Shearwater Well, Reservoir and Facilities Management Optimisation

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Shearwater WRFM Team

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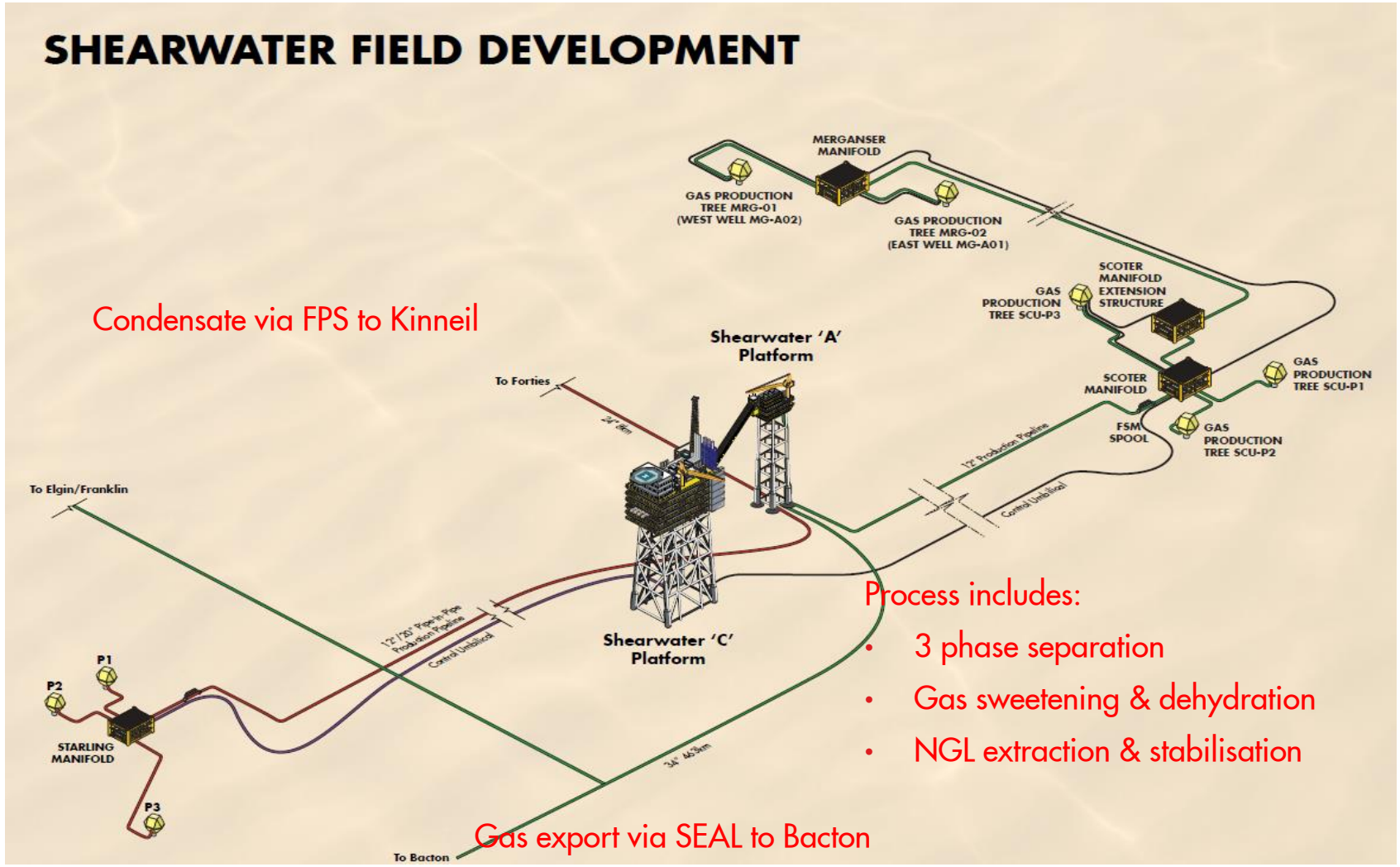
Agenda

