Science for Decisions: National Incident Command Flow Rate Technical Group

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U.S. Department of the Interior
U.S. Geological Survey

Flow Rate Technical Group

- Chartered by the National Incident Command
- Federal scientists, independent experts, university representatives
- Four independent teams developing best methods to estimate oil spill flow
  - Mass Balance Team
  - Plume Analysis Team
  - Reservoir Analysis Team
  - Nodal Analysis Team
- BP provided some raw data
- Providing preliminary and updated assessments since May 27
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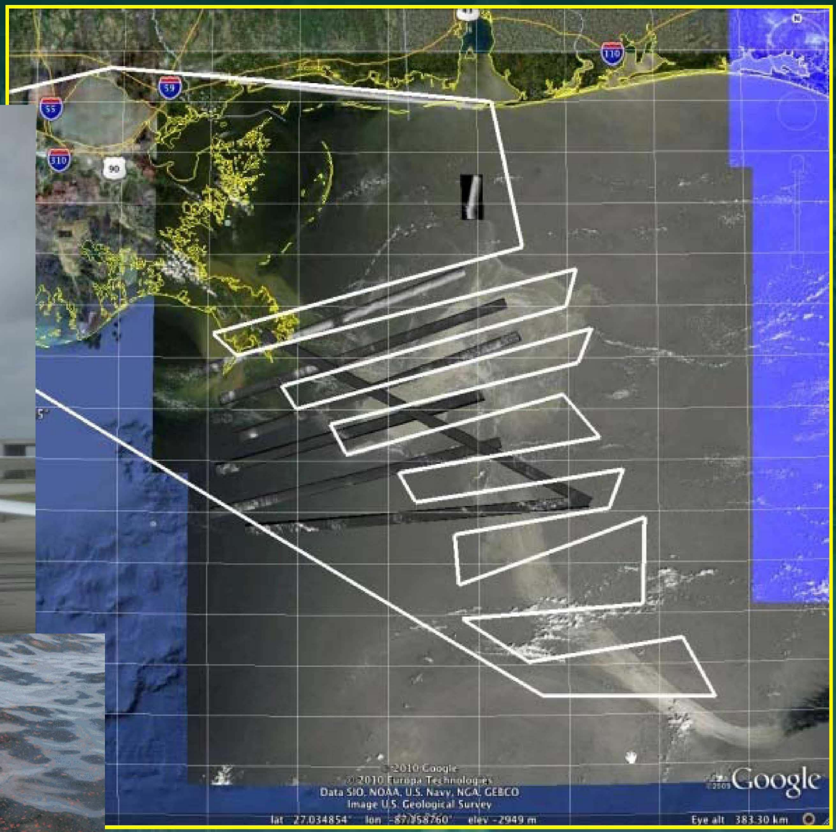
Mass Balance Team



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Mass Balance – Discharge Rate Calculation

- Start with a measured sea-surface oil volume
- Add collected, burned, skimmed, evaporated, dispersed, etc.
- Divide by number of days of oil discharge

RESULT = Average Daily Discharge Rate

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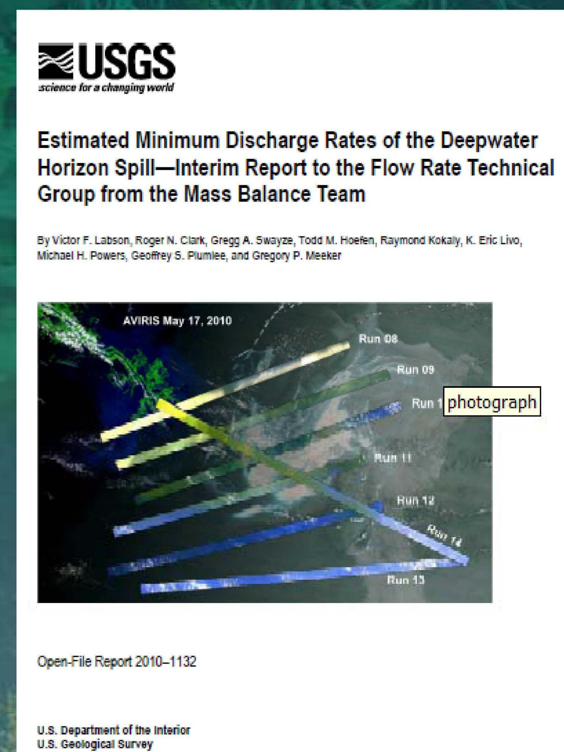
Mass Balance Team Preliminary Results

