

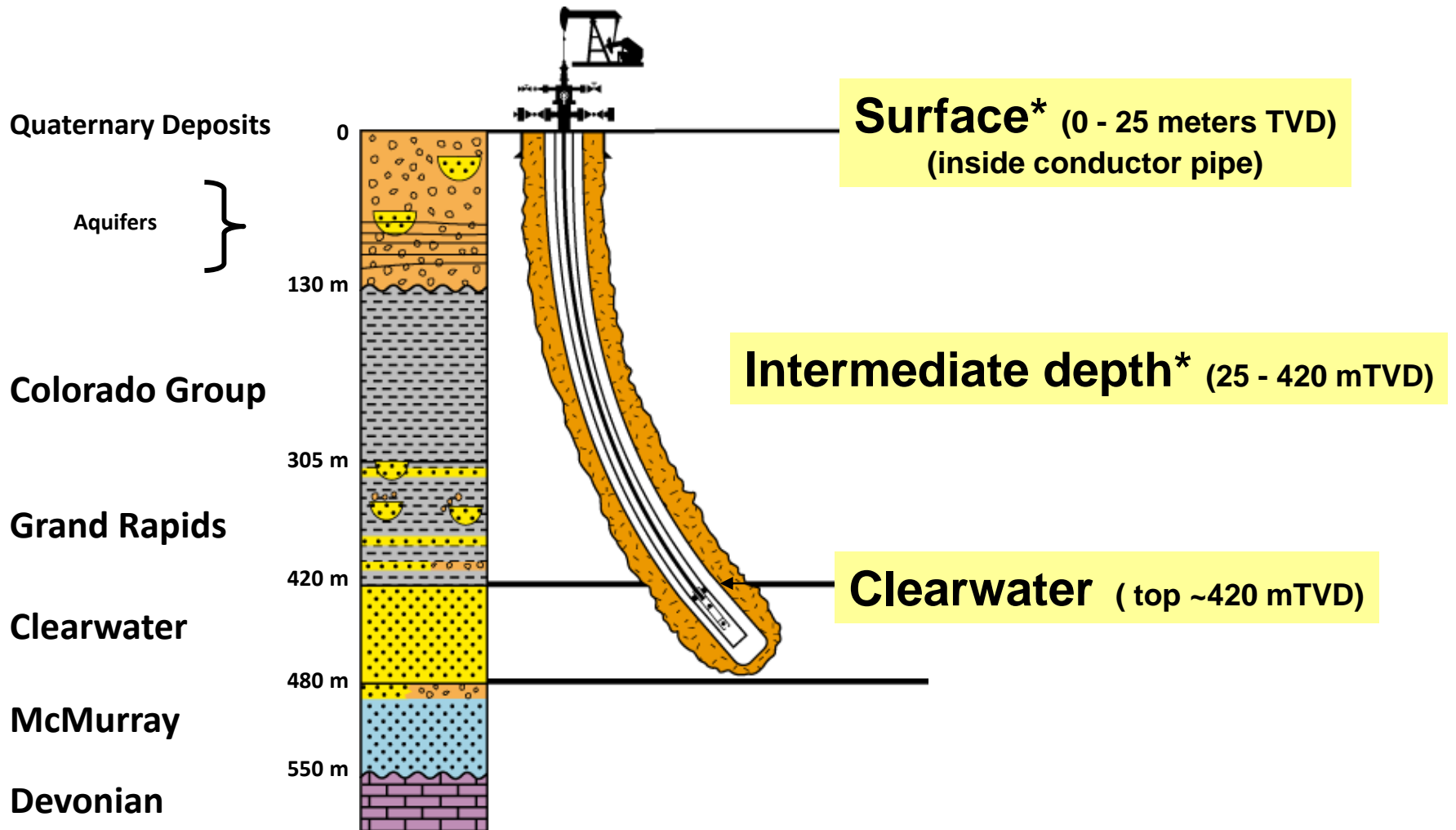


Imperial Cold Lake 2016 Casing Integrity Review

Review with AER

April 24, 2017

