFERENCE	PLACE	LOCATION		ELEVATION
		Latitude	***Length***	
Start	Treatment plant	2° 15’ 22” S	75° 52’ 09” O	192 m
End	Estación Andoas	2° 54’ 18” S	76° 24’ 10” O	215 m

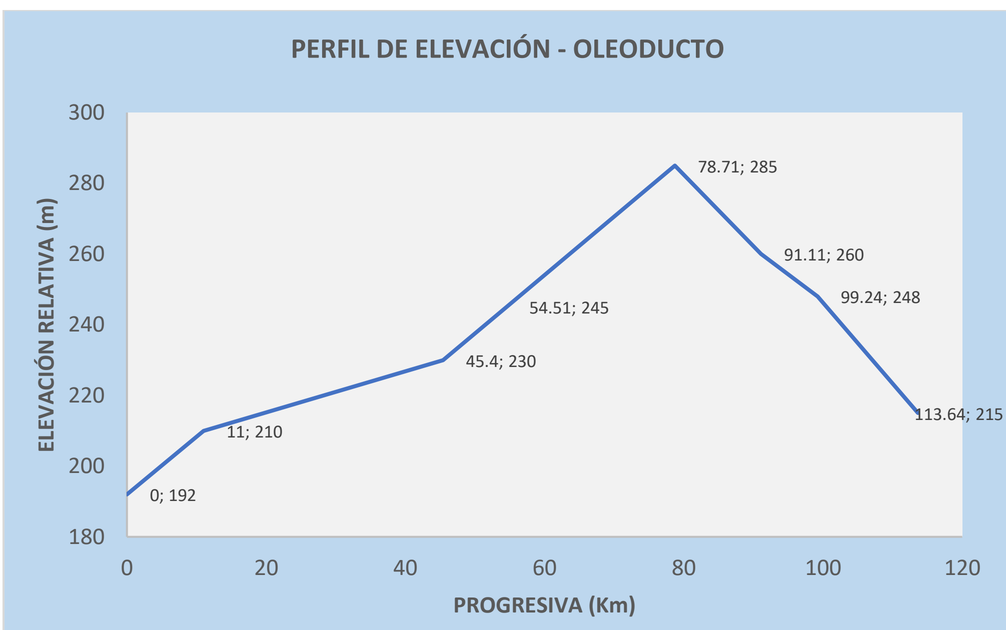
➢ ELEVATION PROFILE OF THE PIPELINE ROUTE

Taking into consideration the different sections of the pipeline design, an elevation profile is made taking the sea level as a reference.

Tabla 162: Specifications of the pipeline sections

REFERENCE POINT	RELATIVE DISTANCE	ACCUMULATED DISTANCE	ELEVATION	SLOPE	ANGLE OF ELEVATION
	km	*km*	*m.a.m.s.l*		
Battery	0	0	192	-	-
B 1	11	11	210	1.64E-03	0.08308
B 2	34.4	45.4	230	5.81E-04	0.03329
B 3	9.11	54.51	245	1.65E-03	0.09454
B 4	24.2	78.71	285	1.65E-03	0.09454
B 5	12.4	91.11	260	-2.02E-03	0.11574
B 6	8.13	99.24	248	-1.48E-03	0.0848
Andoas Station	14.4	113.64	215	-2.29E-03	0.13121

Figura 218: Elevation profile of the pipeline route



- **CHARACTERISTICS OF THE CRUDE TO BE TRANSPORTED**

  - **API Gravity:**

Our San Jacinto Oriental field has two different types of crude; therefore, we can take advantage of the fact that by mixing both, the specifications for their inspection must be achieved, a minimum of 18 ° API.

CHONTA	32 ° API
VIVIAN	11.5° API

When mixing the different crude oils, the mixing proportions will vary depending on the production flow per year, so the following results are obtained:

Figura 219: Mixing proportion of crude oil obtained in field

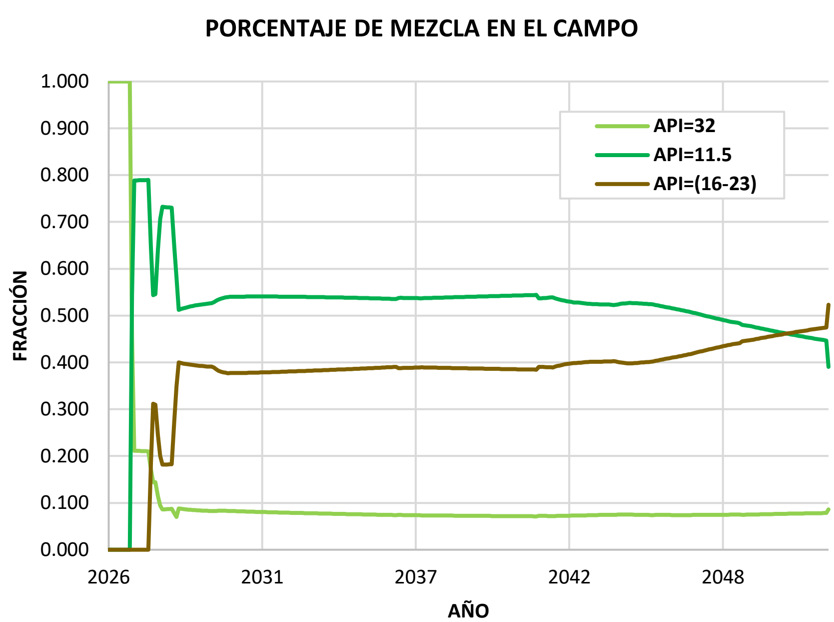
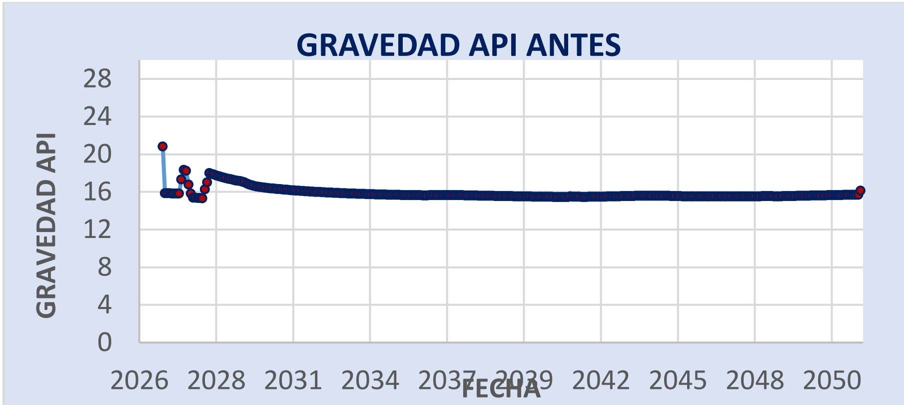


Figura 220: Variation of API gravity



API gravity of the mixture of crude from the field does not meet the requested specifications, therefore, we resort to new strategies.

For this, two alternatives were proposed to treat our crude, the first was to buy light crude from neighboring fields, however, we know that the crude itself presents great uncertainty due to the fact that the operators of the neighboring fields do not have the necessary production. On the other hand, different social problems could paralyze their operations or the instability of light crude prices.

Taking into consideration the above, the following proposal is shown:

- According to the analysis carried out previously, we see that there is easy accessibility from the Iquitos refinery to our field.
- In addition, the amount of naphtha obtained from their processes meets our requirements.

So, we decided to use naphtha giving the following results:

Figura 221: Proportion of Naphtha to apply in the field

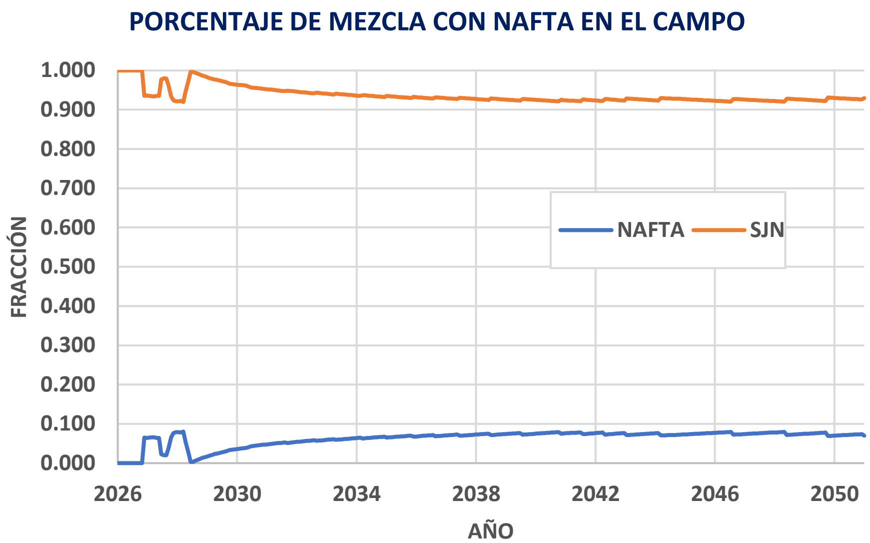


Figura 222 Volume of Naphtha needed

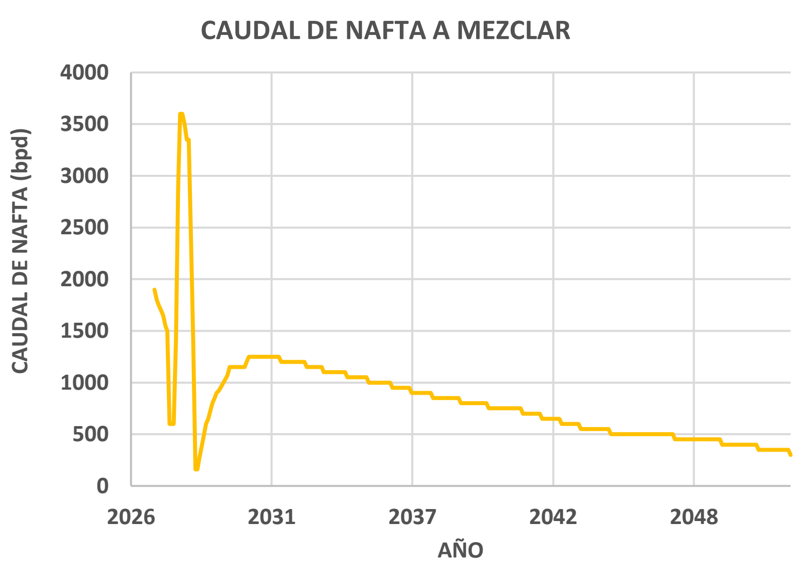
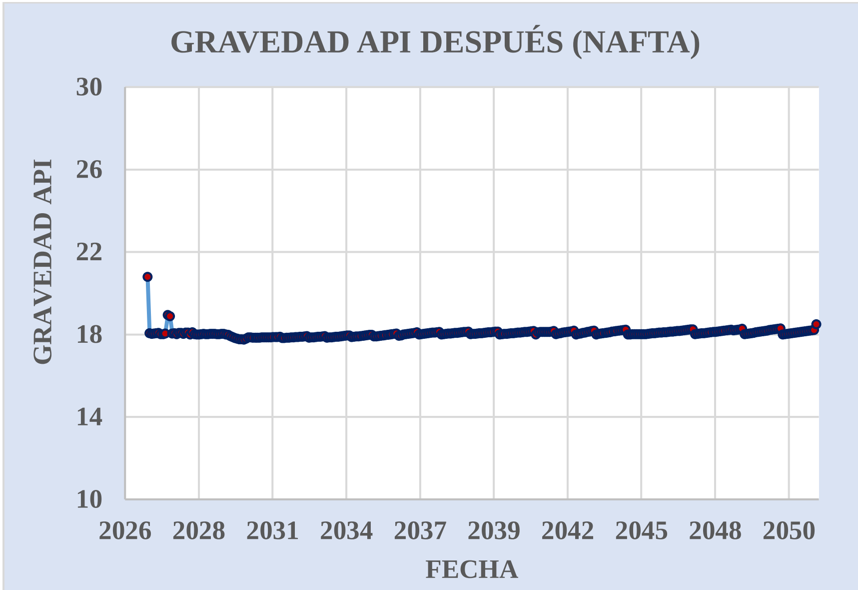


Figura 223: API gravity after applying Naphtha



The first few years will require large amounts of naphtha; however, years later lower amounts will be required. Then the API gravity obtained is:

OIL CRUDE MIXTURE	18.1° API

- **Viscosity**
  - ***Vivian Formation***

Downhole conditions:

Tabla 163: Viscosity – Vivian formation

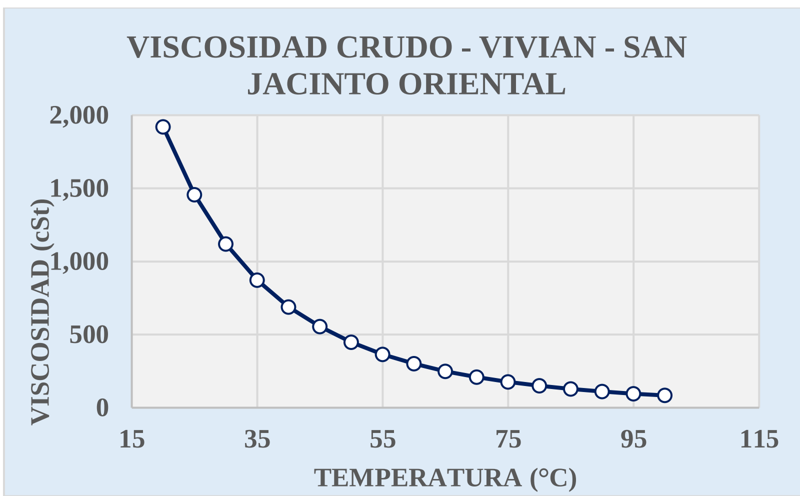
VIVIAN	
Sp.gr	0.98951
cSt	**Cp**
71	70.26
T (°F)	225
T (°C)	107

Surface conditions:

cP	**cSt**
689	696.30
T (°F)	104
T (°C)	40

The variation of the viscosity according to the temperature is determined:

Figura 224: Viscosity vs Temperature-VIVIAN Reservoir



- ***Chonta formation***

Downhole conditions:

Tabla 164: Vivian formation viscosity data

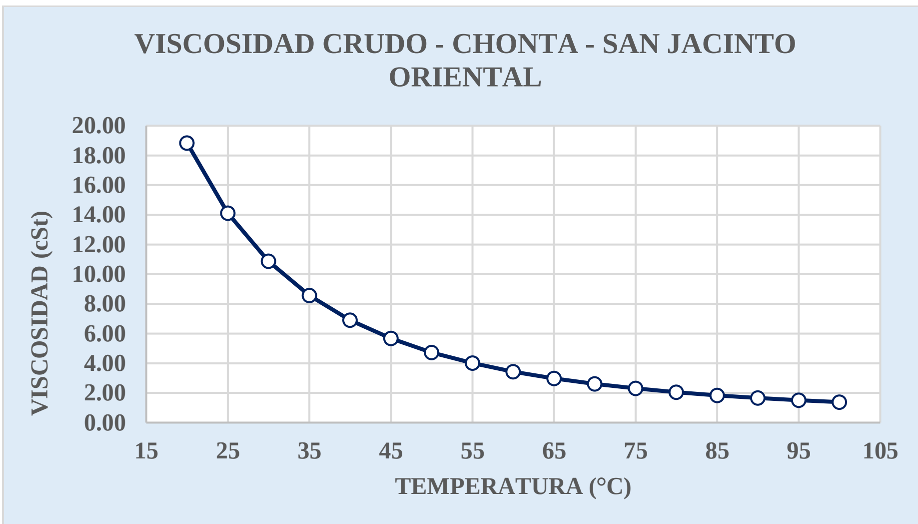
CHONTA	
Sp.gr	0.868631
cSt	Cp
1.41	1.22
T (°F)	240
T (°C)	116

Surface conditions:

cP	cSt
6	6.91
T (°F)	104
T (°C)	40

The variation of the viscosity according to the temperature is determined:

Figura 225: Viscosity Vs Temperature-CHONTA Reservoir



Then, to determine the viscosity of the crude oil mixture, the Shu correlation was used.

$$\ln \mu_m = \left(\frac{\alpha V_p}{\alpha V_p + V_L}\right) Ln\ \mu_p + \left(1 - \frac{\alpha V_p}{\alpha V_p + V_L}\right) Ln\ \mu_L$$

$$\alpha = \frac{17.04\ ((\rho_P - \rho_L)^{0.5237}\ \rho_P^{3.2745}\ \ \rho_L^{1.6316}}{Ln\ (\frac{\mu_P}{\mu_L})}$$

Where:

μ_m: *Mix viscosity*

μ_P: *Viscosity of heavy crude*

μ_L: *Viscosity of light crude*

V_P: *Volumetric fraction of heavy crude*

V_L: *Volumetric fraction of light crude*

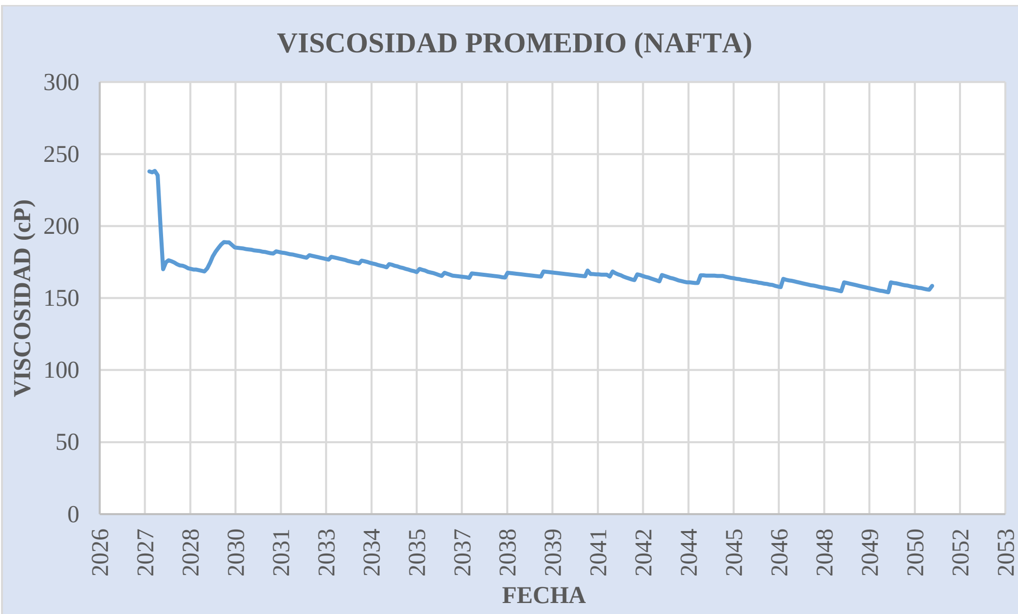
ρ_P: *Relative density of heavy crude*

ρ_L: *Relative density of light crude*

α: *Empirical constant of the Shu model*

A viscosity trend is performed over time, obtaining the following graph:

Figura 226: Crude mix viscosity



Average viscosity of the mixture:

Oil viscosity	168 cP

- **DESIGN FLOW RATE**

According to the estimated production of our field, there is an estimated production of:

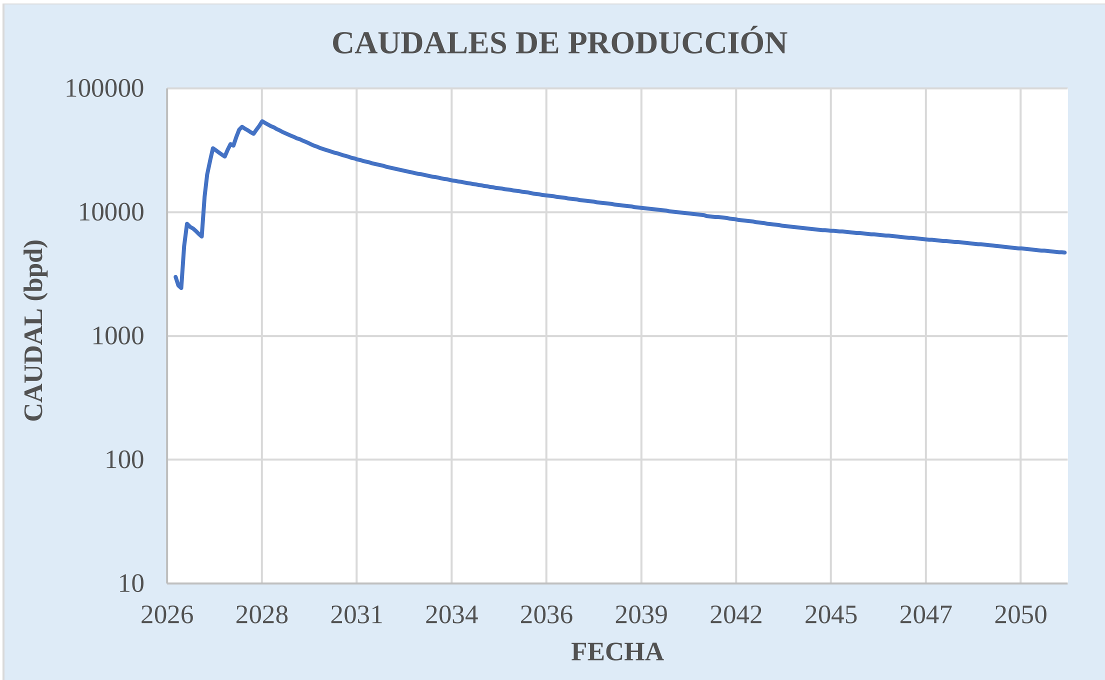
$$\boldsymbol{Q\ max = 54271\ bpd}$$

For calculating the design flow, a safety factor will be considered:

$$Q\ design = Q\ max * 1.1$$

$$Q\ design = 59698\ bpd$$

Figura 227: Production flow rate



- **EQUATIONS FOR OIL PIPELINE DESIGN**

  - **<u>Erosional velocity:</u>**

Equation 2: Determination of the erosional rate

$$Ve = \frac{c}{\sqrt{\rho}}$$

Where:

Ve: Erosional velocity (ft/seg)

P: Liquid density (lb/ft^3)

C: Empirical constant according to API RP 14E, C=100

Tabla 165: Determination of the erosional velocity

Liquid density	59.05	*lb/ft3*
Empirical constant	100	
Erosion velocity	**13.01**	*ft/seg*

- **<u>Allowable diameter:</u>**

$$Vei\ < 13.01\, ft/Seg$$

$$Vei = Q * A$$

$$A = \frac{\pi *\ ID^2}{4}$$

From these equations we can solve for the internal diameter, obtaining the following equation:

$$ID > 0.1091536 * (\frac{Q}{Ve})^{0.5} \ldots (in)$$

Where:

Vei: Velocity inside the pipeline (ft/seg)

Q: Flow rate design (bpd)

A: Pipeline cross-sectional area

ID: Pipeline internal diameter

Tabla 166: Design internal diameter

Design flow rate	59698	*bpd*
Calculated internal diameter	7.39	*in*
Inner Diameter	12.750	*in*

A larger internal diameter is considered to handle the production capacity of the field.

For determining the internal diameter, we use the API 5L - X60 Standard, so specifications of our pipeline are:

- **Calculation of the Reynolds number:**

$$Nre > 92.2 * \frac{q * Yl}{D * \ \mu}$$

Where:

Q: Flow rate design (bpd)

Yl: Relative density of crude

D: Internal diameter (in)

µ: Crude viscosity (cp)

Tabla 167: Determination of Reynolds number

Design flow rate	59698	*bpd*
Relative density	0.9459	
Internal diameter	12.75	*in*
Viscosity	168	*cp*
Reynolds number	**2431**	

- **Calculation of friction factor**

For determining the friction factor:

$$\frac{1}{\sqrt{f}} = -2 * \log\left(\frac{\varepsilon}{3.7 * D} + \frac{2.51}{Nre * \sqrt{f}}\right)$$

Where:

f: Friction factor

Nre: Reynold Number

Ɛ: Roughness (0.0018)

Friction factor is calculated by iteration

Friction loss factor	0.04658

So, the friction factor is 0.04658.

- **Pressure loss**

We see that the starting and ending point of the pipeline are at a long distance, therefore, we establish two pumping stations as shown in the following figure:

Figura 228 Location of proposed pumping stations

In addition, we will use the following equations to determine the design pressures:

Pressure loss due to elevation

$$\Delta Pe = 0.433 * \gamma l * \Delta h$$

Pressure loss due to friction

$$\Delta Pf = 0.06056 * f * \frac{\gamma * q^2 * L}{D^5}$$

Total pressure loss

$$\Delta Pt = \Delta Pe + \Delta Pf$$

For determining the design pressure, 50 psi in addition to the calculated pressure was considered.

Tabla 168: Determination of the design pressure of Section I

LENGTH-1		
Initial height	629.8	*ft*
Final height	754.4	*ft*
Pipe length	31.07	*miles*
Pressure loss due to elevation	51.1	*psi*
Friction pressure loss	877.42	*psi*
Total pressure loss	928.5	*psi*
Design pressure	**978**	*psi*

Tabla 169: Determination of the design pressure of Section II

LENGTH-2		
Initial height	754.4	*ft*
Final height	705.2	*ft*
Pipe length	39.54	*miles*
Pressure loss due to elevation	-20.2	*psi*
Friction pressure loss	1116.78	*psi*
Total pressure loss	1096.6	*psi*
Design pressure	**1147**	*psi*

One pump will be installed in the main battery that allows a sufficient initial pressure to overcome pressure losses. A table of conclusions of the results obtained in the design of the pipeline is presented:

Tabla 170: Pipeline design specifications

PIPELINE DESIGN					
LOCATION					
Initial station	Battery		**Coordinates i**	2° 54' 18" S	
End station	Andoas			76° 24' 10" O	
Initial elevation	192	*m.a.m.s.l*	**Coordinates f**	2° 20' 47" S	
Final elevation	215	*m.a.m.s.l*		75° 50' 44" O	
Length	70.61	miles			
FLUID DATA					
API Gravity	18.57	°	**Viscosity**	168	*cp*
PIPELINE CHARACTERISTICS					
Outer diameter	14	*in*	**Thickness**	0.625	*in*
Inner diameter	12.75	*in*			
PIPELINE DESIGN					
Design flow rate	59698	*bpd*	**Nre**	2431	
Erosion velocity	13.01	*ft/seg*	**Friction factor**	0.04658	
PRESSURE CALCULATION					
LENGTH 1					
Pressure loss due to elevation			51.1	*psi*	
Friction pressure loss			877.4	*psi*	
Total pressure			928.5	*psi*	
Design pressure			**978**	*psi*	
LENGTH 2					
Pressure loss due to elevation			-20.2	*psi*	
Friction pressure loss			1116.8	*psi*	
Total pressure			1096.6	*psi*	
Design pressure			**1147**	*psi*	

4.4.5.2 DESIGN OF POINT OF AUDIT AND SALE

According to the "Reglamento de Adquisiciones y Contrataciones de PETROPERU S.A", approved by "Resolución N° 171-2008-CONSUCODE/PRE", which establishes that our company would sell crude to PETROPERU from the San Jacinto Oriental Field.

The proposed scheme of the designed pipeline has the Andoas station as its end point, where the inspection tank of the KysPetrol company will be located, tank which will receive the crude produced from the San Jacinto Oriental Field. (PETROPERÚ, 2008)

Figura 229: Andoas Station – Audit Point

- **SPECIFICATIONS**

According to what is established in the contract between PETROPERÚ and KYSPETROL, the crude produced must meet certain specifications, however, for the moment the following specifications can be considered as a reference:

Tabla 171: Specifications

API GRAVITY	18°	Average
SULPHUR	1.5 %	Maximum
BSW	0.60 %	Maximum
SALT CONTENT	10.0 PTB	Maximum
BACTERIA	10,000 Cl/mL water	Maximum *

***Determined at Audit Point*

Therefore, our crude oil must be subjected to different tests after its treatment to verify that it meets the specifications, these tests will be based on the following ASTM standards:

Tabla 172: ASTM standards

ESPECIFICATIONS	NORMA ASTM
API GRAVITY	ASTM D1298
SULPHUR	ASTM D129
BSW	ASTM D4007
SALT CONTENT	ASTM D3230

- **LEASE AUTOMATIC CUSTODY TRANSFER UNIT**

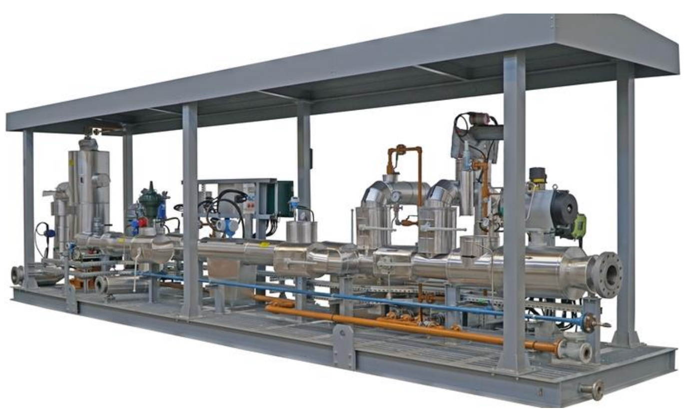
One of the best-known equipment for the control of crude oil, and used for our operations is the LACT unit (Lease Automatic Custody Transfer), this according to the MPMS manual (Manual of Petroleum Measurement Standards), the LACT unit is a measurement system that accurately measures flow of liquid hydrocarbon products for sale to third parties under contract.

