Digital, Data Analytics, and Automation: Value Creation Through Digital E&P

19-20 NOVEMBER 2024| BANGKOK, THAILAND

Complex Risk Assessment of Offset Wells using Cognitive Knowledge-based A.I.

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AUI Systems

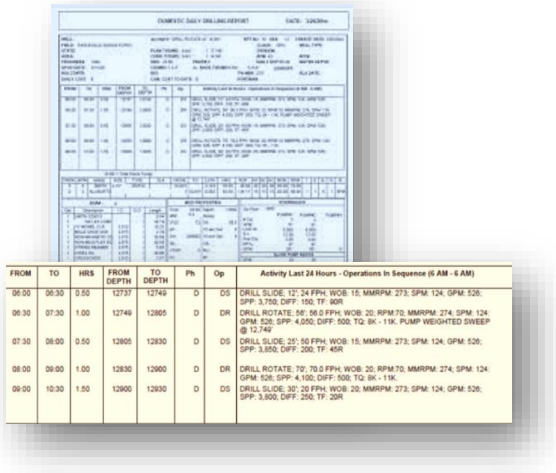
Accurate Information Assists Drilling Workflows

EDR

Electronic Drilling Recorder

- High Frequency Data
- Time Series
- Captured by Sensors
- High Volume, 1 Hz

DDR



Daily Drilling Reports

- Low Frequency Data
- Unstructured, Text
- Activity description
- Low Volume, Complex

- Data Quality Assurance
- Offset Well Analysis
- Performance Benchmarks
- Well Decommissioning
- Commercial Bids
- Data Science / Predictive
- GenAI – Q&A

Risk/Hazard Analysis of Offset Wells is Critical

- Study and understand past issues in nearby/offset wells to perform risk analysis and optimize design for a new well.
- Extend analysis to data from current campaign / well
- Transfer lessons learned and manage risk for the new well
- Relevant information contained in DDRs, End of Well Reports and other unstructured reports – tedious to analyze

Example: Daily Drilling Reports

Operations

Start time	End time	End Depth mMD	Main - Sub Activity	State	Remark
00:00	01:30	3881	formation evaluation -- cor e	ok	CONTINUED CORING FROM 3858 - 3881M. TOTAL CUT 27M.
01:30	02:00	3852	formation evaluation -- trip	ok	FLOW CHECKED, OK. LAID DOWN SPACER PUP JT. PUMP SLUG.
02:00	06:00	780	formation evaluation -- trip	ok	POOH. FLOW CHECKED INSIDE CSG WINDOW, OK. CURRENT DEPTH AT REPORT TIME, 780M.
06:00	09:00	0	formation evaluation -- trip	ok	CONTINUED POOH WITH CORE NO 2. REDUCED SPEED LAST 400M. HELD SAFETY BRIEF BEFORE PULL CORE BARREL TO DRILL FLOOR. HAD 20 PPM H 2S IN COREBARREL. PERSONNEL PUT ON PROTECTION EQUIPMENT BEFORE START LAYING DOWN CORE.
09:00	10:30	0	formation evaluation -- trip	ok	RETRIVED CORE NO 2, 100 % RECOVERY. MAX 5 PPM H2S WHEN RETRIVING CORE.
10:30	12:30	0	formation evaluation -- trip	ok	M/UP COREBARREL AND COREHEAD. SERVICED COREBARREL.
12:30	15:30	2160	formation evaluation -- trip	ok	RIH TO CSG WINDOW AT 2161M. BREAK CIRC EACH 1000 M.
15:30	16:00	2160	formation evaluation -- wai t	ok	HELD SAFETY MEETING WITH ALL PERSONNEL WITH H2S GAS, GAS PROCEDYRES AND CONTINGENCIES.
16:00	18:30	3876	formation evaluation -- trip	ok	CONTINUED RIH TO 3876M.
18:30	20:30	3876	formation evaluation -- circ ulating conditioning	ok	CIRC BTM'S UP IN ORDER TO CLEAN WELL FOR GAS. MAX PEAK FROM PREVIOUS CORING; 15,2 %. CIRC GAS LEVEL DOWN TO 0,9 %.
20:30	21:00	3881	formation evaluation -- trip	ok	ROTATE AND WASH TO BTM AT 3881,5M. SPACED OUT STRING.
21:00	21:30	3881	formation evaluation -- circ ulating conditioning	ok	DROP BALL AND SEATED SAME IN COREBARREL WITH 17 BAR PRESS INCREASE. TAKE SCR'S.
21:30	23:00	3908	formation evaluation -- cor e	ok	CUT CORE NO 3 FROM 3881,5 TO 3908,5M.
23:00	23:30	3820	formation evaluation -- trip	ok	PUMP OUT OF HOLE TO 3820M. HAD 45 T OVER PULL AT CONNECTION AT 3880M. ROTATE STRING AND HAD NO EXCESSIVE TORQUE TO BREAK ROTATI ON, NORMAL PUMP PRESSURES INDICATING GEOMETRICAL OBSTRUCTION.
23:30	00:00	3820	formation evaluation -- circ ulating conditioning	ok	CIRC TO CLEAN OUT CORING GAS.