- Assessment formed from data collected May 17
- Calculated average minimum flow:

  12,600 to 21,500 barrels a day
- Report peer reviewed and published

  http://pubs.usgs.gov/of/2010/1132/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science for a changing world

Estimated Minimum Discharge Rates of the Deepwater Horizon Spill—Interim Report to the Flow Rate Technical Group from the Mass Balance Team

By Victor F. Labson, Roger N. Clark, Gregg A. Swayze, Todd M. Hoefen, Raymond Kokaly, K. Eric Livo, Michael H. Powers, Geoffrey S. Plumlee, and Gregory P. Meeker

Open-File Report 2010–1132

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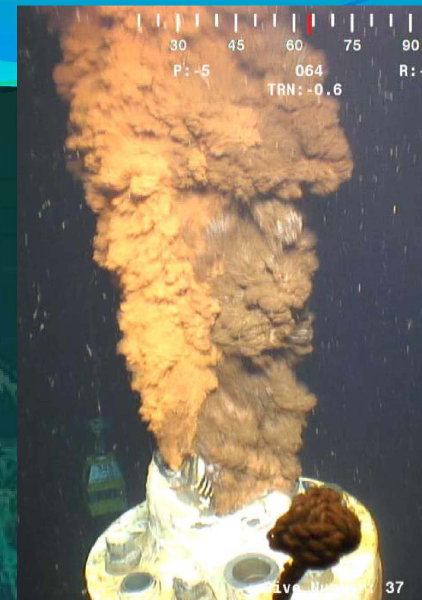
Plume Analysis Team

- Analyze video provided by BP
- Modeled via

  Particle Image Velocimetry (PIV)



A flow model for the reservoir can be constructed using the radial single phase (liquid) version of Darcy's Law shown as equation (1).

$$\frac{q}{p_e - p_{wf}} = \frac{k_o h}{141.2 B_o \mu_o \left[\ln\left(\frac{r_e}{r_w}\right) + s \right]} \text{ .... (1)}$$

$q =$ liquid flow rate (STB/day)

$p_e =$ reservoir boundary pressure = 11,856 (psia)

$p_{wf} =$ flowing pressure inside, but at the bottom of the well (psia)

$k_o =$ permeability to reservoir fluid (md)

$h =$ net reservoir thickness (ft)

$B_o =$ liquid formation volume factor = 2.367 (reservoir bbl/STB)

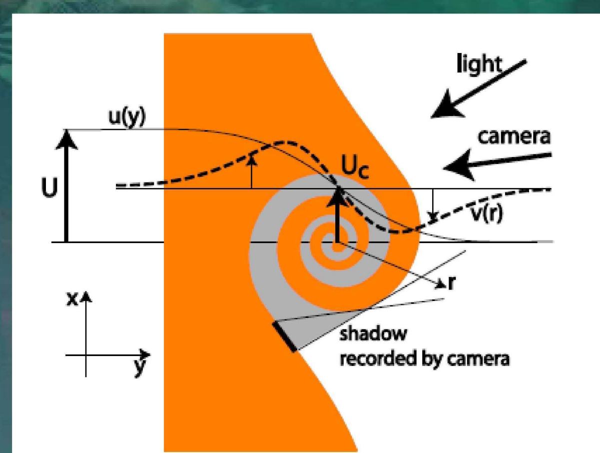
$\mu_o =$ viscosity of reservoir fluid = 0.165 (cp)

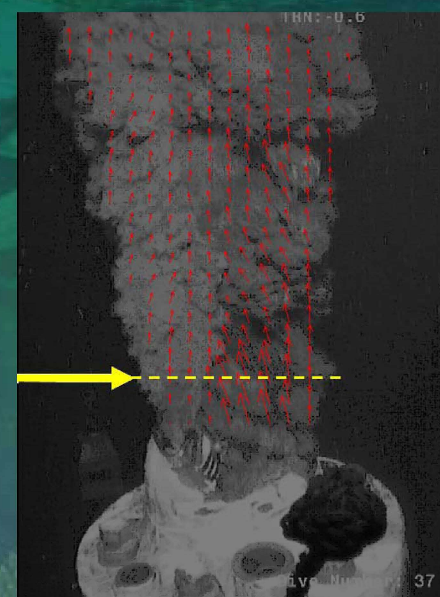
$r_e =$ radius to the well drainage boundary = 4,560 (ft)

