Navigating the Changing World of Reserves and Resources in the Context of the PRMS

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Conventional Field – Prospective Resources (PRs) to Reserves per PRMS 2018

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The presentation material is the view of the collaborators in general, but not necessarily in detail, and not necessarily the view of their employer or SPE. The material is provided to promote discussion amongst the workshop attendees on better understanding of PRMS.

Topics

- Overview
- Key PRMS 2018 guidance
- Extent of discovery – practical guidance
- “Upside in the 3P” versus “Upside outside the 3P”
- Example
- Example 3 Options, 7 Effective Dates (ED)
- Comply with PRMS?
- Questions?

Overview

Example examines PRs -> CRs -> Reserves per PRMS 2018 for Conventional resources using the Scenario method …

- One Entity, no “Government take”
- Starts with a “good” conventional prospect “Field X” (offshore gas condensate)
- Size range dependent on structural, reservoir thickness and fluid limit uncertainty
- Initially Low, Best and High scopes vary
- Example is a discovery at the larger end of range, and is matured through CRs to Reserves -> Justified -> Approved -> On Production (7 Effective Dates, ED1-ED7)
- 3 Options after Discovery presented – **Issue: which comply with PRMS 2018?**

  (1) Keep as 1 project; appraise first, then decide to develop

  (2) Split into 2 projects; develop one, appraise for second, then decide to develop

  (3) Keep as 1 project; develop and appraise as one as part of a single investment decision

Key PRMS Guidance

Key PRMS 2018 guidance (1/3)

General:

- CRs and PRs can have different scopes (e.g. well count, development spacing and facility size) as development uncertainties and project definition mature (2.1.3.4)

- For Reserves, the production forecast reflects a specific development scenario under a specific recovery process, a certain number of wells and particular facilities and infrastructure.

- For PRs and CRs low, best and high scenarios may vary in scope (eg #wells and facilities. Reserves must have reasonable expectation to develop the project for the best estimate case (Glossary Production Forecast, 2.1.3.7.4)

Key PRMS 2018 guidance (2/3)

General:

- Possible Reserves that are located outside of the 2P area (not upside quantities to the 2P scenario) may exist only when the commercial and technical maturity criteria have been met (that incorporate the Possible development scope) (2.2.2.8 C.)

ie Reserves can have different scopes for the low, best and high estimates **BUT only if** the extra scope is included in the defined project and meet all Commerciality Criteria of 2.1.2.1

***Important* in this Example, and even *MORE IMPORTANT* for Unconventionals Example (later topic)**

Key PRMS 2018 guidance (3/3)

General:

- There may be different pathways to commerciality and development
  - discretion of the Entity,
  - one or more projects each with their own Project Maturity Sub-class and Pc (=Pd) after discovery

But do all options comply with PRMS requirements?

For PRs specifically:

- Recognition of PRs via the Full Distribution or Truncated portion of the Full Distribution – Full Distribution is used per AG22 errata

Extent of discovery – practical guidance

Extent of discovery – practical guidance (1/6)

Discovery implies a Pg of 1. What does that mean in the context of distance away from the discovery well or control point?

A simple guide in relation to development wells (and appraisal wells), based on notional well locations – based on COGEH:

Extract from COGEH...

1.4.7.1.2.3 ESTIMATION OF DISCOVERED PETROLEUM INITIALLY-IN-PLACE

...because Contingent Resources are evaluated using the same technical due diligence as Reserves, the evaluator must facilitate an orderly conversion of Resources to Reserves as risks and contingencies are removed. As a practical test, a known accumulation and its associated Discovered PIIP should not carry significant risk whereby the outcome of a development well might result in a significant revision to the interpreted size of the known accumulation and its estimated Discovered PIIP.

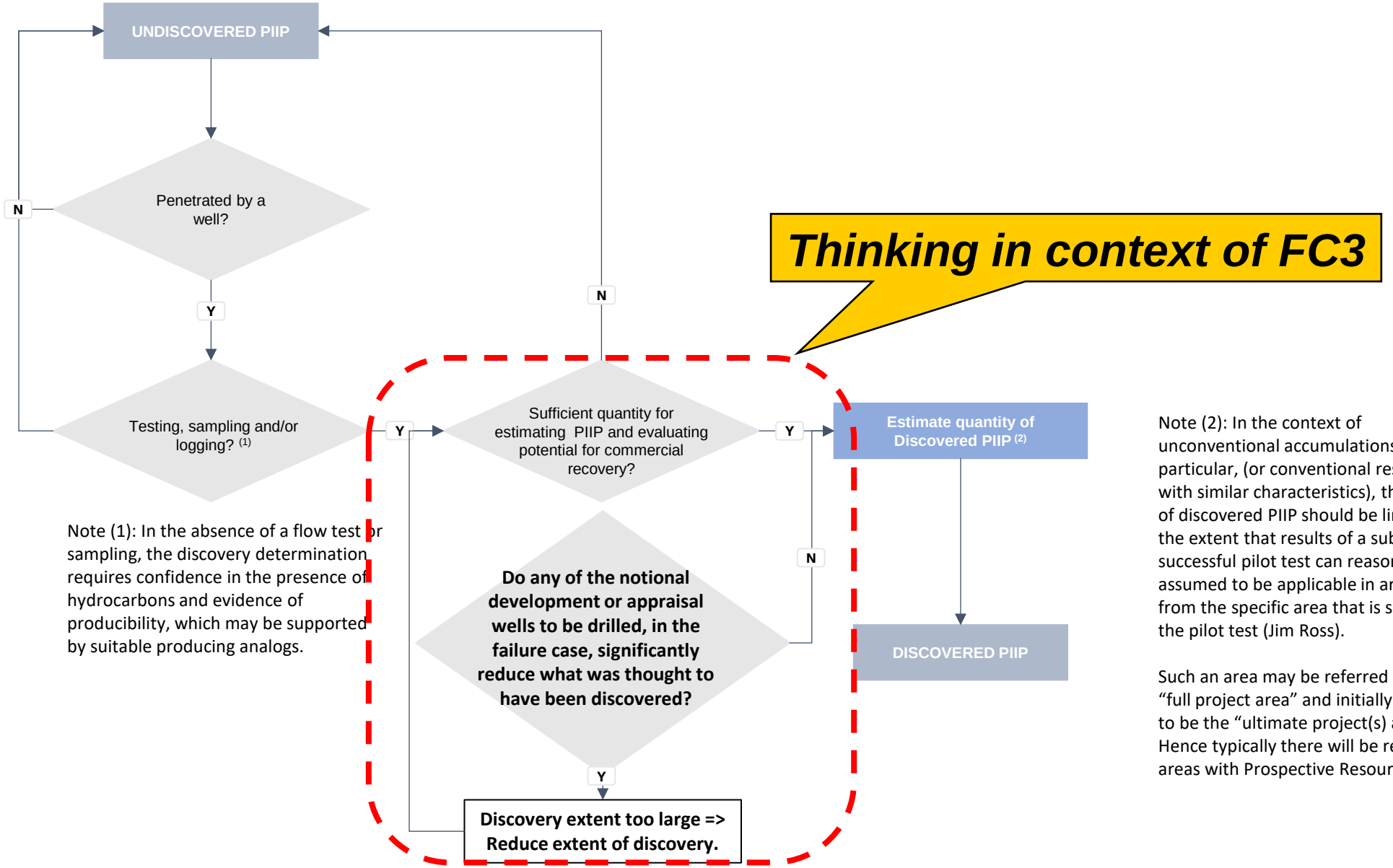
Extent of discovery – practical guidance (2/6)

The evaluator asks themselves: “if any development (or appraisal) well was to be drilled and in the failure case would significantly reduce what was thought to have been discovered, then in fact that area of the accumulation has not been discovered”.

- That area would have a Pg < 1 -> discovered extent should be reduced.
- Includes “Appraisal” wells
  - appraise what has been discovered (ie uncertainty), not whether something is there or not, so also have a Pg = 1.
- “Step out” wells address what has NOT been discovered

  -> have a Pg < 1 by definition.
  - They should ***not*** be thought of as "appraisal" wells, they are “exploration wells”.

