Carbon Storage and Management

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Carbon, Capture and Sequestration (CCS) Screening for Depleted Clastic Oil and Gas Field in PM3 CAA Block, Malaysia

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Presentation Outline

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- Executive Summary
- Field Overview
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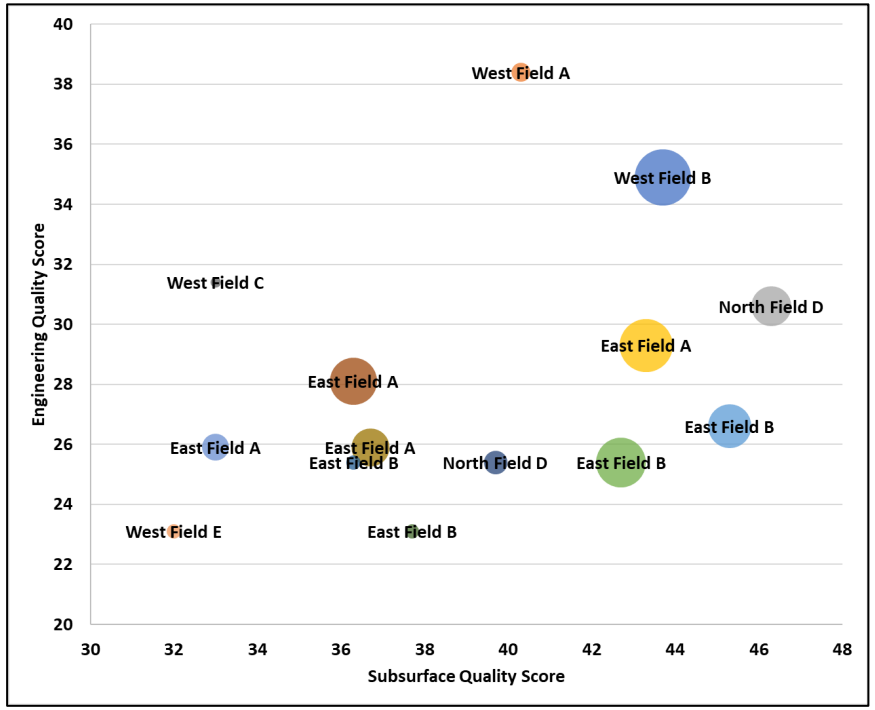
- Sequestration Scorecard Matrix
- Reservoir Ranking
- Conclusion

Presentation Objective

To share Hibiscus Malaysia (HM)'s approach **in screening and selecting suitable depleted clastic oil and gas fields** candidates **for CO2 storage** in the PM3 CAA Block **Offshore Peninsular Malaysia**.

