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Infill Well Potential In Tight Gas Reservoirs

SPE Paper #13249

by

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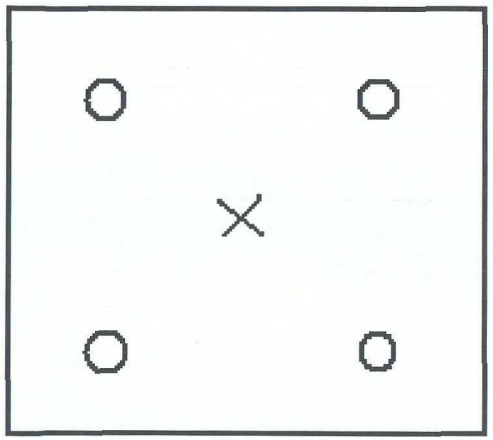
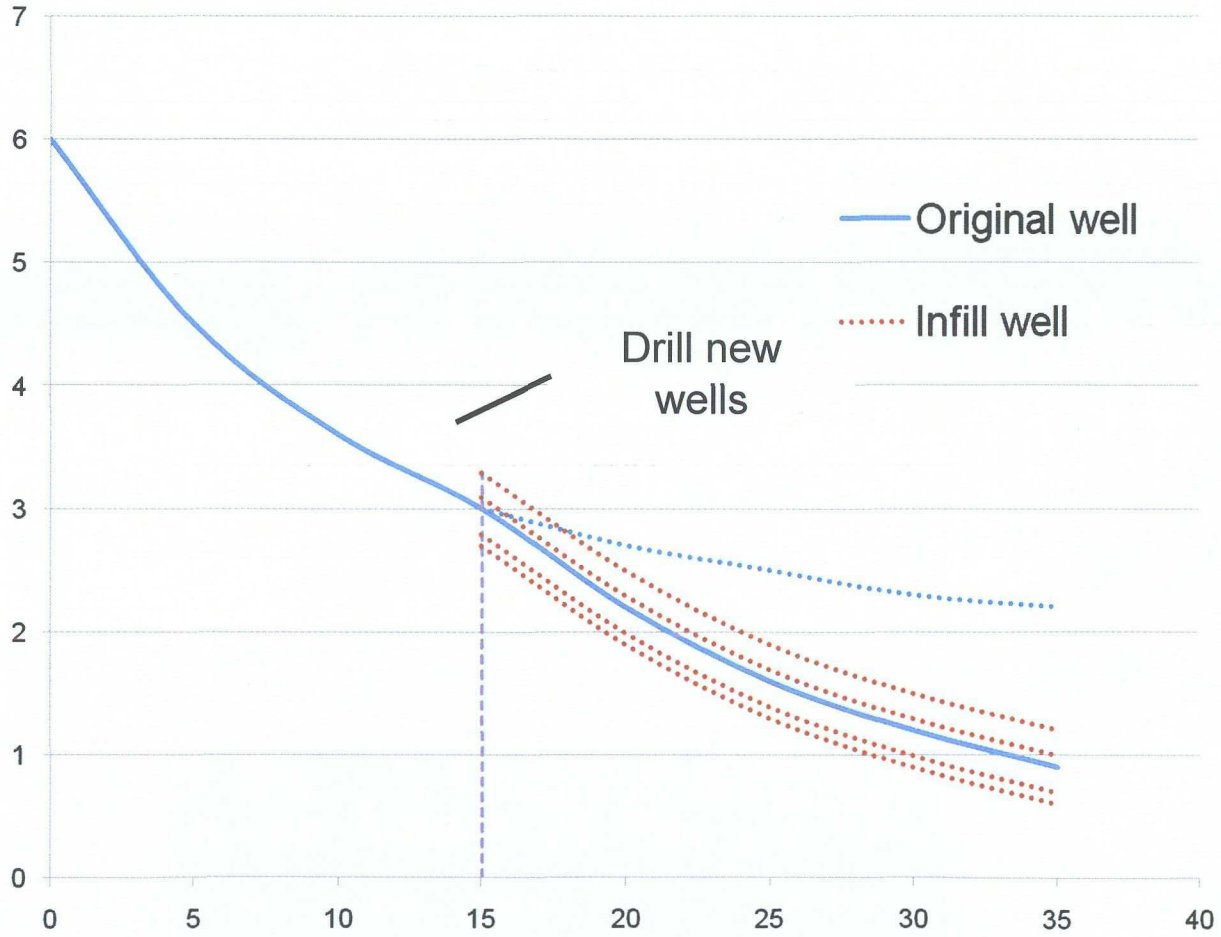
Introduction

- Determine EUR of infill well in tight gas reservoirs
- Predict incremental and acceleration components for infill well
- Homogeneous and heterogeneous reservoirs will exhibit different behavior when infill wells are drilled.

