

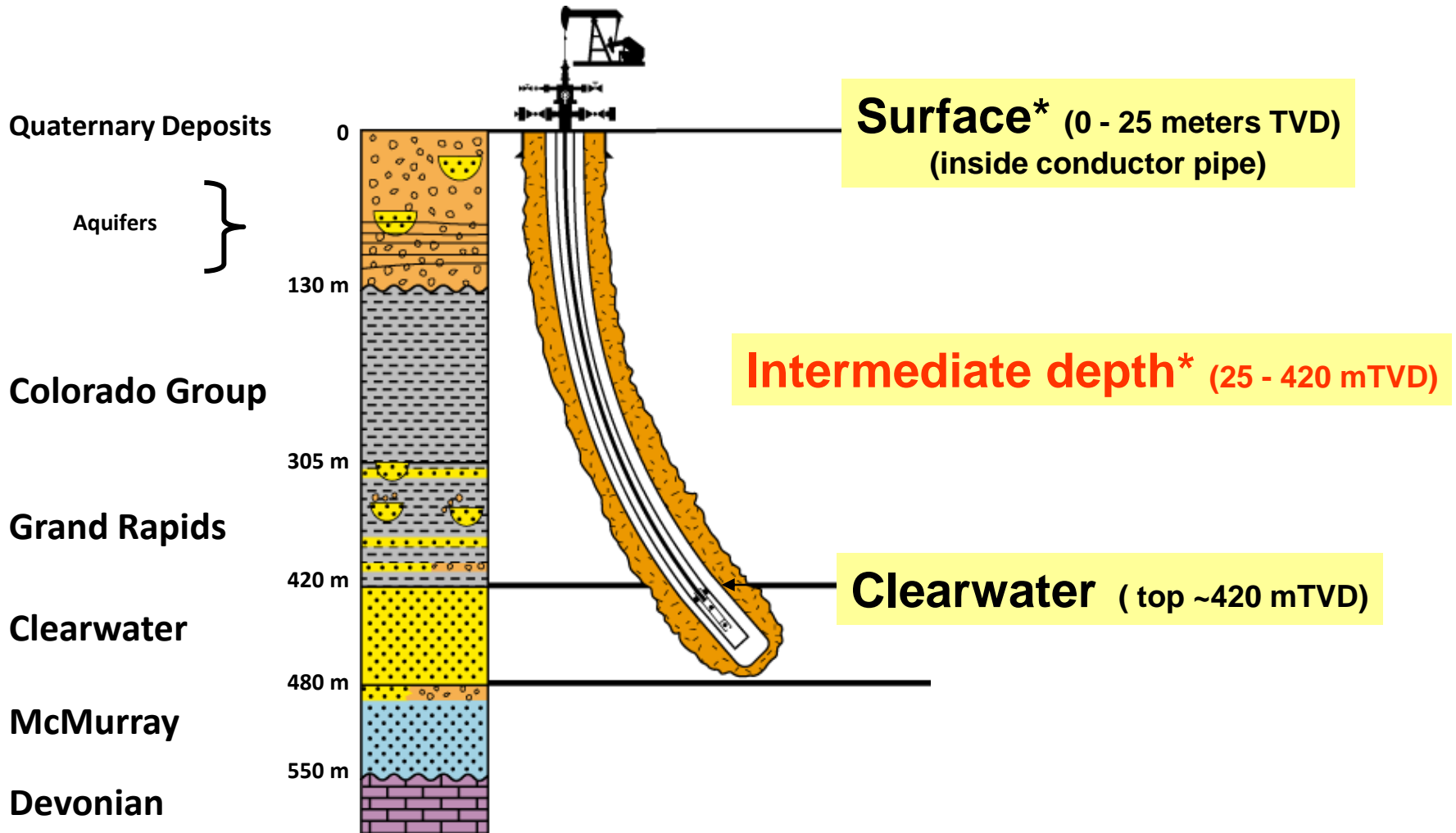


Imperial Cold Lake 2015 Casing Integrity Review

Review with AER

May 18, 2016

