IATMI22-049

Water Management Strategy in Brown Field, Case Study Prabumulih Field: Plan of Sustainable Development, Cost-Effective Implementation, and Zero Discharge

Julda Naufal[*1], Taufik Fansuri[2], Fajrin K. Wijaya[3], Bonus Setiawan Yogassana[4], Arif Rahman Hakim[5]
[1,2,3,4,5] PERTAMINA
* Email: Julda.naufal@pertamina.com

Water production has been a major operational issue that was closely related to oil production activities. It is one of the most challenging issues in Prabumulih Field that is categorized as Brown Field. The main reason is the difficulty on maintaining oil production by implementing a strategy to reduce water production. Therefore, a comprehensive strategy was needed to be able to implement appropriate water management.

There are several obstacles regarding the implementation of appropriate water management in this case: production facility, budget limitation, fluid properties, subsurface condition, and social problems. Hence, a multidisciplinary team, subsurface and surface, is involved to arrange a comprehensive strategy for solving the issues.

Subsequently, the strategy to overcome water-management issues is divided into four phases: planning, execution, monitoring, and evaluation phase. The planning consists of evaluating the matrix risk, determining of the priority level, making work program (short-term, medium-term, and long-term), setting the target, and determining the person in charge. The execution is conducted based on grouping the work program that has similarities (scope of work and location) and alignment with plan of further development. Accordingly, monitoring and evaluation are conducted to observe the progress and the accomplishment of the project periodically. This strategy has been implemented since 2018.

According to this case, it discovers that every phase of the strategy has its own level of complexity. The challenge encountered in the planning phase is how to align budget limitations and program priority. Whereas the most challenging phase is the execution phase. Thus, because Prabumulih Field has a large area. Firstly, obstacles related to the social problem must be resolved before work program is executed. The interconnection strategy is conducted to reduce complexity in the execution phase and cost-effectiveness. As a result, it is proved as the best way for operation mapping and reducing costs. Furthermore, the interconnection strategy also provides a simplification overview for monitoring and evaluating the project's progress. Besides, it helps immensely to monitor and evaluate based on every interconnection project. Finally, the water management problem begins to be resolved gradually in a more planned manner and is easier to align with Plan of Sustainable Development, as well as the long-term reliability of the zero-discharge program can be assured.

Keyword(s): Water Management, Sustainable Development.

1 Introduction

Water production has been a major operational issue that was closely related to oil production activities. It is one of the most challenging issues in Prabumulih Field that is categorized as Brown Field. The main reason is the difficulty on maintaining oil production by implementing a strategy to reduce water production.

Prabumulih Field has 11 active producing structures with only 8 structures having water injection system. Each structure that doesn't have water injection system is pumping the gross fluid (Oil and Water) to the nearest structures that has water injection system or pumping it to main gathering station (MGS) to be separated and then pumped to another structure. In addition, most of structures that has water injection has more water produced than its water injection capacity. All those problems make water management system in Field Prabumulih really complicated as shown in figure 1.