Homogeneous Reservoir



×: Original well
○: Infill wells



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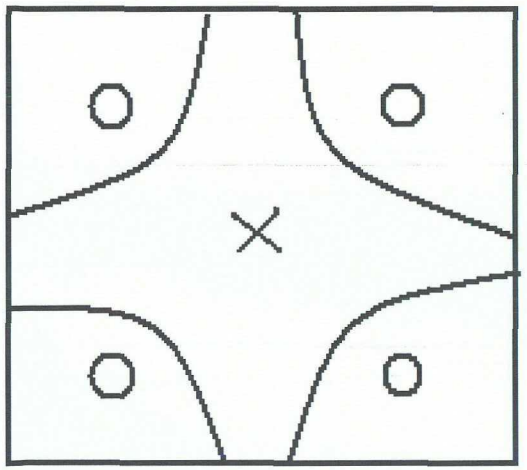
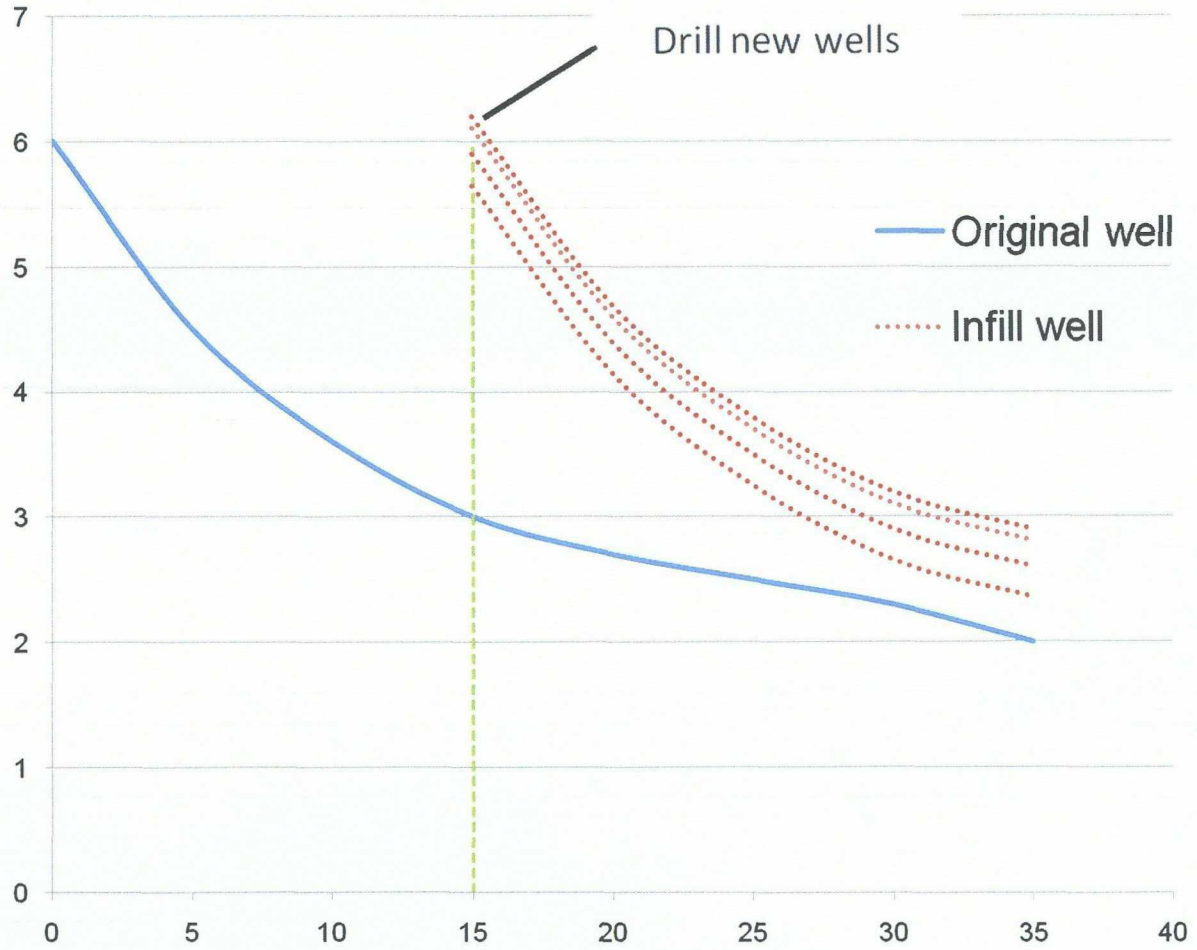
Heterogeneous Reservoir



×: Original well
○: Infill wells



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Objectives

- Develop a methodology to predict the gas which is "accelerated" by new wells.
- Using the existing production data, determine the infill well EUR
- Determine the contribution of acceleration and incremental components of the EUR.

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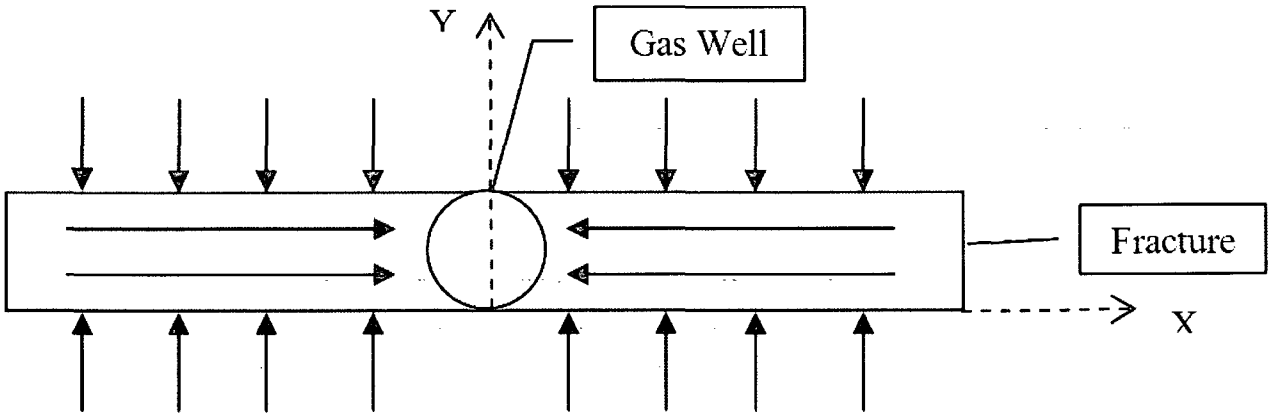
Approach

- Determine an appropriate time function such that cumulative production is linearly related.
- Divide the data into chronological groups so that average behavior can be predicted.
- Plot cum production vs. time function and examine inflection in the graph as successive groups of wells are drilled.
- Compare EUR calculated from this method with the EUR reported by companies.

Bilinear Flow

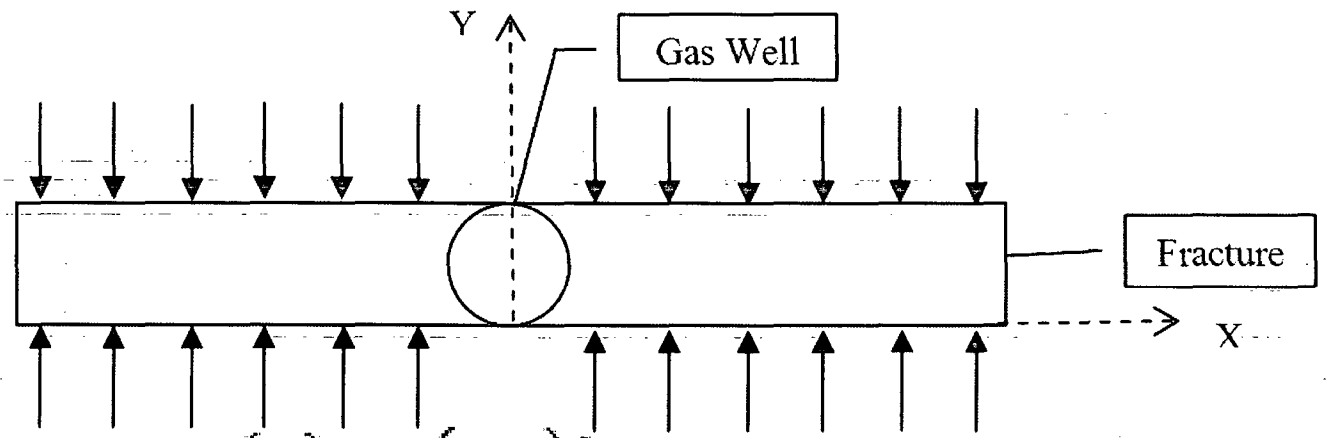


$$q_{sc,bl} = \frac{m(p_i) - m(p_{wf})}{493.83} \frac{h}{T} \sqrt{k_f b_f} (k\varphi(\mu c_t)_i)^{0.25} t^{-0.25}$$

$$\boxed{Gp_{bl,pseudo} = K_2 t^{0.75}}$$

Where: $$K_2 = \frac{h\sqrt{k_f b_f}(k\varphi(\mu c_t)_i)^{0.25}(m(P_i) - m(p_{wf,last}))}{493.83T}$$