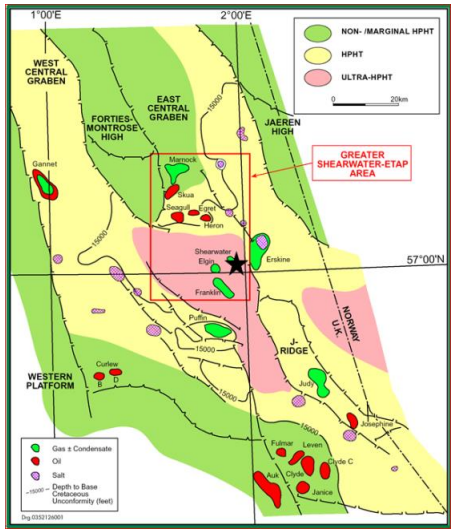
- Introduction to Shearwater
- Topside Facilities
- Well Reservoir Management Plan
- Surveillance
- WRFM Activities
- WRFM Production Optimisation Delivery

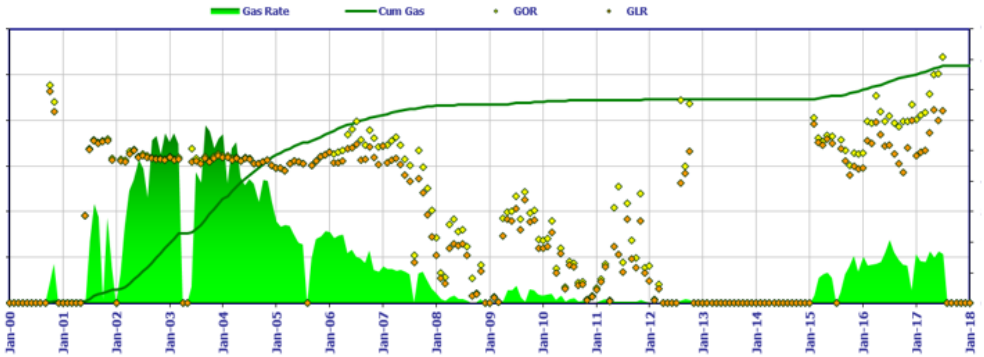
SWR Cluster – Fields and Facility Layout



Shearwater

- Located in block 22/30b in the UK Central Graben of the North Sea.
- Discovered 1991, first production 2000
- HPHT: High Pressure & High Temperature
- Gas /Condensate field, 90m water depth
- Initial pressure 15,500psi,185degC at 16900ft
- Depleted reservoir pressure 6,000-10,000psi
- Liner failures 2004-2007
- Slot recovery executed 2011-2013
- New well drilled in 2014- 2017





Satellite Field (Scoter, Merganser, Starling)

- Subsea wells
  - Scoter 12km to North SW Platform
  - Merganser –Subsea daisy chain tied to Scoter
  - Scoter 4km to SW platform
  - Starling -33KM South West of SW
- Normal Pressure Normal Temperature
- Depleted, reservoir pressure 1,000-1,500psi

