New Environmentally Friendly Fracturing Technique Yields Significant Fluid, Chemical, and Cost Savings and Increased Operational Efficiencies

Lyle Laun NCS Oilfield Services

CSUR – March 7, 2012

Agenda

- Evolution of Frac Techniques – SE Sask & Mb
- Coiled Tubing Frac'ing Techniques
- What is the NCS Half-Straddle™ ?
- How Does it Work ?
- Why would I Want it ?
- Treatment Examples
- Savings / Benefits

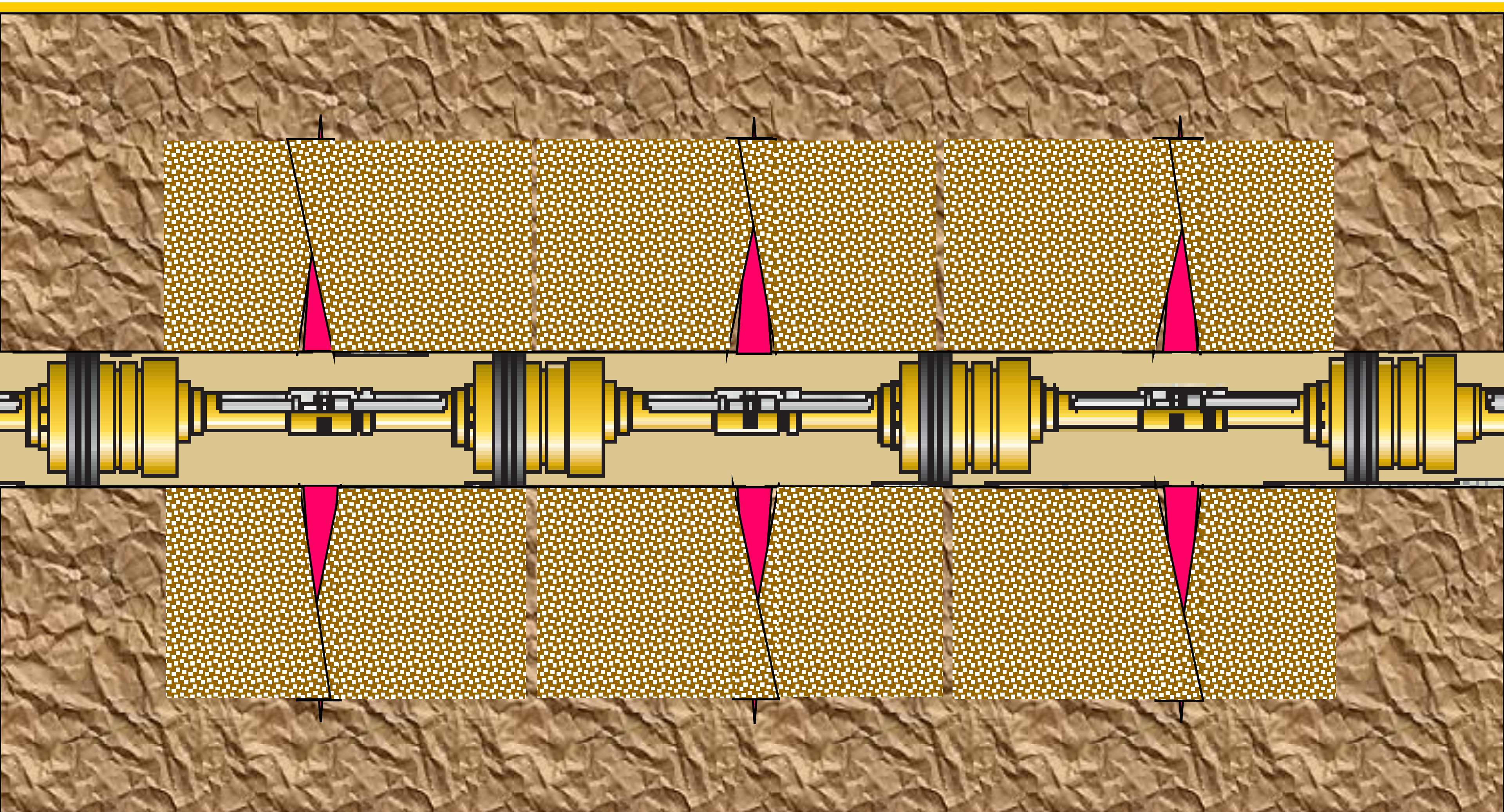
Evolution of Frac Techniques in the SE Sask Bakken

2006 - Ball Drop Systems Begin

- Started by Packers Plus & BJ Services
- 8 Stage Open Hole completion with packers
- "Industry Stampede" to this system
- Steep learning curve
- Increased to 12 stages within a year
- Increased to 18+ stages within 2 years
- Efficient use of limited frac crews