Linear Flow



$$q_{sc,l} = \frac{m(p_i) - m(p_{wf})}{64.345} \frac{h}{T} x_f \sqrt{k_f b_f (k\varphi(\mu c_t)_i)^{0.5} t^{-0.5}}$$

$$\Rightarrow \boxed{Gp_{l,pseudo} = K_3 t^{0.5}}$$

Where: $$K_3 = \frac{h x_f \sqrt{k_f b_f} (k\varphi(\mu c_t)_i)^{0.5} (m(P_i) - m(p_{wf,last}))}{64.345T}$$

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Approach

- Determine a function of time such that cumulative production is directly related.
- Divide the data into chronological groups so that average behavior can be predicted.
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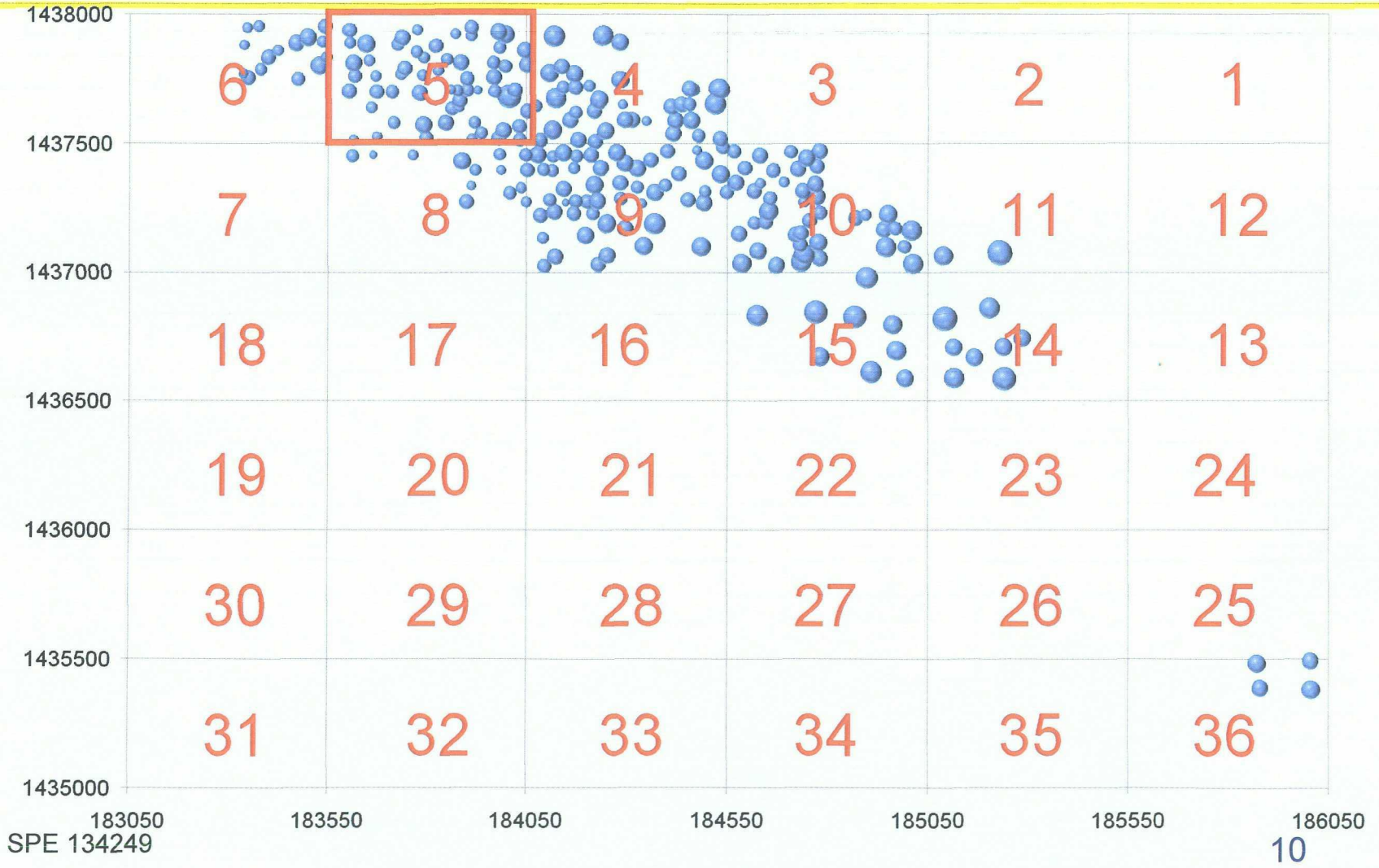
Pinedale Field



Grouping

	API	Start Date
Group 1:	49-035-23339	2/4/2004
	49-035-23856	6/27/2005
	49-035-23786	6/27/2005
	49-035-23977	2/27/2006
	49-035-23872	5/13/2006
	49-035-24237	6/7/2006
	49-035-24371	7/3/2006
	49-035-23979	7/4/2006
	49-035-24367	7/13/2006

	API	Start Date
Group 2:	49-035-24531	2/9/2007
	49-035-25105	3/28/2007
	49-035-24838	4/2/2007
	49-035-24849	4/8/2007
	49-035-24295	4/15/2007
	49-035-24851	4/22/2007
	49-035-25110	4/24/2007
	49-035-24852	4/24/2007
	49-035-24269	5/8/2007
	49-035-24326	5/14/2007
	49-035-25276	6/8/2007
	49-035-25275	6/9/2007
	49-035-25107	6/14/2007
	49-035-25112	6/25/2007
	49-035-25171	7/25/2007
	49-035-25170	7/25/2007
	49-035-25169	9/11/2007

	API	Start Date
Group 3:	49-035-25173	1/27/2008
	49-035-25168	1/27/2008
	49-035-25172	3/7/2008
	49-035-25167	3/7/2008
	49-035-25165	4/6/2008
	49-035-25969	4/12/2008
	49-035-25968	4/12/2008
	49-035-24411	4/20/2008
	49-035-24412	4/20/2008
	49-035-25114	5/13/2008
	49-035-25113	5/13/2008
	49-035-26141	5/17/2008
	49-035-25295	5/17/2008
	49-035-25115	6/1/2008
	49-035-25104	6/1/2008
	49-035-24835	6/17/2008
	49-035-25300	6/17/2008
	49-035-26170	6/22/2008
	49-035-26169	6/22/2008
	49-035-25075	7/5/2008
	49-035-25111	7/5/2008
	49-035-25634	7/16/2008
	49-035-25638	7/18/2008
	49-035-25903	8/30/2008
	49-035-25076	8/31/2008
	49-035-25108	8/31/2008
	49-035-25762	11/29/2008
	49-035-25712	12/1/2008
	49-035-25714	12/2/2008
	49-035-25713	12/3/2008
	49-035-26422	12/23/2008