Data source: Volve Field, publicly available DDRs from Equinor

Example: Granular Processes in Drilling & Completion

Drilling	Casing	Tripping	Testing
Drill Cement	Cut casing	POOH OH pumping	Function test diverter / BOP
Drill ahead rotary	POOH casing cutters	POOH logging tools	Pressure Test
Drill ahead sliding	RIH casing in casing	POOH OH back reaming	Shallow test MWD/LWD
Drill Shoe Track	RIH casing in open hole	RIH wash ream	FIT / LOT
Drilling with Casing	RIH spear	Run/Pull wear bushing	Bump plug & pressure test casing

Contextual Risks and Hazards are encountered

Tight Spot

Stuck Pipe

Lost Circulation

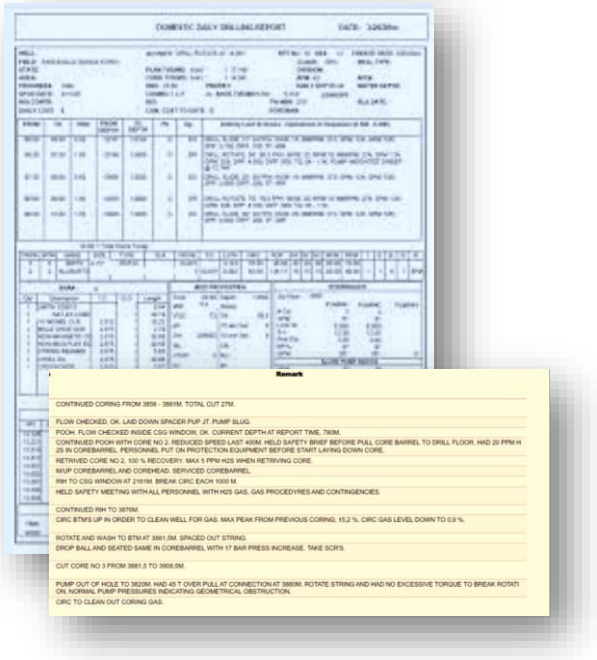
Pack off

Fishing

Repair

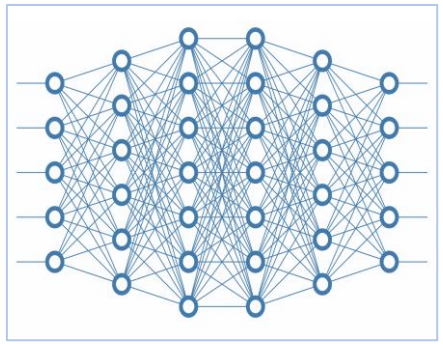
Waiting on..