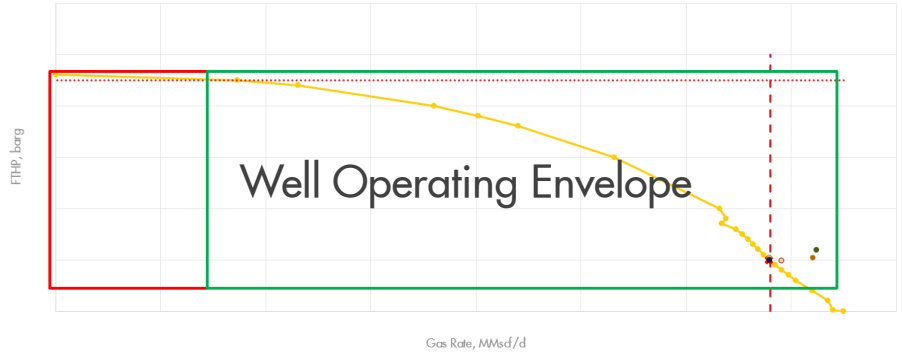
Shearwater WRFM Plan

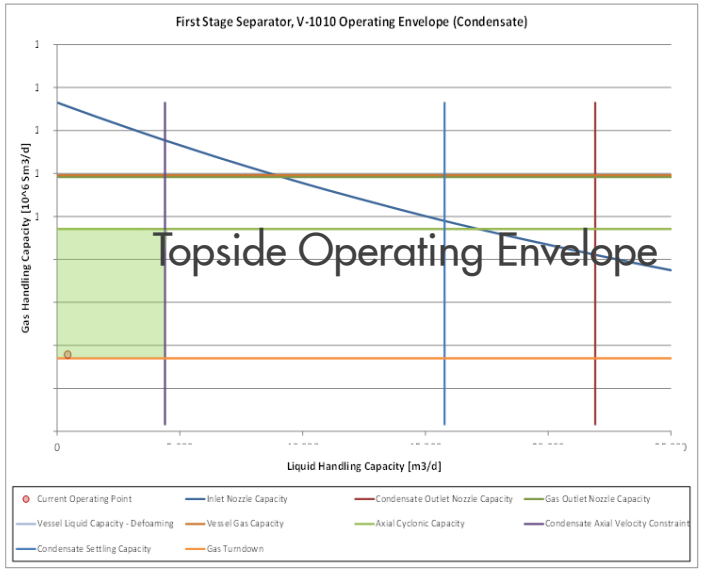
Focus on

- "Make it safe" (e.g. Integrity scope)
- "Make it Work" (e.g. restoration scope)
- "Make it Grow" (e.g. optimisation scope)
- Ensure safe production
- Safeguard current production
- Maximise production incremental to Business Plan using Production System Optimisation (PSO) and the WRFM E2E process to identify, assess and execute well and facilities optimisations.