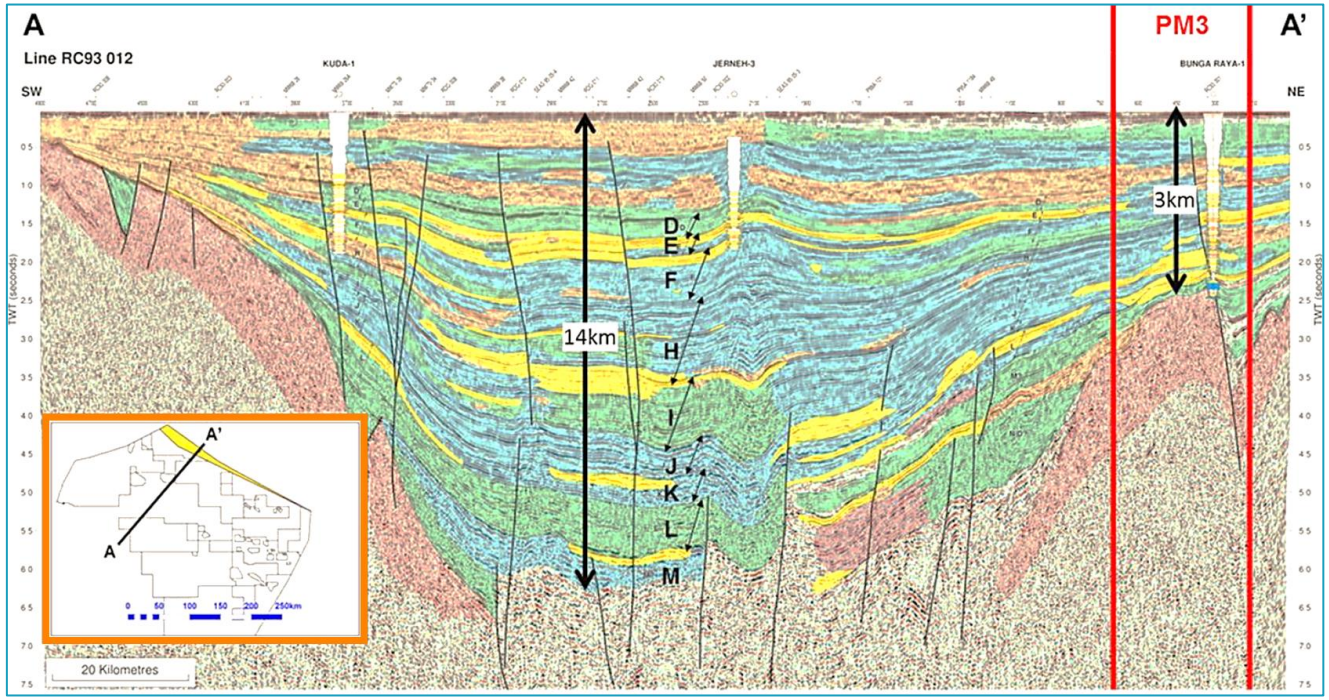
Executive Summary

- PM3-CAA fields vented a total GHG volume of approximately **61.5Bcf and 60.9Bcf in year 2022 and 2023** which at present emits about 200MMscfd with typically about 90% CO2 and 10% methane
- Therefore, CCS study was initiated to reduce CO2 emission which will also be aligned with Petronas commitment to reduce carbon emission.
- PM3 CAA CCS **study commenced in April 2023** and was divided into 2 main phases:
  - **Phase-1**:Pre-screening assessment of depleted hydrocarbon reservoirs, wells and topside facilities (Completed)
  - **Phase-2**: Detailed subsurface feasibility and wells studies (On-going)
- Outcome from Phase-1 Study shows that PM3 CAA will have sufficient storage from depleted gas reservoirs to handle current base production and upcoming future projects and tie-ins.
- With the above screening methodology and selection criteria, only 14 depleted gas reservoirs have been selected, with a **total estimated storage capacity of 930 Bscf**
- Collaboration study with our consultant SLB