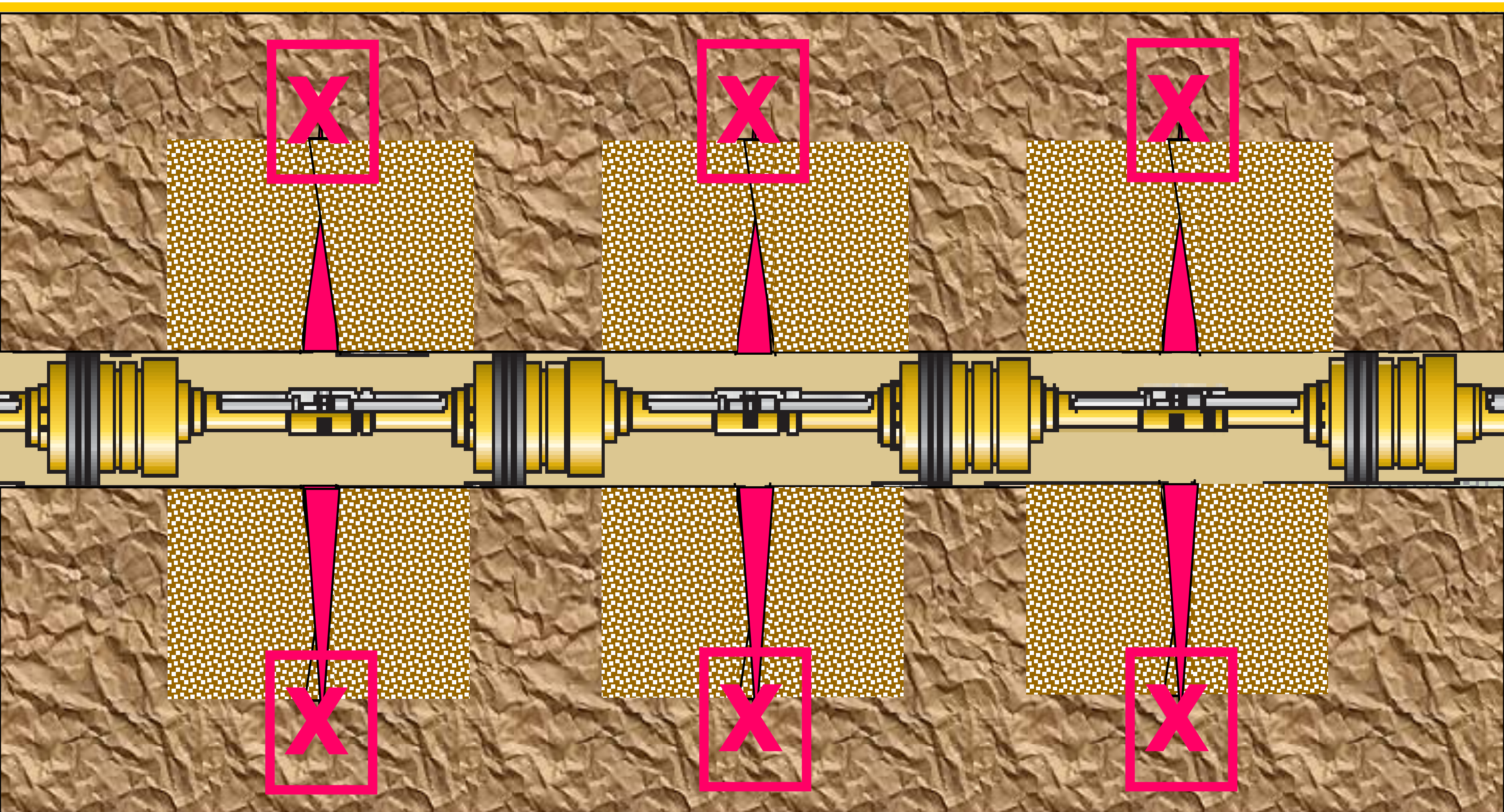
Fracture Spacing – 125m

“The Plan” - Optimum Drainage



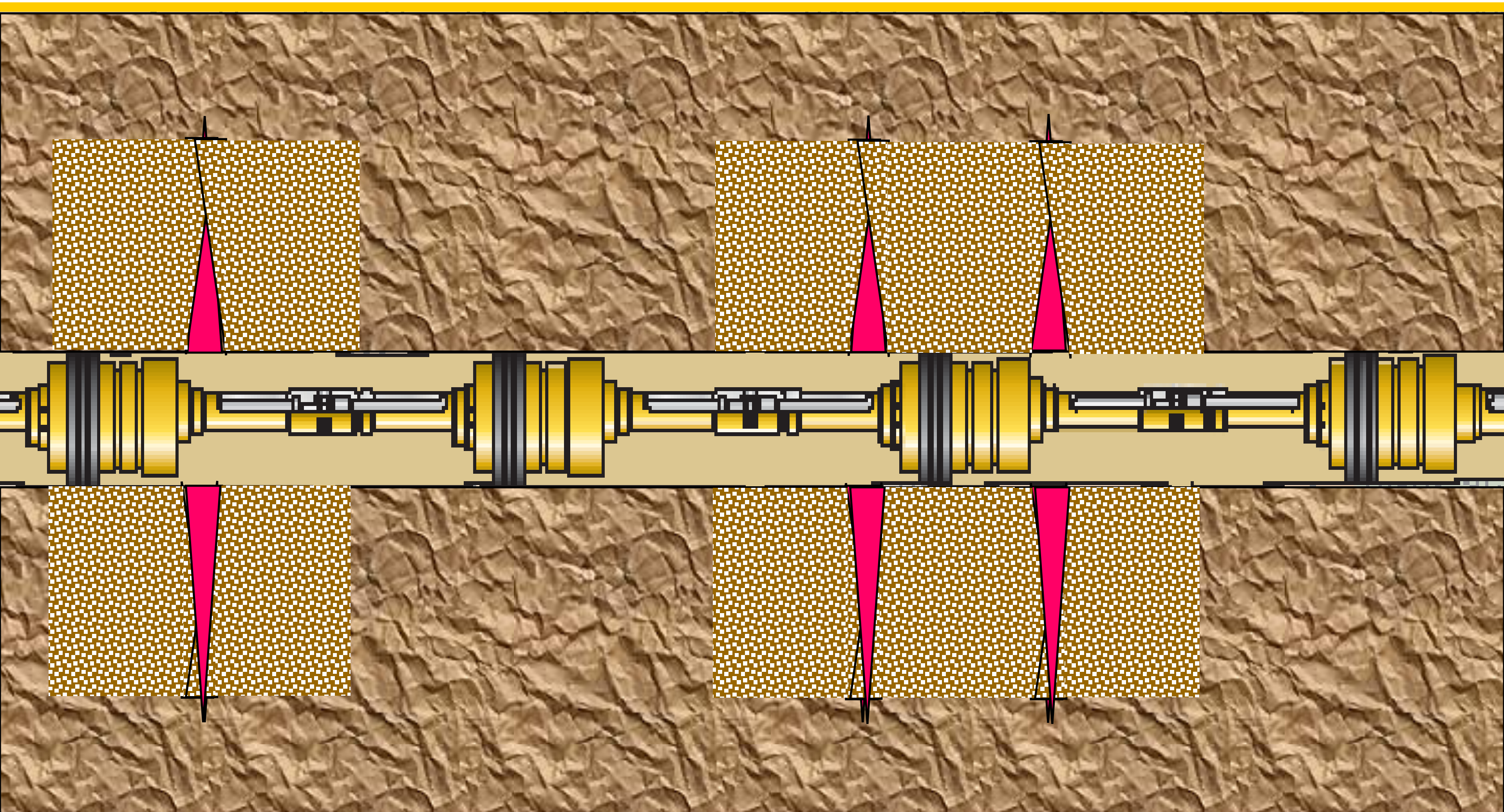
Fracture Spacing – 125m

Why Initiate Evenly ?



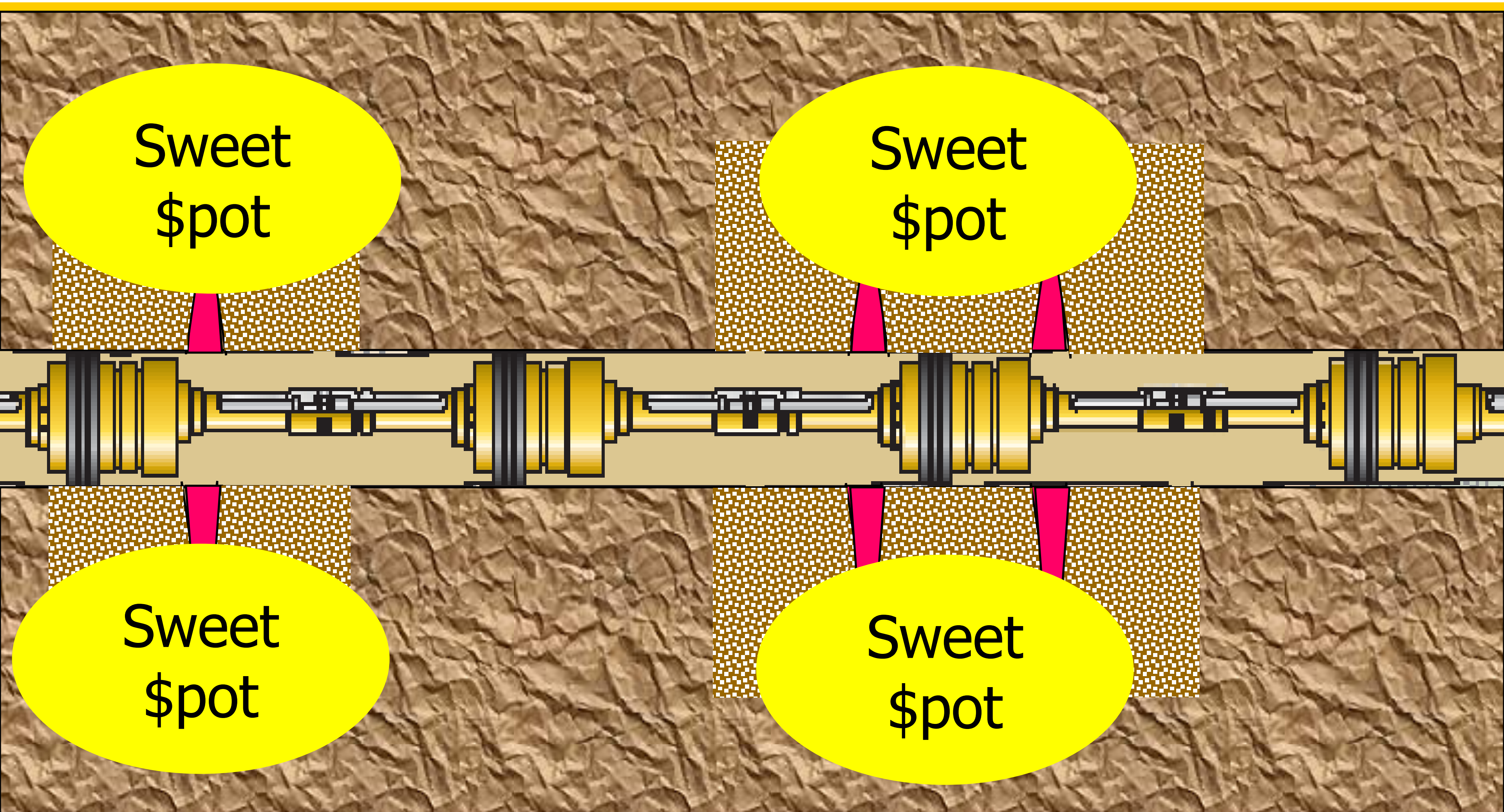
Fracture Spacing – 125m

Why not This ?



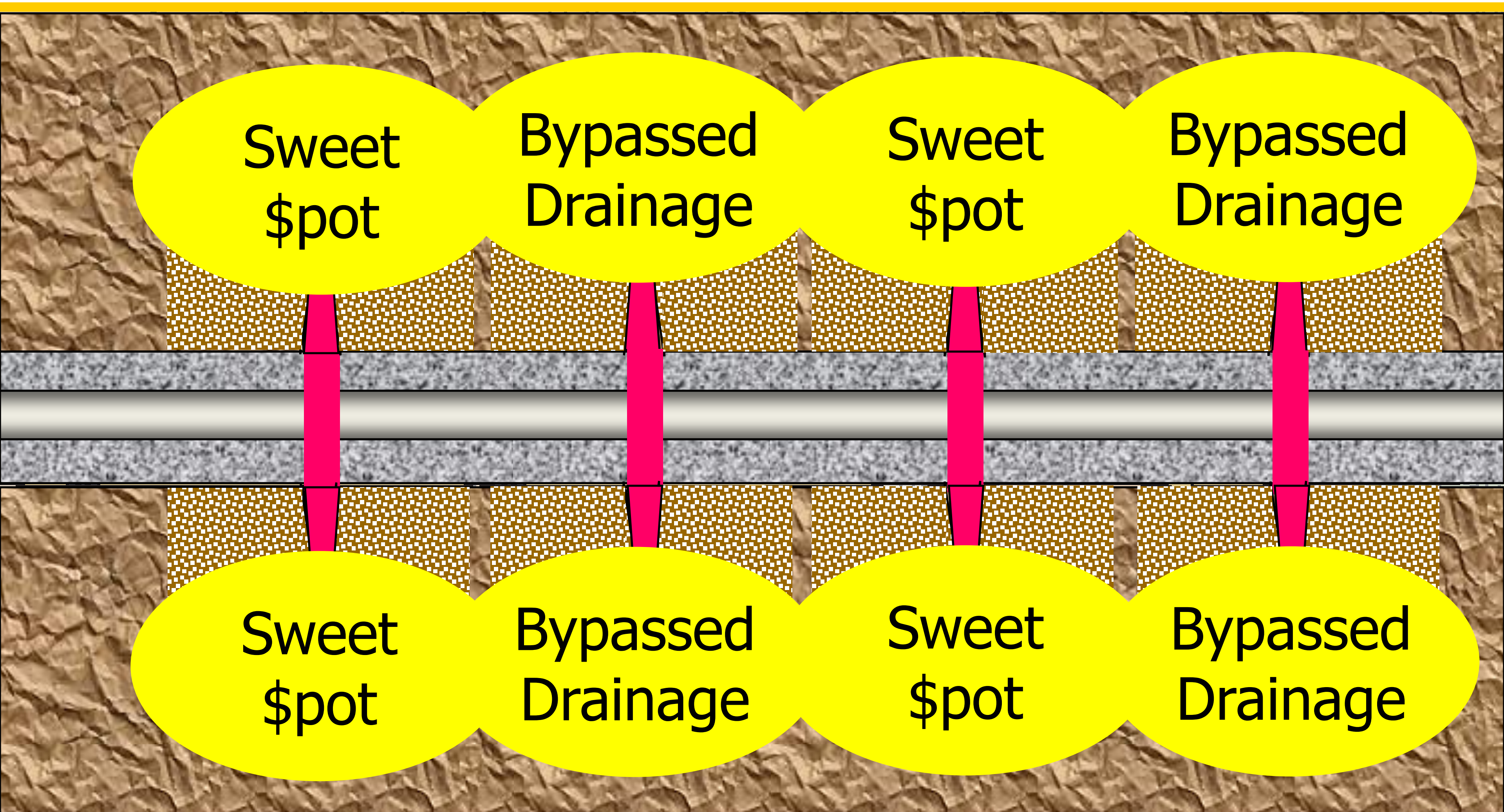
Fracture Spacing – 125m

Fracture(s) Initiates at the Sweet Spot



Cemented Liners

Closer Spacing = Better Production



Evolution of Frac Techniques 2008 - 2010

- Moves to Spearfish in Manitoba
- Moves to Lower Amaranth in Manitoba
- Moves to Torquay in SE Sask

- "Everybody" came up with a Ball Drop System and they are working across the WCSB

Evolution of Frac Techniques

2010 – Ball Drop Systems

- High Jewellery Costs
- Expensive Mill-outs
- 2010 – Industry moving to CT Frac's in this area
- 2011 – Ball Drop Systems in limited use due to economics of 25-30 stage fracs

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Evolution of Frac Techniques

2010 – Coiled Tubing Frac Systems Begin

- Typically 16 stages
- Cemented liners most common
- Industry split between CT Annular Frac'ing & Frac down CT
- Steep learning curve
- Increased to 25+ stages within a year
- Limited by Coiled Tubing availability
- 2011 – Ball Drop Systems in limited use

