PLANNING FOR THE FUTURE OF UNCONVENTIONAL RESOURCE DEVELOPMENT IN COLOMBIA

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GENERAL OBJECTIVE

Develop an action plan with execution times and documented work priorities for the development of an unconventional reservoir with a sustained activity of 500 wells per year for 15 years, providing solutions to the challenges during the execution of the project.

SPECIFIC OBJECTIVES

- Develop a project plan and a summary report that explains the development of the project.
- Creation of a tool that works to modify, visualize and analyze this plan in an agile way, that also works as a preliminary planning/screening element for other projects.
- A catalogue of all assumptions and known challenges with the team's solution or mitigation plan.
- Project timeline with key deliverable dates for project execution.

RESUMEN

INTRODUCTION

Currently Colombia is showing a strong decrease in hydrocarbon reserves in the order of 17% for oil and 23% for gas (UPME 2019). These statistics are a cause for concern in the current scenario, since if new sources of energy are not found, the country will face a crisis of self-sufficiency in hydrocarbons, which would lead to the need to import them, and at the same time would leave the nation's finances at risk, since they depend to a large extent on hydrocarbon revenues.

This has motivated interest in new techniques for obtaining hydrocarbons, and it is there where unconventional reservoirs appear on the national scene, resources that due to the experience of countries such as the United States, pioneer of this technique, Argentina, Canada, China, among others, have proven to be an effective source in increasing their oil and gas reserves. Currently Colombia has great potential in unconventional resources, a large prospect is in La Luna formation located in the Middle Magdalena Valley, and according to the ANH, (2012), is the main source rock in the basin.

According to data issued by the ANH, (2012) there are resources of more than 5000 million barrels of oil which is equivalent to approximately three times the reserves currently available in the country, projections that turn out to be very favorable for a country that in a very short time will lose its energy sustainability.

By 2012 the ANH began to offer blocks where this resource can possibly be extracted and by 2014 Resolution 421 of March 20 was issued, which highlights the environmental impact guidelines that must be considered to develop this type of project.

At present, pilot wells are being developed that will allow a greater knowledge of the technique in the country and will contribute to the creation of good practices for the exploitation of the resource, generating the least possible impact. Once it is demonstrated that the technique is viable and that the development of these projects will follow all the guidelines that guarantee the security in the operations in all the aspects, the development of these will be viable; for this panorama it is required to count on the preparation of the companies involved in the production of petroleum and the academic organizations; a first step is to evaluate the plans of development of this type of resource in the country.

For this reason Energy Team has begun to generate a plan for 500 wells per year in a project that will last 15 years, which seeks to establish how this project could be addressed from the drilling stage to production, taking into account social, technical and environmental aspects that allow a viable development of the industry.

INFRASTRUCTURE AND CIVIL WORKS

LOCATION

The development of the project of unconventional reservoirs will be located in the Middle Magdalena Valley basin, this has an extension of 32949 km2, where La Luna formation is the area from which the hydrocarbon will be extracted, it is worth noting that this is subdivided into three sections which are Salada, Pujamana and Galembo, shale-type rock prospects. It is expected that each well to be drilled will have a depth of 4921.26 ft (1500m), which means that the final point of the drilling is located in the Galembo formation since this complies with the section in which the base of the casing will be positioned. Figure 1, shows the stratigraphic profile where the sections can be detailed.

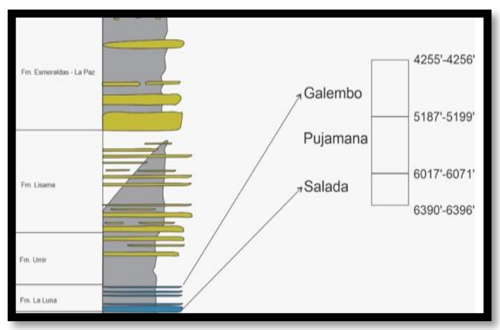

Figure 1. La Luna formation

Once the layer to be reached has been selected, the necessary extension to cover the project of 7500 wells in a range of 15 years is established.

To calculate the required area, the initial parameters established by Halliburton for the development of the project were taken into account, which indicate that the distance between the well heads must be complied by 800 m and that the well heads will occupy a space of 25 m x 25 m. Using the Google maps tool, a possible area to cover the project was identified, sectoring it in the vicinity of the department of Antioquia, more specifically in the area of Yondó, since this is located near the town of Barrancabermeja where national roads can be accessed, which will allow the project to be easily supplied, as well as being close to the Magdalena River and the refinery.

