COILED TUBING & WELL INTERVENTION
CONFERENCE & EXHIBITION
2014

25—26 March 2014 | The Woodlands, Texas, USA

# SPE 168278-MS
# Optimizing Horizontal Wellbore Design to Extend Reach with Coiled Tubing

J. Forrester, Athabasca Oil Corporation, J. Yeung, F. Marzara, Essential Energy Services

ATHABASCA OIL CORPORATION

ESSENTIAL ENERGY SERVICES

ICoTA Intervention & Coiled Tubing Association

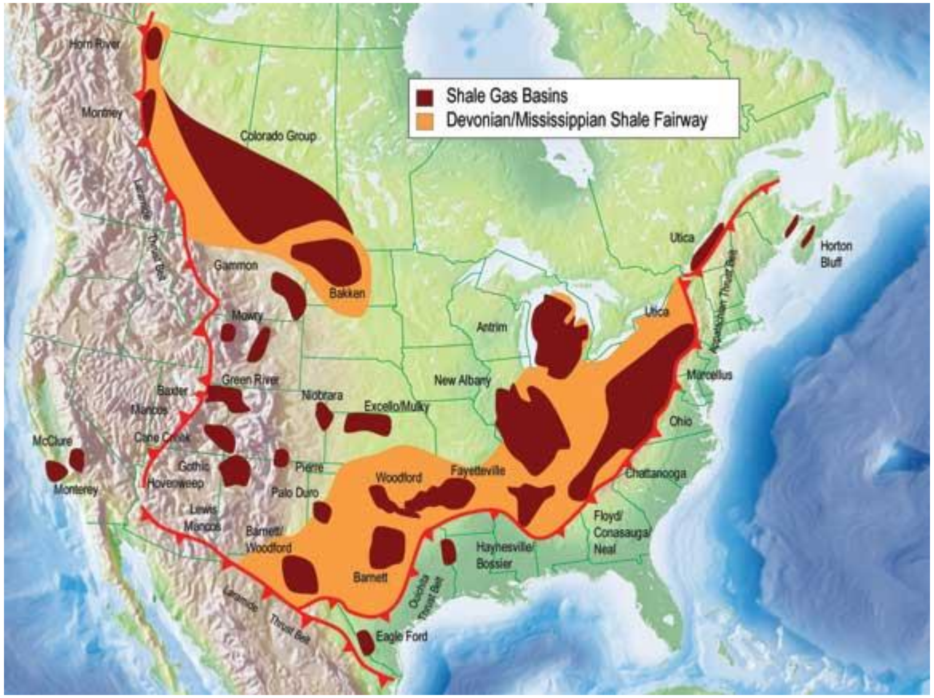
SPE International

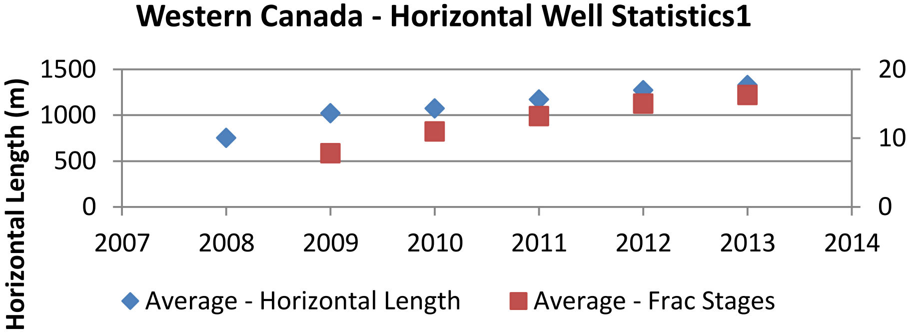
# Introduction

- What?
  - How can wellbore designs be altered to maximize coil tubing reach capacity?
  - Concentrate on key wellbore variables that effect coil tubing lockup depths
  - Maintain a set of control variables
  - Compare field data to model results
  - Provide a set of recommendations for drilling of wells
- Why?
  - Allow for wellbore cleanouts post frac
  - Allow all frac stages to be stimulated
  - Prevent sterilizing production and reserves due to inability to reach TD

# Background

- Area of interest:
  - Western Canada, Montney Formation
- Investigation drivers:
  - CT annular frac design
  - Wellbore interventions
- General:
  - Wellbore lengths
  - # of stimulations
  - Trends