Casing Failure Classifications

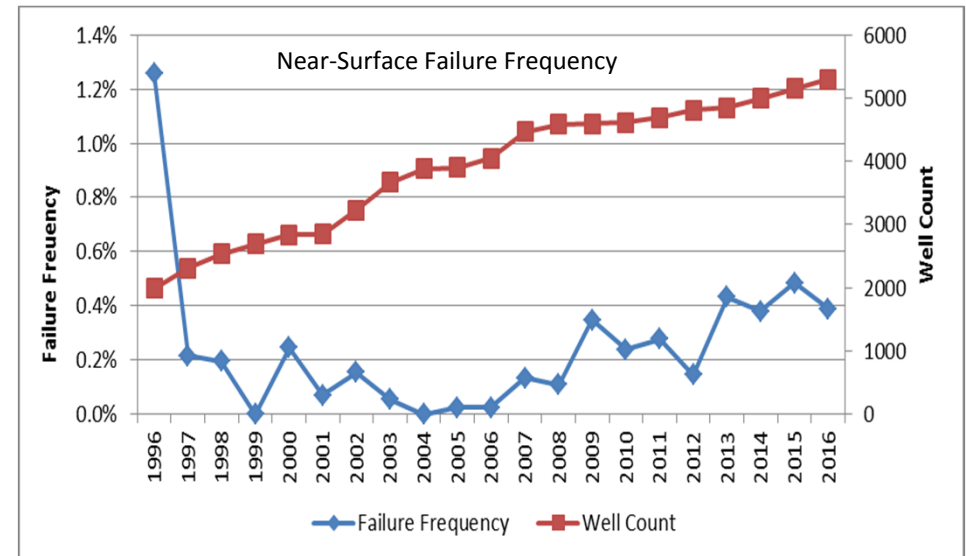
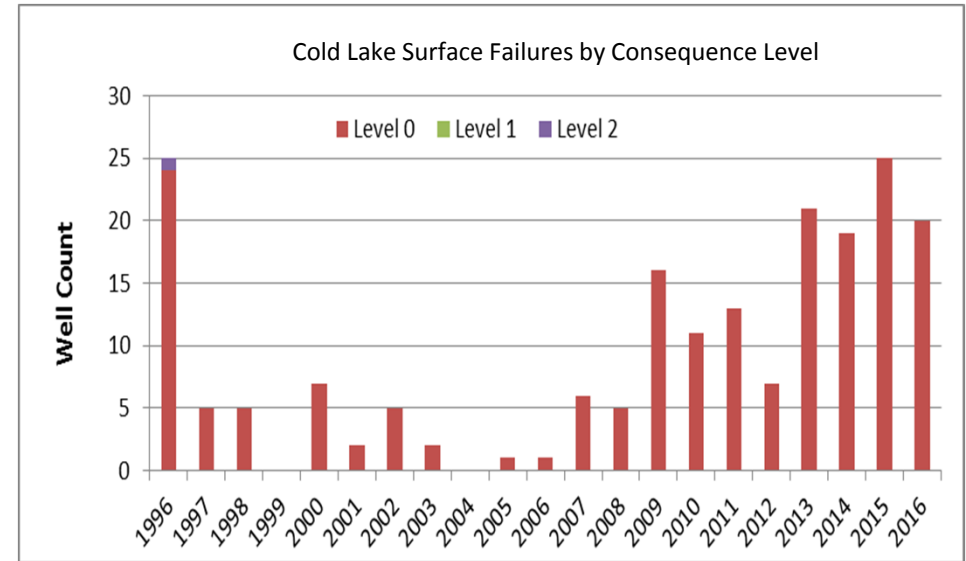
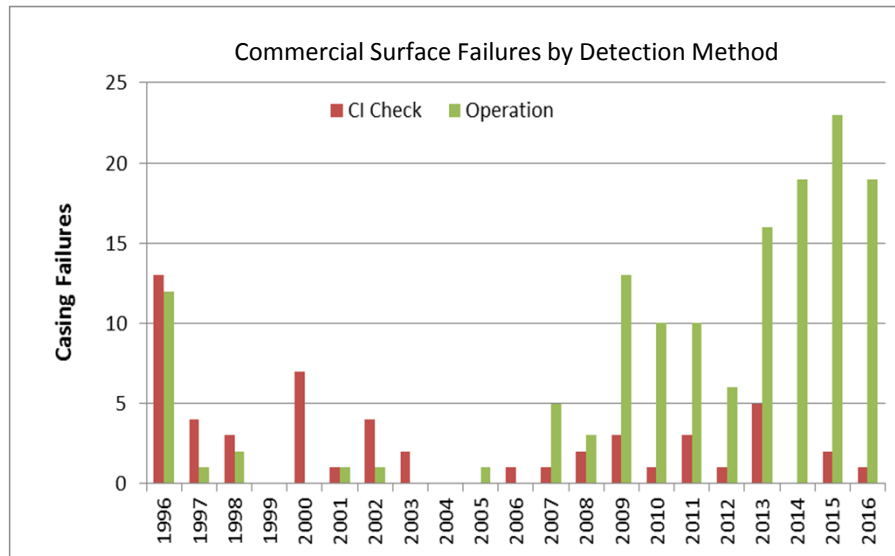