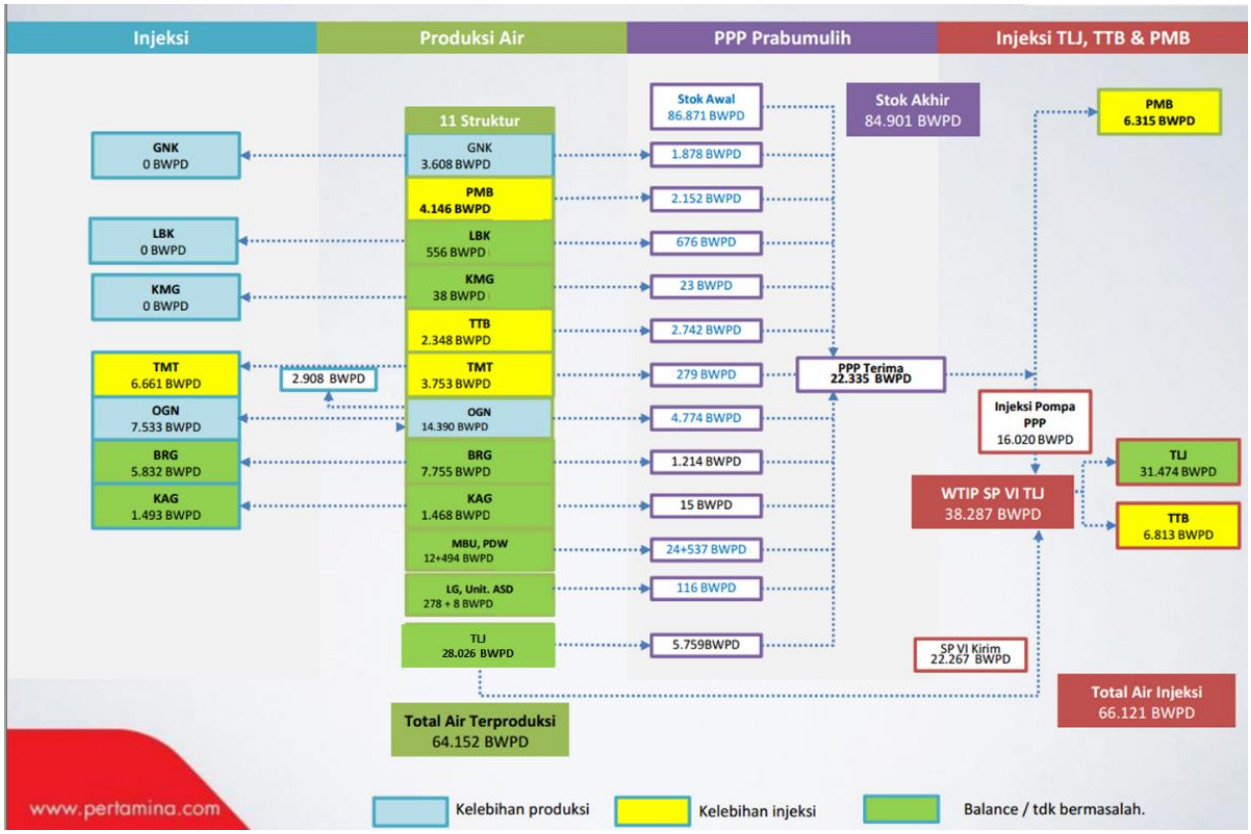

Figure 1. Water Management System Field Prabumulih

Excessive water produced that received by Prabumulih Main Gathering Station causing three major problems:

- High Water Stock in MGS production tank. To prevent overflowing water from the tank, several producing well with high water cut was shut in. Loss Production Opportunity due to this problem was 4040 Bbl Oil in 2021.
- High water stock cause inadequate oil and water separation in Main Gathering Station that led to high Salt Content in the Crude oil to be sales to the customer
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- Water produced that has been separated from oil in Prabumulih MGS is pumped to SP-6 Talang Jimar and SP TTB. High pump pressure is needed to pump that huge amount of produced water, unfortunately most of the flowline facilities are old and causing leaking. Produced water discharge even in small quantity also causing environmental and social problem.

Therefore, a comprehensive strategy was needed to be able to implement appropriate water management.

2 Methods, Procedure and Process

2.1 Clustering Strategy

There are several obstacles regarding the implementation of appropriate water management in this case: production facility, budget limitation, fluid properties, subsurface condition, and social problems. In order to simplify the framework of water management in Field Prabumulih, execution strategy is conducted based on grouping the work program (Clustering) that has similarities (scope of work and location) and alignment with plan of further development. This is a cost-effective strategy since it can reduce investment cost around eight million USD from redundant Water Injection Facilities from every structure in field Prabumulih. Four cluster are defined as illustrated in figure 2.

