

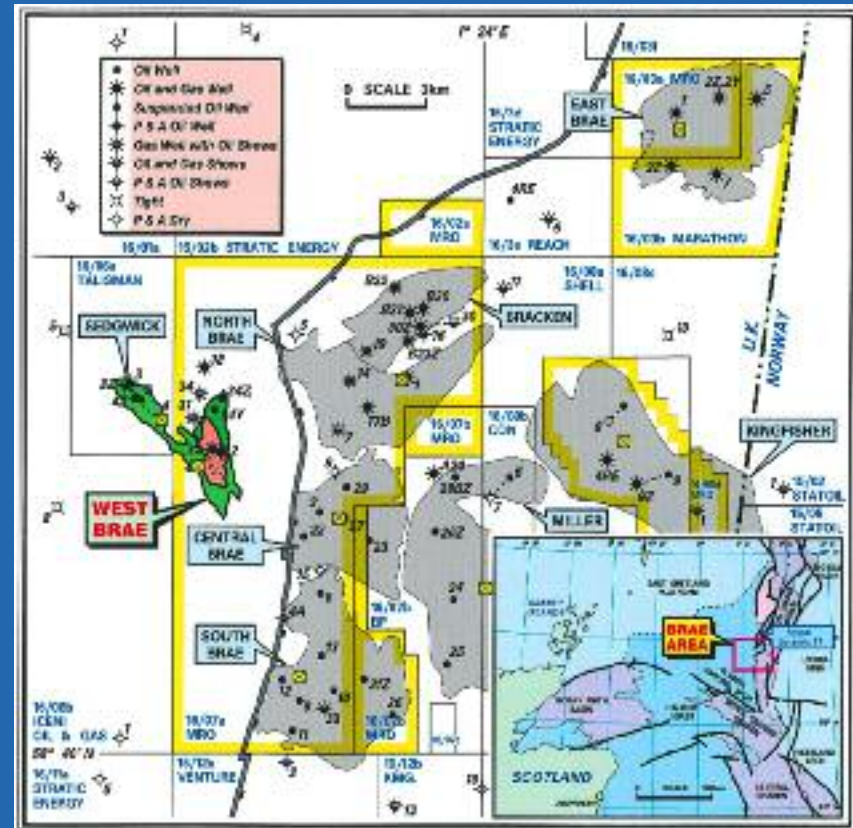
The Value of Well Testing

Optimisation of the West Brae Field

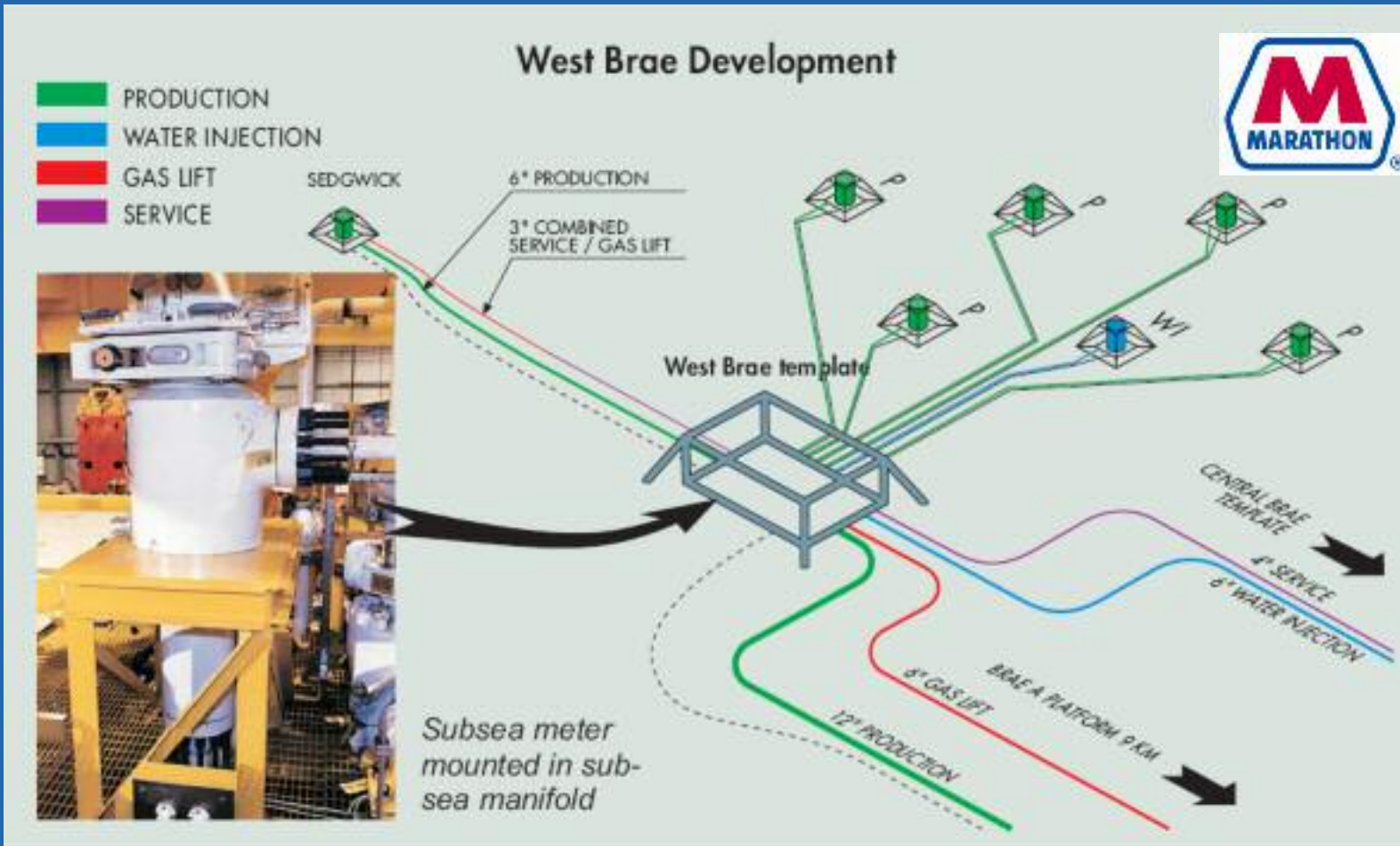
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Corporation

Introduction

- Field background & history
- Original meter/meter replacement
- Information gathered
- Post change out optimisation
- Future potential



West Brae Subsea Layout



West Brae Properties

- Reservoir depth = 5,500 ft (1,680 m)
- Initial P_{res} = 2,500 psi (172 bar)
- Oil viscosity = 3.5 cP_{Gas}
- Oil gravity = 22.5 API (918 kg/m³)
- GOR = 290 scf/bbl (51 sm³/m³)
- Average porosity = 0.29 p.u.
- Average permeability = 6,000 md
- Tie-back length = 8,900 m (V1 an additional 2,300 m)
- Flowline ID = 11.4" (29 cm), V1 line ID = 5.4" (14 cm)
- Topsides arrival pressure = 200 psi (14 bar)

Original West Brae Development

- **First oil in October 1997**
 - 6 x horizontal oil producers
 - 1 x vertical water injector
- **Venturi-based MPFM included as part of original development**
 - Robust measurement principle
 - Independent of flow regime
 - Cost effective
 - Low pressure drop through the system

Use of Original Meter

- Meter within $\pm 5\%$ of ultrasonically measured platform rates
 - Agreement during stable production phases within $\pm 1\%$
- Meter used as part of process for well optimisation
 - Key for monitoring gas coning on wells near gas-oil contact
 - Used in conjunction with DHG to choke wells back as required
- Used to identify a direct connection between W2z (producer) and W4 (water injector)
 - Water injector shut in as a result
- Used for rate control within reservoir simulation