**Potential for adverse environmental impact*

Near Surface Casing Integrity

Near Surface Performance:

- 20 near surface casing failures detected in 2016 (0.38%/year).
- All near surface failures were late cycle, low pressure wells (no high pressure failures); majority at 25-30 years from well drilling and completion date.
- No failures had environmental consequences (all Level 0).
- Surface failures are occurring at or near ground level, not at the primary cement top.
- All 20 failures detected operationally through visual checks or scheduled pressure testing.



Near Surface Casing Integrity

2016 Near Surface Failure Management:

- 18 repairs with a near surface casing patch
- 1 well slimholed as two intermediate casing failures were also identified
- 1 well that were already zonally abandoned remained in that configuration

Near Surface Initiatives

- Continuation of field trial applying high temperature resistant metallic coating product:
 - 15 moderate near surface corrosion wells treated in 2016
 - Evaluating coating performance and change in long term corrosion rates
- Concluded 'log-off' of 9 in-well corrosion measurement tools to determine which technologies are most suitable for Cold Lake thermal wellbores.
- Ultrasonic (UT) inspection adopted to detect more accurate near surface corrosion:
 - 57 wells received UT inspection in 2016.
 - 21 wells returned to HPCSS
- Improvements made to the casing shroud design in 2016:
 - Change material to prolong the life
 - Change how shroud is attached to the well for easier installation and removal



Well prepared for UT inspection



Applying high temperature resistant metallic coating

Intermediate Depth Casing Integrity

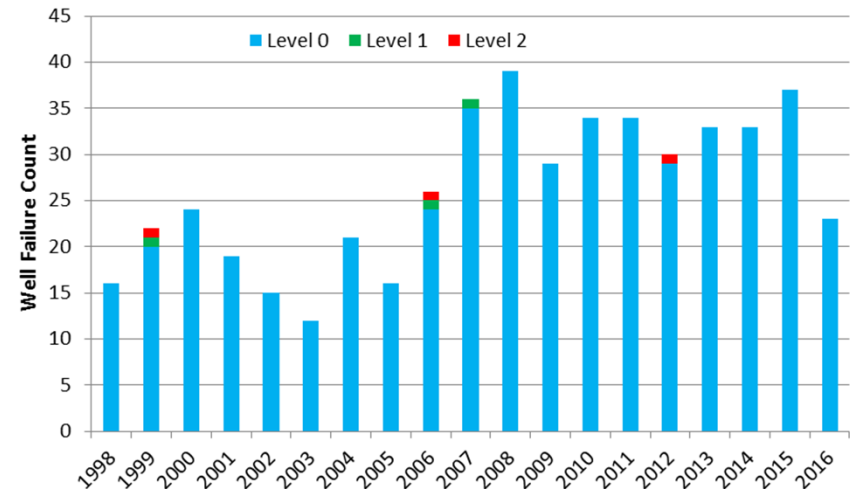
2016 Intermediate Depth Performance:

- 23 intermediate well failures detected in 2016 (0.44%/year)
- No failures with environmental consequences (all Level 0)
- 9 consecutive years with no secondary or multi-well failures
- 13 wells proactively slimhole repaired due to casing impairment or deformation (wells had not failed)
- 46 wells with casing failures or impairments repaired and returned to service in 2016