Casing Failure Classifications

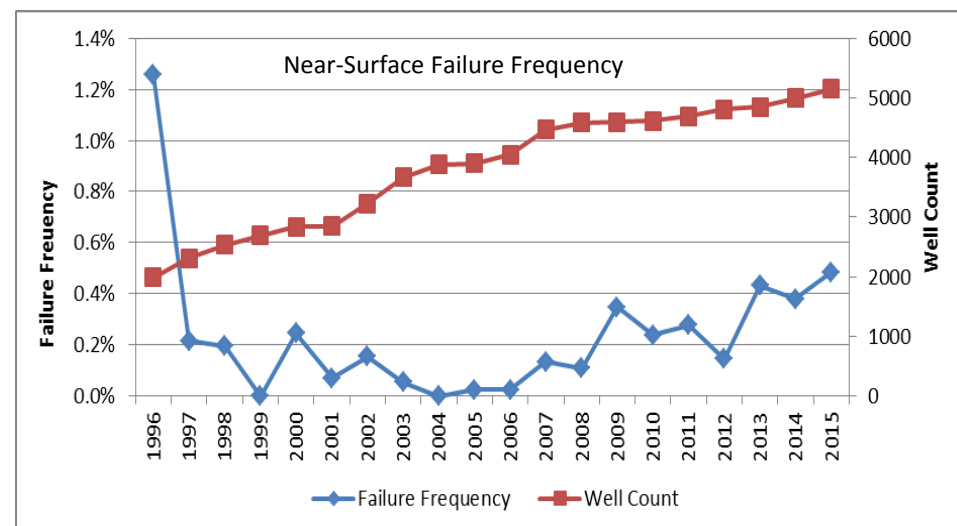
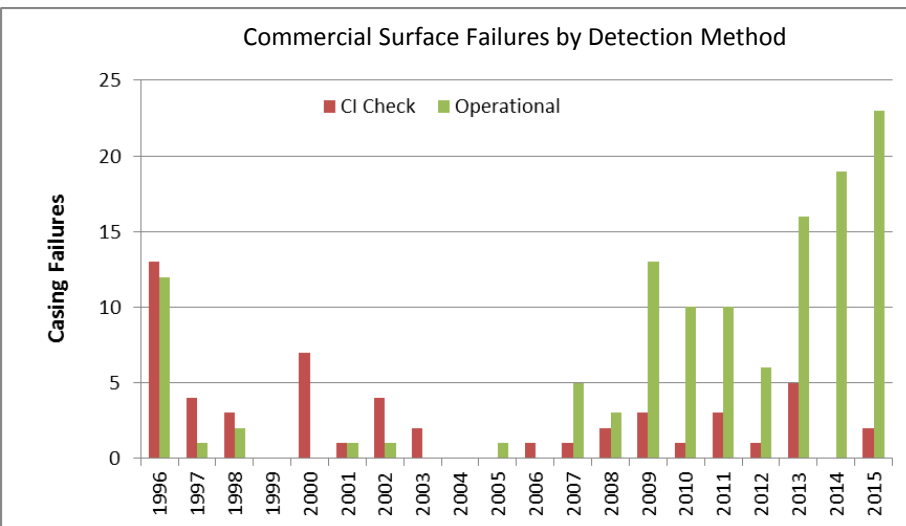
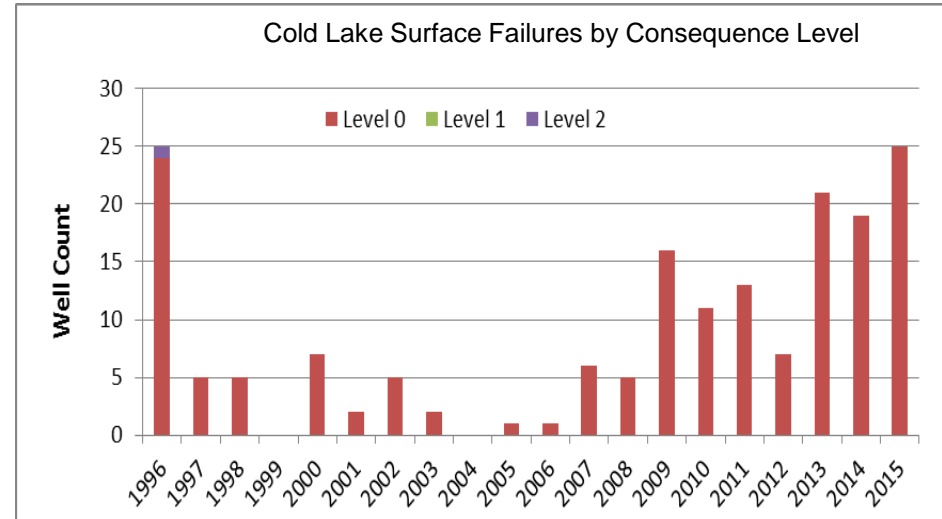


