Increasing Oil Production at Mature Fields

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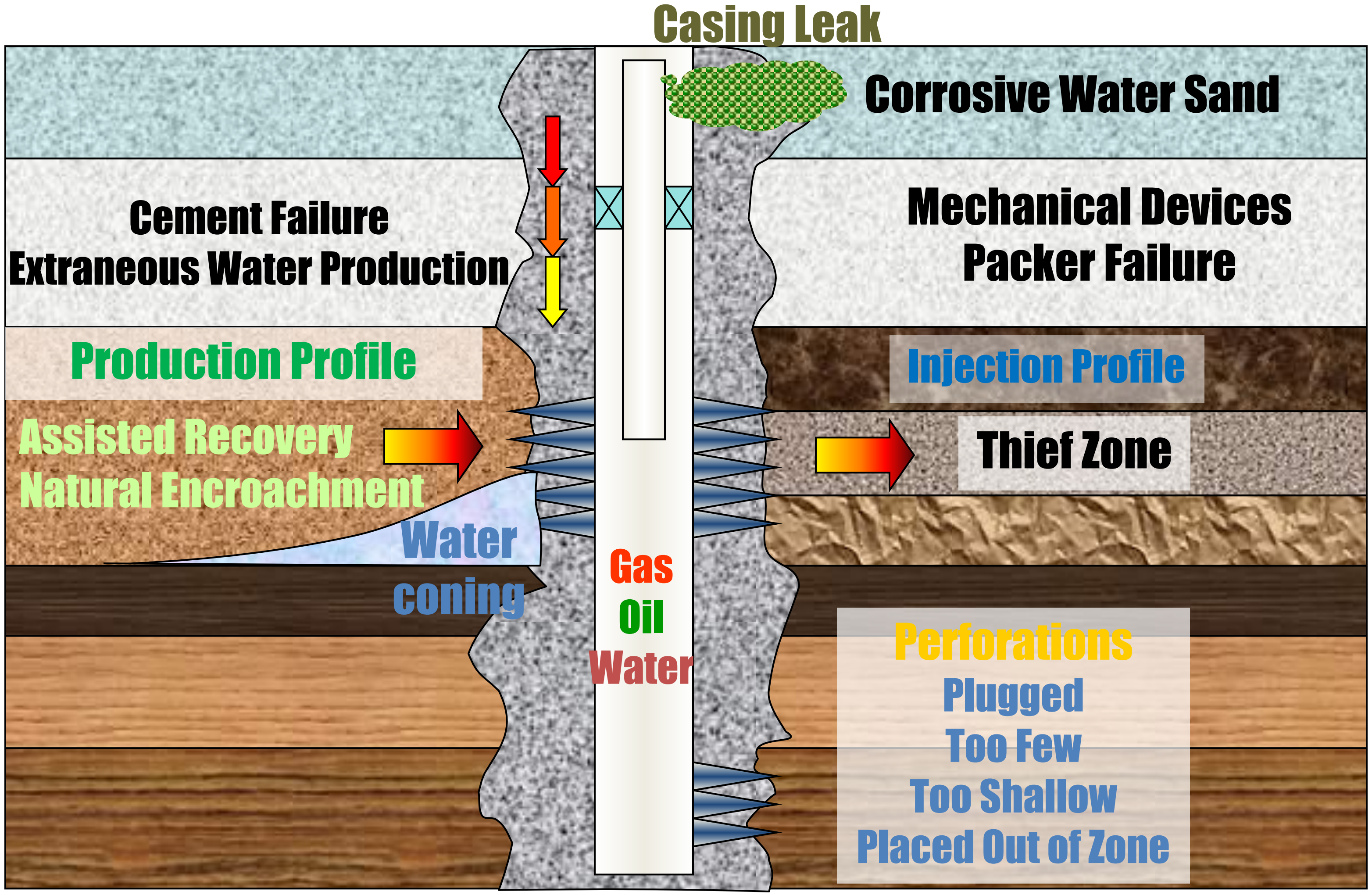
Outline

- Production Problems
- Well Selection for Optimization
- Production Optimization Workflow
- Data Requirement
- Heterogeneity Index Screening
- Identifying Gaps & Opportunities
- Diagnostics
- Design & Recommendation
- Conclusion

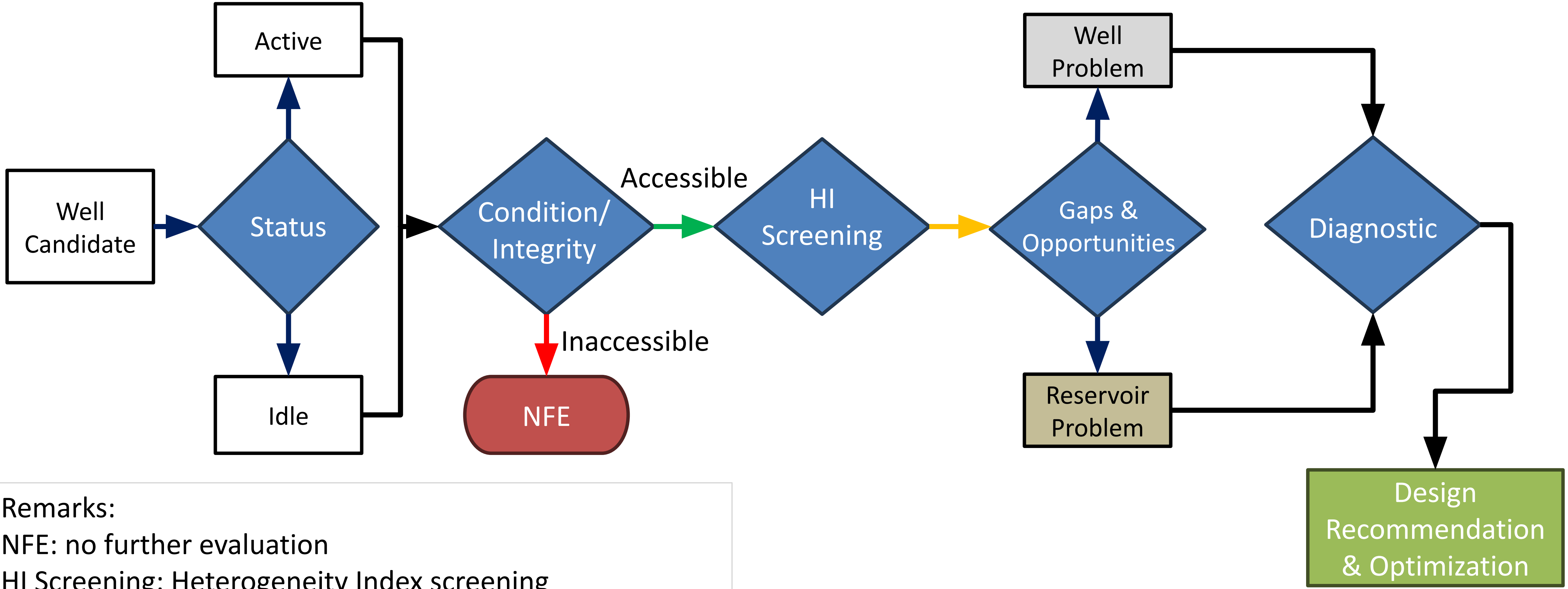
Production Problems



Factors leading to production problems must be analyzed through proper diagnostic methods before deciding on the solution

Lee, J. Does Production Have Problems?; Texas A&M University.