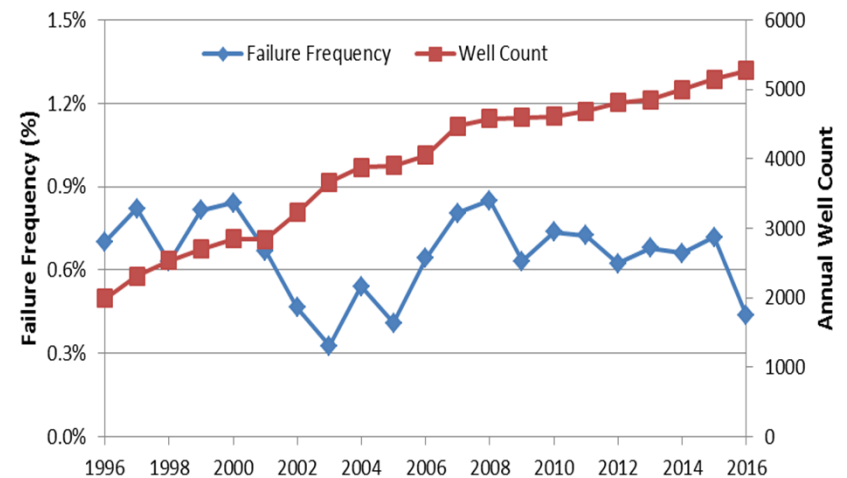
2016 Intermediate Failure Management:

- 1 well is currently flowing up the tubing with Nitrogen on the annulus to depressure so that a Service rig can move to the well
- 7 wells repaired with a cemented slimhole liner
- 3 wells repaired with a retrievable casing patch
- 1 well suspended
- 2 wells that were already suspended remained in that configuration
- 3 wells zonally abandoned
- 3 wells zonally abandoned with cement brought above the break
- 3 wells that were already zonally abandoned remained in that configuration

Cold Lake Intermediate Failures by Consequence Level



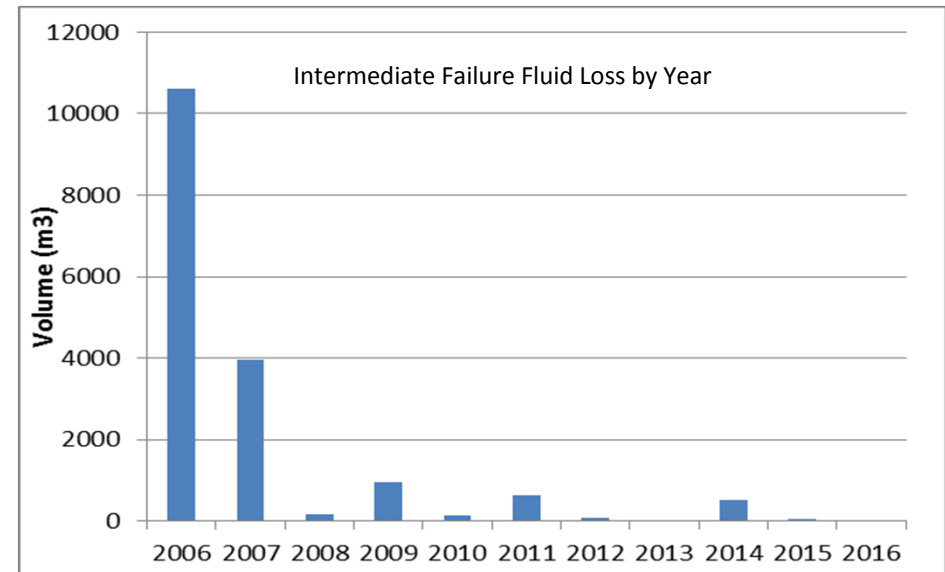
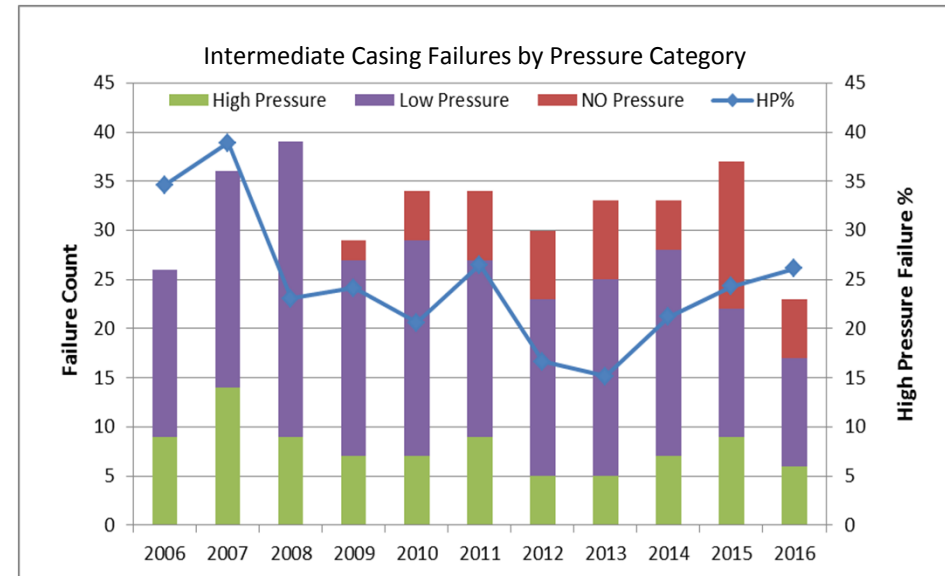
Primary Intermediate Commercial Casing Failure and Well Count