Components of a LACT Measurement System:

- **The Meter** – As discussed above there are a variety of different meters available with different advantages and disadvantages. Meters are the most fundamental part of LACT Units, providing the actual measuring ability.
- **The LACT Control Panel** – The LACT control panel is the primary point from which the entire unit can be operated.
- **The Charge Pump and Motor** – The charge pump and motor provide the energy source for the LACT Unit.
- **The Meter Prover Loop** – The meter prover loop is designed to verify that no leakage is occurring within the LACT Unit.

- **The Strainer** – In some systems a strainer may be installed upstream of the pump or meter to help prevent damage from debris.
- **The Air Eliminator** – The air eliminator removes air and vapor from the flow stream before it reaches the meter, thereby preventing skewed results that include air content.
- **The BS&W Probe and Monitor** – The BS&W Probe and Monitor are designed to measure and monitor the basic sediment and water content of the flow stream.
- **The Sampler System** – The sampler system gathers samples to determine API Gravity and BS&W Content.
- **Valves and Sealings** – LACT Units feature many valves and sealings which are designed to regulate the system, maintain pressure, prevent leakage or divert flow as needed.

Figura 230: LACT Unit



The following activities will be carried out:

- A representative sample is taken
- Control panel reading
- Determine the parameters (API, BS&W and salt content)
- A measurement ticket is issued
- The repeatability and linearity of the equipment is verified

- The net volume transferred is calculated
- Measurement ticket signature

The audit ticket that will have the approval of both the company and PERUPETRO. The audit ticket would be like the following:

Tabla 173: Audit ticket

KYSPETROL S.A.	
Andoas audit station – Lote 192	
Audit ticket	
1. LABORATORY DATA	
API Gravity observed	19.34
Temperature	104°F
API Gravity at 60°F	19.74
Salt Content	8.8 PTB
Water and sediment (A)	0.35%
2. METER DATA	
Final counter	235461
Initial counter	22561
Volume at 60°F (D)	10000
3. CALCULATION OF THE AUDITED PRODUCTION	
Audited Production = (D) * (1- A/100)	
Audited Production =9965 BLS net	

5. LEGAL STUDY

In this section we will see the entire legislative part regarding the hydrocarbons sector that we need to know, as well as the implications of each of them. We must limit ourselves in order to be able to carry out all kinds of processes or operations within the regulations and to avoid future mishaps or sanctions.

5.1. Legal norms

5.1.1. Overall

The aim is to create a favorable climate for foreign investment that contributes to the expansion of the free enterprise economy in the country.

Tabla 174: General norms in the hydrocarbon sector.

Constitución Política del Perú	TITULO III DEL REGIMEN ECONÓMICO Capítulo II DEL AMBIENTE Y LOS RECURSOS NATURALES
Decreto Legislativo N° 662	Régimen de estabilidad jurídica a las inversiones extranjeras mediante el reconocimiento de ciertas garantías
Decreto Legislativo N° 757	Ley marco para el crecimiento de la inversión privada
Ley N° 27343	Ley que regula los Contratos de Estabilidad con el Estado al amparo de las Leyes Sectoriales

Source: National Society of Mining

5.1.2. Specific

The aim is to regulate the activities of hydrocarbons in the national territory.

Tabla 175: Specific norms in the hydrocarbon sector.

Ley N° 26221	Ley Orgánica de Hidrocarburos.
Decreto Supremo N° 042-2005-EM	Aprueban Texto Único Ordenado de la Ley Orgánica de Hidrocarburos.
Ley N° 27377	Ley de Actualización en Hidrocarburos.
Ley N° 27624	Ley que dispone la devolución del Impuesto General a las Ventas e Impuesto de Promoción Municipal para la exploración de hidrocarburos.
Ley N° 29852	Ley que crea el Sistema de Seguridad Energética en hidrocarburos y el Fondo de Inclusión Social Energético.

Decreto Supremo N° 021-2012-EM	Reglamento de la Ley N.º 29852, que crea el Sistema de Seguridad Energética en Hidrocarburos y el Fondo de Inclusión Social Energético.
Decreto Supremo N° 32-95-EF	Regalía de garantía de estabilidad tributaria y de normas tributarias de la Ley Orgánica de Hidrocarburos.
Decreto Supremo N° 040-98-EM	Reglamento de Utilización de los Recursos y Medios Provenientes de los Contratistas.
Decreto Supremo N° 032-2002-EM	Aprueban Glosario, Siglas y Abreviaturas del Subsector Hidrocarburos
Decreto Supremo N° 043-2007-EM	Aprueban Reglamento de Seguridad para las Actividades de hidrocarburos y modifican diversas disposiciones.
Ley N° 28551	Ley que establece la obligación de elaborar y presentar planes de contingencia.
Decreto Supremo N° 048-2009-EM	Dictan Normas Reglamentarias de la Ley N° 28552.
Decreto Supremo N° 045-2008-EM	Aprueban el Reglamento del Artículo 11 del texto Único Ordenado de la Ley Orgánica de Hidrocarburos
Ley N° 26734	Ley del Organismo Supervisor de la Inversión en Energía (OSINERG).
Ley N° 27699	Ley Complementaria de Fortalecimiento Institucional del Organismo Supervisor de la Inversión en Energía (OSINERG)
Ley N° 26225	Ley de Organización y Funciones de PERUPETRO S.A.
Decreto Legislativo N° 043	Ley de la Empresa Petróleos del Perú (PETROPERU

Source: (MINEM/SNMPE, s.f.)

5.2.Technical norms

5.2.1. Exploration and exploitation

The aim is to ensure the efficient exploitation of our oil reserves, the integrity of the human person, as well as the preservation of the environment in which these activities are carried out.

Tabla 176: Norms in the activities of Exploration and Exploitation of hydrocarbons.

Decreto Supremo N° 032-2004-EM	Aprueban Reglamento de las Actividades de Exploración y Explotación de Hidrocarburos.
Decreto Supremo N° 043-2007-EM	Reglamento de Seguridad para Actividades de Hidrocarburos
Decreto Supremo N° 049-93-EM	Aprueban el Reglamento para la aplicación de la regalía y retribución en los contratos petroleros.
Ley N° 28109	Ley para la promoción de la inversión en la explotación de recursos y reservas marginales de hidrocarburos a nivel nacional.
Decreto Supremo N° 030-2004-EM	Aprueban Reglamento de Calificación de Empresas petroleras.
Decreto Supremo N° 005-2002-EF	Reglamento de la Ley de Canon

Source: (MINEM/SNMPE, s.f.)

5.2.2. Storage and transport of hydrocarbons by pipeline

Based on the pipeline integrity system, requirements for granting concessions for the transport of hydrocarbons by pipeline, pricing, security measures, as well as the powers of regulatory authorities.

Tabla 177: Norms for oil storage and transport activities

Decreto Supremo N° 052-93-EM	Reglamento de Seguridad para el Almacenamiento de Hidrocarburos
Decreto Supremo N° 081-2007-EM	Aprueban Reglamento de Transporte de Hidrocarburos por ductos.
Decreto Supremo N° 032-2005-EM	Autorizan a titulares de ductos principales a prestar a través de dichos ductos el servicio de transporte de gas natural, en aquellas zonas reservadas para ser entregadas en concesión de distribución mediante licitación o concurso público.

Source: (MINEM/SNMPE, s.f.)

5.2.3. Commercialization of hydrocarbons

It will focus on the requirements for establishing the sale to the public of liquid fuels, safety conditions for the sale of hydrocarbons, quality provisions, as well as the pricing regime.

Tabla 178: Commercialization of hydrocarbons

Decreto Supremo N° 030-98-EM/ Decreto Supremo N° 045-2001-EM	Aprueban el Reglamento para la comercialización de combustibles líquidos y Otros Productos Derivados de los Hidrocarburos.
Decreto Supremo N° 054-93-EM	Aprueban Reglamento de Seguridad para Establecimientos de venta al público de combustibles derivados de hidrocarburos.
Decreto Supremo N° 052-93-EM	Aprueban Reglamento de Seguridad para el almacenamiento de hidrocarburos.
Decreto Supremo N° 26-94-EM	Aprueban Reglamento de Seguridad para el transporte de hidrocarburos.
Decreto Supremo N° 043-2005-EM	Disponen que agentes de la cadena de comercialización de combustibles derivados de hidrocarburos deben de proveer información sobre sus precios de venta, así como su publicación a cargo de OSINERG.
Decreto Supremo N° 064-2009-EM	Aprueban norma para la inspección periódica de hermeticidad de tanques y tuberías enterrados que almacenan combustibles líquidos y otros productos derivados de los hidrocarburos.
Decreto Supremo N° 004-2010-EM	Transfieren a OSINERG el Registro de Hidrocarburos.
Decreto Supremo N° 023-2006-EM	Reglamento para el uso de Marcadores en los combustibles líquidos y OPDH.

Source: National Society of Mining

5.3.Contractual aspects

5.3.1. Environment

It regulates the system for the sustainable use of natural resources and constitutes the heritage of the nation by establishing conditions in compliance with articles 66 and 67 of chapter II of Title III of the Constitution of Peru.

Its purpose is to strike a balance between economic growth, the conservation of natural resources and the environment, as well as the integral development of the human person.

Tabla 179: Environmental Norms in the Hydrocarbons Sector. (Sociedad Nacional de Minería, s.f.)

Ley N° 26821	Ley orgánica para el aprovechamiento sostenible de los recursos naturales.
Ley N° 26834	Ley de Áreas Naturales Protegidas.
Ley N° 27446	Ley del Sistema Nacional de Evaluación del Impacto Ambiental.
Decreto Supremo N° 019-2009-MINAM	Aprueban el Reglamento de la Ley N° 27446, Ley del Sistema Nacional de Evaluación del Impacto Ambiental.
Ley N° 28245	Ley Marco del Sistema Nacional de Gestión Ambiental.
Decreto Supremo N° 008-2005-PCM	Reglamento de la Ley N° 28245 – Ley Marco del Sistema Nacional de Gestión Ambiental.
Ley N° 28611	Ley General del Ambiente.
Ley N° 29325	Ley del Sistema Nacional de Evaluación y Fiscalización Ambiental.
Ley N° 29134	Ley que regula los pasivos ambientales del subsector hidrocarburos.
Decreto Supremo N° 039-2014-EM	Aprueban el Reglamento de la Ley que regula los pasivos ambientales del subsector hidrocarburos.
Resolución de Consejo Directivo N° 005-2013-OEFA-CD	Aprueban el Plan de Identificación de pasivos ambientales en el Subsector Hidrocarburos 2013 – 2014.
Resolución de Consejo Directivo N° 022-2013-OEFA-CD Directiva N° 01-2013-OEFA-CD	Directiva para la Identificación de Pasivos Ambientales en el Subsector Hidrocarburos a cargo del OEFA” y “Metodología para la calificación del nivel de riesgos de pasivos ambientales en el subsector hidrocarburos.
Ley N° 30011	Ley que modifica la Ley N° 29325 (Ley del Sistema Nacional de Evaluación y Fiscalización Ambiental.
Decreto Supremo N° 002-2006-EM	Establecen disposiciones para la presentación del Plan Ambiental Complementario – PAC por parte de las empresas que realicen actividades de hidrocarburos.
Decreto Supremo N° 037-2008-PCM	Establecen Límites Máximos Permisibles de Efluentes Líquidos para el Subsector Hidrocarburos.

Source: National Society of Mining

5.3.2. Social affairs

Its purpose is to guarantee protection of the rights of the indigenous peoples of the Peruvian Amazon who are in isolation. In this way, these norms allow to take care of their rights to life and health safeguarding their existence and integrity.

Tabla 180: Norms in social affairs for hydrocarbons.

Ley N° 28736	Ley para la protección de pueblos indígenas u originarios en situación de aislamiento y en situación de contacto inicial.
Ley N° 29785	Ley del Derecho a la Consulta Previa a los Pueblos Indígenas u Originarios reconocido en el Convenio 169 de la Organización Internacional del Trabajo (OIT).
Decreto Supremo N° 001-2012-MC	Reglamento de la Ley N° 29785, Ley del Derecho a la Consulta Previa a los Pueblos Indígenas u Originarios reconocido en el Convenio 169 de la Organización Internacional del Trabajo (OIT).
Resolución Ministerial N° 571-2008-MEM-DM	Aprueban Lineamientos para la Participación ciudadana en las Actividades de Hidrocarburos.
Decreto Supremo N° 012-2008-EM	Reglamento de participación ciudadana para la realización de actividades de hidrocarburos.

Source: National Society of Mining

5.4.Supervision and control

5.4.1. OSINERGMIN

Its purpose is to improve the regulatory framework for the conduct of monitoring and control of energy and mining activities, as well as compliance with legal and technical standards for the conservation and protection of the environment, in the development of those activities.

Tabla 181: Norms of OSINERGMIN.

Decreto Supremo N° 054-2001-PCM	Aprueban el Reglamento General del Organismo Supervisor de la Inversión en Energía – OSINERG.
Decreto Supremo N° 007-2003-EM	Encargan a OSINERG la publicación semanal de los precios referenciales.
Resolución de Consejo Directivo N° 171-2013-OS-CD	Reglamento de Supervisión de Actividades Energéticas y Mineras de OSINERGMIN.
Ley N° 29901	Ley que precisa competencias del Organismo Supervisor de la Inversión en Energía.

Source: National Society of Mining

5.4.2. OEFA

Its purpose is to conserve the environment, ensure the sustainable, responsible, rational and ethical use of natural resources and the environment that sustains them, and thus permit comprehensive social development, economic and cultural rights of the human person to ensure for present and future generations the right to enjoy a balanced and life-enhancing environment.

Tabla 182: Norms of OEFA

Decreto Legislativo N° 1013	Decreto Legislativo que aprueba la Ley de Creación, Organización y Funciones del Ministerio del Ambiente.
Resolución de Consejo Directivo N° 007-2013-OEFA-CD	Reglamento de Supervisión Directa del Organismo de Evaluación y Fiscalización Ambiental - OEFA
Resolución de Consejo Directivo N° 026-2013-OEFA-CD	Reglamento Especial de Supervisión Directa para la terminación de actividades bajo el ámbito de competencia del Organismo de Evaluación y Fiscalización Ambiental - OEFA
Resolución de Consejo Directivo N° 046-2013-OEFA-CD	Reglamento para la subsanación voluntaria de incumplimientos de menor trascendencia
Resolución de Presidencia de Consejo Directivo N° 045-2015-OEFA-CD	Texto Único Ordenado del Reglamento del Procedimiento Administrativo Sancionador del Organismo de Evaluación y Fiscalización Ambiental - OEFA
Resolución de la Presidencia de Consejo Directivo N° 020-2013-OEFA-PCD	Lineamientos que establecen criterios para calificar como reincidentes a los infractores ambientales bajo el ámbito de competencia del Organismo de Evaluación y Fiscalización Ambiental - OEFA
Resolución de Presidencia del Consejo Directivo N° 035-2013-OEFA-PCD	Metodología para el cálculo de las multas base y la aplicación de los factores agravantes y atenuantes a utilizar en la graduación de sanciones, de acuerdo con lo establecido en el artículo 6º del Decreto Supremo N° 007-2012- MINAM
Resolución de Consejo Directivo N° 010-2013-OEFA-CD	Lineamientos para la aplicación de las medidas correctivas previstas en el literal d) del numeral 22.2 del artículo 22º de la Ley N.º 29325 - Ley del Sistema Nacional de Evaluación y Fiscalización Ambiental
Resolución de Consejo Directivo N° 032-2013-OEFA-CD	Reglamento Interno del Tribunal de Fiscalización Ambiental del Organismo de Evaluación y Fiscalización Ambiental
Resolución de Consejo Directivo N° 018-2013-OEFA-CD	Reglamento del reporte de emergencias ambientales de las actividades bajo el ámbito de competencia del Organismo de Evaluación Ambiental OEFA
Resolución de Presidencia del Consejo Directivo N° 038-2013-OEFA-PCD	Reglas Generales sobre el ejercicio de la Potestad Sancionadora del Organismo de Evaluación y Fiscalización Ambiental - OEFA
Resolución de Consejo Directivo N° 042-2013-OEFA-CD	Tipificación de infracciones administrativas y escala de sanciones relacionadas con la eficacia de la fiscalización ambiental

Resolución de Consejo Directivo N° 045-2013-OEFA-CD	Tipificación de infracciones administrativas y escala de sanciones relacionadas al incumplimiento de los límites máximos permisibles
Resolución de Consejo Directivo N° 016-2012-OEFA-CD	Aprueban Reglamento del Registro de Infractores Ambientales del Organismo de Evaluación y Fiscalización Ambiental - OEFA
Resolución de Consejo Directivo N° 035-2015-OEFA-CD	Tipifican las infracciones administrativas y establecen la escala de sanciones aplicable a las actividades desarrolladas por las empresas del subsector hidrocarburos que se encuentran bajo el ámbito de competencia del OEFA

Source: (MINEM/SNMPE, s.f.)

5.5. Tax aspects

Its aim is to establish conditions for public investment and the promotion of private investment.

Tabla 183: Economic or tax aspects of the hydrocarbons sector.

Ley N° 27116	Ley que crea la Comisión de Tarifas de Energía.
Ley N° 27037	Ley de Promoción de la Inversión en la Amazonía.
Ley N° 27506	Ley del Canon
Ley N° 27909	Ley Referida a los Alcances del impuesto a la Renta en los Convenios o Contratos que otorgan Estabilidad Tributaria.

Source: (MINEM, s.f.)

5.6.API Norms

API Standard is an organization that sets standards since it was formed in 1919 having experts in each segment of the oil and gas industry to establish, maintain and distribute consensus rules. The API standards are mentioned in the following Table that will serve as a guiding tool for each stage to ensure good practices throughout the project.

- **API norms for the installation of drilling equipment:**

Tabla 184: API norms in the drilling rig installation section

API RP 500	Práctica recomendada para la clasificación de ubicaciones para Instalaciones Eléctricas en Instalaciones Petroleras
API SPEC 8A	Especificación para equipos de elevación y perforación de producción.
API RP 4G	Operación, inspección, mantenimiento y reparación de perforación y Estructuras de mantenimiento de pozos
API SPEC 4F	Especificaciones de estructuras para perforación y servicio de pozos
API SPEC 2B	Especificaciones para la fabricación de tubos de acero.

- **API norms for Well Completion:**

Tabla 185: API norms in Completion

API RP 10B	Práctica recomendada para analizar cementos de pozos
API SPEC 6D	Especificación para tuberías y válvulas de tuberías
API RP 14B	Diseño, instalación, operación, prueba y reparación del subsuelo Sistemas de válvulas de seguridad
API SPEC 5B	Roscado, calibración e inspección de la carcasa, tubería y línea Hilos de tubería
API BULL 5C3	Boletín sobre fórmulas y cálculos para revestimiento, tubería, taladro Propiedades de tubería y tubería de línea
API SPEC 5CT	Carcasa y tubo
API SPEC 10D	Especificación para centralizadores de carcasa de cuerda de arco
API SPEC 6A	Especificación para equipo de cabeza de pozo y árbol de navidad
API SPEC 6FA	Especificación para prueba de fuego para válvulas
API RP 5A5	Inspección de campo de la nueva carcasa, tubería y tubería de perforación de extremo liso
API RP 5C1	Práctica recomendada para el cuidado y uso de la carcasa y los tubos

- **API norms for well drilling:**

Tabla 186: API norms in drilling

API RP 9B	Aplicación, cuidado y uso de cables para servicio en campos petroleros.
API SPEC 3A	Especificación para materiales de fluidos de perforación.
API SPEC 9A	Especificación para cuerda de alambre.
API SPEC 7F	Cadena y piñones del campo petrolífero.
API SPEC 7G	Práctica recomendada para el diseño del vástago de perforación y los límites operativos.
API SPEC 7B-11 C	Especificación para motores alternativos de combustión interna para Servicio de campo petrolífero.
API RP 7A1	Práctica recomendada para la prueba de compuesto de hilo para Conexiones rotatorias de hombros.
API SPEC 7	Especificación para elementos de vástago de perforación giratoria.
API SPEC 5D	Especificación para tubo de perforación.
API SPEC 16D	Sistemas de control para equipos de control y control de pozos de perforación Sistemas para equipos de desvío.
API SPEC 16C	Choke and Kill Equipment.
API RP 13K	Práctica recomendada para el análisis químico de la barita.
API RP 13I	Práctica recomendada para pruebas de laboratorio de fluidos de perforación.
API RP 13E	Práctica recomendada para el paño de pantalla Shale Shaker Designación.
API RP 13B1	Práctica recomendada para pruebas de campo Perforación a base de agua.
API RP 49	Práctica recomendada para operaciones de perforación y servicio de pozos que implica sulfuro de hidrógeno

- **API norms for surface facilities:**

Tabla 187: API norms for surface facilities

API RP 12R1	Práctica recomendada para configuración, mantenimiento, inspección, Operación y Reparación de Tanques en Servicio de Producción
API SPEC 12D	Especificación para tanques soldados en campo para almacenamiento de producción líquidos
API SPEC 5L	Tubería
API SPEC 12B	Especificación para tanques atornillados para almacenamiento de líquidos de producción
API SPEC 12J	Especificación para separadores de petróleo y gas

- **API norms for well production:**

Tabla 188: API norms for well production:

API RP 11S	Prácticas recomendadas para operación, mantenimiento y detección de fallas en instalaciones BES.
API RP 11S1	Prácticas recomendadas para el informe de ensamblaje de BES
API RP 11S2	Prácticas recomendadas para prueba de BES.
API RP 11S3	Prácticas recomendadas para instalaciones de BES

- **Additional API norms:**

Tabla 189: Additional API norms

SPEC 11N	Especificaciones para equipo de transferencia automática (Unidad LACT)
RP 42	Practicas recomendadas para pruebas de laboratorio de agentes activos de superficie para Estimulación de pozos.
RP 44	Prácticas recomendadas para muestrear fluidos de Reservorios

- **Norms of occupational safety:**

Ley 29783	Ley de Seguridad y Salud en el Trabajo

6. ENVIRONMENTAL STUDY

6.1.Identification of environmental impacts

First, we will focus on our activities to be carried out in order to know your risk or environmental impact in the future. We will divide the activities into stages of the well project process.

Tabla 190: Activities in the management of an oil field

ETAPA	ACTIVIDAD
PRE-OPERACIONAL (PREPARACIÓN/CONSTRUCCIÓN)	• Limitación del área de campo como su respectivo despeje. • Movilización de equipos vía aérea o terrestre para la perforación de pozos. • Registros geofísicos de pozos. • Instalación y construcción de sistemas para la perforación de pozos. • Perforación de pozo. • Procesamiento o tratamiento de detritos. • Completación o revestimiento de pozos. • Instalación de facilidades de superficie.
OPERACIONAL	• Registros eléctricos, prueba de pozos. • Producción del pozo. • Operación de los pozos inyectores. • Mantenimiento de los maquinarias y equipos. • Servicio de pozo.
ABANDONO	• Desplazamiento y retiro de instalaciones. • Abandono de pozo (ATA, APA. etc.) • Remediación de daño ambiental generado. • Reestructuración de la zona explotada.

6.2. Evaluation of environmental impact

Continuing with our environmental study, we will see the main components of the environment with their due impact that may be affected in a positive or negative way with our project.

Tabla 191: Environmental impact evaluation

MEDIO	COMPONENTE DEL ENTORNO	IMPACTO AMBIENTAL
FÍSICO	AIRE	• Ruido estruendoso generado por las maquinarias. • Presencia de micropartículas nocivas.
	SUELO	• Suelo inestable. • Contaminación en caso de derrames de hc. • Debilitamiento de la zona por proyecto de pozos inyectores. • Contaminación por el mal control de detritos.
	AGUA	• Contaminación del agua subterránea por infiltración de lodo.
BIOLÓGICO	FLORA	• Alteración de la flora por consecuencia de la contaminación de agua.
	FAUNA	• Alteración de la fauna por cambios en la biodiversidad por efectos de la contaminación.
SOCIOECONÓMICO	SOCIAL	• Mayor incorporación y relevancia en proyectos de inversión. • Mayor empleo. • Disuasión cultural.
	SALUD	• Accidentes de trabajo • Afectación a la población por las operaciones en el área.

The environmental qualification criteria for the impact assessment are presented below.

6.2.1. Environmental quality (Ca)

Defines the action or activity of the Project that is beneficial or positive, negative or harmful or neutral.

Tabla 192: Range of environmental quality

Rango	Puntaje
Negativo	**-1**
Positivo	**+1**
Neutro	**0**

6.2.2. Intensity (I)

The intensity of the impact expresses the relative importance of the consequences that would cause the alteration of the element in the environmental component. It is defined by the interaction between the degree of disturbance and environmental value.

a) Degree of disturbance (GP)

Assess the extent of modifications made by project activities to the structural and functional characteristics of the affected element.

There are 3 degrees of disturbance:

- Strong: The execution of the project significantly modifies the characteristics of the element.
- Medium: Project execution only modifies some features of the element.
- Low: the execution of the project does not significantly modify the affected element.

b) Environmental value (Va)

It measures the degree of importance of a territorial unit or an element of its environment. This importance is defined by the interest and quality that this represents for the judgment of the specialist and on the other hand for the social value it represents in terms of environmental protection. The range of environmental values can be very high, high, medium, and low.

To determine the degree of intensity of an impact, the following table is done.

Tabla 193: Degrees of disturbance according to intensity

Grado de Perturbación	Valor Ambiental			
Fuerte	Muy alto	Alto	Medio	Bajo
Medio	Alto	Alto	Medio	Bajo
Bajo	Medio	Medio	Bajo	Bajo

Tabla 194: Disturbance ranges

Rango	Puntaje
Muy Alto	1.0
Alto	0.7
Medio	0.4
Bajo	0.1

6.2.3. Extension (E)

Defines the magnitude of the area affected by the Impact being the relative area where the impact has spread.

Tabla 195: Range of extensions

Rango	Puntaje
Regional	0.8-1.0
Local	0.4-0.7
Punto específico	0.1-0.3

6.2.4. Duration (Dt)

It includes a unit of measures over time to assess the period during which the impact will be felt on the element concerned.

Tabla 196: Duration range

Rango	Puntaje
Permanente (más de 10 años)	0,8-1,0
Larga (5-10 años)	0,5-0,7
Medio (3-4 años)	0,3-0,4
Corto (hasta 2 años)	0,1-0,2

6.2.5. Development (D)

It measures the time it takes for the impact to develop internally. In other words, it describes how an impact evolves over time from the moment it begins until it appears fully with all its consequences.

Tabla 197: Developmental range

Rango	Puntaje
Muy rápido (menos de 1 mes)	0.9-1.0
Rápido (1-6 meses)	0,7-0,8
Medio (6-12 meses)	0,5-0,6
Lento (12-24 meses)	0,3-0,4
Muy lento (más de 24 meses)	0,1-0,2

6.2.6. Reversibility (R)

Assess the ability or probability that the Impact can be reversed.

Tabla 198: Range of reversibility

Rango	Puntaje
Irreversible	0.8-1.0
Parcialmente reversible	0,4-0,7
Reversible	0,1-0,3

6.2.7. Occurrence (O)

It allows us to measure the probability that the Impact will occur during the execution of the project.

Tabla 199: Range of occurrence

Rango	Puntaje
Cierto	9-10
Muy probable	7-8
Probablemente	4-6
Improbable	1-3

6.2.8. Ecological Rating (Ce)

It is applied mathematically.

$$\boldsymbol{Ce = \frac{Ca(I + E + Dt + D + R) * O}{5}}$$

Tabla 200: Negative impacts on ecological rating

Impactos Negativos	
Muy alto (muy fuerte)	-10 a -8
Alto (fuerte)	-7 a -5
Medio (moderado	-4 a -2
Bajo (débil)	-2 a -1

Tabla 201: Impacts on the ecological rating

Impactos Neutros	0
Impactos Positivos	Más de 1

Therefore, we can develop our environmental impact matrix.

6.3.Environmental impact matrix

This matrix has been developed for each activity to be carried out.