**Potential for adverse environmental impact*

Near Surface Casing Integrity

Near Surface Performance:

- 25 near surface casing failures detected in 2015 (0.49%/year).
- 24 near surface failures were late cycle, low pressure wells; majority at 25+ years of operation. One failure at high pressure was successfully managed as a level 0 incident.
- No failures had environmental consequences (all Level 0).
- Surface failures are occurring at or near ground level, not at the primary cement top.
- All 25 failures detected operationally through visual checks or scheduled pressure testing.



Near Surface Casing Integrity

2015 Near Surface Failure Management:

- 18 repairs with a near surface casing patch
- 5 wells plugged with zonal aband. or suspension
- 2 wells that were already zonally abandoned remained in that configuration

Near Surface Initiatives

- External Corrosion Resistant Coating Treatment
 - High temperature resistant metallic coating product
 - 50 moderate near surface corrosion wells treated in 2015
 - Evaluating coating performance and change in long term corrosion rates
- Initiated an external corrosion measurement 'log-off' of various wall loss measurement tools to determine which technology is most suitable for Cold Lake thermal wellbores.
- Initiated detailed investigation to update understanding of near surface corrosion drivers and root cause of K26-07 failure
- Continued focus on bentonite top-up and casing shroud program



Machined holes in test casing for 'log-off'

Intermediate Depth Casing Integrity

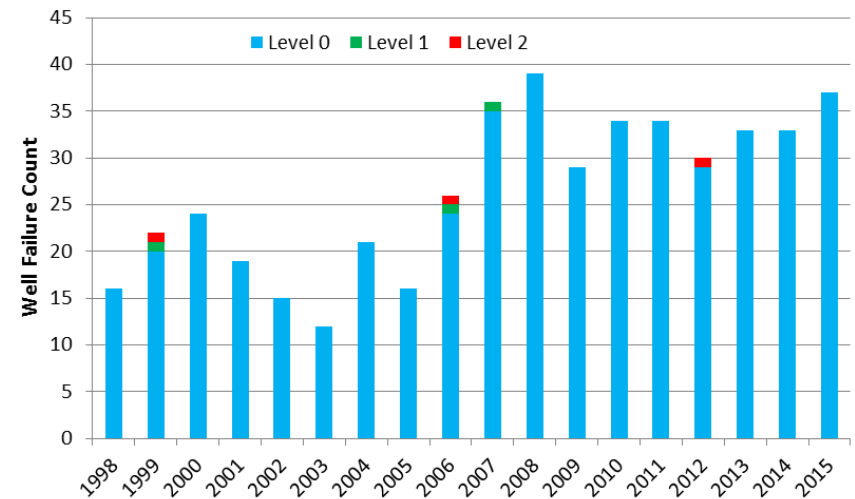
2015 Intermediate Depth Performance:

- 37 intermediate well failures detected in 2015 (0.72%/year)
- No failures with environmental consequences (all Level 0)
- 8 consecutive years with no secondary or multi-well failures
- 47 wells proactively slimhole repaired due to casing impairment or deformation (wells had not failed)
- Record 111 wells with casing failures or impairments repaired and returned to service in 2015

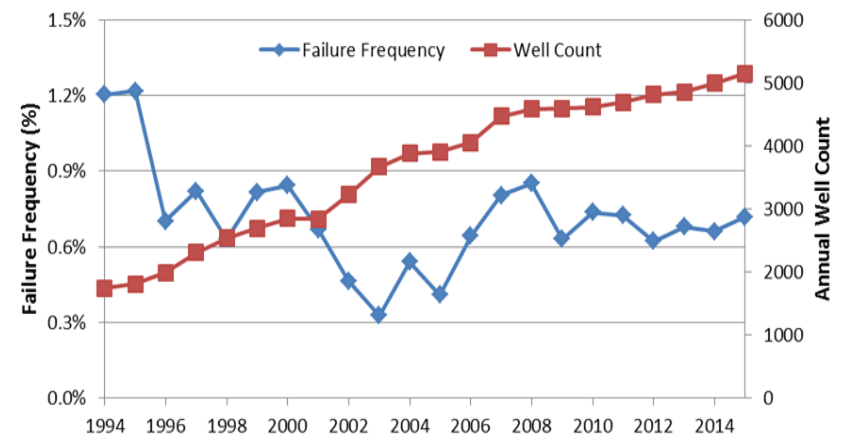
2015 Intermediate Failure Management:

- 15 wells repaired with a cemented slimhole liner
- 8 wells repaired with a retrievable casing patch
- 1 well with a slimhole repair in progress
- 1 well suspended and 1 with an upcoming suspension to evaluate repair options
- 5 wells zonally abandoned
- 2 wells fully subsurface abandoned
- 4 wells that were already zonally abandoned remained in that configuration

Cold Lake Intermediate Failures by Consequence Level



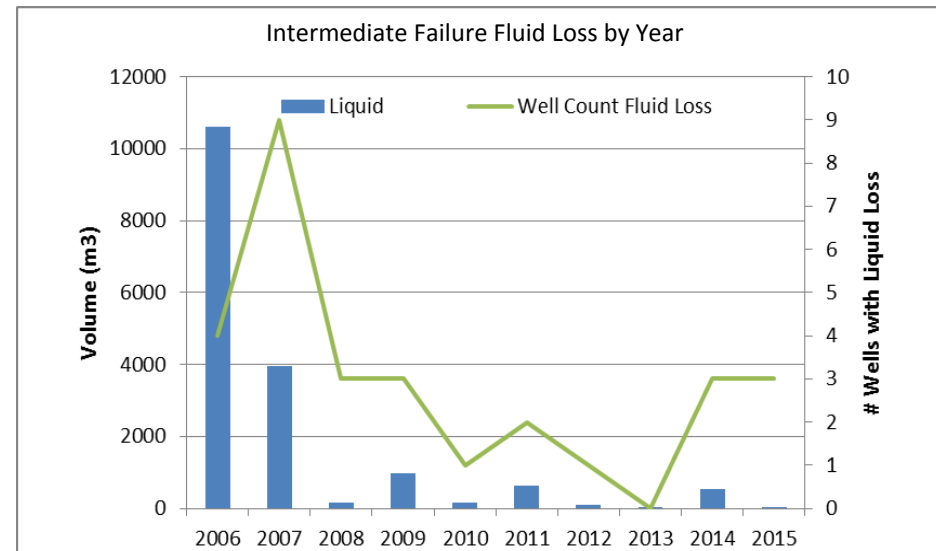
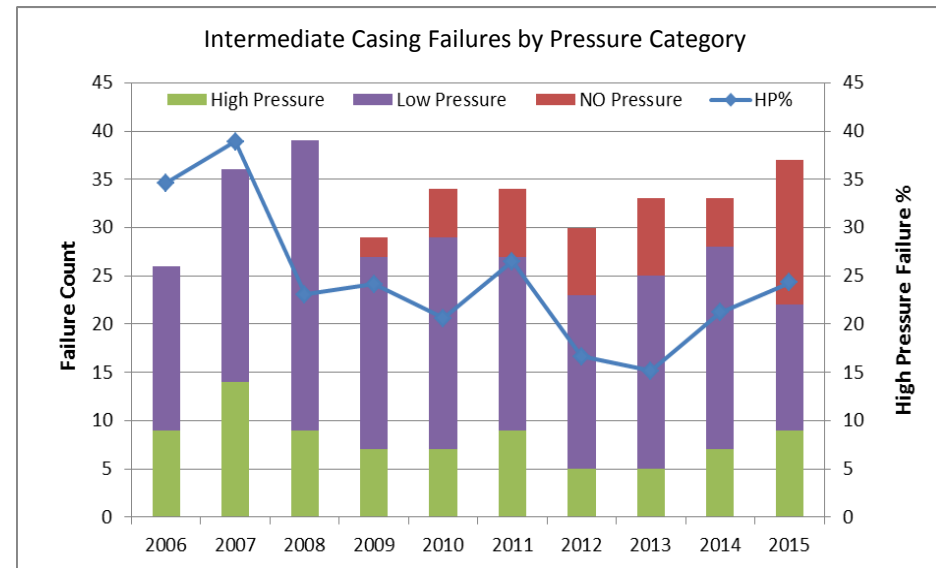
Primary Intermediate Commercial Casing Failure and Well Count



