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Evaluating Reserves and Resources for Unconventional Plays

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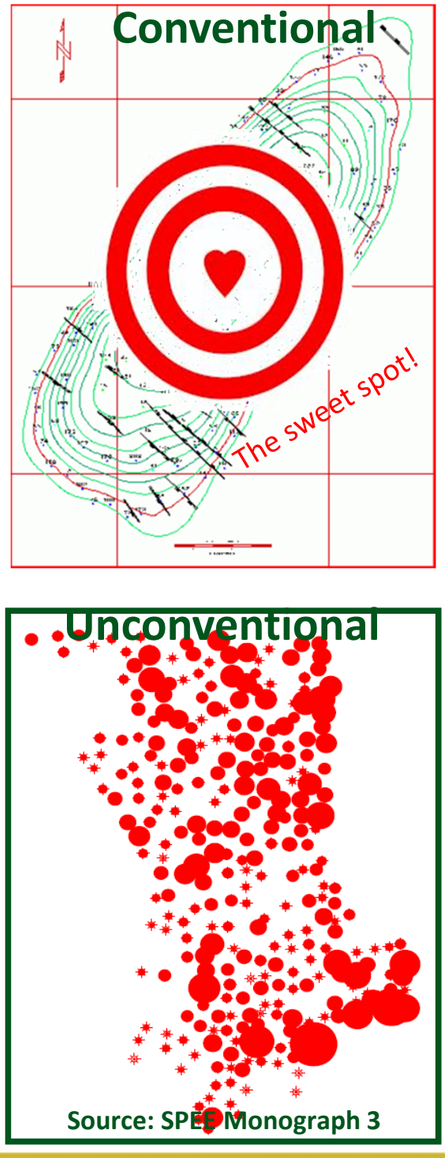
CONSIDERATIONS FOR THE EVALUATION OF UNCONVENTIONAL RESOURCES

- Generally adjacent undrilled portions of the reservoir are considered as proved undeveloped locations…but…
- SPEE Monograph 3:
  - "Offset well performance is not a reliable predictor of undeveloped location performance."
  - "Consequently, predicting the performance of any particular well prior to completion is virtually impossible."
- **Implication**: reasonable certainty (P90) volumes for a single well or a small number of wells is generally **far below expectations for PUD**
  - Expect significant well variability even after the sweet spots have been identified