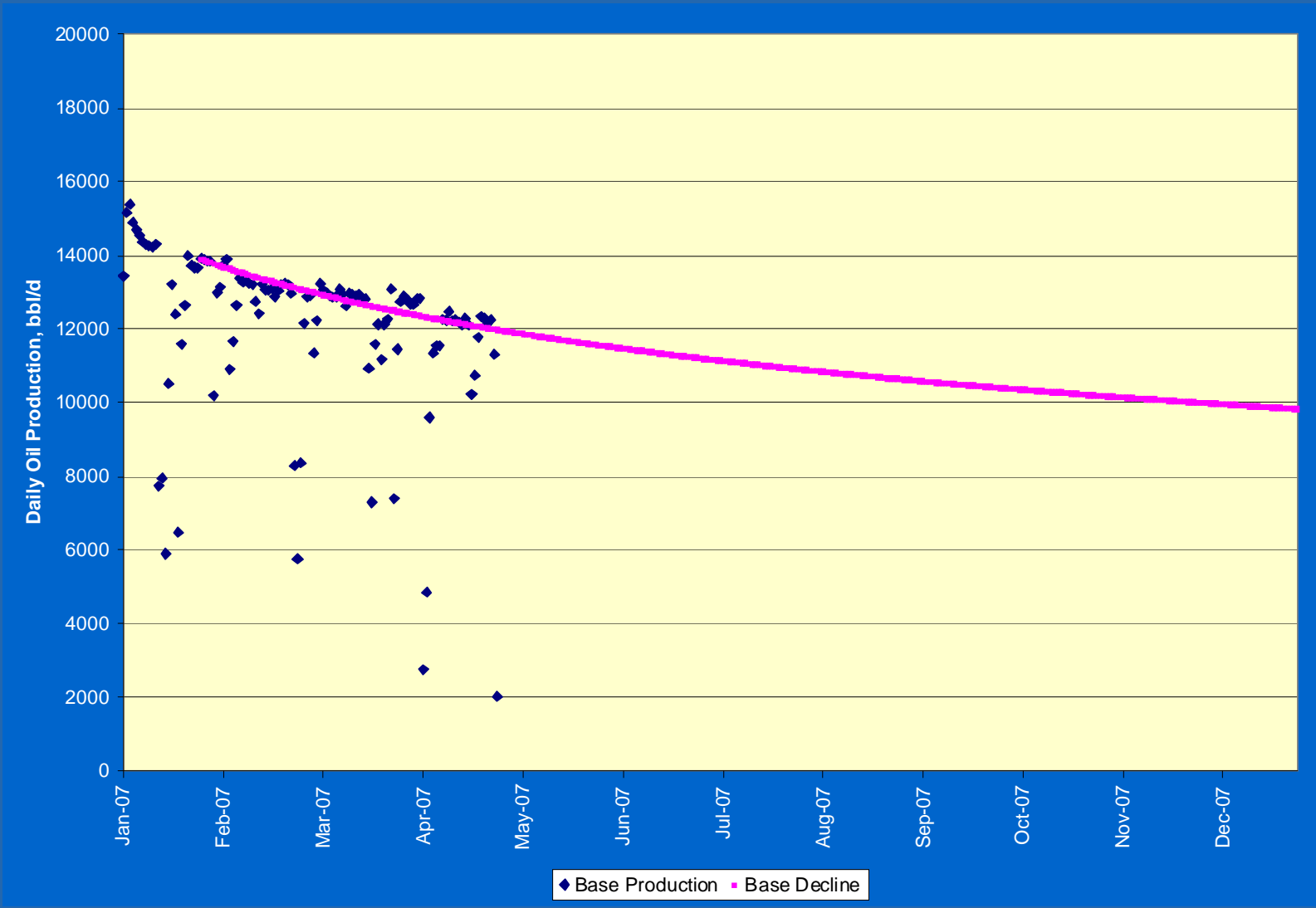
MPFM Failure & Reinstatement

- Failure of original meter nuclear measurement system in 2004
 - Teardown to confirm whether failure is the system itself or an electrical component failure
- Decision to change out meter taken
 - Little information in public domain regarding value of reinstating/retrofitting a subsea MPFM at the time
 - Value of optimisation of 2.5% used for project sanction
- Meter changed out in April 2007
 - ‘Simple’ change out of older style Framo meter to Phasewatcher Vx
- Nothing unusual about field decline during intervening 3 years
 - Infill drill well added during meter outage