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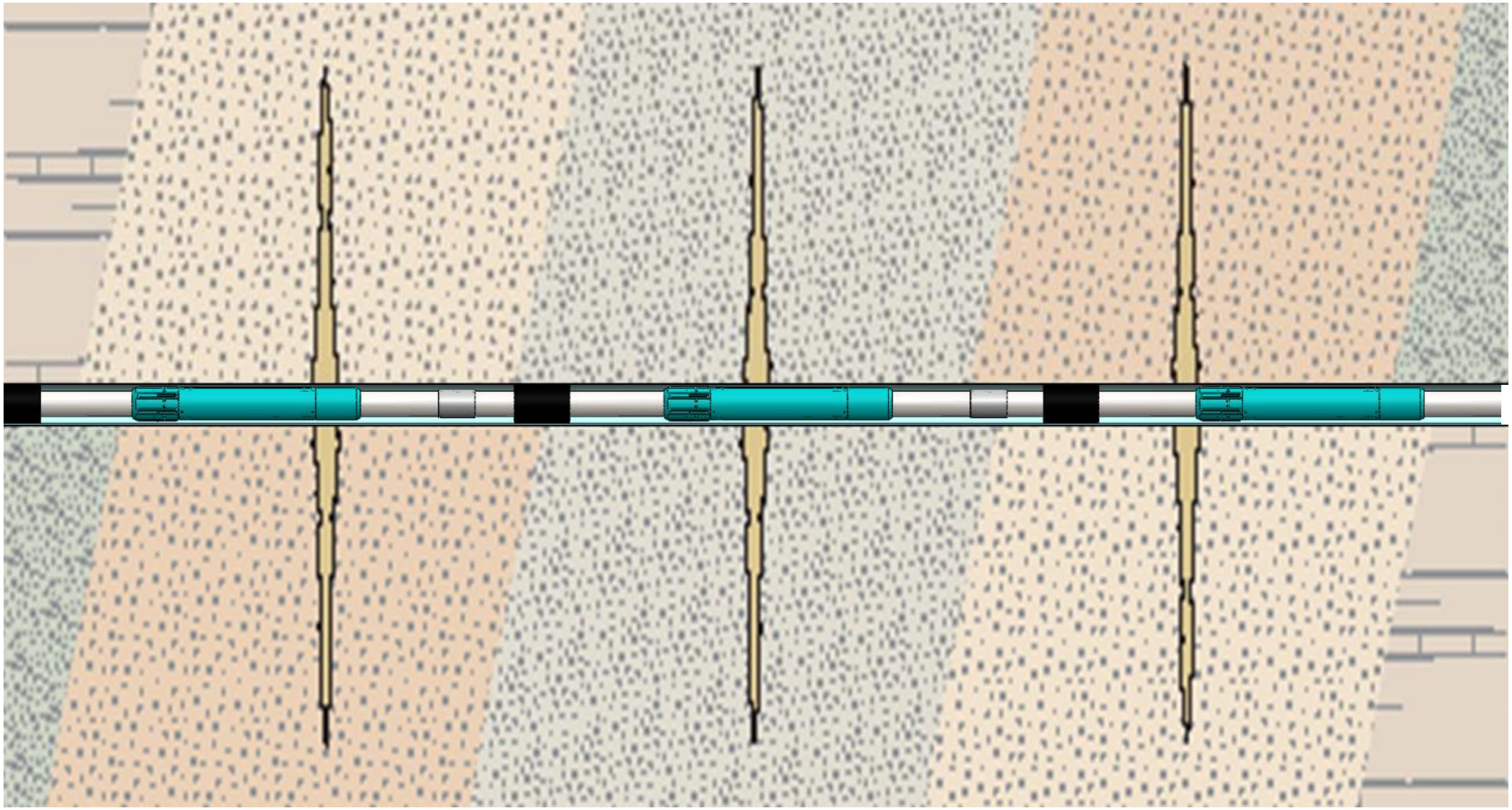
All CT Frac Techniques Work With Cemented Liners or Open Hole Packers



Frac Through Coil - 2010

2010 – Coiled Tubing Straddle Frac Systems

- Cemented Liner most common
- Liner is Pre-perforated after cementing
- Frac through the Coiled Tubing

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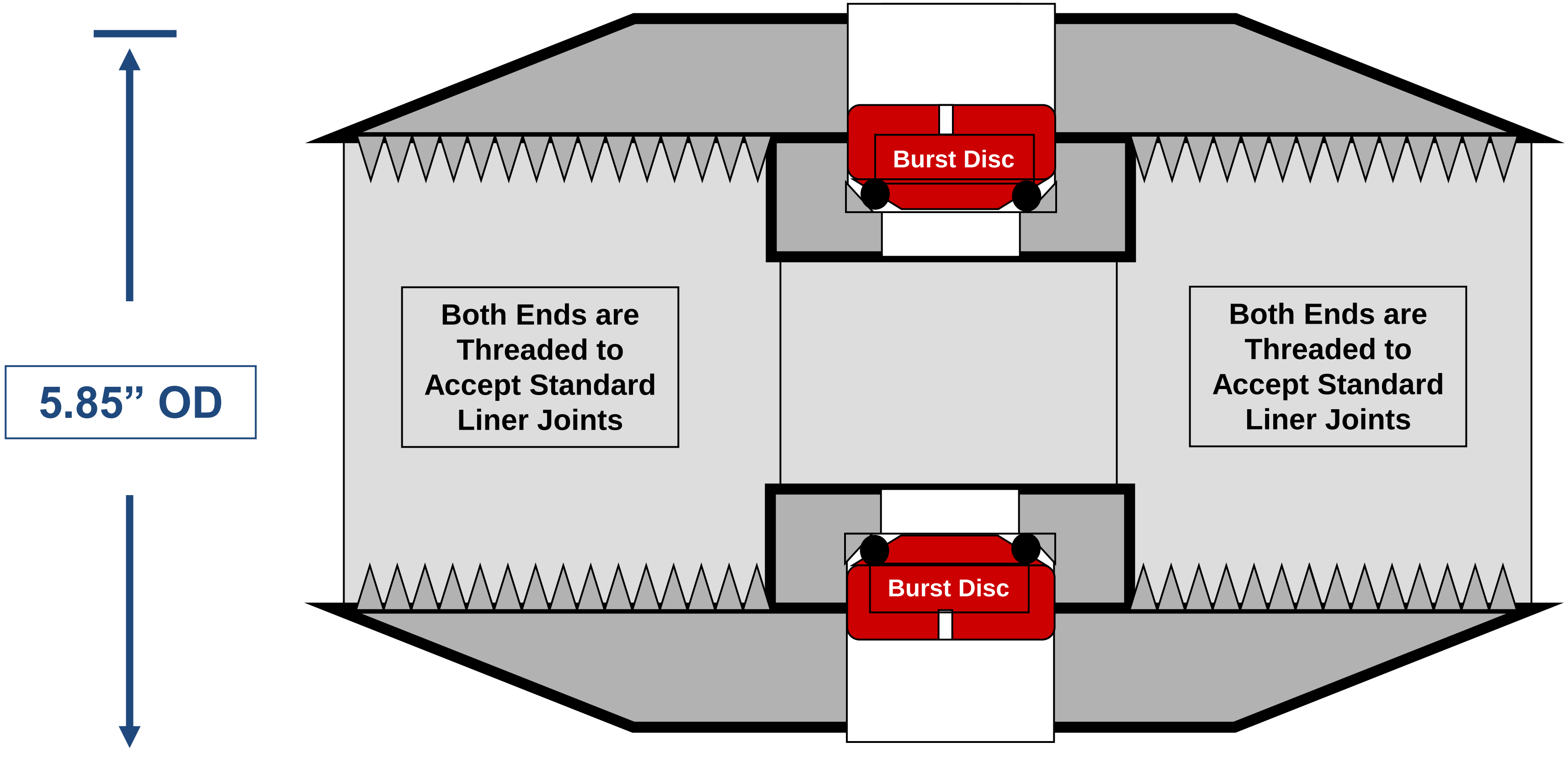
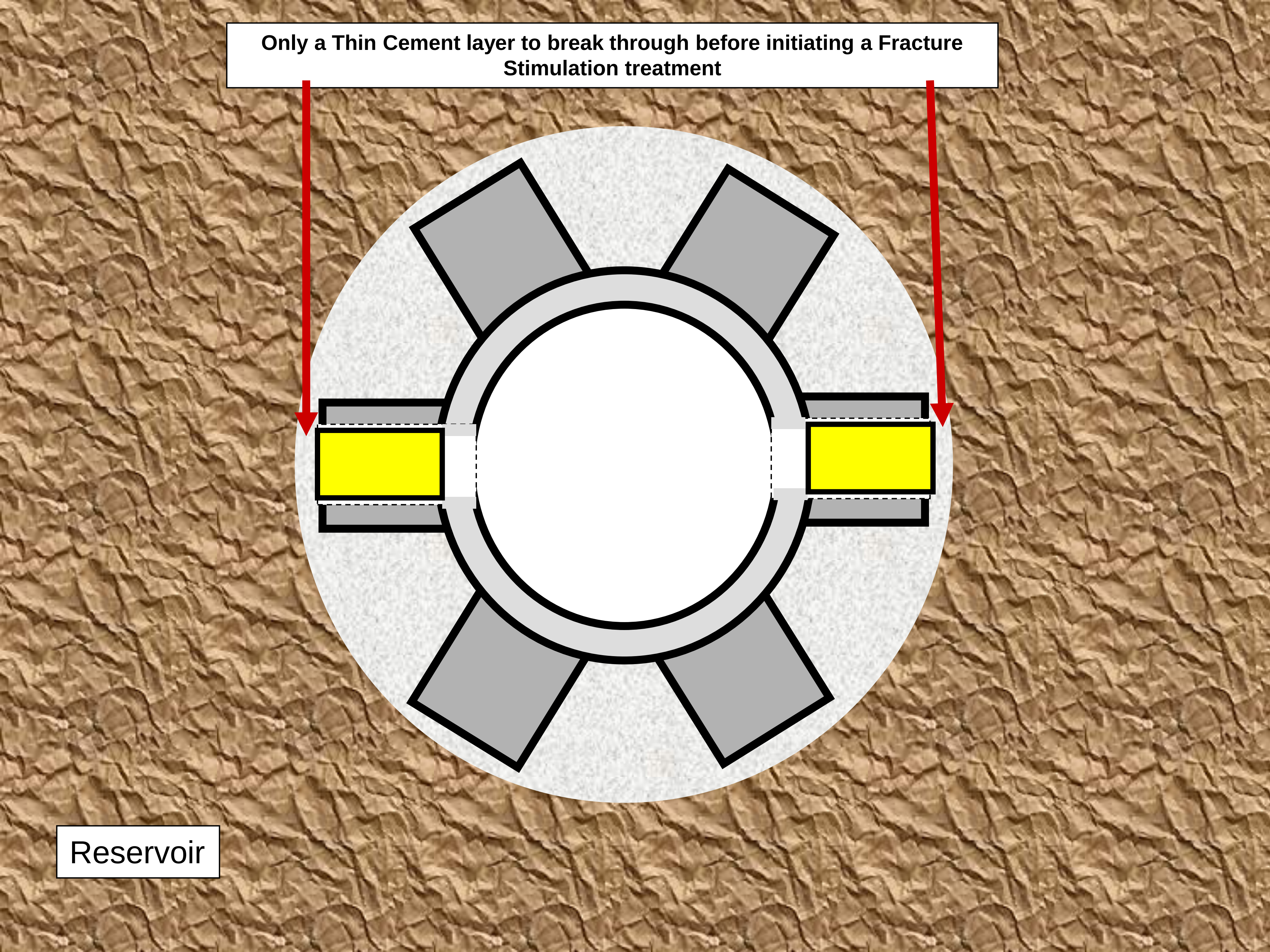
Frac Through Coil - 2011