Extent of discovery – practical guidance (3/6)



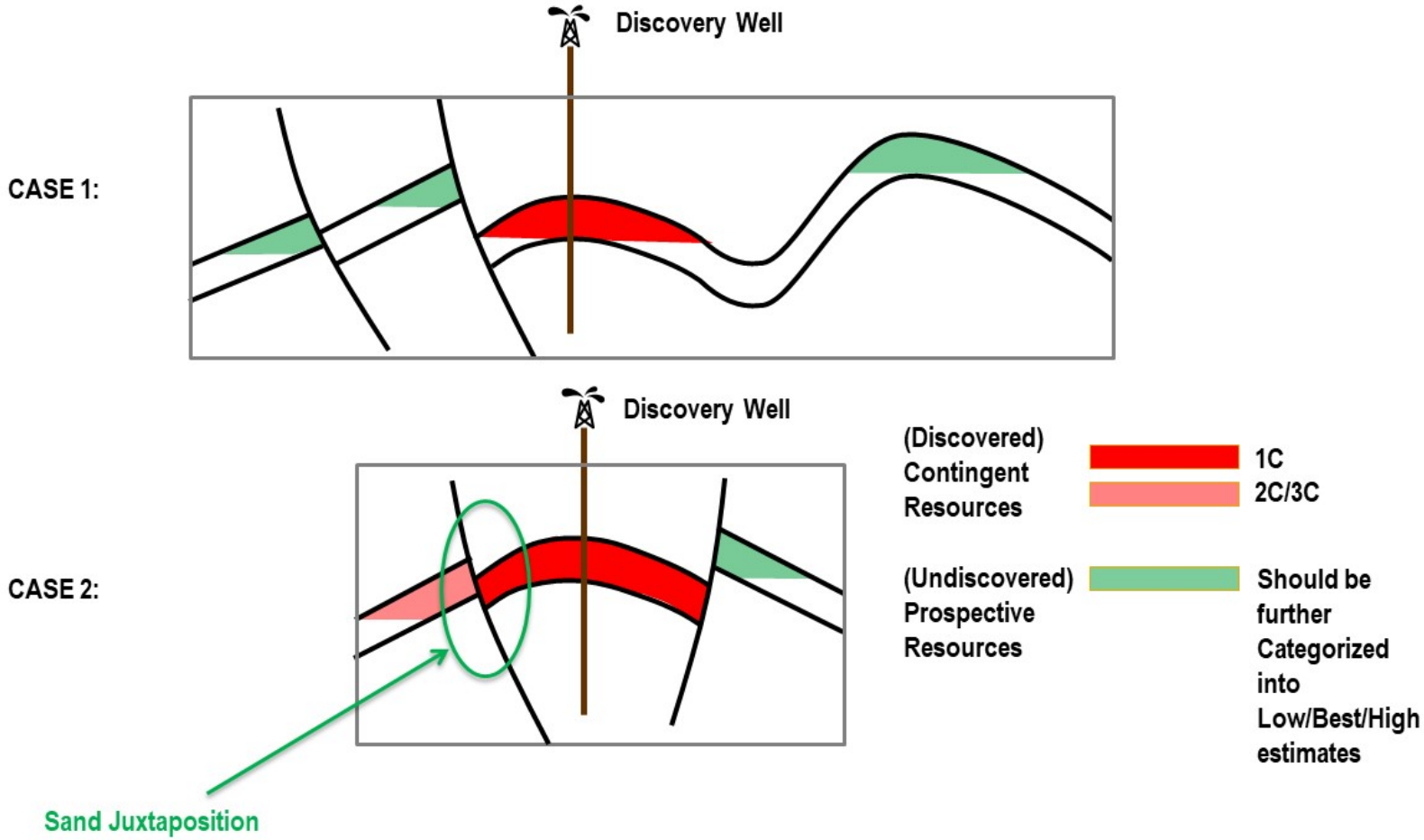
Note (1): In the absence of a flow test or sampling, the discovery determination requires confidence in the presence of hydrocarbons and evidence of producibility, which may be supported by suitable producing analogs.

Note (2): In the context of unconventional accumulations in particular, (or conventional reservoirs with similar characteristics), the extent of discovered PIIP should be limited to the extent that results of a subsequent successful pilot test can reasonably be assumed to be applicable in areas away from the specific area that is subject to the pilot test (Jim Ross).

Such an area may be referred to as the “full project area” and initially is unlikely to be the “ultimate project(s) area”. Hence typically there will be remaining areas with Prospective Resources.

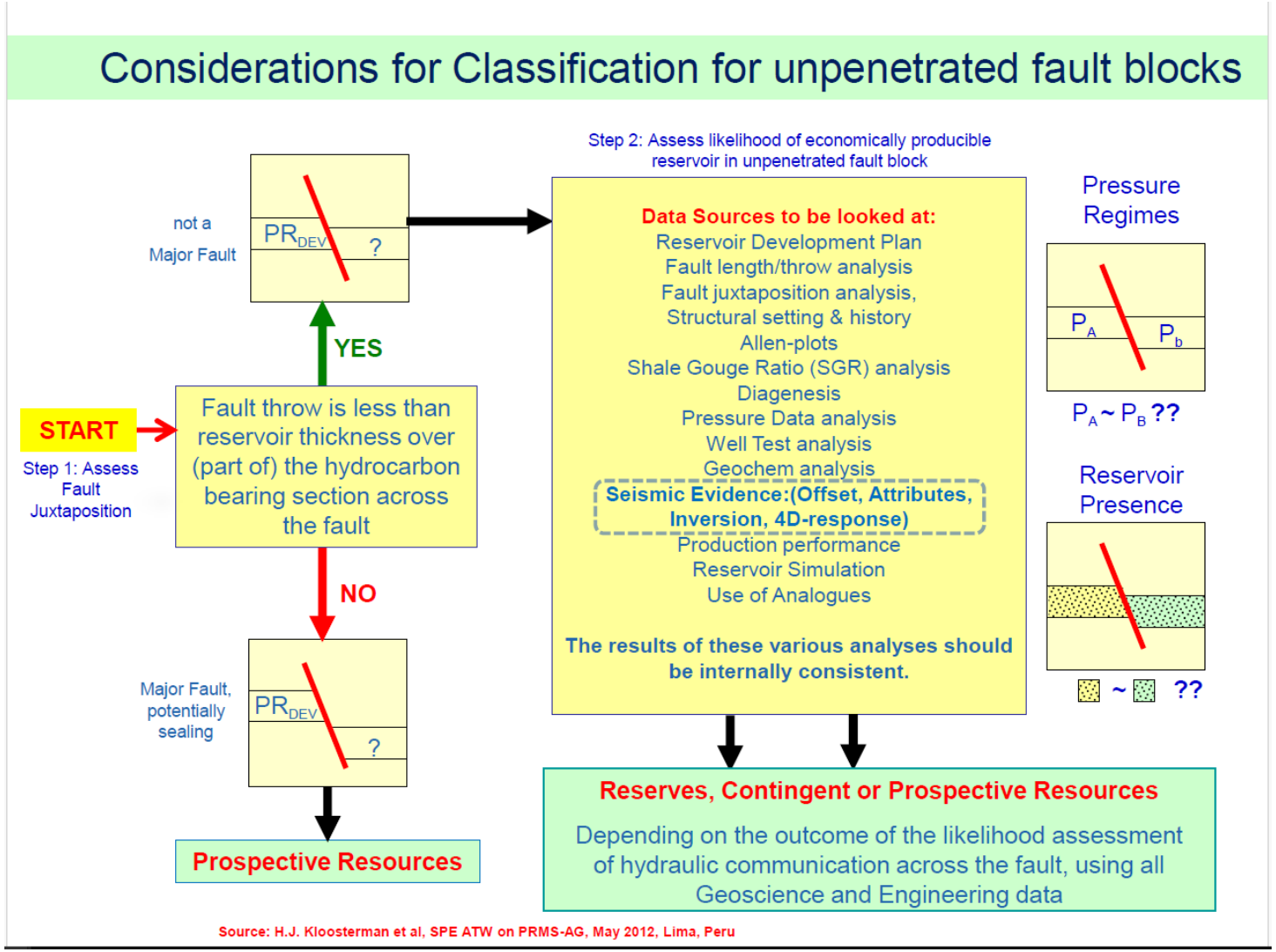
Extent of discovery – practical guidance (4/6)

Examples:



Extent of discovery – practical guidance (5/6)

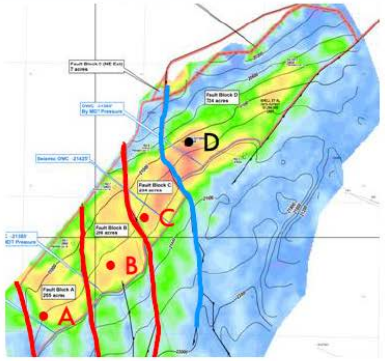
Examples (ctd):