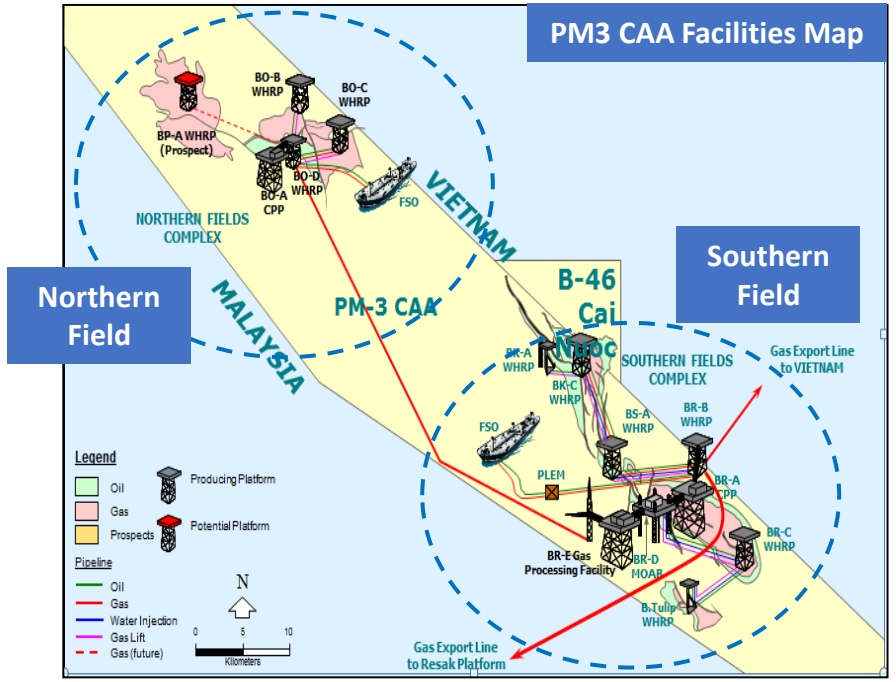


Selected Reservoir Through Phase 1 Screening for CO2 Sequestration in PM3 CAA

Field Overview PM3 CAA Block

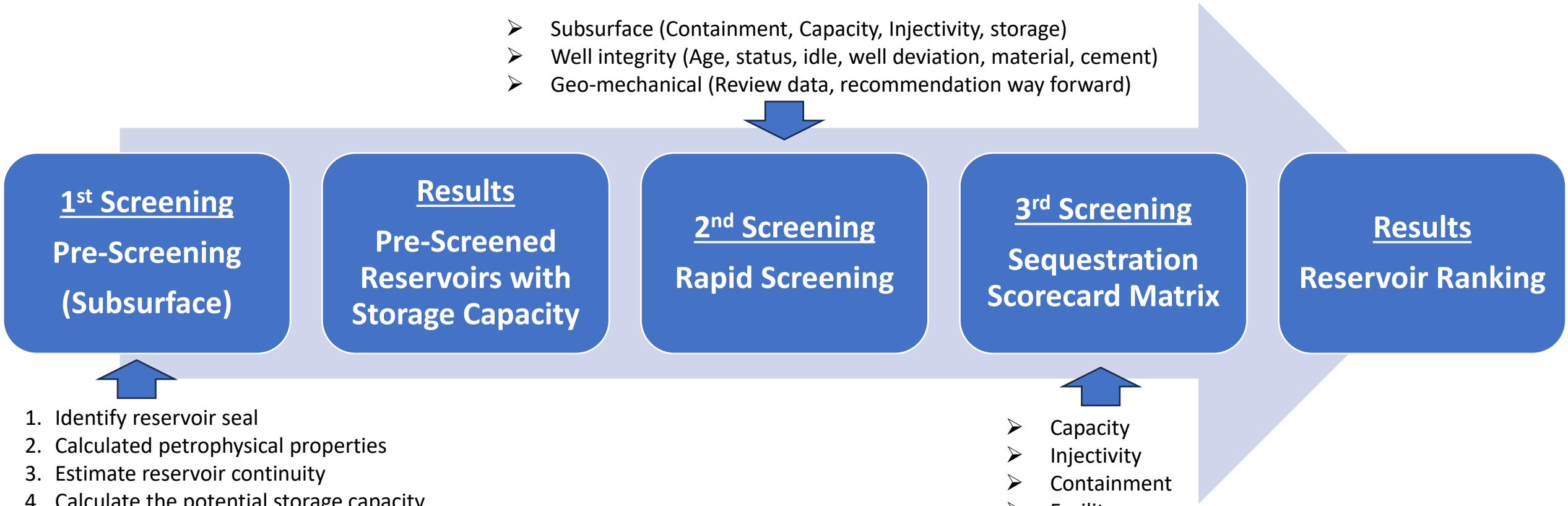


- Located on the N-E margin of the Malay Basin
- Located at the basement high, 3km stratigraphic zones thinning from the center of the basin which is 14km thick



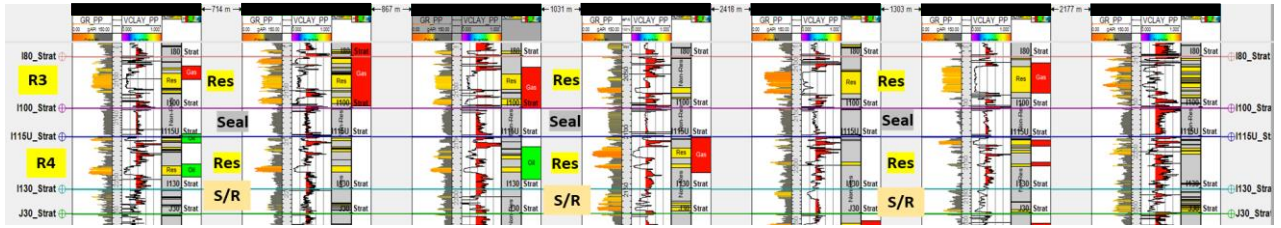
Northern Field	Southern Field
6 Fields	7 Fields