2011 – Coiled Tubing Straddle Frac Systems

- Issues with Pre-perforated liners during the frac moved most operators to burst type systems
- Burst Type job costs similar to pre-perforating

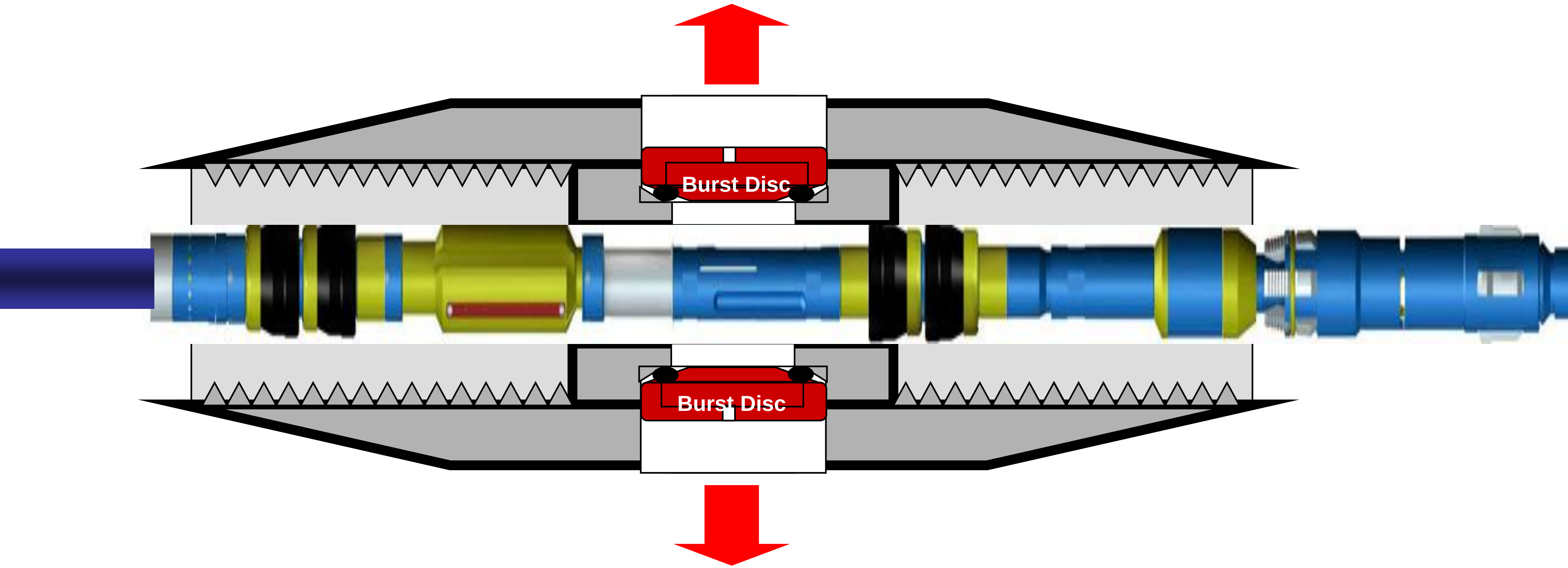
Cutaway - Burst Type Straddle System



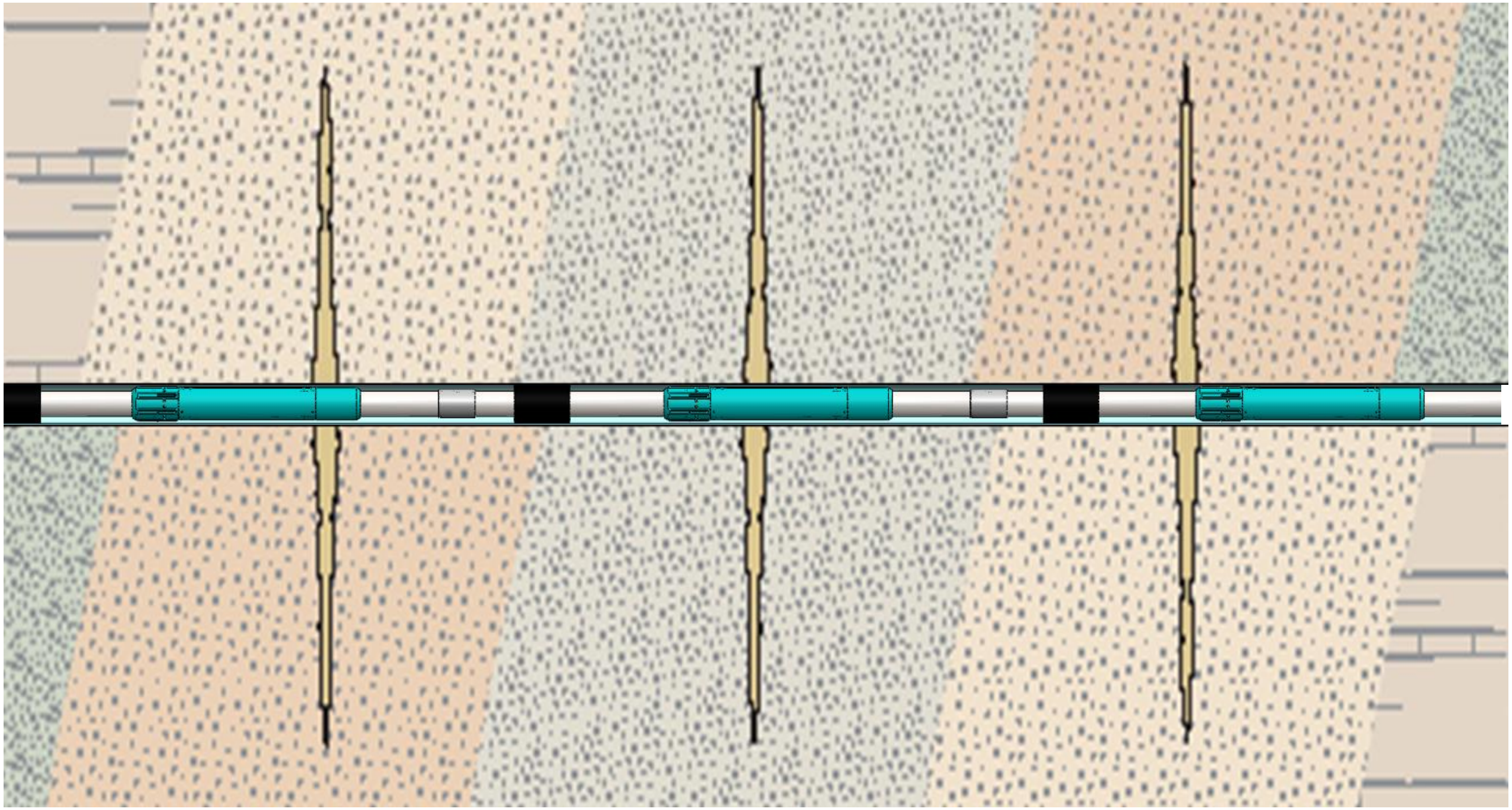


Only a Thin Cement layer to break through before initiating a Fracture Stimulation treatment
Reservoir

Cutaway - Burst Type Straddle System



Burst Type Straddle Systems are Ran by the Drilling Rig – Pick your intervals Quickly



Coiled Tubing Annular Frac - 2010

2010 – Coiled Tubing Annular Frac Systems

- Cemented Liner most common
- Abrasive Perforate through the Coiled Tubing during each frac stage
- Frac down the CT/Casing Annulus

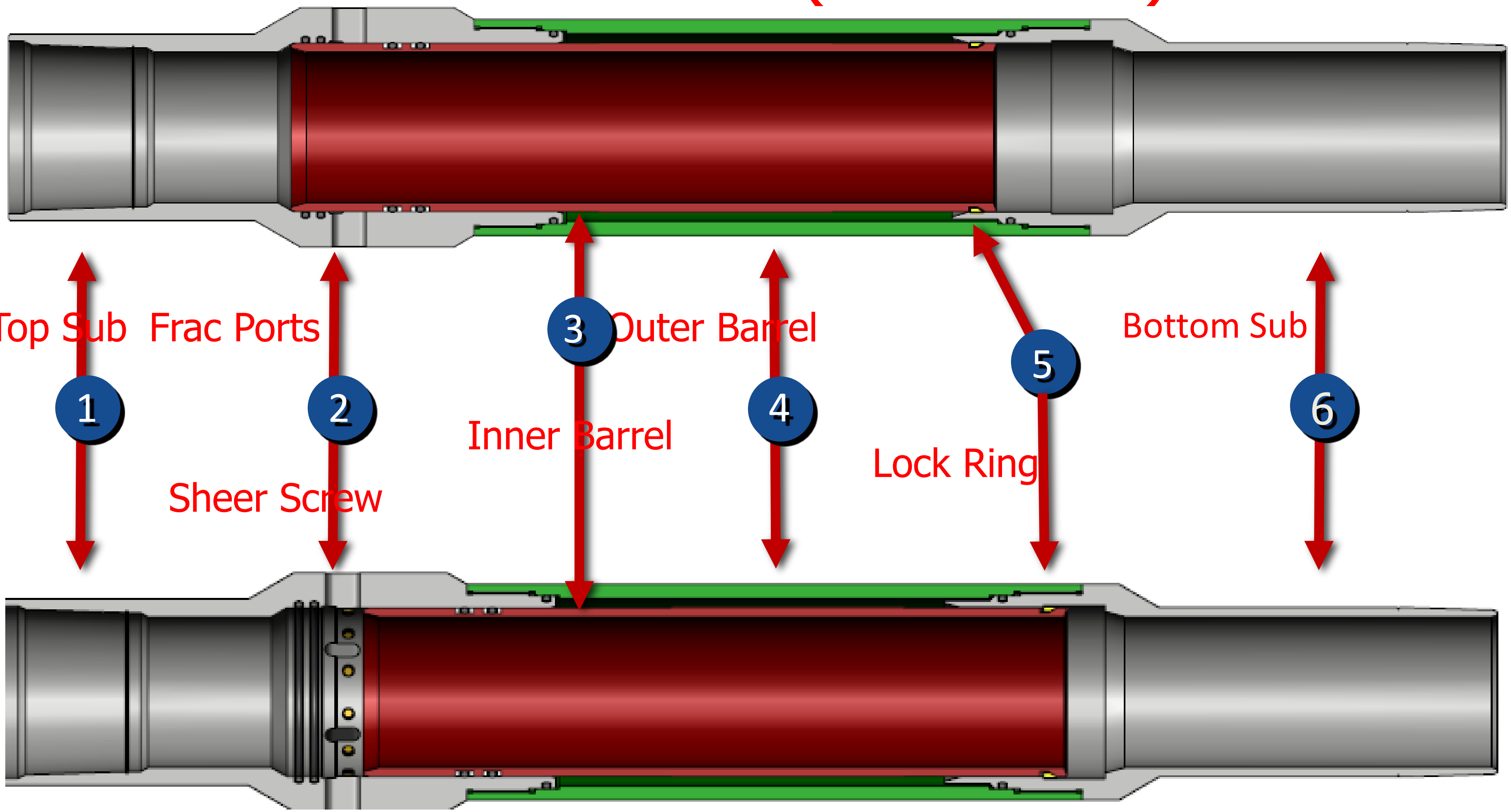
Coiled Tubing Annular Frac - 2011

2011 – Coiled Tubing Annular Frac Systems

- Time and Fluid Issues with Abrasive Perforating moved most Operators to CT Frac Sleeves
- Frac down the CT/Casing Annulus