It's Challenging for Machines to Unlock Unstructured Information



Daily Drilling Reports
End of Well Reports
Other Unstructured Info

Current Machine Understanding Approaches



AI/ML
NLP
LLM

- Accuracy
- Granularity
- Explainability
- Scale
- Compute Footprint

A Knowledge-Based, Cognitive System Proves Capable

Operations

Start time	End time	Remark
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01:30	02:00	FLOW CHECKED, OK. LAID DOWN SPACER PUP JT. PUMP SLUG.
02:00	06:00	POOH. FLOW CHECKED INSIDE CSG WINDOW, OK. CURRENT DEPTH AT REPORT TIME, 780M.
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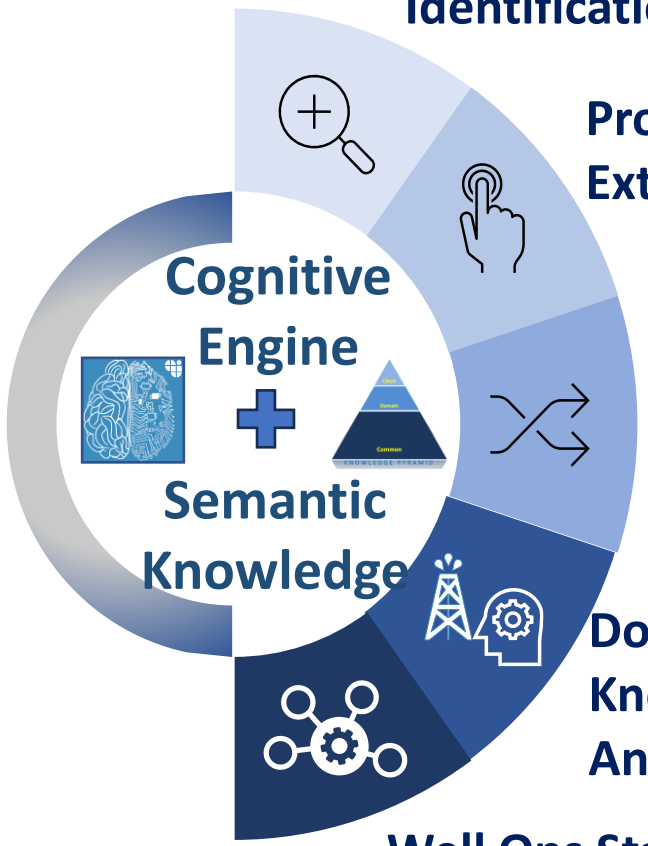
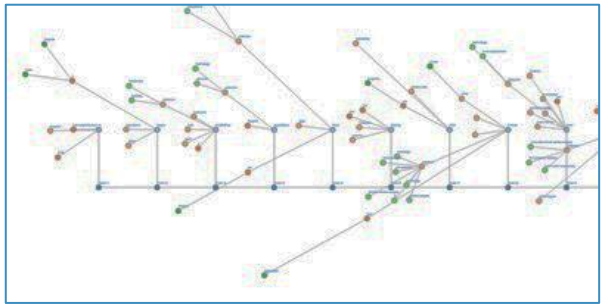
23:30	00:00	CIRC TO CLEAN OUT CORING GAS.

Textual Activity Description With Timestamp



Semantic Structured Output



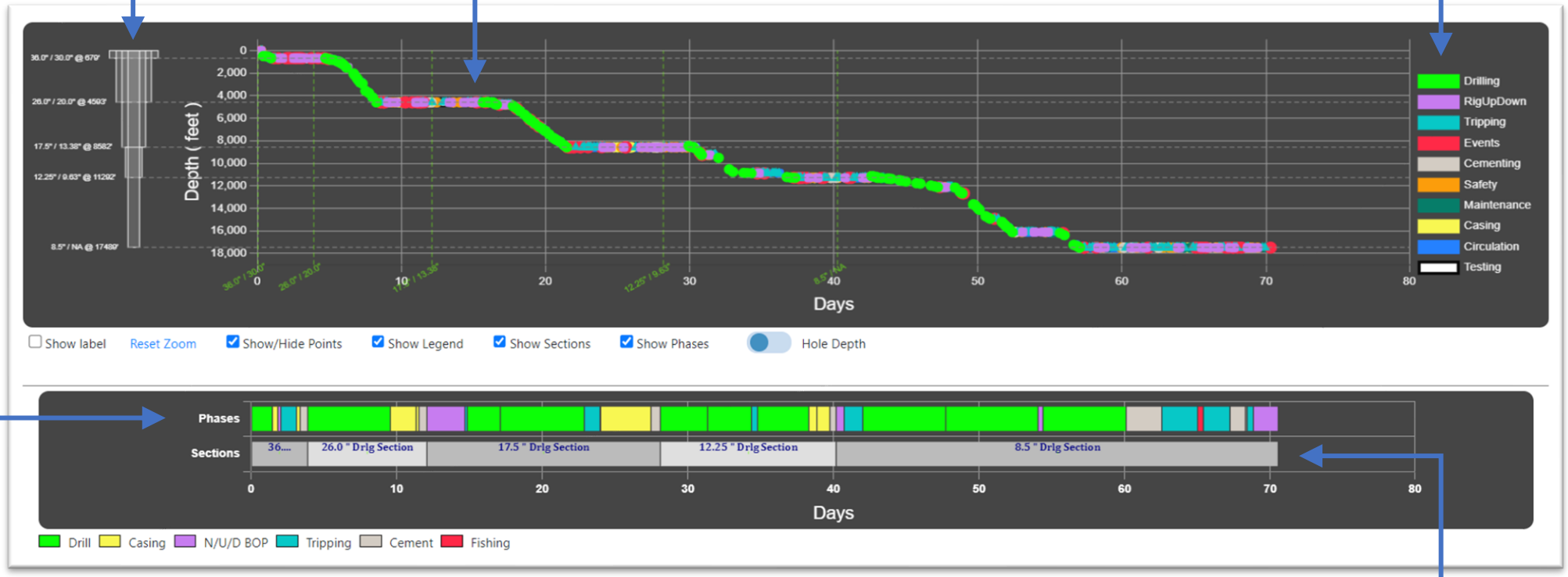
- Ops Code Classification
- NPT / Event Details
- Extract Drilling Parameters
- Activity-Sequence Analysis
- Phase, Section Analysis
- Hazard/Risk Analysis