CONSIDERATIONS FOR THE EVALUATION OF UNCONVENTIONAL RESOURCES

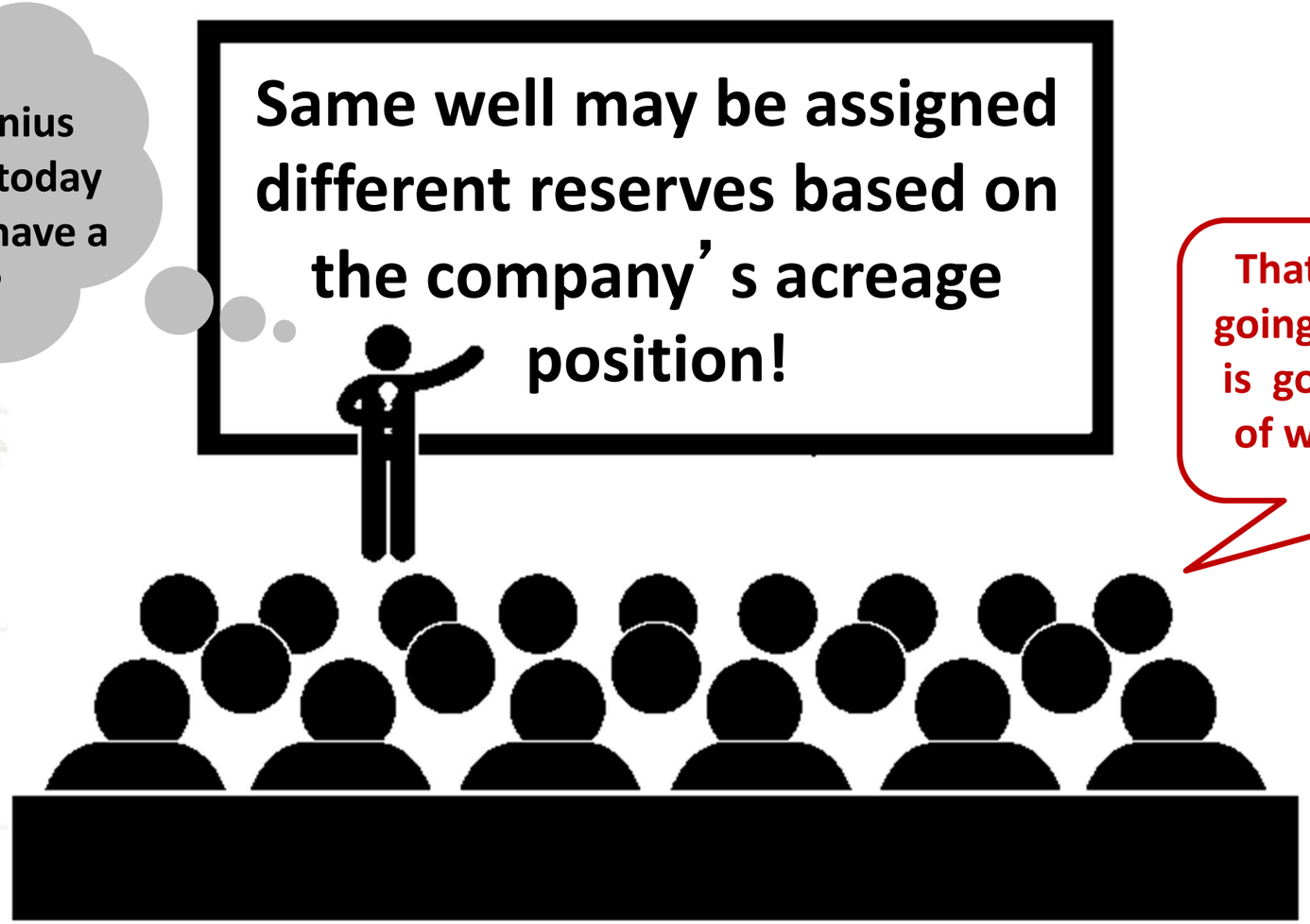
- Apply probabilistic analysis to drilling portfolio – this <u>entire program</u> then becomes the minimum incremental project.
  - Continuous investment vs. front end loading
  - Continuous improvement and optimization
  - Learning curve