Production Optimization Workflow



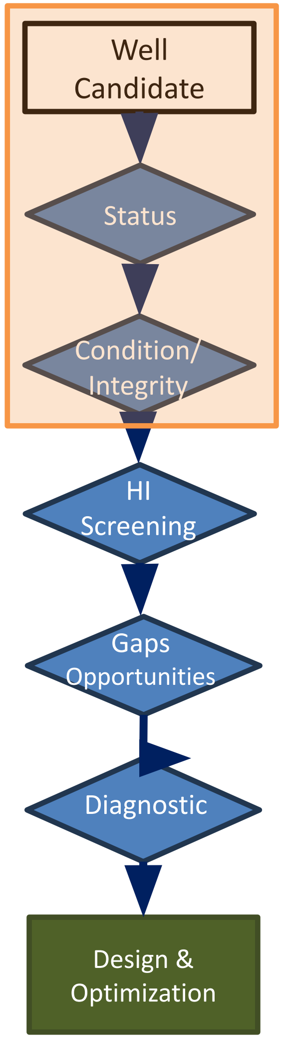
Remarks:
NFE: no further evaluation
HI Screening: Heterogeneity Index screening

Al-Mufarrej, M. M., Abdel-Basset, M. ., Al-Mutawa, M. ., Chetri, H. B., Anthony, E. P., al Zaabi, H. A., Bolanos, N. ., Ruiz, H. ., Chernikoff, A. ., & Harami, K. K. (2017). Integrated and Structured Production Optimization Workflow Provides Robust Platform for Significant Oil Gain to a Mature Oilfield. Day 4 Thu, March 09, 2017. https://doi.org/10.2118/183952-MS

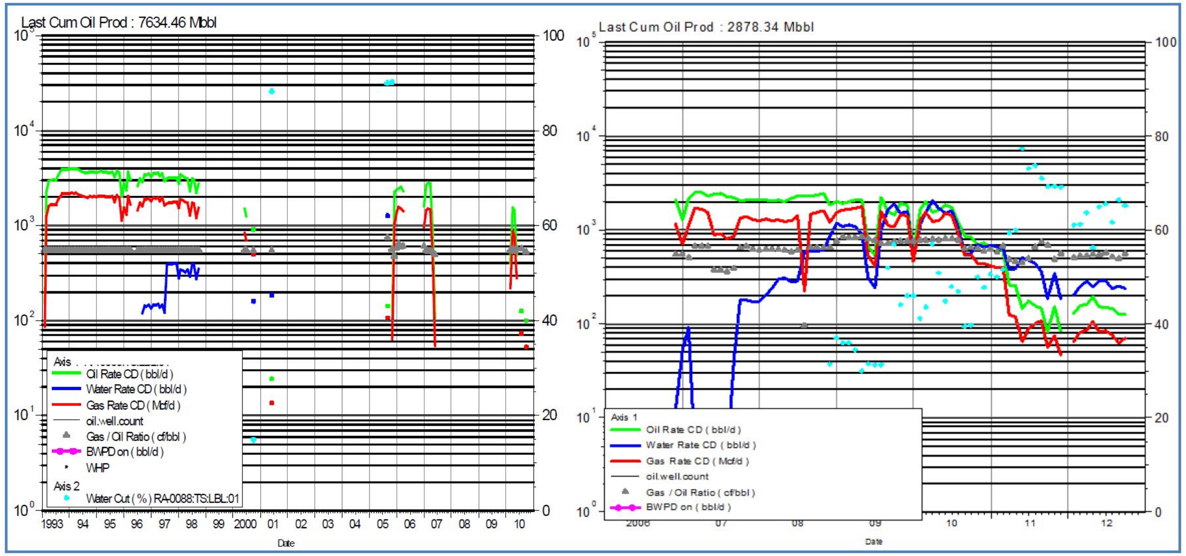
Well Selection for Optimization

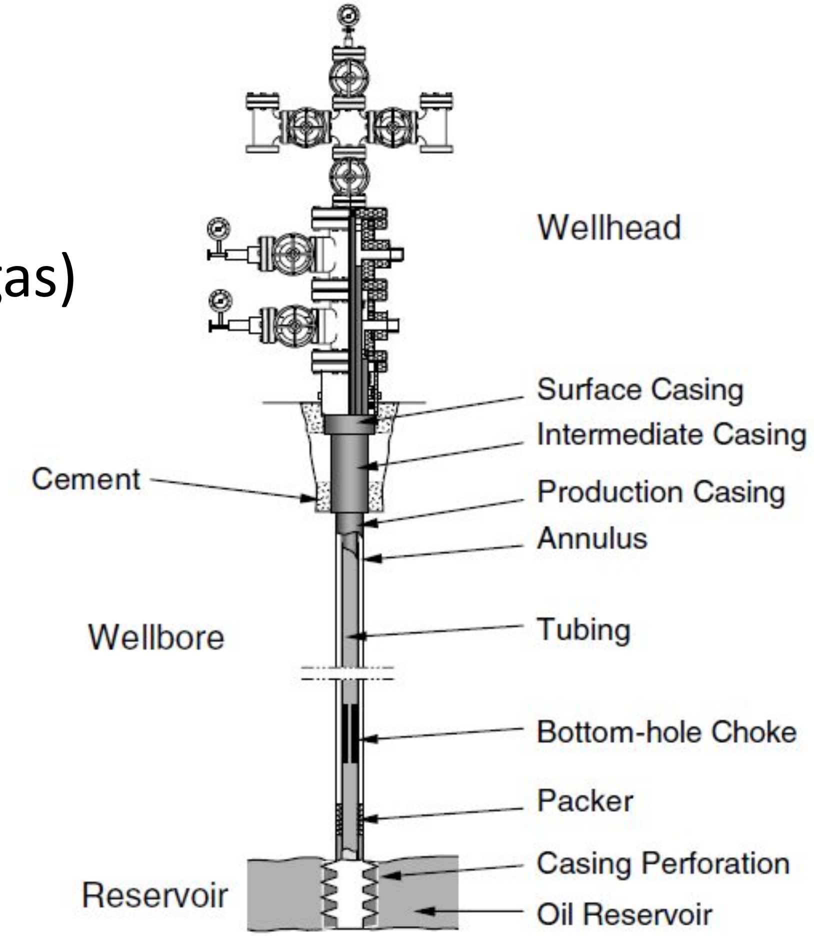
1. What is the well status? (active or idle)
2. How is the condition of the well? (*accessibility*, *well head availability*, *existing pipeline*, *well integrity*)?
3. Does the well still have economical estimated ultimate recovery (EUR)?
4. Does the well have reliable production records for analysis?
5. Problem evaluation:
   a. *Reservoir problems: water coning, cresting, fingering, channeling*
   b. *Well problems: casing leak, corrosion, cementing problems, mechanical failure, misfired perforation*
6. Technical recommendation will be decided based on the identified problem(s)

