

Follow-on Flow Analysis Activities for the MC252 Well

Report-outs by Government Teams

PREDECISIONAL DRAFT

**Saturday, July 31
12:30 – 1:30 PM CDT**

Agenda

Time (CDT)	Speaker	Topic
12:30-12:35	Bill Lehr	Flow Visualization Before TopHat-4
12:35-12:40	Dan Maclay	Reservoir – Time of Event with Production
12:40-12:45	George Guthrie	Nodal Analyses – Pre/Post Cut
12:45-12:50	Rich Camilli	Doppler Velocities → Kink and more
12:50-12:55	Paul Hsieh	Reservoir Studies Around Times of Well Integrity Test Shut-in
12:55-1:00	Art Ratzel	Flow prediction around Well Integrity Shut-in
1:00-1:30	Tom Hunter	Closure

Flow Visualization Before TopHat-4

Bill Lehr

Alberto Aliseda

Steve Wereley

BOEM

Reservoir – Time of Event with Production

**Don Maclay
Gerald Crawford**

BOEM/USGS

Flow Estimates

Don Maclay (BOEM)

Assumptions for the case include the following:

Permeability = 250 md

Rock compressibility = $10 \times 10^{-6} \text{ psi}^{-1}$

GOR = 2,542 scf/stb

Annular flow outside of the production casing

Results

Base Case

- Initial production rate = 58,000 BOPD
- Flow day 87 = 52,000 BOPD
- Cumulative production = 4,700,000 BO

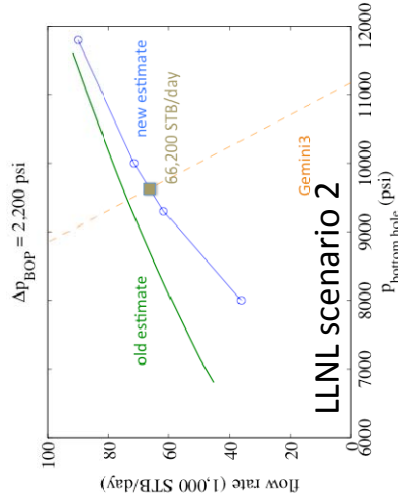
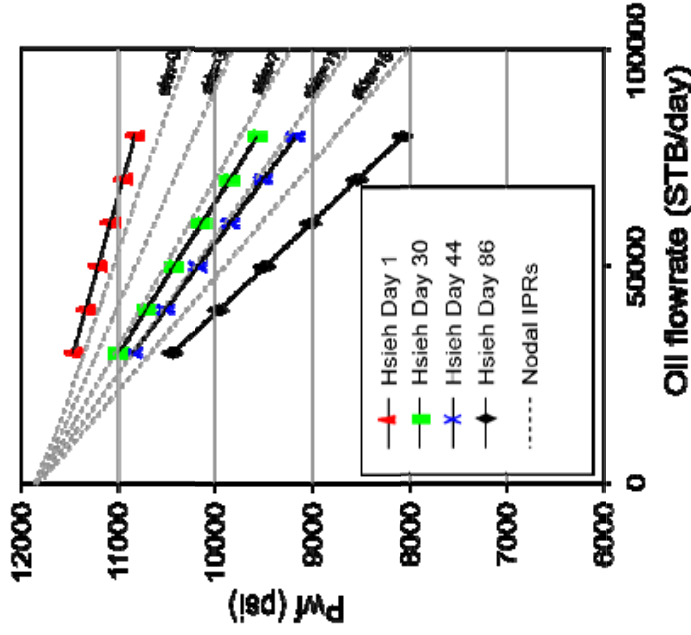
Nodal Analyses – Pre/Post Cut