  - Relatively large resources volumes to production ratios



IMPLICATION OF THE RANDOM NATURE OF UNCONVENTIONAL RESOURCES

- Acreage position to diversify uncertainty can be very important.

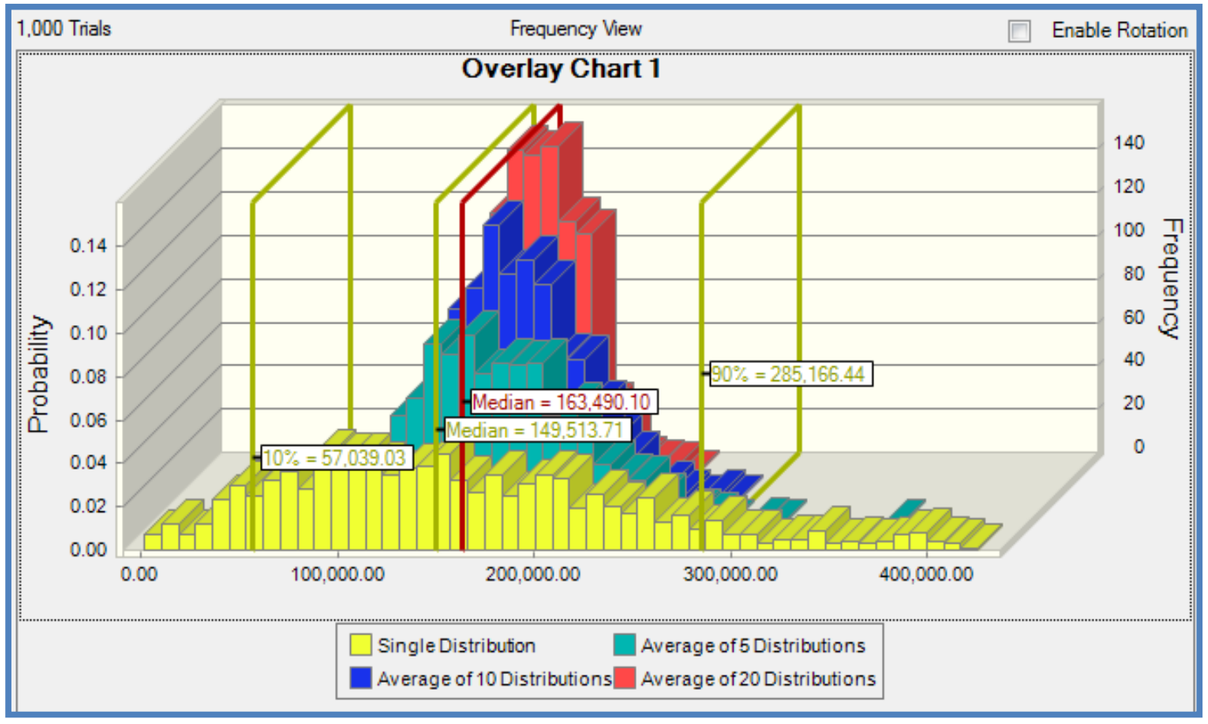
Sigh! Thank you genius but if we knew that today neither of us would have a job, would we?