Data Requirement



- Well status, location, condition
- Well schematics (inc. perforation history)
- Estimated ultimate recovery (by well)
- Historical production data (oil, water cut, gas)
- Installed artificial lift system
- Well test data (DST, swab)
- Well logs & petrophysical markers





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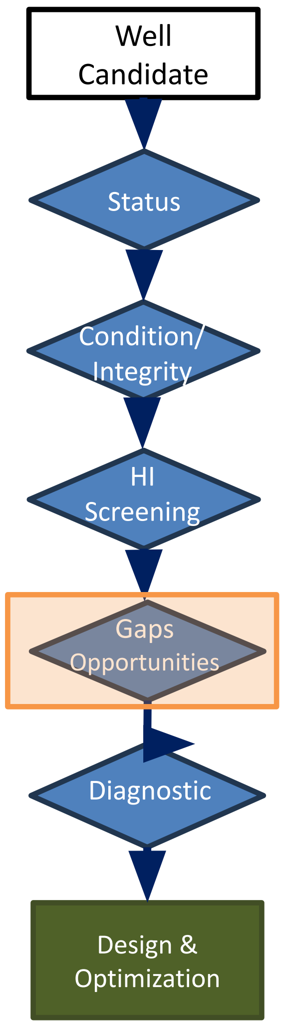
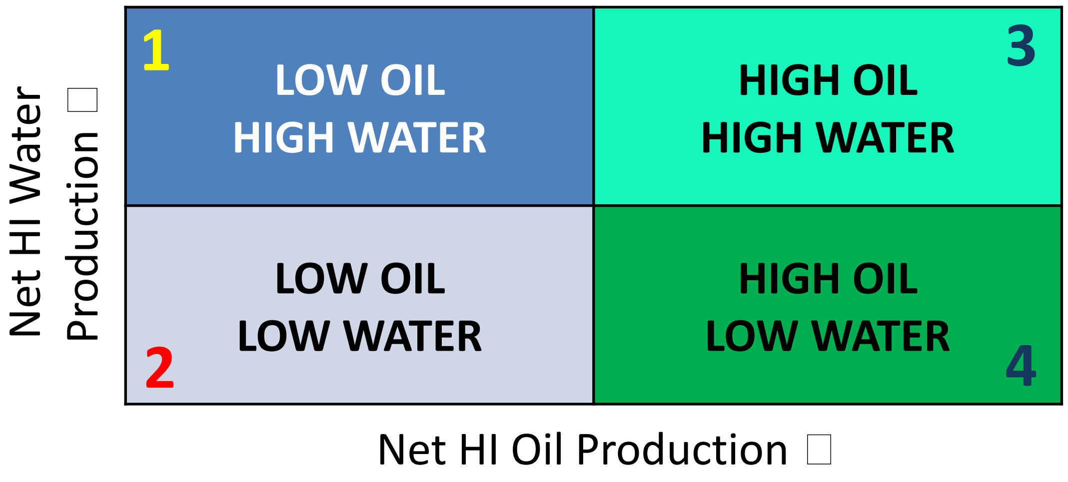
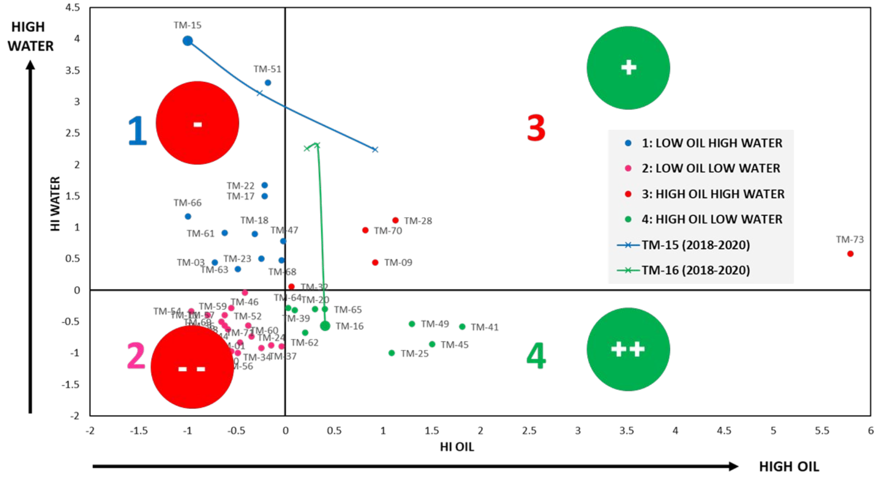
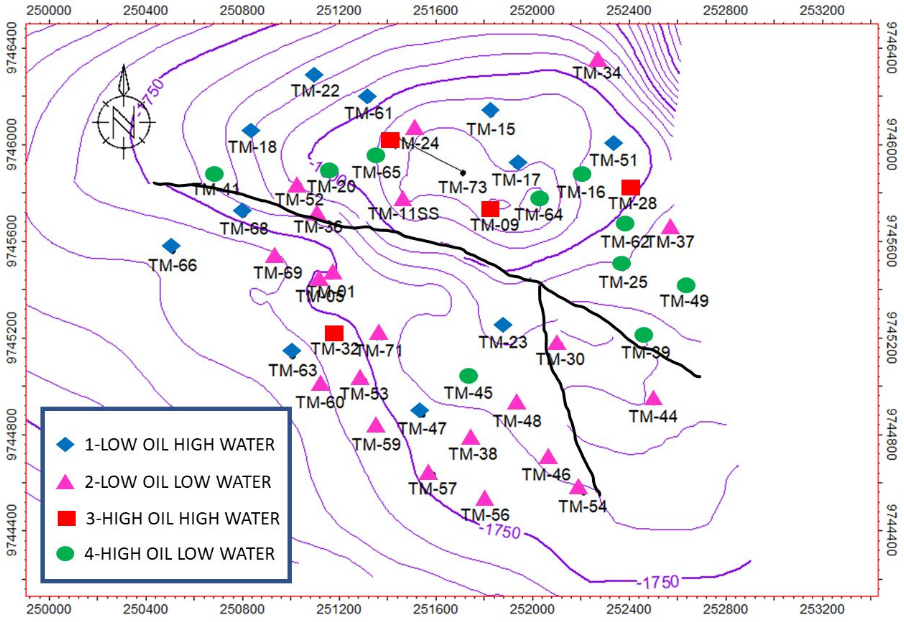
Heterogeneity Index Screening



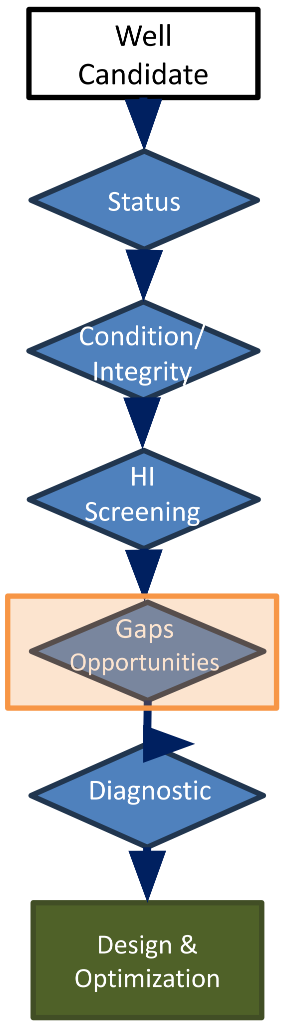


- HI screening provides quick outlook to identify over/under-performing wells
- Selected wells or clusters will be diagnosed to identify the production problem
- Prioritized wells will be optimized and impact of technical intervention will be forecasted