Intermediate Depth Casing Integrity

2015 Intermediate Depth Performance:

- 9 of 37 failures occurred at high pressure (HP) in 2015
 - 24% high pressure failures
- 2 of 9 HP failures occurred on Cycle 1 Nabiye wells
 - Unique situation: production casing collapse due to trapped water in primary cement inside surface casing.
 - Steam strategies assessed and modified for cycle 1 wells to help prevent collapse
- 7 HP failures managed with N2/Flowback; while 2 required heavy mud kill
- 22 failures on operating wells (high or low pressure), which was the lowest number in the past decade.
- 15 failures occurred on non-operating wells with no pressure, and no environmental consequence.
- Negligible liquid losses from three casing failures in 2015; no adverse environmental affects or impact to adjacent well integrity

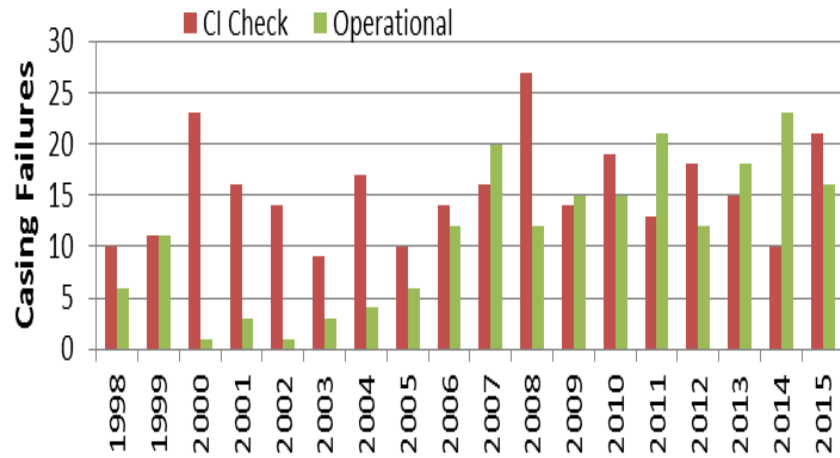


Intermediate Depth Casing Integrity

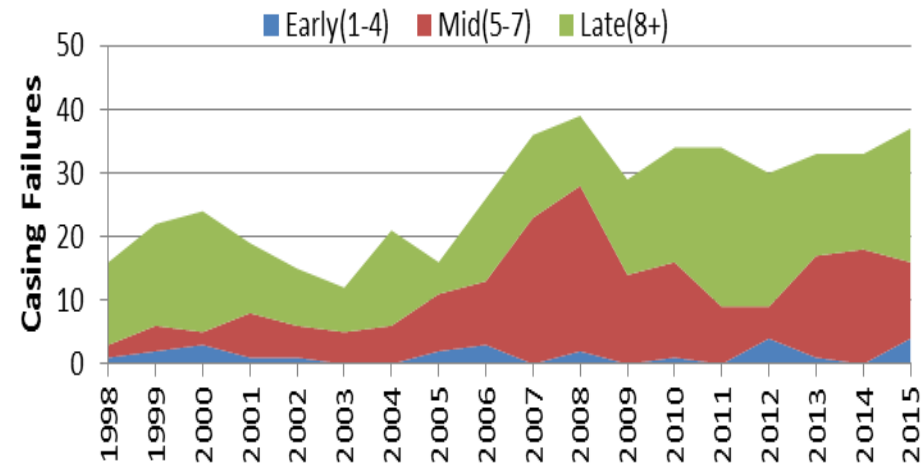
Intermediate Depth Performance:

- 21 failures detected by Casing Integrity check
 - 15 on previously suspended wells or occurred with rig on well
- 10 failures detected Operationally with Passive Seismic
- 6 failures detected Operationally with N2 soak procedures