Tabla 202: Matrix of environmental impacts

ETAPA	ACTIVIDAD	COMPONENTE AMBIENTAL — Calificación Ecológica: Aire	Suelo	Agua	Biológico	Socioeconómico	DESCRIPCIÓN DE LA ACTIVIDAD
PRE-OPERATIVA (PREPARACIÓN/CONSTRUCCCIÓN)	**Limitación del área de campo como su respectivo despeje.**	-2	-3	-2	-3	-3	Se realizará despeje para los caminos de los vehículos y el establecimiento de pequeños campamentos base.
	Movilización de equipos vía aérea o terrestre	-4	-5	0	-3	-2	Se transportarán nuestros pesados accesorios de trabajo por el medio más accesible hacia el campamento.
	Instalación y construcción de sistemas para la perforación de pozos.	-4	-6	-4	-5	-4	Durante esta etapa se realizará la construcción, adecuación e implementación de estos campamentos, los cuales deberán contar con todas las facilidades para albergar al personal y así dar inicio a la etapa de operación.
	Perforación de pozo.	-6	-7	-6	-5	-5	Atravesaremos las formaciones geológicas hasta alcanzar el(los) reservorio(s) de hidrocarburos. Para ello, se utiliza una sarta de perforación conformada por la tubería de perforación de acero, componentes adicionales (martillos, estabilizadores, entre otros) y una broca.
	Procesamiento o tratamiento de detritos.	-3	-2	-3	0	0	Aquí los equipos de Control de sólidos están conformados por un sistema de zarandas, hidrociclones y centrífugas decantadoras dispuestos de tal forma que el proceso sea

							secuencial, continúo y eficiente para separar y descartar los sólidos producidos durante la perforación.
	Completación o revestimiento de pozos.	-1	-4	-5	-1	-1	Se colocará una lechada de cemento en el espacio anular formado entre las formaciones perforadas y el revestidor (Casing) instalado en el pozo, con el fin de crear un sello hidráulico.
	Instalación de facilidades de superficie.	-2	-4	-1	-1	-1	Se movilizará el equipo de perforación, el cuál será colocado y armado sobre el terreno, y posteriormente se iniciará la campaña de perforación
	Registros eléctricos, prueba de pozos.	0	-2	0	0	0	Concluida la perforación hasta la profundidad estimada, se procede a evaluar el tramo perforado y las arenas de producción (a hueco abierto), mediante la toma de registros que consiste en la introducción en el pozo de cables con dispositivos medidores de los distintos parámetros característicos de las formaciones atravesadas y de su contenido.
OPERACIONAL	**Producción del pozo.**	-1	-3	-3	0	0	Se inicia con la adecuación y revestimiento de la tubería por la cual se transportará el petróleo hasta la superficie. Posteriormente se procede a perforar la tubería en los sitios donde se encuentra el yacimiento, a fin de permitir que los hidrocarburos fluyan hacia su interior.
	Operación de los pozos inyectores.	0	-3	-5	-4	-2	Primeramente, estos se basan en la creación de pozos adjuntos a los pozos de perforación y extracción de crudo, que se encargan de inyectar fluidos (normalmente agua o gas) en los yacimientos petrolíferos.
	Mantenimiento de los maquinarias y equipos.	0	-1	0	-1	0	Para proteger los equipos debemos invertir en sistemas que permitan el mantenimiento preventivo y de esa forma optimizar la productividad.
	Servicio de pozo.	0	-2	0	-1	-1	Las actividades de servicio al pozo se realizan generalmente para mantener o mejorar la productividad del pozo.
	Desplazamiento y retiro de instalaciones.	-3	-3	-2	-2	-2	Consiste en el desmontaje y desmovilización de equipos y facilidades.
ABANDONO	**Abandono de pozo**	-1	-2	-1	0	0	Si el pozo va a ser abandonado temporalmente, la(s) zona(s) productiva(s) con contenido de hidrocarburos será(n) aislada(s) completamente con tapones de cemento o mecánicos. Si el pozo va a ser abandonado en forma permanente, se colocarán tapones permanentes de acuerdo al Reglamento para Actividades de Exploración y Explotación de Hidrocarburos D.S. N° 032-2004-EM.
	Remediación de daño ambiental generado.	3	4	3	1	1	Se realizarán actividades de limpieza de sitios contaminados.
	Reestructuración de la zona explotada.	3	4	3	2	2	Se realizarán actividades tendentes a la recuperación y restablecimiento de las condiciones que propician la evolución y continuidad de los procesos naturales

On the other hand, we will develop an Environmental Plan (AP) where we commit to manage the negative environmental impacts produced by our activities. In this way, we can achieve the elimination or minimization of impacts.

6.4.Environmental management plan

The Environmental Management Plan includes the following programs:

6.4.1. Prevention, Correction and/or Mitigation Program:

- Measures for the control of particulate matter emissions
  Examples:
  - ✓ If necessary, all work areas during the development of activities (leveling, loading, transportation, unloading, exposure of bare earth to the effect of the wind), must be watered with water, in order that these areas maintain the degree of humidity necessary to avoid, as far as possible, the generation of dust. These irrigations will be carried out, through a tanker, with periodicity depending on the weather conditions.
  - ✓ Any surplus material will be used for leveling the ground, during its temporary stacking it will remain moist.
  - ✓ The speed of the vehicles will be controlled, especially on the access roads to the terrain, by means of adequate speed regulation signs.
- Measures for the protection of fauna
  Examples:
  - ✓ Hunting, fishing and / or gathering of wild species will be strictly prohibited.
  - ✓ The machinery and equipment will be in perfect working order to mitigate the disturbance of species of fauna.
  - ✓ The organic and inorganic garbage collection campaigns will be reinforced in the surroundings of the facilities.
- Measures for the protection of soil and surface waters
  Examples:

- ✓ The storage and disposal of waste in work areas near bodies of water will be prohibited. Waste management will be carried out following the guidelines established in the Waste Management Program.
- ✓ During the transfer of fuels, the use of funnels will be mandatory, as well as keeping the container containers closed with their respective lids, so that the risks of contamination due to spills are minimized.

- Measures for the protection of air quality and noise control
  Examples:
  - ✓ Electric generators will use silencers and will be in booths to reduce noise in the work area.
  - ✓ Workers exposed to gases or particulate matter must use respiratory protection equipment in the workplace.
- Health and Safety Measures for Personnel
  Examples:
  - ✓ The burning of solid waste, containers, containers made of artificial or synthetic material such as plastics, paper, cardboard, among others, that can cause respiratory diseases is prohibited.
  - ✓ Before the start of activities, all workers must pass a medical check-up in relation to contagious diseases. Likewise, at the end of the project, a medical check-up will also be carried out on all staff.
  - ✓ It is necessary to train and keep staff informed about sanitary and health issues and about emergency evacuation procedures.

6.4.2. Environmental Training Program:

The topics of the environmental training are:

- Environmental policy of the company.
- Responsibility of staff on environmental protection.
- Role of the Department of EHS & Community Affairs.
- Measures for the prevention, mitigation, and correction of environmental impacts.
- Procedures and waste disposal.
- Water and soil contamination.

- Protection of biological resources.
- Handling of domestic and industrial waste appropriately.
- Procedures for responding to environmental emergencies.
- Restoration of disturbed areas.
- Community relations with native communities.

6.4.3. Health and Safety Program:

This will promote a safe and healthy workplace, as well as responsible stewardship of the environment.

Prevent and eliminate activities or conditions that may present an unacceptable risk to the health or safety of personnel or the environment.

Establish activities and responsibilities in order to prevent occupational accidents.

Examples:

- Food handling personnel and kitchen personnel will undergo a full medical examination prior to entering work.
- Before the start of the activities, all personnel working in the various stages of the project must have undergone a medical examination and must have vaccines against the following diseases:
  - ✓ Yellow fever.
  - ✓ Hepatitis B.
  - ✓ Tetanus

6.4.4. Spill Prevention and Management of Fuels, Lubricants and Toxic Materials Program:

The objective of the program is the safe handling of fuels, lubricants and hazardous materials by the company, as well as the prevention of spills due to their use.

Examples:

- ✓ The transportation of fuels will be carried out in appropriate containers (drums) and duly labeled.
- ✓ The personnel in charge of the handling, as well as the loading and unloading of fuels, will be duly trained in spill prevention and management; and they will have containment elements for spills both on the ground and in water and firefighting systems.
- ✓ Fuel storage tanks will be checked periodically for leaks and corrosion.

6.4.5. Effluent Management Program:

Effluents from this type of operation can be classified into:

- o Sewage from the camps.

The Red Fox type plant will be used, which is a compact system that basically consists of 3 parts: a sewage collection system through pipes and an accumulation tank, a transfer system, and then treatment tanks. In the accumulation tanks, flocculants are added to settle the suspended solids, and in the treatment tanks, chemicals are added to regulate their pH and eliminate pathogens so that it is harmless to the environment.

- o Contaminated rainwater and equipment cleaning effluents.

There will be a perimeter drainage channel around the entire work area, which has the function of collecting rainwater that may fall on the ground, which will be led to safety ponds for subsequent discharge into the environment.

- o Water from training tests.

Formation test waters may not be disposed of to the environment, these waters will be pumped to the reinjection system.

- Production water.

The production water from the primary separators is sent to the skimmer tank. In this tank a complementary process is carried out that allows obtaining values of oil content in water, the treated water is driven by a reinforcement pump (booster) through low pressure aqueducts (less than 200 psi) towards the pumping station for reinjection.

6.4.6. Waste Management Program

The objective of this program is to carry out an adequate management and handling of the waste generated by the drilling and construction activities of the production facilities.

Waste management will be carried out considering the current environmental legal framework, policies and procedures regarding adequate management practices, and final disposal methods for each type of waste generated.

To achieve these objectives in order of importance are:

- Regulations for the classification and handling of waste.
- Staff training.
- Reduction of waste generation, reuse and recycling / recovery of waste.
- Responsible disposition.
- Monitoring and supervision

Examples:

- ✓ Hazardous waste will be confined in labeled containers and properly disposed of in the means of transport.
- ✓ The mixture of this type of waste with others of a combustible or flammable nature shall be avoided.
- ✓ During transportation, safe routes will be used and the loss or dispersion of collected waste will be avoided.
- ✓ It should be ensured that the vehicles used to transport waste are properly maintained.

6.4.7. Environmental Monitoring Program:

It is a technical document that establishes the follow-up measures for environmental variables during the drilling of wells. Its purpose is to control and guarantee compliance with the environmental commitments assumed by the company during all stages of project execution.

In a complementary way:

- Verify that the proposed mitigation measures are fulfilled.
- Comply with the environmental legislation of the hydrocarbon subsector of the MEM that obliges project owners to implement and maintain Environmental Monitoring Programs.
- Clearly establish the aspects on which this Environmental Monitoring Program will be applied, the parameters according to which these aspects will be measured, the personnel in charge of applying the program and their functions, the points and frequencies of sampling and monitoring.
- Keep a record of all the activities of the Environmental Monitoring Program.

Examples:

- ✓ The monitoring points will be located according to the place where the spill occurred or, failing that, in the area of bare soil closest to the point where the spill occurred.
- ✓ The number of samples taken will depend on the impacted area.
- ✓ An area will be considered clean when it meets the environmental standards established for the project.

6.4.8. Contingency plan

This plan contains a set of procedures that describe how KYSPETROL and / or its contractors, subcontractors will respond to the eventuality of accidents and / or states of emergency that may occur during the operation of the project.

- Risk study

To prepare this contingency plan, we must first identify possible threats, identified risks, as well as the estimation of the probability of occurrence of emergencies and the definition of vulnerability factors that allow qualifying the severity of the events that generate emergencies in each scenario, considering each one. of the processes and activities to be carried out in the project.

- Design of the contingency plan

  Based on the information obtained from the risk analysis, the contingency plan will be structured in such a way that it includes a set of procedures that describe how KYSPETROL and / or its contractors, subcontractors will respond in the event of accidents and / or states of emergency. that may occur during the operation of the project.

  KysPetrol will have the following resources:

  - ✓ First aid equipment
  - ✓ Medical professionals available
  - ✓ Medical facility at the camp
  - ✓ Prevention and fighting in case of fires
  - ✓ Procedures in the event of an oil spill
  - ✓ Procedures in case of work accidents
  - ✓ Procedures in case of Natural Disasters
  - ✓ Portfolio of entities where to go in case of emergency.

6.5.Abandonment plan

The purpose of this document is to reflect our environmental commitment that the KysPetrol company has when carrying out the oil well drilling project in Block 192, of which under a set of activities at the definitive end of the project, they assure to return the initial state of state resources intervened by its facilities and activities.

For the preparation of this document, national regulations have been cited, considering the basic minimum requirements of Peruvian legislation, which are presented below:

For the protection of the environment:

Decreto Supremo N° 015-2006-EM.

“Regulation for Environmental Protection in Hydrocarbon activities”

From the development of the Abandonment Plan:

Decreto Supremo N° 032-2004-EM (18/08/2004).

“Regulation of Hydrocarbon Exploration and Exploitation Activities”.

6.5.1. Abandonment

6.5.1.1. Temporary Abandonment

If an oil well is found, which meets the requirements for the economic development and exploitation decision, it will be completely isolated with cement and / or mechanical plugs. There are two possible mechanical states of the well:

A. With cemented liner sealing the hydrocarbon zone without completion by testing.

B. With cemented liner sealing the hydrocarbon zone with completion by testing.

6.5.1.2. Permanent Abandonment

They will be two types of wells that need permanent abandonment.

- **Dry wells.**

Dry wells will be in one of these mechanical states:

  - With open shaft with zones without hydrocarbons
  - With open hole with non-productive hydrocarbon zones

- **Wells that do not meet the requirements for the economic development and exploitation decision will be temporarily abandoned.**

The management of water, remaining residues, sludge with fluid content mixed with toxic chemical additives or hydrocarbons, will be managed and disposed of in accordance with Title VII "Of the Exploratory or Development Drilling Phase" of the Regulation for Environmental Protection in the Hydrocarbon activities.

Waste is segregated according to its characteristics and its final disposal.

- Hazardous Waste: Rags contaminated with hydrocarbon or paints, used oils, fuel contaminated with water or another substance, batteries, soil contaminated with fuel, hydrocarbons, oils and lubricants, and hospital waste.
- Non-hazardous Inorganic Waste: Metal remains, glass, cables.
- Organic Waste: Food waste.

The segregated waste will be placed in previously waterproofed polyethylene bags and will later be delivered to a specialized Solid Waste-Service Processing Company (EPS - RS) for transport and final disposal.

Post-Abandonment Monitoring

After the abandonment activities of the wells, it is proposed to carry out a post-abandonment monitoring that will consider the sampling of the bottom of the well for each exploration location. Said monitoring will be aimed at verifying and controlling the non-alteration of the following components of the ecosystem:

- Surface Water Quality.
- Bottom Water Quality.
- Soil quality.

The following monitoring will also be carried out:

- Monitoring of the quality of Flora.
- Monitoring the quality of Fauna.

7. SOCIAL STUDY

The analysis for social impacts has as a methodology to identify the direct and indirect impacts that are generated by the characteristics of the project.

- **DIRECT IMPACTS:** Corresponds to the entire project area, where the impacting effects are expected to occur in the construction, operation, and abandonment stages of the project; are of greater intensity.
- **INDIRECT IMPACTS:** It was established based on the secondary social and / or environmental impacts that may occur because of the operation of the project. They are less predictable.
- **SOCIOECONOMIC CHARACTERISTICS OF THE LOCATION WHERE THE PROJECT WILL BE DEVELOPED:**
    - ❖ **Identify the needs of the area**: Characteristics of the regions that will allow us to have a general overview of the conditions of the area.
    - ❖ **Information source:** Community data.
- **BENEFIT TO THE COMMUNITY:**
    - ❖ **Incorporation strategies:** Incorporate the community in the formulation and execution of the project as this will affect the sustainability of the project.
    - ❖ **Jobs generated:** Direct, indirect, temporary, or permanent jobs.
    - ❖ **Expected impacts:** Expected impacts with the execution of the project considering the beneficiary population and its context.

7.1.Evaluation of Social Impacts

Figura 231: Evaluation of Social Impacts

7.1.1. Identification of the area influenced by the project:

In accordance with article IV subsection b of the S.D. No. 012-2008-EM, the area of influence is the geographic space on which hydrocarbon activities have a considerable impact. It is considered as an area of direct influence where the hydrocarbon activity will be developed and indirectly to the areas surrounding the Project.

To determine the Areas of Influence of the Project, the existing national legislation on hydrocarbon activities has been considered, as well as the following criteria:

1) **Geographical** (topography, landscape, geomorphology, presence of water sources and roads). The Project will be carried out within Block 192, which is an area that has already been intervened.

2) **Ecological** (ecoregions, life zones, ANP and Important Bird Area).

The project site area is not in Protected Natural Areas, the distance to the Pucacuro Reserved Zone is 49.1 km and to the Santiago-Comaina Reserved Zone is 269 km, in addition the area is 187 km from the Cordillera del Cóndor National Park.

3) **Potential significant environmental impact,** which can occur on flora, fauna, water, air, socioeconomic and cultural landscapes because of the activity generated.

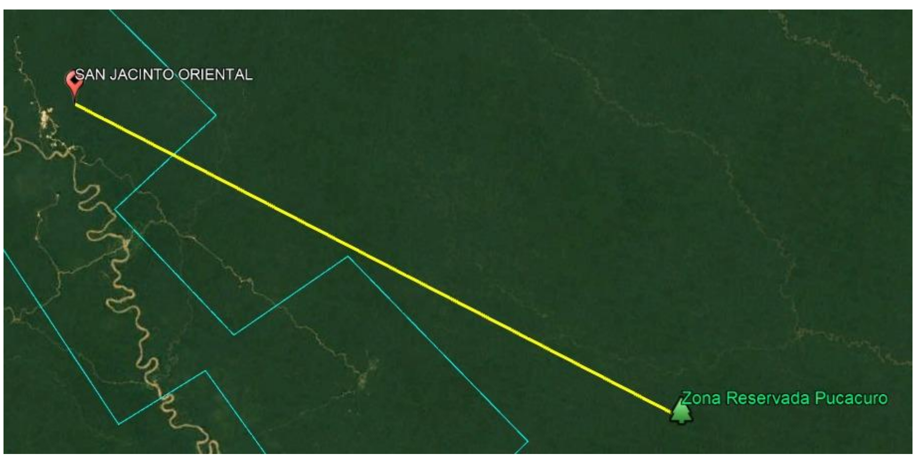
4) **Potential cumulative impact** on environmental components near other Projects.

5) Socioeconomic and cultural.

Figura 232: Project location according to reserved areas

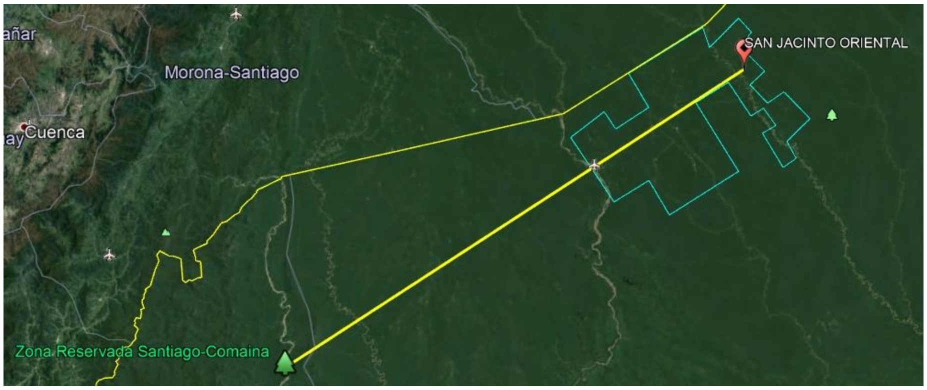
The Indirect impact to Reserved Zones and Conservation Areas is minimal since they are very far away

Figura 233: Project location according to reserved areas



Distance: 49.1 km

Figura 234: Project location according to reserved areas Santiago Comaina



Distance: 269 km

Figura 235: Project location according to Alto Nanay Regional reserved areas

Distance: 187 km

7.1.2. Identification of populations within the project's area of influence:

7.1.2.1. Identification of populations within the project's area of influence:

Tabla 203: Native communities of influence

COMUNIDADES NATIVAS DE INFLUENCIA	DISTRITO
Comunidad Nativa Los Jardines	Andoas
Comunidad Nativa Nuevo Porvenir	Andoas
Comunidad Nativa Marsella	El Tigre
Comunidad Nativa Capahuariyacu	Andoas
Comunidad Nativa Andoas Viejo	Andoas
Comunidad Nativa Doce de Octubre	El Tigre
Comunidad Nativa José Olaya	Trompeteros
Comunidad Nativa Remanente	El Tigre
Comunidad Nativa Titiyacu	Andoas
Comunidad Nativa Nuevo Andoas	Andoas
Comunidad Nativa Nueva Jerusalén	Trompeteros
Comunidad Nativa Alianza Cristiana	Andoas

Villa Trompeteros, a capital town center that holds the category of town according to Law No. 24696 of 06.21.1987. According to the field work carried out by the OAT-SIG, this town has a population of 1,274 inhabitants, presents an urban projection, with the basic services of electricity, water, and sewage operating twenty-four hours a day, the same as They are implemented by the hydrocarbon company, which is located on the opposite bank of the Corrientes River.

In addition, this town has health and education services, presents conditions for its expansion and growth, there is a commercial flow and services motivated by the presence of company workers.

For the classification of provincial territorial areas, the following ranges were used:

- **From 0 – 1 inh/km²**......................... *Unoccupied.*
- **From 1 – 10 inh//km²**....................... *Sparsely inhabited.*
- **From – 20 inh//km²**..................... *Moderately Inhabited.*
- **From – 50 inh//km²**..................... *Normally inhabited.*
- **From – 100 inh//km²**................... *Densely Inhabited.*
- **>100 inh/km²**............................. *Highly Inhabited.*

7.1.2.2. Population in the province of Loreto by districts

Tabla 204: Populations in the province of Loreto

AMBITO	POBLACIÓN	SUPERFICIE	DENSIDAD (hab./km^2)	CLASIFICACIÓN TERRITORIAL
Dpto. Loreto	**884,144**	**368,851.95**	**2.40**	**Escasamente habitado**
Provincia Loreto	**63,515**	**65,804.17**	**0.97**	**Deshabilitado**
Nauta	29,859	6,329.69	4.72	Escasamente habitado
Pariani	7,394	11,786.36	0.63	Deshabilitado
Tigre	7,616	17,825.20	0.43	Deshabilitado
Trompeteros	6,621	13,270.88	0.50	Deshabilitado
Urarinas	12,025	16,592.04	0.72	Deshabilitado

Source: INEI: X Population Census and V of Housing.

7.1.3. Loreto province: number of populated centers

Tabla 205: Populated centers in the province

DESCRIPCIÓN	CIUDAD	PUEBLO	VILLA	CASERÍO	COMUNIDAD INDÍGENA	TOTAL
Provincia de Loreto	0	5	0	147	129	281
Distrito de Nauta	0	1	0	76	19	96
Distrito de Pariani	0	1	0	10	17	28
Distrito Tigre	0	1	0	28	18	47
Distrito Trompeteros	0	1	0	6	24	31
Distrito Urarinas	0	1	0	27	51	79

7.1.4. Number of populated centers greater than or equal to 150 inhabitants

Tabla 206: Number of populated centers

DESCRIPCIÓN	CIUDAD	PUEBLO	VILLA	CASERÍO	COMUNIDAD INDÍGENA	TOTAL
Provincia de Loreto	0	5	0	95	80	180
Distrito de Nauta	0	1	0	47	15	63
Distrito de Pariani	0	1	0	9	13	23
Distrito Tigre	0	1	0	11	9	21
Distrito Trompeteros	0	1	0	5	14	20
Distrito Urarinas	0	1	0	23	29	53

7.1.1. Projected costs of the social management plan

Tabla 207: Projected costs of the social management plan

PROGRAMA	TIPO DE PROGRAMA	COSTO ANUAL (US$)
Plan de Relaciones Comunitarias	***Programa de empleo local***	$ 3,000.00
	Programa de responsabilidad social	$ 4,000.00
	Programa de Monitoreo Socioambiental participativo	$ 5,000.00
	Programa de Comunicación	$ 4,000.00
	Programa de capacitación en Grupos de interés en Seguridad y Ambiente	$ 4,000.00
	Programa de consulta	$ 5,000.00
TOTAL, ANUAL	TOTAL, ANUAL	**$ 25,000.00**

7.1.2. Code of conduct

Tabla 208: Code of conduct

Artículo 1°:	Los trabajadores deberán utilizar obligatoriamente equipo de protección personal.
Artículo 2°:	Los trabajadores deben evitar divulgar datos sobre los aspectos técnicos, procesos, planes, diseños, costos, información administrativa y otra información perteneciente a la empresa.
Artículo 3°:	Los trabajadores deben respetar las primeras normas y reglamentos de prevención de accidentes establecidos para cada tipo de trabajo.
Artículo 4°:	Los trabajadores deben desempeñar sus funciones de buena fe y con su mejor esfuerzo, habilidad y eficiencia.
Artículo 5°:	Los trabajadores no pueden abandonar el área de trabajo durante los turnos de trabajo sin la autorización por escrito de su supervisor.
Artículo 6°:	Los trabajadores deben portar su identificación debidamente en la ropa y en un lugar visible durante las horas de trabajo.
Artículo 7°:	Los trabajadores tienen prohibido subcontratar a la población local para cualquier tipo de servicio personal.
Artículo 8°:	En el lugar de trabajo, los trabajadores evitarán agresiones o acciones que puedan causar perjuicios a personas, equipos, materiales y maquinaria.
Artículo 9°:	Los trabajadores tienen prohibido portar o usar drogas, o usar drogas o bebidas alcohólicas durante las horas de trabajo.
Artículo 10°:	Los trabajadores tienen prohibido portar armas de fuego durante las horas de trabajo.
Artículo 11°:	Los trabajadores eliminarán los desechos sólidos en lugares autorizados.
Artículo 12°:	Los trabajadores utilizarán los servicios higiénicos implementados para las obras.
Artículo 13°:	El personal no podrá disponer del material de trabajo, elementos, material de desecho, etc., para la confección de objetos personales o para beneficio de terceros.
Artículo 14°:	Los trabajadores leerán avisos, circulares, boletines y comunicaciones de la empresa publicados en los tableros o vitrinas o distribuidos entre el personal.
Artículo 15°:	En caso de obsequio de la población, estos deberán remitirse mediante la emisión de un Certificado o comprobante de entrega.
Artículo 16°:	Se prohíbe la difusión de videos y películas que vayan en contra de la moral o la sensibilidad de los trabajadores.
Artículo 17°:	Se prohíbe el acoso y el acto que atente contra la moral del ser humano.

Source: Preliminary Environmental Assessment (EVAP) -UNIPETRO ABC Company

7.2.Matrix of social impacts:

Tabla 209: Matrix of social impacts

Actividades por Etapa		Afectación a la salud	Empleo local	Riesgo de Contaminación Ambiental	Riesgo en Materia de Seguridad
		Tipo de Impacto			
Etapa Pre-operativa	***Perforación del pozo***		+	-	-
	Preparación del campo para las instalaciones de Perforación y Producción		+		-
	Instalación de las facilidades de superficie		+	-	
	Llevar los equipos a la zona seleccionada		+		
	Instalación de las plataformas y equipos de perforación		+	-	-
Etapa Operativa	***Vigilancia del pozo***		+		
	Producción de pozo			-	-
	Transporte del crudo	-		-	-
	Tratamiento e Inyección de agua en pozo disposal			-	
Etapa de Abandono	***Movilización de instalaciones y facilidades***		+		
	Remediación del área	+		+	+
	Restauración del área	+		+	+

7.3.Social Responsibility Program

7.3.1. Components of the social management plan

Tabla 210: Components of the social management plan

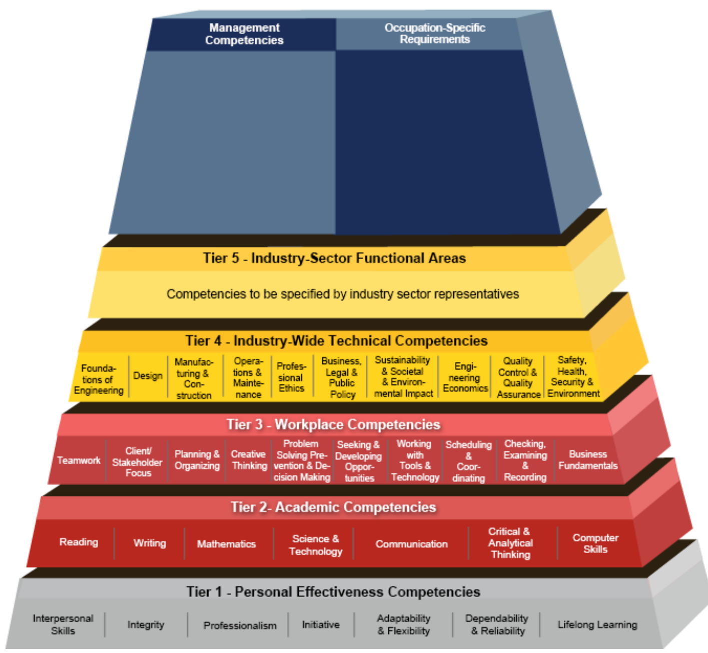
N °	PROGRAMAS	LINEAMIENTOS
1	***Programa de empleo local***	Programas y proyectos destinados a fomentar el trabajo por cuenta propia y a mejorar la ocupación de las personas desempleadas.
2	***Programa de responsabilidad social***	Dar a conocer los lineamientos de del programa de responsabilidad social.
3	***Programa de Monitoreo Socioambiental participativo***	Programa para integrar grupos de interés afines con la actividad de agricultura.
4	***Programa de Comunicación***	Se realiza actividades para informar sobre el manejo y cuidado ambiental, además se dará a conocer medidas de mitigación ambiental, programas de empleo local.
5	***Programa de capacitación en Grupos de interés en Seguridad y Ambiente***	Programa de capacitación a los grupos de interés en temas de seguridad del medio ambiente a través de reuniones informativas.
6	***Programa de consulta***	Programa con fin de construir un diálogo de buena fe entre el estado y las comunidades.