George Guthrie

NETL

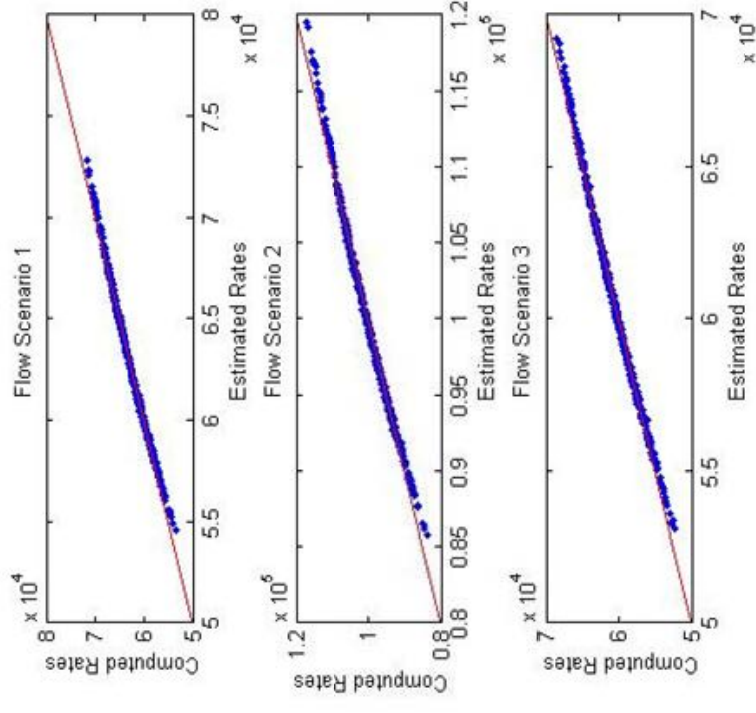
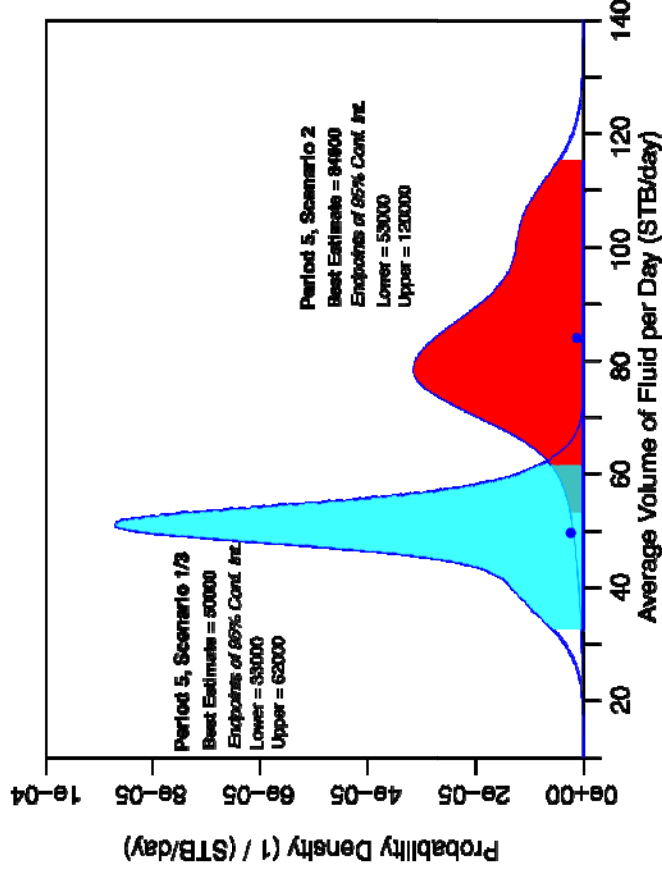
Nodal Flow Estimates

George Guthrie (DOE NLs)



- New information on reservoir behavior (Hsieh) has been assessed and is consistent with initial reservoir model
 - time variance behaves like skin
 - nodal assessments averaged over skins/time so represent a time-“averaged” rate (but not time weighted)
 - Two independent approaches to evaluate impact of depleting reservoir pressure (Hsieh IPR and coupled model) suggest ~15–20% impact over time/pressure depletion
 - effect is larger for scenario 2
- | | Scenario 1 | Scenario 2 | Scenario 3 |
|--------|------------|------------|------------|
| Day 1 | 65824 | 122907 | 63433 |
| Day 18 | 45429 | 70092 | 44725 |
| Day 44 | 48799 | 78161 | 48462 |
- Assessment of new BOP observations are consistent with BOP treatment in nodal models
 - Nodal approach included impacts of partial closure of rams and uncertainty associated with potential time varying behavior of resistance
 - New BOP data are within
 - Nodal models included resistance in drill flow-pipe

Results



- Nodal analysis results are consistent with flow rates in the range 50–60 kbpd
- Spread in nodal analysis reflects remaining uncertainty in the system, even with incorporation of new data on reservoir (Hsieh) and BOP (additional pressure measurements)
- Primary driver is uncertainty in flow scenario
 - scenario 2 or scenario 1+2 result in flows that are generally higher when honoring reservoir in-flow behavior (reservoir permeability, skin, etc.)