$r_w =$ well bore radius = 0.254 (ft)

$s =$ reservoir skin damage = 0 (dimensionless)

$$\frac{q}{p_e - p_{wf}} = \frac{223.7(95.5)}{141.2(2.367)0.165\left[\ln\left(\frac{4,560}{0.254}\right) + 0 \right]} = 39.5 \text{ STB/day/psia .... (2)}$$





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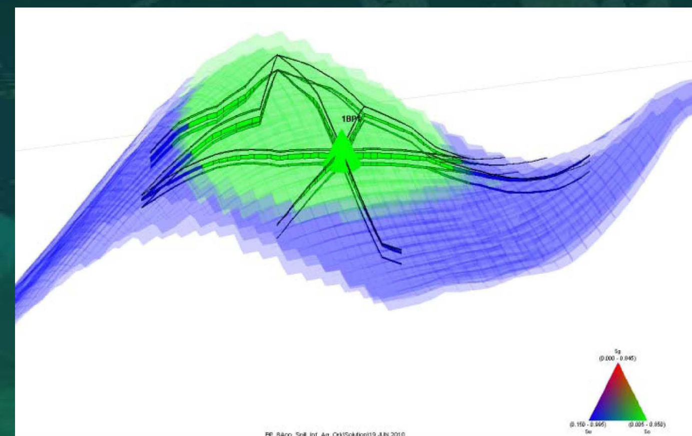
Nodal and Reservoir Teams

- Reservoir Team investigate characteristics of oil field/reservoir



- Nodal Team uses Reservoir Team and other data to model potential flow from well

1.1.2 Static Pressure Changes Across Sudden Enlargement

The static pressure drop for two-phase flow through an enlargement from area A_0 to area A_1 is:

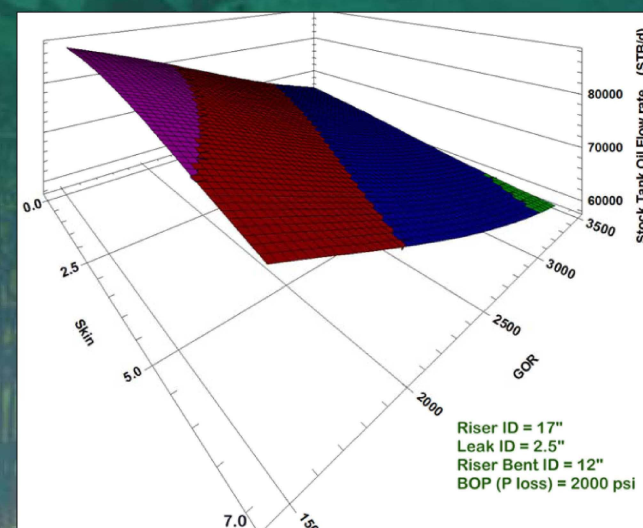
$$p_1 - p_0 = G_0^2 \frac{A_0}{A_1}\left(1-\frac{A_0}{A_1}\right)v_f\left[1+\frac{v_{fg}}{v_f}\frac{x_0+x_1}{2}\right] \quad (8)$$

where gas quality is averaged across the expansion. This equation has been found satisfactory for two-phase flow through expansions at high pressure (82.6 bar) and high mass flux ($G>2700$ kg/m^2-s).

1.1.3 Static Pressure Changes Across Sudden Contraction

The change in static pressure at a sudden contraction from area A_0 to area A_1 is:

$$p_0 - p_1 = \frac{G_1^2}{2}v_f\left[\left(\frac{1}{(A_c/A_1)}-1\right)^2+\left(1-\frac{1}{(A_0/A_1)^2}\right)\right]\left[1+\frac{v_{fg}}{v_f}\frac{x_0+x_1}{2}\right] \quad (9)$$



Current Government Flow Estimate

- Based on updated Plume Team analyses and collaboration with DOE science team
- Estimate released to public June 15
- Flow rate estimated at 35,000 – 60,000 BPD

Next steps:

- Finalize analyses and estimates
- Produce FRTG Final Report