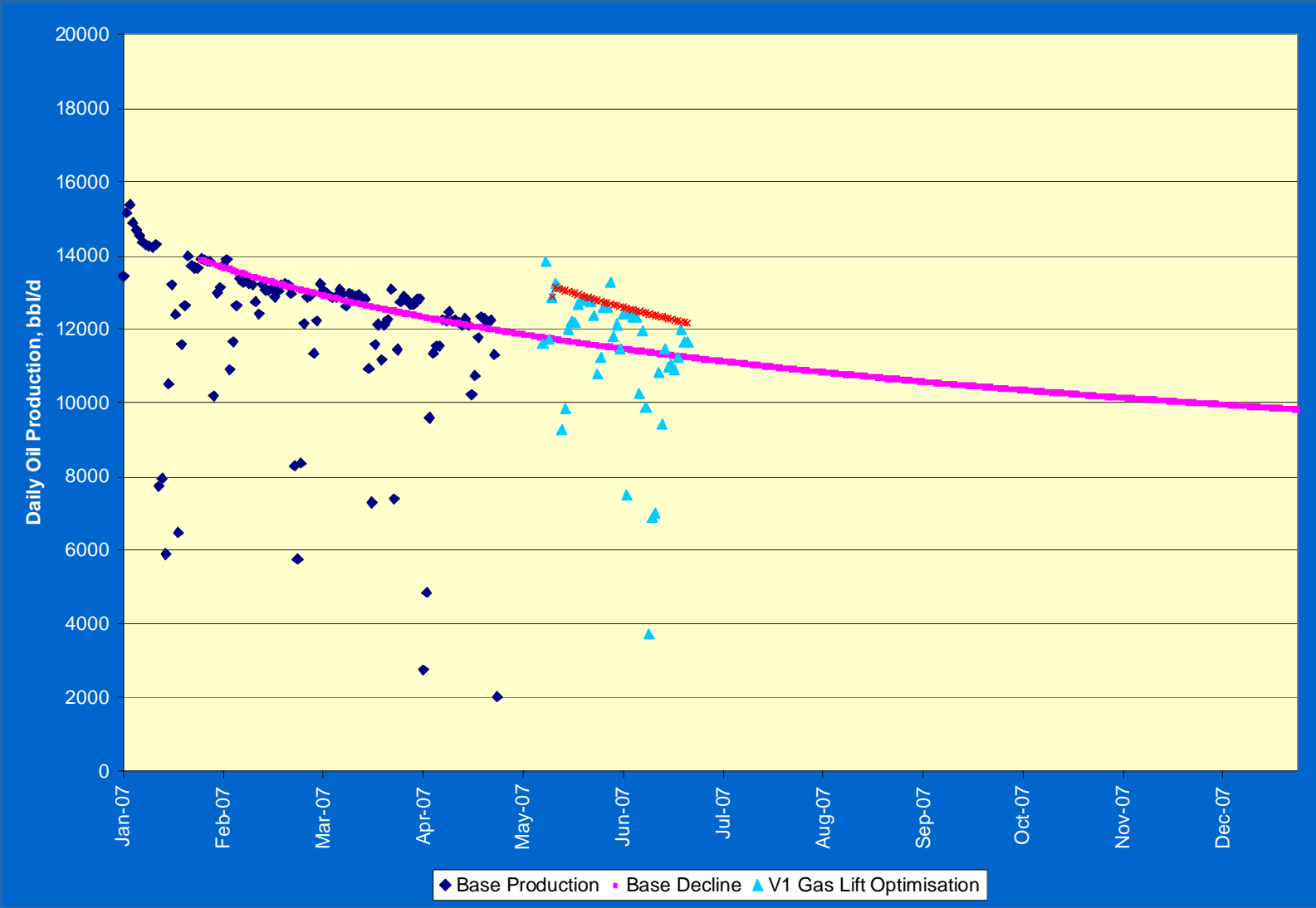
Estimated vs. Actual Well Performance

- V1 production 30% higher than expected
 - Well overlifted; 8 MMSCFD of total 11 to one well
- W8z production 30% lower than expected
 - Water cut 15% higher than expected
- W3 production 50% higher than expected
 - Water cut 20% lower than expected
- W7z production 10% higher than expected
 - Water cut 15% higher than expected
- W6z production, water cut as expected
- W2z production as expected
 - Water cut 25% lower than expected
 - Gas cone had dissipated