That's not correct, the well is going to produce what the well is going to produce regardless of who the interest owner is!

PORTFOLIO EFFECT IN PROBABILISTIC AGGREGATIONS

- In statistical aggregation, except in the rare situation when all the reservoirs being aggregated are totally dependent**, the P90 (high degree of certainty) quantities from the aggregate are always greater than the arithmetic sum of the reservoir level P90** quantities, and the P10 (low degree of certainty) of the aggregate is always less than the arithmetic sum P10 quantities assessed at the reservoir level.



PROJECT APPROVALS, FINAL INVESTMENT DECISIONS

- A company's staying power with a project that may initially not yield expected resources:
- Company A expects to heavily rely on the cash flow generated by the first few wells to pay back loans to drill these wells and finance the rest of the program - Very Risky, may never achieve portfolio expectations
- Company B has enough financial resources for the entire program and management fortitude to stay with the program – Likely to achieve portfolio expectations assuming properly estimated

STAYING POWER AND GAMBLER'S RUIN

- Gambler's Ruin

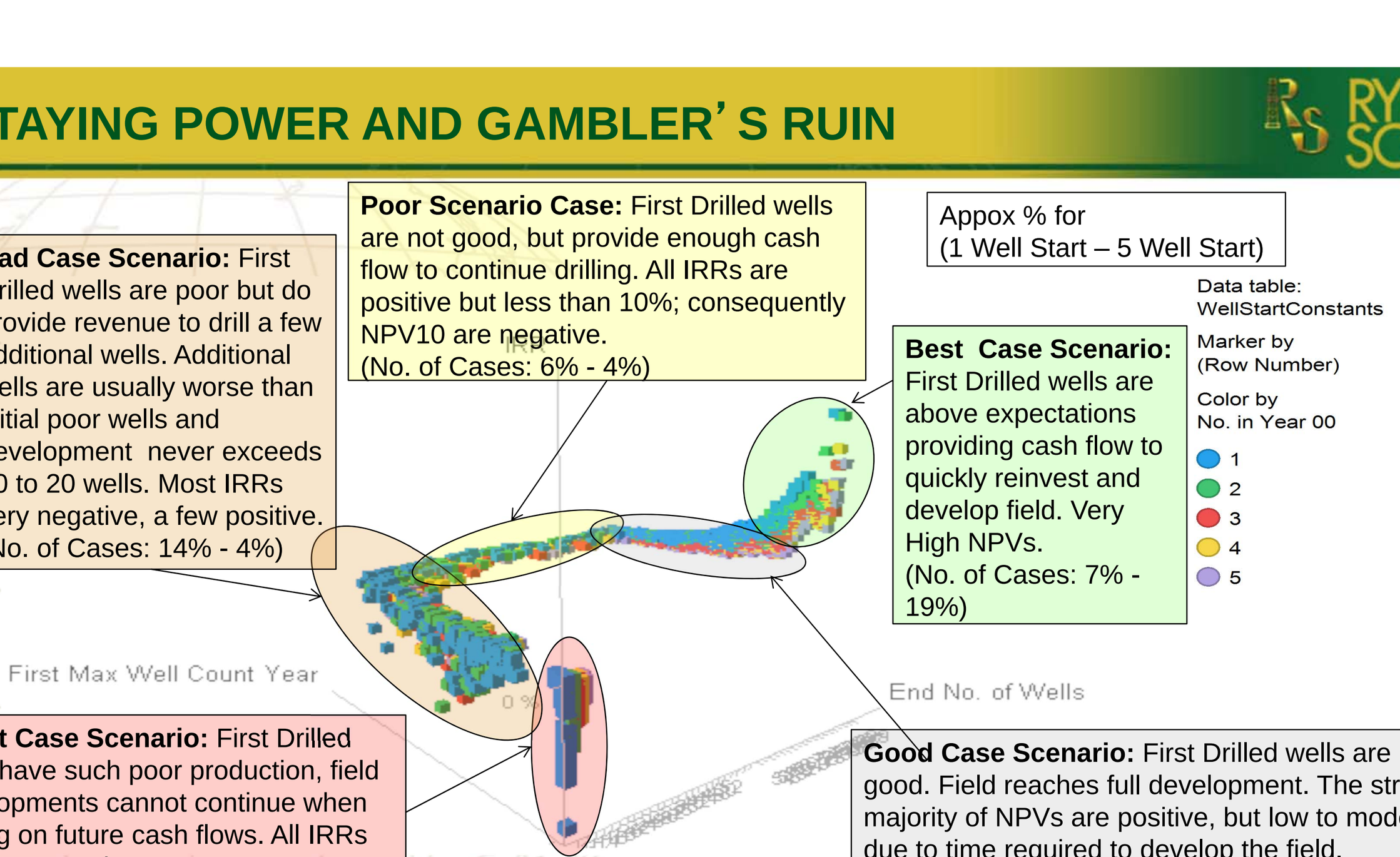
- Company A enters a resource play with **$n** in cash and starts drilling where he wins with probability "***p***" and loses with probability "**l=1-*p***" The Company drills repeatedly, spending $ (D&C) in each round. Company A leaves the play when total fortune reaches **$*N*** or it runs out of money (*ruined*), whichever happens first. What is the probability that Company A is ruined?

STAYING POWER AND GAMBLER'S RUIN

Bad Case Scenario: First Drilled wells are poor but do provide revenue to drill a few additional wells. Additional wells are usually worse than initial poor wells and development never exceeds 10 to 20 wells. Most IRRs very negative, a few positive.
(No. of Cases: 14% - 4%)

Poor Scenario Case: First Drilled wells are not good, but provide enough cash flow to continue drilling. All IRRs are positive but less than 10%; consequently NPV10 are negative.
(No. of Cases: 6% - 4%)

Appox % for
(1 Well Start – 5 Well Start)



Best Case Scenario: First Drilled wells are above expectations providing cash flow to quickly reinvest and develop field. Very High NPVs.
(No. of Cases: 7% - 19%)

Worst Case Scenario: First Drilled wells have such poor production, field developments cannot continue when relying on future cash flows. All IRRs extreme negative
(No. of Cases: 35% - 6%)

Good Case Scenario: First Drilled wells are good. Field reaches full development. The strong majority of NPVs are positive, but low to moderate due to time required to develop the field.
(No. of Cases: 38% - 67%)