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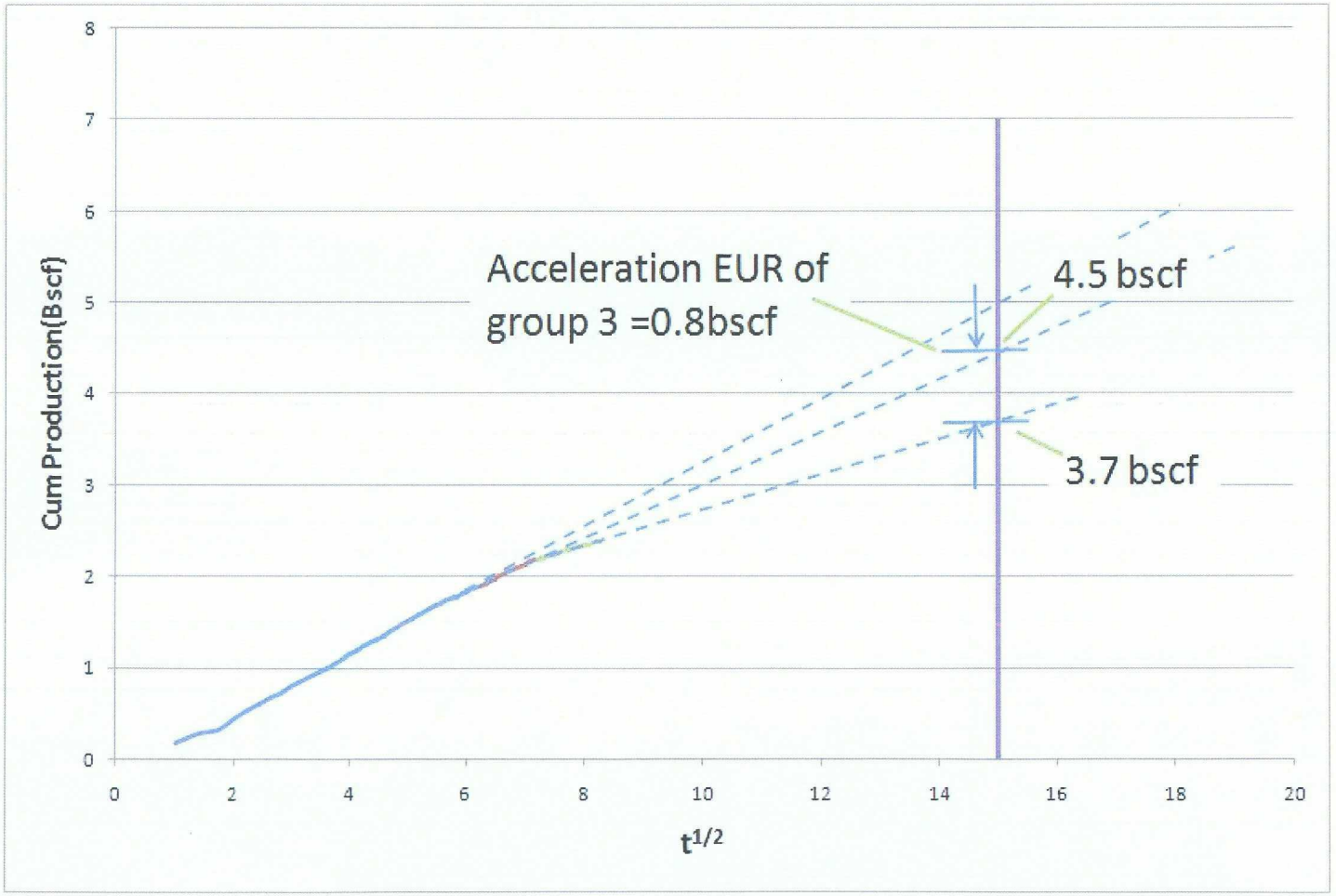
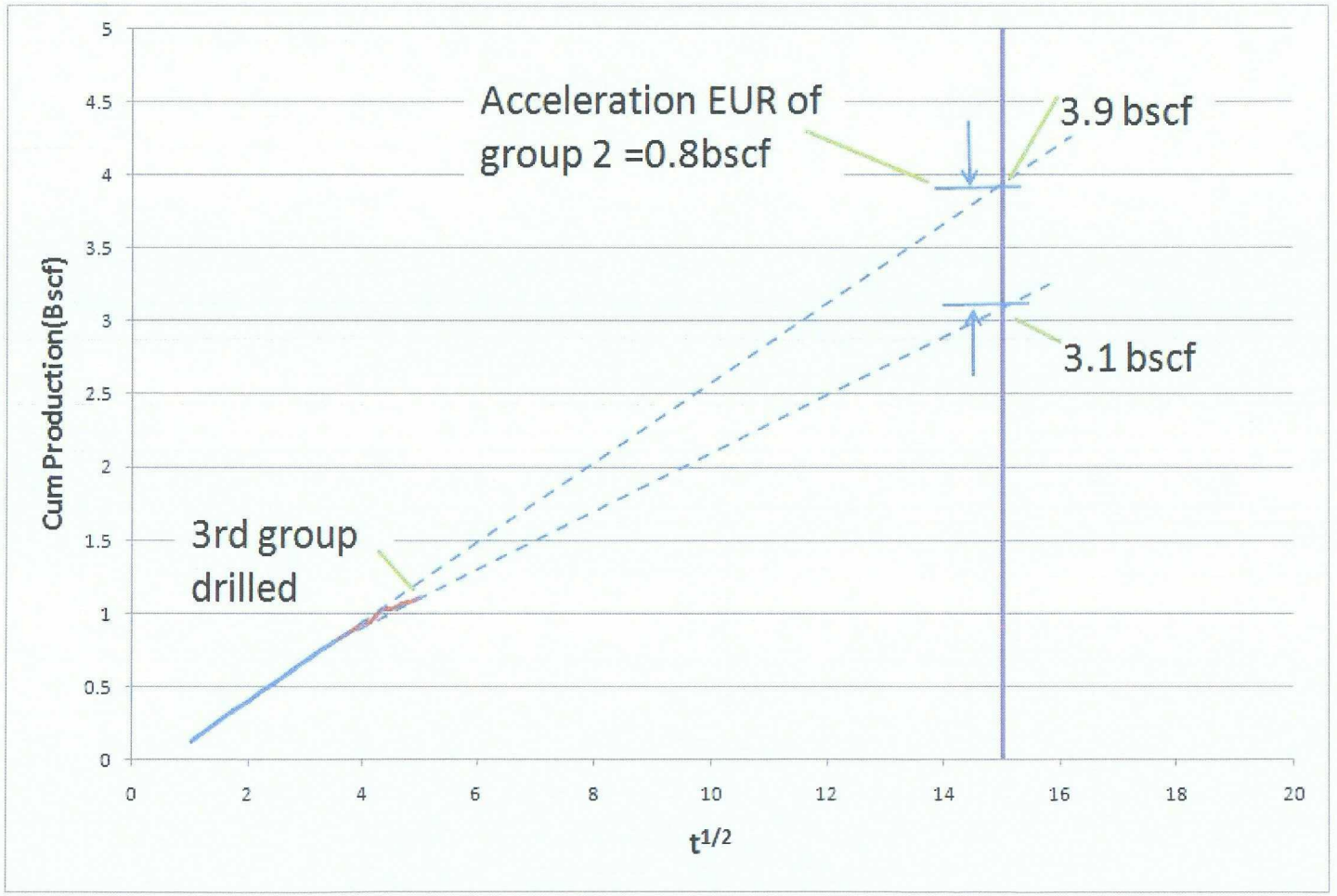
Example in Pinedale Field