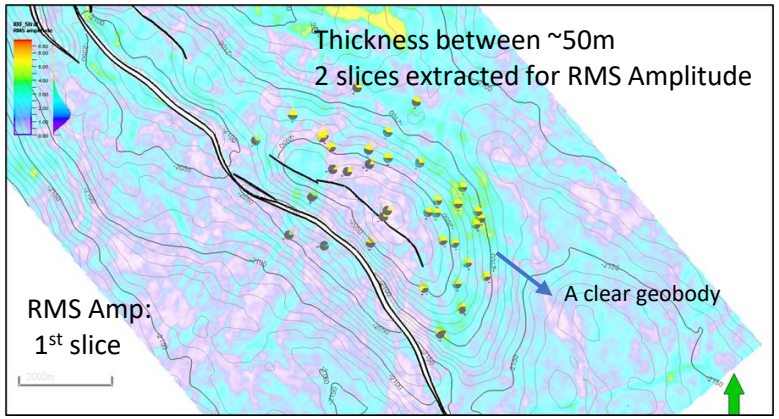
Screening Workflow

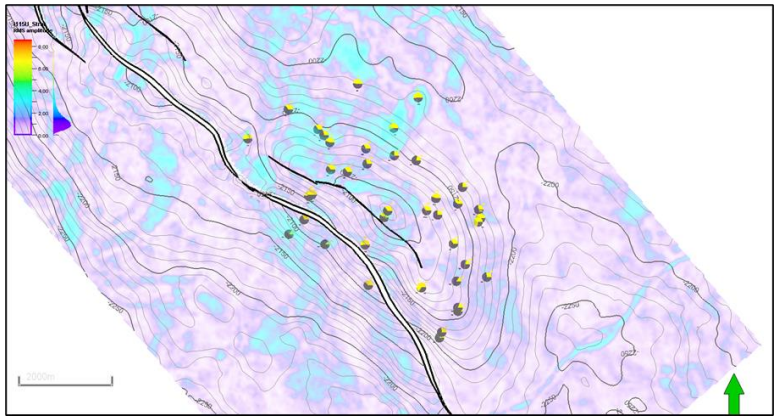


Pre-Screening Workflow

- Identify reservoir seal pairs for all the fields.
- Calculate petrophysical properties of the identified pairs.
- Estimate reservoir continuity (Low, Medium, High) based on X-section and Proportional Surface attribute maps.
- Calculate the storage potential for each reservoir (deterministic).
- Filter the reservoir with High and Medium continuity.
- Filter the reservoir with an estimate storage capacity above 20 BSCF.
- Estimate the potential for comingled injection for reservoir with High and medium continuity.







Reservoir package	Continuity	NTG	Vsh	Porosity	Shortlisted
Reservoir 3	High	0.38	0.15	0.2	Yes
Reservoir 4	Low	0.21	0.16	0.17	No

Gas Reservoir:

$$G_{CO2} = \frac{G_p\, B_g}{Bg_{CO2}}$$

G_p: Amount of gas produced; B_g: Gas Formation Volume Factor; G_{CO2}: CO2 storage potential; Bg_{CO2}: CO2 Formation Volume Factor

Oil Reservoir:

$$G_{CO2} = \frac{G_p\, B_g + N_p(B_o - B_g R_s) + (W_p - W_I)B_w}{Bg_{CO2}}$$

Amount of Oil produced; Oil Formation Volume Factor; Solution GOR; Water Formation Volume Factor; Produced Water; Injected Water