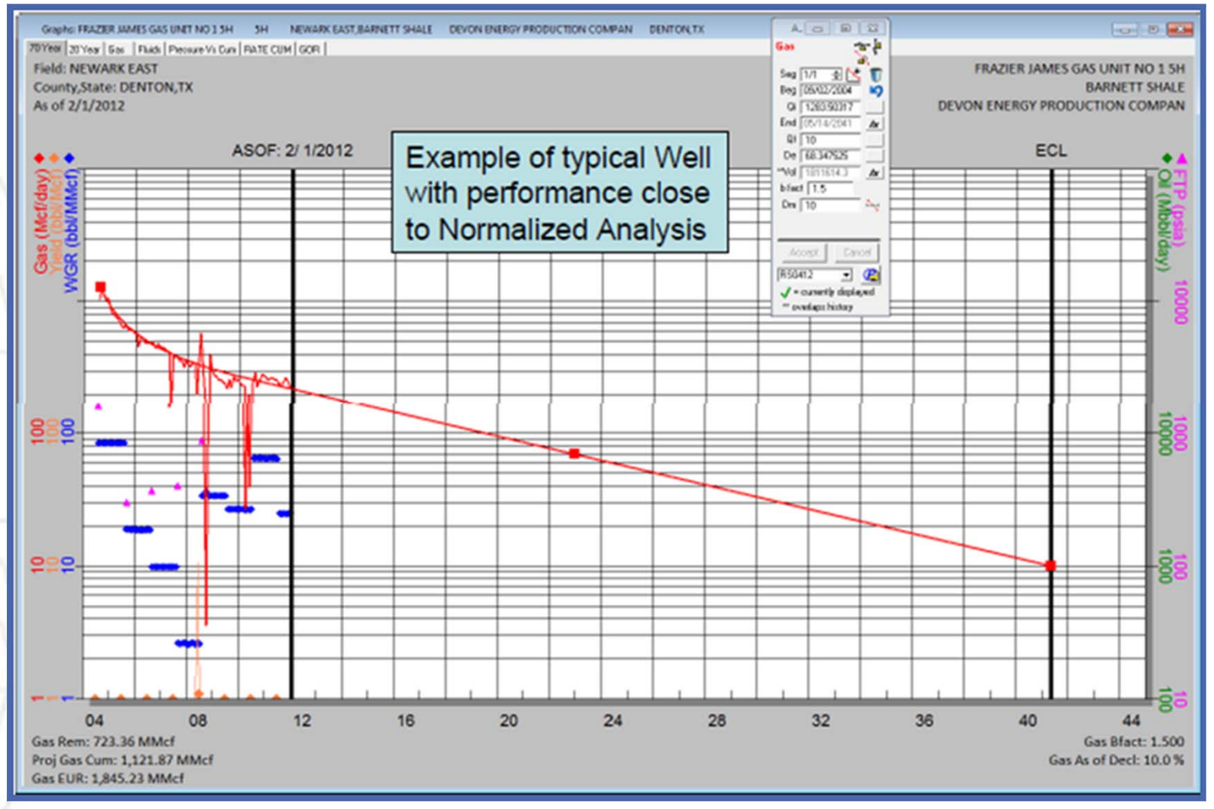
EVALUATION WORKFLOW

1. Develop your well by well projections as you would normally do.
2. Confirm that there are no discernible trends or group the wells according to representative trends.
3. Develop the well level distribution(s).
4. Aggregate the distributions according to the program size and derive the distribution of type wells (average program distributions).
5. Select appropriate reserves for each reserves category according the percentiles (P90, P50, P10) in that distribution.