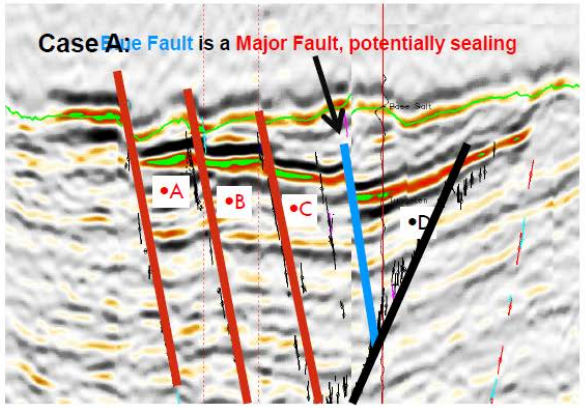
Extent of discovery – practical guidance (6/6)

Examples (ctd):

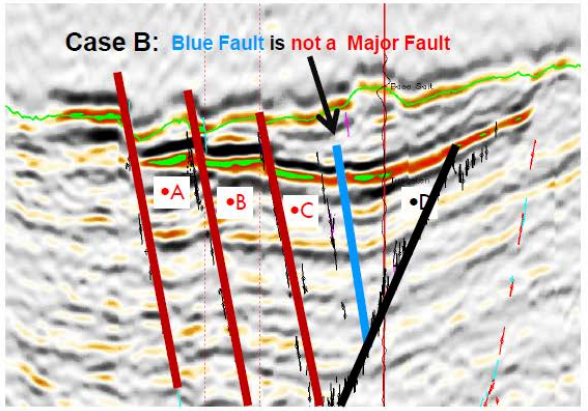
PRMS-AG Guidance – unpenetrated Fault Blocks



- Example 1 - Unpenetrated Fault Blocks
  - FID taken on Full Field Development
  - Field with 4 fault blocks
    - Only Block D penetrated by E&A well
    - Commercial flow rates demonstrated in D-well
  - 3 Development wells committed for in A,B & C blocks
  - **Blue** fault separates Block D from other blocks



If blue fault is a **major fault, potentially sealing** : only Prospective Resources can be assigned to Blocks A, B & C



If blue fault is a **not a major fault**: Reserves, Contingent or Prospective Resources can be assigned to Blocks A, B & C, depending on the likelihood assessment of hydraulic communication across the fault, using all Geoscience and Engineering data.

Source: H.J. Kloosterman et al, SPE ATW on PRMS-AG, May 2012, Lima, Peru

“Upside in the 3P” versus “Upside outside the 3P”

“Upside in the 3P” versus “Upside outside the 3P”

ie high–case scenario evaluated to assess “upside opportunity” (2.1.2.2)

Management always wants to know what the “upside potential” is!

2 types of “upside”:

1) ***Upside within the project*** as defined and achieving all commerciality criteria and commitment => ok for 3P

   - If all commerciality criteria are not met and not committed to, then such upside must be treated as a separate project => not ok for 3P

2) ***Upside outside the project*** as defined.

   - Such upside will be in a separate project(s) typically CRs or even PRs.

   => not ok for 3P

Example

Other Points

- Pd, Chance of Development, must reflect all commercial risks not just "economic" – this is done in this example but not specifically discussed – see later topic

- In this example it is assumed:
  - No contractual limit
  - Minimal difference between the Economic Limit and Technical Limit
  - Significant differences -> Entity may choose to recognise the difference as a separate project(s).

Example with 3 Options

Pathway over 7 EDs

(1) Keep as 1 project; appraise first, then decide to develop

(2) Split into 2 projects; develop one, appraise for second, then decide to develop

(3) Keep as 1 project; develop and appraise as one as part of a single investment decision

ED1: PRs “full” vs “truncated” distribution

Effective Date		Low_{Full}	$Best_{Full}$	$High_{Full}$	Mean U_{Full} (ie Mean of full distribution of PRs)	$TPS/Best_{Full}$	TPS	Comment	Low_{Trun}	$Best_{Trun}$	$High_{Trun}$	Mean U_{Trun} (ie Mean of truncated distribution of PRs)
		1U	2U	3U					1U	2U	3U	
ED1	mmboe	50	158	500	237	0.5	79	In this example the TPS is the MEPS and is 50% of the P50	98	203	566	289
	Pre Discovery Scope	3	5	10			$P_{D(Full)} = (Mean\ U_{Trun} \times P_{D(Trun)}) / Mean\ U_{Full}$ 95%	By analogy there is a range of scopes (represented by # wells) for the project given the large range in size of potential discovery	3	5	10	$P_{D(Trun)}$ 78%

Note as the example goes forward the ***PRs are from the Full Distribution***

ED1: PRs "Full Distribution" Notional Development Locations

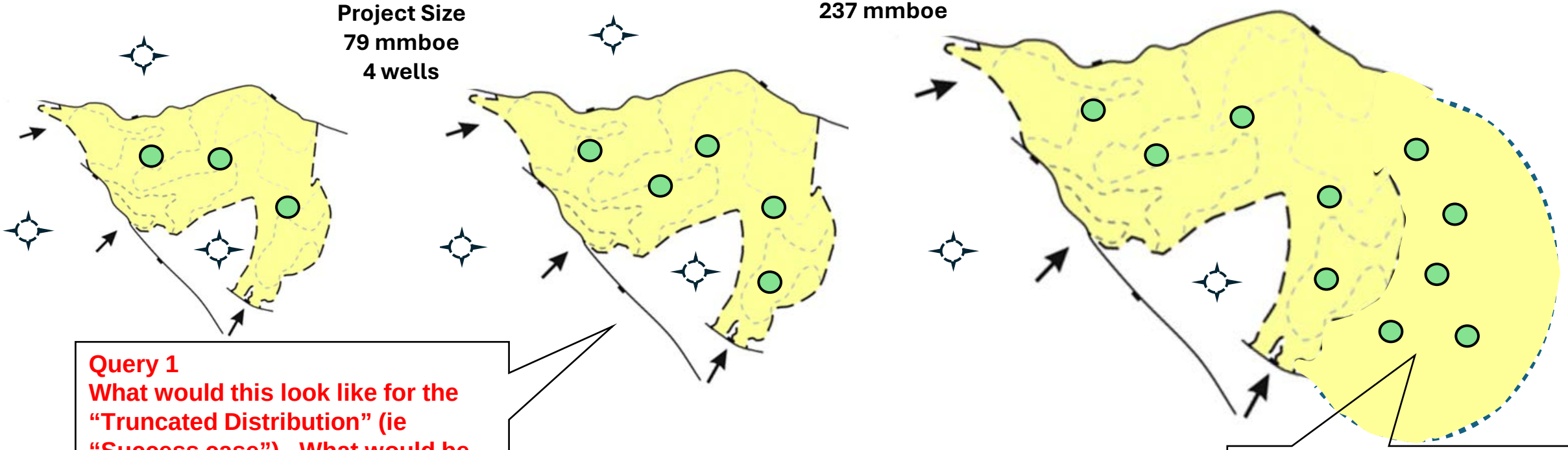
1U
50 mmboe
3 wells

Threshold Project Size
79 mmboe
4 wells

2U
158 mmboe
5 wells

Mean
237 mmboe

3U
500 mmboe
10 wells



Query 1
What would this look like for the "Truncated Distribution" (ie "Success case"). What would be the scopes for the 1U, 2U, 3U? Discuss?

Query 2
The upside potential here is due to structural and sand thickness and continuity uncertainty. It is expected to require additional wells to develop. Ok? Discuss!

structure contour (shallow)
structure contour (deep)
fault
reservoir
stratigraphic pinch-out
paleo-transport direction