8. MANAGEMENT STUDY

At the managerial level, petroleum professionals must have the appropriate skills to carry this role. The profile of the petroleum engineer has evolved following the complex petroleum activity. Today, the oil industry requires professionals prepared to incorporate new knowledge and apply it to the industry.

Also, the figure below shows the engineering competency model.

Figura 236: Engineering competency model



Fuente: AAES, 2016

NOTE: In the case of petroleum engineers, you must manage areas of interest, know the objectives, goals of the organization and seek the appreciation of the company. In addition, the current petroleum engineer must know the participation of his company in the market and how his work as a professional impact in the development of the company and industry.

8.1. Managerial, technical and administrative capabilities

8.1.1. Managerial skills

For the development of the project, managers capable of leading groups and areas of interest are required. Additionally, these leaders must have skills to interact with managers, operational heads and other interest groups; as the neighboring communities and regulatory entities of the Peruvian government.

Therefore, the following table shows everything previously mentioned.

Figura 237: Managerial skills

Source: Own elaboration

8.1.2. Technical skills

It should be noted that exploration and production projects are based on the operational part of the organizational pyramid, that is, qualified technicians, specialized engineers, among others.

On the other hand, this project has a high risk and uncertainty. For that reason, it is necessary to mitigate these impacts, thus the necessity for qualified and experienced staff.

The technical skills that are considered most relevant to carry out this project are shown below.

- Ability to solve problems, using logical thinking, analytical thinking, creativity and imagination.
- Stay up-to-date on developments in the oil industry.
- An excellent control of modern technology.
- Organizational ability to coordinate your own time and resources.
- Responsibility for leading and motivating other people.
- Communication skills to write reports and explain complex information to people with non-technical backgrounds.
- A good knowledge of security laws and procedures.

8.1.3. Administrative skills

According to Robert L. Kaltz there are 3 important skills for a successful managerial performance.

Figura 238: Administrative skills

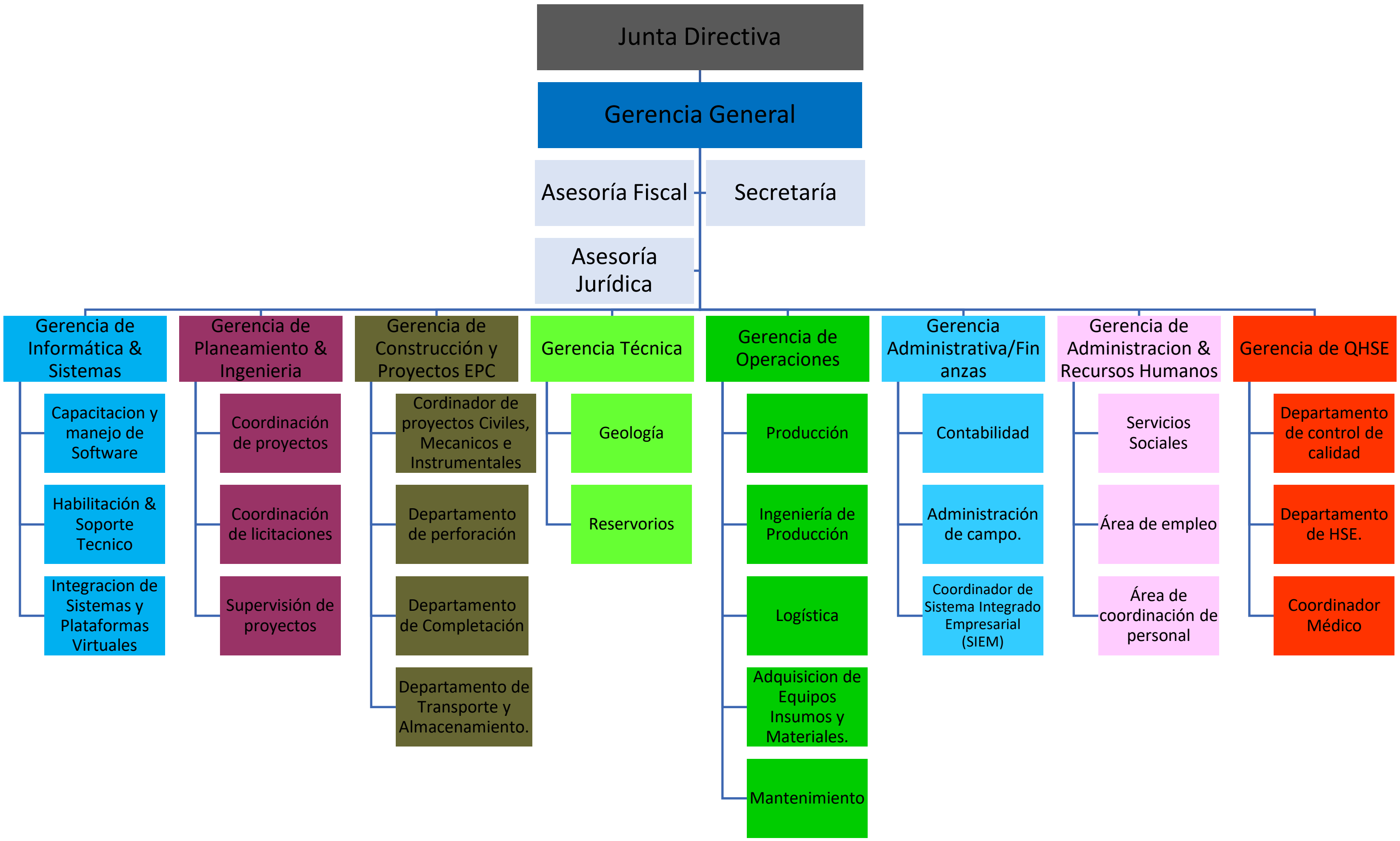
Uso de conocimiento y pericia para realizar actividades que incluyen métodos, procesos y procedimiento con el uso de herramientas y técnicas

Se relaciona con nuestro trato hacia las personas, se refiere a la capacidad para trabajar con personas: esfuerzo cooperativo, trabajo en equipo, ambiente adecuado.

Uso de la capacidad de reconocer los elementos importantes en una situación y comprender la relación entre ellos.

8.2.Organigram

Figura 239: Organization chart



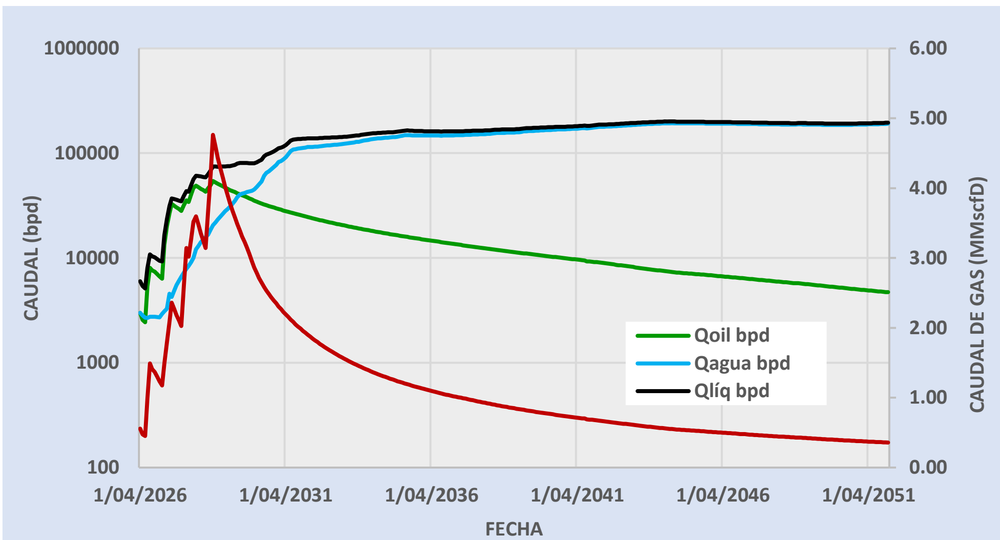
9. ECONOMIC STUDY

9.1. Economic considerations

9.1.1. Oil production forecast

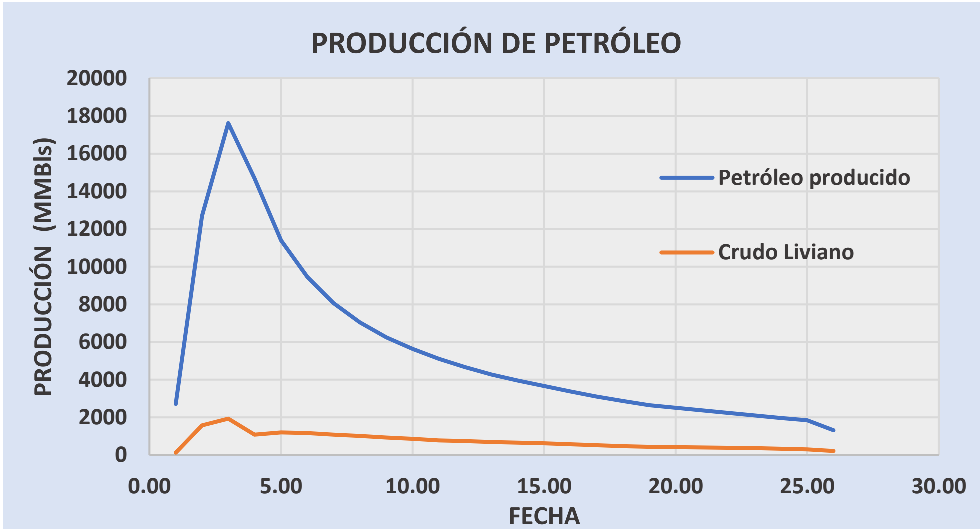
Using the geology, reservoirs, drilling and production studies, we estimated the forecast of fluids for our field. So, we have the following oil, gas and water production forecast for the next 26 years.

Figura 240: Oil and gas production estimation



En el escenario de Crudo Liviano tendremos un volumen de hidrocarburo adicional debido a que el volumen de crudo liviano se sumará al crudo pesado extraído. Esto no aplica para la Nafta

Figura 241: Production Oil



The results are shown below:

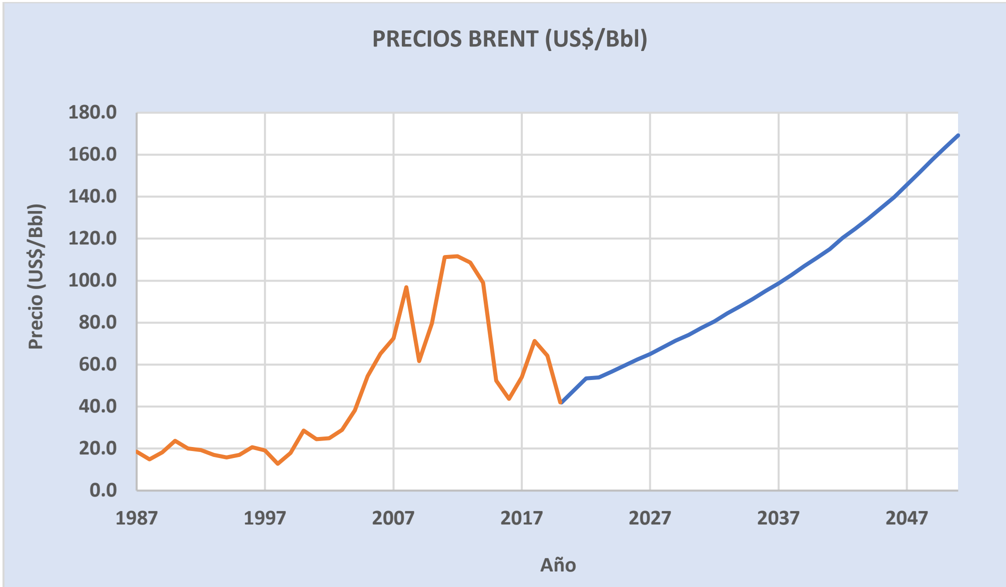
Tabla 211: Results

CUMULATIVE OIL	143.64	*MMbls*
CUMULATIVE GAS	11.35	*BCF*
CUMULATIVO LIGHT OIL	19.05	*MMbls*

9.1.2. Crude oil price estimation

We estimate the price of crude oil using different entities recognized as EIA or World Bank Commodity, they make a maximum prediction of 3 years, this due to the uncertainty of crude prices, however, Knoema portal which offers a variety of crude price estimates, in this case it presents a long-term prediction according to the EIA (US Energy Information Administration), the following prediction is available for the year in which the project would culminate.

Figura 242: Brent Price forecast by EIA



Source: Knoema

We can see that in the long term there is an overly optimistic price scenario, so we take a more realistic flat price taking into consideration the short-term forecasts and other reports from other entities, so we establish a Flat price of US $ 65.

Tabla 212: Basket Price history.

	BRENT	BASKET
Ene-20	63.65	56.50
Feb-20	55.66	48.28
Mar-20	32.01	27.48
Abr-20	18.38	17.82
May-20	29.38	23.36
Jun-20	40.27	35.27
Jul-20	43.24	38.60
Ago-20	44.74	39.24
Set-20	40.91	36.63
Oct-20	40.19	36.38
Nov-20	42.69	39.27

Source: Perupetro

The table shows the Brent marker crude, however, our crude does not have the same characteristics as this crude, so a basket price is established taking a history in the Perupetro publications of the year 2020.

From this data, it can be seen that there is a differential of 8%, therefore, from this we establish the price of our crude oil, which would be 59.8 US$/bl.

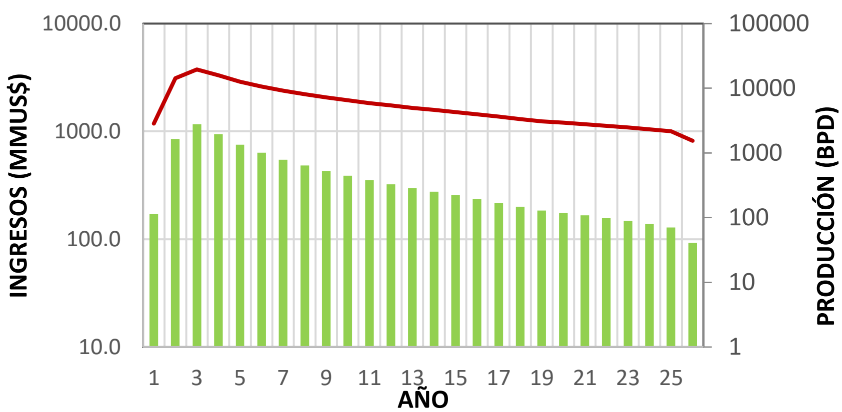
9.1.3. Income estimate

After establishing the basket price for our crude, we can estimate our gross revenue from forecast production:

- Light Oil

The graph shows us that the estimated income would be 9'728.8 MMUS$.

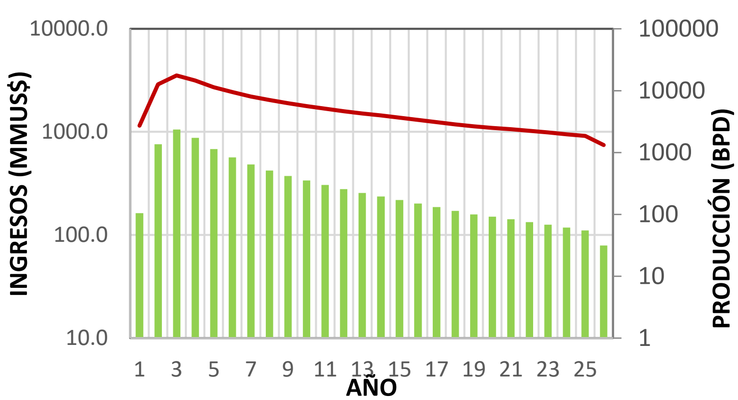
Figura 243: Revenue estimations by production forecast



- Naphtha

The graph shows us that the estimated income would be 8'589.6 MMUS$.

Figura 244: Revenue estimations by production forecast



9.1.4. CAPEX

The investments and expenses that will be made throughout the life of the project will be shown below. In the first stage, exploration investments and the construction of a thermoelectric plant are made. Then the major expenses will be made in the drilling of the development wells and in the acquisition of the surface equipment. It is worth mentioning that these investments must be divided into tangible and intangible for further analysis.

9.1.4.1. Geology costs

Tabla 213: Geology investment

	Estimated investment (MMUS$)	Tangible (MMUS$)	Intangible (MMUS$)	TOTAL (MMUS$)
Environmental and social impact studies - interrelationships	0.5		0.5	0.5
Reprocessing of existing 2D seismic information	0.5		0.5	0.5
Generate, record, process and interpret 120 km of seismic lines	4.8		4.8	4.8
Reprocess and interpret 150 km of seismic lines	0.05		0.05	0.05
Generate, record, process and interpret 500 km2 of 3D seismic	25		25	25
Reprocess and interpret 40 km of seismic lines	0.125		0.125	0.125
	Total		30.975	30.975

9.1.4.2. Drilling, completion and logs costs

9.1.4.2.1. Exploration Well

Tabla 214: Drilling, completion and logs costs of exploratory well

FIELD	**San Jacinto Oriental**	
AVERAGE DEPTH	**9,800**	**ft**
AVERAGE DRILLING AND COMPLETION TIME	**55**	**DAYS/ Well**
Number of wells	**1**	

DRILLLING				
INTANGIBLES				15,640,000
AIR TRANSPORT	200,000	1	200,000	
CAMP ASSEMBLY	10,000	1	10,000	
DRILLING BITS	25,000	4	100,000	
ROAD AND TRANSPORT GENERATION	2,000,000	1	2,000,000	
PLATFORM AND ACCESS	2,000,000	1	2,000,000	
DRILLING FLUIDS SERVICES	500,000	1	500,000	
DRILLING EQUIPMENT COSTS / DAY	120,000	55	6,600,000	
MOBILIZATION AND DEMOBILIZATION	100,000	1	100,000	
WIRELINE SERVICES	140,000	1	140,000	
CEMENTING EQUIPMENT AND SERVICES	350,000	1	350,000	
DRILLING FLUIDS SERVICES SURFACE	800,000	1	800,000	
OTHER INTANGIBLE EXPENSES	200,000	1	200,000	
TANGIBLES				776,210
TRANSPORT	600,000	1	600,000	
CONDUCTOR CASING	15,000	1	15,000	
SUPERFICIAL CASING	30,500	1	30,500	
INTERMEDIATE CASING	70,710	1	70,710	
Linner 7"	40,000	1	40,000	
CABEZAL	20,000	1	20,000	
OTHER TANGIBLE EXPENSES	-	0		
COMPLETION				
INTANGIBLES				1,150,000
AIR TRANSPORT	300,000	1	300,000	
COMPLETION FLUIDS	350,000	1	350,000	
CASED HOLE LOG CSG GUN	30,000	1	30,000	
WELL SERVICE RIG	250,000	1	250,000	
SUB. AND SUPERF TOOLS	50,000	1	50,000	
PHYSICAL MEASUREMENTS AND ANALYSIS	60,000	1	60,000	
TRANSPORTATION AND INSPECTION	80,000	1	80,000	
OTHER INTANGIBLE EXPENSES	30,000	1	30,000	

RESERVOIRS AND GEOLOGY				2,743,000
PVT ANALYSIS	350,000	1	350,000	
CORE SAMPLING	2,100,000	1	2,100,000	
PHYSICAL AND RHEOLOGICAL ANALYSIS OF FLUIDS	1,000	3	3,000	
PLT AND PRESSURE TESTING	190,000	1	190,000	
SPECIAL LOGS	100,000	1	100,000	

Total	**23.31**

9.1.4.2.2. Appraisal Well

Tabla 215: Drilling, completion and logs costs of confirmatory well

FIELD	**San Jacinto Oriental**	
AVERAGE DEPTH	**9,800**	**ft**
AVERAGE DRILLING AND COMPLETION TIME	**35**	**DAYS/ Well**
Number of wells	**2**	

EXPLORATIONO				110,000
TRANSPORTE AEREO	100,000	1	100,000	
GEOLOGÍA DE CAMPO / MES	5,000	2	10,000	
ESTUDIO DE IMPACTO AMBIENTAL	-	-		
SISMICA Y PROCESAMIENTO	-	-		

DRILLING				
INTANGIBLES				15,745,606
AIR TRANSPORT	200,000	2	400,000	
CAMP ASSEMBLY	100,000	2	200,000	
DRILLING BITS	29,110	8	232,876	
ROAD AND TRANSPORT GENERATION	1,000,000	2	2,000,000	
PLATFORM AND ACCESS	1,200,000	2	2,400,000	
DRILLING FLUIDS SERVICES	300,000	2	600,000	
DRILLING EQUIPMENT COSTS / DAY	120,000	74	8,400,000	
MOBILIZATION AND DEMOBILIZATION	100,000	2	200,000	
CEMENTING EQUIPMENT AND SERVICES	366,365	2	732,730	
DRILLING FLUIDS SERVICES SURFACE	50,000	2	100,000	
OTHER INTANGIBLE EXPENSES	-	0		
TANGIBLES				622,425
TRANSPORT	100,000	2	200,000	
CONDUCTOR CASING	19,003	2	38,006	
SUPERFICIAL CASING	37,500	2	75,000	
INTERMEDIATE CASING	81,710	2	163,420	
Linner 7"	48,000	2	96,000	
CABEZAL	25,000	2	50,000	
OTHER TANGIBLE EXPENSES	-	0		
COMPLETATION				
				1,035,000
INTANGIBLES				
AIR TRANSPORT	100,000	2	200,000	
COMPLETION FLUIDS	80,000	2	160,000	
CASED HOLE LOG CSG GUN	30,000	2	60,000	
WELL SERVICE RIG	100,000	2	200,000	
SUB. AND SUPERF TOOLS	50,000	2	100,000	
PHYSICAL MEASUREMENTS AND ANALYSIS	17,500	2	35,000	
TRANSPORTATION AND INSPECTION	80,000	2	160,000	
OTHER INTANGIBLE EXPENSES	10,000	2	20,000	
TANGIBLES	50,000	0	100,000	
PRODUCTION TUBING				

RESERVOIRS AND GEOLOGY				1,004,000
PVT ANALYSIS	300,000	2	600,000	
CORE SAMPLING	2,000,000	0	0	
PHYSICAL AND RHEOLOGICAL ANALYSIS OF FLUIDS	1,000	4	4,000	
PLT AND PRESSURE TESTING	200,000	1	200,000	
SPECIAL LOGS	100,000	2	200,000	
ADMINISTRATION FIELD-CITY				**1,500,000**

Total	**20.02**

9.1.4.2.3. Development Well (Comingled)

Tabla 216: Drilling, completion and logs costs of development well (comingle)

FIELD	**San Jacinto Oriental**	
AVERAGE DEPTH	**9,800**	**ft**
AVERAGE DRILLING AND COMPLETION TIME	**35**	**DAYS/ Well**
Number of wells	**5**	

DRILLING				
INTANGIBLES				46,510,000
AIR TRANSPORT	200,000	2	400,000	
CAMP ASSEMBLY	80,000	2	160,000	
DRILLING BITS	25,000	20	500,000	
DRILLING FLUIDS SERVICES	500,000	5	2,500,000	
DRILLING EQUIPMENT COSTS / DAY	120,000	185	22,200,000	
MOBILIZATION AND DEMOBILIZATION	100,000	5	500,000	
CEMENTING EQUIPMENT AND SERVICES	300,000	5	1,500,000	
DRILLING FLUIDS SERVICES SURFACE	50,000	5	250,000	
DIRECTIONAL WELL SERVICES	100,000	185	18,500,000	
TANGIBLES				1,556,063
TRANSPORT	100,000	5	500,000	
CONDUCTOR CASING	19,003	5	95,014	
SUPERFICIAL CASING	37,500	5	187,500	
INTERMEDIATE CASING	81,710	5	408,549	
Linner 7"	48,000	5	240,000	
CABEZAL	25,000	5	125,000	
OTHER TANGIBLE EXPENSES	-			
COMPLETATION				
INTANGIBLES				2,587,500
AIR TRANSPORT	100,000	5	500,000	
COMPLETION FLUIDS	80,000	5	400,000	
CASED HOLE LOG CSG GUN	30,000	5	150,000	
WELL SERVICE RIG	100,000	5	500,000	
SUB. AND SUPERF TOOLS	50,000	5	250,000	
PHYSICAL MEASUREMENTS AND ANALYSIS	17,500	5	87,500	
TRANSPORTATION AND INSPECTION	80,000	5	400,000	
OTHER INTANGIBLE EXPENSES	10,000	5	50,000	
TANGIBLES				
PRODUCTION TUBING	50,000	5	250,000	

RESERVOIRS AND GEOLOGY				1,406,000
PVT ANALYSIS	300,000	1	300,000	
PHYSICAL AND RHEOLOGICAL ANALYSIS OF FLUIDS	600	10	6,000	
PLT AND PRESSURE TESTING	200,000	5	1,000,000	
SPECIAL LOGS	100,000	1	100,000	

Total	**52.06**
Total/well	**10.41**

9.1.4.2.4. Horizontal Well

Tabla 217: Drilling, completion and logs costs of horizontal well

FIELD	**San Jacinto Oriental**		
AVERAGE DEPTH	**12,000**		**ft**
AVERAGE DRILLING AND COMPLETION TIME	**50**		**DAYS/ Well**
Number of wells	**7**		
	POZO SELVA	**TOTAL Horizontal development 7 POZO**	**Subtotal**

DRILLING				
INTANGIBLES				234,220,000
AIR TRANSPORT	500,000	2	1,000,000	
CAMP ASSEMBLY	10,000	2	20,000	
DRILLING BITS	25,000	28	700,000	
DRILLING FLUIDS SERVICES	500,000	7	3,500,000	
DRILLING EQUIPMENT COSTS / DAY	120,000	350	42,000,000	
MOBILIZATION AND DEMOBILIZATION	100,000	2	200,000	
CEMENTING EQUIPMENT AND SERVICES	400,000	7	2,800,000	
DRILLING FLUIDS SERVICES SURFACE	1,000,000	7	7,000,000	
OTHER INTANGIBLE EXPENSES	300,000	350	105,000,000	
AIR TRANSPORT	200,000	360	72,000,000	
TANGIBLES				2,213,488
TRANSPORT	0	0	0	
CONDUCTOR CASING	100,000	7	700,000	
SUPERFICIAL CASING	19,003	7	133,019	
INTERMEDIATE CASING	37,500	7	262,500	
Linner 7"	81,710	7	571,969	
CABEZAL	48,000	7	336,000	
OTHER TANGIBLE EXPENSES	30,000	7	210,000	
COMPLETATION				
INTANGIBLES				4,446,000
AIR TRANSPORT	0	0	0	
COMPLETION FLUIDS	200,000	2	400,000	
CASED HOLE LOG CSG GUN	100,000	7	700,000	
WELL SERVICE RIG	80,000	7	560,000	
SUB. AND SUPERF TOOLS	100,000	7	700,000	
PHYSICAL MEASUREMENTS AND ANALYSIS	200,000	7	1,400,000	
TRANSPORTATION AND INSPECTION	18,000	7	126,000	
OTHER INTANGIBLE EXPENSES	80,000	7	560,000	

RESERVOIRS AND GEOLOGY				1,504,200
PVT ANALYSIS	0	0	0	
CORE SAMPLING	300,000	1	300,000	
PHYSICAL AND RHEOLOGICAL ANALYSIS OF FLUIDS	2,000,000	0	0	
PLT AND PRESSURE TESTING	600	7	4,200	
SPECIAL LOGS	400,000	3	1,200,000	
ADMINISTRATION FIELD-CITY				1,000,000

Total	**243.38**
Total/well	**34.77**

9.1.4.2.5. Vertical Well

Tabla 218: Drilling, completion and logs costs of vertical well

FIELD	**San Jacinto Oriental**	
AVERAGE DEPTH	**9,800**	**ft**
AVERAGE DRILLING AND COMPLETION TIME	**35**	**DAYS/ Well**
Number of wells	**1**	