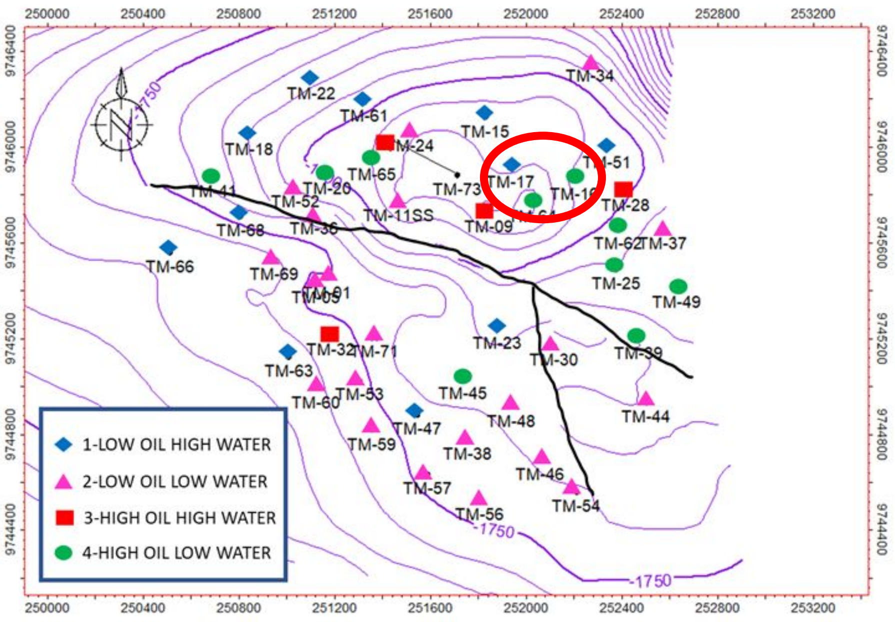


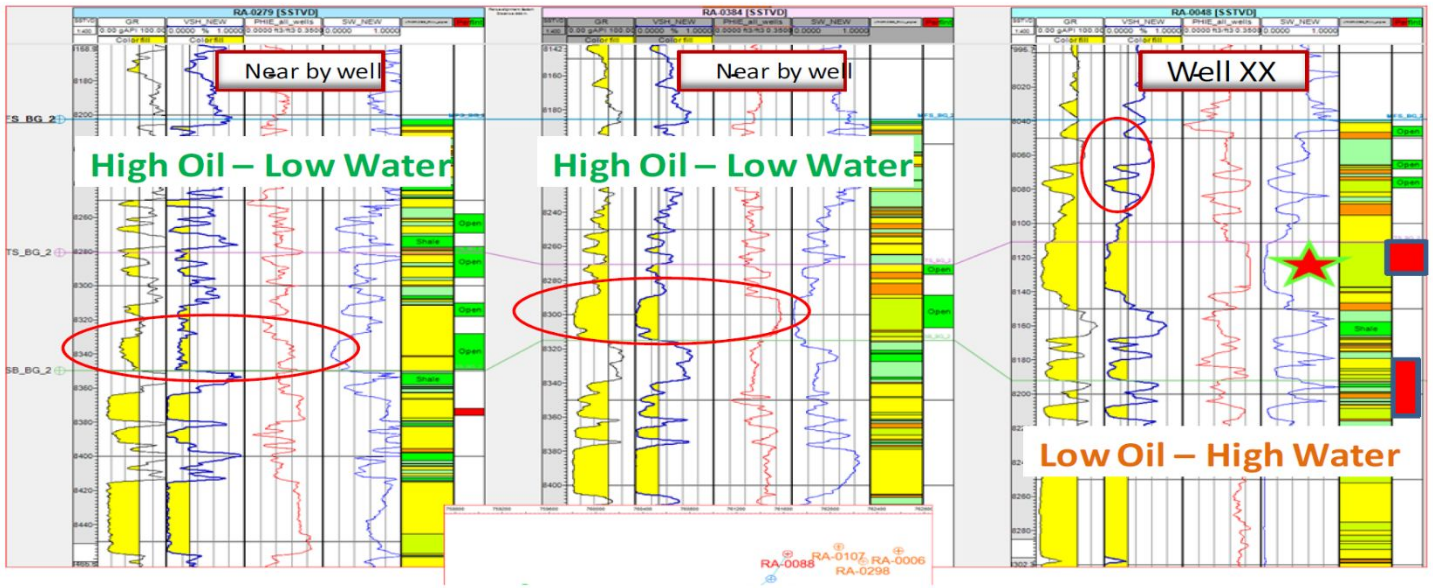


Identifying Gaps & Opportunities

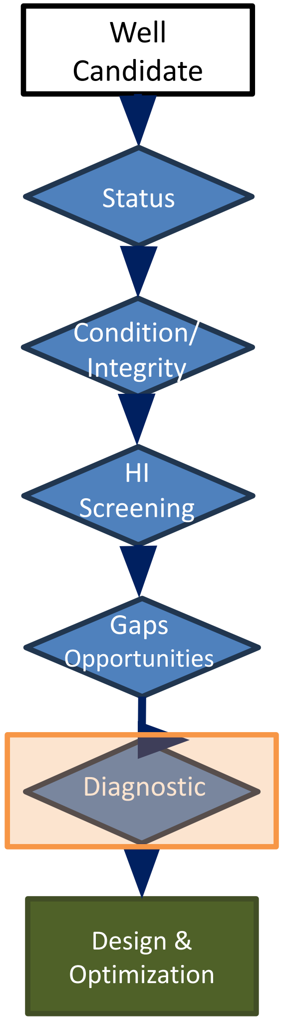


- Select Candidate (From HI plot)
- Log/PLT Review
- Perforation Analysis
- Production History Analysis
- Behind Casing Opportunity
- DCA
- etc..