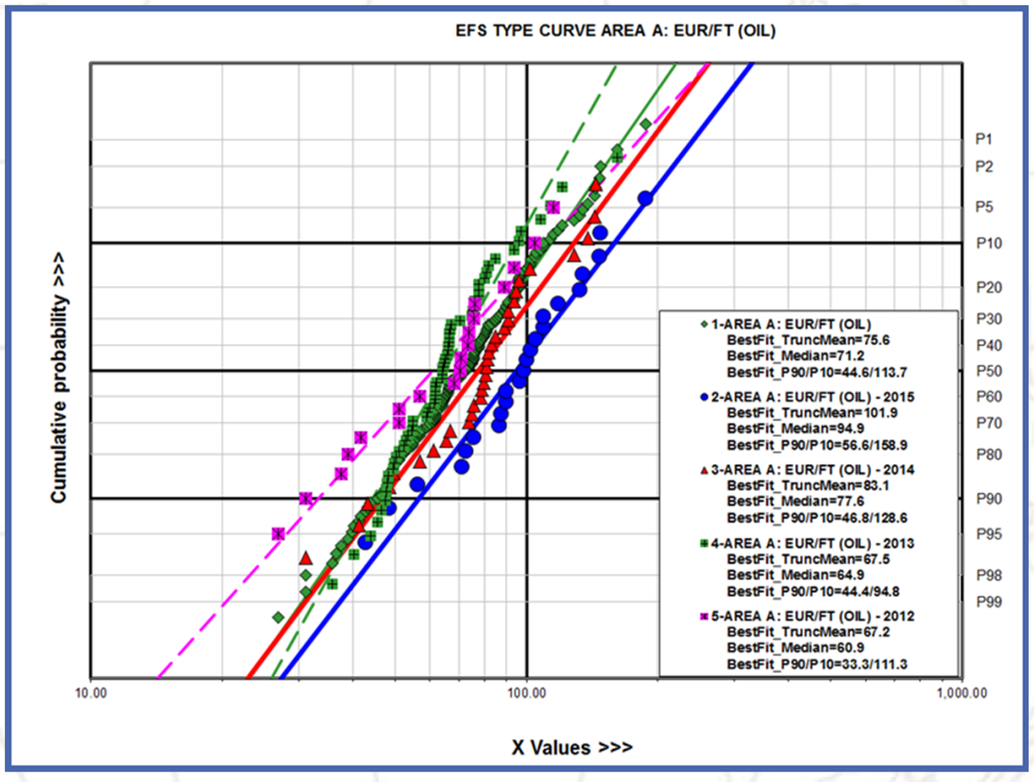
EVALUATION WORKFLOW – STEP 1

1. **Develop your well by well projections as you would normally do.**

   a) Initial rates
   b) b- factors
   c) Minimum declines
   d) Vintage effect?
   e) Multi-variable analysis

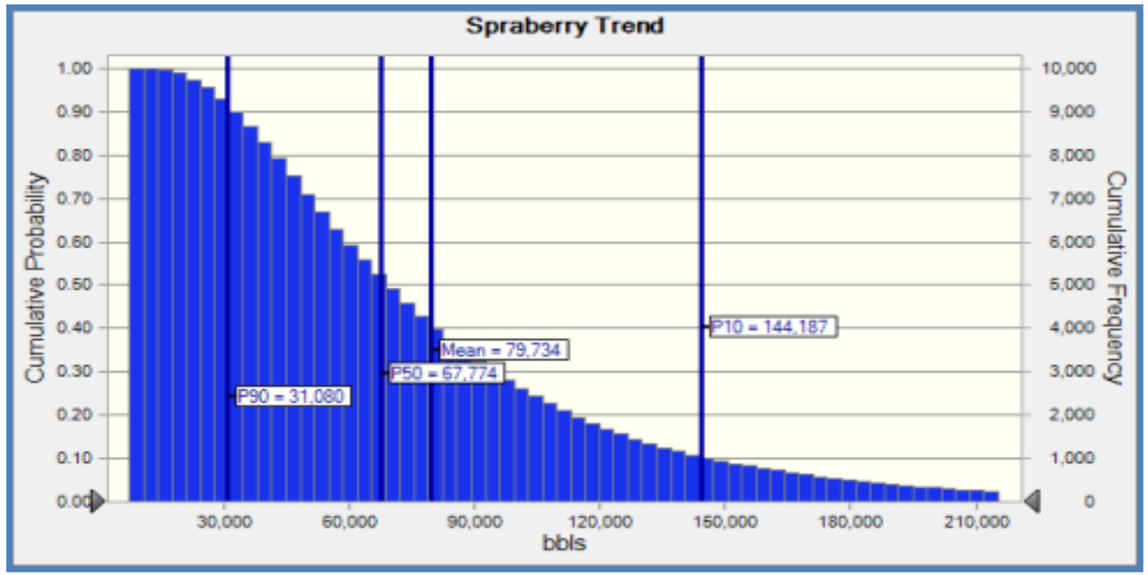


2. Confirm that there are no discernible trends or group the wells according to representative trends.



2. Develop well level distribution.

- After the SPEE Monograph
  3 Spraberry Trend, Southwestern
  Martin County, Texas (pp. 45-46)
  - P90 = 31 kbbls
  - P50 = 68 kbbls
  - P10 = 144 kbbls
  - Mean = 80 kbbls
  - P^ = 74 kbbls