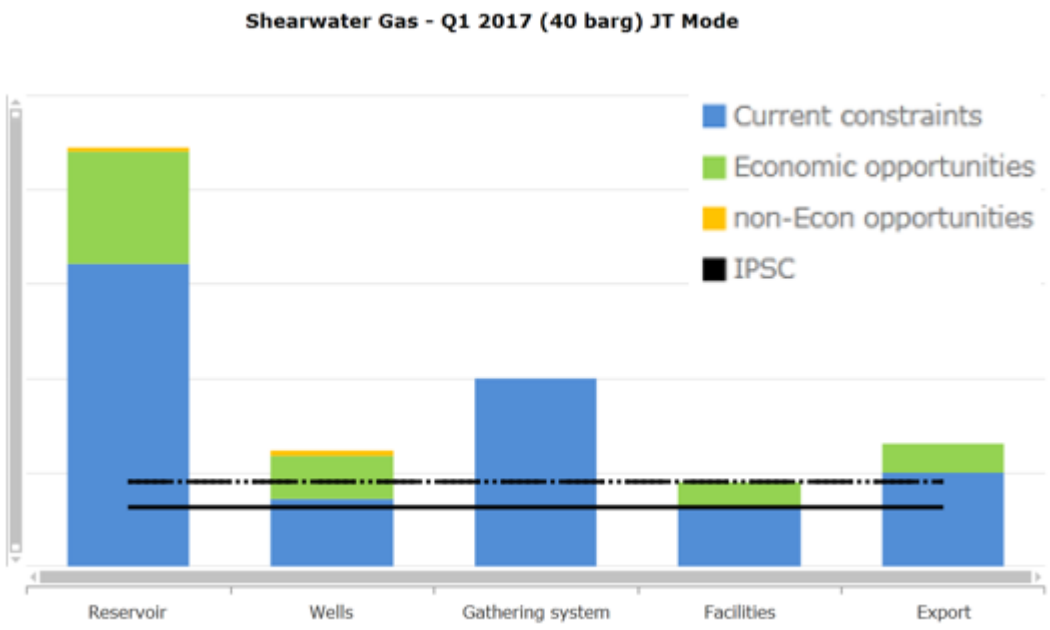
Surveillance

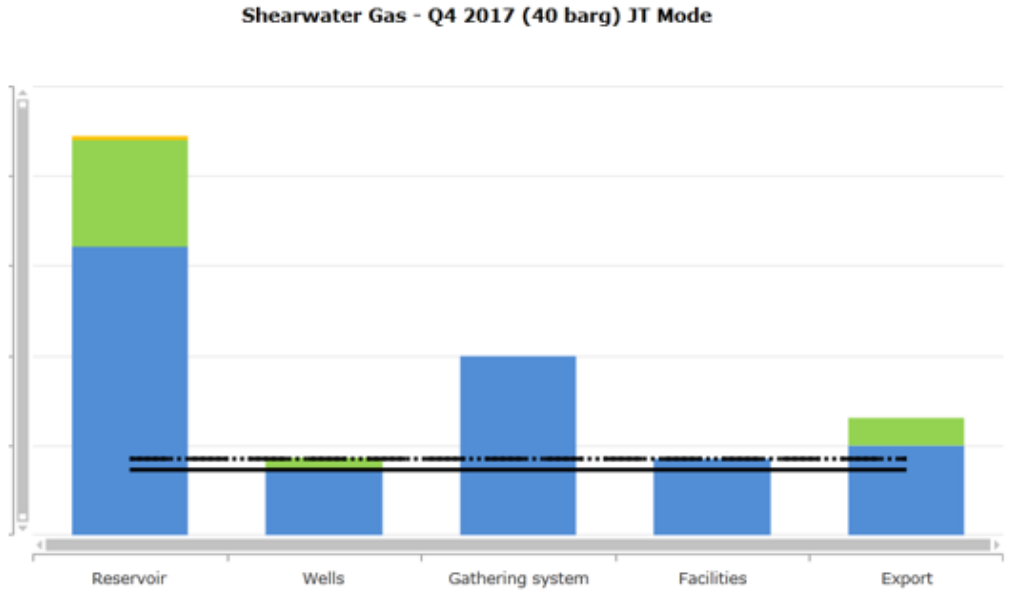
- Integrated team
- Surveillance hub
- Real time Interaction with offshore
- Real time data- PI Process Book
- Exception Based Surveillance- EBS
- Operating envelopes
- Well testing
- Sampling
- Sand sensor





Shearwater Limit Diagram





Q1 2017- Locked in Potential shown in Green

Q4 2017- Optimised Production

Well Activities

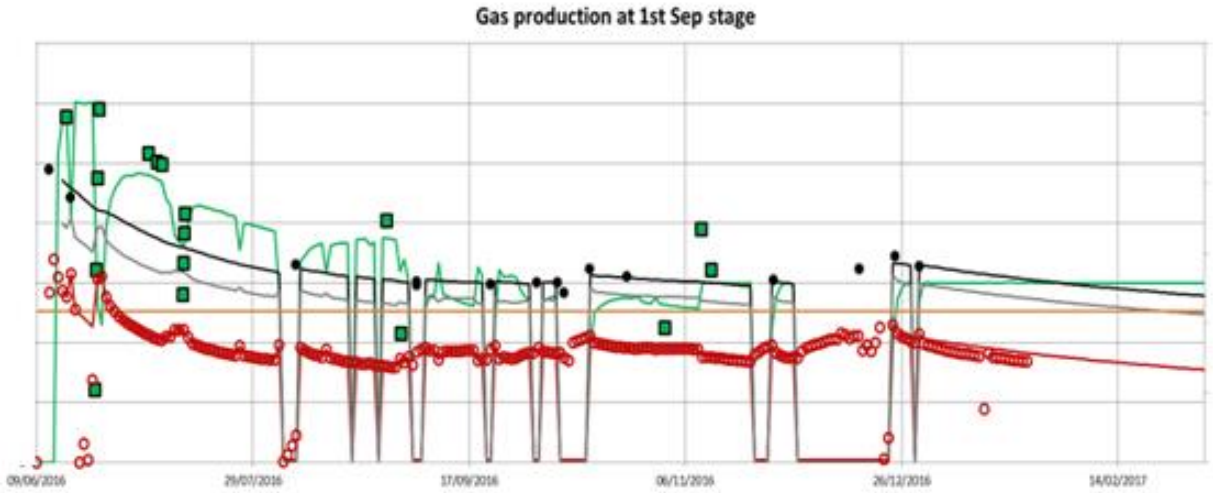
- Revived a closed in well
  - Well start up strategy
  - Unload to lower back pressure

- Unblocked SSSV control line
  - impermeable blockage in the control line
  - involved temporarily installing a “hold open sleeve” across the SSSV
  - instantaneous gain of 3.0 kboepd