NCS Unlimited™ CT Frac Sleeve

Closed Position (Red Barrel)



Open Position (Red Barrel)

NCS Unlimited™ Frac Sleeve

Open CT Sleeve with NCS Mongoose Frac® BHA

Fluted Centralizer

Packer

Slips

Equalizing Valve

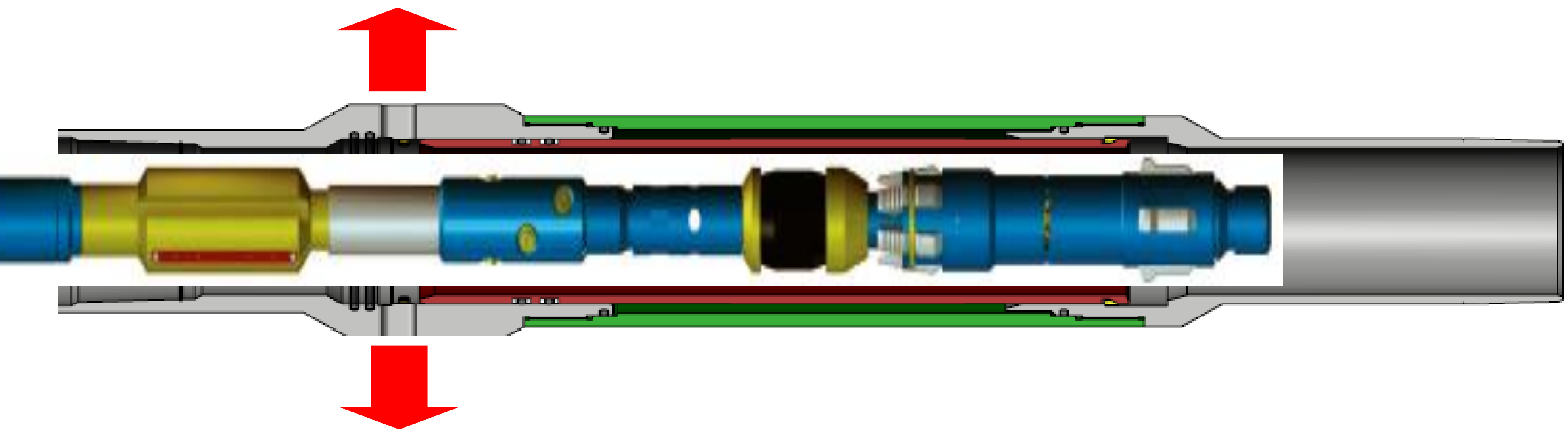
Sand Jet perforator is contingency

Mechanical CCL locates in custom length liner collar

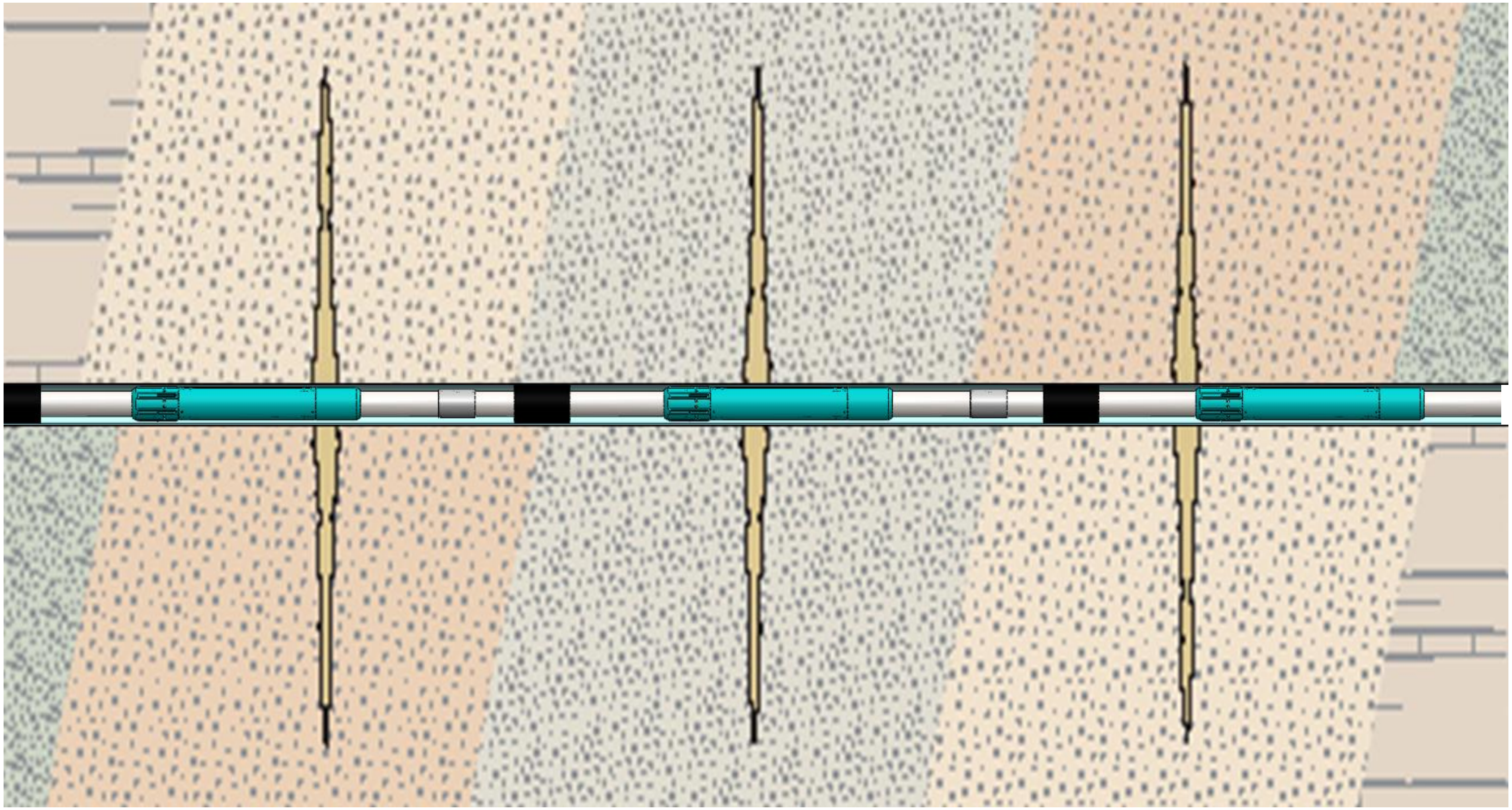
NCS Unlimited™ Frac Sleeve Shifted Open w/Mongoose BHA

Top Sub

Bottom Sub



Annular Frac Systems are Ran by the Drilling Rig – Standardized intervals



Evolution of Frac Techniques

2011 – Coiled Tubing Frac Systems

- Typically 25 - 30 stages
- CT Annular Frac'ing moves to CT Frac Sleeves
- Frac down CT moves to Burst Type Ports
- Coiled Tubing Frac'ing dominates SE Sask & Mb. Approx. – 850 Wells in 2011
- 2011 – Ball Drop Systems in limited use in SE Sask & Mb. Approx. – 100 Wells in 2011

Frac Techniques - 2012

2012 – Coiled Tubing Frac Systems

- NCS Half Straddle CT Frac System "marries" CT Annular Frac'ing and Frac Through CT Techniques
- Combines the best of both systems

- Fluid/Chemical Usage drops dramatically
- Well Completion Costs drop dramatically

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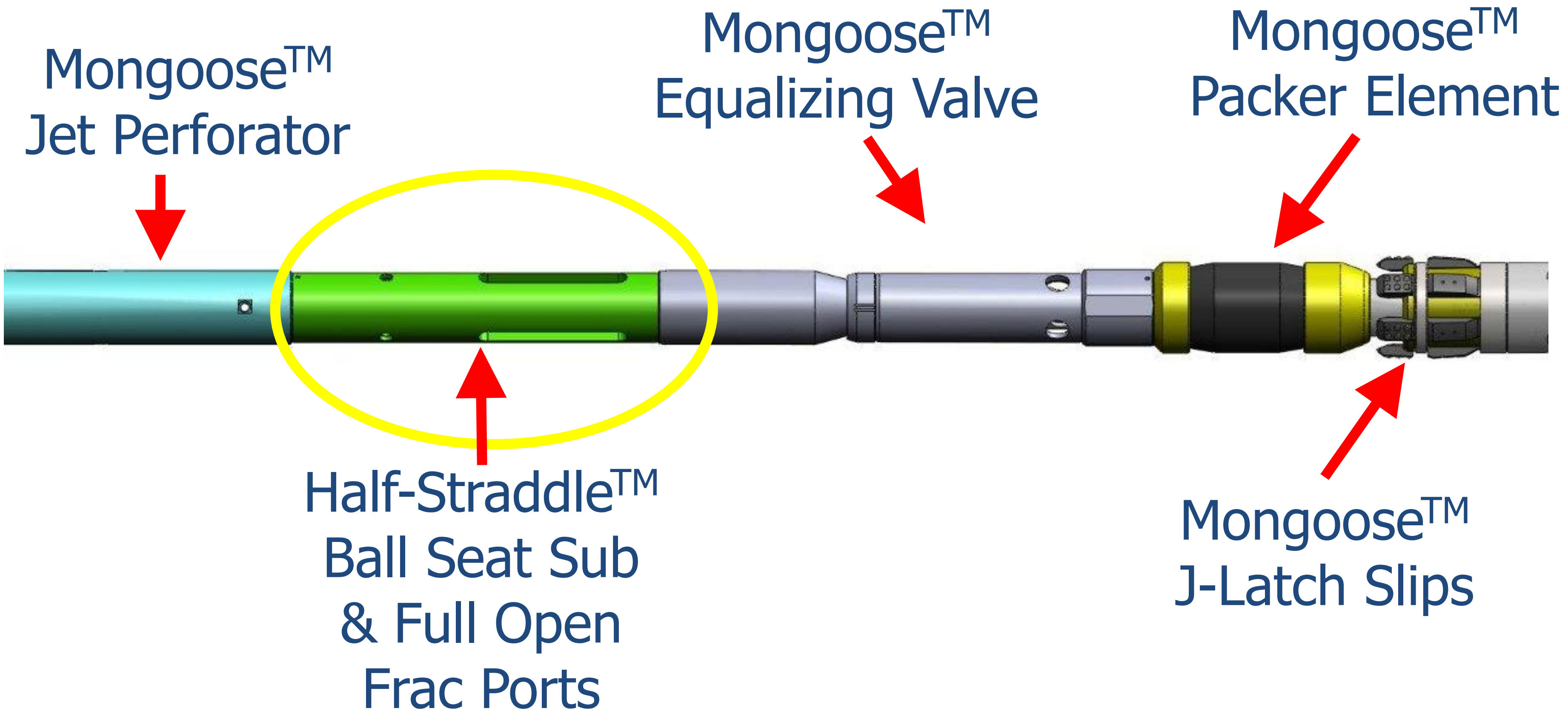
Why "Marry" These Systems ?