Doppler Velocities → Kink and more

Rich Camilli
Andy Bowen

WHOI

Flow Estimates

Rich Camilli, (WHOI)

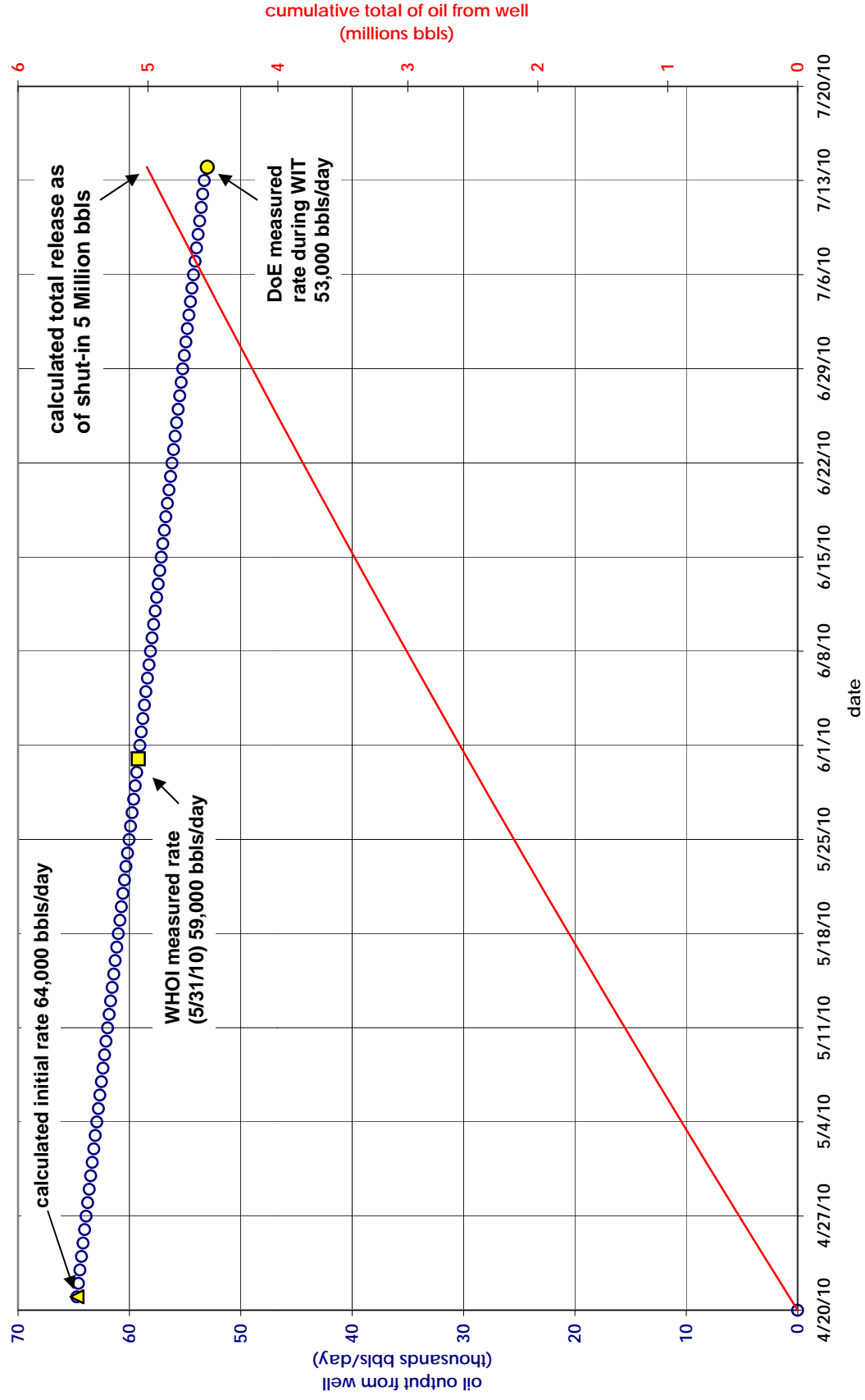
Acoustic flow measurements were completed using a 1.8 MHz imaging multibeam sonar and 1.2MHz acoustic Doppler velocity profiler (ADCP) mounted to a work class remotely operated vehicle (ROV). Flow measurements were recorded at two distinct plume sites, above the riser pipe and at the kink above the BOP. Velocity estimates are derived from three different ADCP view angles above the riser pipe and three ADCP view angles above the BOP. Plume cross section measurements were completed using the imaging multibeam sonar concurrently with the ADCP on the ROV.