Slick line Rig Up

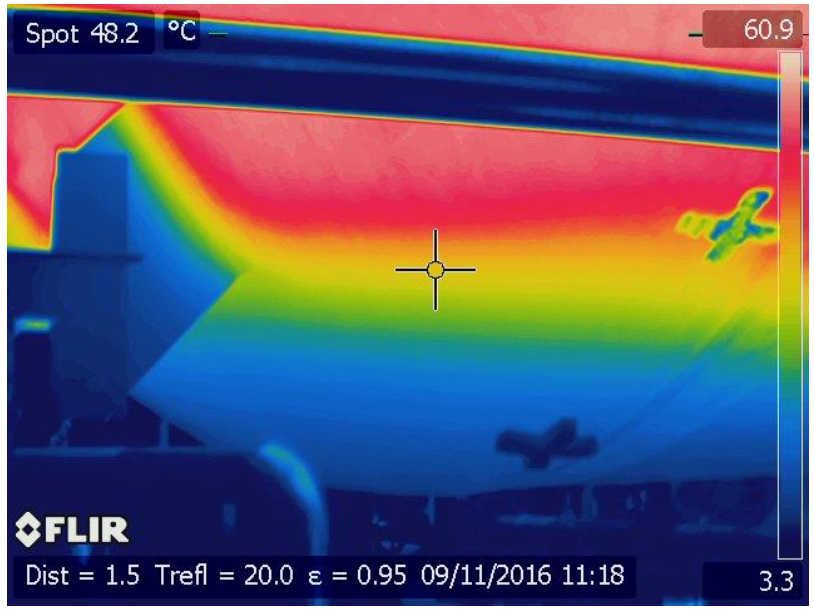
Production System Optimisation

- IPSM for Surveillance
  - Multiple cases run
  - Opportunities to optimize identified and implemented
    - Managing dew point
    - Choke optimization
    - Compression optimization
    - Flash gas optimization



Sand Issues in Separators

- Reduction in separation residence time and separation efficiency due to sand accumulation in separators.
- Thermographs below show cold spots (blue) indicating sand deposition in the Separator.

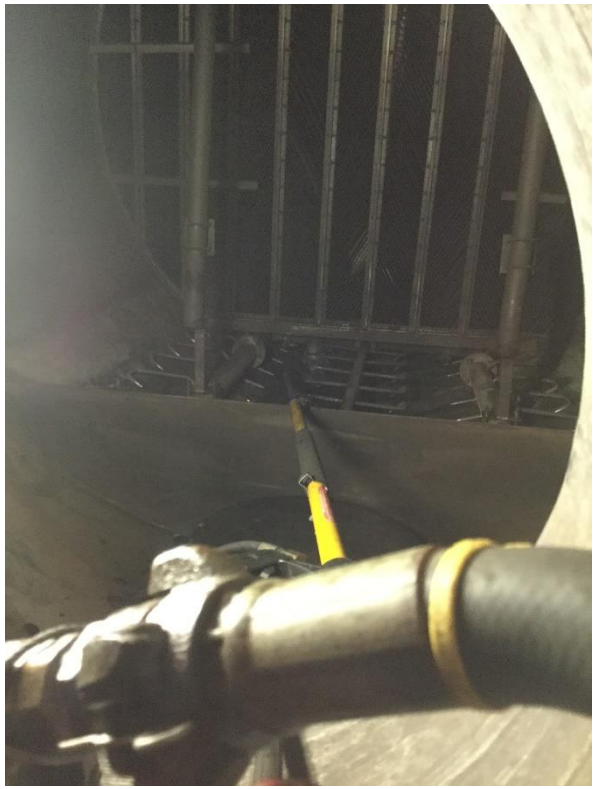


Accelerated Cleaning of Separator

- Separator was soaked with chemical to help Separator with significant sand. (Photo below taken post initial chemical soak)
- Significant fouling of internals impacting separator performance. Multiple online sand removal attempts did not prove effective due to high viscous and clay based nature of solids.

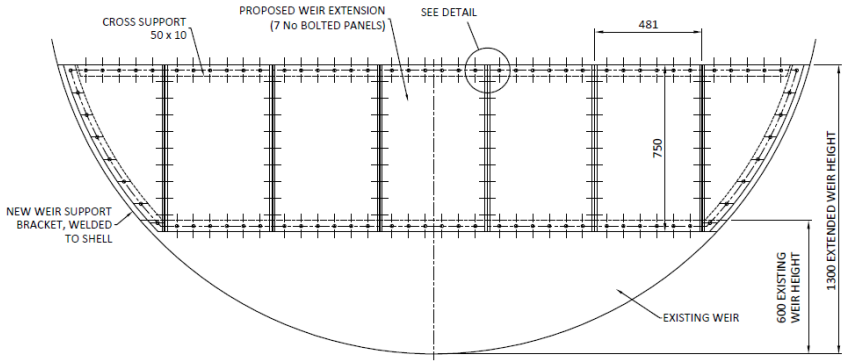
Accelerated Cleaning of Separator

- Localised cleaning with tubes was used to avoid entry into separator and expedite cleaning process.