Example in Pinedale Field



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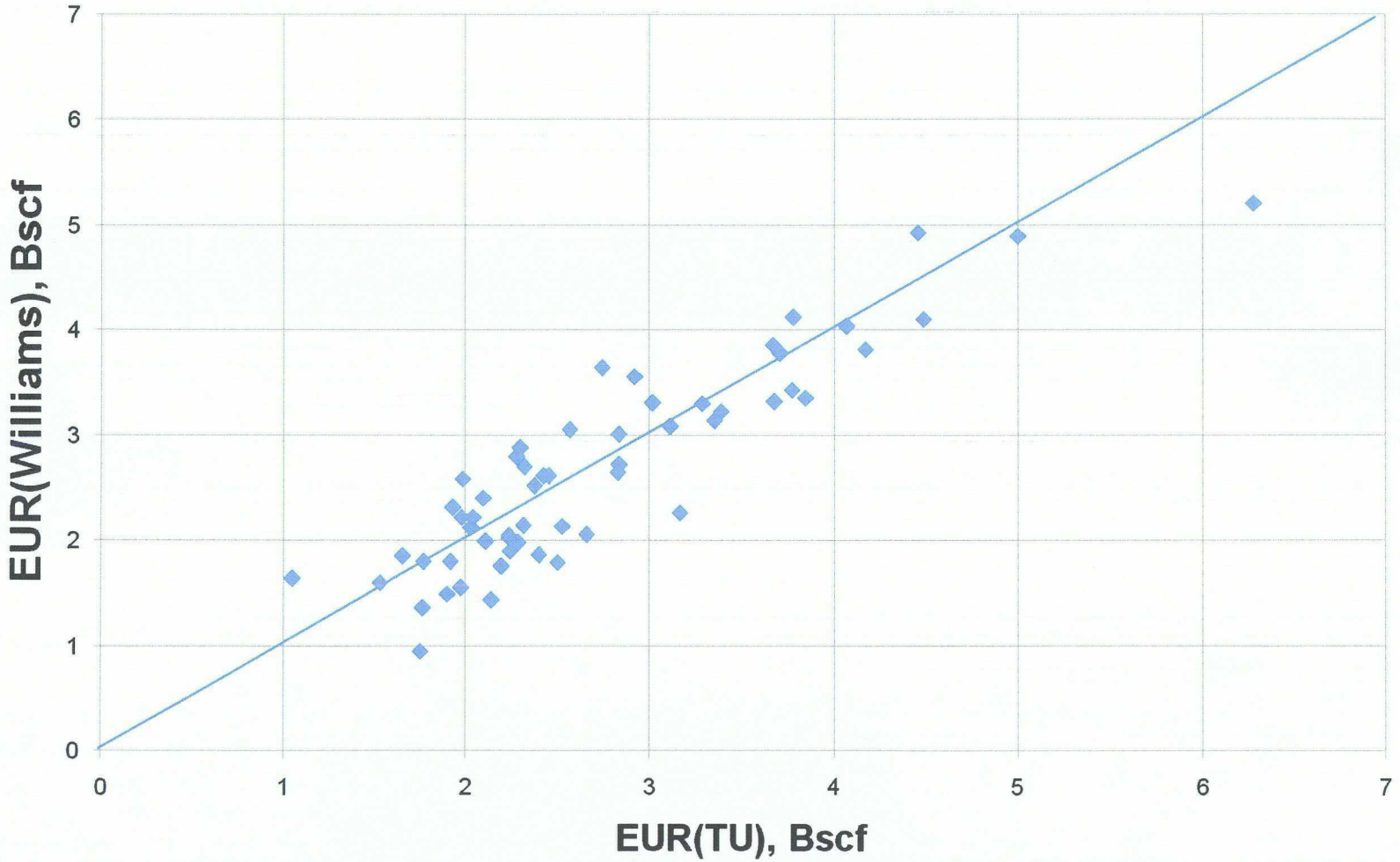
EUR Comparison
Pinedale Field



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Approach

- For every "child" well, calculate average Incremental and Acceleration components.
- Plot Acceleration percentage, Incremental percentage and total EUR as a function of spacing.
- Recommend potential sections where infill well potential is the greatest.

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Calculation

- Acceleration vs. Incremental
  - Total EUR for 2nd group per well = 3.57 BCF
  - Acceleration EUR for 2nd group (avg. per well) = Decreased EUR for 1st group = 0.24 BCF
  - To Calculate the Incremental EUR for 2nd group per well