DRILLING				
INTANGIBLES				7,632,803
AIR TRANSPORT	200,000	1	200,000	
CAMP ASSEMBLY	100,000	1	100,000	
DRILLING BITS	29,110	4	116,438	
ROAD AND TRANSPORT GENERATION	1,000,000	1	1,000,000	
PLATFORM AND ACCESS	1,200,000	1	1,200,000	
DRILLING FLUIDS SERVICES	300,000	1	300,000	
DRILLING EQUIPMENT COSTS / DAY	120,000	35	4,200,000	
MOBILIZATION AND DEMOBILIZATION	100,000	1	100,000	
CEMENTING EQUIPMENT AND SERVICES	366,365	1	366,365	
DRILLING FLUIDS SERVICES SURFACE	50,000	1	50,000	
OTHER INTANGIBLE EXPENSES	-			
TANGIBLES				311,213
TRANSPORT	100,000	1	100,000	
CONDUCTOR CASING	19,003	1	19,003	
SUPERFICIAL CASING	37,500	1	37,500	
INTERMEDIATE CASING	81,710	1	81,710	
Linner 7"	48,000	1	48,000	
CABEZAL	25,000	1	25,000	
OTHER TANGIBLE EXPENSES	-			
COMPLETATION				
INTANGIBLES				517,500
AIR TRANSPORT	100,000	1	100,000	
COMPLETION FLUIDS	80,000	1	80,000	
CASED HOLE LOG CSG GUN	30,000	1	30,000	
WELL SERVICE RIG	100,000	1	100,000	
SUB. AND SUPERF TOOLS	50,000	1	50,000	
PHYSICAL MEASUREMENTS AND ANALYSIS	17,500	1	17,500	
TRANSPORTATION AND INSPECTION	80,000	1	80,000	
OTHER INTANGIBLE EXPENSES	10,000	1	10,000	
TANGIBLES				
PRODUCTION TUBING	50,000	0	50,000	

RESERVOIRS AND GEOLOGY				704,000
PVT ANALYSIS	300,000	1	300,000	
CORE SAMPLING	2,000,000	0	0	
PHYSICAL AND RHEOLOGICAL ANALYSIS OF FLUIDS	1,000	4	4,000	
PLT AND PRESSURE TESTING	200,000	1	200,000	
SPECIAL LOGS	100,000	2	200,000	
ADMINISTRATION FIELD-CITY				1,000,000

Total	**10.17**

9.1.4.2.6. Dry Well

Tabla 219: Drilling costs of dry well

FIELD	**San Jacinto Oriental**	
AVERAGE DEPTH	**9,800**	**ft**
AVERAGE DRILLING AND COMPLETION TIME	**35**	**days/ well**
Number of wells	**2**	

DRILLING				
INTANGIBLES				18,949,241
AIR TRANSPORT	200,000	1	200,000	
CAMP ASSEMBLY	100,000	1	100,000	
DRILLING BITS	29,110	8	232,876	
ROAD AND TRANSPORT GENERATION	1,000,000	1	1,000,000	
PLATFORM AND ACCESS	1,200,000	1	1,200,000	
DRILLING FLUIDS SERVICES	300,000	1	300,000	
DRILLING EQUIPMENT COSTS / DAY	120,000	70	8,400,000	
MOBILIZATION AND DEMOBILIZATION	100,000	1	100,000	
CEMENTING EQUIPMENT AND SERVICES	366,365	1	366,365	
DRILLING FLUIDS SERVICES SURFACE	50,000	1	50,000	
DIRECTIONAL WELL SERVICES	100,000	70	7,000,000	
OTHER INTANGIBLE EXPENSES	-	0		

TANGIBLES				263,213
TRANSPORTE	100,000	1	100,000	
CASING DE CONDUCTOR	19,003	1	19,003	
CASING SUPERFICIE	37,500	1	37,500	
CASING DE INTERMEDIO	81,710	1	81,710	
CABEZAL	25,000	1	25,000	

RESERVOIRS AND GEOLOGY				704,000
PVT ANALYSIS	300,000	1	300,000	
CORE SAMPLING	2,000,000	0	0	
PHYSICAL AND RHEOLOGICAL ANALYSIS OF FLUIDS	1,000	4	4,000	
PLT AND PRESSURE TESTING	200,000	1	200,000	
SPECIAL LOGS	100,000	2	200,000	
ADMINISTRATION FIELD-CITY				1,050,000

Total	**20.97**
Total/well	**10.48**

9.1.4.2.7. Injector Well

Tabla 220: Drilling, completion and logs costs of injector well

FIELD	**San Jacinto Oriental**	
AVERAGE DEPTH	**9,800**	**ft**
AVERAGE DRILLING AND COMPLETION TIME	**55**	**DAYS/ Well**
Number of wells	**6**	

DRILLLING				
INTANGIBLES				45,796,818
AIR TRANSPORT	200,000	6	1,200,000	
CAMP ASSEMBLY	100,000	6	600,000	
DRILLING BITS	29,110	24	698,629	
ROAD AND TRANSPORT GENERATION	1,000,000	6	6,000,000	
PLATFORM AND ACCESS	1,200,000	6	7,200,000	
DRILLING FLUIDS SERVICES	300,000	6	1,800,000	
DRILLING EQUIPMENT COSTS / DAY	120,000	210	25,200,000	
MOBILIZATION AND DEMOBILIZATION	100,000	6	600,000	
CEMENTING EQUIPMENT AND SERVICES	366,365	6	2,198,189	
DRILLING FLUIDS SERVICES SURFACE	50,000	6	300,000	
OTHER INTANGIBLE EXPENSES	-	0		
TANGIBLES				1,867,276
TRANSPORT	100,000	6	600,000	
CONDUCTOR CASING	19,003	6	114,017	
SUPERFICIAL CASING	37,500	6	225,000	
INTERMEDIATE CASING	81,710	6	490,259	
Linner 7"	48,000	6	288,000	
CABEZAL	25,000	6	150,000	
OTHER TANGIBLE EXPENSES	-	0		
COMPLETATION				
INTANGIBLES				3,105,000
AIR TRANSPORT	100,000	6	600,000	
COMPLETION FLUIDS	80,000	6	480,000	
CASED HOLE LOG CSG GUN	30,000	6	180,000	
WELL SERVICE RIG	100,000	6	600,000	
SUB. AND SUPERF TOOLS	50,000	6	300,000	
PHYSICAL MEASUREMENTS AND ANALYSIS	17,500	6	105,000	
TRANSPORTATION AND INSPECTION	80,000	6	480,000	
OTHER INTANGIBLE EXPENSES	10,000	6	60,000	
TANGIBLES	0	0		
PRODUCTION TUBING	50,000	6	300,000	

RESERVOIRS AND GEOLOGY				1,004,000
PVT ANALYSIS	300,000	2	600,000	
CORE SAMPLING	2,000,000	0	0	
PHYSICAL AND RHEOLOGICAL ANALYSIS OF FLUIDS	1,000	4	4,000	
PLT AND PRESSURE TESTING	200,000	1	200,000	
SPECIAL LOGS	100,000	2	200,000	
ADMINISTRATION FIELD-CITY				1,000,000

Total	**52.77**

9.1.4.2.1. *Cutt off Well*

YACIMIENTO	San Jacinto Norte			
PROFUNDIDAD PROMEDIA		9,800		Pies
TIEMPO PROMEDIO DE PERFORACION Y C		35		Dias/ pozo
Numeros de pozos		1		
	POZO SELVA		TOTAL Confirmatorio 1 POZO	Subtotales
PERFORACIÓN				
INTANGIBLES				7,545,474
TRANSPORTE AEREO	200,000	1	200,000	
ARMADO DE CAMPAMENTO	100,000	1	100,000	
BROCAS DE PERFORACION	29,110	1	29,110	
GENERACIÓN DE CARRETERAS Y TRANSPORTE	1,000,000	1	1,000,000	
PLATAFORMA Y ACCESOS	1,200,000	1	1,200,000	
SERVICIOS DE FLUIDOS DE PERFORACION	300,000	1	300,000	
COSTOS DE EQUIPO DE PERFORACION / DIA	120,000	35	4,200,000	
MOVILIZACION Y DESMOVILIZACION	100,000	1	100,000	
EQUIPOS Y SERVICIOS DE CEMENTACION	366,365	1	366,365	
SERVICIOS DE FLUIDOS DE PERFORACION SUPERFICIE	50,000	1	50,000	
OTROS GASTOS INTANGIBLES	-	0		
TANGIBLES				311,213
TRANSPORTE	100,000	1	100,000	
CASING DE CONDUCTOR	19,003	1	19,003	
CASING SUPERFICIE	37,500	1	37,500	
CASING DE INTERMEDIO	81,710	1	81,710	
Linner 7"	48,000	1	48,000	
CABEZAL	25,000	1	25,000	
OTROS GASTOS TANGIBLES	-	0		
COMPLETACIÓN				
INTANGIBLES				517,500
TRANSPORTE AEREO	100,000	1	100,000	
FLUIDOS DE COMPLETACIÓN	80,000	1	80,000	
CASED HOLE LOG CSG GUN	30,000	1	30,000	
WELL SERVICE RIG	100,000	1	100,000	
HERRAMIENTAS DE SUB. Y SUPERF.	50,000	1	50,000	
MEDICIONES FISICAS Y ANÁLISIS	17,500	1	17,500	
TRANSPORTE E INSPECCIÓN	80,000	1	80,000	
OTROS GASTOS INTANGIBLES	10,000	1	10,000	
TANGIBLES				
TUBERÍA DE PRODUCCIÓN	50,000	1	50,000	
RESERVORIOS Y GEOLOGÍA				604,000
ANÁLISIS PVT	300,000	1	300,000	
TOMA DE NUCLEOS	2,000,000	0	0	
ANÁLISIS FISICOS Y REOLOG DE FLUIDOS	1,000	4	4,000	
PLT Y PRUEBAS DE PRESIÓN	200,000	1	200,000	
REGISTROS ESPECIALES	100,000	1	100,000	
GASTOS GENERALES E IMPREVISTOS				
ADMINISTRACION (LIMA - CAMPO) /MES				1,000,000
			Total pozo exp.	-
			Total	9.98
			Total/pozo	9.98

9.1.4.2.2. Cost summary (Drilling, completion and logs)

Tabla 221: Cost summary of wells

Well type	Quantity	Unit cost Tangible USD	Unit cost Intangible USD	Unit cost MMUSD	Total, MMUSD
Exploration	1	23.309	0.77621	22.533	23.31
Appraisal/ developmental	2	10.009	0.31121	9.697	20.02
Comingled Development	5	10.412	0.31121	10.101	52.06
Horizontal Development	7	34.698	0.31621	34.310	243.38
Vertical Development	1	10.166	0.31121	9.854	10.17
Dry Development	2	10.48	0.13161	10.352	20.97
CutOff Development	1	9.978	0.31121	9.667	9.98
Injector	6	8.796	0.31121	8.484	52.77
	25				432.65

9.1.4.2.3. Electric System.

Tabla 222 Thermoelectric Plant

Component	Unitary Cost (KUSD)	Quantity	Cost (MMUSD)
Thermoelectric Plant	15000	4	60
TOTAL COST			**60**

9.1.4.3. Electrosubmersible pumps cost

Tabla 223: Electro submersible pumps cost

1 / SJN-X01: C											
	Quantity					Cost, USD					TOTAL, MUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	1	1	1	1	1	25000	25000	25000	25000	25000	
Motor	1	1	1	1	1	20000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal (MMUSD)						563000	99000	99000	99000	99000	**1256**

2 / SJN-C02: C											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	2	2	2	2	2	50000	50000	50000	50000	50000	
Motor	1	1	1	1	1	20000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						588000	124000	124000	124000	124000	**1381**

3 / SJN-C03: C											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	2	2	2	2	2	50000	50000	50000	50000	50000	
Motor	1	1	1	1	1	20000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						588000	124000	124000	124000	124000	**1381**

4 / SJN-H04: V											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	4	3	3	3	3	100000	75000	75000	75000	75000	
Motor	2	2	2	2	2	40000	40000	40000	40000	40000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						658000	169000	169000	169000	169000	**1631**

5 / SJN-H05: V											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	3	2	2	2	2	75000	50000	50000	50000	50000	
Motor	2	1	1	1	1	40000	20000	20000	20000	20000	

Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						633000	124000	124000	124000	124000	**1426**

6 / SJN-H06: V											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	2	2	2	2	2	50000	50000	50000	50000	50000	
Motor	1	1	1	1	1	20000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						588000	124000	124000	124000	124000	**1381**

7 / SJN-H07: V											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	4	3	3	3	3	100000	75000	75000	75000	75000	
Motor	2	2	2	2	2	40000	40000	40000	40000	40000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						658000	169000	169000	169000	169000	**1631**

8 / SJN-G08:											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	2	2	2	1	1	50000	50000	50000	25000	25000	
Motor	1	1	1	1	1	20000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						588000	124000	124000	99000	99000	**1331**

9 / SJN-G09:											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	3	1	2	2	2	75000	25000	50000	50000	50000	
Motor	1	1	1	1	1	20000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						613000	99000	124000	124000	124000	**1381**

10 / SJN-H10: V											
	Quantity					Cost, USD					TOTAL, KUSD

Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	4	3	3	3	3	100000	75000	75000	75000	75000	
Motor	3	2	2	2	2	60000	40000	40000	40000	40000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						678000	169000	169000	169000	169000	**1651**

11 / SJN-H11: V											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	3	2	2	2	2	75000	50000	50000	50000	50000	
Motor	2	1	1	1	1	40000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						633000	124000	124000	124000	124000	**1426**

12 / SJN-H12: V											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	4	2	2	2	2	100000	50000	50000	50000	50000	
Motor	2	1	1	1	1	40000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						658000	124000	124000	124000	124000	**1451**

13 / SJN-G13:											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	1	1	1	1	1	25000	25000	25000	25000	25000	
Motor	1	1	1	1	1	20000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						563000	99000	99000	99000	99000	**1256**

14 / SJN-G14:											
	Quantity					Costo, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	4	3	3	3	3	100000	75000	75000	75000	75000	
Motor	3	2	2	2	2	60000	40000	40000	40000	40000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						678000	169000	169000	169000	169000	**1651**

15 / SJN-G15:											
	Quantity					Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	3	2	2	2	2	75000	50000	50000	50000	50000	
Motor	2	1	1	1	1	40000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						633000	124000	124000	124000	124000	**1426**

16 / SJN-V16: C											
						Cost, USD					TOTAL, KUSD
Item	1°	2°	3°	4°	5°	1°	2°	3°	4°	5°	
Pump	4	2	2	2	2	100000	50000	50000	50000	50000	
Motor	2	1	1	1	1	40000	20000	20000	20000	20000	
Seal	1	1	1	1	1	4000	4000	4000	4000	4000	
Cable	1	1	1	1	1	50000	50000	50000	50000	50000	
VSD	1					35000					
Transformer Reducer	1					12000					
Transformer Elevator	1					12000					
4 1/2" production tubing	9000					405000					
Subtotal						658000	124000	124000	124000	124000	**1451**

	1° (2027)	2°	3°	4°	5°	
Subtotal (MMUSD)	9.978	2.089	2.114	2.089	2.089	**23.11**

9.1.4.4. Pipe and Surface facilities cost

Tabla 224: Flow lines cost to Andoas

Type of pipe	LINE	COST (USD/m*pulg)	COST (USD/M)	M	COST (USD)
Field Lines	10"	10	100	22067	2.2067
Pipeline Lines	16"	10	160	115040	18.4064
					20.6

Tabla 225: Battery 1

Batery 1						
		Capacity (Mbbl)	Quantity	Total Capacity	Unit Cost (MUSD)	Total Cost (MMUSD)
Three-phase separator			3	105	700	2.100
Scrubber			3	-	70	0.210
Gas meter		-	2	-	5	0.010
Compressor			1	-	1000	1.000
Test tank		15	1	15	750	0.750
Totals tank			4	100	1100	4.400
OIL TREATMENT	Oil treatment	10	1	10	500	0.500
	Oil storage	25	1	25	1100	1.100
	LACT Unit		0	-	200	0.000
WATER TREATMENT	Water Treatment	25	3	75	1000	3.000
	Flotation units	25.1	1	25.1	1000	1.000
	Water storage	26.2	5	131	750	3.750
	Pumps		1	0	30	0.030
					TOTAL	17.850

Tabla 226 Battery 2

		Capacidad (Mbbl)	Cantidad	Capacidad total	Costo Unitario(MUSD)	Costo total(MMUSD)
Separador Trifasico		35	4	140	700	2.800
Scrubber		-	1	-	70	0.070
Medidor de gas		-			5	0.000
Compresor		-	1	-	1000	1.000
Tanque de prueba		15	1	15	750	0.750
Tanque de totales		25	3	75	1100	3.300
TRATAMIENTO DE OIL	Tratamiento de oil	10	2	20	500	1.000
	Almacenamiento de oil	20	1	20	1100	1.100
	Unidad LACT		1	0	200	0.200
TRATAMIETNO DE AGUA	Tratamiento de agua	25	4	100	1000	4.000
	Unidades de flotacion	25.1	1	25.1	1000	1.000
	Almacenamiento de agua	26.2	6	157.2	750	4.500
	Bombas		1	0	30	0.030
					TOTAL	19.750

9.1.4.5. Decommissioning

Tabla 227: Cementation Cost - Abandonment

Cementing cost		
	Cost/ well (MMUSD)	Total cost (MMUSD)
Type of abandonment	**Permanent**	
Lower cement plug	**0.8**	**16.8**
Upper cement plug	**1.5**	**31.5**
Transport	**0.2**	**4.2**
	Total	**52.5**

Tabla 228: Restoration Cost

Restoration Cost		
	Cost/ well (MUSD)	Total cost (MMUSD)
Cost of the camp	**50**	**1.05**
Staff	**40**	**0.84**
Machinery	**35**	**0.735**
Site remediation	**100**	**2.1**
Water treatment	**-**	**1.5**
Indirect charges	**15**	**0.315**
Transport	**50**	**1.05**
	Total	**7.59**

In the table 229 a summary of CAPEX is presented and for the Light Oil Case

Tabla 229 CAPEX Summary. Light Oil Case.

	Exploration	Exploratory wells	Appraisal wells	Development wells	Disposal and cuttoff wells	Surface facilities	Pumps	Thermoelectric Plant	Light crude Pipeline	Vehicles	Others	decommissionin g wells	
Year	**Sub total**	**Sub total**	**Sub total**	**Sub total**	**Sub total**	**Sub total**	**Sub total**	**Sub total**	**Sub total**	**Sub total**	**Sub total**	**Sub total**	**Total**
	MMUS$	**MMUS$**	**MMUS$**	**MMUS$**	**MMUS$**	**MMUS$**	**MMUS$**	**MMUS$**	**MMUS$**	**MMUS$**	**MMUS$**	**MMUS$**	**MMUS$**
2022-2025	***31.0***	**23.3**	**20.0**		**10.0**			***60.0***	***23.7***	***0.6***	***8.5***		**177.09**
2026				**149.6**	**17.6**	**38.46**							**205.61**
2027				**135.6**	**17.6**	**19.75**	**10.0**						**182.93**
2028				**41.4**	**17.6**								**58.99**
2029													**0.00**
2030							**2.1**						**2.09**
2033							**2.1**						**2.11**
2036							**2.1**			**0.3**			**2.39**
2039							**2.1**						**2.09**
2042							**1.6**						**1.58**
2045							**1.6**						**1.58**
2046										**0.3**			**0.30**
2049							**1.6**						**1.58**
2051												***60.1***	**60.09**
	30.975	**23.3**	**20.0**	**326.58**	**52.77**	**58.2**	**23.1**	**60.0**	**23.7**	**1.2**	**8.5**	**60.1**	**698.45**

In the table 230 a summary of CAPEX is presented

Tabla 230 CAPEX Summary. Naphtha Case

	Exploration	Exploration wells	Appraisal wells	Development wells	Disposal wells	Production Facilities	Pumps	Thermoelectric Plant	Storage and barges	Others	vehicles	decommissioning wells	
Year	Sub total	Sub total	Sub total	Sub total	Sub total	Sub total	Sub total	Sub total	Sub total	Sub total	Sub total	Sub total	Total
	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$		MMUS$	MMUS$	MMUS$
2022-2025	*30.98*	23.309	20.02		9.978			*60.00*	*43.02*	*8.50*	*0.60*		186.7
2026				149.6	17.591	38.4631							205.6
2027				135.6	17.591	19.75	10.0						182.9
2028				41.4	17.591								59.0
2029													9.7
2030							2.1						2.1
2033							2.1						2.1
2036							2.1				0.3		2.4
2039							2.1						2.1
2042							1.6						1.6
2045							1.6						1.6
2046											0.3		0.3
2049							1.6						1.6
2051												*60.09*	60.1
	30.98	23.31	20.01703134	326.58	52.77	58.21	23.1	60.00	43.02	8.50	1.20	60.09	717.8

9.1.5. OPEX

The highest operating expenses of the project will be: reinjection of water, buying naphtha and transportation of crude oil.

9.1.5.1. NorPeruano Pipeline Transportation cost

Production (Mbpd)	18	20.45	72.25	94.05
Transport fee($/bl)	7.41	7.41	2.58	2.58

Figura 245: Graph of Production rate vs Pipeline fare

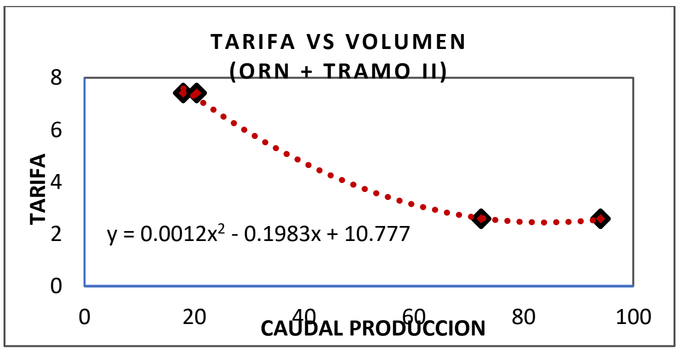


Tabla 231: Transportation expenses in pipeline

- Light Oil

Year	Production	Production	Fees	Transp. C.
	Mbls	*MBD*	*$/bl*	*MMUS$*
1	2,856.3	7.8	7.41	21.2
2	14,279.8	39.1	4.86	69.3
3	19,553.8	53.6	3.60	70.3
4	15,771.9	43.2	4.45	70.2
5	12,600.7	34.5	5.36	67.6
6	10,621.9	29.1	6.02	64.0
7	9,151.5	25.1	6.56	60.0
8	8,057.5	22.1	6.98	56.3
9	7,190.4	19.7	7.41	53.3
10	6,508.5	17.8	7.41	48.2
11	5,898.7	16.2	7.41	43.7
12	5,412.6	14.8	7.41	40.1
13	4,987.8	13.7	7.41	37.0
14	4,629.1	12.7	7.41	34.3
15	4,292.1	11.8	7.41	31.8
16	3,957.1	10.8	7.41	29.3

17	3,644.4	10.0	7.41	27.0
18	3,349.2	9.2	7.41	24.8
19	3,088.2	8.5	7.41	22.9
20	2,940.1	8.1	7.41	21.8
21	2,783.9	7.6	7.41	20.6
22	2,622.1	7.2	7.41	19.4
23	2,473.9	6.8	7.41	18.3
24	2,318.4	6.4	7.41	17.2
25	2,155.7	5.9	7.41	16.0
26	1,543.6	4.2	7.41	11.4
TOTAL	162,689.1		6.87	996.0

- Naphtha

Year	Production	Producción	Fee	Transp. C.
	Mbls	*MBD*	*$/bl*	*MMUS$*
1	2,725.6	7.5	7.41	20.2
2	12,694.6	34.8	5.33	67.7
3	17,616.7	48.3	4.00	70.5
4	14,685.2	40.2	4.74	69.6
5	11,388.6	31.2	5.76	65.6
6	9,452.6	25.9	6.45	60.9
7	8,058.2	22.1	6.98	56.3
8	7,040.3	19.3	7.41	52.2
9	6,254.4	17.1	7.41	46.3
10	5,645.3	15.5	7.41	41.8
11	5,107.9	14.0	7.41	37.8
12	4,668.1	12.8	7.41	34.6
13	4,288.4	11.7	7.41	31.8
14	3,965.7	10.9	7.41	29.4
15	3,664.3	10.0	7.41	27.2
16	3,385.3	9.3	7.41	25.1
17	3,112.5	8.5	7.41	23.1
18	2,865.3	7.9	7.41	21.2
19	2,650.8	7.3	7.41	19.6
20	2,511.5	6.9	7.41	18.6
21	2,370.5	6.5	7.41	17.6
22	2,235.8	6.1	7.41	16.6
23	2,103.5	5.8	7.41	15.6
24	1,976.0	5.4	7.41	14.6
25	1,850.6	5.1	7.41	13.7
26	1,321.0	3.6	7.41	9.8
TOTAL	143,638.8		6.98	907.4

- LIGTH OIL CASE

Tabla 232 OPEX SUMMARY LIGHT OIL CASE

				Fixed/ Semi-fixed										Variables			
	YEAR	oil production, bbls	Water production, bbl	Salaries/ Social Benefits	Water injection	ligth crude cost	MPR cost	Transport cost	logistic	Enviromental /Social	Software	Office cost	other costs	Pulling	Maintenance equipment	Training	**Total**
				MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	**MMUSD**
2022-2025	0																
2026	**1**	2,856,257	1,038,883	3.0	0.6	8.0	0.00	10.0	1.0	0.5	0.3	1.0	1.0	5.0	1.0	1.0	**32.4**
2027	**2**	14,279,833	2,642,746	3.0	1.6	96.7	0.00	50.0	1.0	0.5	0.3	1.0	1.0				**155.1**
2028	**3**	19,553,765	7,235,290	3.0	4.3	118.2	0.00	68.4	1.0	0.5	0.3	1.0	1.0				**197.7**
2029	**4**	15,771,873	14,108,617	3.0	8.5	66.3	0.05	55.2	1.0	0.5	0.3	1.0	1.0				**136.8**
2030	**5**	12,600,683	24,895,574	3.0	14.9	73.9	0.05	44.1	1.0	0.5	0.3	1.0	1.0				**139.8**
2031	**6**	10,621,949	39,720,880	3.0	23.8	71.3	0.00	37.2	1.0	0.5	0.3	1.0	1.0	5.0	1.0		**145.1**
2032	**7**	9,151,482	43,269,299	3.0	26.0	66.7	0.05	32.0	1.0	0.5	0.3	1.0	1.0				**131.5**
2033	**8**	8,057,490	46,995,881	3.0	28.2	62.0	0.05	28.2	1.0	0.5	0.3	1.0	1.0			1.0	**126.3**
2034	**9**	7,190,363	51,306,019	3.0	30.8	57.1	0.05	25.2	1.0	0.5	0.3	1.0	1.0				**119.9**
2035	**10**	6,508,477	54,026,488	2.0	32.4	52.7	0.09	22.8	1.0	0.5	0.3	1.0	1.0				**113.7**
2036	**11**	5,898,685	53,886,182	2.0	32.3	48.2	0.00	20.6	1.0	0.5	0.3	1.0	1.0	5.0	1.0		**113.0**
2037	**12**	5,412,586	54,945,161	2.0	33.0	45.4	0.00	18.9	1.0	0.5	0.3	1.0	1.0				**103.1**
2038	**13**	4,987,757	57,013,853	2.0	34.2	42.7	0.05	17.5	1.0	0.5	0.3	1.0	1.0				**100.2**
2039	**14**	4,629,129	59,630,261	2.0	35.8	40.5	0.00	16.2	1.0	0.5	0.3	1.0	1.0				**98.2**
2040	**15**	4,292,139	61,544,352	2.0	36.9	38.3	0.00	15.0	1.0	0.5	0.3	1.0	1.0				**96.0**
2041	**16**	3,957,133	63,795,776	2.0	38.3	34.9	0.00	13.8	1.0	0.5	0.3	1.0	1.0	5.0	1.0		**98.8**
2042	**17**	3,644,378	66,516,059	2.0	39.9	32.4	0.05	12.8	1.0	0.5	0.3	1.0	1.0				**91.0**
2043	**18**	3,349,185	69,413,778	2.0	41.6	29.5	0.00	11.7	1.0	0.5	0.3	1.0	1.0			1.0	**89.7**
2044	**19**	3,088,227	70,423,727	2.0	42.3	26.7	0.00	10.8	1.0	0.5	0.3	1.0	1.0				**85.5**
2045	**20**	2,940,058	70,024,759	2.0	42.0	26.1	0.00	10.3	1.0	0.5	0.3	1.0	1.0				**84.2**
2046	**21**	2,783,891	69,579,691	2.0	41.7	25.2	0.05	9.7	1.0	0.5	0.3	1.0	1.0	5.0	1.0		**88.6**
2047	**22**	2,622,140	69,147,969	2.0	41.5	23.6	0.00	9.2	1.0	0.5	0.3	1.0	1.0				**80.0**
2048	**23**	2,473,893	68,537,168	3.0	41.1	22.6	0.00	8.7	1.0	0.5	0.3	1.0	1.0				**79.2**
2049	**24**	2,318,406	68,151,457	3.0	40.9	20.9	0.00	8.1	1.0	0.5	0.3	1.0	1.0				**76.7**
2050	**25**	2,155,670	68,211,595	3.0	40.9	18.6	0.05	7.5	1.0	0.5	0.3	1.0	1.0				**73.9**
2051	**26**	1,543,620	52,065,608	3.0	31.2	13.6	0.00	5.4	1.0	0.5	0.3	1.0	1.0				**57.0**
TOTAL		**162689071.5**	**1308127075**	**65.00**	**784.88**	**1162.07**	**0.50**	**569.41**	**26.00**	**13.00**	**7.80**	**26.00**	**26.00**	**25.00**	**5.00**	**3.00**	**2713.7**

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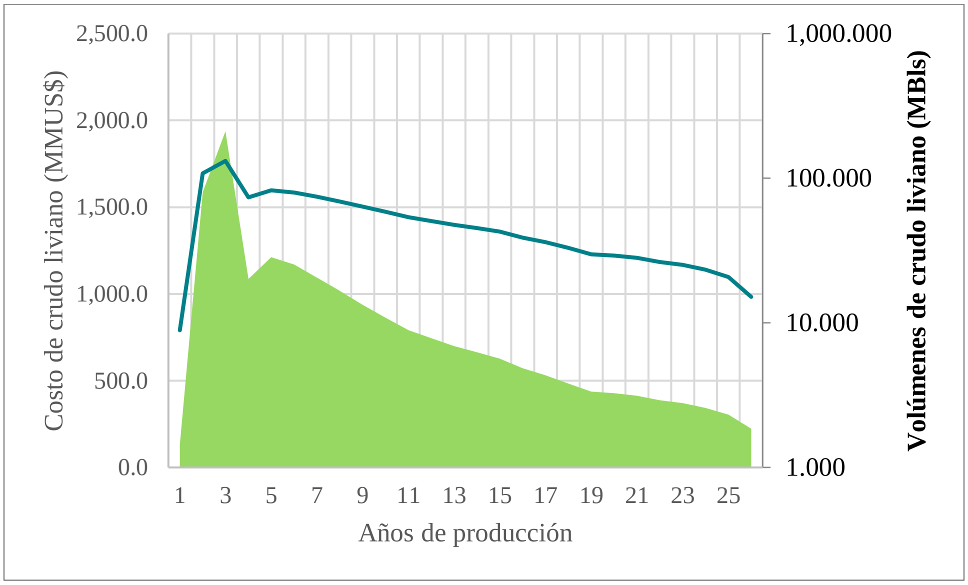
Figura 246: Graph of Cost Oil vs Time production



Se observa en el gráfico el costo del crudo liviano durante la etapa productiva y los costos de inversión.