Dry Hole

Potential Development Well

ED2: CRs Post Discovery; Notional Development Locations

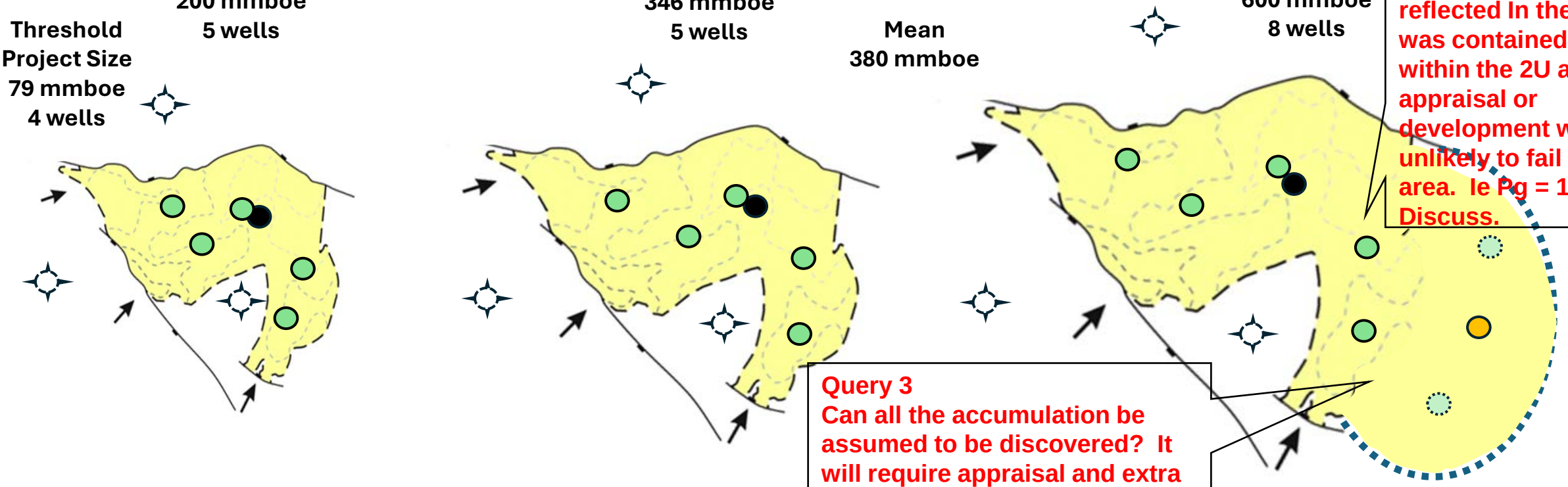
Threshold Project Size 79 mmboe 4 wells

1C 200 mmboe 5 wells

2C 346 mmboe 5 wells

Mean 380 mmboe

3C 600 mmboe 8 wells



Query 4
What if the upside reflected In the 3U was contained largely within the 2U area? An appraisal or development well is unlikely to fail in this area. Ie Pg = 1. Discuss.

Query 3
Can all the accumulation be assumed to be discovered? It will require appraisal and extra development to realise the upside recoverable resources. These will have Pg<1. Discuss.

structure contour (shallow)
structure contour (deep)
fault
reservoir
stratigraphic pinch-out
paleo-transport direction

Dry Hole
Discovery well (P&A)
Potential Development Well
Appraisal Well (Development well if successful)
Future Development Wells if appraisal successful

Option 1

Keep as 1 project; appraise first then decide to develop

Option 1: ED4->ED7: CRs – Post-appraisal; 7 well development – Reserves Developed and On Production

Example – Option 1: ED3 – ED7

Assessment sometime after Initial Post Discovery assessment at Effective Date 3:

Option 1

ED3	Project Scope (# wells)	5	5	8	
	Recoverable Resources	200	346	600	380
	Pre appraisal: CRs: Development Unclarified				
ED4	Project Scope (# wells)	7	7	7	
	Recoverable Resources	300	406	550	418
	Post appraisal: CRs: Development Pending				
ED5	Project Scope (# wells)	7	7	7	
	Recoverable Resources	300	406	550	418
	Meet minimum reserves requirements: Reserves: Justified for Development				
ED6	Project Scope (# wells)	7	7	7	
	Recoverable Resources	310	417	560	428
	Meet requirements for Approved for Development: Reserves: Approved for Development				
ED7	Project Scope (# wells)	7	7	7	
	Recoverable Resources	340	425	530	431
	Developed and On production: Reserves: On Production				

ED3 Option 1 Retain the project as ... development plan wit... **Development Unclar...** recoverable resources... though the resources...

Option 1 ED4 In this example the ap... optimal.

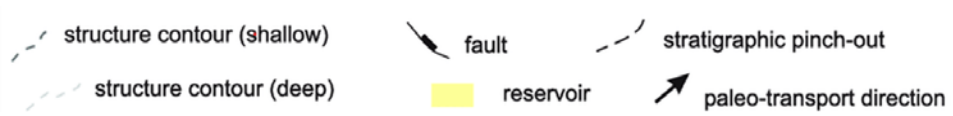
The range of resource... expiry are expected to... the Entity decides not...

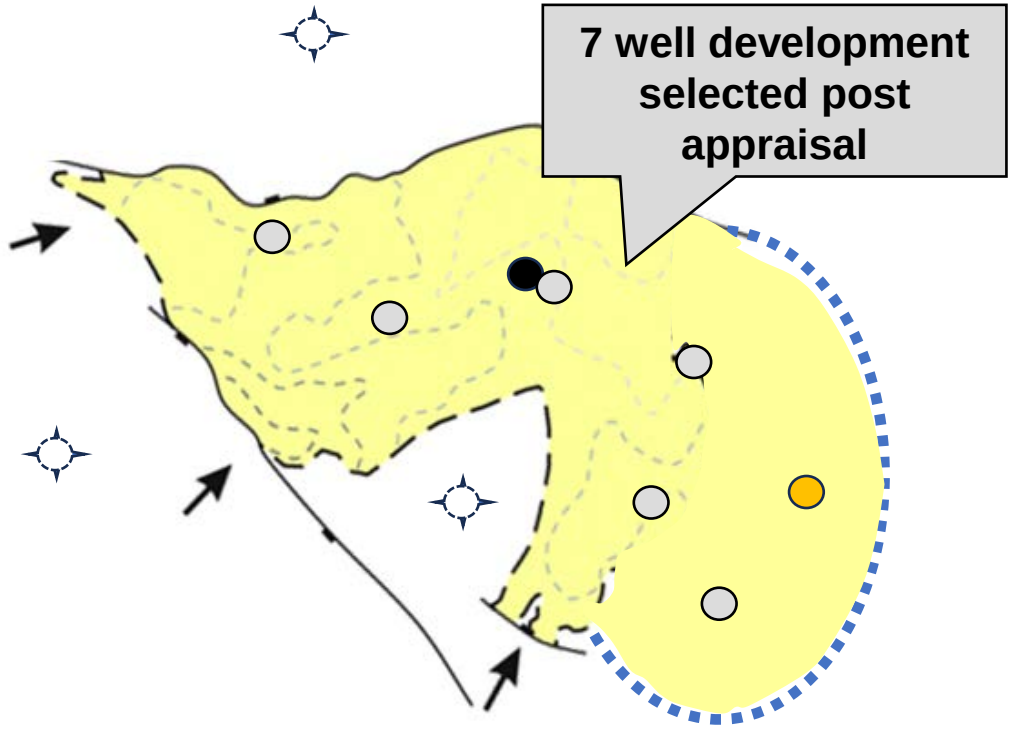
The Entity believes tha... is presented as **Devel...**

Option 1 ED5 The project receives s... Reserves **Justified fo...** all documents to secu...

Option 1 ED6 There are minor adjus... the project is **Approve...**

Option 1 ED7 The field is develope... early production perf...





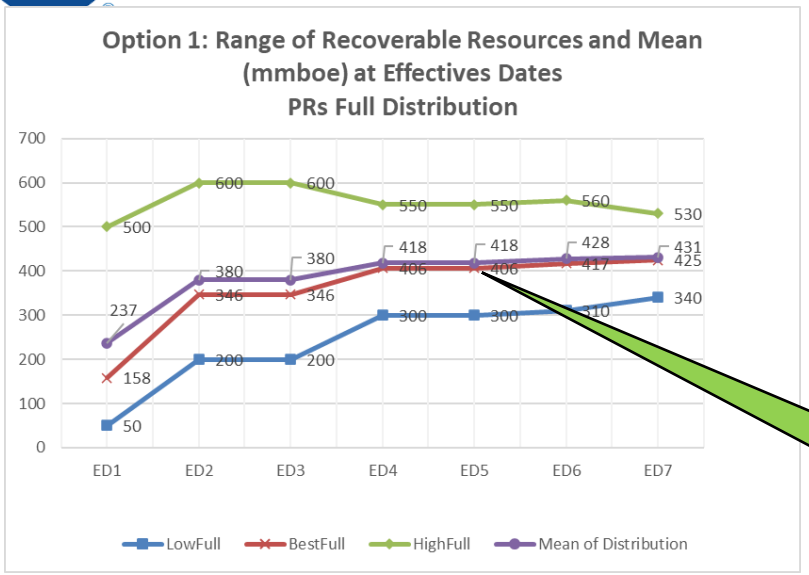
Dry Hole

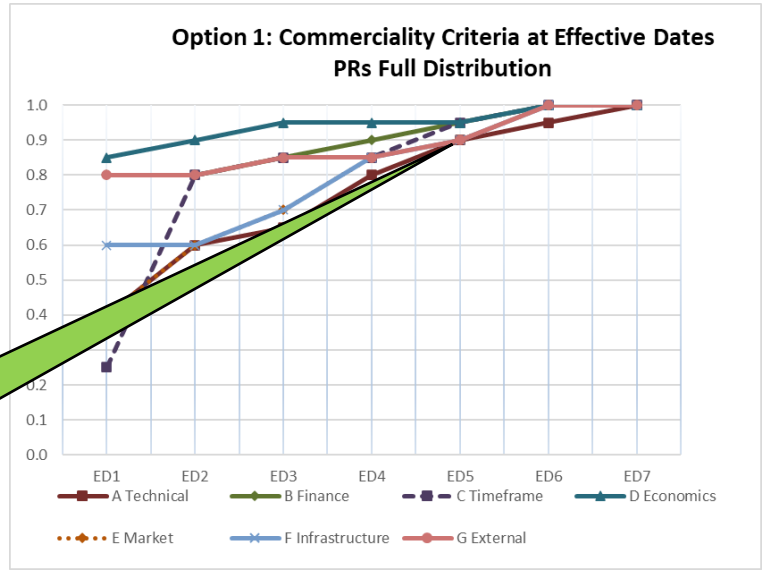
Development Well

Discovery well (P&A)