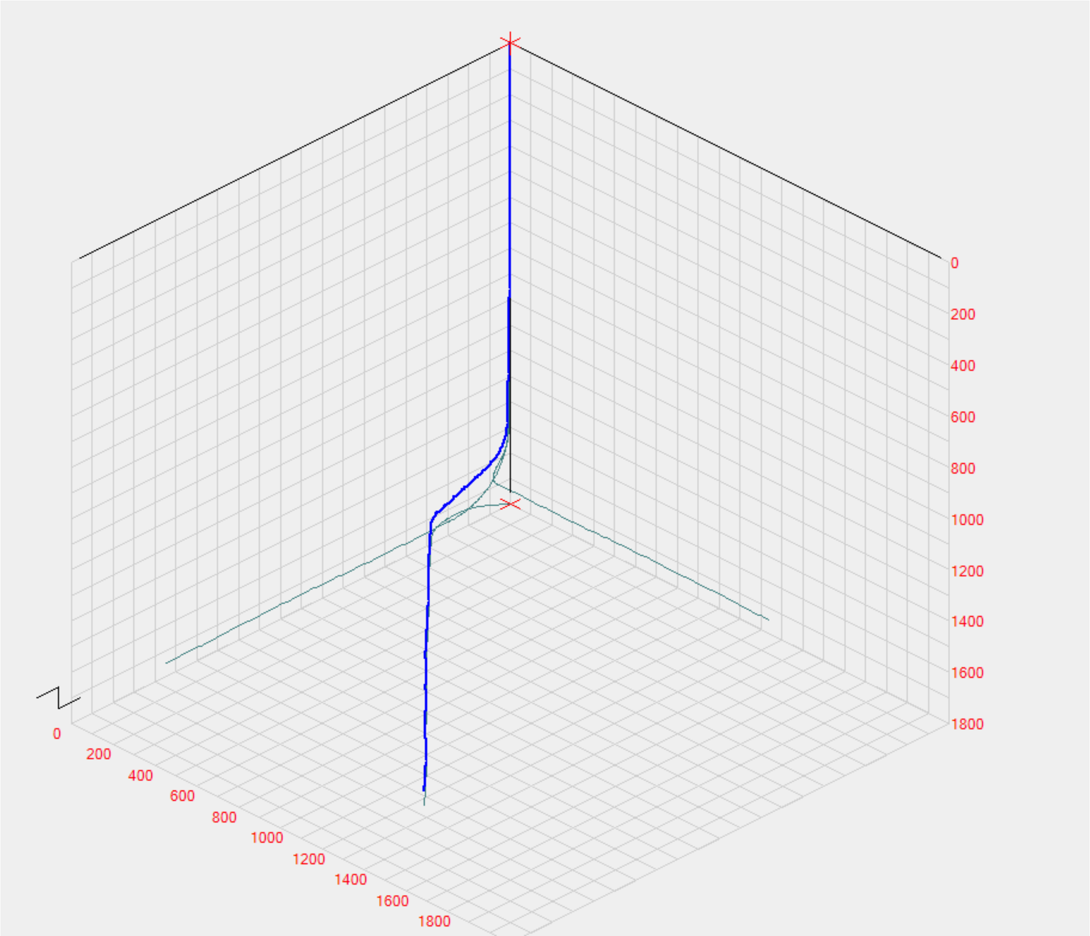



1. Canadian Discovery, Western Canadian Frac Database

# Horizontal Wellbore Design Factors

- Build Rate
  - Expected to have largest impact
- Turn Rate
  - Multi-well pad applications
- Casing Size
  - Cost
  - Artificial Lift