LAND DEVELOPMENT

Once the territory where the wells will be located is known, the land will be adapted considering the conditions mentioned above.

A key aspect to consider for this development was to establish that the land will be sectorized for each year of work, that is to say that the adaptation of this will be done for every 500 wells. Counting with a period of 12 months to have the road infrastructure and the area of the wells developed.

Each wellhead requires an area of 6727.44 ft^2 (625 m^2) for 500 wells it is necessary to adapt a total of 77.22 acres (0.3125 km^2).

ROAD CONSTRUCTION

The project requires the construction of roads that allow access between wells, as shown in figure 2, in which a location scheme is proposed for a square geometry, the distances of the roads will be calculated as a function of the location of the wells according to the geometry of the terrain.

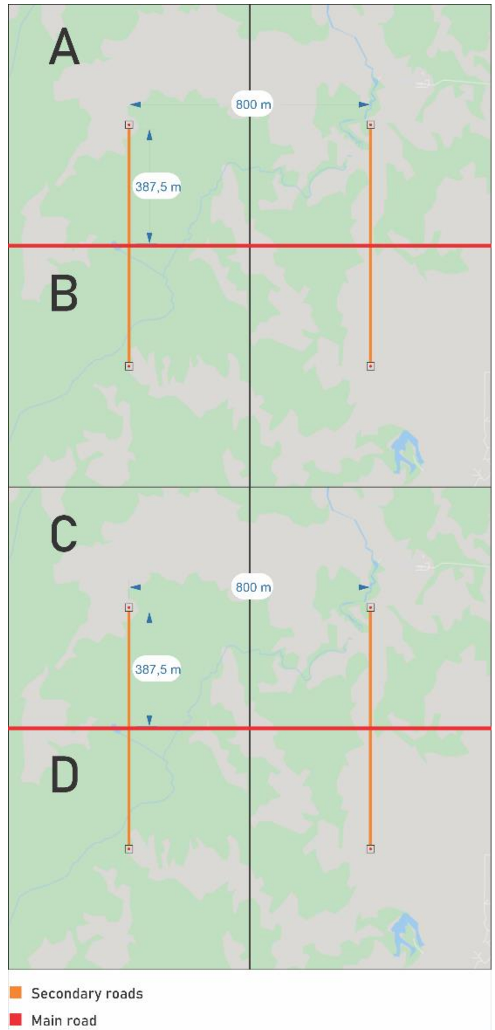

Figure 2. Project roads

The figure shows an outline of the roads for eight wells, where the red line represents the general road, which will cover the wells longitudinally, while the orange roads will allow access to each of the wells from the general road.

It was determined that the wells in region A and B will share a path, as will those in region C and D, a configuration that is repeated indefinitely.

Taking into account the generality of the roads in Colombian territory, table 1 shows the specifications for the road sections.

Item	Description
Type of road	Uncovered, double roadway
Road Width	10 m
Rainwater drainage	Cunetas eGrounded gutters
Rolling material	Granular type

Table 1. Road specifications

OVERALL PROJECT DEVELOPMENT

Once the location of the project was identified and the land was suitable, we proceeded to identify how many teams were required for each of the activities, this was done according to the time that a well required for its development, which is detailed in table 2.

Activities	Time Lapse (days)
Drilling	7
Completion	14
Testing & Clean Up	7
Tie In	14
Drawbacks	3

Table 2. Days of operation

Drawback times have been considered in case any activity is delayed in order to have a margin of time to solve the problem and give continuity to the development of the 500 annual wells.

From these times the equation showed in the figure 3, was developed, which allows to determine the amount of drills that were required to be contracted for the drilling stage. For the calculations, one year of work was considered and it was assumed that the others would maintain the same behavior, therefore, the total number of wells would correspond to 500; on the other hand, the drawback days were considered in the drilling stage to facilitate the calculations, where a variable called Batch Days was created which is equivalent to the days that drilling takes plus those of drawback.

The total number of days corresponds to the year of work. The initial days correspond to the time it takes for the first well to reach production.