Diagnostics



$$E_R = (m \cdot X) + n,$$

where

$$E_R = \text{recovery},$$
$$X = \ln[(1/f_w) - 1] - (1/f_w),$$
$$f_w = \text{fractional water cut},$$
$$m = 1/[b(1 - S_{wi})],$$
$$n = -1/(1 - S_{wi})[S_{wi} + 1/b \ln(A)],$$
$$A = a\ (\mu_w/\mu_o),\ \text{and}$$

a and b from

$$k_{ro}/k_{rw} = a\ e^{bS_w}.$$

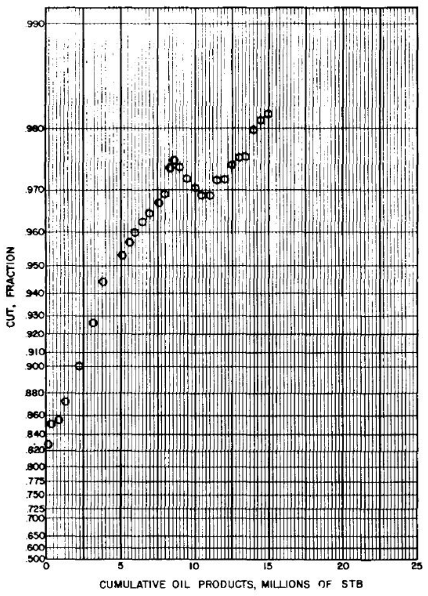


Fig. 12—Performance of the East Burbank flood on the cut

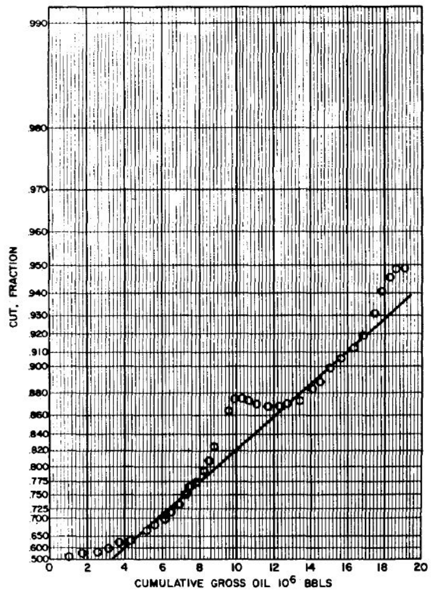
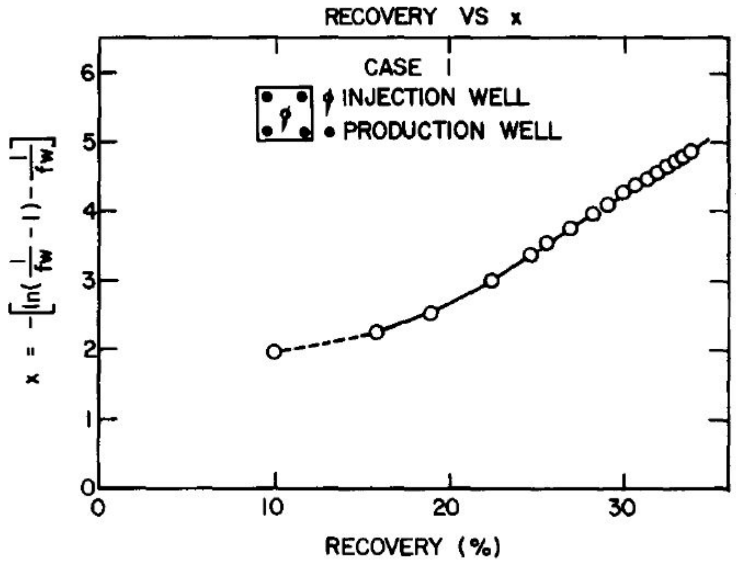
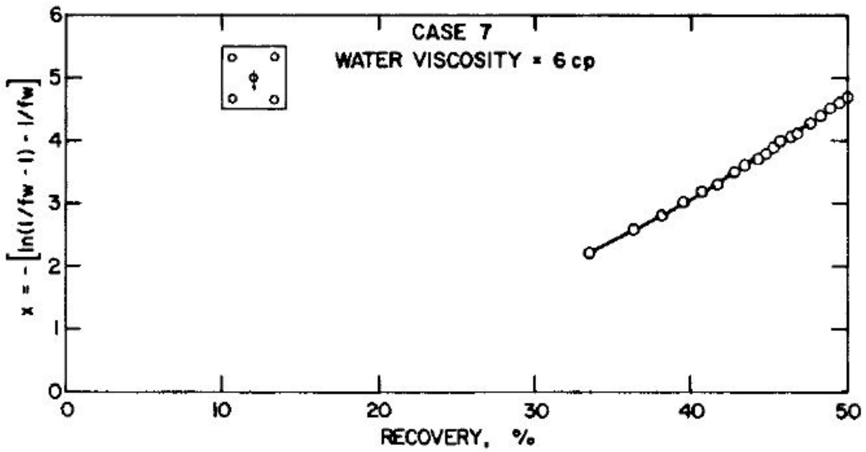


Fig. 14—Performance of the Main and 99 East pool on the





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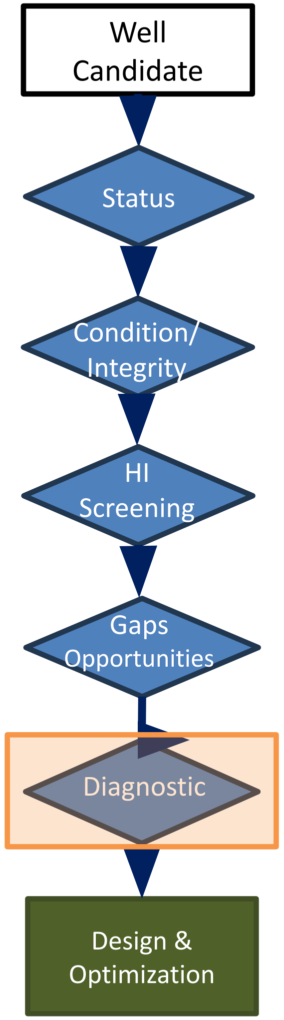
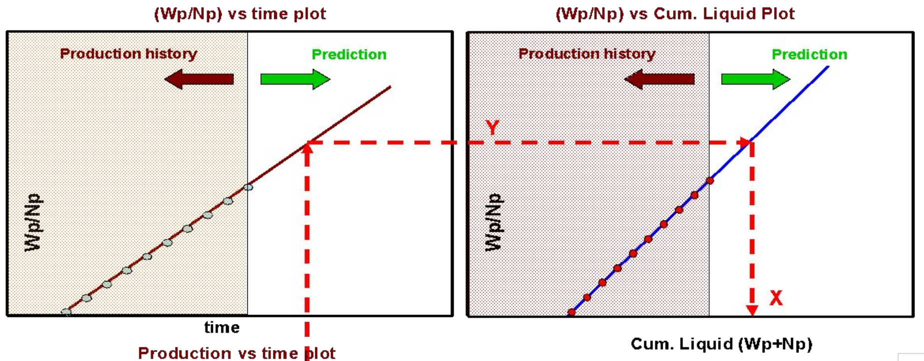
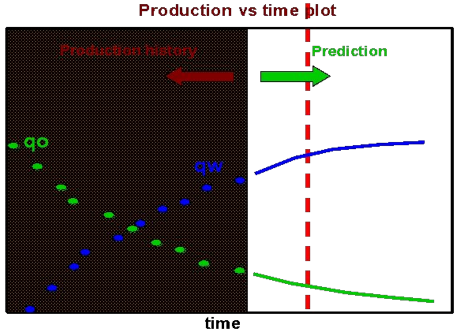
Diagnostics