COILED TUBING & WELL INTERVENTION
CONFERENCE & EXHIBITION
2014

# Horizontal Wellbore Design

**Limiting Factors**

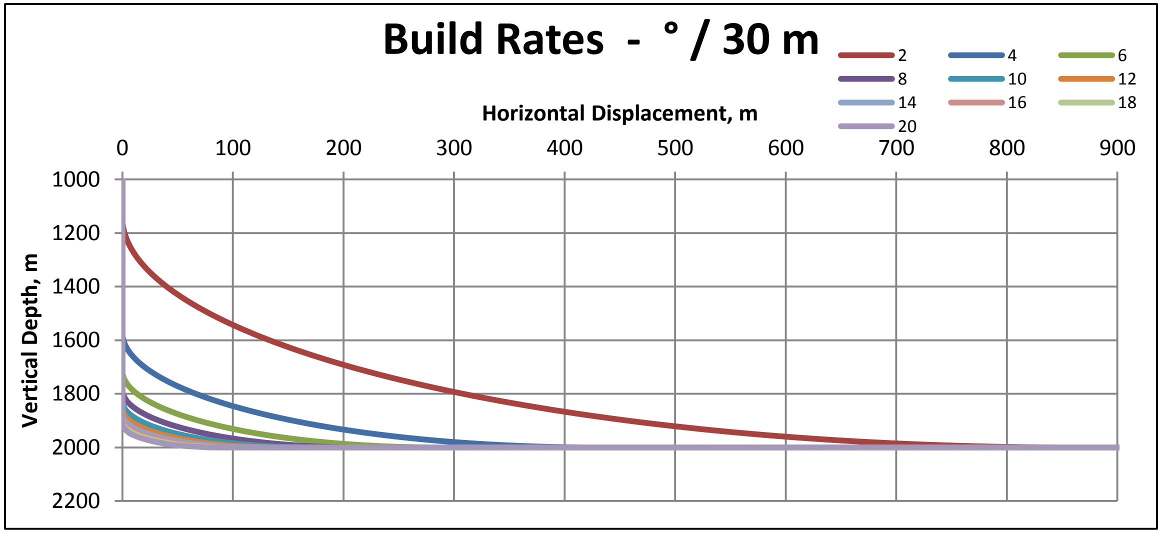
- Directional tools
- Geology
- Surface access
- Stimulation System
- Economics

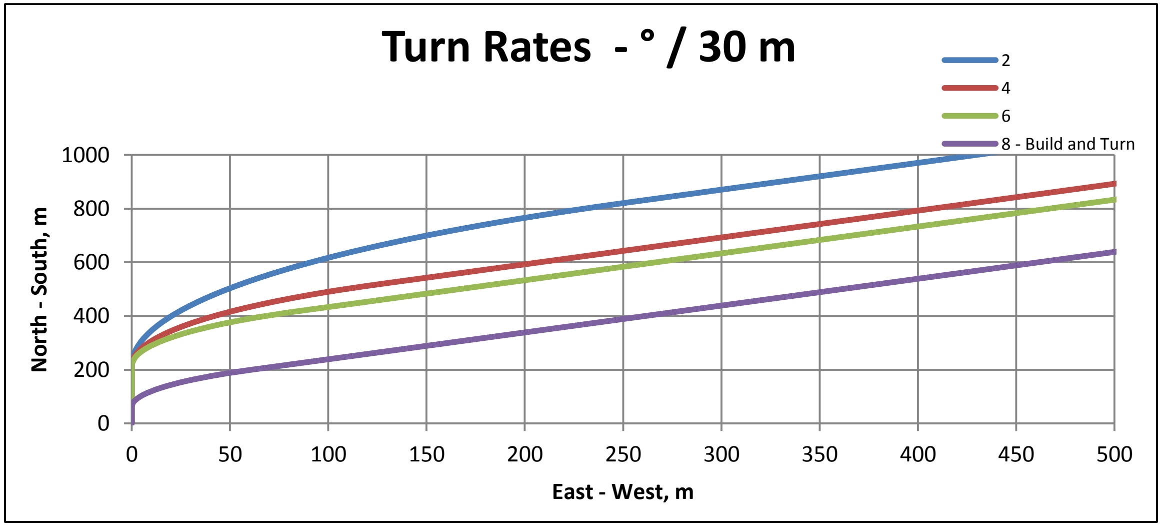
Fox Creek, Alberta

# Coil Tubing Model Design

## Manipulated Variables

- **Build Rate**
  - **0 – 20 ° / 30 m**
- **Turn Rate**
  - **0 – 6 ° / 30 m**
  - **'Build and turn'**
- **Casing Size**
  - **114 mm**
  - **139 mm**
  - **139 mm w/ 114 mm lateral**