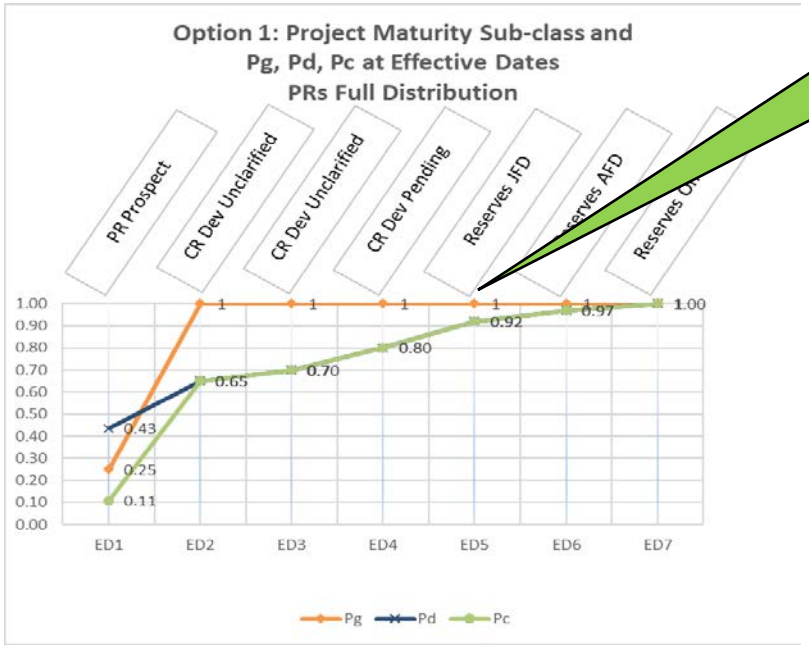
Appraisal Well (Development well as successful)

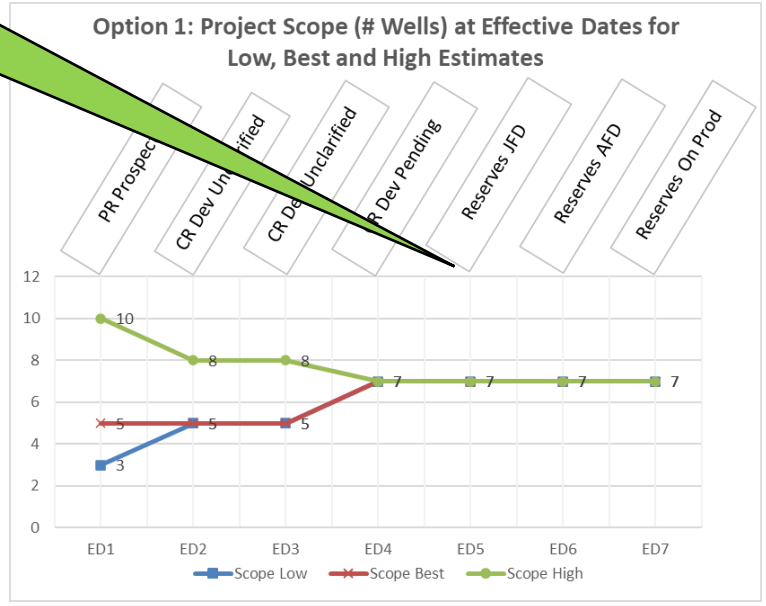
Option 1: Keep as 1 project; appraise first then decide to develop





ED5 Reserves Justified for Development





Option 2

Split into 2 projects, develop one, appraise for second, then decide to develop

Option 2: ED3: CRs – Split into 2 Projects

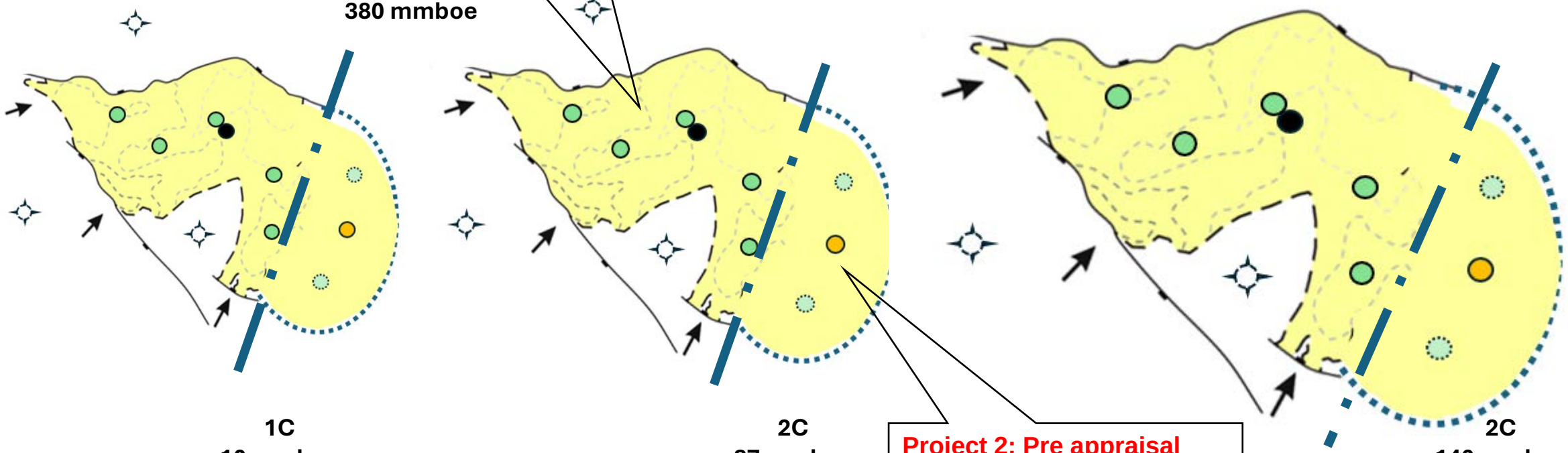
Project 1: No appraisal required
CRs: Development Pending

1C
180 mmboe
5 wells

Mean
380 mmboe

2C
285 mmboe
5 wells

3C
450 mmboe
5 wells



1C
10 mmboe
3 wells

2C
37 mmboe
3 wells

Project 2: Pre appraisal
CRs: Development Unclarified

2C
140 mmboe
3 wells

structure contour (shallow)
structure contour (deep)
fault
reservoir
stratigraphic pinch-out
paleo-transport direction

Dry Hole
Discovery well (P&A)
Proposed Development Well
Appraisal Well (Development well if successful)
Future Development Wells if appraisal successful

Option 2: ED4-ED7: CRs – 2 Projects; Project 1: 5 wells-> Reserves; Project 2: Post-appraisal 2 wells-> Reserves -> Combined 7 well project On Production

Example – Option 2: ED3 – ED7

Project 1: No appraisal required CRs: Development Pending

Project 2: Pre appraisal CRs: Development Unclarified

Project 1: Meets min requirement for Reserves Reserves: Justified for Development

Project 2: No change

Project 1: Meets requirements for Approved for Development Reserves: Approved for Development

Project 2: No change

Project 1: Reserves: Developed and On Production

Project 2: Meets requirements for Approved for Development Reserves: Approved for Development

Project 1: Producing Project 2: Developed and On Production Combined into 1 Project

Pg = 0.25 TPS = 0.5 x BestFull Outline of PRs Pre-Discovery to Initial Post Discovery then throu

Option 2

ED3					
Project 1 Scope (# wells)	5	5	5		
Recoverable Resources	180	285	450	303	
Project 2 Scope (# wells)	3	3	3		
Recoverable Resources	10	37	140	64	
ED4					
Project 1 Scope (# wells)	5	5	5		
Recoverable Resources	180	285	450	303	
Project 2 Scope (# wells)	3	3	3		
Recoverable Resources	10	37	140	64	
ED5					
Project 1 Scope (# wells)	5	5	5		
Recoverable Resources	185	292	460	311	
Project 2 Scope (# wells)	3	3	3		
Recoverable Resources	10	37	140	64	
ED6					
Project 1 Scope (# wells)	5	5	5		
Recoverable Resources	250	345	475	356	
Project 2 Scope (# wells)	2	2	2		
Recoverable Resources	50	67	90	69	
ED7					
Project 1 and 2 combined as one Scope (# wells)	7	7	7		
Recoverable Resources	330	410	510	416	