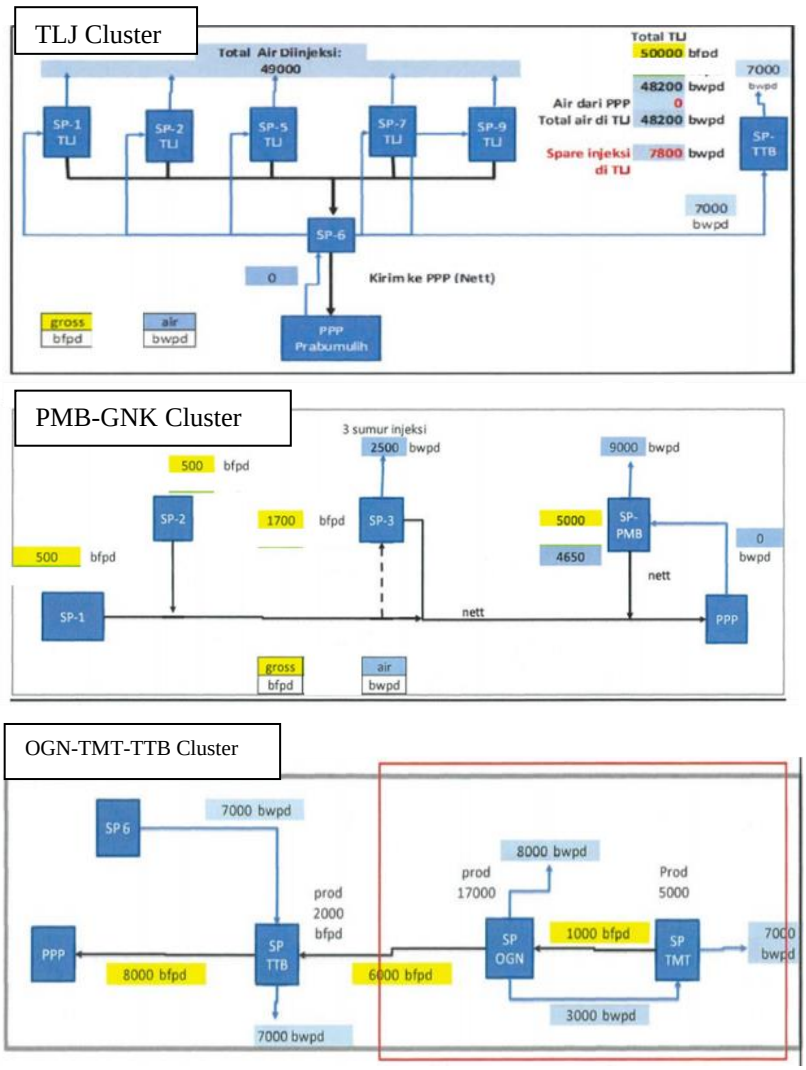

Figure 2. Clustering Strategy

Subsequently, the strategy to overcome water-management issues is divided based on four cluster as described on Table 1.

2.2 Planning Phase

The strategy to overcome water-management issues is divided into four phases: planning, execution, monitoring, and evaluation phase. The planning consists of determining work program that divided into short-term, medium-term, and long-term program based on prioritization. Work program prioritization is based on careful consideration of cost, impact and complexity of each project such as illustrated in figure 3.

Table 1. Water Management strategy for each cluster

Cluster	Issues	Solution	Impact	Cost
TLJ-TTB	Water Injection Flowline Integrity	Flowline replacement with non-metal	Medium	Low
PMB-GNK	Inadequate Injection Well in GNK & PMB	Searching for candidate of Water Injection Well Conversion program from idle / low producing well	High	Medium
	Inadequate Water Handling Facilities in PMB	Water injection plant construction in PMB	Medium	High
OGN-TMT	Injection trunkline plugging due to scale deposit (SP OGN to SP TMT)	Trunkline replacement with non-metal	High	Medium
BRG-KAG	Inadequate Injection Well in BRG	Searching for candidate of Water Injection Well Conversion program from idle / low producing well	High	Medium
	Inadequate Water Handling Facilities in BRG	Water injection plant construction in BRG	Medium	High
OGN-TMT to TTB connection	There is opportunity to inject more water in TMT Structure	Construction of water injection trunkline from TTB to OGN	High	Medium
All	Bad produced water quality to be injected into injection well	Injection of chemical to treat produced water	High	low

Figure 3. Work Program

2.3 Execution phase

According to this case, it discovers that every phase of the strategy has its own level of complexity. Whereas the most challenging phase is the execution phase.

2.3.1 Short Term

The quick win program was conducted successfully in 2019 and gives significant impact.