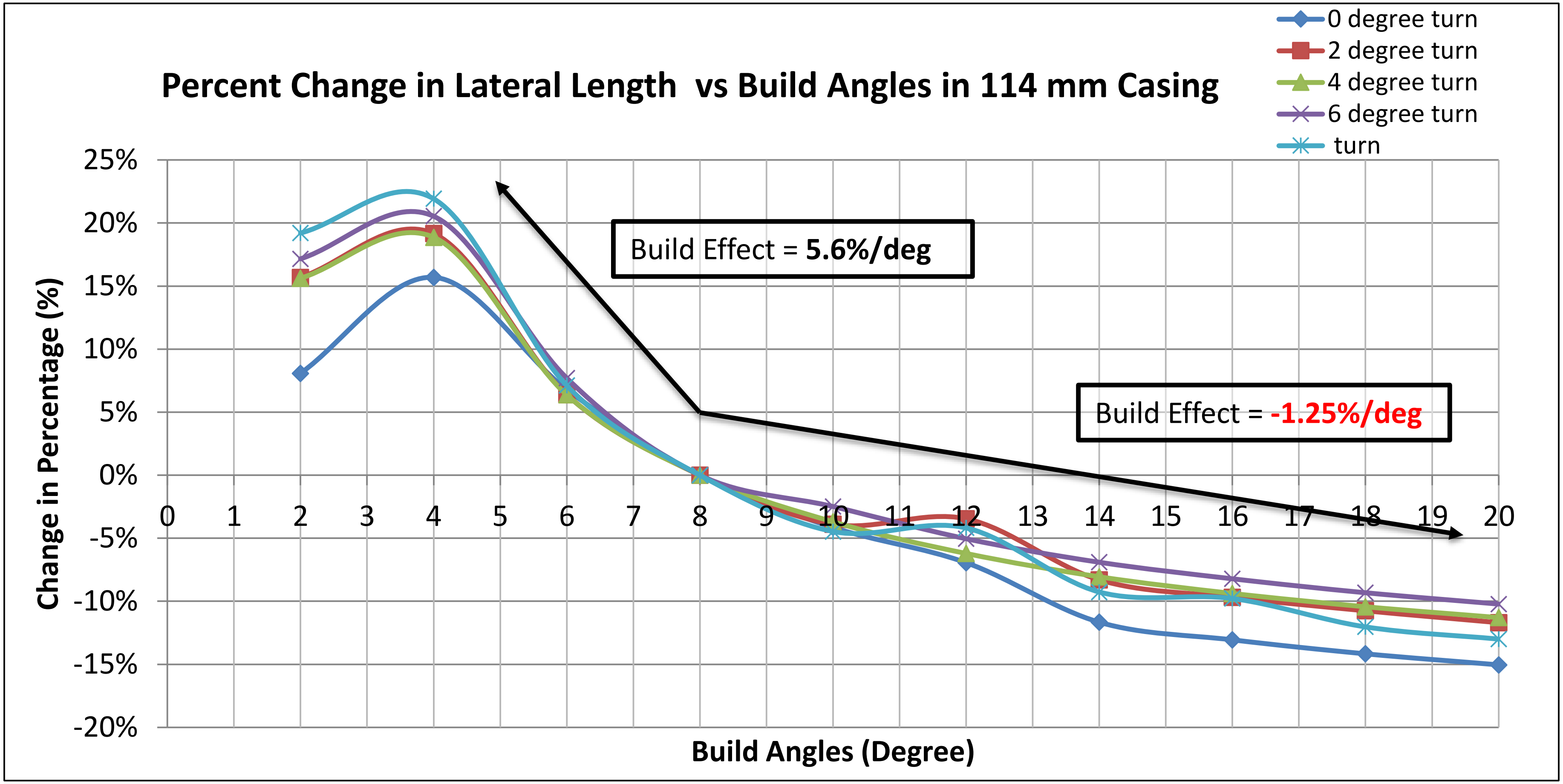




COILED TUBING & WELL INTERVENTION CONFERENCE & EXHIBITION 2014

# Coil Tubing Model Assumptions

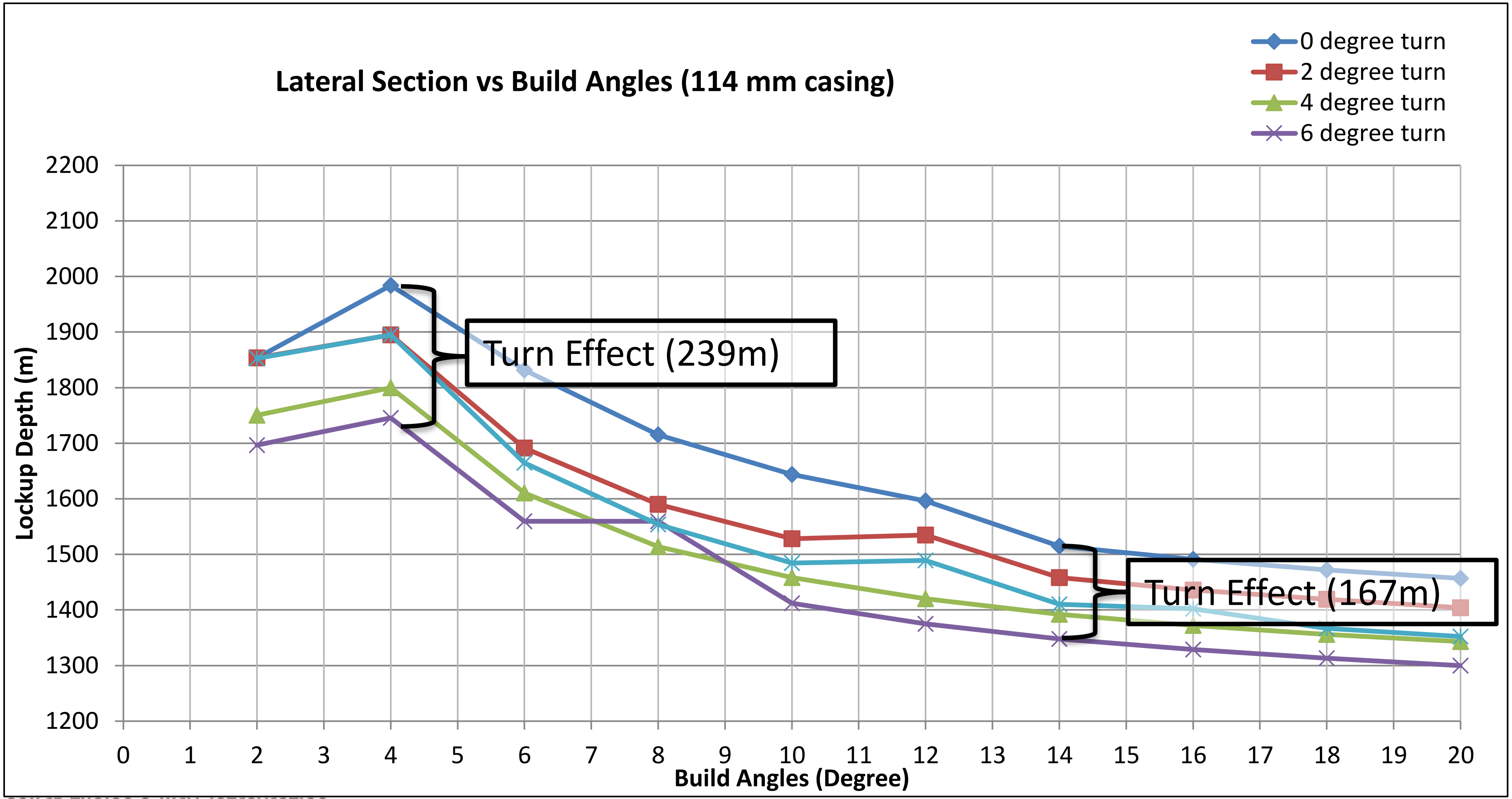
| Variable | Assumed Value | | Justification |
|---|---|---|---|
| **Coil tubing OD** | 50.8 mm | 2” | Match field data<br>Common size<br>Annular velocity limits |
| **TVD** | 2000 m | 6561 ft | Match field data |
| **Friction Coefficient** | 0.3 | | Conservative value used |
| **Lateral** | Smooth / Flat | | Impractical to model random variations |
| **Fluid** | Fresh Water | | Match field data |
| **Reference Point** | 8 degrees / 30 m | | Match field data |