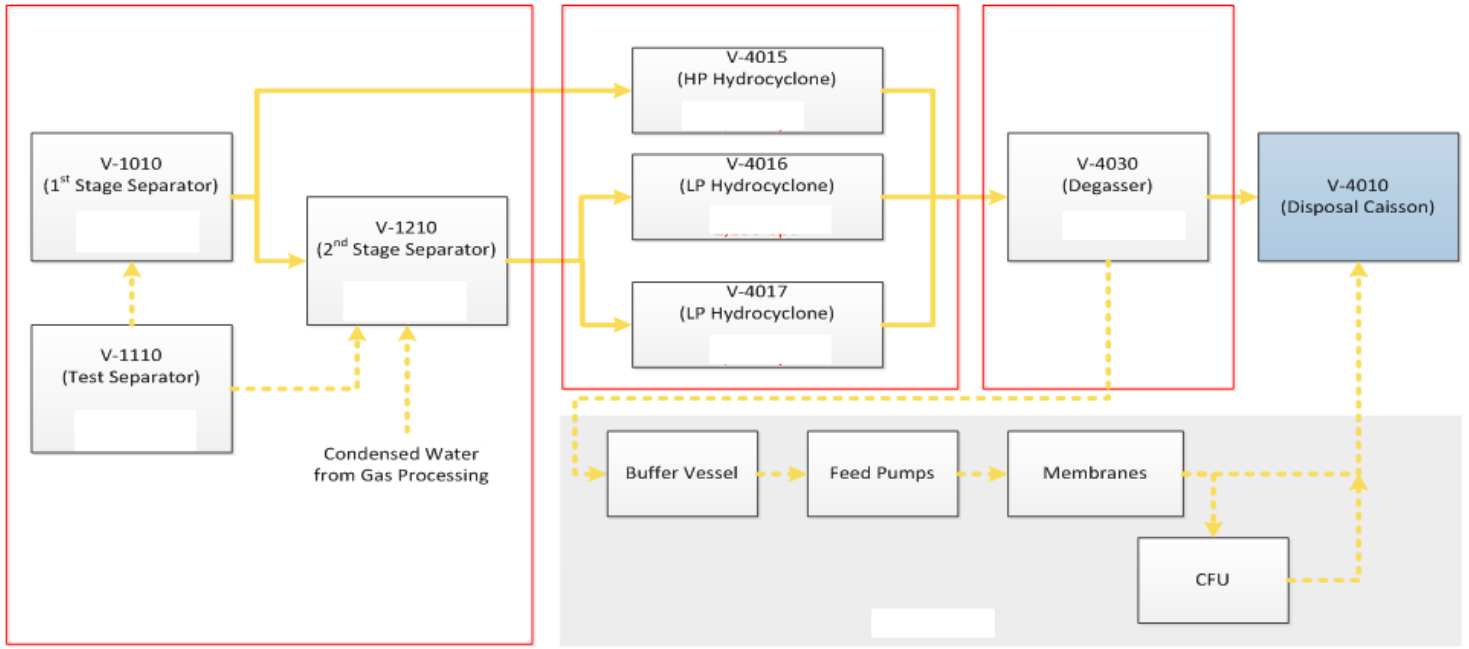


First Stage Separator Weir Height increase

- First Stage Separator weir height increased from 0.6m to 1.3m
- Handling capacity increased from 5,000bbl/d to 15,000bbl/d