Tabla 233: Costo de Flow line

Pipeline type	Line	COST (USD/m*in)	COST (USD/m)	Length(mt)	COST (MMUSD)
Block 64 – San Jacinto	10"	**10.0**	**100.0**	**207072**	20.70

Tabla 234: Light Oil Storage

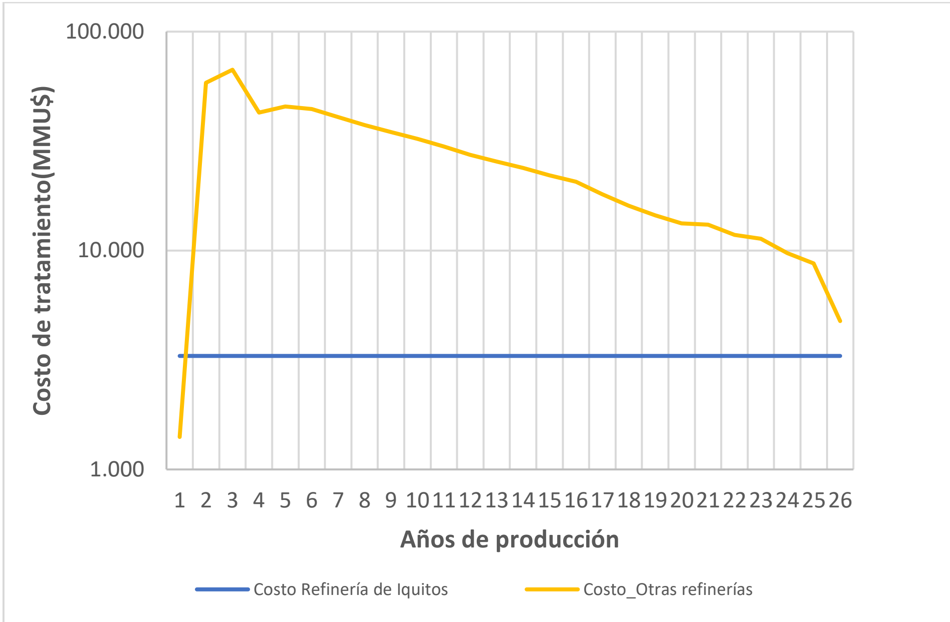
Batery					
	Capacity (Mbbl)	Qty	Total Capacity total	Unit Cost (MUSD)	Total Cost (MMUSD)
Oil Storage	25	3	75	1000	3.000

- Naphtha CASE

Tabla 235 OPEX SUMMARY. NAPHTHA CASE

				Fijos/ semifijo										Variables			Total
		Producción de crudo bls	Producción de Agua bls	Salaries/Security and Benefits	Water injection	Napht cost	MPR cost	Transport cost	logistic	Enviromental/Social	software	Office cost	other costs	Pulling	Maintenance in equipment	Training	
				MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	MMUSD	**MMUSD**
2022-2025	0																
2026	**1**	2,725,640	1,038,883	3.00	0.62	4.71	0.00	5.45	1.00	0.50	0.30	1.00	1.00	5.00	1.00	1.00	**24.58**
2027	**2**	12,694,594	2,642,746	3.00	1.59	61.73	0.00	25.39	1.00	0.50	0.30	1.00	1.00				**95.50**
2028	**3**	17,616,740	7,235,290	3.00	4.34	70.27	0.00	35.23	1.00	0.50	0.30	1.00	1.00				**116.64**
2029	**4**	14,685,225	14,108,617	3.00	8.47	46.01	0.05	29.37	1.00	0.50	0.30	1.00	1.00				**90.69**
2030	**5**	11,388,553	24,895,574	3.00	14.94	48.85	0.05	22.78	1.00	0.50	0.30	1.00	1.00				**93.41**
2031	**6**	9,452,625	39,720,880	3.00	23.83	47.55	0.00	18.91	1.00	0.50	0.30	1.00	1.00	5.00	1.00		**103.09**
2032	**7**	8,058,178	43,269,299	3.00	25.96	44.08	0.05	16.12	1.00	0.50	0.30	1.00	1.00				**93.00**
2033	**8**	7,040,326	46,995,881	3.00	28.20	40.75	0.05	14.08	1.00	0.50	0.30	1.00	1.00			1.00	**90.87**
2034	**9**	6,254,372	51,306,019	3.00	30.78	38.11	0.05	12.51	1.00	0.50	0.30	1.00	1.00				**88.25**
2035	**10**	5,645,280	54,026,488	2.00	32.42	35.67	0.09	11.29	1.00	0.50	0.30	1.00	1.00				**85.27**
2036	**11**	5,107,933	53,886,182	2.00	32.33	33.17	0.00	10.22	1.00	0.50	0.30	1.00	1.00	5.00	1.00		**87.52**
2037	**12**	4,668,099	54,945,161	2.00	32.97	30.66	0.00	9.34	1.00	0.50	0.30	1.00	1.00				**78.77**
2038	**13**	4,288,440	57,013,853	2.00	34.21	28.82	0.05	8.58	1.00	0.50	0.30	1.00	1.00				**77.46**
2039	**14**	3,965,711	59,630,261	2.00	35.78	27.13	0.00	7.93	1.00	0.50	0.30	1.00	1.00				**76.64**
2040	**15**	3,664,294	61,544,352	2.00	36.93	25.35	0.00	7.33	1.00	0.50	0.30	1.00	1.00				**75.41**
2041	**16**	3,385,285	63,795,776	2.00	38.28	23.90	0.00	6.77	1.00	0.50	0.30	1.00	1.00	5.00	1.00		**80.75**
2042	**17**	3,112,451	66,516,059	2.00	39.91	21.39	0.05	6.22	1.00	0.50	0.30	1.00	1.00				**73.37**
2043	**18**	2,865,341	69,413,778	2.00	41.65	19.30	0.00	5.73	1.00	0.50	0.30	1.00	1.00			1.00	**73.48**
2044	**19**	2,650,801	70,423,727	2.00	42.25	17.77	0.00	5.30	1.00	0.50	0.30	1.00	1.00				**71.12**
2045	**20**	2,511,462	70,024,759	2.00	42.01	16.62	0.00	5.02	1.00	0.50	0.30	1.00	1.00				**69.46**
2046	**21**	2,370,481	69,579,691	2.00	41.75	16.43	0.05	4.74	1.00	0.50	0.30	1.00	1.00	5.00	1.00		**74.77**
2047	**22**	2,235,783	69,147,969	2.00	41.49	15.09	0.00	4.47	1.00	0.50	0.30	1.00	1.00				**66.85**
2048	**23**	2,103,546	68,537,168	3.00	41.12	14.63	0.00	4.21	1.00	0.50	0.30	1.00	1.00				**66.76**
2049	**24**	1,975,981	68,151,457	3.00	40.89	13.02	0.00	3.95	1.00	0.50	0.30	1.00	1.00				**64.67**
2050	**25**	1,850,648	68,211,595	3.00	40.93	12.02	0.05	3.70	1.00	0.50	0.30	1.00	1.00				**63.49**
2051	**26**	1,321,014	52,065,608	3.00	31.24	8.06	0.00	2.64	1.00	0.50	0.30	1.00	1.00				**48.75**
TOTAL		**143,638,801**	**1,308,127,075**	**65.00**	**784.88**	**761.10**	**0.50**	**287.28**	**26.00**	**13.00**	**7.80**	**26.00**	**26.00**	**25.00**	**5.00**	**3.00**	**2030.55**

Figura 247: Graph of Cost vs Time production



En el gráfico se observa los costos de tratamiento utilizando la nafta según la refenienría de donde se adquirirá, esto corresponde a la propuesta anteriormente explicada.

Tabla 236: NAPHTHA PRICE

		Iquitos Refinery	Other refineries
Naphtha Price	$/bl	65	80

Tabla 237: Storage and Barges Investment (NAPHTHA)

Storage Capacity	Quantity	Barges	Investment
20000 bls	5	11	43.02 MMU$

9.1.6. Royalty estimations

Based on Supreme Decree No. 017-2003-EM, there are two methodologies to determine royalties. First one is the R Factor that depends on income and expenses; and the other one depends on our production. We will use the second methodology:

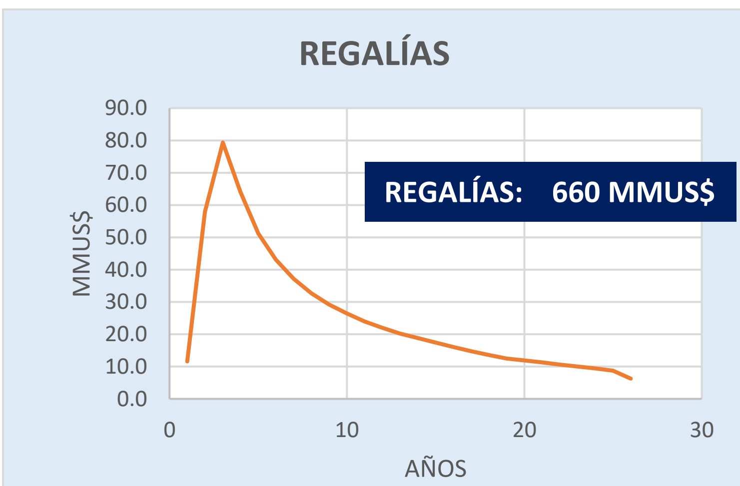
Tabla 238: Criteria for establishing royalty. Source: Minem, Decreto Supremo N°17-2003-EM

MBD	% Royalty
0-5	5
5-100	5-20
>100	20

Using the table, we will determine the royalty percentage for each year of production:

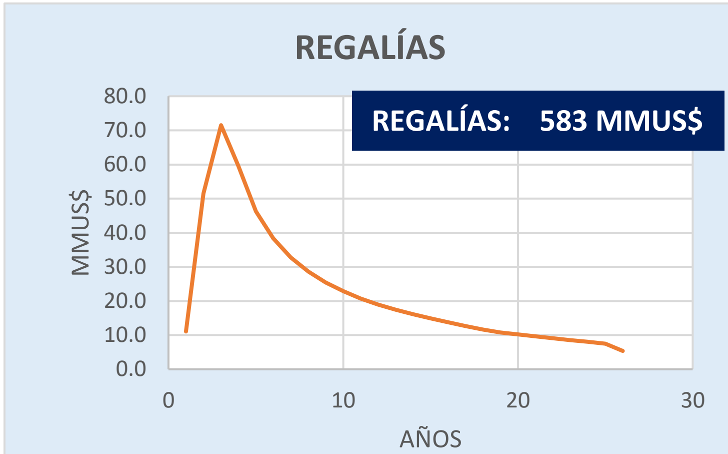
- Light Oil

Figura 248: Royalty estimation



- Naphtha

Figura 249: Royalty estimation

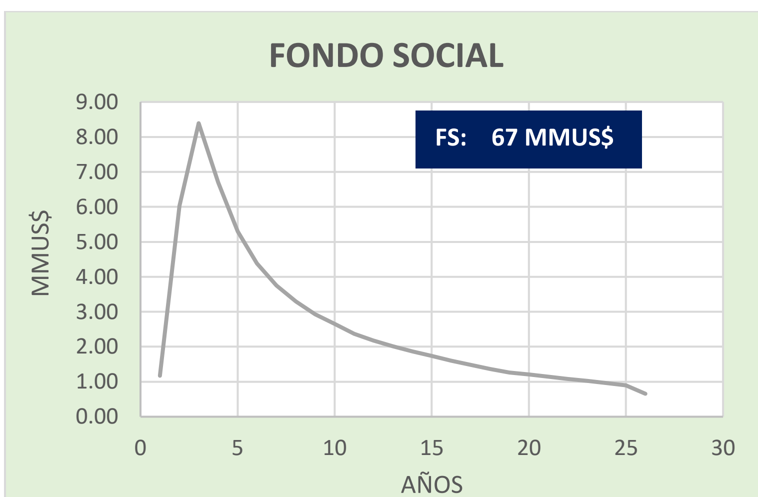


As an initiative of the Ministry of Culture, the creation of a fund was proposed by 0.75% of value of the total production, as a direct benefit for the native communities of Loreto. (Source: Peruvian News Agency).

Therefore, we have the following graph:

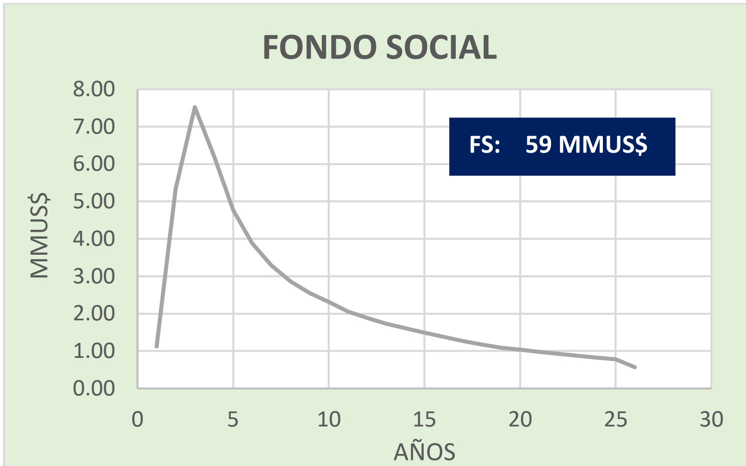
- Light Oil

Figura 250: Social fund's contribution



- Naphtha

Figura 251: Social fund's contribution



9.1.7. Discount rate estimation

<u>Discount rate:</u>

It is that rate at which an investor risks his capital, it should be noted that, higher risk generates higher profit or loss.

It is recommended to use an appropriate discount rate for each type of business, for this project we will use the economic model CAPM (Capital Asset Pricing Model) and plus for Country Risk factor.

We must take into consideration the following definitions:

Cost of equity: Economic return.

Cost of capital: Economic return plus debt.

Risk Free Rate: There is no bankruptcy risk.

<u>Capital Asset Pricing Model (CAPM)</u>

Due to the history of the market and the risk that investors take, this model is consolidated.

Following an empirical formula, the equation of the return rate is based on:

$$Re = Rf + B(Rs - Rf)$$

Re: Return rate

Rf: Risk free rate

Rs: Market rate

Rs-Rf: Market premium

B: Correlation market factor.

For this project we rely on the data from the website of the teacher Aswath Damodaran de NYU Stern School of Business:

Rf= 3 %

B= 1.18

Rs= 6.52 %

Applying the formula:

$$Re = 3\% + 1.18x(6.02\% - 3\%)$$

$$Re = 6.56\%$$

Now when applying the formula, you still have to add an additional Risk because this formula is based on the returns of companies listed on the New York Stock Exchange.

It remains to be seen if the business presents a greater risk due to the country where the investment will be development. Therefore, a very important factor called Country Risk has to be added to the discount rate (it is based on political, economic factors, etc.).

In the same way, the data is taken from the website of Professor Aswath Damodaran, which Peru presents a Risk of 1.16%.

$$Td = 6.5636\% + 1.16\%$$

$$Td = 7.7236\%$$

Due to the risk that will come up in the different stages of the oil project, a discount rate of 15% will be considered.

9.1.8. Depreciation, amortization of intangibles and income tax

Knowing the wear and tear suffered by an asset as it is used, depreciation and amortization will be taken into consideration as appropriate to the nature of the asset.

The only difference between these is that depreciation corresponds to tangible assets and amortization to intangible assets. (*Fuente: Reglamento de la Ley de impuesto a la Renta.*)

The following table shows the depreciation of tangibles and the amortization of intangibles:

Tabla 239: Depreciation and amortization

Light Oil		Naphtha	
Depreciation	**Amortization**	**Depreciation**	**Amortization**
TANGIBLES	**INTANGIBLES**	**TANGIBLES**	**INTANGIBLES**
MMUS$	*MMUS$*	*MMUS$*	*MMUS$*
174.15	524.3	193.47	524.3

In the case of income tax, it is divided into different categories:

Tabla 240: Income tax

First category	6.25% (rent, transfers)
Second category	6.25% (bonuses, dividends)
Third category	30% Income generated by the company
Fourth category	15% Income from self-employed workers
Fifth category	Between 15 and 30%, dependent workers

The income tax that corresponds to our company (Kyspetrol) is the third category with a value of 30%.

Figura 252: Income tax evolution

Fuente: SUNAT

9.2. Cash Flow

In the cash flow we find the following terms:

- **Discount rate:** Interest rate that will be discounted to the continuous flow.
- **Depreciation:** For the project we carry out a linear depreciation (tangibles).
- **Amortization:** For the project we carry out a linear depreciation (intangibles).
- **Production:** Daily production.

- **Net production:** Production audited per year (factor of 0.95)
- **Basket price:** Base price will be taken for the contract.
- **Revenue:** Earnings in millions of dollars.
- **Transportation cost**
- **Royalties**
- **Social fund**: 0.75 % of incomes.
- **Opex (US$/barrel):** cost of water, naphtha, pipeline, logistics, environment, office, etc.

- Linear depreciation of tangible investment.
- **Profit before tax:** Gross profit.
- **Income tax:** Value of 30 %.
- **Labor participation:** 5 % of gross profit.
- **Profit after tax:** Net profit

.

Tabla 241 Economic Evaluation Light Oil Case

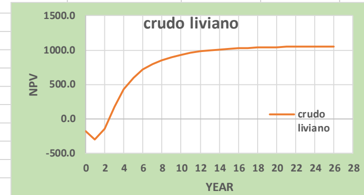
SAN JACINTO NORTE FIELD - 30 YEARS CONTRACT

VARIABLES		
Brent Price	$/bl	65
Basket Differential	%	8%
Transport	$/bl	6.9
Royalty	%	0.07
OPEX	MM$/año	16.7
Audict factor		0.95
Tax	%	30.0%
Labor Participation	%	5%
Social Fund	%	0.75%

Development wells	N°	15
Exploratory well	N°	1
Confirmatory well	N°	2
cutt¡off wells	N°	1
Disposal well	N°	6

RESULTS MM US$	
Revenue	9,728.8
Transport	996.0
Royalty	660.4
Social fund	67.4
OPEX	2,713.7
Depreciation &	698.4
Income tax	1,329.0
Labor Participation	233.2
Income after tax	3,030.7
CAPEX	698.4
Goverment take	2,056.8

	INDICATORS	
15%	NPV.MM US$	1050
	IRR	72%
	ROI	1.50
	PAY OUT, YEARS	3



Year	Production		oil Basket Price	Revenue	Royalty	Social fund	Transport	OPEX	Depreciation & Amortization	Income before tax	Labor Participation	Income tax	Income after tax	CAPEX	Cash flow	Net Cash Flow	Cumulative Net Cash Flow
	MBD	MBls	$/bl	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$	MMUS$
0	-	-	-	-	-	-	-	0.00						177.1	-177.1	-177.1	-177.1
1	7.8	2856	59.8	170.8	11.6	1.17	21.2	32.39	6.8	97.7	4.9	27.8	65.0	205.6	-133.8	-116.4	-293.5
2	39.1	14280	59.8	853.9	58.0	6.03	69.3	155.06	15.0	550.5	27.5	156.9	366.1	182.9	198.2	149.9	-143.6
3	53.6	19554	59.8	1169.3	79.4	8.39	70.3	197.74	22.7	790.8	39.5	225.4	525.9	59.0	489.6	321.9	178.3
4	43.2	15772	59.8	943.2	64.0	6.70	70.2	136.80	25.2	640.3	32.0	182.5	425.8	0.0	451.0	257.9	436.1
5	34.5	12601	59.8	753.5	51.1	5.29	67.6	139.83	25.2	464.5	23.2	132.4	308.9	2.1	332.0	165.1	601.2
6	29.1	10622	59.8	635.2	43.1	4.38	64.0	145.14	25.3	353.3	17.7	100.7	234.9	0.0	260.2	112.5	713.7
7	25.1	9151	59.8	547.3	37.1	3.75	60.0	131.53	25.3	289.5	14.5	82.5	192.5	0.0	217.8	81.9	795.6
8	22.1	8057	59.8	481.8	32.7	3.29	56.3	126.29	25.3	238.0	11.9	67.8	158.2	2.1	181.4	59.3	854.9
9	19.7	7190	59.8	430.0	29.2	2.93	53.3	119.89	25.4	199.3	10.0	56.8	132.5	0.0	157.9	44.9	899.8
10	17.8	6508	59.8	389.2	26.4	2.66	48.2	113.74	25.4	172.7	8.6	49.2	114.9	0.0	140.3	34.7	934.5
11	16.2	5899	59.8	352.7	23.9	2.37	43.7	113.01	25.4	144.3	7.2	41.1	95.9	2.4	119.0	25.6	960.1
12	14.8	5413	59.8	323.7	22.0	2.18	40.1	103.12	25.6	130.7	6.5	37.2	86.9	0.0	112.5	21.0	981.1
13	13.7	4988	59.8	298.3	20.2	2.01	37.0	100.17	25.6	113.3	5.7	32.3	75.3	0.0	100.9	16.4	997.5
14	12.7	4629	59.8	276.8	18.8	1.87	34.3	98.25	25.6	98.0	4.9	27.9	65.2	2.1	88.7	12.5	1010.0
15	11.8	4292	59.8	256.7	17.4	1.74	31.8	96.05	25.8	83.9	4.2	23.9	55.8	0.0	81.6	10.0	1020.0
16	10.8	3957	59.8	236.6	16.1	1.60	29.3	98.81	25.8	65.1	3.3	18.5	43.3	0.0	69.0	7.4	1027.4
17	10.0	3644	59.8	217.9	14.8	1.48	27.0	90.96	25.8	57.9	2.9	16.5	38.5	1.6	62.7	5.8	1033.2
18	9.2	3349	59.8	200.3	13.6	1.37	24.8	89.68	25.9	44.9	2.2	12.8	29.8	0.0	55.8	4.5	1037.8
19	8.5	3088	59.8	184.7	12.5	1.26	22.9	85.55	25.9	36.5	1.8	10.4	24.3	0.0	50.2	3.5	1041.3
20	8.1	2940	59.8	175.8	11.9	1.21	21.8	84.25	25.9	30.7	1.5	8.7	20.4	1.6	44.8	2.7	1044.0
21	7.6	2784	59.8	166.5	11.3	1.14	20.6	88.55	26.2	18.6	0.9	5.3	12.4	0.3	38.3	2.0	1046.1
22	7.2	2622	59.8	156.8	10.6	1.08	19.4	80.03	26.3	19.3	1.0	5.5	12.9	0.0	39.1	1.8	1047.9
23	6.8	2474	59.8	147.9	10.0	1.02	18.3	79.17	26.3	13.1	0.7	3.7	8.7	0.0	35.0	1.4	1049.3
24	6.4	2318	59.8	138.6	9.4	0.96	17.2	76.69	26.3	8.1	0.4	2.3	5.4	1.6	30.1	1.1	1050.3
25	5.9	2156	59.8	128.9	8.8	0.90	16.0	73.92	27.1	2.3	0.1	0.7	1.5	0.0	28.6	0.9	1051.2
26	4.2	1544	59.8	92.3	6.3	0.66	11.4	57.02	87.2	-70.2	0.0	0.0	-70.2	60.1	-43.2	-1.1	1050.0
TOTAL	**446**	**162,689**		**9,728.8**	**660.4**	**67.4**	**996.0**	**2,713.7**	**698.4**	**4,592.8**	**233.2**	**1,329.0**	**3,030.7**	**698.4**	**3,030.7**	**1,050.0**	

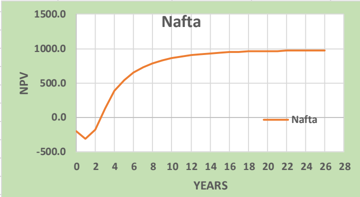
Tabla 242 Economic Evaluation – Naphtha Case

SAN JACINTO NORTE FIELD - 30 YEAR

VARIABLES		
Brent Price	*$/bl*	65
Basket Differential	*%*	8%
Transport	*$/bl*	7.0
Royalty	*%*	0.07
OPEX	*MM$/año*	26.6
Audict factor		0.95
Tax	*%*	30.0%
Labor Participation	*%*	5%
Social Fund	*%*	0.75%
Development wells	*N°*	15
Exploratory well	*N°*	1
Confirmatory well	*N°*	2
cutt¡off wells	*N°*	1
Disposal well	*N°*	6

RESULTS MM US$	
Revenue	8,589.60
Transport	907.38
Royalty	583.06
Social fund	59.57
OPEX	2,030.55
Depreciation &	717.76
Income tax	1,244.67
Labor Participation	218.36
Income after tax	2,828.24
CAPEX	717.76
Goverment take	1,887.30

	INDICATORS	
15%	NPV.MM US$	970
	IRR	66%
	ROI	1.35
	PAY OUT, YEARS	3



Year	Production		oil Basket Price	Revenue	Royalty	Social fund	Transport	OPEX	Depreciation & Amortization	Income before tax	Labor Participation	Income tax	Income after tax	CAPEX	Cash flow	Net Cash Flow	Cumulative Net Cash Flow
	MBD	*MBls*	*$/bl*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*	*MMUS$*
0	-	-	-	-	-	-	-	0.00						196.4	-196.4	-196.4	-196.4
1	7.5	2726	59.8	163.0	11.1	1.12	20.2	24.58	7.6	98.5	4.9	28.1	65.5	205.6	-132.6	-115.3	-311.7
2	34.8	12695	59.8	759.1	51.5	5.34	67.7	95.50	15.8	523.3	26.2	149.1	348.0	182.9	180.8	136.7	-174.9
3	48.3	17617	59.8	1053.5	71.5	7.52	70.5	116.64	23.4	763.9	38.2	217.7	508.0	59.0	472.4	310.6	135.7
4	40.2	14685	59.8	878.2	59.6	6.21	69.6	90.69	26.0	626.1	31.3	178.4	416.3	0.0	442.3	252.9	388.6
5	31.2	11389	59.8	681.0	46.2	4.77	65.6	93.41	26.0	445.1	22.3	126.9	296.0	2.1	319.9	159.0	547.6
6	25.9	9453	59.8	565.3	38.4	3.88	60.9	103.09	26.1	332.9	16.6	94.9	221.4	0.0	247.5	107.0	654.6
7	22.1	8058	59.8	481.9	32.7	3.29	56.3	93.00	26.1	270.5	13.5	77.1	179.9	0.0	206.0	77.4	732.0
8	19.3	7040	59.8	421.0	28.6	2.87	52.2	90.87	26.1	220.5	11.0	62.8	146.6	2.1	170.6	55.8	787.8
9	17.1	6254	59.8	374.0	25.4	2.56	46.3	88.25	26.2	185.3	9.3	52.8	123.2	0.0	149.4	42.5	830.2
10	15.5	5645	59.8	337.6	22.9	2.32	41.8	85.27	26.2	159.1	8.0	45.3	105.8	0.0	132.0	32.6	862.9
11	14.0	5108	59.8	305.5	20.7	2.06	37.8	87.52	26.2	131.1	6.6	37.4	87.2	2.4	111.0	23.9	886.7
12	12.8	4668	59.8	279.2	18.9	1.88	34.6	78.77	26.3	118.6	5.9	33.8	78.9	0.0	105.2	19.7	906.4
13	11.7	4288	59.8	256.4	17.4	1.74	31.8	77.46	26.3	101.7	5.1	29.0	67.7	0.0	94.0	15.3	921.7
14	10.9	3966	59.8	237.1	16.1	1.61	29.4	76.64	26.3	87.1	4.4	24.8	57.9	2.1	82.2	11.6	933.3
15	10.0	3664	59.8	219.1	14.9	1.49	27.2	75.41	26.5	73.7	3.7	21.0	49.0	0.0	75.5	9.3	942.5
16	9.3	3385	59.8	202.4	13.7	1.38	25.1	80.75	26.5	55.0	2.7	15.7	36.6	0.0	63.1	6.7	949.3
17	8.5	3112	59.8	186.1	12.6	1.27	23.1	73.37	26.5	49.3	2.5	14.0	32.8	1.6	57.7	5.4	954.6
18	7.9	2865	59.8	171.3	11.6	1.18	21.2	73.48	26.7	37.1	1.9	10.6	24.7	0.0	51.4	4.2	958.8
19	7.3	2651	59.8	158.5	10.8	1.09	19.6	71.12	26.7	29.2	1.5	8.3	19.4	0.0	46.1	3.2	962.0
20	6.9	2511	59.8	150.2	10.2	1.04	18.6	69.46	26.7	24.2	1.2	6.9	16.1	1.6	41.2	2.5	964.6
21	6.5	2370	59.8	141.8	9.6	0.98	17.6	74.77	27.0	11.9	0.6	3.4	7.9	0.3	34.5	1.8	966.4
22	6.1	2236	59.8	133.7	9.1	0.93	16.6	66.85	27.0	13.3	0.7	3.8	8.8	0.0	35.8	1.7	968.0
23	5.8	2104	59.8	125.8	8.5	0.88	15.6	66.76	27.0	7.0	0.4	2.0	4.7	0.0	31.7	1.3	969.3
24	5.4	1976	59.8	118.2	8.0	0.83	14.6	64.67	27.0	3.0	0.1	0.9	2.0	1.6	27.4	1.0	970.3
25	5.1	1851	59.8	110.7	7.5	0.78	13.7	63.49	27.8	-2.6	0.0	0.0	-2.6	0.0	25.2	0.8	971.0
26	3.6	1321	59.8	79.0	5.4	0.57	9.8	48.75	87.9	-73.4	0.0	0.0	-73.4	60.1	-45.6	-1.2	969.8
TOTAL	**394**	**143,638.8**		**8,589.6**	**583.1**	**59.6**	**907.4**	**2,030.6**	**717.8**	**4,291.3**	**218.4**	**1,244.7**	**2,828.2**	**717.8**	**2,828.2**	**969.8**	

9.3.Economic Evaluation

- **ECONOMIC EVALUATION: LIGHT OIL**

In the following table you can see the results obtained from the cash flow:

/

Tabla 243 Cash flow results – Light Oil case

RESULTS MM US$	
Revenue	9,728.8
Transport	996.0
Royalty	660.4
Social fund	67.4
OPEX	2,713.7
Depreciation &	698.4
Income tax	1,329.0
Labor Participation	233.2
Income after tax	3,030.7
CAPEX	698.4
Goverment take	2,056.8

INDICATORS	
NPV.MM US$	**1050**
IRR	72%
ROI	1.50
PAY OUT, YEARS	3

From the cash flow the following economic indicators were obtained (NPV, IRR and PAY OUT). These indicators determine that the development of the project would be profitable.