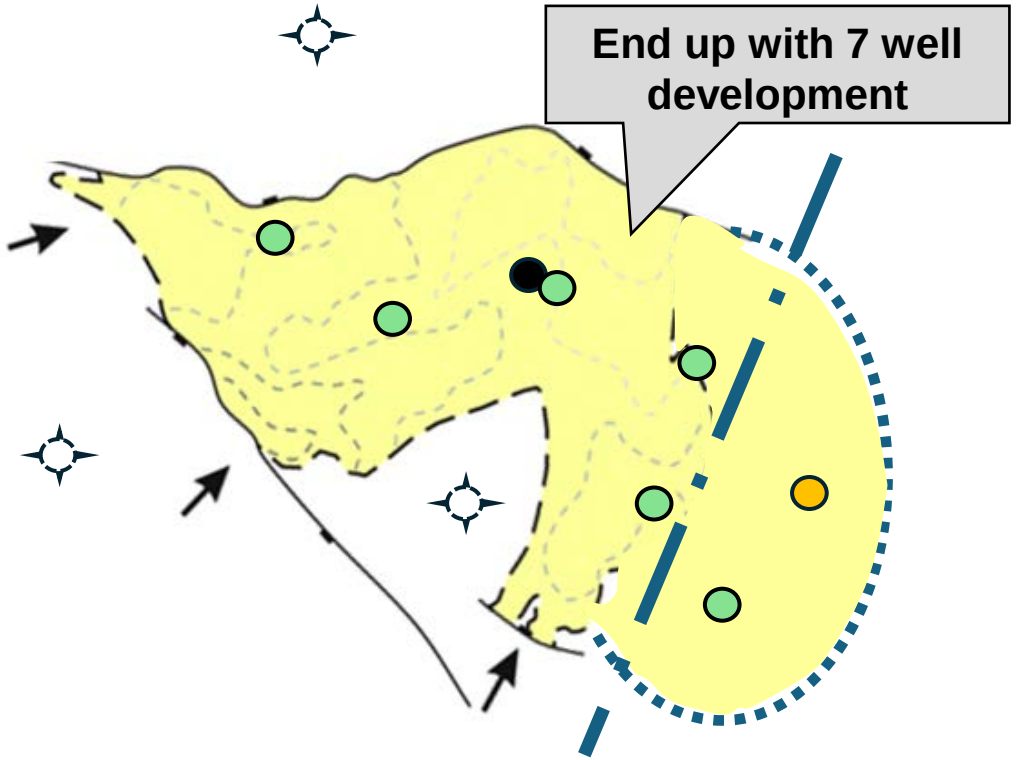
ED3
Option 2
Split project into 2 projects
Project 1: The example w
limit of production for the
Project 2: The recoverabl
PRMS, but may be used
For simplicity in the exa
each project. More opti

Option 2 ED4
The 2 project option is
approval by the JV to c
that sub-class. There i
No change to estimates

Option 2 ED5
There are minor adjustm
Project 1 is **Approved f**
Project 2 estimates rema

Option 2 ED6
The results of the develo
There are adjustments to
Approved for Developm
Project 2 is optimised to
regulatory bodies and JV
for a project in that sub-c
The Economic Limit for e

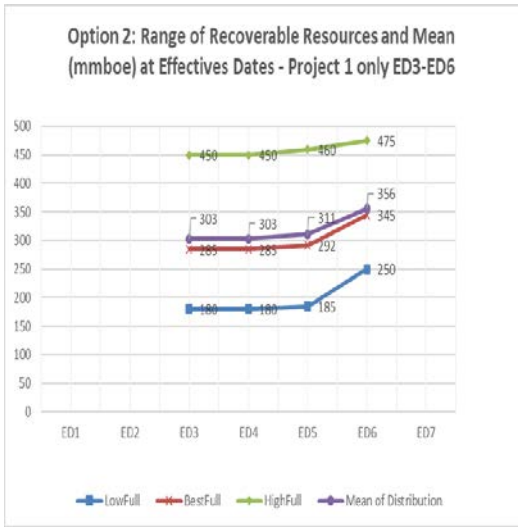
Option 2 ED7
Project 1 is producting ar
some adjustments to the
Pd is 100% and the proje

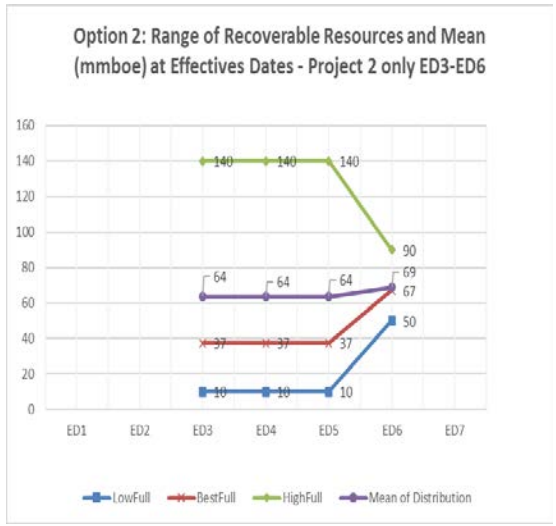


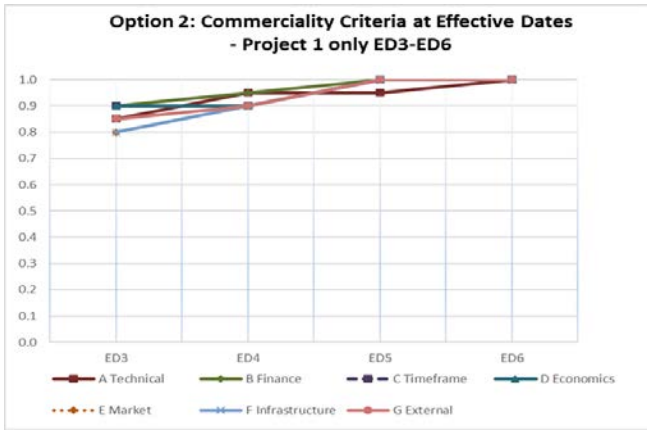
structure contour (shallow)
structure contour (deep)
fault
reservoir
stratigraphic pinch-out
paleo-transport direction

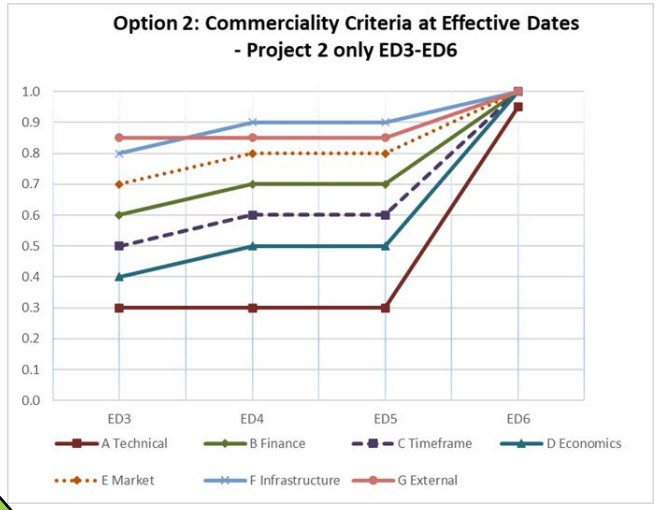
Dry Hole
Discovery well (P&A)
Development Well
Appraisal Well (Development well as successful)

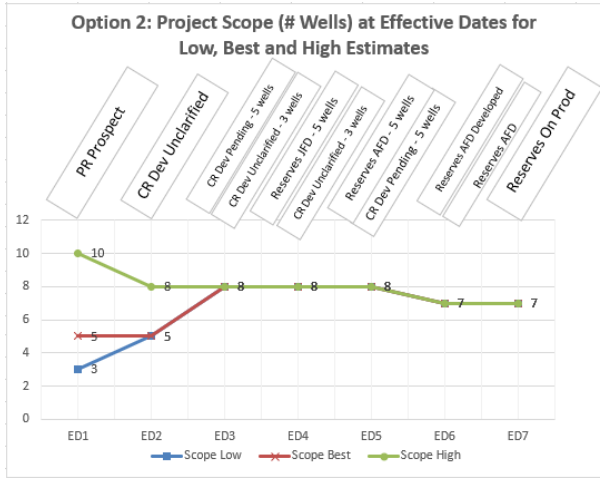
Option 2: Split into 2 projects; develop one, appraise for second, then decide to develop