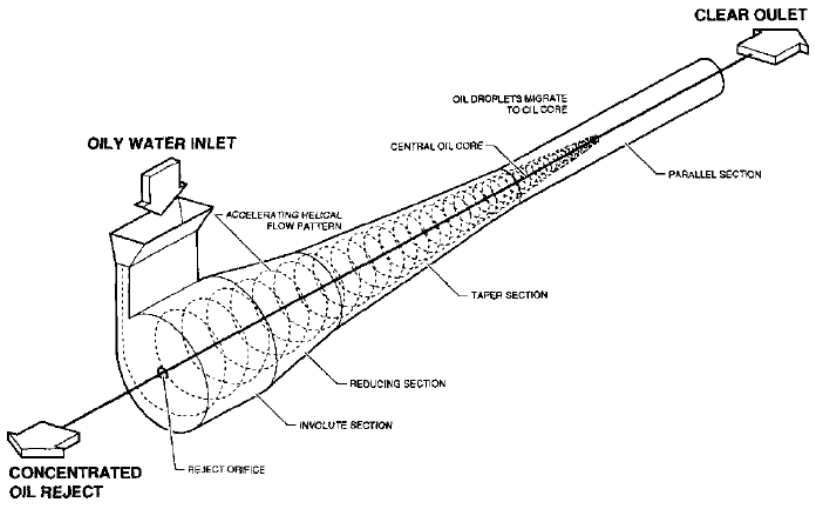
Produced Water Capacity Increased



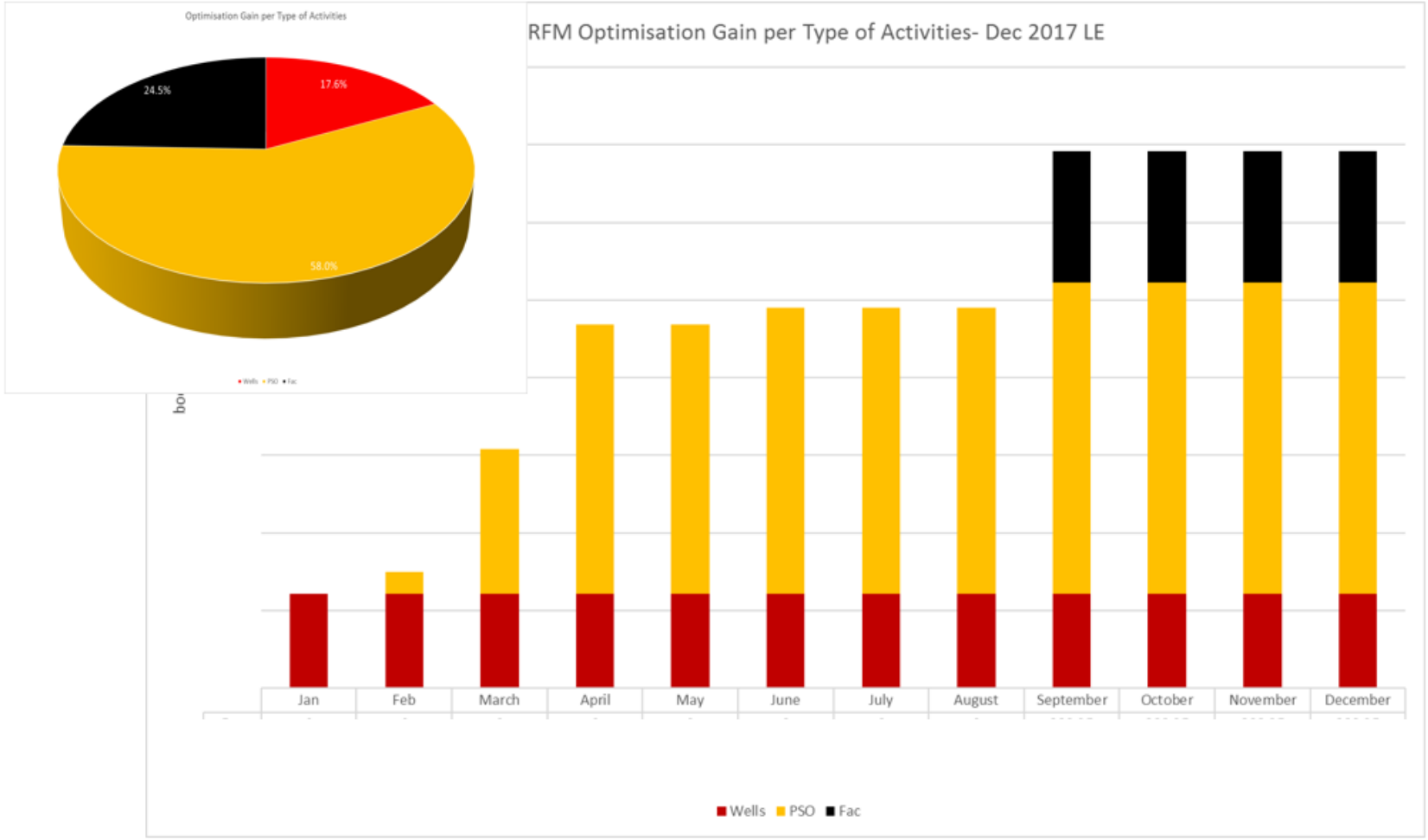
System	Bottleneck
1st Stage Separator V-1010	Water residence time / water axial velocity limit
2nd Stage Separator V-1210	Water axial velocity limit
HP Hydrocyclone V-4015	Number of liners (13)
LP Hydrocyclones V-4016/17	Number of liners (6)
Degasser V-4030	Inlet liquid distributor / vane pack
(Membrane Package – parallel with Degasser)	*(Membrane modules)*