Primary Commercial Intermediate Failures by Detection Method



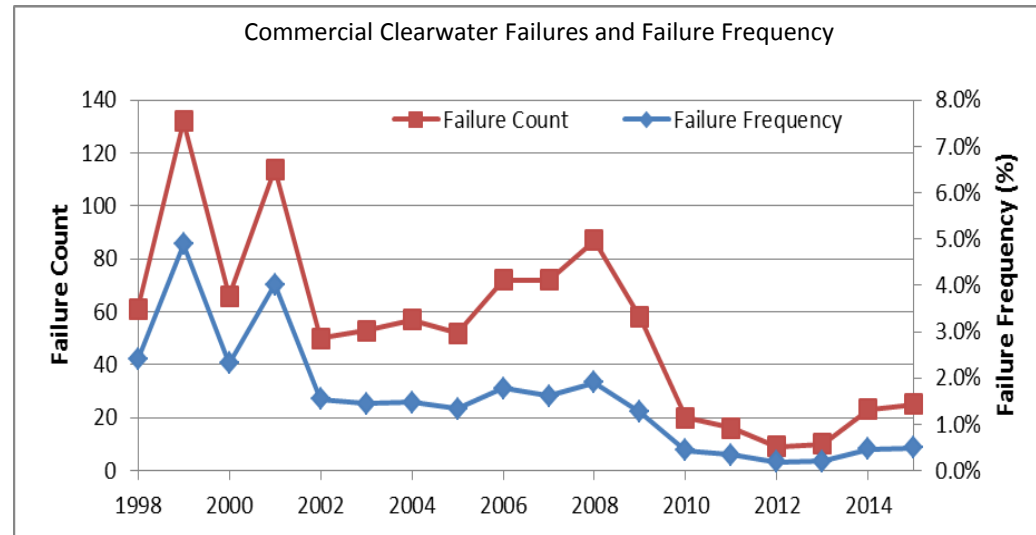
Primary Intermediate Commercial Failures by Cycle Range



Clearwater Top Casing Integrity

Clearwater Performance:

- 25 Clearwater failures detected in 2015 (0.49%/yr).
- No adverse environmental impacts
- Clearwater failure frequency has reduced significantly since 2008 and remained relatively flat since 2010
- Performance improvement attributed to many late cycle areas moving to low pressure operations (LP CSS, LP IOI, Steamflood), an increase in use of horizontal wells, proactive shear liner installations, and enhanced shear stress management



Operational Performance

Casing Integrity Check Program:

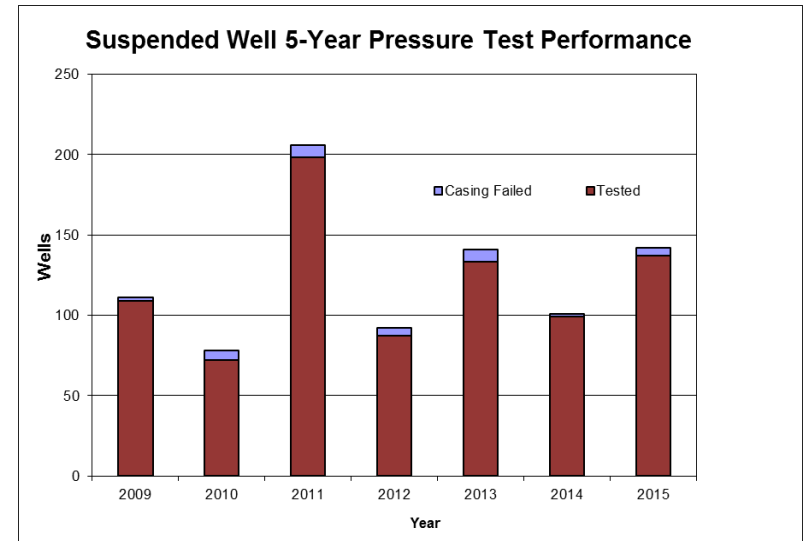
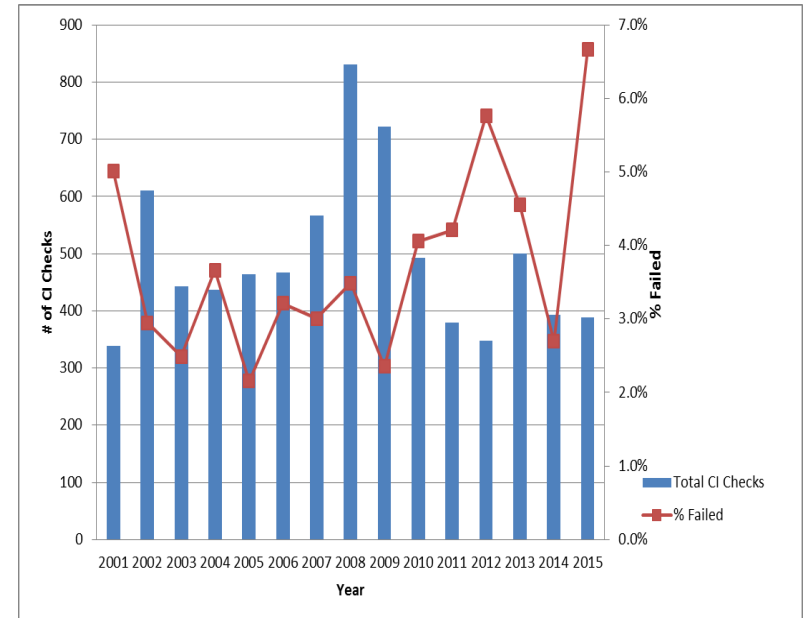
- 388 Casing Integrity checks executed in 2015
- Number of CI checks varies by year based on changing mix of well vintages, depletion methods
- % failed stat affected by the high number of zero pressure failures discovered in 2015