  = Total EUR - Acceleration EUR

  = 3.57 - 0.24 = 3.33 BCF

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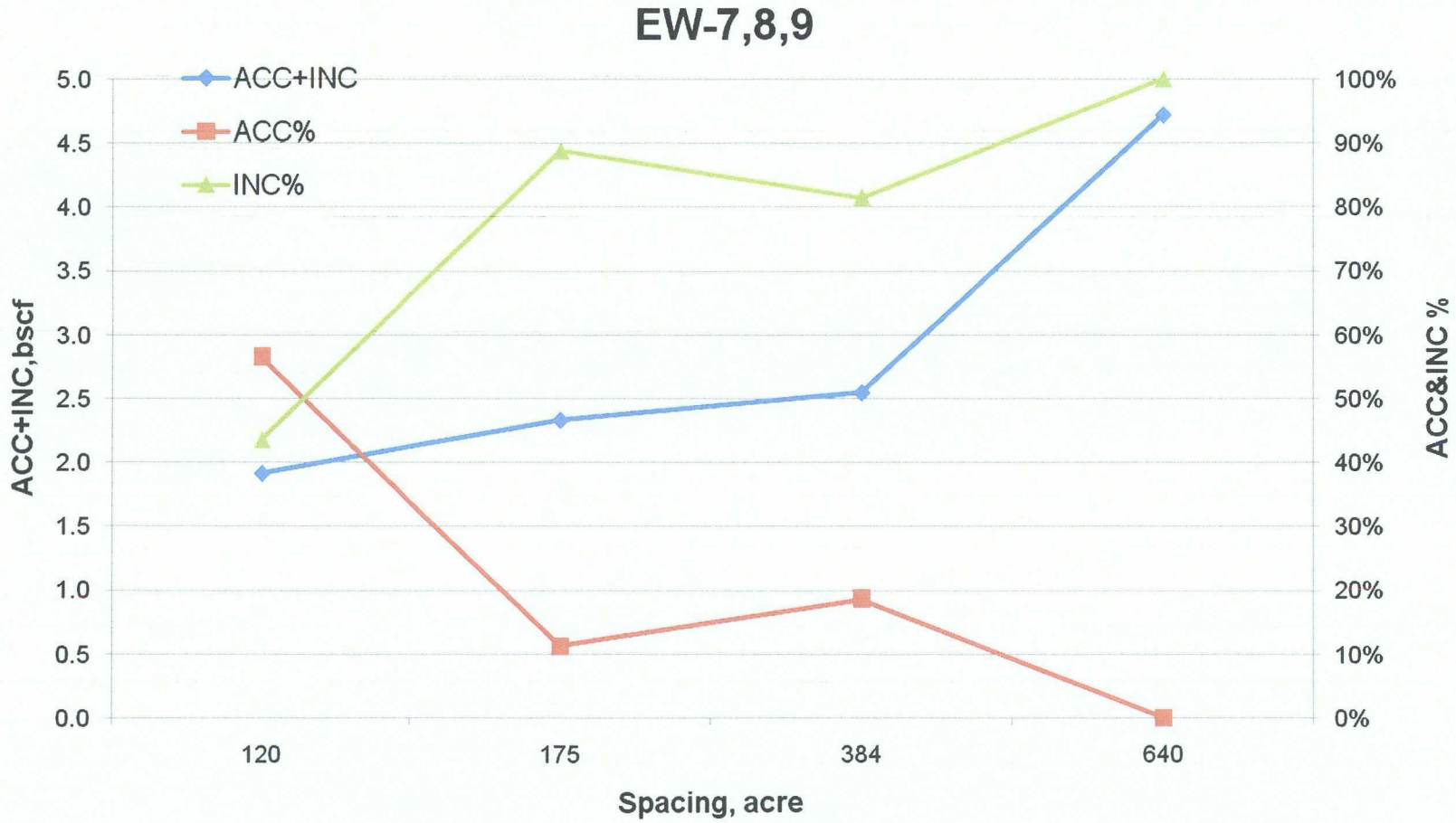
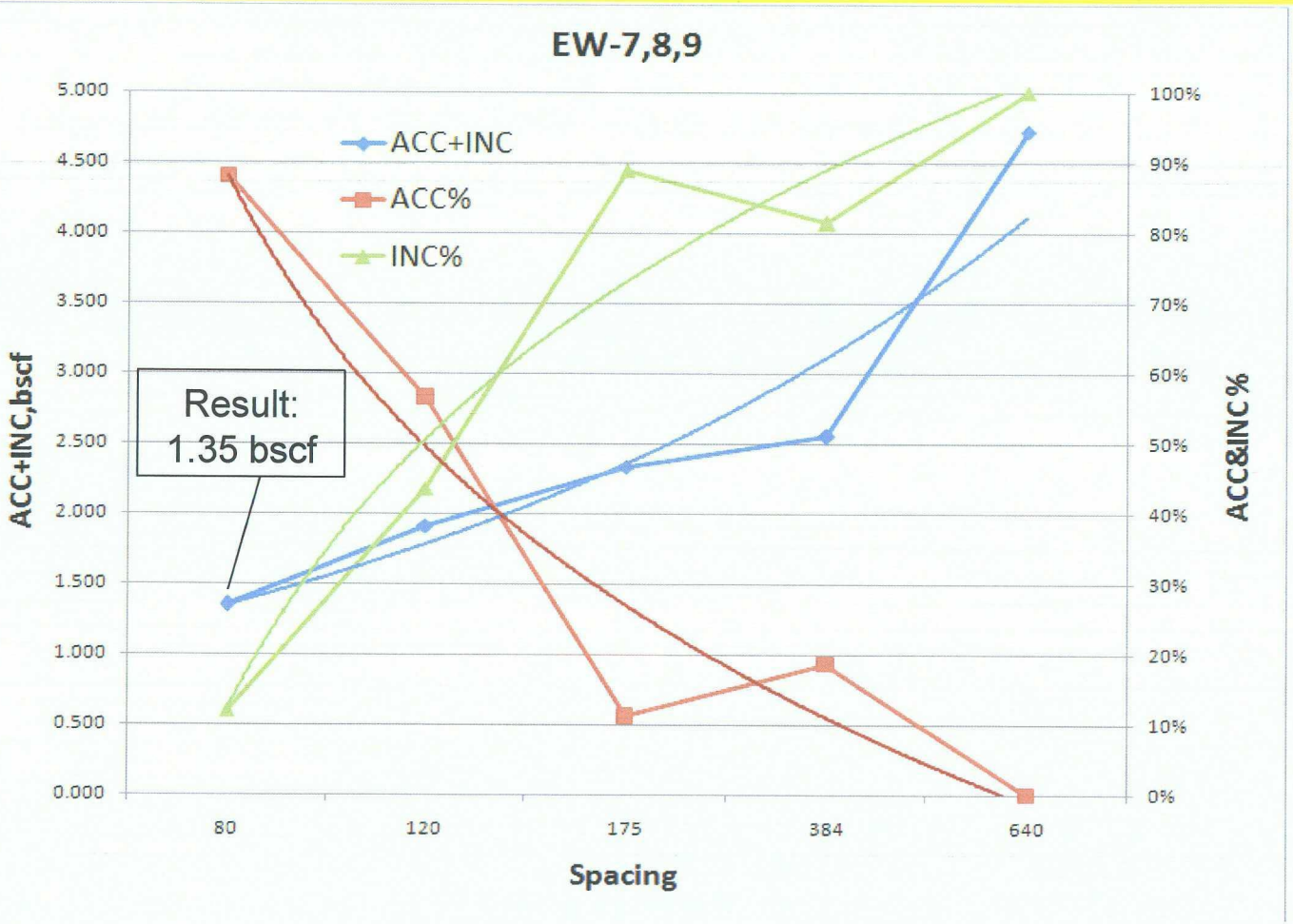
Acceleration vs. Incremental