In addition, we can see that the economic limit is reached one year before the end of the contract, therefore, in this year the abandonment plan begins to be implemented.

- **ECONOMIC EVALUATION: NAPHTHA**

Ilustración 1 244 Cash flow results – Naftha Case

RESULTS MM US$	
Revenue	8,589.60
Transport	907.38
Royalty	583.06
Social fund	59.57
OPEX	2,030.55
Depreciation &	717.76
Income tax	1,244.67
Labor Participation	218.36
Income after tax	2,828.24
CAPEX	717.76
Goverment take	1,887.30

INDICATORS	
NPV.MM US$	**970**
IRR	66%
ROI	1.35
PAY OUT, YEARS	3

From the cash flow the following economic indicators were obtained (NPV, IRR and PAY OUT). These indicators determine that the development of the project would be profitable.

In addition, we can see that the economic limit is reached one year before the end of the contract, therefore, in this year the abandonment plan begins to be implemented.

9.4. Sensitivity and Risk Analysis

- **Sensitivity analysis: Naphtha**

We can determine a break-even point taking into consideration different criteria:

Tabla 244: Criteria for sensitivity and risk analysis – NAPHTA.

CRITERIA	BREAK-EVEN
BRENT PRICE	38.7
ROYALTIES	43.77%
OPERATING COST	41.35
DISCOUNT RATE	23.72%
INCOME TAX	75.57%
INVESTMENTS	59.13
POES	146.52

A Monte Carlo simulation was performed to estimate NPV values at different degrees of risk.

Figura 253 Montecarlo simulation – NPV

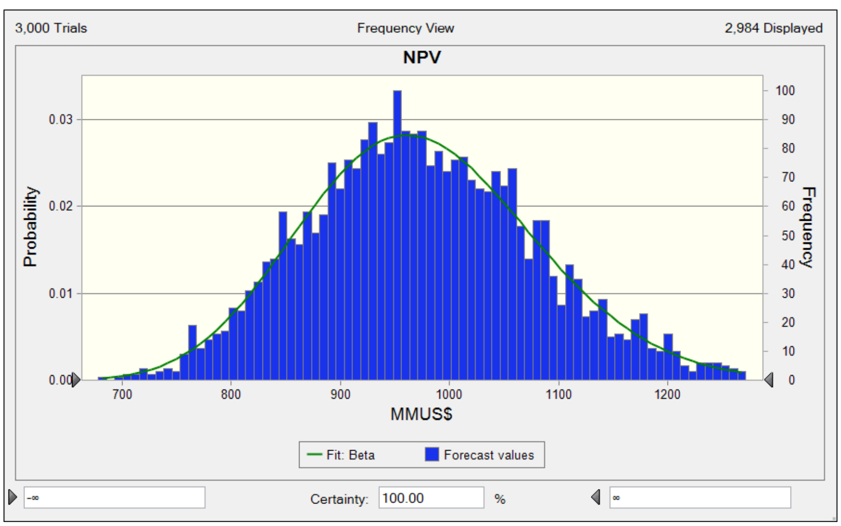


Tabla 245: NPV estimation

		OPTIMISTIC P90	OPTIMISTIC P50	OPTIMISTIC P10
NPV	*MMUS$*	841	969	1112

We carry out the same procedure for the IRR:

Figura 254 Montecarlo simulation - IRR

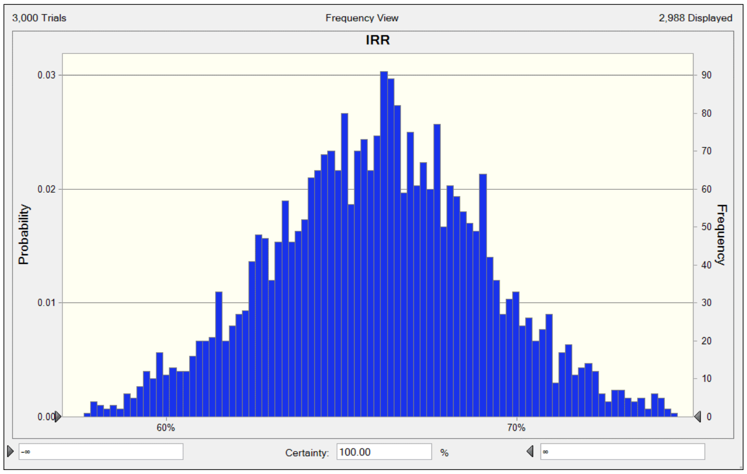


Tabla 246: IRR estimation

		CONSERVATIVE	BEST ESTIMATE	OPTIMISTIC
		P90	P50	P10
IRR	$	62	66	70

As part of the sensitivity analysis, the tornado and spider graphs were performed for the Net Present Value (NPV) and the Internal Rate of Return (IRR).

Figura 255 Tornado NPV

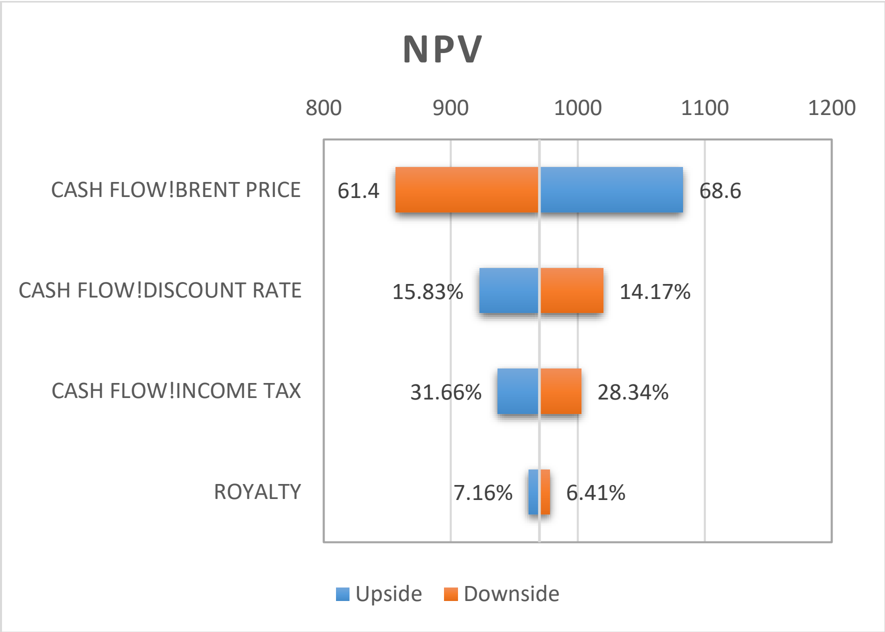
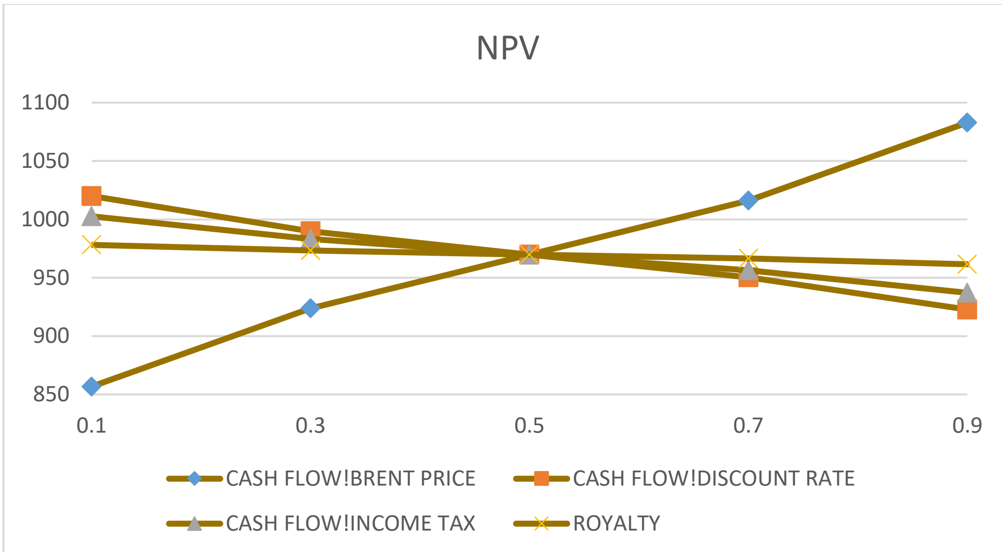


Figura 256 Spider graphic - NPV



From the graphs we can see that the factor that would have the greatest impact on NPV would be the price of oil. Likewise, it is one of the parameters that presents the greatest instability, since it depends on several random factors.

In the same way that the graphs were analyzed for the NPV, they will be analyzed for the IRR.

Figura 257 Tornado graphic - IRR

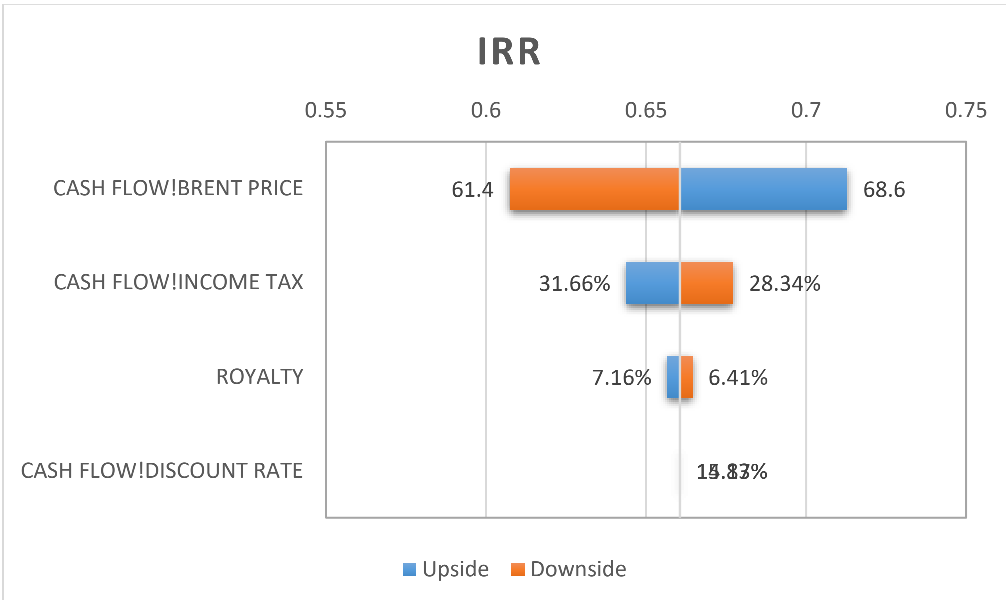
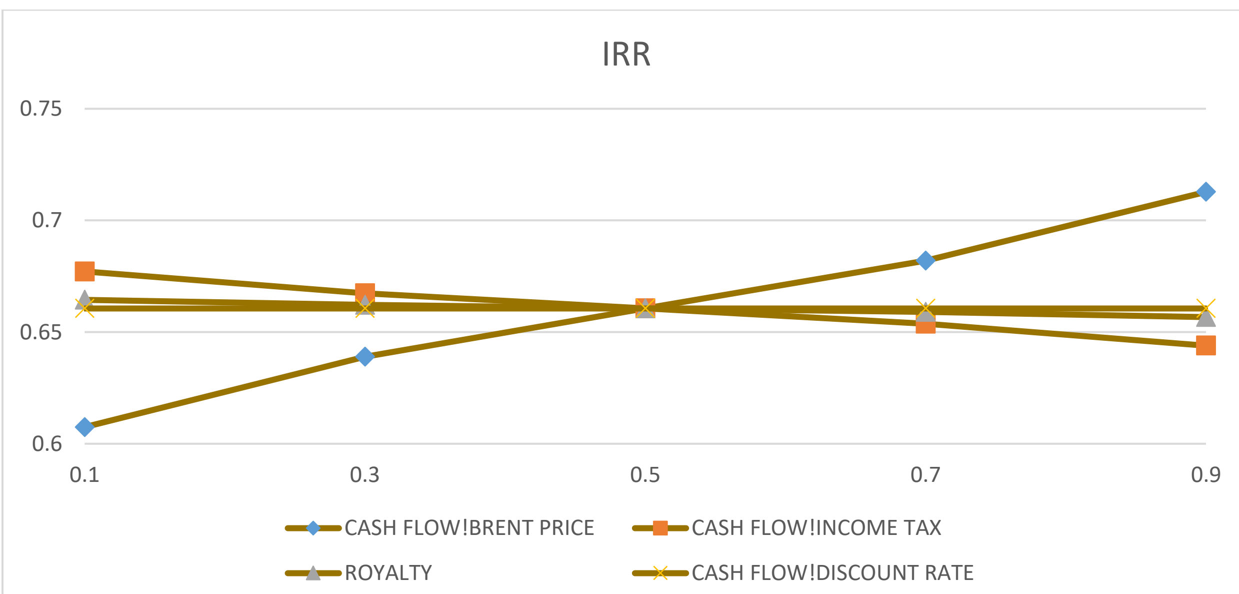


Figura 258 Spider graphic - IRR



- **Sensitivity analysis: Light Oil**

We can determine a break-even point taking into consideration different criteria:

Tabla 247: Criteria for sensitivity and risk analysis – LIGHT OIL

CRITERIA	BREAK-EVEN
BRENT PRICE	38.9
ROYALTIES	43.98%
OPERATING COST	36.58
DISCOUNT RATE	23.89%
INCOME TAX	83.23%
INVESTMENTS	122.92
POES	89.18

A Monte Carlo simulation was performed to estimate NPV values at different degrees of risk.

Figura 259 Montecarlo simulation - NPV

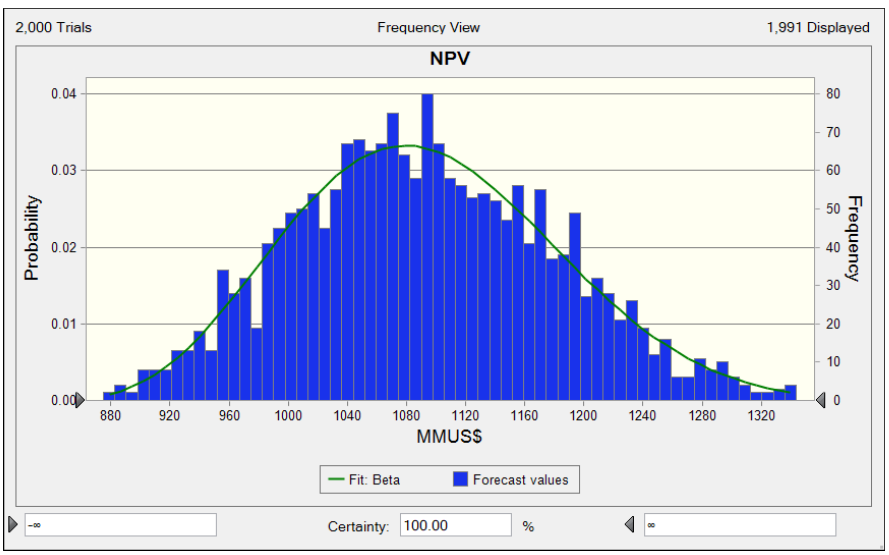


Tabla 248: NPV estimation

		CONSERVATIVE	BEST ESTIMATE	OPTIMISTIC
		P90	P50	P10
VAN	*MMUS$*	938	1097	1335

As part of the sensitivity analysis, the tornado and spider graphs were performed for the Net Present Value (NPV).

Figura 260 Tornado graphic - NPV

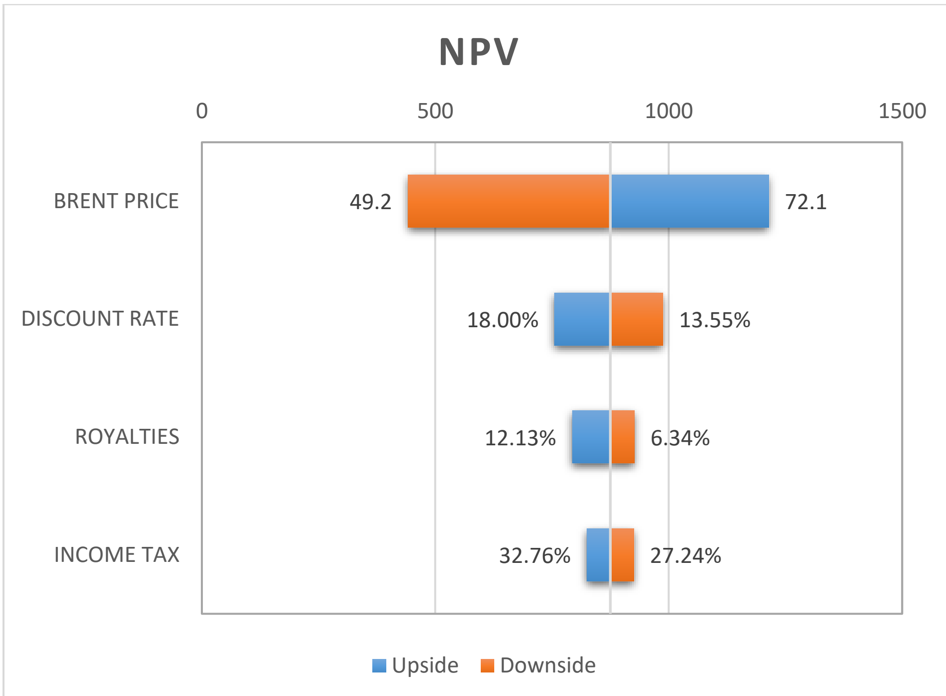
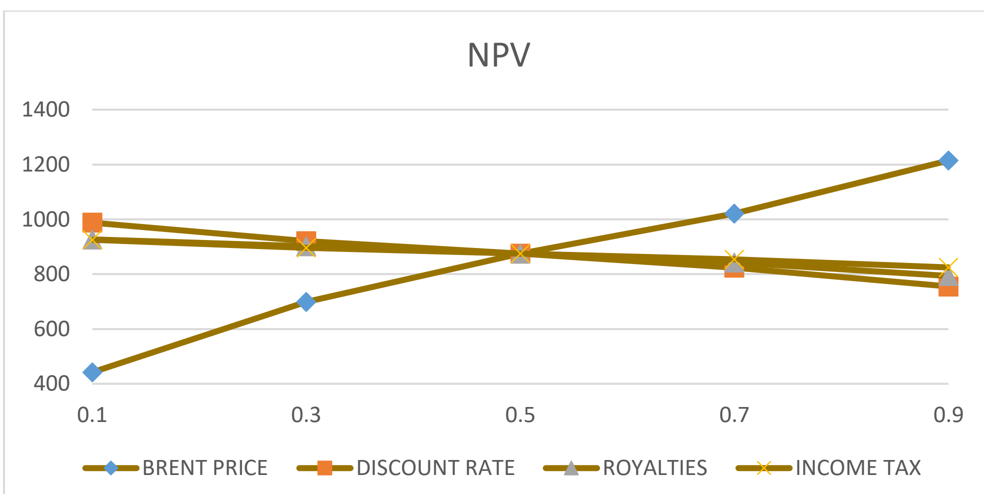


Figura 261 Spider graphic -NPV



In the same way that the graphs were analyzed for the NPV, they will be analyzed for the IRR.

Figura 262 Tornado graphic - NPV

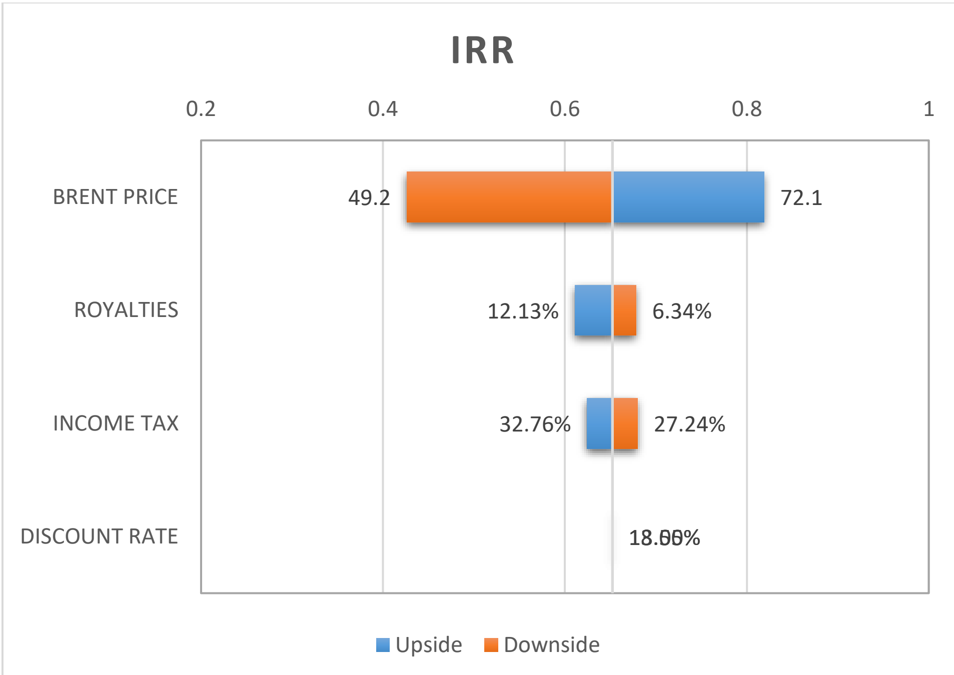
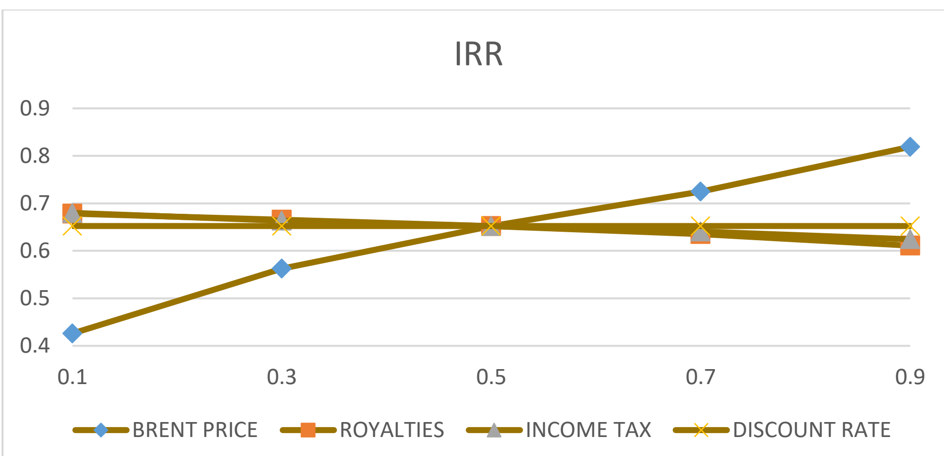


Figura 263 Spider graphic -NPV



CONCLUSIONS

Strategic Analysis

- The proper use of strategies will lead us to better decision making, allowing us to improve the profitability of the San Jacinto Oriental Field through indicators based on our strengths and opportunities.

Geology

- Geology allows us to have a referential geological framework from field evaluations, seismic works, rock studies, framework studies, reservoir quality studies, rock source, permitting to evaluate its initial hydrocarbon potential.

Reservoir Engineering

- To calculate the OOIP the information of, Petrophysical evaluations, PVT data, rock volume has been used. The results are: In the chonta formation 32 MM bbls and in the Vivian formation 115 MM bbls.
- To calculate Recovery Factor the API correlation as the numerical simulation model has been used.
- Oracle's Crystal Ball has been used for probabilistic evaluation in several scenarios.

Drilling Engineering

- Drilling costs in the Peruvian jungle are expensive due to the high cost of transportation of materials and equipment, and drilling can reach up to 12,000 feet.
- The San Jacinto Oriental field has normal pressure values, but different fracture gradients have been found, which must be taken into account for a better interpretation.
- -It is necessary to drill disposal wells to avoid water contaminating the environment.

- -The selection of tubing for drilling has been optimized due to the fact that higher strength tubing is more expensive.
- The use of platforms for directional, horizontal and deviated well drilling has been considered.
- Studies on horizontal drilling of wells in Block 192 suggest lengths of 1000 to 1500 feet for heavy and light oil wells.

Production Engineering

- -Artificial lift equipment must be thoroughly maintained in order to perform adequate production tests.
- The nodal analysis carried out in the wells of the San Jacinto Oriental field shows that the Vivían formation has greater productive potential than the Chonta formation, so production will be dominated by heavy oil.
- Different evaluations of MPR (relative permeability modifiers) were carried out and it was determined that MPRs are a good alternative to reduce water cut in conditions of high-water flow rates in the Vivian formation.
- According to the economic evaluation it is observed that the purchase of barges is the most cost-effective option compared to barge rental, due to the long rental times.
- It has been decided to drill horizontal open hole wells instead of slotted liner because in the second option there is a higher pressure drop in the hole.
- Block 192 is a remote operation which requires having sufficient critical equipment and highly qualified personnel.
- It is necessary to determine the viscosity of the crudes and their blends quite frequently.

Transportation and Storage

- The mixture of the different densities of crude produced in the San Jacinto Oriental field does not reach the requirements requested by the regulatory entity, so diluents must be used, the best alternative is to use of Naphtha, which allows us to reach an API gravity of 18.1°.
- The quality of the crude must be assured with a LACT unit.
- Due to the long distances, additional pumping stations are required.

Legal Study

- - The legislative implication in each of the stages of exploration and exploitation of hydrocarbons, have the purpose of permanently improving the conditions and governmental guidelines in order to avoid setbacks and obtain the highest productivity.

Environmental Study

- Oil must be treated without altering its properties in such a way that it does not affect the environment.
- The impact matrix helps us to identify the problems and impacts of the environment surrounding the field and carry out operations with a positive environmental awareness, avoiding community dissatisfaction.
- All the environmental aspects that could be affected were considered with the proper prevention or solution of risks, in accordance with Peruvian environmental regulations.