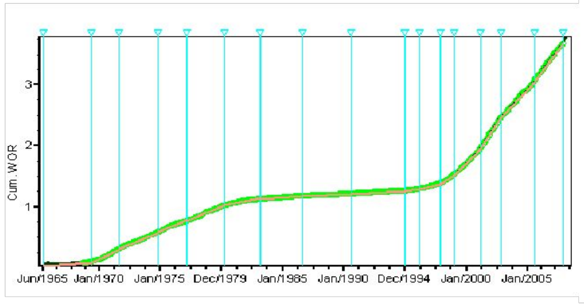
Calculate prediction rate using this relationship :

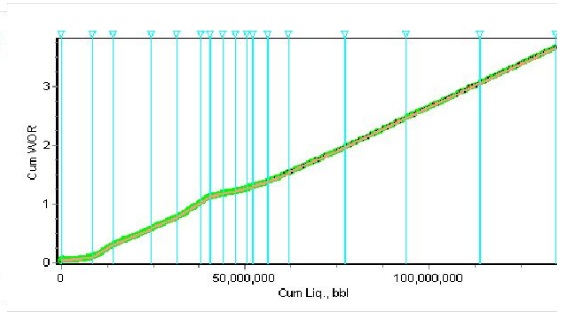
(Wp/Np)=Y and (Wp+Np)=X

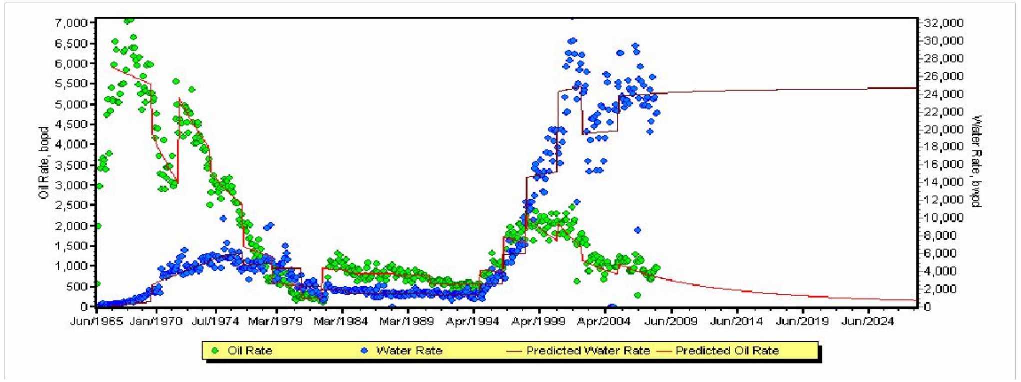
and then

Np = X/(1+Y) and Wp=(X.Y)/(Y+1)