Intermediate Depth Casing Integrity

2016 Intermediate Depth Performance:

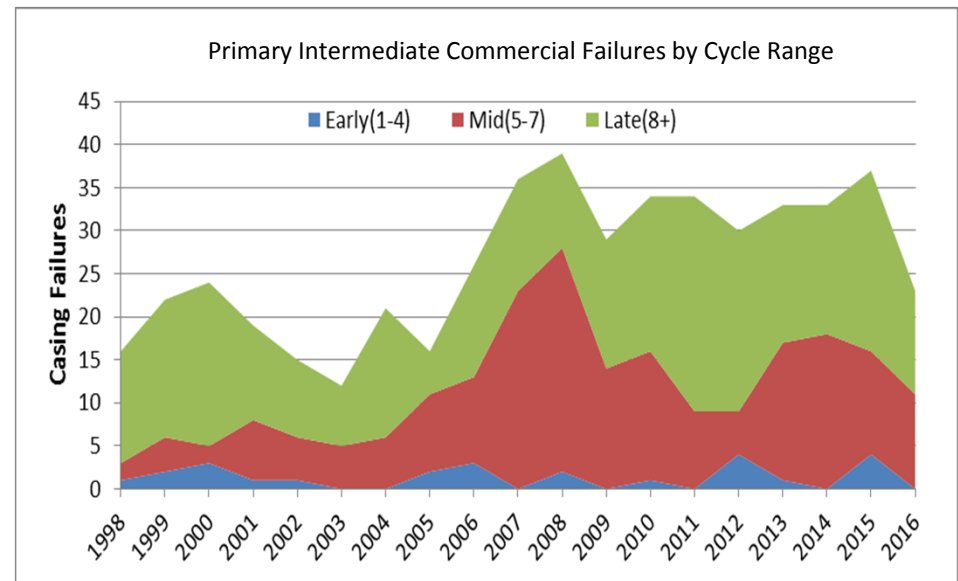
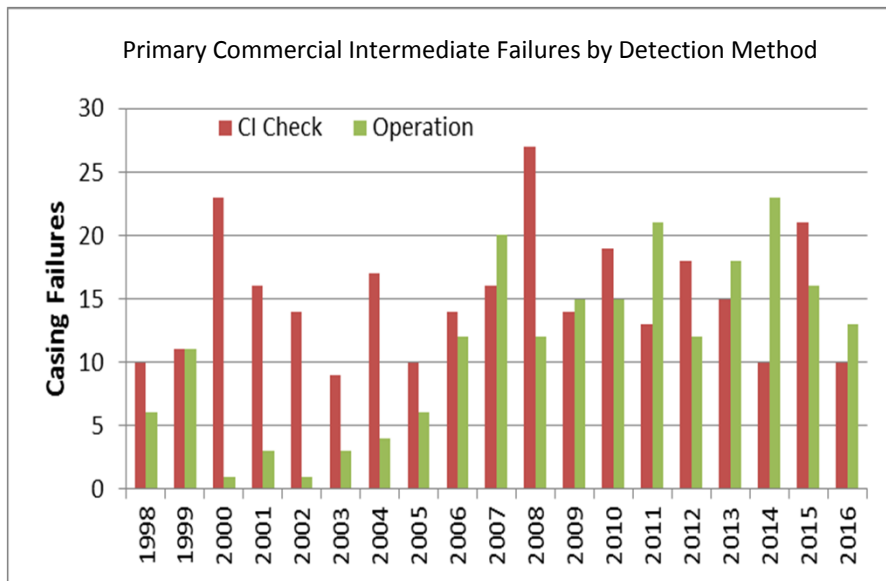
- 6 of 23 failures occurred at high pressure (HP) in 2016
 - 26% high pressure failures – % similar to 2015 but actual number of failures is lower
 - All failures managed with N2/Flowback
 - 17 failures on operating wells (high or low pressure), which was the lowest number in the past decade.
 - 6 failures occurred on non-operating wells with no pressure, and no environmental consequence.
-
- Negligible liquid losses from five casing failures in 2016; no adverse environmental affects or impact to adjacent well integrity