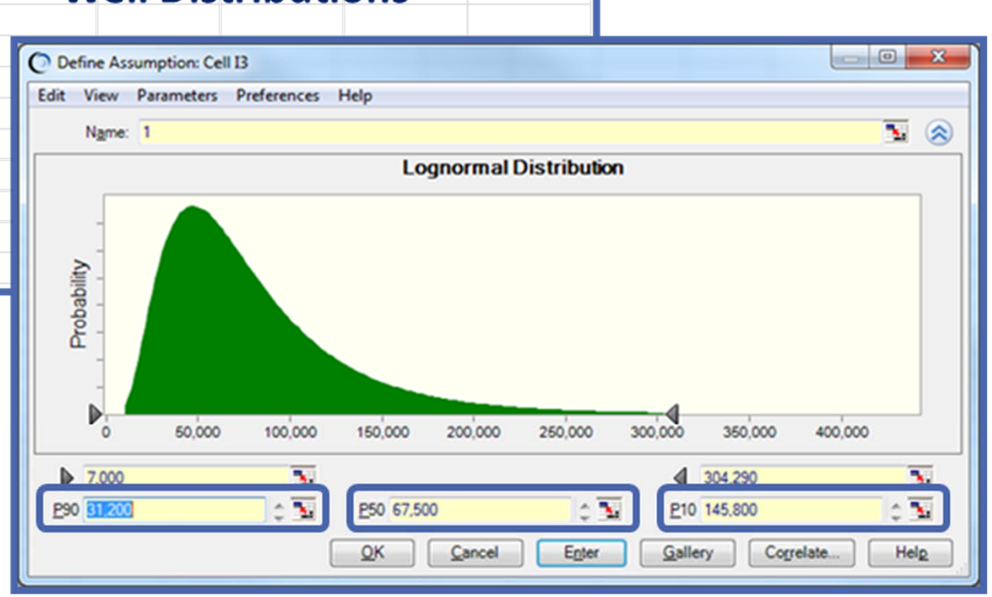
- Well level distribution
- Are these economic wells only or all wells?
- Should we be using a distribution of economic wells only and apply an economic COS factor?

- These examples will be discussed in terms of EUR & EUR per well. Nevertheless, the concepts apply to any variable (bbls/ft, peak rate, etc.) used to determine reserves following the SPEE recommended probabilistic analysis.

4. Aggregate the distributions according to the program size and derive the distribution of type wells (average program distributions).

Well	Min	P90	P50	P10	Mean	Max.	Std. Dev	Dist	Forecast	Spraberry Trend	100 Loc.	8 Loc.	56 Loc.	28 Loc.
1	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039	79,039	79,039	79,039	79,039	79,039
2	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
3	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
4	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
5	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
6	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
7	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
8	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
9	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
10	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
11	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
12	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
13	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
14	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
15	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					
16	7,000	31,200	67,500	145,800	79,000	304,290	52,393	79,039	79,039					

Average Type Well Distributions



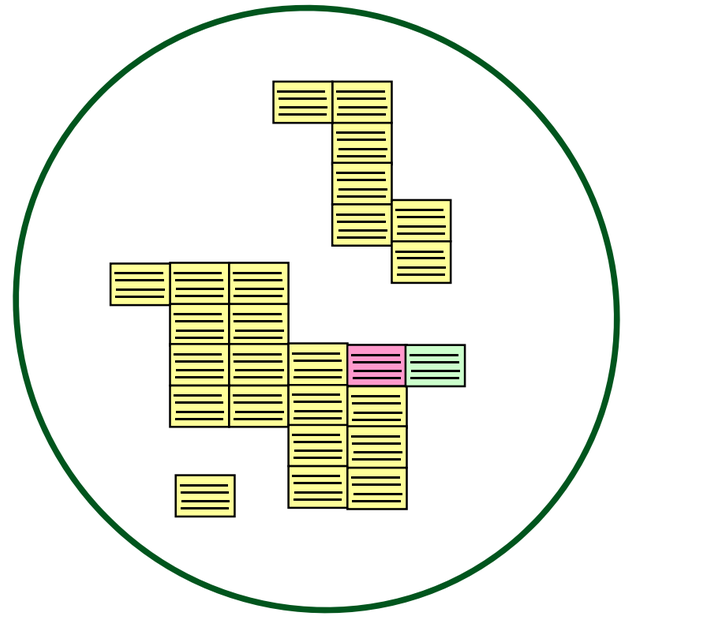
4. Aggregate the distributions according to the program size and derive the distribution of type wells (average program distributions).