Social Study

- -The participation of the local population in the development of social activities that contribute to the sustainability of the project has been considered.

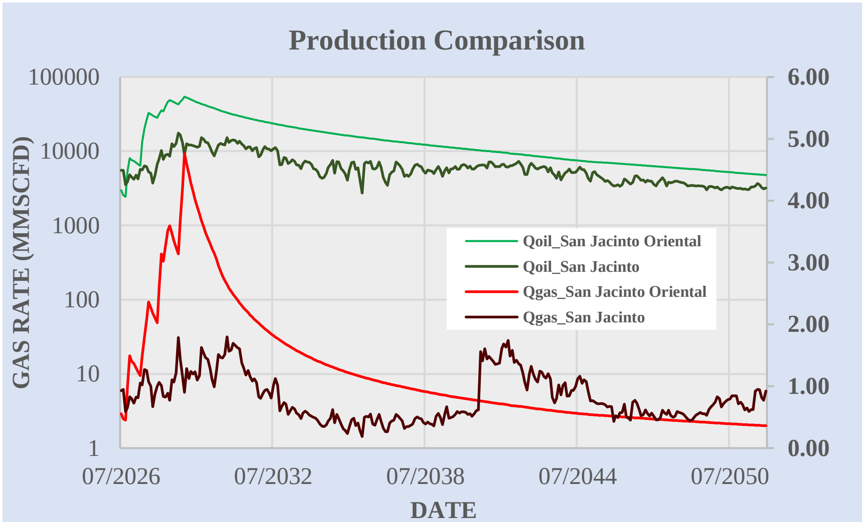
Management Study

- There must be a management system for the main activities and the support of highly qualified personnel to manage this activity.
- Management of reserves and resources will allow for greater access to project financing for the sector.

Economic Study

- The Light Oil economic evaluation shows a profitable project with a NPV of US$ 1,050 MM, an IRR of 72% and a PAY OUT of 3 years and for an investment of US$ 698.4 MM. All this was run with a crude oil price of 65.
- The Naphtha economic evaluation shows a profitable project with a NPV of US$ 970 MM, an IRR of 66% and a PAY OUT of 3 years and for an investment of US$717.8 MM. All this was run with a crude oil price of 65.
- Despite the contingencies presented in the field, KysPetrol has the technical, economic and legal capabilities to develop the San Jacinto Oriental field in a profitable manner.
- Multidisciplinary work using methodologies for economic evaluation allowed the maximum benefit obtain from KyspeTrol's resources.
- The major operating expenses in the San Jacinto Oriental project will be in water injection, and pipeline fee and the diluents.
- Making a comparison between the estimated production for the San Jacinto Oriental field and the San Jacinto field, we see that with the estimated flow rates show an increase in production by 139%. See Figure 260.

Figura 264: Production comparison



- It is necessary to make a sensitivity analysis of the injection water and the diluent used in the mixture.
- There must be a contingency plan for technical, social, environmental and economic contingencies.

  Sensitivity analysis must be carried out for all the variables involved in the project.
- The economic evaluation was carried out for the two fields, resulting in both being profitable, but with different utilities. See Figure 261 and Table 249

Figura 265: VAN comparison

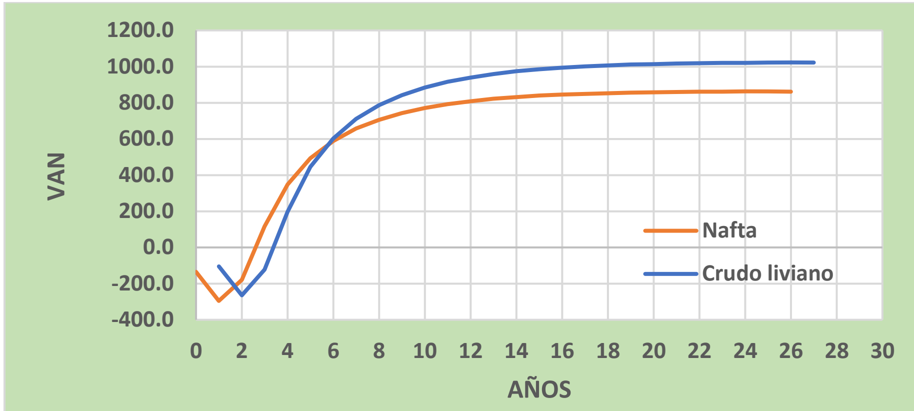


Tabla 249:Acumulaciones

FIELD	CUMULATIVE PRODUCTION
San Jacinto Oriental	143.64 MMbls
San Jacinto	59.14 MMbls

- It was observed that the best alternative is to use light crude oil, due to the price of oil and the production potential.

RECOMMENDATIONS

Strategic Analysis

- Consider PETROPERU as a fundamental part of the strategic analysis, which will provide us with facilities for transporting crude oil and its subsequent sale.
- Updated data on the economic situation at the regional, national and global levels to have a better overview of our reality.
- Promote government support to guarantee the strategic management of hydrocarbons to ensure the sustainability of the country's energy supply.

Geology

- Take 2D and 3D seismic for a better geological analysis of the San Jacinto Oriental field.
- Conduct a surface geological study of the San Jacinto Oriental field to recategorize it from Play to Prospect.

Reservoir Engineering

- Update data interpretation processes by means of flow charts, improvements in procedures with the purpose of to reduce uncertainties, in this way we will have more reliable processes.
- Use probabilistic evaluation software in all processes (for example, in decline curves) because they allow taking into account all variables with different patterns.

Drilling Engineering

- Optimize drilling costs at all times.
- Perform geomechanically studies to understand abnormal fracture pressures and gradients. Consider drilling disposal wells to inject produced water from producing wells so as not to affect the environment.

- Evaluate different types of drill pipe to find the optimal balance between utility and cost.
- Save drilling cost by using platforms for multi-well drilling.
- Consider between 1000 to 1500 ft of horizontal length in the wells of San Jacinto Oriental Pool

Production Engineering

- Prepare a maintenance program for all equipment to be used in the production stage.
- Drill simultaneously the Chonta and Vivian formations to use the API difference as an advantage.
- Evaluate and use MPRS for water control to reduce water cut.

  Purchase barges to transport crude oil because the analysis shows positive economic parameters.
- Consider using open hole wells instead of slotted casing during horizontal drilling.
- Have enough replacement equipment and authorized personnel.
- Use correlations to obtain average viscosities of crudes and their blends. It would be better to have measuring instruments.

Transportation and Storage

- Identify naphtha suppliers to form strategic alliances as an alternative to purchasing naphtha from the Iquitos refinery.
- Purchase a LACT unit to deliver crude within specifications.
- Implement an intermediate pumping station to ensure pumping of crude.

Legal Study

- Have a legal department with extensive knowledge in hydrocarbon legal matters.
- Recommend to the authorities to provide support to the operators to avoid fiscal barriers during the development of operations.

Environmental Study

- Use additives that improve the specifications of the crude oil, minimally altering its properties without affecting the environment.
- Update the impact matrix every year in order to have a reliable environmental monitoring system.
- Have references from reliable sources related to the environment.

Social Study

- Elaborate a scheme of feasible social activities that will benefit the population near the San Jacinto field

Management Study

- Prepare a management system to manage the field in its different activities.
- Evaluate and train personnel on an ongoing basis and commit them to the management system.
- Manage reserves and resources adequately to obtain external credits.

Economic Study

- Execute the project because it is technically and economically feasible. Light oil case is the best alternative.
- Create multidisciplinary teams linked to each other to obtain the maximum benefit in hydrocarbon operations.

- Reduce to the maximum the costs in the water injection projects, purchase of naphtha and crude oil transportation fee because these are the main variables that affect the project.
- Apply the methodology shown in similar fields.
- Evaluate the different periods of the water and crude production forecast to estimate the volumes of water to be reinjected and the amount of naphtha to be used.
- To have a contingency plan in case of technical, social or environmental problems during the development of the operations, which allows us to guarantee the continuity of our operations. These can range from having cash capital or establishing alliances with operating companies in the area.
- Establish an adequate sensitivity analysis methodology that allows us to study all possible scenarios to which our operations would be subjected, since we are in an industry exposed to an infinite number of risks and uncertainties.

BIBLIOGRAPHY

Ambiente, M. d. (s.f.). Obtenido de https://www.gob.pe/minam

B., A. M. (2019). *Mejoras en Cementación primaria de pozos con probelmas de invasión y/o impulsión de agua.*

BBC. (12 de noviembre de 2020). Crisis en Peru. *Inestabilidad Politcia*.

BCRP. (2020). *Estadisticas.* Lima: BCRP.

BCRP. (nov. 2020). *Programa monetario* . Lima: BCRP.

Comercio, E. (29 de febrero de 2020). Amplían fase de explotación por seis meses más en Lote 192 a favor de Frontera Energy. *Amplían fase de explotación por seis meses más en Lote 192 a favor de Frontera Energy*.

Cultura, M. d. (s.f.). *LA IMPLEMENTACIÓN DEL DERECHO A LA CONSULTA PREVIA EN EL SECTOR HIDROCARBUROS.* Obtenido de https://centroderecursos.cultura.pe/es/registrobibliografico/la-implementaci%C3%B3n-del-derecho-la-consulta-previa-en-el-sector-hidrocarburos-la

EconoJournal. (2020). *Las regalías que pagan las petroleras en Perú cayeron un 44% en lo que va del año.* Lima: EconoJournal.

El Comercio. (10 de octubre de 2020). *OEFA y Pluspetrol un pleito sin fin*. Obtenido de https://www.google.com/search?q=Pluspetrol+y+OEFA+en+disputa+por+la+remediaci%C3%B3n+de+pasivos+ambientales+del+lote+192&rlz=1C1CHBF_esPE868PE868&oq=Pluspetrol+y+OEFA+en+disputa+por+la+remediaci%C3%B3n+de+pasivos+ambientales+del+lote+192&aqs=chrome..69i57

García, D. (2016). *Estudio técnico de los MPRs para reducir el corte de agua y mejorar la tasa de producción de Petróleo en el campo Shushufindi.* Quito: Universidad Tecnológica Equinoccial.

Gestion. (2020). Obtenido de https://gestion.pe/economia/empresas/cientos-indigenas-toman-lote-1ab-pluspetrol-loreto-74591-noticia/

Gestion. (25 de setiembre de 2020). *Evacuacion de personal.* Obtenido de https://gestion.pe/economia/empresas/petroperu-evacua-a-personal-de-estaciones-ante-amenaza-de-toma-de-instalaciones-noticia/

Gestion. (1 de agosto de 2020). Oleoducto Norperuano reanuda sus operaciones bajo estrictos protocolos de seguridad. *Oleoducto Norperuano reanuda sus operaciones bajo estrictos protocolos de seguridad*. Obtenido de https://gestion.pe/signwall/?outputType=signwall&signwallHard=1

(2017). *Gobierno Regional de Loreto.*

INEI. (2020). *PBI trimestral.* Lima: Informe tecnico (Anexo N°16).

INEI. (nov. 2020). *Variacion de los indicadores de los precios de la economia.* Lima: INEI.

INVESTING. (nov. 2020). *Tasa de desempleo.* Lima.

Merino, L. (2019). *Mejoras en cementación primaria de pozos con problemas de invasión y/o impulsión de agua.* Perú: Universidad Nacional de Piura.

MINAM. (2005). *Minan.gob.pe*. Obtenido de Ley General del Ambiente: https://www.minam.gob.pe/wp-content/uploads/2013/06/ley-general-del-ambiente.pdf

MINEM. (s.f.). Obtenido de http://www.minem.gob.pe/_detalle.php?idSector=5&idTitular=706&idMenu=sub550&idCateg=371

MINEM/SNMPE. (s.f.). *Hidrocarburos (Leyes y Reglamentos)*. Obtenido de http://www.minem.gob.pe/_area.php?idSector=5&idArea=63&idTitular=707&idMenu=sub550&idCateg=372

OSINERGMIN. (2019). *Conflictos sociales en la industria de.* Lima: OSINERGMIN.

PERUPETRO. (s.f.). Obtenido de https://www.perupetro.com.pe/wps/portal/corporativo/PerupetroSite/perupetro%20s.a./historia/!ut/p/z0/04_Sj9CPykssy0xPLMnMz0vMAfIjo8zi_YxcTTw8TAy93AN8LQwCTUJcvEKADF8fA_3g1GL9gmxHRQBkwZvu/#:~:text=La%20necesidad%20de%20elaborar%20una,1993%20se%20crea%20PER%

PERUPETRO. (2002). *PORTAL PERUPETRO*. Obtenido de https://www.perupetro.com.pe/wps/wcm/connect/corporativo/ebc3fc34-f203-4f8e-a7f0-39c0e9762f00/Maranon%2BBasin%2BSummary%2C%2BPerupetro%2B2002.pdf?MOD=AJPERES

PERUPETRO. (2018).

Perupetro. (2019). *Estadísticas.* https://www.perupetro.com.pe/wps/wcm/connect/corporativo/f2052159-3e73-4049-bac3-bf2fc0730e45/Estad%C3%ADstica+2019.pdf?MOD=AJPERES&2019.

PERUPETRO. (2019). *Estadísticas.*

Perupetro. (2019). *Statistics.* https://www.perupetro.com.pe/wps/wcm/connect/corporativo/f2052159-3e73-4049-bac3-bf2fc0730e45/Estad%C3%ADstica+2019.pdf?MOD=AJPERES&2019.

Perupetro. (Septiembre de 2020). Obtenido de https://www.perupetro.com.pe/wps/wcm/connect/corporativo/ad821034-edb7-4d98-

b0e0-ec61eddb7a04/Estadistica+Mensual+-+SEPTIEMBRE.pdf?MOD=AJPERES&Estadistica%20septiembre%202020

PERUPETRO. (2020).

PERUPETRO. (2020). *Programa de perforación 1X - BLOCK 8323.*

PERUPETRO. (s.f.). *Cuencas Petroleras del Perú*. Obtenido de https://www.perupetro.com.pe/wps/wcm/connect/corporativo/ebc3fc34-f203-4f8e-a7f0-39c0e9762f00/Maranon%2BBasin%2BSummary%2C%2BPerupetro%2B2002.pdf?MOD=AJPERES

PETROPERÚ. (2008). *Contrato N° 010-2008-MEXT/PETROPERU, Suministro de petróleo crudo para refinería El Milagro.*

Rumbo Minero. (23 de noviembre de 2020). *Gobierno afirma que aplicará una mejor política social para impulsar inversiones.* Obtenido de Gobierno afirma que aplicará una mejor política social para impulsar inversiones: http://www.rumbominero.com/noticias/hidrocarburos/hidrocarburos-gobierno-afirma-que-aplicara-una-mejor-politica-social-para-impulsar-inversiones/

Sociedad Nacional de Minería, P. y. (s.f.). *Legislación del sector hidrocarburos*. Obtenido de https://www.snmpe.org.pe/precios-de-referencia/3691-legislacion-del-sector-hidrocarburos.html

SPE. (s.f.). *Sistema de Gerencia de los Recursos de Petróleo*. Obtenido de https://www.spe.org/media/filer_public/24/fe/24fe7cf3-7c23-485d-a966-e3243f1d20ce/2018_sistema_de_gerencia_de_los_recursos_de_petroleo_-_traduccion_en_espanol_-_vf.pdf

Times, T. N. (2020). *El petróleo y la COVID-19: Una tragedia sobre otra en la Amazonía peruana.* Lima: The New York Times. Obtenido de https://www.nytimes.com/es/2020/10/02/espanol/opinion/coronavirus-amazonia-peru.html

Wayka. (7 de agosto de 2020). Obtenido de https://wayka.pe/lote-192-ocho-derrames-de-petroleo-en-la-selva-peruana-durante-la-pandemia/#:~:text=Durante%20el%20Estado%20de%20emergencia,la%20empresa%20canadiense%20Frontera%20Energy.&text=Actualmente%2C%20esa%20zona%20es%20habitada,comunidad%20kichwa

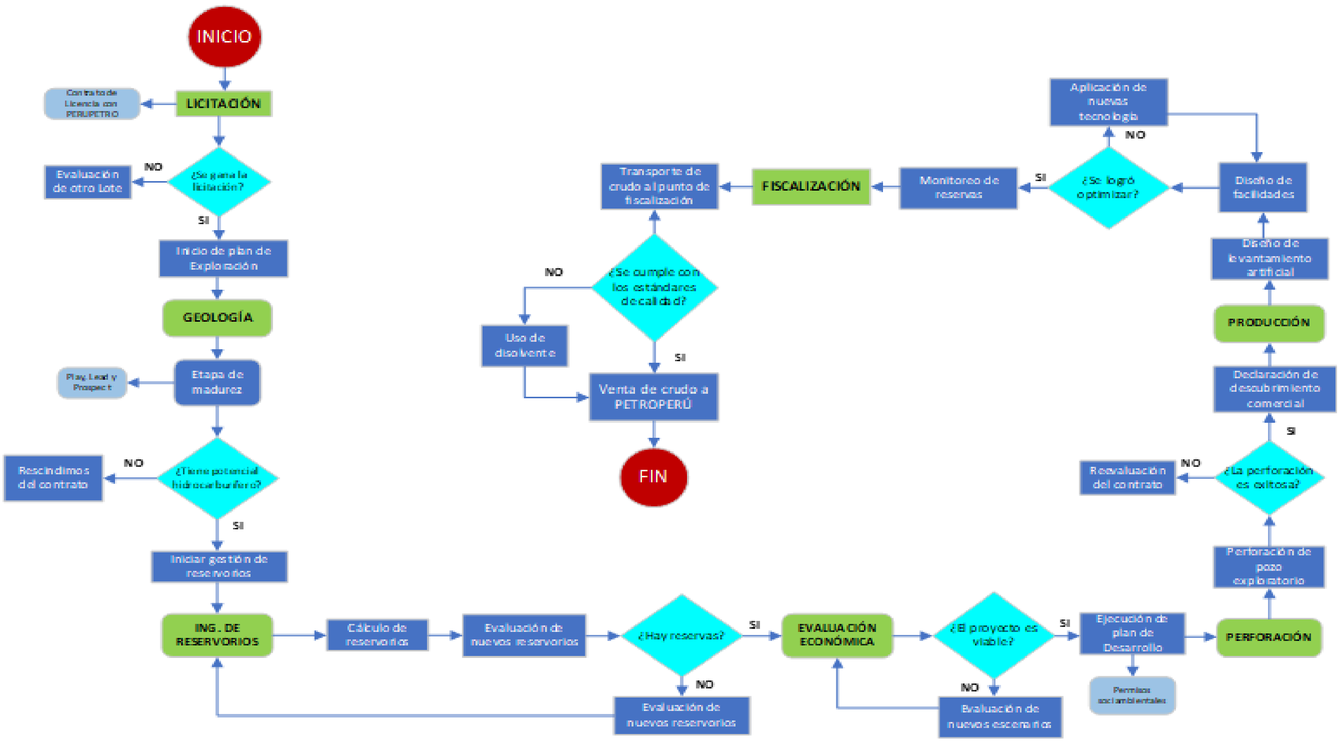
Yesquén, S. (28 de noviembre de 2020). "Urgente Reactivación del Sector Hidrocarburos". *Rumbo Minero TV*, págs. http://www.rumbominero.com/noticias/hidrocarburos/perupetro-con-menos-produccion-local-en-5-anos-la-importacion-de-hidrocarburos-podria-llegar-s-100-millones-diarios/.

ANNEXES

Anexo 1 Schedule Progress

		Noviembre	Diciembre				Enero			
		Semana 4	Semana 1	Semana 2	Semana 3	Semana 4	Semana 1	Semana 2	Semana 3	Semana 4
1	Análisis Estrategico									
2	Estudio Tecnico-Geologia									
3	Estudio Tecnico-Reservorios									
4	Estudio Tecnico-Perforacion									
5	Estudio Tecnico- Produccion, transporte y Almacenamiento									
6	Estudio Legal									
7	Estudio Ambiental									
8	Estudio Social									
9	Estudio Economico									
10	Conclusiones									
11	Recomendaciones									

Anexo 2 Activities



APPENDIX A

Engineering Standards and Government Regulations Applied in the Project

Engineering Standards

API SPEC 4F

Specification for Drilling and Well Servicing Structures

This specification states requirements and gives recommendations for suitable steel structures for drilling and well servicing operations in the petroleum industry, provides a uniform method of rating the structures, and provides two product specification levels (PSLs).

This specification is applicable to all new steel derricks, masts (including masts with guy lines and service rig masts), substructures, and crown block assemblies with a date of manufacture after the effective date of this specification.

API RP 5A3

Recommended Practice on Thread Compounds for Casing, Tubing, and Line Pipe

The purpose of this recommended practice is to provide means for evaluating the suitability of thread compounds, regardless of composition, for use on API round thread and buttress

casing, tubing and line pipe connections in high-pressure service. The tests outlined herein are used to evaluate the critical performance properties of thread compounds under laboratory conditions. When evaluating the suitability of a thread compound, the user should consider full size connection test results and field experience in addition to the results of reduced scale (bench top) test methods like those described herein.

API TR 5C3

Calculating Performance Properties of Pipe Used as Casing or Tubing

This technical report illustrates the equations and templates necessary to calculate the various pipe properties, including the following: (a) pipe performance properties, such as axial strength, internal pressure resistance, and collapse resistance, (b) minimum physical properties, (c) product assembly force (torque), (d) product test pressures, (e) critical product dimensions related to testing criteria, (f) critical dimensions of testing equipment, (g) critical dimensions of test samples.

Equations presented here are intended for use with pipe manufactured in accordance with API 5CT or ISO 11960, API 5DP or ISO 11961, and API 5L or ISO 3183, as applicable. Pipe modified by cold working after production, such as expandable tubes and coiled tubing, is beyond the scope of this technical report.

ANSI/API STANDARD 610

Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries

This international standard specifies requirements for centrifugal pumps, including pumps running in reverse as hydraulic power recovery turbines, for use in petroleum, petrochemical and gas industry process services.

This standard is applicable to overhung pumps, between-bearing pumps and vertically suspended pumps. The standard provides requirements applicable to specific types of pumps, as well as to all pump types.

Relevant industry operating experience suggests pumps produced to thos international standard are cost effective when pumping kiquids at conditions exceeding any one of the following: (a) discharge pressure (gauge) 1,900 KPa (275 psi, 19 bar), (b) suction pressure (gauge) 500 KPa (75 psi, 5 bar), (c) pumping temperature 150 Celsius cent-degrees (300 Fahrenheit), (d) rotation speed 3600 RPM, (e) rated total head 120 m (400 ft), (f) impeller diameter 330 mm (13 in).

API Technical Report 1PER15K-1

Protocol for Verification and Validation of High-Pressure High-Temperature Equipment

This report establishes a process for evaluating equipment used in high-pressure and/or high-temperature (HPHT) environments both on and offshore. This standard provides industry with a consistent approach to designing up-to-date drilling and completion equipment that is fit-for-service in deeper, HPHT wells.

API Standard 521

Pressure-Relieving and Depressuring Systems

This standard is applicable to pressure-relieving and vapor depressuring systems. Although intended for use primarily in oil refineries, it is also applicable to petrochemical facilities, gas plants, liquefied natural gas (LNG) facilities, and oil and gas production facilities. The information provided is designed to aid in the selection of the system that is most appropriate for the risks and circumstances involved in various installations. This standard specifies requirements and gives guidelines for the following: – examining the principal causes of overpressure; – determining individual relieving rates; – selecting and designing disposal systems, including such component parts as piping, vessels, flares, and vent stacks.

ISO 14998:2013

Downhole equipment. Completion accessories. Petroleum and natural gas industries.

This standard provides requirements and guidelines for completion accessories, as defined herein for use in the petroleum and natural gas industry. The standard provides requirements for the functional specification and technical specifications including: design, design verification and validation, materials, documentation and data control, redress, repair, shipment, and storage. The standard covers the pressure containing, load bearing, disconnect/reconnect, tubing movement, and opening a port functionalities of completion accessories.

ISO 11960:2020

Petroleum and natural gas industries. Steel pipes for use as casing or tubing for wells

This standard specifies the technical delivery conditions for steel pipes (casing, tubing and pup joints), coupling stock, coupling material and accessory material. The standard is also applicable to the following connections: short round thread casing (SC), long round thread casing (LC), buttress thread casing (BC), non-upset tubing (NU), external upset tubing (EU), integral-joint tubing (IJ).

API Recommended Practice 54

Recommended Practice For Occupational Safety For Oil And Gas Well Drilling And Servicing Operations

This Recommended Practice provides procedures for promoting and maintaining safe and healthy working conditions for personnel in drilling and well servicing operations.

The document applies to rotary drilling rigs, well servicing rigs, and special services as they relate to operations on location. It includes sections on flowback operations which are key for safe well testing, revised requirements for facility and site process hazard assessment and mitigation, and introduction of formal risk assessments as well as expanded provisions for offshore operations.

API Bulletin 75L

Guidance Document For The Development Of A Safety And Environmental Management System For Onshore Oil And Natural Gas Production Operations And Associated Activities

This recommendation provides general information and guidance for the development of a safety and environmental management system (SEMS) for onshore oil and natural gas operations, including drilling, production, and well servicing activities, fostering continuous improvement in industry safety and environmental performance.

Many onshore oil and natural gas companies have effective SEMS in place. However, the intent of this document is to provide an additional tool that can assist these and especially other operators in taking the next step toward implementing a complete system at a pace that complements their business plan.

More engineering standards applied in the project are presented in pages 299-301.

Government Regulations

Government Decree Nº 032-2004-EM

Regulation of Hydrocarbon Exploration and Exploitation Activities

Fuel Storage

Fuel storage in the camp will be strictly controlled. The storage of fuels, lubricants and chemical substances must be in a closed place, with a waterproof cover. Fuel tanks must be equipped with safe valves (which can be locked to prevent unauthorized use). Any leak or contamination of fuel to the ground or water must be reported to OSINERG and MINEM, proceeding to clean it to prevent any threat of contamination.

Government Decree Nº 032-2004-EM

Regulation of Hydrocarbon Exploration and Exploitation Activities

Environmental Protection

Hydrocarbon exploration and exploitation camps and facilities will comply with the standards indicated in the Regulations for Environmental Protection in Hydrocarbon

Activities. The Personnel must comply with all matters relating to the protection of the local flora and fauna, in accordance with the provisions of the aforementioned Regulations.

The waste and waste produced during exploration and exploitation will be managed as indicated in the Regulation for environmental protection in hydrocarbon activities.

More government regulations applied in the project are presented in pages 293-299.

APPENDIX B

Multiple and Realistic Constraint and Limitations Considered un the Project

Availability of Petroleum Geological Data

Several information and data sources have been considered and analyzed to gather proper and significant data to complete the project. The following sources have been considered: National Society of Mining, Petroleum and Energy SNMPE, Geological, Mining and Metallurgical Peruvian Institute IGMMP, Peruvian Geological Institute, Hydrocarbon Department of the Government Ministry of Mining and Energy. All required information and data was finally found and made available.

Uncertainties and Risks

Petroleum exploration and production projects are high-risk ventures with many uncertain factors affecting the outcomes of the project. Hydrocarbon concepts with respect to structure and petroleum reserves are uncertain. On the other hand, economic evaluations have uncertainties related to cost estimation, changing conditions in economically viable sites, changes in petroleum exploitation technologies, seismic activity in the project area, fluctuations in petroleum price and market conditions, political situation, community relations, etc. All these issues must be carefully analyzed in order to ensure the profitability of the project for the most conservative economic conditions and diversity of scenarios. In this project, all these issues have been considered from a conservative scenario and criteria.

Safety Considerations

Hydrocarbon exploration and exploitation projects are characterized by diverse safety issues that must be taken into account in the development of the project, in order to ensure its feasibility and sustainability. In recent years, Peruvian regulations on petroleum safety and environment have become stricter. It is important to comply with safety standards pointing to satisfy proper safety levels considering their impact in the project budget. Care of human life, well-being and safety is an important issue to take into account throughout the different stages of the project and its life-cycle.

Environment and Sustainability

The petroleum and natural industry in the country face diverse and broad environmental issues at both local and global levels which could affect the project sustainability. The project considers environmental issues such as potential effluents spills, soil, air and water pollution, habitat protection and biodiversity. The project also considers community relations with local people as an important stakeholder of the project.

Electric Energy Supply

Electricity supply to meet the requirements of all equipment and operations. The different possible energy sources (electrical network, local generation) are analyzed along with the conditions of cost, availability, continuity, environmental impact, investment.

Schedule

The project must be completed in one academic semester. It is estimated the project requires an average of 150 hours of teamwork with 4-5 students per team. Considering that, besides the senior design project course, students are enrolled in 3-4 additional courses in the academic semester, students have to plan ahead in order for identify all required activities, distribute the tasks among all team members and, finally, integrate all partial tasks to configure the final project.

Budget

Limited budget assigned to the project. Student team had to deal with limited budget to finally complete the project satisfying specifications.

Other Constraints

The following constraints have also been considered in the project:

- Geographical and accessibility restrictions that make difficult the transport of materials and equipment.
- Technology availability and applicability in the well(s) area.