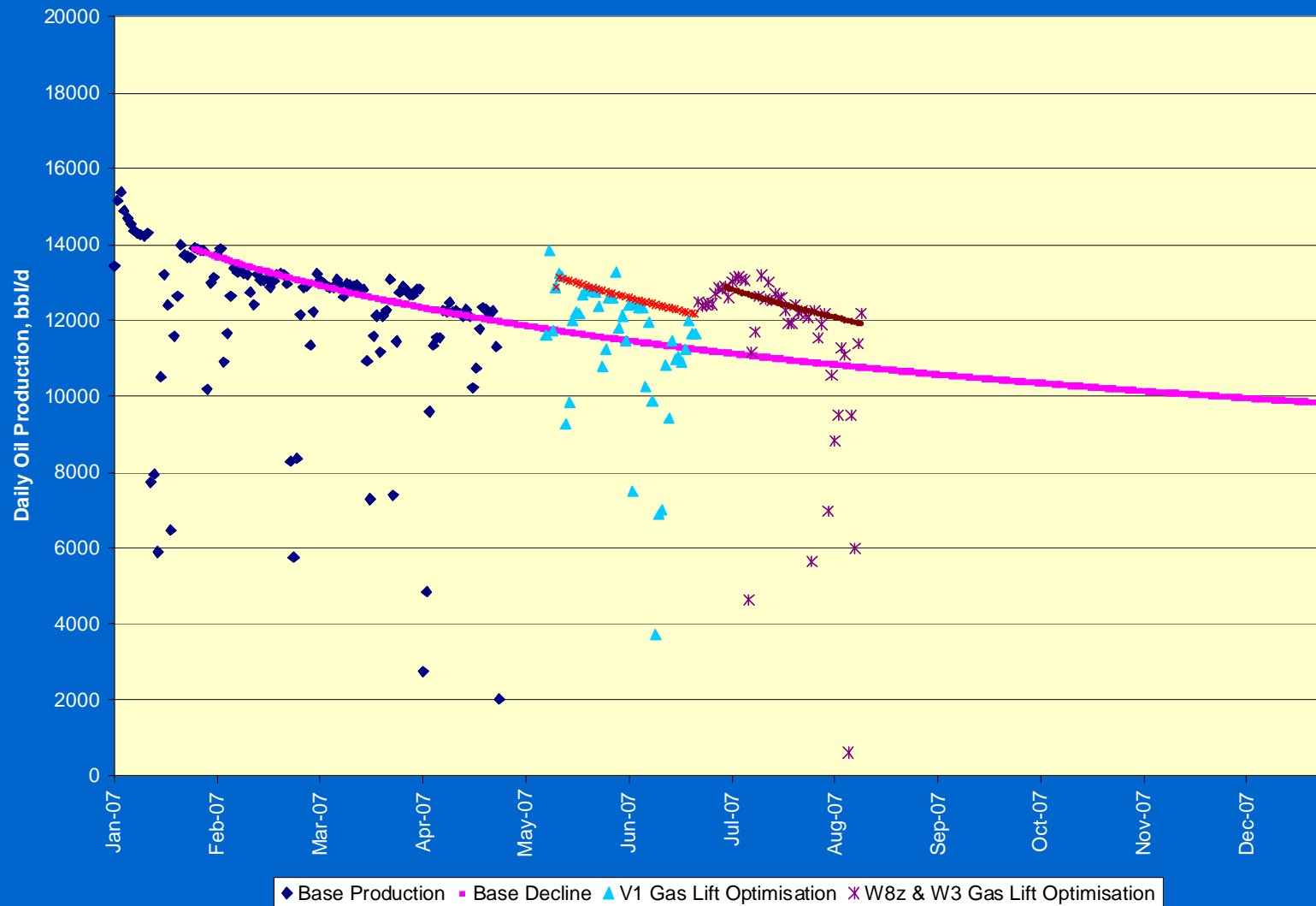
Baseline Production



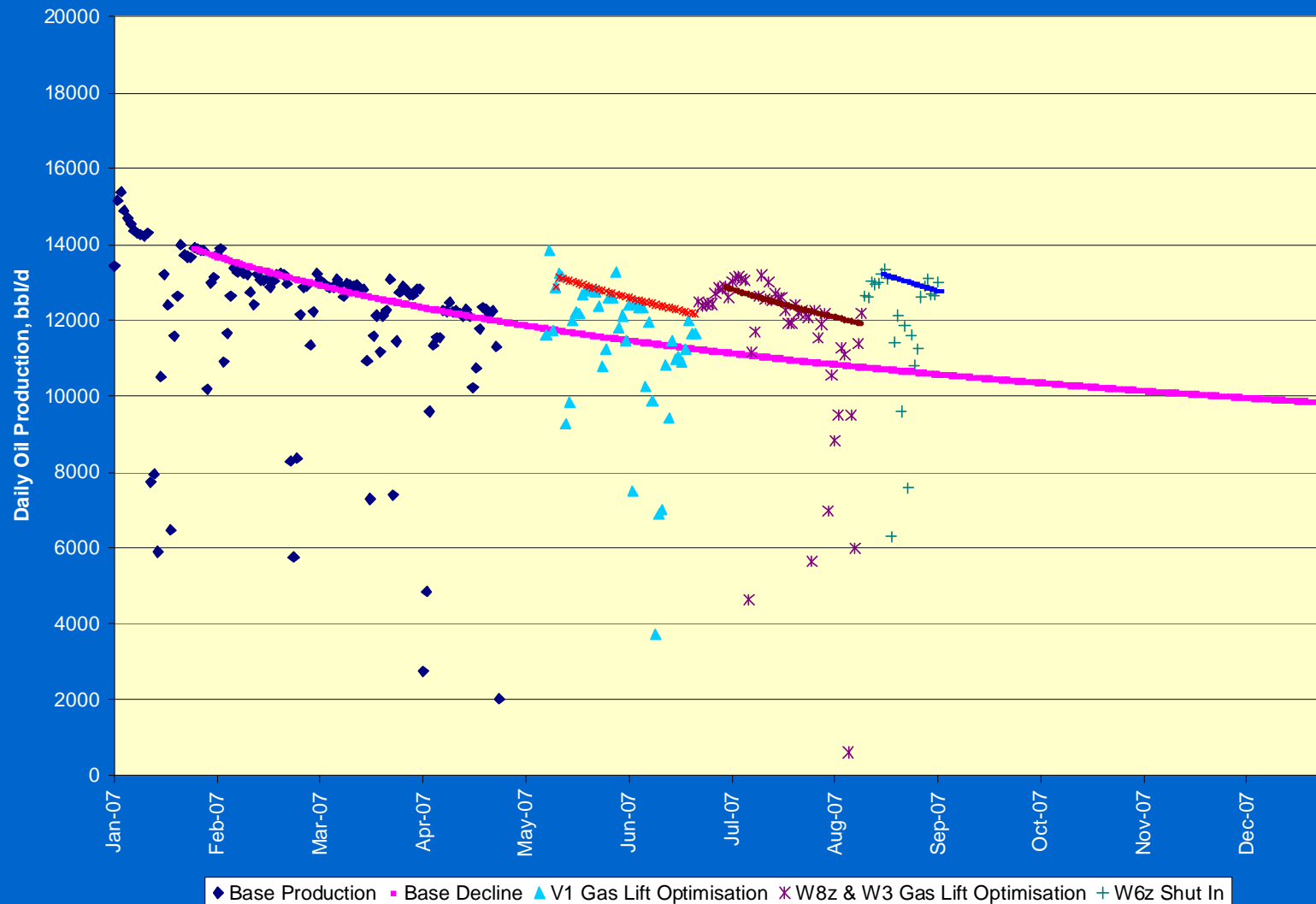
Optimisation – Phase 1



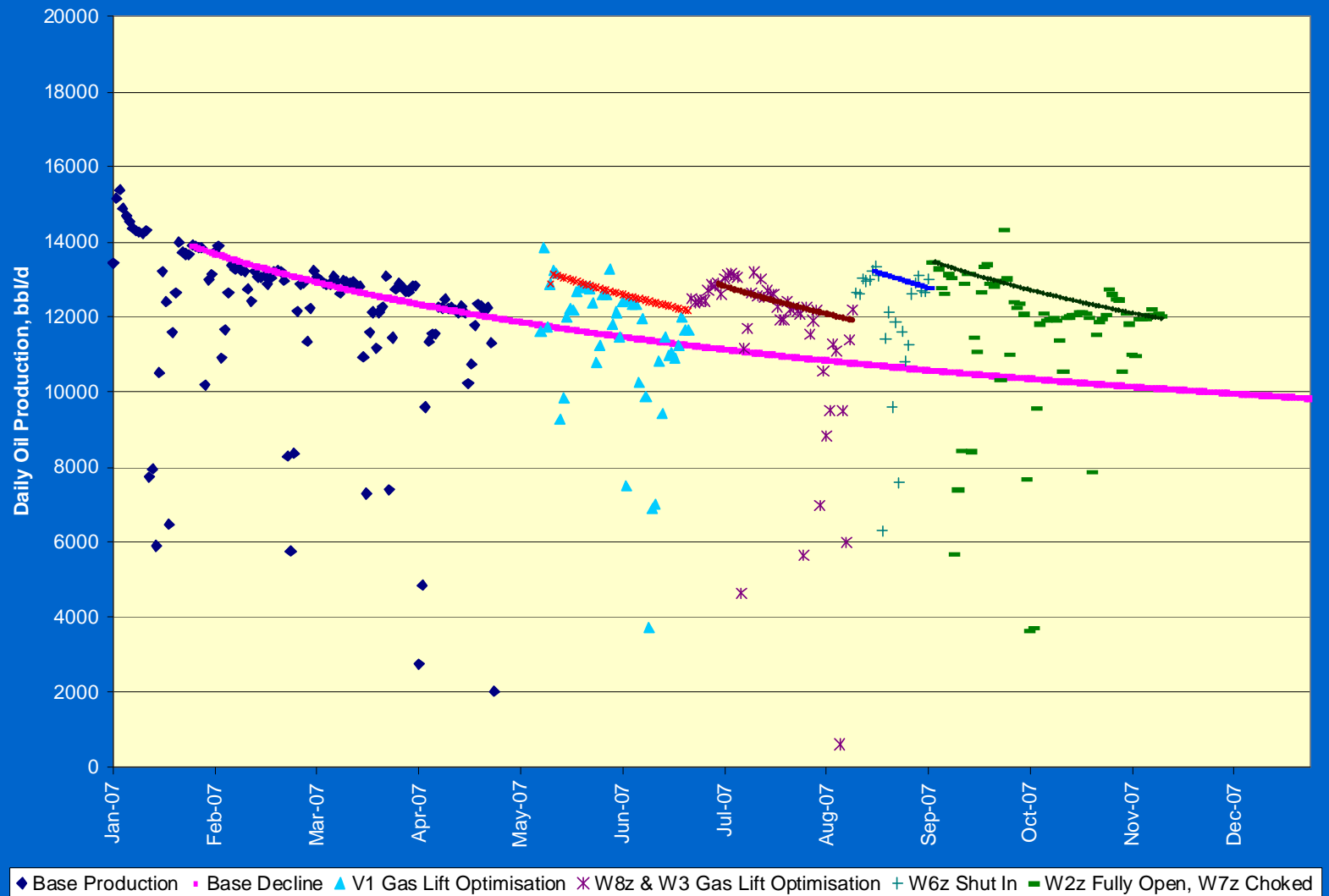
Optimisation – Phase 2



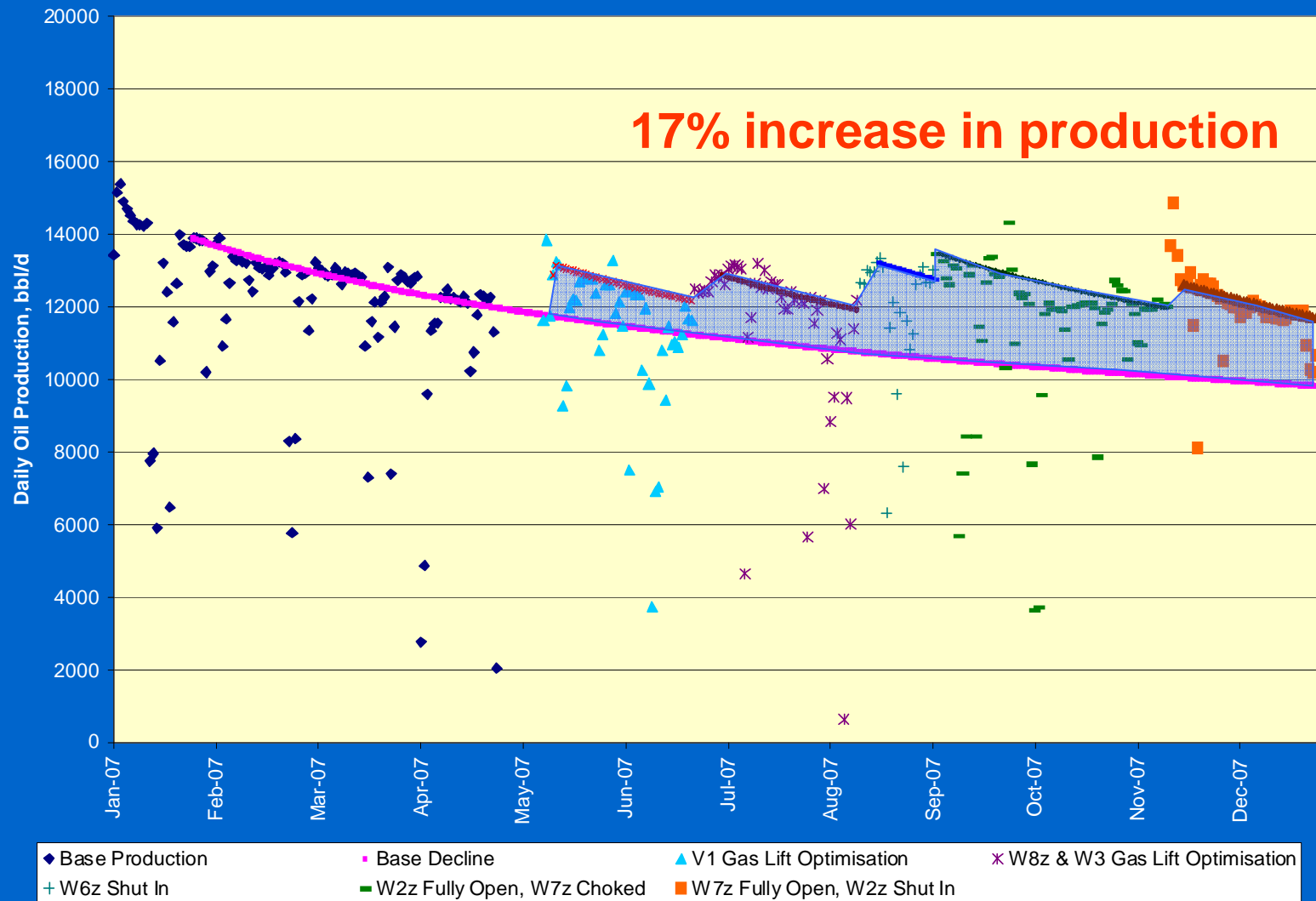
Optimisation – Phase 3



Optimisation – Phase 4



Optimisation – Phase 5



Future Plans

- Evaluating addition of multiphase pump to system
 - Potential to increase production ~ 50 - 80%
 - Able to assess potential now good well data is available
- Able to refine reservoir model with well production data
 - Further 2 drill wells being evaluated
- Even greater potential when multiphase pumping is combined with new drill wells
- Continued diagnosis of well issues
 - Screen plugging diagnosed in one well
 - Gas lifting via uppermost valve diagnosed in one well

Summary

- Reinstallation of MPFM critical to ongoing development of mature field
- Value of this data was a 17% increase in production over the period
 - Little public domain information on this type of operation
 - There is value in testing wells
 - Potential to nearly double production now we have a good understanding of well performance