- PMB-31 and PMB-32 workover program is successfully increasing water injection capacity in SP PMB with injection rate of 12,000 BWPD
- BRG-17 workover program is successfully increasing water injection capacity in SP BRG with injection rate of 4,800 BWPD
- GNK-66 and GNK-13 workover program is successfully increasing water injection capacity in SP BRG with injection rate of 2500 BWPD
- Replacement of 3 water injection flowline with non-metal in talang jimar structure.

This quick win program significantly decrease flowline leaking frequency and led into zero produced water discharge

2.3.2 Medium Term

- Bad water produced quality that injected into water injection well in Field Prabumulih causing severe problem: corrosion in the surface facilities and plugging in the injection well. Untreated produced water in Field Prabumulih quality is shown in table 2.

Table 2. Water Management strategy for each cluster

ANALISA	SP 6 TLJ inlet WS	SP 6 TLJ Outlet Skimmer	SP 3 GNK	SP OGN	SP PMB	SP TTB	SP 1 TMT	SP BRG	SP KAG	Persyaratan Pertamina		Struktur yang tidak memenuhi syarat
										Nilai	Satuan	
Scale Index	0,58	0,79	0,84	1,25	1,09	1,8	1,35	0,7	0,83	0		All
Corrosion Rate			-	-						< 3	MPY	All (History kebocoran)
Bacteri (col/CC)	10^5-10^6	10^3-10^4	10	10	10^5 - 10^6	10^5 - 10^6	10^5 - 10^6	10	10-100	< 100	Coll/CC	TLJ,PMB,TMT,TTB
Turbidity (NTU)	237	51	461	119	575	80,9	128	196	128	< 5	NTU	All
Oil Content (PPM)	>2000	935	872	157	255	940	139	102	190	< 5	PPM	All
Dis. Oxygen (DO) (PPM)	0,1	0,1	0,2	0,1	0,5	0,2	0,2	0,3	0,1	< 0,2	PPM	PMB, BRG
Total Suspended Solid (TSS) (mg/l) Dengan membrane filter test	240	30	58,33	51,69	95	54,29	60	42,59	25,83	< 7	mg/l	All
Relative Plugging Index (RPI)	Over Range		36,13	64,45	59,31	106	56,53	75,13	43,89	28,96	<10	All

In 2021 a performance based produced water chemical treatment contract is initiated, and in 2022 this contract is already applied in 8 Structures that has water injection system. After chemical is

injected almost all of the aforementioned water quality parameters are on specification except total suspended solid. To reduce TDS, construction of the water handling facilities is needed (long term work program).

- In 2022 construction of Non-metal trunkline SP Ogan to TMT is finished. This Project giving significant impact to the overall water management system because excess of the water produced in the SP Ogan kan be transferred to SP TMT to be injected into TMT water injection well.
- Construction of TTB to OGN water injection trunkline is ongoing with overall progress of 90% in September 2022

3 Conclusion

- Water production has been a major operational issue that was closely related to oil production activities and also causing environmental and social issue due to flowline leaking.
- In order to simplify the framework of water management in Field Prabumulih, execution strategy is conducted based on grouping (Clustering) into 4 cluster (TLJ-TTB, OGN-TMT, PMB-GNK & BRG-KAG). This is a cost-effective strategy since it can reduce investment cost around eight million USD from redundant Water Injection Facilities from every structure in field Prabumulih.
- The planning consists of determining work program that divided into short-term, medium-term, and long-term program based on prioritization.
- The quick win program was conducted successfully in 2019. workover program is successfully increasing water injection capacity in SP PMB with injection rate of 12,000 BWPD, SP BRG with injection rate of 4,800 BWPD and SP GNK with injection rate of 2500 BWPD. In addition, Replacement of 3 water injection flowline with non-metal in talang jimar structure are strengthening the facilities integrity. This quick win program significantly decrease flowline leaking frequency and led into zero produced water discharge
- Several medium-term work programs were conducted successfully while one program is still on going. Performance based produced water chemical treatment contract is applied in 8 Structures that has water injection system. After chemical is injected almost all of the aforementioned water quality parameters are on specification except total suspended solid. construction of Non-metal trunkline SP Ogan to TMT is finished while water injection trunkline of TTB to OGN is still on going.
- Long term program with high cost of capital is needed to further strengthen water management system in the Prabumulih Field.

Appendices

References

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