Intermediate Depth Casing Integrity

Intermediate Depth Performance:

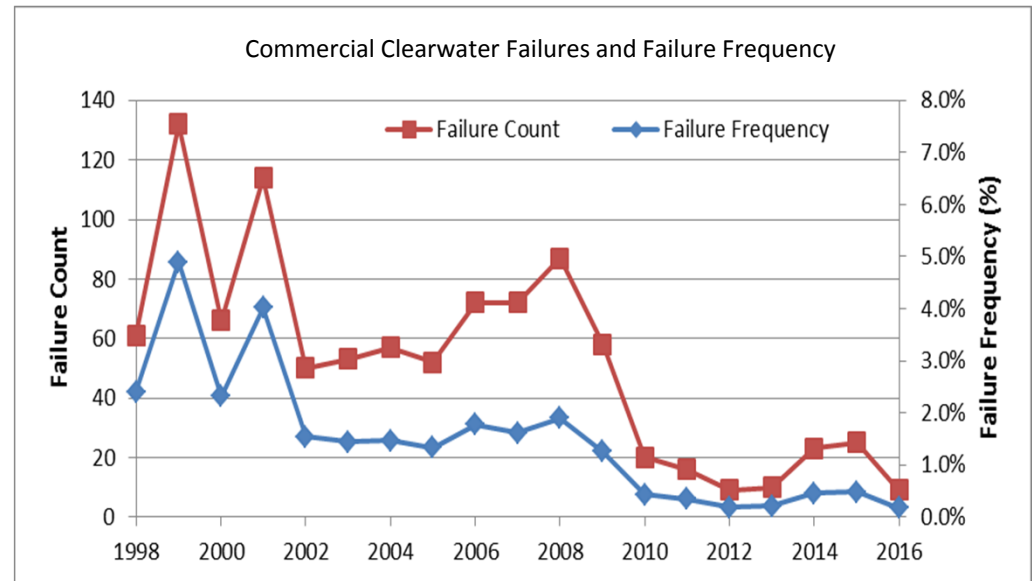
- 10 failures detected by Casing Integrity Check
 - 4 on previously suspended wells
- 10 failures detected Operationally with Passive Seismic
- 3 failures detected Operationally with N2 soak procedures



Clearwater Top Casing Integrity

Clearwater Performance:

- 9 Clearwater failures detected in 2016 (0.17%/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), increased use of horizontal wells and enhanced shear stress management



Operational Performance

Casing Integrity Check Program:

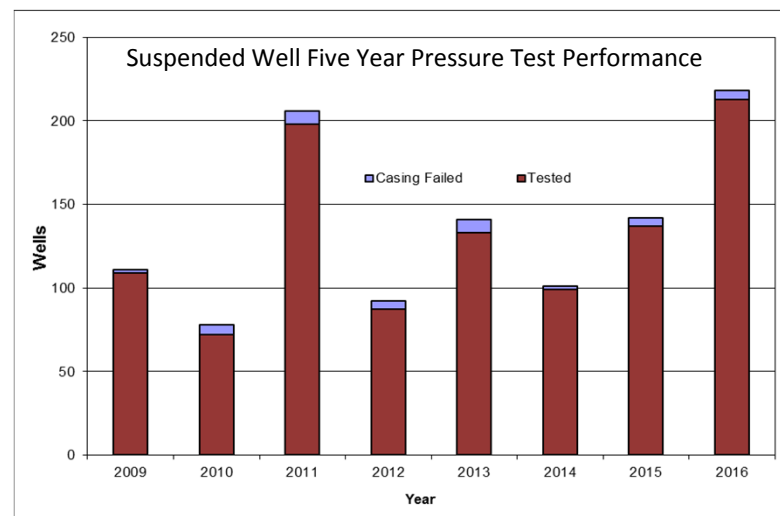
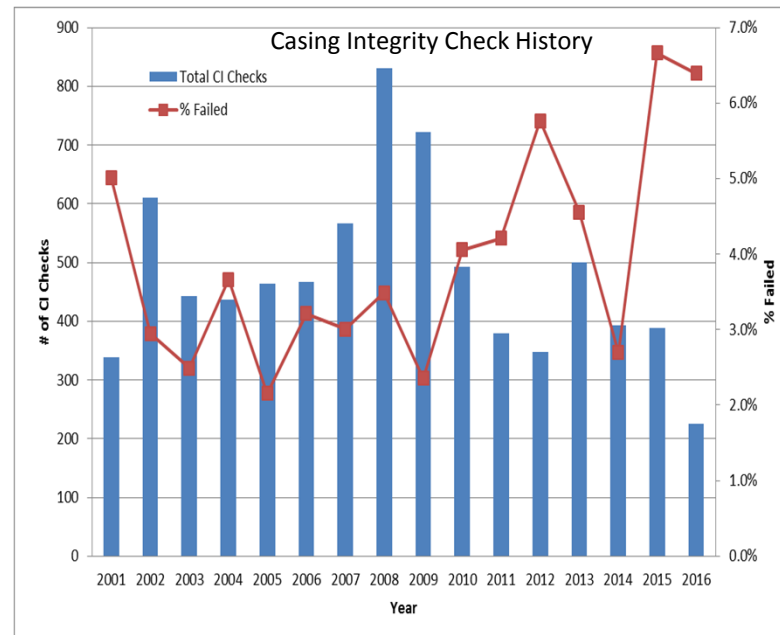
- 225 Casing Integrity checks executed in 2016
- Number of CI checks varies by year based on changing mix of well vintages, depletion methods
- % failed stat affected by the high number of zero pressure failures and rig based casing integrity check following identification of near surface casing failures and EM Scanner follow-up discovered in 2016

Suspended Well Management:

- Performed 213 Directive13 pressure tests
- Five casing failures identified (no conseq.)

Nitrogen Purge Performance:

- 8,688 nitrogen purges executed in 2016
- Purge compliance (being purged within 48 hours) at or near 100% throughout most of year
- In 2016, N2 purging was discontinued at pads with reservoir pressure < 4 MPa, and where pressure will not increase above that level in the future



Monitoring and Operations

Passive Seismic Monitoring Program:

- Automated software for real-time passive seismic alarms now functional for high pressure pads.
- The software has in some cases resulted in up to a 24hr reduction in failure event recognition and response compared to historic practices.

Design and Technology

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 two 7" deviated wells in 2015/2016 show proven success with full cycle volumes of steam.
- Next step → Install Saltel patches in more wells to return to HPCSS.
- Schlumberger MHE Patch redesign field tested on horizontal 9-5/8" well with a full cycle volume of steam.
- Next step → Confirm integrity with a service rig.

Casing Materials Evaluation

- Analysis was completed which determined that there was no value to increasing the current 7" 23lb/ft casing to a heavier 7" 32lb/ft casing for new drill wells. This design change will not be pursued further.

Summary

- 2016 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 frequency is the lowest since 2005 with negligible fluid losses and no environmental consequence events above Level 0
 - Clearwater formation top failures remain low
- Strong focus on reducing near surface corrosion failures (coating trial, UT inspection, casing shroud redesign)
- Technology development and operational learnings continue to improve intermediate depth practices:
 - Passive Seismic Automation to improve response timing
 - Strong progress on two high temperature/pressure casing patch developments