Predicted rate will be equal to the additional Np or Wp for every unit time used

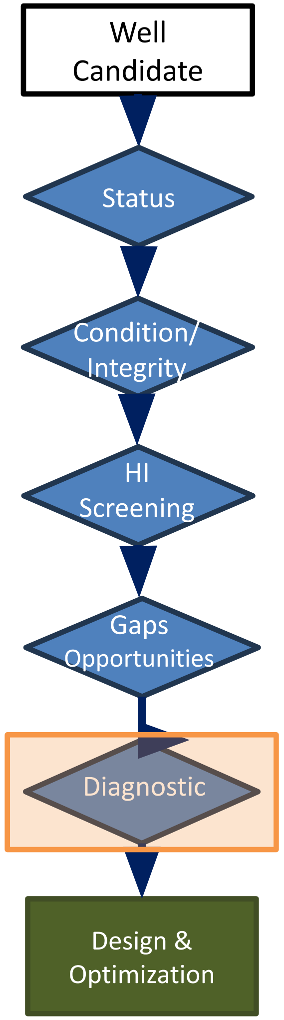


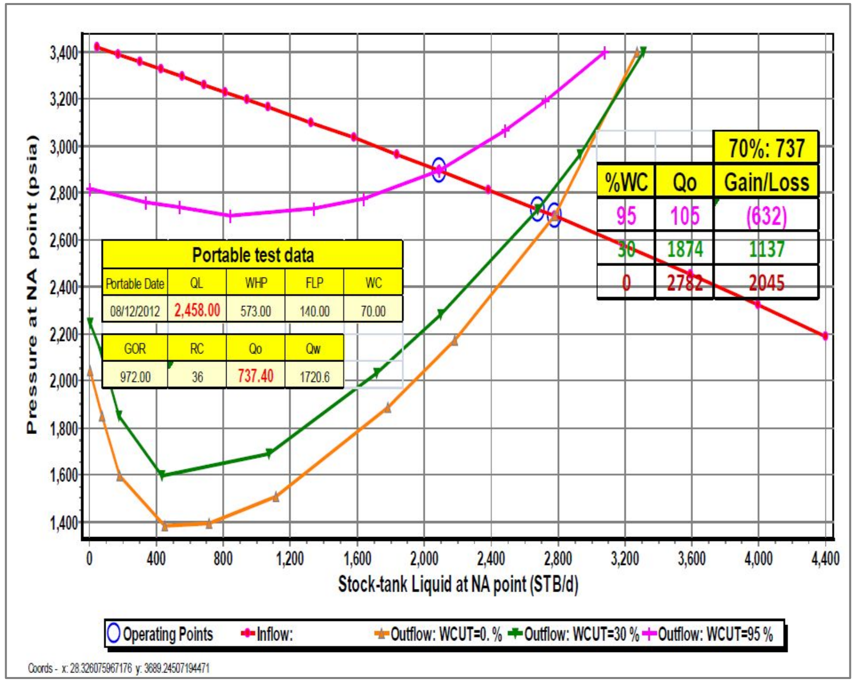


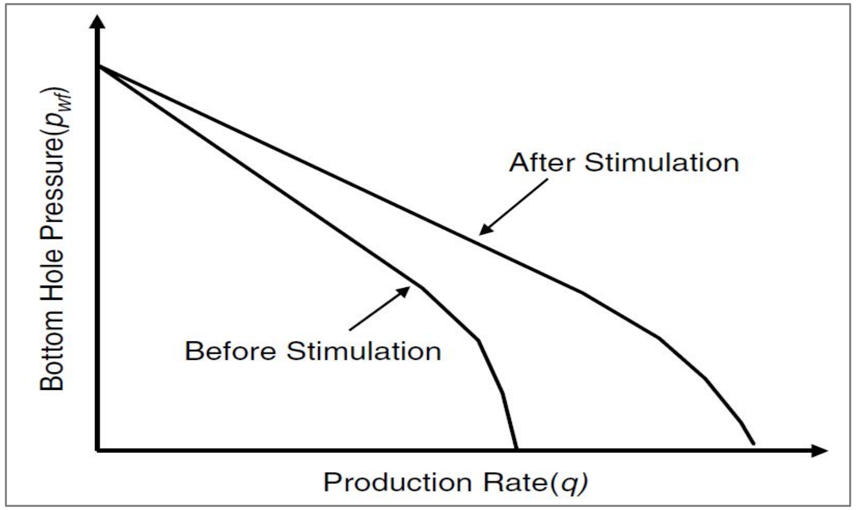


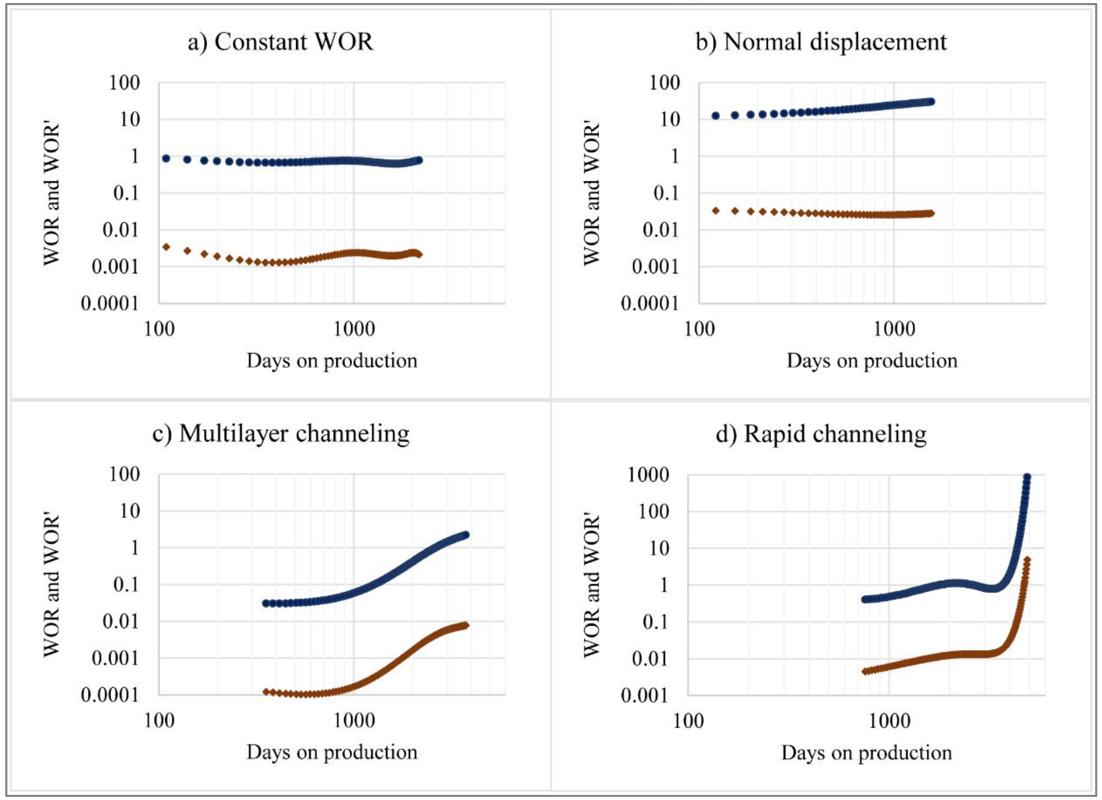
Irawan, D., & Abdassah, D. (2012). METODE EVALUASI DAN PERAMALAN KELAKUAN PRODUKSI UNTUK APLIKASI DI LAPANGAN LAPANGAN TUA (BROWNFIELDS)

Diagnostics









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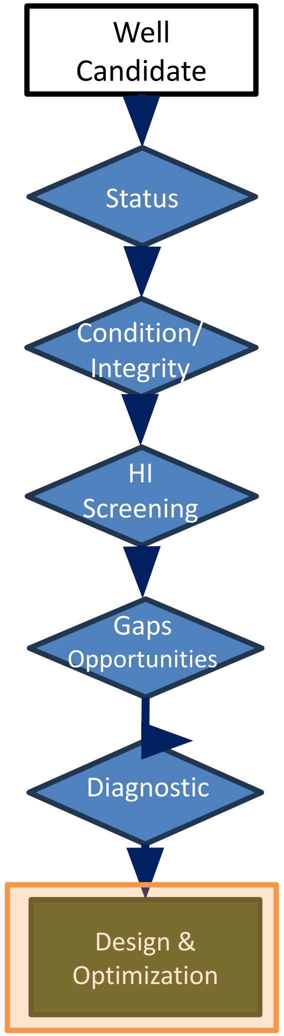
Design & Recommendation



Technical recommendation shall be formulated based on identified problems on every well.

Water Coning →	Qcrit & AOF evaluation	Near-Well Reservoir Intervention
Suboptimal flow →	Ar-Lift Optimization	Hydraulic/Acid Stimulation
Well Integrity Prolblems →	Well Service Technologies	
Depleted →	P&A	

Example of Recommendation

Well	Shut In Reason	Normalized *				Sum of Aditive Factor	Well Intervention Type	Ease of Intervention (Multiplication Factor)	Well Performance Index
		BCO	Cum production	Prediction gain	Other parameter				
Well X	High WC	0.37	0.36	0.89	0.23	1.85	PLT, WSO & Leak impairment	0.51	0.9435
Well Y	Mechanical	0.35	0.6	0.9	0.32	2.17	Fishing	0.95	2.0615
Well Z	High WC	0.55	0.19	0.92	0.14	1.8	WSO & Leak repairment.	0.9	1.62
Well A	Low Influx	0.27	0.97	0.77	0.28	2.29	fracturing	0.79	1.8091

Each well will be scored based on various engineering aspects, e.g.:

- Forecasted production gain from well intervention/stimulation
- Expected cumulative production
- Other parameters including well's remaining reserve, uncertainty factors, etc.
- The score is normalized relative to the maximum corresponding values at each aspect

Economics, operational difficulties, and other factors unique to the operator should be quantified as "multiplication factor", which may reflect ease of intervention

Well Performance Index is calculated as product of normalized additive factor and multiplication factor

Simple Economics Model

Case Study: Well ZZ-10 that is listed as idle wells potential with the following information.

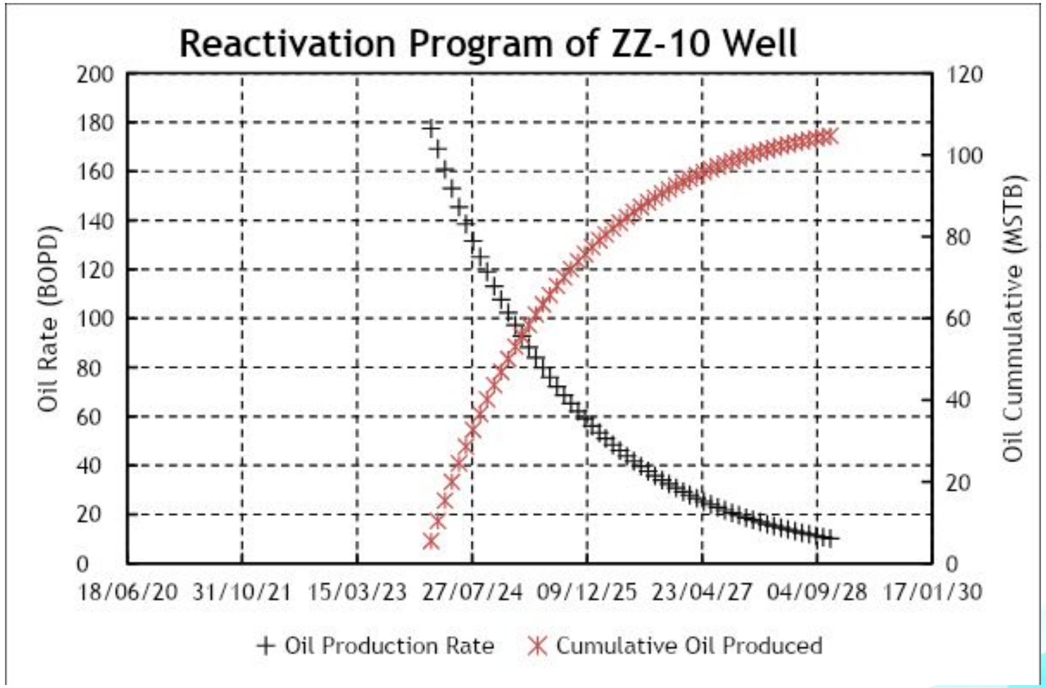
Well	Status	Layer	Depth (ftMD)	Perf. Status	Fluid Type	Liq Gain (BFPD)	Rem. Reserve (MSTB)	Remarks
ZZ-10	Idle	A3	6760-6774 & 6780-6788	Open	Oil (Tested WC 0%)	177.44	361.35	Shut in due to no flow, suspected tubing leak from FGS