Suspended Well Management:

- Performed 137 Directive13 pressure tests
- Five casing failures identified (no conseq.)

Nitrogen Purge Performance:

- 12,559 nitrogen purges executed in 2015
- Purge compliance (being purged within 48 hours) at or near 100% throughout most of year



Initiatives – Monitoring and Operations

Passive Seismic Monitoring Program:

- Software being developed to automate passive seismic data analysis.
- The software has in some cases resulted in up to a 24hr reduction in failure event recognition and response compared to historic practices.

Casing Integrity Checks:

- Analysis shows 9-5/8" horizontal wells have fewer impairments and failures through early and mid cycles vs. 7" deviated wells. Practice revised to utilize EM scanner log for horizontal wells in place of rig checks for these cycles.
- Analysis also revealed that casing damage on 7" deviated wells begins to appear one cycle before prescribed casing integrity checks (CIC) are scheduled to begin. Practice revised to incorporate the option to advance the CIC schedule (from pre-cycle 6 to pre-cycle 5) and/or utilize synergistic integrity checks on select deviated wells. Allows proactive deployment of mitigation such as shear liner installation or modified steam strategies.

High Temperature Casing Patch Project:

- Imperial evaluating alternative technologies to the cemented slimhole for high pressure/temperature steam
- CSS casing patch developed through Saltel Industries with field trials currently underway
- Saltel patches installed in three 7" deviated wells in 2015 show proven success with "warm-up" volumes of steam.
- Next step → full cycle steaming

- Schlumberger MHE Patch redesign field tested on horizontal 9-5/8" well with a "warm-up" volume of steam. Patch successfully retained pressure integrity.
- Go-forward plans are being evaluated.

Casing Materials Evaluation

- First phase of finite element analysis (FEA) modeling indicated that thicker walled pipe outperforms thinner pipe in terms of fatigue life.
- Second phase of FEA modeling aimed to improve likeness to field conditions by introducing casing connection at slip plane. Thicker walled pipe again outperformed thinner pipe over a range of slip conditions.
- Modeling results consistent with field observation that horizontal 9-5/8" casing outperforming deviated 7" casing.

Summary

- 2015 program showed continued field integrity commitment while reducing casing failure consequences:
 - Near surface casing failures have increased in recent years; however, the mechanism is well understood, and risks and environmental consequences are minimized
 - Intermediate depth failure performance continues to trend flat with negligible fluid losses and no environmental consequence events above Level 0
 - Clearwater formation top failures remain low
 - Record number of casing repairs conducted in 2015, restoring 111 wells to service
- Strong focus on reducing near surface corrosion failures (coating trial, log off, bentonite top ups/shroud install)
- Technology development and operational learnings continue to improve intermediate depth practices:
 - Passive Seismic Automation Initiative to improve response timing
 - CI check advancement on 7" wells, proactive shear liner installations
 - Extended use of EM scan log technology on 9-5/8" wells
 - Strong progress on two high temperature/pressure casing patch developments