To Get Less……

- Less Cost Operations
- Less Fluid Used
- Less Chemicals Used
- Less Frac Height Growth (Reduce WaterCut)
- Less Time on Location
- Less Equipment on Location
- Less Carbon Footprint

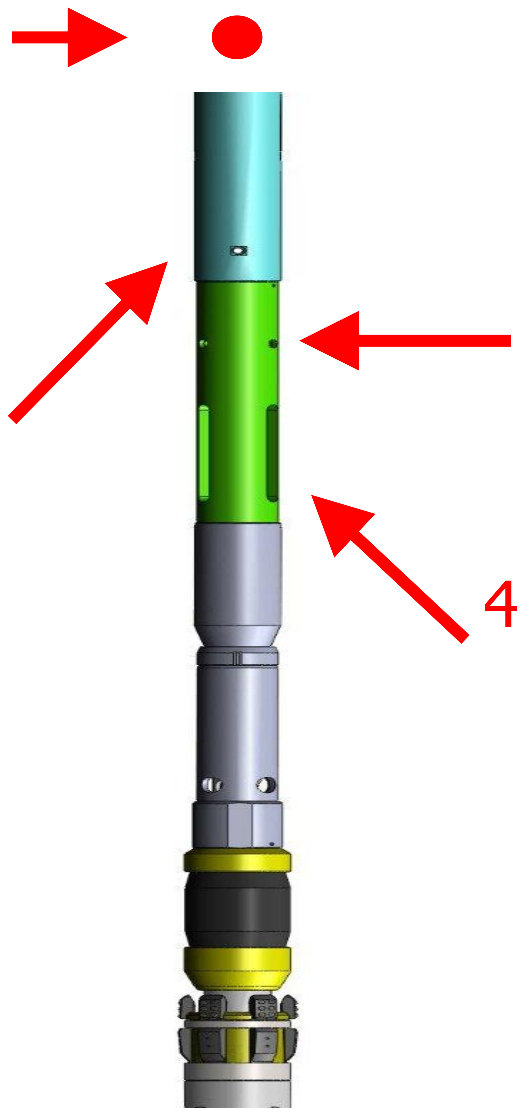
NCS Half-Straddle™ Frac BHA



Same Mongoose Frac® BHA
With <u>One</u> Additional Item

Contingency – Abrasive Cutter

1. Contingency
Land Ball Thru
the Perforator



2. Ball Lands in
Half-Straddle™ Seat

3. Cut With
Jet Sub

4. Ball Shifted Through
Half-Straddle™ Seat,
Pump Frac Down CT

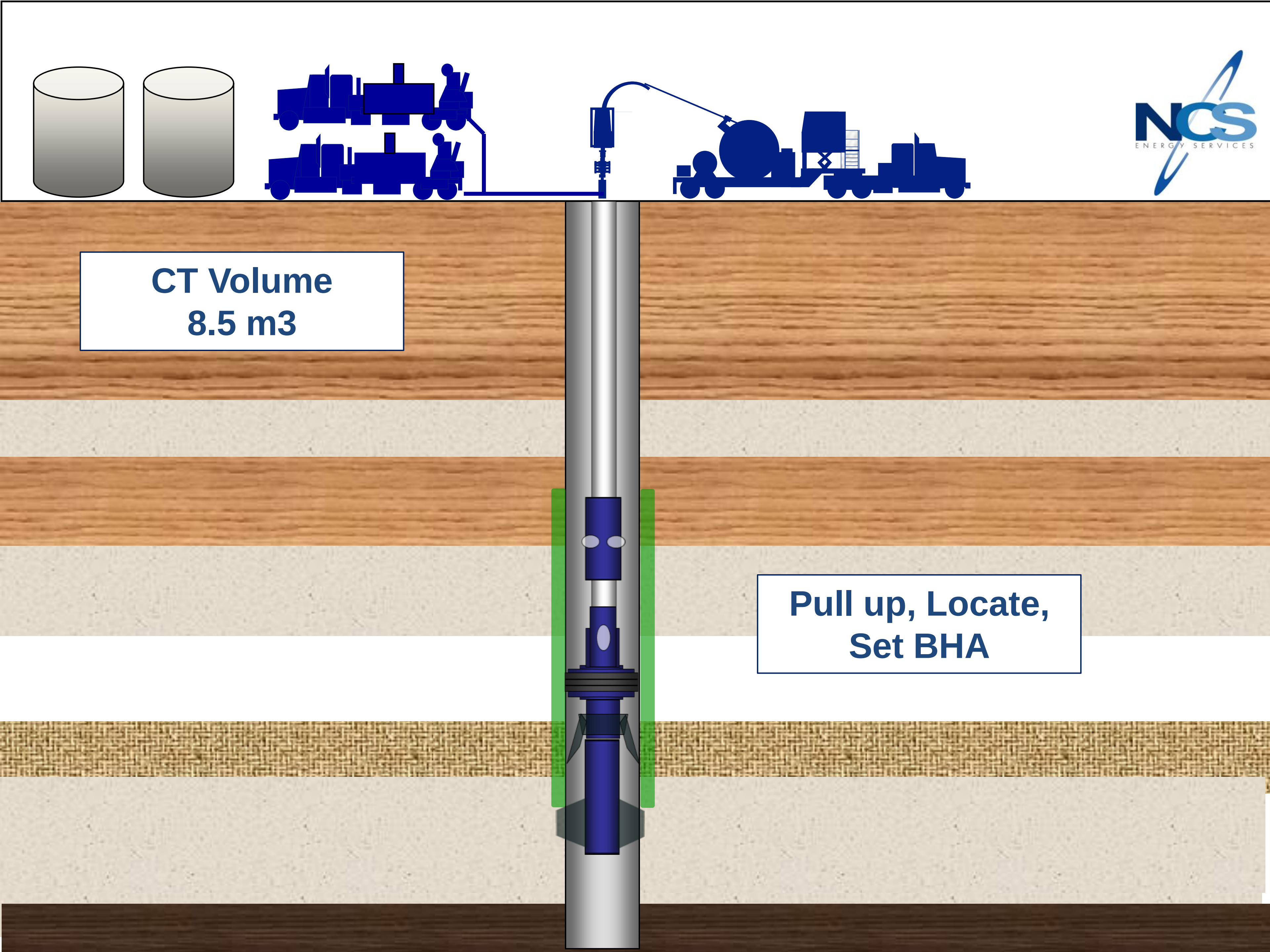
5. Continue
Uphole Shifting
Frac Sleeves

Why Frac Down the Coiled Tubing ?

- Shorter Route - Usually Less Volume
- Quicker Operation – Less Time to Pump a Frac Stage
- Ability to Circulate Sand to Bottom – Save Pad Fluid
- Less Fluid Required Less Chemicals Required
- Less Equipment & Iron Needed on Location

Why Not Previously ?

- Abrasive Cutter was the impediment
- Cup Cup Straddles can be problematic
- Can't circulate sand to perfs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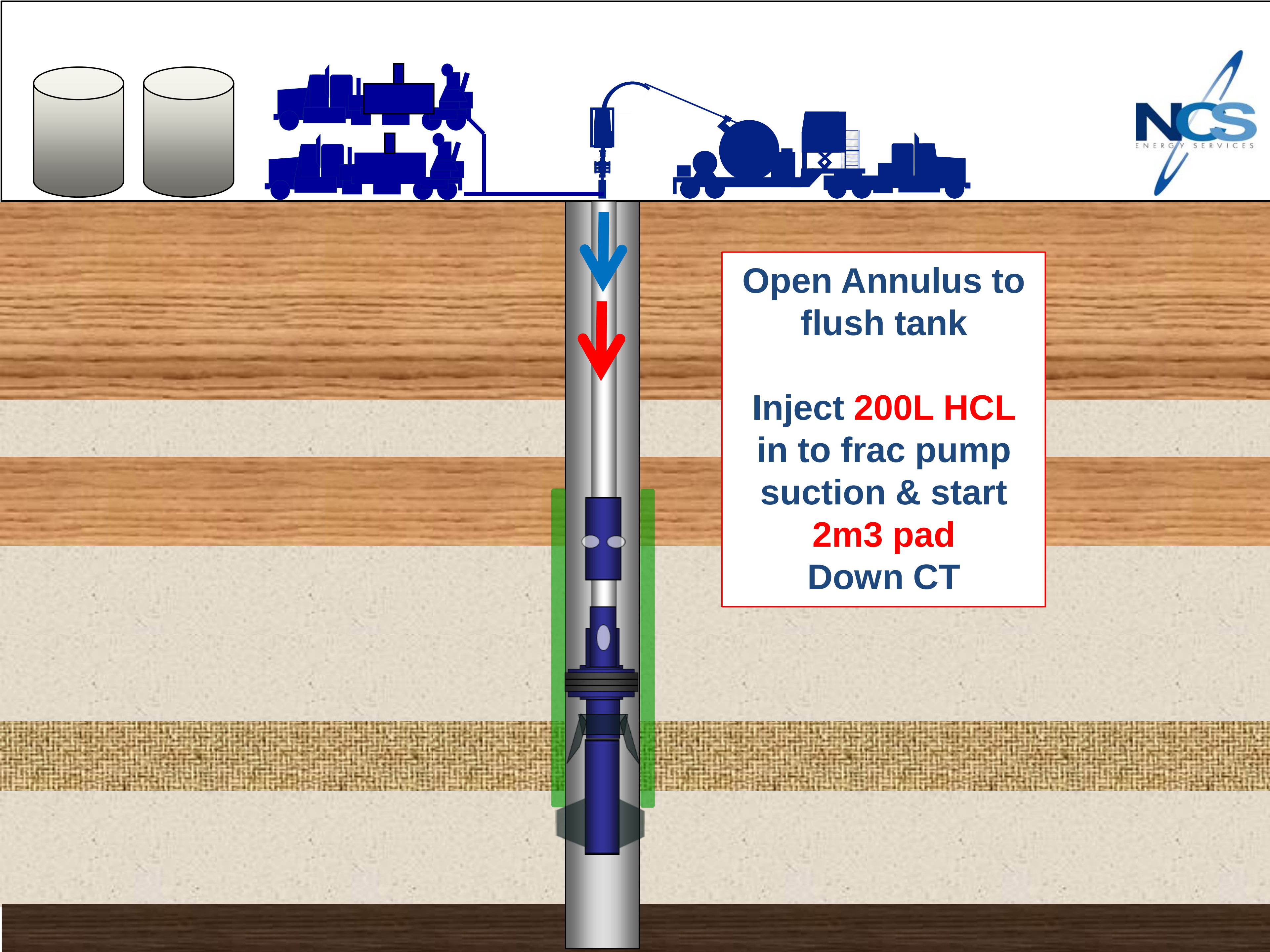
CT Volume
8.5 m3
Pull up, Locate,
Set BHA