HP hydrocyclone changeout

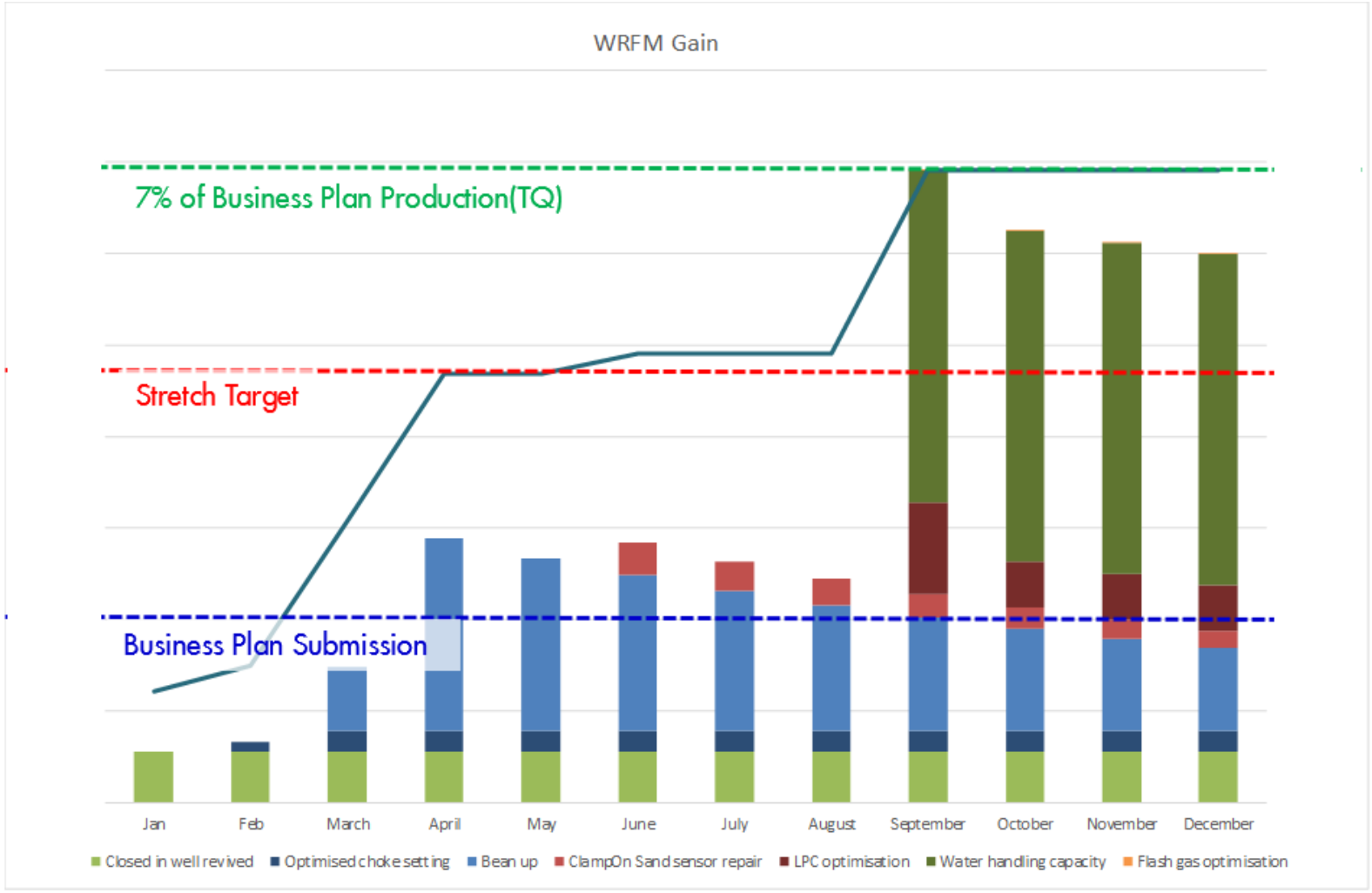
- HP hydrocyclone processing capacity increased by 80%
- OIPW improvement



Shearwater WRFM Production Optimisation Delivery



Shearwater WRFM Production Optimisation Delivery 2017



Questions and Answers