000 Trials — Percentiles View — 7

Percentile	Spraberry Trend	8 Loc.	16 Loc.	20 Loc.	40 Loc.	80 Loc.	100 Loc.
P100	7,956	32,028	39,012	41,099	54,505	60,474	61,138
P90	31,121	58,628	64,311	65,750	69,629	72,361	72,943
P80	40,563	64,549	69,062	70,039	72,634	74,455	74,949
P70	49,076	69,205	72,436	73,208	74,869	76,073	76,416
P60	57,741	73,365	75,568	75,853	76,800	77,510	77,721
P50	67,188	77,482	78,482	78,553	78,658	78,894	78,957
P40	78,166	81,962	81,435	81,336	80,638	80,294	80,144
P30	91,836	86,712	84,663	84,270	82,896	81,776	81,487
P20	110,767	92,715	88,661	87,856	85,381	83,459	82,984
P10	142,976	101,450	94,360	92,676	88,964	85,928	85,233
P0	303,279	164,864	133,722	130,634	120,611	102,501	100,219

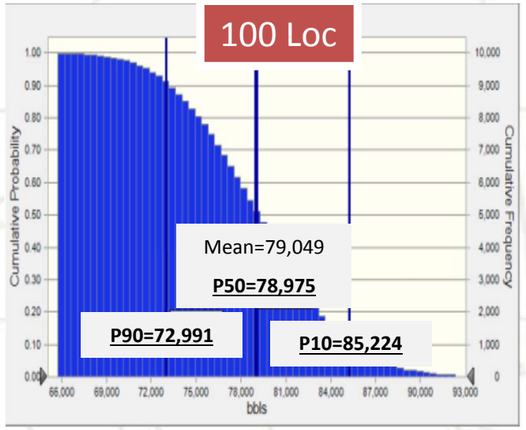
SAME WELL – DIFFERENT RESERVES

- "Wells exhibit a repeatable statistical distribution of estimated ultimate recoveries (EURs)
- "A continuous hydrocarbon system exists that is regional in extent"
- Problem: Acreage position may not be of regional extent and may vary from company to company
- Implication: Same well(s) may be assigned different reserves based on the company's acreage position.

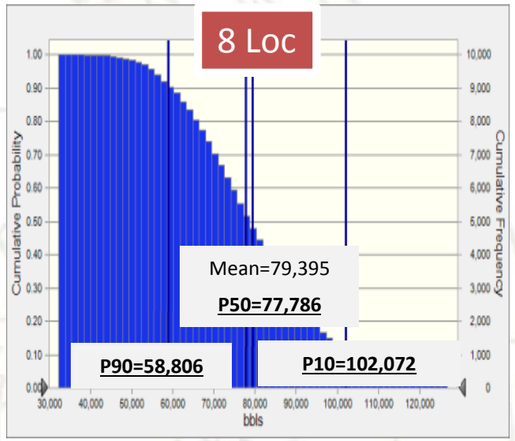


SAME WELL – DIFFERENT RESERVES

Company A



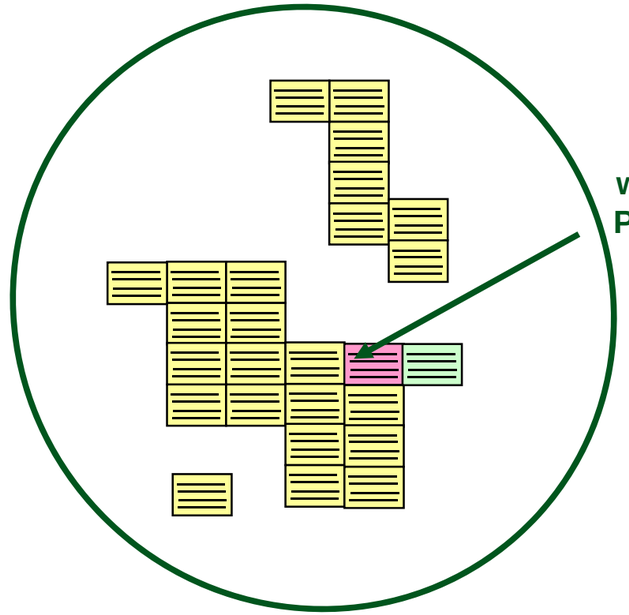
Company B



- **Assign 1P reserves/well:**
  - 73 kbbls for Company A (notice close to P^)
  - 59 kbbls for Company B
- **What about 3P – Higher for Company B?**

Per Well (kbbls)

	1P	2P	3P
Company A	73	79	85
Company B	59	78	102



THANK YOU