1st Pre-Screening CO2 Storage Capacity

No	Field	Sand Package	Platform	Depleted Year	Storage 100% efficiency (Bscf)	(2) Storage 70% efficiency (Bscf)	
1	East Field A	I10U-I25	Platform 1	2009	79.1	55.4	
2	East Field A	I40U-I68	Platform 1	2031/2033	140.0	98.0	~ 100 Bscf
3	East Field A	I80-I100	Platform 1	2031/2033	156.3	109.4	> 100 Bscf
4	West Field A	I60-I69	Platform 1	2012	55.8	39.1	
5	East Field A	J30-J50	Platform 1	2030	111.6	78.1	
6	East Field B	H2-H3	Platform 2	2013	128.9	90.2	
7	East Field B	H3- H4	Platform 2	2027	146.1	102.3	> 100 Bscf
8	East Field B	I40U-I40L	Platform 2	2024	42.5	29.8	< 30 Bscf
9	East Field B	I23U-I30	Platform 2	2012	41.5	29.0	< 30 Bscf
10	West Field B	H4	Platform 3	2029	166.4	116.5	> 100 Bscf
11	West Field C	K5-K15	Platform 3	2028	31.8	22.2	< 30 Bscf
12	North Field D	Fchannel	Platform 4	2025	116.7	81.7	
13	North Field D	H-H1	Platform 4	2023	70.0	49.0	
14	West Field E	K5-K15	Platform 2	2035	42.4	29.7	< 30 Bscf
				TOTAL	**1329.1**	**930.4**	

(1) Storage capacity of West Field E K5-K15 reservoir is estimated from oil reservoir. Other storage is coming from depleted/almost depleted gas reservoirs

(2) 70% efficiency factor based on widely used in CCS projects

Rapid Screening Workflow

Subsurface

Capacity

Extend of the sand body -> Reservoir properties -> Map based volume estimation calibrated with production data

Containment

Structural complexity -> Number of wells -> Reservoir continuity -> Number of goebodies

Storage & **Injectivity**

Combination of identified reservoir -> production history and historical performance

Well Integrity

Review of 105 wells for the 14 reservoirs

Well integrity components:

- Well age
- Well status
- Idle well period
- Well deviation
- Casing and tubing material
- Cement material
- Annulus pressure issue

Geomechanical

Review existing available data

Recommendations for additional core test program for legacy cored wells

Sequestration Scorecard Matrix

A scorecard Matrix was developed to rank all reservoirs that has been selected from Pre-Screening phase accordingly. The scoring criteria and its weightage is as per below:

Subsurface Quality Matrix

Item	Weightage (%)	Criteria
Capacity	20	➢ Total net thickness ➢ Mean in place volume ➢ Number of reservoir layers ➢ Storage volume estimated ➢ Cum. Gas production ➢ Recovery Factor
Injectivity	20	➢ Definition of seismic attribute ➢ Reservoir layer continuity ➢ Peak production ➢ Injectivity index estimation ➢ Number of wells
Containment	20	➢ Gas accumulation ➢ Presence of fault ➢ Number of wells ➢ Top seal average thickness ➢ Top seal continuity ➢ Maximum column height

Engineering Quality Matrix

Item	Weightage (%)	Criteria
Facility	20	➢ Connectivity well to platform ➢ Injection platform ➢ Intraplatform flowing conduit requirement ➢ Topside modification
Well Integrity	20	➢ Well count ➢ Well age ➢ Idle well ➢ Well head material ➢ Tubing material ➢ Cement material ➢ Production casing material ➢ Well head subsidence/uplift ➢ Well integrity problem