# Results - Build Angle

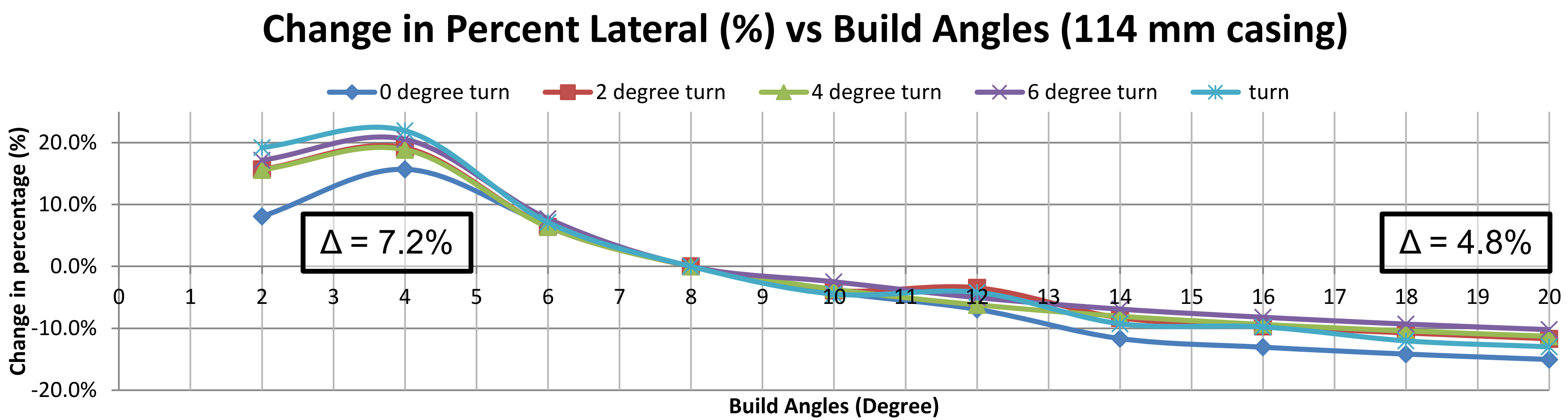


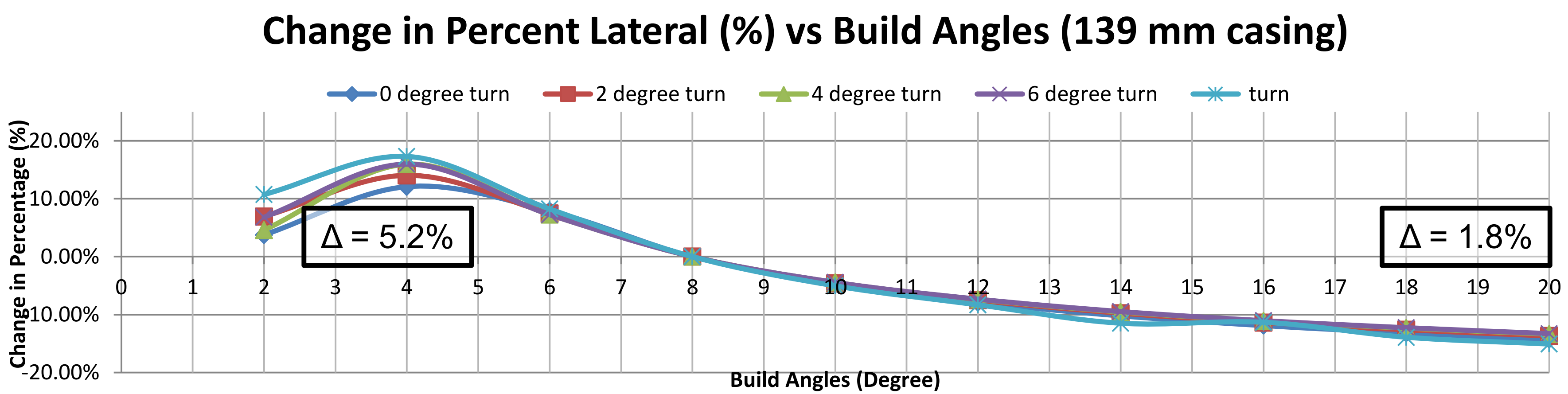

Note: Y-axis depicts percentage change in lateral length relative to an 8˚ /30m build rate