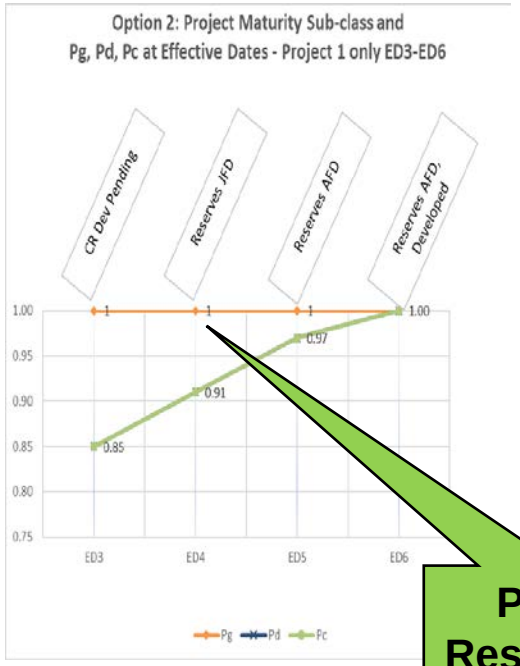


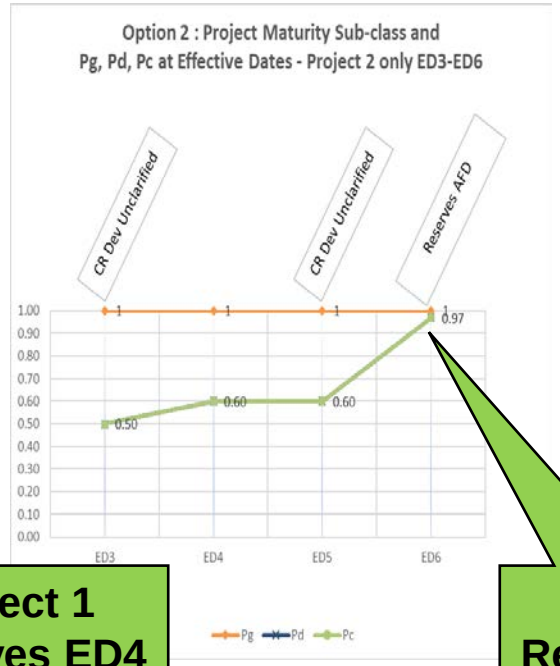












Project 1 Reserves ED4

Project 2 Reserves ED6

Option 3

Keep as 1 project; develop and appraise as part of a single investment decision

Option 3: ED3: Reserves: Justified for Development with appraisal and development to be undertaken together – Economic Limit truncations made

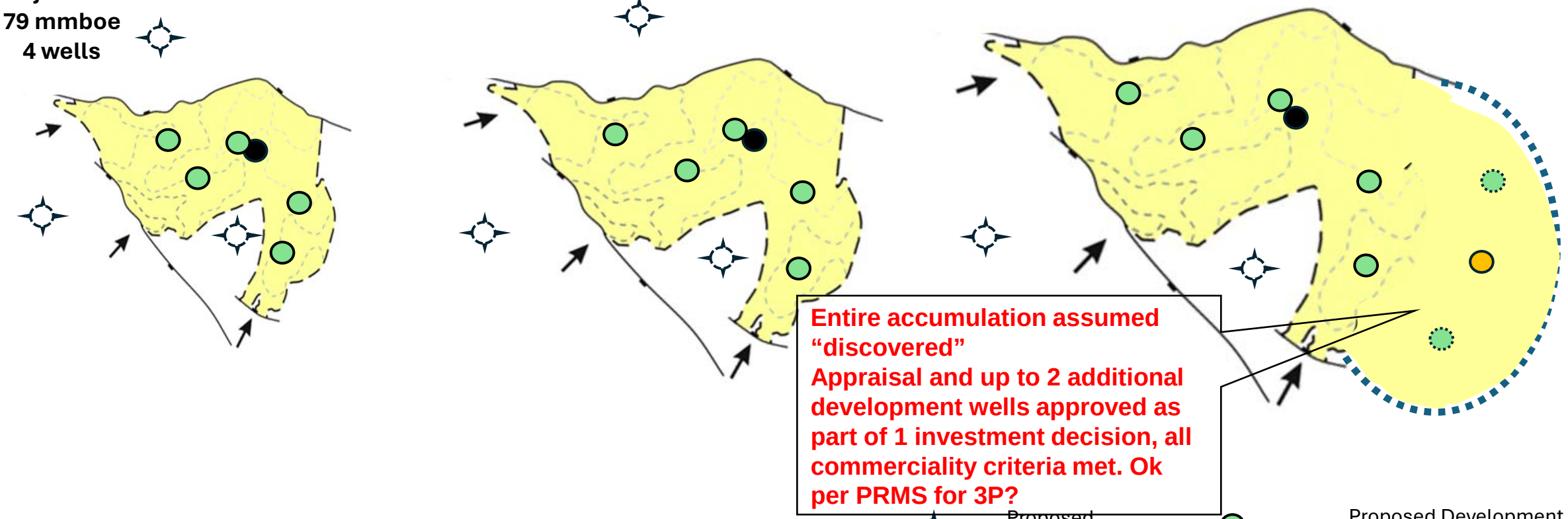
Threshold Project Size
79 mmboe
4 wells

1C
195 mmboe
5 wells

2C
341 mmboe
5 wells

Mean
374 mmboe

3C
595 mmboe
8 wells



Entire accumulation assumed "discovered"
Appraisal and up to 2 additional development wells approved as part of 1 investment decision, all commerciality criteria met. Ok per PRMS for 3P?

structure contour (shallow)
structure contour (deep)
fault
reservoir
stratigraphic pinch-out
paleo-transport direction

Dry Hole
Discovery well (P&A)
Proposed Development Well
Appraisal Well (Development well if successful)
Proposed Development Wells if appraisal successful

Option 3: ED4-ED6: Appraisal well successful and 6 development wells drilled for total development of 7 wells

Example – Option 3 – ED3 – ED6

Pg = 0.25 TPS = 0.5 x Best/Full **Outline of PRs Pre-Discovery to Initial Post Discovery then through**

Assessment sometime after Initial Post Discovery assessment at Effective Date 3:

ED3				
Project Scope (# wells)	5	5	8	
Recoverable Resources	195	341	595	374

ED3
Option 3
Consider the project as one proje
all under one investment decision
agree to fast track the developme
Development. The estimates ar
assigned to a separate project.

The estimates only change slight

Note, even the High Estimate mu
in that case is included in the proj
additional scope and quantities to

In this option only the High Estima
Estimate PIIP.

Reserves: Justified for Development

ED4				
Project Scope (# wells)	5	5	8	
Recoverable Resources	195	341	595	374

Option 2 ED4
The project is presented to the JV
Pc improves.

Reserves: Approved for Development

ED5				
Project Scope (# wells)	7	7	7	
Recoverable Resources	300	406	550	418

Option 3 ED5
The field development plan incorp
extension to the East and that a

The range of resources is reevalu
the Technical Limit is still small a

The Entity releases the results to
the development is finished. The

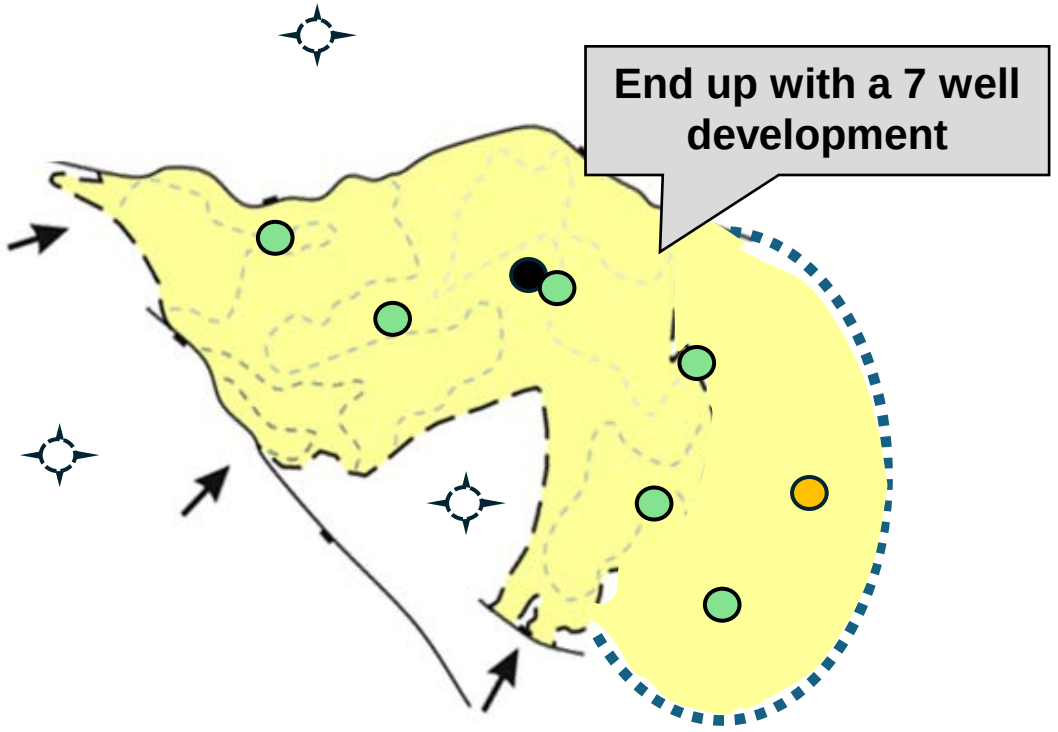
Appraisal completed and successful
Reserves: Approved for Development