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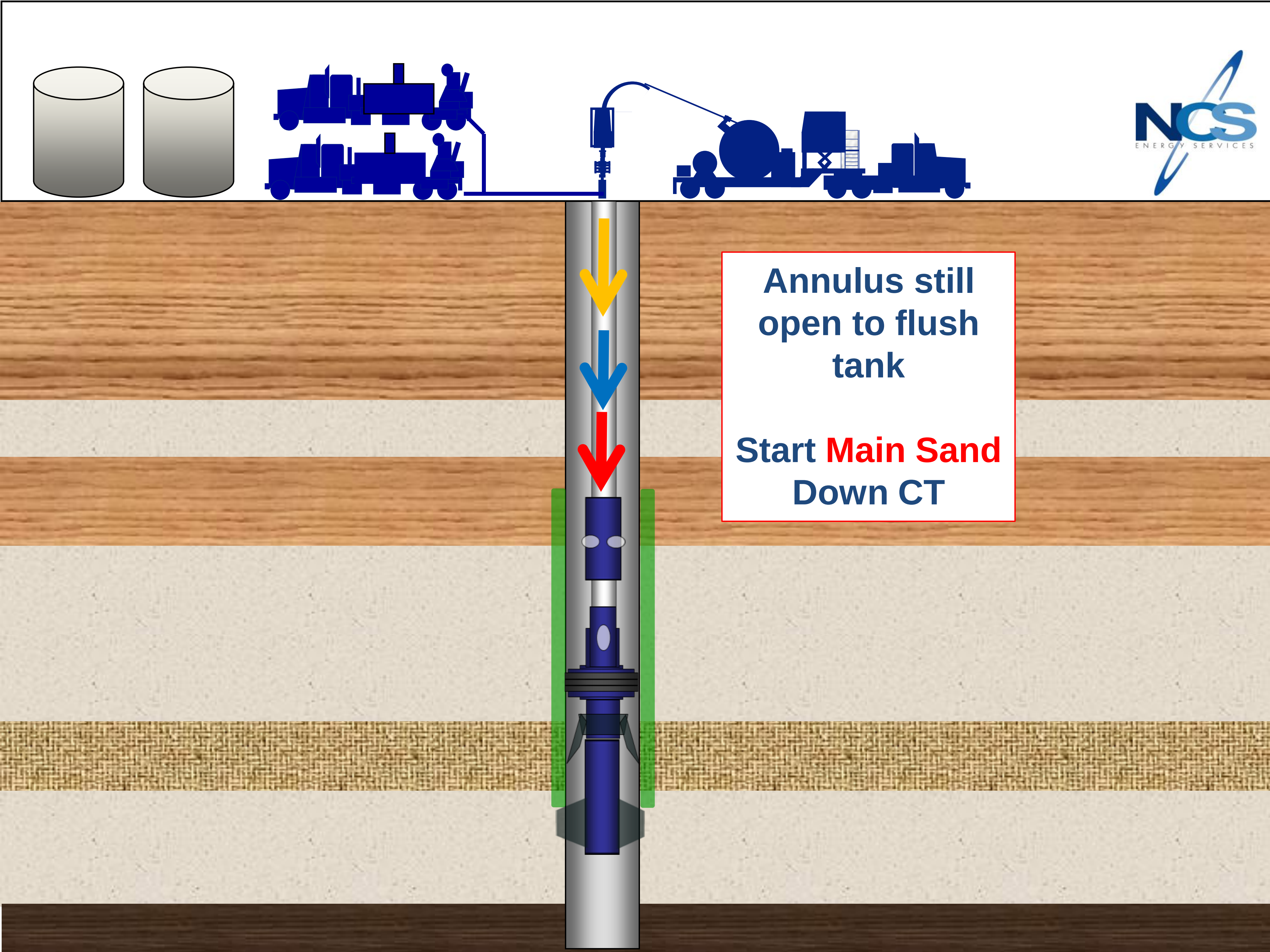
Open Annulus to flush tank
Inject 200L HCL in to frac pump suction & start 2m3 pad Down CT


Annulus still open to flush tank
Start Main Sand Down CT
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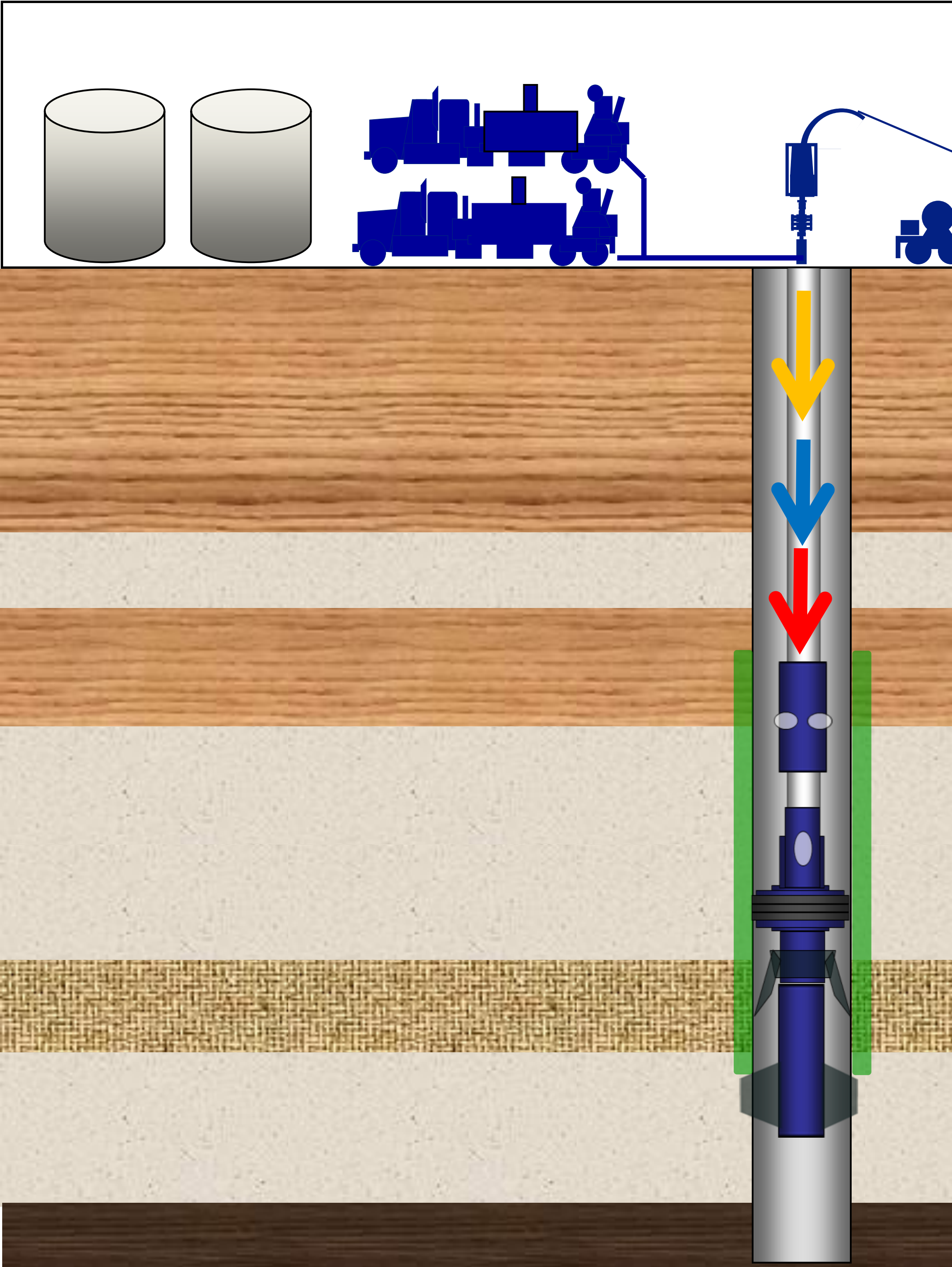

Acid at end of CT

Close Annulus (new deadleg)

Keep pumping down CT

Well pressures up, CT Frac Sleeve opens

Finish sand, flush sand

Shut down pumps

Move BHA uphole

Example Well - Bakken

Well Parameters:

- TVD: +/- 1050m
- MD: +/- 2400m
- Frac rate < 0.9m3/min
- 139.7mm 23.07 kg/m monobore
- 73mm CT 0-2700m CT Vol. = 8.5m3
- 5tonne fracs / stage
- 29 stage job