# Results – Turn Angle



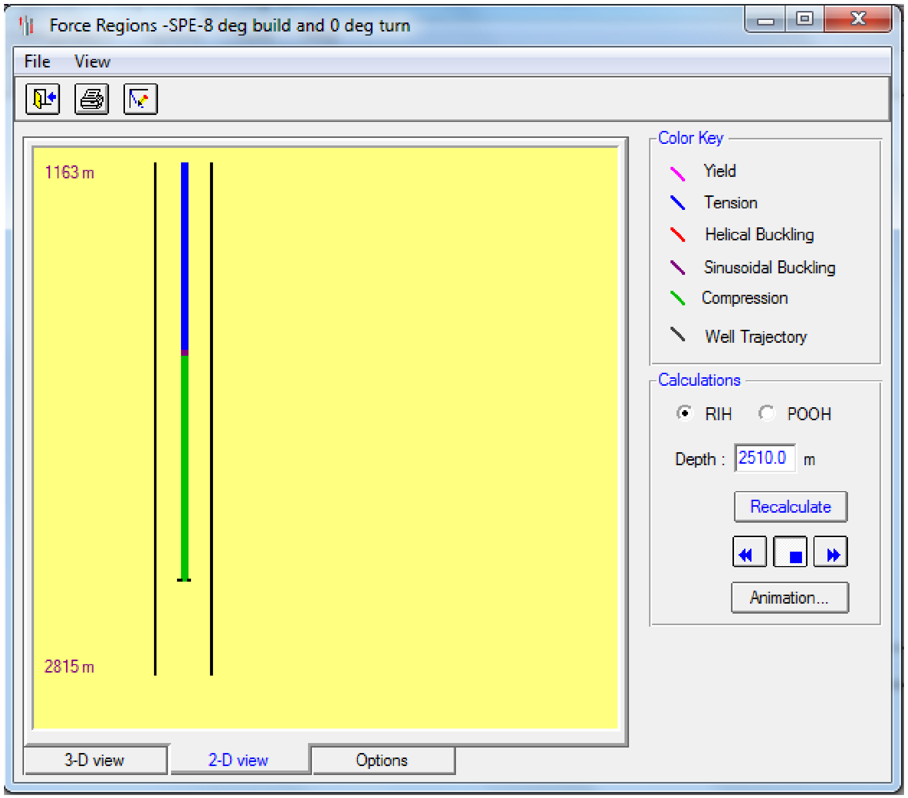
# Results – Casing Size

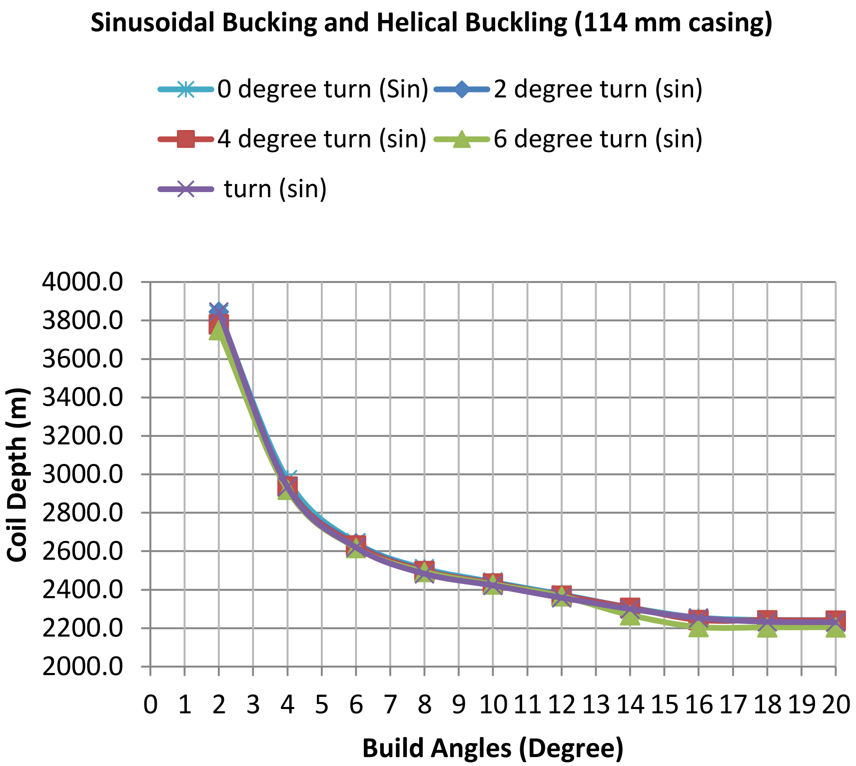



COILED TUBING & WELL INTERVENTION CONFERENCE & EXHIBITION 2014

# Results – Sinusoidal and Helical Buckling

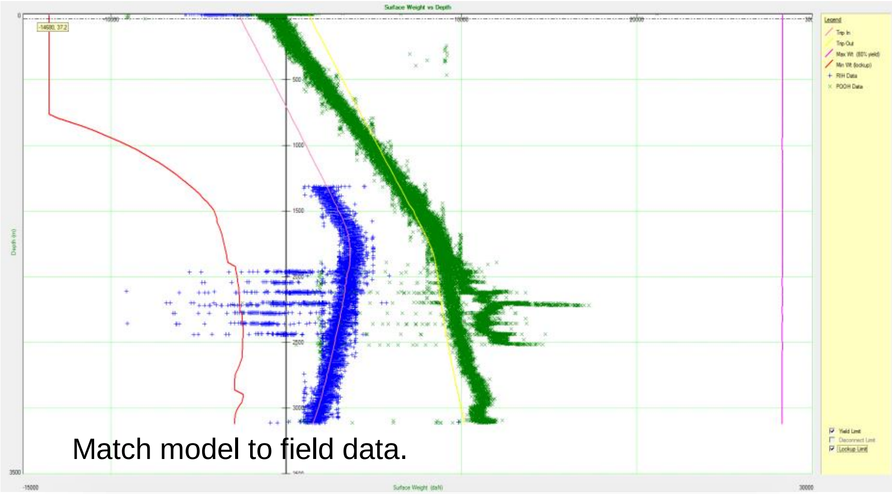



COILED TUBING & WELL INTERVENTION CONFERENCE & EXHIBITION 2014

# Matching Field Data

| Variable | Effects |
|---|---|
| **Lubrication Additives** | Friction Coef. |
| **Wellbore DLS** | Wellbore comparison<br>Coil behavior |
| **Fluid Types** | Friction coef.<br>Buoyancy |
| **Wellbore Pressures** | Coil behavior |
| **Debris** | Coil behavior<br>Drag |



Match model to field data.

Debris sample, stage tool millout.

# Quantifying Model to Field Data

- 30 well data set
- Compare matched friction coefficient
- Large variety of well types
- Casing size ignored (proven to be lower impact variable)
- Build to 45 – turn @ 4 ° /30m shown to be lowest average friction coefficient

| Average build (degrees / 30m) | Build-Land | Build-land-turn | Build to 45 deg - start turn |
|---|---|---|---|
| 4 | - | - | **0.150** |
| 5 | 0.300 | - | 0.247 |
| 6 | 0.300 | 0.270 | 0.263 |
| 7 | 0.300 | 0.213 | 0.260 |
| 8 | 0.300 | - | 0.225 |

# Conclusions

### Build Angle

- Directly related to the maximum coil reach, as well as friction coefficient
- Relative effect of decreasing the build angle (relative to 8 degrees/30m) drastically increases reach (up to 20%); while the loss is not as drastic for the same change (-5%)
- Increasing build angle above 12 degrees / 30 m shows a diminishing losses
- Decreasing build angle below 4 degrees / 30 m shows diminishing gains

**Build rates of 4° /30m**

### Turn Angle

- Lower turn rates are directly related to coil reach, as well as friction coefficient
- A build and turn profile provides an extended reach and lower friction coefficient relative to when a turn is completed in the lateral section of the well

**Turn rates of 2-3° /30m**
**'Build and turn'**

### Casing Size

- 114 mm casing allows for extended reach versus 139 mm casing
- 114 mm casing is more sensitive to changes in turn rates than 139 mm casing
- Casing size effect is dominated by the size of casing from surface to the heel of the well

**114 mm monobore design**

# Thank You / Questions

**Acknowledgements**

1. Essential Energy Services
2. Athabasca Oil Corp.
3. Joe Fisher, Newsco Energy Services
4. Jeff Liu, Trican Well Services