These acoustic measurements, (composed of approximately 16,000 ADCP data points, and 2,600 imaging sonar cross-section images) are used in conjunction with a liquid petroleum fraction of 43.7% (calculated from IGT sample) to calculate a flow rate on 5/31/10 of approximately 59,000 bbls/day.

Based on this 5/31/10 flow estimate and the DOE Tri-Lab Flow Modeling Team's WIT shut-in estimate (53,000 bbls/day), a linear flow rate trend is extrapolated for the interval between 4/20/10 and 7/14/10. The summation of each day's flow rate is then used to calculate a cumulative total flow from the well. This approach is consistent with the hypothesis that flow rate decreases approximately linearly with time as a result of well pressure decrease. Additional well flow/pressure data collected between 4/20/10 and 7/14/10 should be examined to ascertain if a non-linearly decreasing flow model would be more appropriate for estimating initial flow rate and cumulative release from the well.

Results

Oil flow from Deepwater Horizon MC252 well



9/19/2012

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Reservoir Studies Around Times of Well Integrity Test Shut-in

Paul Hsieh

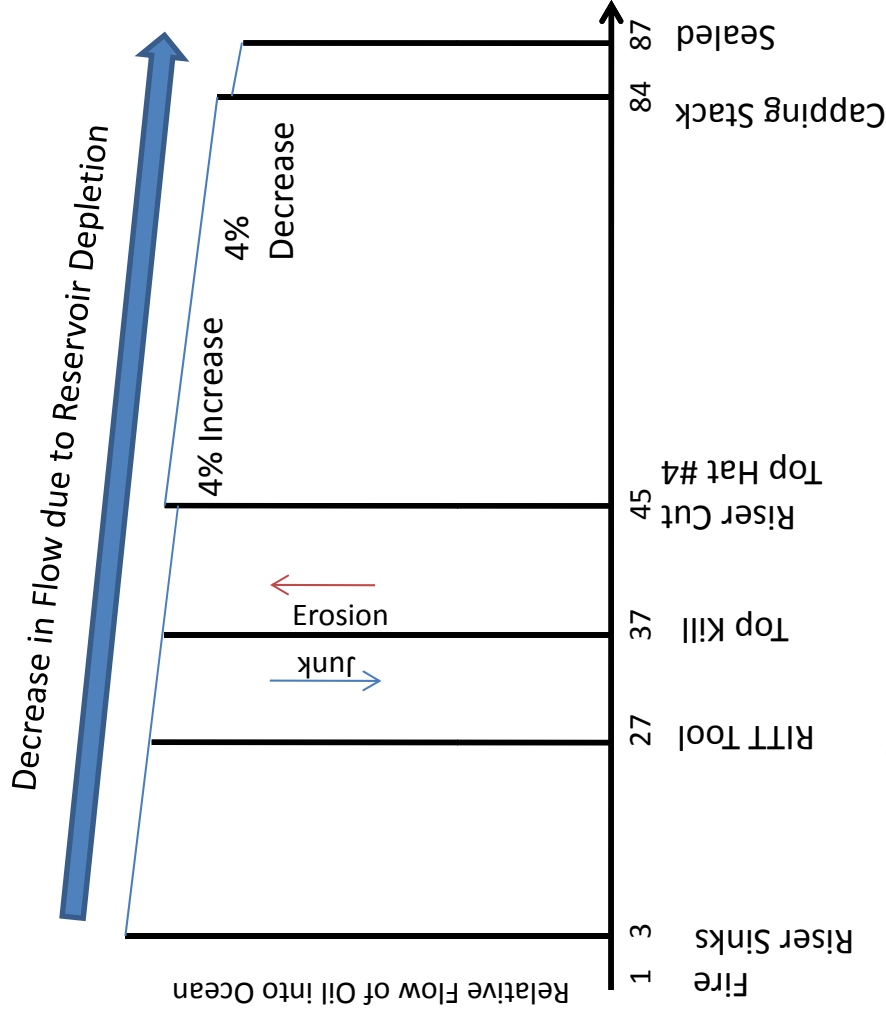