Extrapolation to 80 acre spacing



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Recommended Sections

	Total (bscf)	%(ACC)	%(INC)
EW-7,8,9	1.350	88%	12%
EW-12,13,14	2.300	43%	57%
EW-17,18,19	2.140	84%	16%
NS-7,12,17	0.900	70%	30%
NS-8,13,18	1.750	91%	9%
NS-9,14,19	2.150	64%	36%

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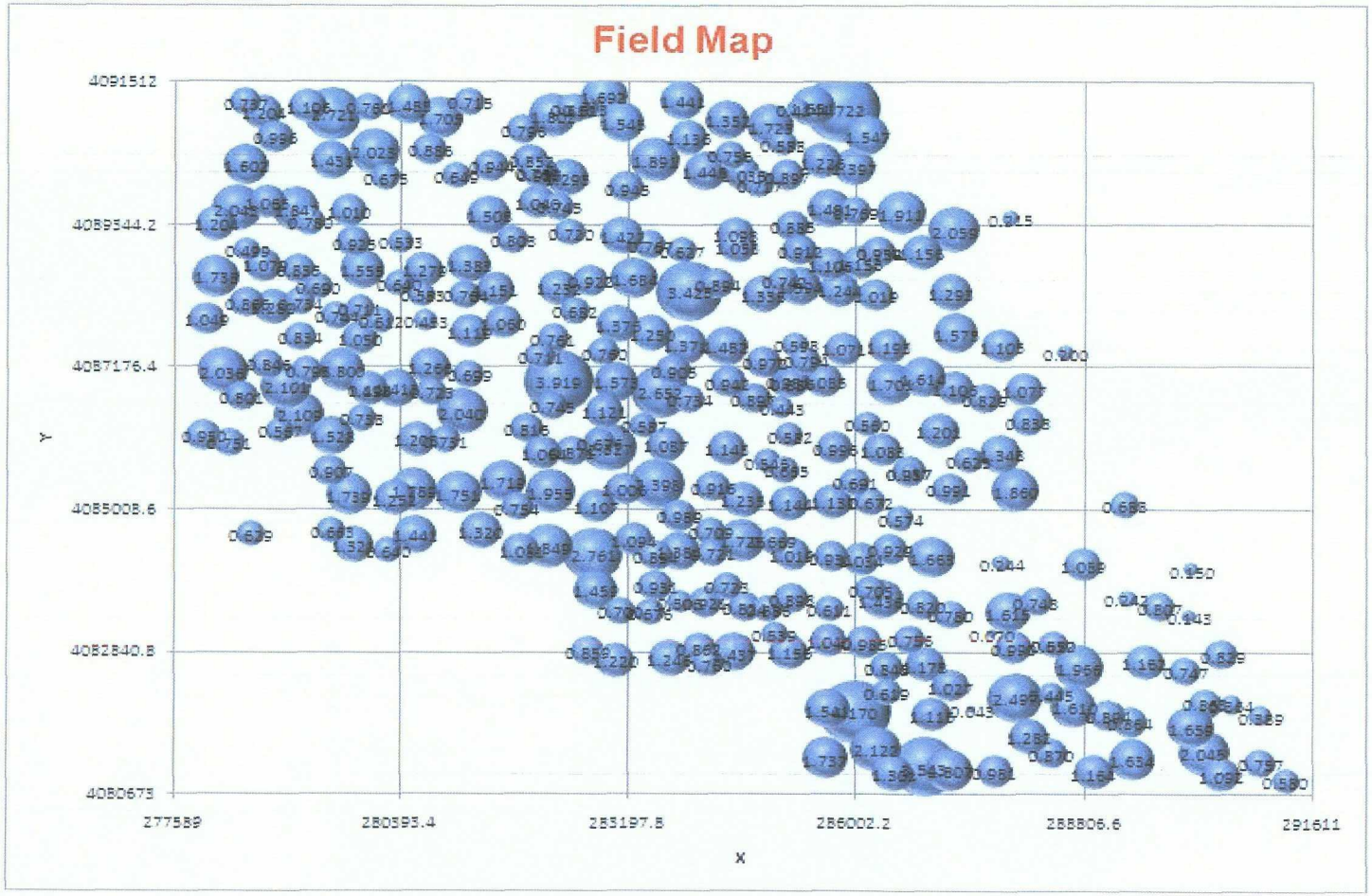
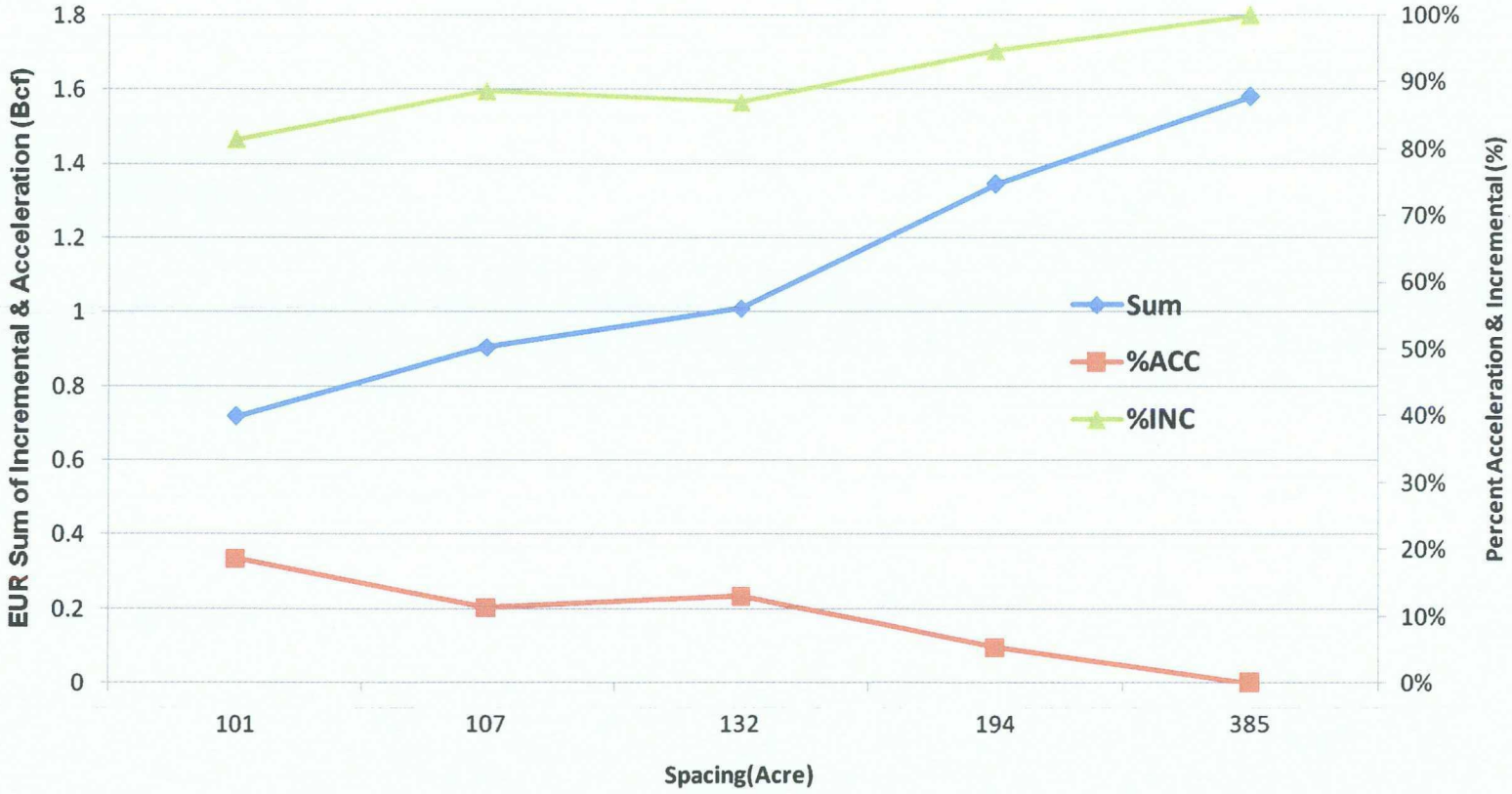
Conclusions