From this equation it was determined that the drills required for a year of work correspond to 15.16, therefore, it is necessary to contract 16 of these.

$$Requiered\ Rigs = \frac{Total\ wells * (\ batch\ days)}{(Total\ days - Initial\ days) + (batch\ days)}$$

$$Requiered\ Rigs = \frac{500 * (7+3)}{(365-45)+(7+3)}$$

$$Requiered\ Rigs = 15{,}16 = 16$$

Figure 3. Equation to determine the amounts of drills required

Once the number of drills required for drilling was determined, it was indispensable to know the availability of these drills in Colombia. According to the Campetrol drill report, by March 2020 there were a total of 109 drills for drilling operations of which 40 were already contracted, therefore, it is assumed that 69 drills will be available. This means that using 16 drills per year is feasible for this project.

TECHNICAL EVALUATION

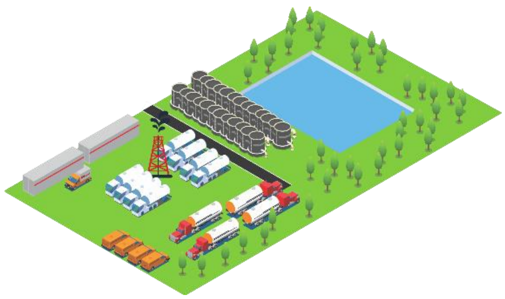

Figure 4. Proposed scheme of surface development. Own elaboration.

This scheme proposes a possible distribution of equipment for the development of the project.

DRILLING

For the drilling stage, it was contemplated that each well will have 8-hour shifts with a crew of 16 people, except for the Company Man which will have 12-hour shifts. This configuration will allow the creation of more jobs, including personnel from the same community, and at the same time will avoid overload of work and thus ensure that the activities are safe for the workers. The distribution of the crew is shown in table 3.

Persons#	Drill Crew per Well	Hours
1	Company Man	12h
1	Company Man Assistant	8h
2	Driller	8h
2	Floor Man	8h
2	Roughneck	8h
2	Derrick Man	8h
2	Roustabout	8h
2	Electrical and Mechanical Maintenance	8h
2	Instrument Technician	8h

Table 3. Drill crew per well.

COMPLETION

Once the drilling is completed, the completion stage will begin, in which each team will have a crew of 24 people, who, as in drilling, work in 8-hour shifts as established in table 4.

Persons#	Drill Crew per Well	Hours
1	Company Man	12h
1	Company Man Assistant	8h
2	Derrick Man	8h
2	Floor Man	8h
2	Roughneck	8h
2	Roustabout	8h
2	Electrical and Mechanical Maintenance	8h
2	Instrument Technician	8h
2	Completion Specialist	8h
2	Perforating Team	8h
3	Reservoir Team	8h
3	Well Log Team	8h

Table 4. Completion crew

In addition, the operation will require 24m3 of cement per well

TESTING AND CLEAN UP

A mobile system will be used in these operations. It will have a team of 7 people and will take a total of 14 days.

TIE-IN

This process will involve a team of 10 people and will take a total of 7 days.

PRODUCTION

In the production section, the accumulated production graphs were made for the 15 years of operation, following the gas and oil production parameters indicated. The figures 5 and 6 are evidence of the accumulated production. In this case the calculation of the production was made by checking the drop in daily production, in order to make an accumulated of the wells put in production attending to the time that each well took to be put in production during the respective year of operation.

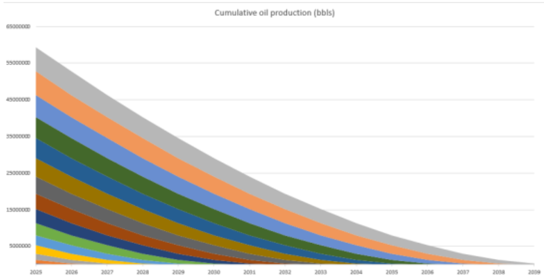

Figure 5. Cumulative oil production (bbls)

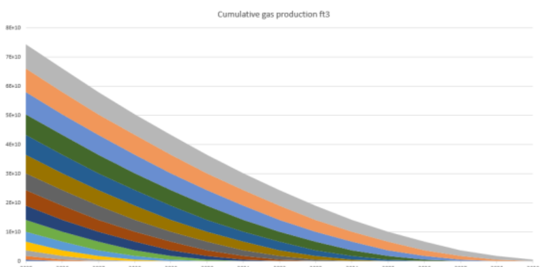

Figure 6. Cumulative gas production (ft3)

PROJECT LOGISTICS

For this purpose, possible arrival times in the project supply chain were taken into account.