Assuming decline rate of 60% per year and economic limit of 10 BOPD (no changes in water cut) and the following cost structure,

- Oil price assumption (constant) of 65 US$/bbl
- Lifting cost of 12 US$/bbl
- Workover cost of US$ 350,000

The resulting Benefit/Cost (B/C) calculation indicates the value of 5.83. In conclusion, based on the assumed cost structure ,the project is economically feasible and prospective to be developed.

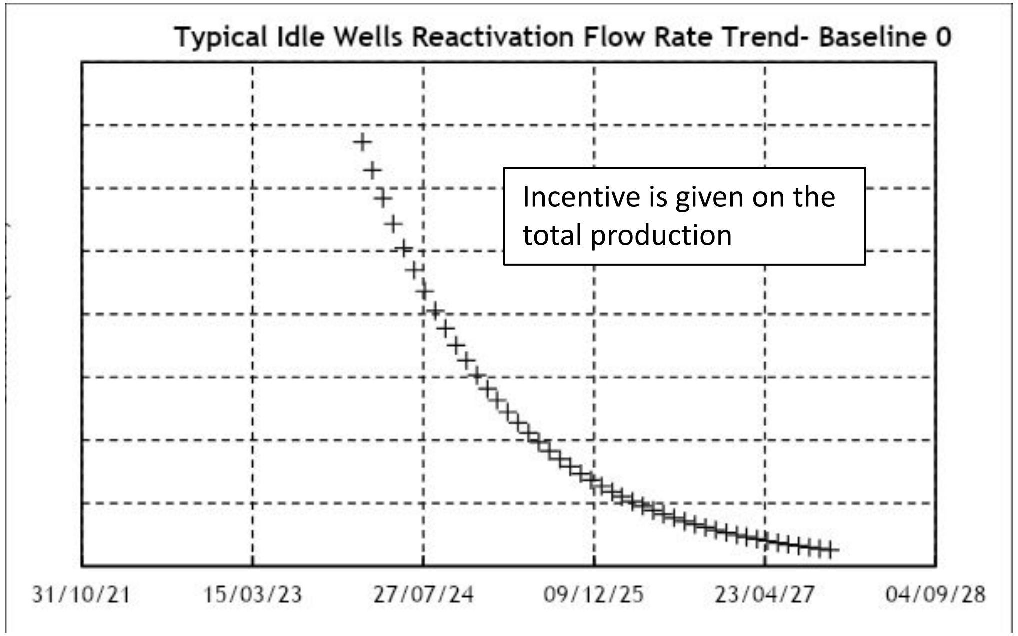
*Disclaimer: all costs are based on ITB's estimation and will be updated with respect to current field condition.

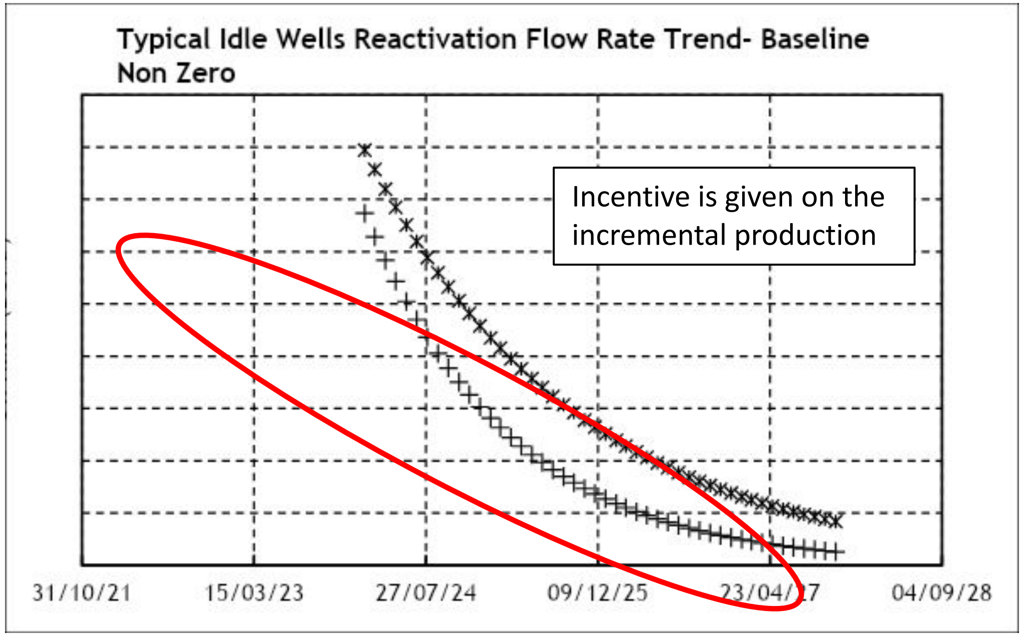


Improving Investment Climate for Idle Wells

In order to increase the willingness of contractors (i.e., K3S) to perform more idle wells reactivation, ITB proposes that Government of Indonesia (GoI) provides incentives when idle wells reactivation are proposed in OPL (Optimasi Pengembangan Lapangan/Plan of Further Development), with the following reasons.

- Incentives will encourage contractors to perform a deep dive on current idle wells to identify more opportunities
- Incentives will encourage higher spending related to ensuring safety and operability of the reactivated wells (i.e., well integrity issues, leak detection, etc.)
- Incentives will be able to encourage investment most notably in marginal wells with higher technical risk (e.g., wells with notable production problems, higher operating cost, etc.)





Conclusion

1. Indonesia has thousands of wells with their own unique problems. The proper intervention for each well shall be prescribed based on robust analysis and diagnostics.
2. The workflow for optimization of wells in mature fields has been established based on well-understood petroleum engineering practices. The workflow reflects the needs for multidisciplinary team and approach.
3. While the workflow itself is robust, the application still needs reliable and detailed database, especially well production history and petrophysics.
4. Real application of the workflow is ongoing, and its outcomes shall be witnessed soon.
5. In order to increase the willingness for contractors to perform idle wells reactivation, ITB proposes that incentives will be given based on the production baseline.

References

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Terima Kasih