ED6				
Project Scope (# wells)	7	7	7	
Recoverable Resources	340	425	530	431

Option 3 ED6
The field is developed and brough
production performance, operatin

Reserves: Developed and On Production

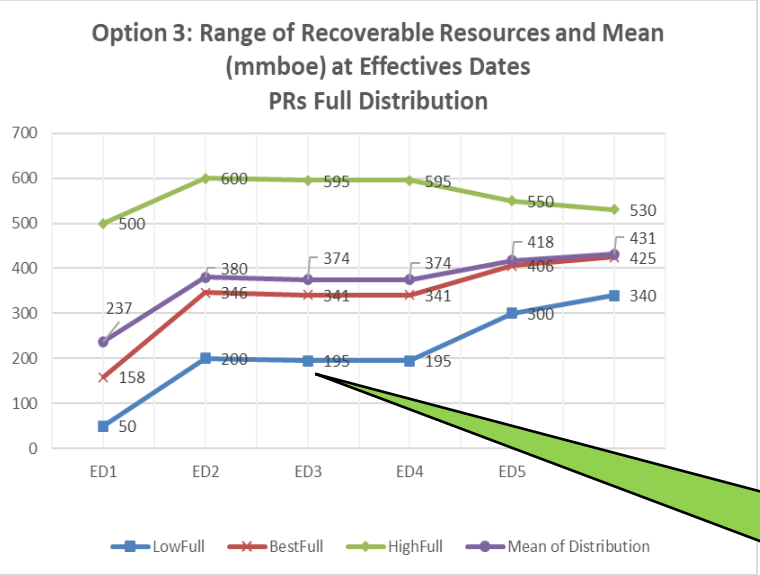
Option 3

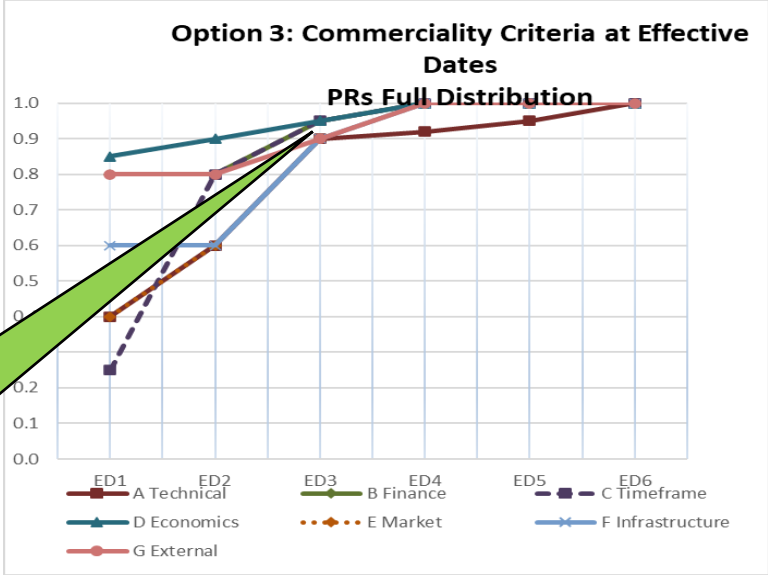


structure contour (shallow)
structure contour (deep)
fault
reservoir
stratigraphic pinch-out
paleo-transport direction

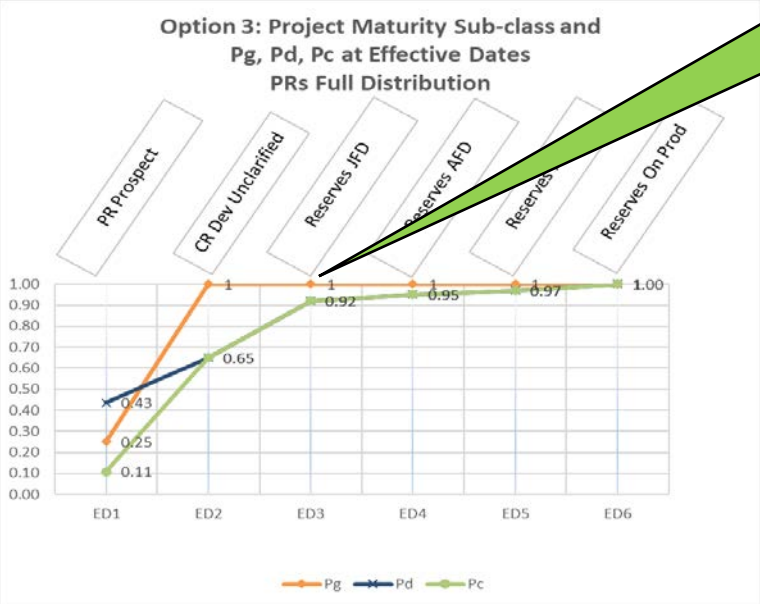
Dry Hole
Discovery well (P&A)
Development Well
Appraisal Well (Development well as successful)

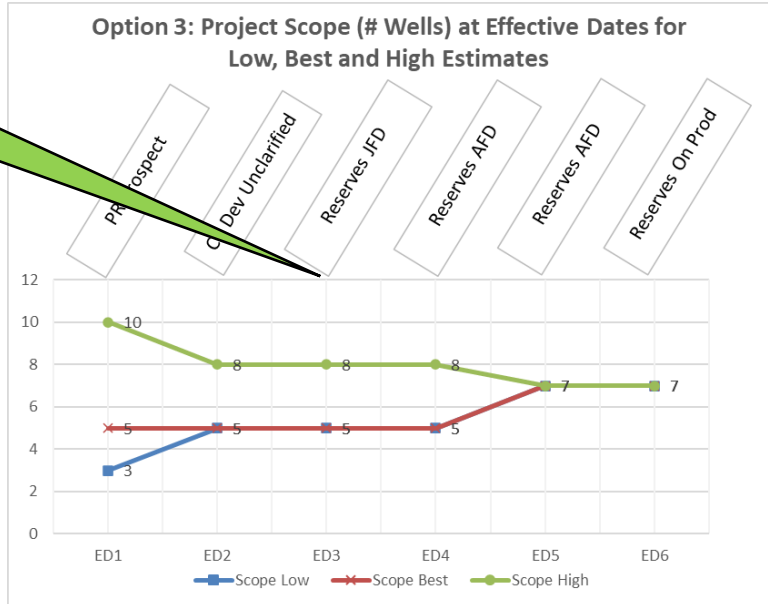
Option 3: Keep as 1 project; develop and appraise as part of a single investment decision





ED3 Reserves Justified for Development





Comply with PRMS? (1/2)

2 main issues: All discovered? Extra scope in high side dependent on successful appraisal? Or perhaps "step out"?

- Is the accumulation "all discovered" by the discovery well since the extension to the east has "Pg < 1"
  - a failure of the appraisal well would significantly reduce what was thought to be discovered (ie is it an appraisal well)?

=> split into 2 projects with "west" either kept as CRs or promoted to Reserves; and

should the "east" be retained as PRs until ***step out*** well is successful and converts PRs to CRs or perhaps Reserves?

- Option 3 includes development that is dependent on successful "appraisal" or "step out" so is it really made up of 2 separate investment decisions?

Comply with PRMS? (2/2) *Discuss!*

Option	Prudence!	NPV	Reserves Claimed	Comply with PRMS?
1: Appraise then develop	Highest	Lowest	Latest (ED5)	Yes, if can claim discovery of whole accumulation
2: Split into 2 projects	Middle	Middle	Middle (ED4)	Ditto
3: Claim Reserves and appraise and develop	Lowest	Highest	Earliest (ED3)	It depends and only if appraisal and subsequent development in East meets all CC requirements and commitment

Questions?