The supply times were calculated taking into account only the transportation times, it is assumed that the loading times are assumed by the companies hired, and the unloading times are not detailed because it is expected to have enough stock to supply the needs while the materials are being unloaded..

Firstly, considerations were made regarding the places of origin of the drilling and completion pipes. The decision was made to purchase from Tenaris, so this pipe will be received at the Cartagena harbor and is estimated to take about 11 hours to arrive in Barrancabermeja. Therefore, the orders must comply with the quantities estimated in the web application and be requested taking into account the time it takes to transport, load and unload. In the case of drilling the pipes will be acquired annually, while the completion pipe must be purchased in advance, the possibility of 3 large orders in the year is considered to facilitate stock management.

Afterwards, the place where the cement would be acquired was checked, the company selected was Argos, leader in the Colombian cement market. It has 19 cement plants, located in different parts of the country, the interest is focused on the one in Tunja due to its proximity to the place of development of the project. It is estimated that transportation takes about 8 hours.

The next material that needed to be detailed was the frac sand that would be used as proposed, according to the research of Carreño et al., (2016), in the Colombian case the best alternative to acquire this material is its purchase from China. In this case, it is assumed that the project for the development of non-conventional resources has the support of the government and that therefore in the years prior to the start of the operation it is expected that companies will be created to acquire the product and distribute it in the country. Therefore, the acquisition operations from China will be carried out by these companies and for the development of the project, only the time it takes to get this material from the port in Cartagena to Barrancabermeja will be reviewed, which would be 11 hours.

SOCIAL MANAGEMENT PLAN

Any project that generates both environmental and social influence must be planned for.

Energy Team has made several considerations that should be taken into account when conducting the project of non-conventional in Colombian territory in which the approach to communities has been highlighted, complying with current regulations.

COMMUNITY HANDLING

In this sense, it follows the stipulations of Decree 328 of February 28, 2020, which establishes the guidelines for unconventional field projects.

Before starting the projects, the regulations established by the regulatory entities must be taken into account.

It is essential that throughout the development of the project there is a system of transparency and citizen participation, as decreed by Law 1712 of 2014, which states that all information must be public and transparent, so that communities can know how each of the activities are being carried out.

Prior to the development of the project, socialization and training will be carried out, which will be aimed at the communities located in the area of influence, local authorities and operators. In these, the activities to be carried out are socialized, complying with environmental regulations to generate the least environmental impact.

On the other hand, a territorial follow-up will be carried out that will work permanently in the areas of influence, and territorial dialogue tables will be created, where direct communication will be established between the contractors, the communities and the state.

Finally, complementary resources must be allocated for social investment, which will be available for projects in favor of the communities, as established by the National Hydrocarbons Agency. It must be guaranteed that qualified or unqualified labor will be linked to the project and that services will be hired from the area in which the project will be carried out, as established in Resolution 030 of 2012.

SOFTWARE DEVELOPMENT

For this case energy team developed its own website and there is also the digital tool for planning. In the first section you will find information about our team, you can find a video of our presentation, the skills of each of the participants among others.

You will also find our youtube channel with our videos in the unconventional tab you will find our planning for the development of unconventional reservoirs in Colombia, where we present the planning from drilling to production, you will know why the development of the project was implemented and how Energy Team work together to provide a practical and comprehensive solution.

In our website you will find the energy app which is an application that will allow you to plan the development of unconventional reservoirs in Colombia, it is a friendly application and the best thing is that you can do it at any time and place, you will find a first entry where the user enters the information. Once it is loaded you only have to press the send button and you can use the clean button for other implementations.

Once the Energy app has been sent it will show you the results, for every area from drilling to production. In addition, we implemented complementary sections where you will find information for chemical additives that can be used for flowback, plus a structure for the entire drilling crew and support equipment and you will find the regulations to keep in mind for the development of unconventional reservoirs in Colombia.

On the other hand, you will find some of the references that our team used for this project. In the section about us you will find information about each Energy team members and our contacts.

CONCLUSIONS

There is viability in Colombia to develop the non-conventional deposits, it is required the joint work of the academy, the state and the private companies to advance in this objective.

State policies in the following years should focus on facilitating the creation of new companies that contribute to the supply chain necessary for the development of these projects.

Involving communities and contributing positively to their environment has an important role in the sustainable development of such large projects.

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