USGS

Flow prediction around Well Integrity Shut-in

Art Ratzel

DOE Team

DOE Team Estimates for Flow Rates



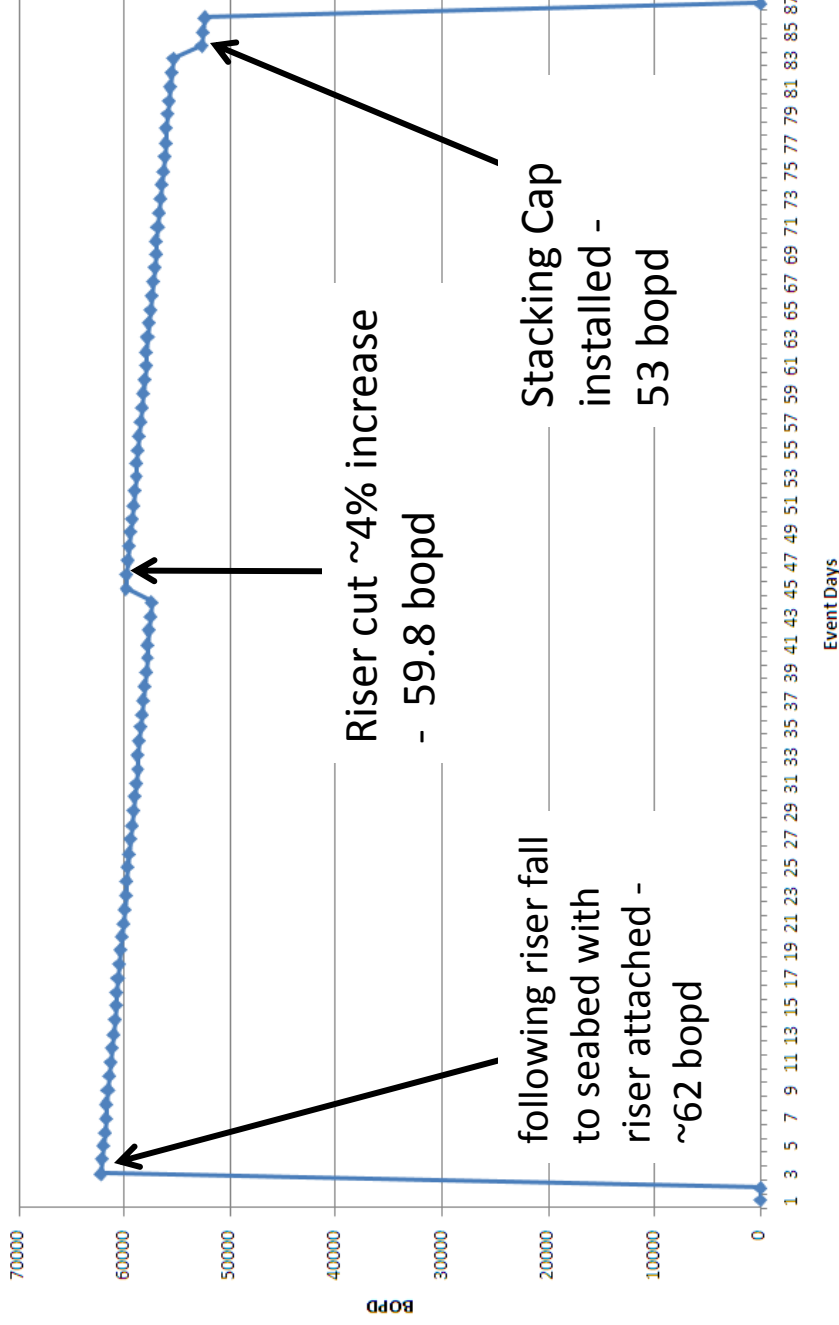
Assumptions

- Linear fit for Reservoir Depletion of 1800psi (Hsieh est.)
 - $P_{\text{initial}} = 11850\text{psi}$
 - $P_{\text{final}} = 10050\text{psi}$
- Events effecting flow rate (see chart)
 - Riser cut and stacking cap
 - Top Kill effect not considered (indeterminant)
- Oil directly recovered: 804k bbls (per BP)

Results from Flow Rate Models

- **Shut-in flow rate:** Used DOE Team methods 1 & 2 (Kill Line models) – 53K bopd
- **Initial State:** Used reservoir initial condition and DOE team methods (Reservoir-to-Sea models) ~65K bopd (did not correct for riser pipe in the calculation)
- **Riser cut:** DOE team predicted 4% increase
- **Install of Capping Stack:** DOE team computed ~4% decrease in flow rate

DOE Team Flow Results for 87 Days



Checked assumption of linearity for flows against results for linear reservoir depletion model and good agreement

Integral Release ~4.9 million barrels

Oil Collected ~0.8 million barrels (from BP)

Discussion and Close-out

Tom Hunter

Total Loss less Directly Collected by BP

Flow Rate Minus Oil Recovered