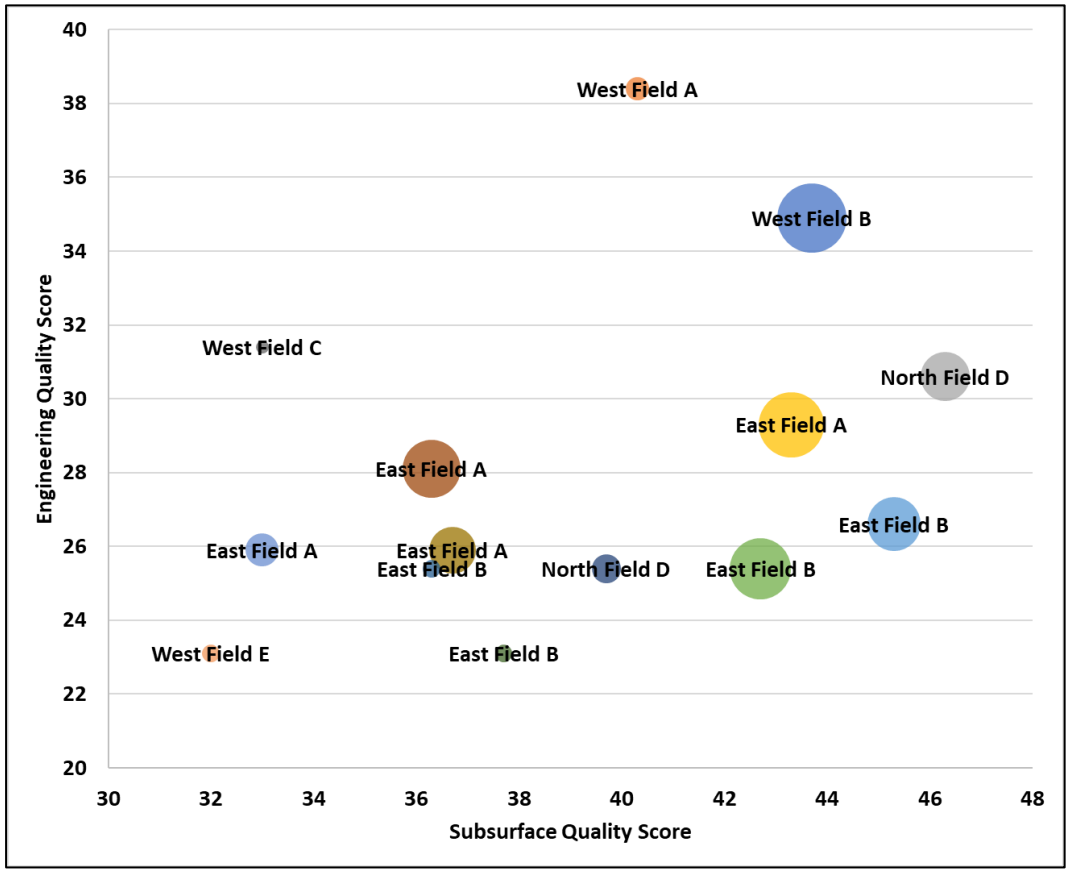
- Each criterion carries a maximum score of 5 points. Scoring type:
  - On scale: 1 (low), 3 (medium) or 5 (high)
- The scoring targets are customized based on the specific status and requirements of the reservoir or field.

Reservoir Ranking

Selection based on below criteria:

- Priority on selection given to BRB and BSA platform mainly due to proximity with existing gas processing facilities.
- Priority given to bigger storage capacity reservoir

Scorecard Ranking	Reservoir	Platform	Storage Capacity (bcf)	Subsurface Quality Score	Engineering Quality Score	Weighted Score
1	West Field A	Platform 1	39.1	40.3	**38.4**	78.8
2	West Field B	Platform 3	**116.5**	43.7	34.9	78.5
3	North Field D	Platform 4	81.7	**46.3**	30.6	76.9
4	East Field A	Platform 1	109.4	43.3	29.3	72.6
5	East Field B	Platform 2	90.2	45.3	26.6	71.9
6	East Field B	Platform 2	102.3	42.7	25.4	68.1
7	North Field D	Platform 4	49.0	39.7	25.4	65.1
8	East Field A	Platform 1	98.0	36.3	28.1	64.5
9	West Field C	Platform 3	**22.2**	33.0	31.4	64.4
10	East Field A	Platform 1	78.1	36.7	25.9	62.5
11	East Field B	Platform 2	29.8	36.3	25.4	61.8
12	East Field B	Platform 2	29.0	37.7	**23.1**	60.8
13	East Field A	Platform 1	55.4	33.0	25.9	58.9
14	West Field E	Platform 2	29.7	**32.0**	**23.1**	55.1
		TOTAL	930.4			



- Highlighted above is the reservoir chosen to undergoes Phase-2 detailed subsurface feasibility studies
- **Subsurface Quality**: Score is referring to Storage Capacity, Injectivity and containment (max: 60)
- **Engineering Quality**: Score is referring to Facility and Well Integrity Scoring (max: 40)

Conclusion

- HM & SLB **developed a fit for purposed screening criteria** for selecting CO2 storage sites by utilizing depleted oil and gas fields within the PM3 CAA block.
- This approach has been crucial in identifying optimal storage locations for the project to continue with Phase 2 feasibility study**.**

Acknowledgement

Thank you to both the HM and SLB teams for their collaboration on the CCS Study Phase 1.

The joint efforts have been instrumental in making this project a success.