Flush - Save 190m3 Fluid + 3,5 hrs

Perforations / Openhole

	DSC	Formation	Top (m TVD)	Bottom (m TVD)	Top (m TMD)	Bottom (m TMD)	Comments
1	Jetted Holes	Torquay	1,036.3	1,036.3	2,363.8	2,370.0	4 T Annular Hole vol. = 19.50 m3
2	Frac Port	Torquay	1,036.3	1,036.3	2,326.44	2,327.71	4 T Annular Hole vol. = 19.15 m3
3	Frac Port	Torquay	1,036.3	1,036.3	2,288.97	2,290.24	4 T Annular Hole vol. = 18.89 m3
4	Frac Port	Torquay	1,036.3	1,036.3	2,251.27	2,252.54	4 T Annular Hole vol. = 18.53 m3
5	Frac Port	Torquay	1,036.3	1,036.3	2,214.08	2,215.35	4 T Annular Hole vol. = 18.23 m3
6	Frac Port	Torquay	1,036.3	1,036.3	2,176.3	2,177.57	4 T Annular Hole vol. = 17.92 m3
7	Frac Port	Torquay	1,036.3	1,036.3	2,139.0	2,140.2[illegible]	4 T Annular Hole vol. = 17.61 m3
8	Frac Port	Torquay	1,036.3	1,036.3	2,101.46	2,102.[illegible]3	4 T Annular Hole vol. = 17.30 m3
9	Frac Port	Torquay	1,036.3	1,036.3	2,064.08	2,065.35	4 T Annular Hole vol. = 16.99 m3
10	Frac Port	Torquay	1,036.3	1,036.3	2,026.5	2,02[illegible].77	4 T Annular Hole vol. = 16.68 m3
11	Frac Port	Torquay	1,036.3	1,036.3	1,988.64	1,98[illegible].91	4 T Annular Hole vol. = 16.37 m3
12	Frac Port	Torquay	1,036.3	1,036.3	1,950.74	1,95[illegible].01	4 T Annular Hole vol. = 16.06 m3
13	Frac Port	Torquay	1,036.3	1,036.3	1,913.28	1,9[illegible]4.55	4 T Annular Hole vol. = 15.75 m3
14	Frac Port	Torquay	1,036.3	1,036.3	1,875.69	1,8[illegible]6.96	4 T Annular Hole vol. = 15.44 m3
15	Frac Port	Torquay	1,036.3	1,036.3	1,837.99	1,8[illegible]9.26	4 T Annular Hole vol. = 15.13 m3
16	Frac Port	Torquay	1,036.3	1,036.3	1,800.48	1,8[illegible].75	4 T Annular Hole vol. = 14.82 m3
17	Frac Port	Torquay	1,036.3	1,036.3	1,763.12	1,76[illegible].39	4 T Annular Hole vol. = 14.52 m3
18	Frac Port	Torquay	1,036.3	1,036.3	1,725.49	1,72[illegible].76	4 T Annular Hole vol. = 14.21 m3
19	Frac Port	Torquay	1,036.3	1,036.3	1,687.73	1,68[illegible].0	4 T Annular Hole vol. = 13.90 m3
20	Frac Port	Torquay	1,036.3	1,036.3	1,650.06	1,651.33	4 T Annular Hole vol. = 13.59 m3
21	Frac Port	Torquay	1,036.3	1,036.3	1,600.8	1,602.[illegible]7	4 T Annular Hole vol. = 13.18 m3
22	Frac Port	Torquay	1,036.3	1,036.3	1,551.58	1,552.8[illegible]	4 T Annular Hole vol. = 12.78 m3
23	Frac Port	Torquay	1,036.3	1,036.3	1,502.17	1,503.44	4 T Annular Hole vol. = 12.37 m3
24	Frac Port	Torquay	1,036.3	1,036.3	1,453.11	1,454.38	4 T Annular Hole vol. = 12.57 m3
25	Frac Port	Torquay	1,036.3	1,036.3	1,404.24	1,405.51	4 T Annular Hole vol. = 11.95 m3
26	Frac Port	Torquay	1,036.3	1,036.3	1,355.57	1,356.84	4 T Annular Hole vol. = 11.56 m3
27	Frac Port	Torquay	1,036.3	1,036.3	1,306.36	1,307.63	4 T Annular Hole vol. = 11.16 m3
28	Frac Port	Torquay	1,036.3	1,036.3	1,257.3	1,258.57	4 T Annular Hole vol. = 10.76 m3
29	Frac Port	Torquay	1,036.3	1,036.3	1,208.19	1,209.46	4 T Annular Hole vol. = 10.35 m3

29 Stages of Flush Down the Annulus = **437**m3

29 Stages of Flush Down the CT = **247**m3

Save $16,900 of Chemicals

Fluid System 3

System Name	Temp (℃)	SG	Program Volume (m³)		Total Volume Required (m³)	Comments
Linear Gelled Water	20.0	1.00	498.88		498.88	Flush

Fluids (System 3)

Fluid Name	Percent of Fluid Blend (%)	SG	Program Volume (m³)		Total Volume Required (m³)	Tank Group Assignment	Comments
Water	100.0%	1.00	498.88		498.88	1	

Additives (System 3)

AdditiveName	Concentration	Units	Program Amoun[t]	Liters Saved	Money Saved	Total Amount Required	Addition Type	Comments
Gellant	2.00	L / m³	997.[illegible]6	400	$4,500	[illegible]97.8	On-The-Fly (Suction)	Add 200L for third pary truck
PH Buffer	2.00	L / m³	997[illegible]76	400	$1,800	[illegible]97.8	On-The-Fly (Suction)	
Clay Stabilizer	3.00	L / m³	1,49[illegible]64	600	$6,750	[illegible],496.8	On-The-Fly (Discharge)	
Breaker	1.00	L / m³	498.8[illegible]	300	$1,160	498.8	On-The-Fly (Discharge)	Confirm with Lab prior to treatment
Demulsifier	1.00	L / m³	498.88	300	$2,700	498.8	On-The-Fly (Discharge)	

Table B Above - $16,900 saved in chemical reduction of 190m3 less fluid

Save 3.5 hrs Pump Time

- Flush Pump Rate = 0.9m3/min
- Time saved by Flushing 190m3 less fluid
- 210 minutes or 3.5 hrs

Plus

- Reduce Frac height growth – less fluid ahead of the frac helps stay away from water in thin formations
- Reduction in water cuts – why push 19m3 of water ahead of each frac stage ?
- Less frac fluid to recover

Circulate Fracs to Bottom

Reduce pads to +/- 2m3

- Volume 2m3 Pad save 6.5m3/stage x 29 stages = 189m3 of fluid
- "No Pad" fracturing works !

Save Another $16,000 of Chemicals

Fluid System 3

System Name	Temp (℃)	SG	Program Volume (m³)		Total Volume Required (m³)	Comments
Linear Gelled Water	20.0	1.00	498.88		498.88	Flush

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Breaker	1.00	L / m³	498.8[illegible]	300	$1,160	498.9	On-The-Fly (Discharge)	Confirm with Lab prior to treatment
Demulsifier	1.00	L / m³	498.88	300	$2,700	498.9	On-The-Fly (Discharge)	

Table C Above - $16,000 saved in chemical reduction of 189m3 less fluid

Circulate Fracs to Bottom

Benefits

- Reduce Frac height growth – stay away from water in thin formations
- Less frac fluid to recoverReduction in water cuts – why push 6.5m3 of water ahead of each frac stage ?

- Check back in 6 months for water cut numbers !

Sand Schedule/stage

Event	Stage Volume m3	Density Start kg/m3	Density End kg/m3	Stage tonne
Pad	2.0	-	-	-
Proppant stage #1	3.7	100	330	0.8
Proppant stage #2	3.7	330	570	1.67
Proppant stage #3	3.7	570	800	2.53
Flush (average)	-	-	-	-
Total / stage	13.1 m3	-	-	5.0t

Fluid Summary - 29 Stage Frac

Technique	Stage Volume m3	Fluid x 29 Stages m3	Sand x 29 Stages tonnes
CT Annular Frac	28.1 (average)	815.0	159.5
CT Annular Frac w/ Frac Sleeves	21.6	626.0	145
Straddle System	19.1	554.0	145
Circulate Sand to Sleeves (NCS Half Straddle System)	13.1	380.0	145

In less than 2 years we've reduced water usage by 53%

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NCS Half Straddle™ - Benefits

- Reduce Frac height growth – Stay Away from Water
- Ability to "Turn On/Off" Abrasive Cutter contingency
- Less frac fluid to recover
- Easiest recovery from a screen-out
- Controlled process – every stage is identical steps & volumes

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Savings/Game Changers After +/- 60 Half Straddle wells

- Frac Ticket reduced by 36%
- Water in Formation reduced by 34%
- Frac Chemicals reduced by 35%
- Frac Time reduced by 30%
- Total Frac & Complete AFE reduced by 25%
- Excess Frac Height growth reduced by ?
- Check back in 6 months for revised water cuts !

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Frac Costs – 20 Well Comparison

NCS Mongoose w/Sleeves					
Stages /Well	Tonnage /Stage	Frac Ticket /Well	Frac Ticket /Tonne	Frac Ticket /Stage	Fluid Used M3/Well
24	4.25	251,000	2,461	10,458	656
23	4	217,000	2,296	9,435	623
25	4	278,000	2,808	11,120	774
24	3.75	211,000	2,322	8,805	850
22	3.5	197,500	2,531	8,975	719
24	4.5	270,000	2,548	11,253	686
	Average: 4	Average: $237,500	Average: $2,494	Average: $10,007	Average: 718m3
Burst Type 6 wells	4	$207,500	$2,210	$8,704	634m3
NCS Mongoose w/Sleeves – Half Straddle System					
22	3.75	158,500	1,887	7,205	445
25	4.25	175,000	1,667	7,000	595
19	4.25	161,000	1,988	8,474	462
24	4.25	170,000	1,700	7,083	470
22	4	165,000	1,875	7,500	361
13	4	100,870	1,940	7,759	315
23	3.6	143,000	1,723	6,217	467
24	4.9	164,642	1,395	6,860	682
22	3.8	126,276	1,503	5,740	505
	Average: 4	Average: $151, 600	Average: $1,742	Average: $7,093	Average: 478m3
Actual Savings - Half Straddle Compared to Mongoose w/CT Frac Sleeves					
Savings	-	$85,900/well	$752/tonne	$2,914/stage	240m3/well

NCS Half Straddle – 500 wells/year

Frac Ticket Cost Reduction
- 500 wells x $85k/well = $42,500,000 year

Water Cut Reduction
- 500 wells x 5bbls/day Oil increase
- 500wells x 5bbl/day/well x $85/bbl = $77,562,500 year

Fluid Savings
- 500 wells x 240m3/well = 120,000m3
- Enough water for 251 wells
- 4,000 Less Tractor Trailer Trips Hauling Water

Frac Techniques Going Forward

Coiled Tubing Frac Systems

- Half Straddle CT Frac System should become the "Standard" for most of the SE Sask & Mb plays

Frac Spacing

- Expect to see closer frac spacing – Already some operators are at 30m. Watch for 20m

Sand Tonnage per Stage

- Expect to see this drop as low as 2tonne per stage

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Thanks to the Following

- Canadian Society for Unconventional Resources
- Curtis Swain - Crescent Point Energy Corp.
- Craig Lane - Tundra Oil and Gas
- Sean Meehan – PennWest Energy
- Ralph Claussner - Questerre Energy Corp.
- NCS Oilfield Services

Questions ?