- Using a newly developed methodology, the acceleration and incremental contributions for infill wells was determined
- Method validated in Wamsutter and Pinedale gas fields.
- Based on recommendation, Devon will drilled seven wells in Wamsutter field.

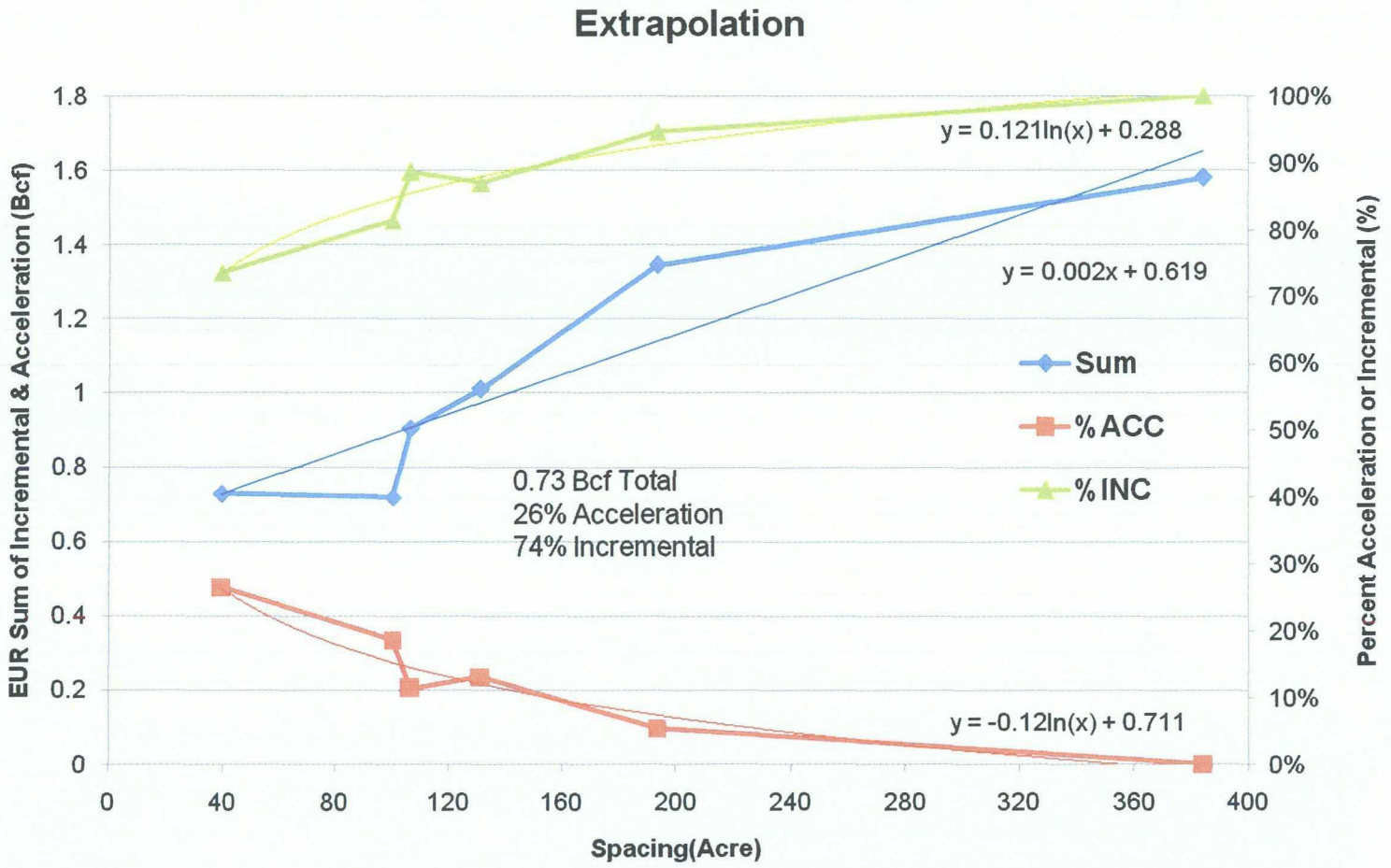
Field Map


Field Map
4091512
4089544.2
4087176.4
4085008.6
4082840.8
4080673
Y
277589
280393.4
283197.8
286002.2
288806.6
291611
X

Rosa MV Field-wide Results



Rosa MV Field-wide Extrapolation



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Rosa MV 40 Acre Projections

	Sum	%(ACC)	%(INC)	ACC	INC
Area1:	0.829	16%	84%	0.136	0.693
Area2:	0.855	13%	87%	0.108	0.747
Area3:	0.729	25%	75%	0.183	0.546
Area6:	0.846	9%	92%	0.072	0.774
Area7:	0.818	13%	87%	0.103	0.716
Area8:	0.915	38%	63%	0.344	0.572
Area9:	1.019	12%	88%	0.121	0.897
Area11:	0.758	37%	62%	0.284	0.474
Area12:	0.791	19%	81%	0.148	0.642
Area13:	0.700	45%	55%	0.315	0.384
Area14:	0.676	17%	83%	0.117	0.560
Area18:	0.922	19%	81%	0.176	0.745
Area19:	0.430	28%	72%	0.119	0.310
Area24:	0.593	51%	49%	0.303	0.289
Area25:	1.009	32%	68%	0.327	0.682
Average:	0.793	25%	75%	0.190	0.602