Automated Outputs from Cognitive System

Casing Diagram

Interactive DvD Curve

Operational Grouping

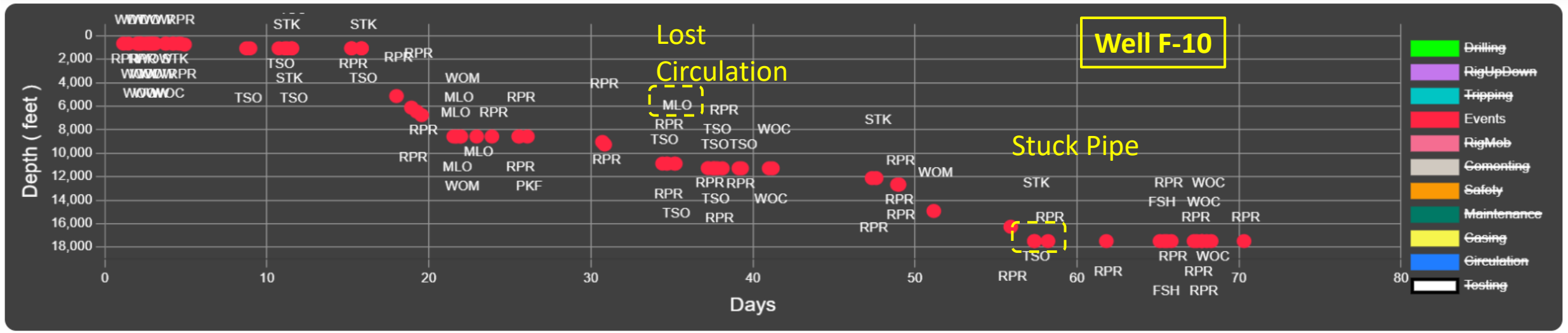


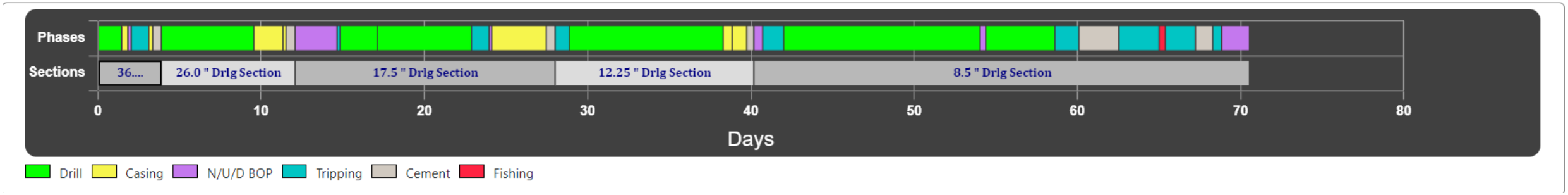
Phase Identification

~150 Operations (Drilling, Completions)
10+ NPT types, 10+ Drilling Parameters

Section Identification

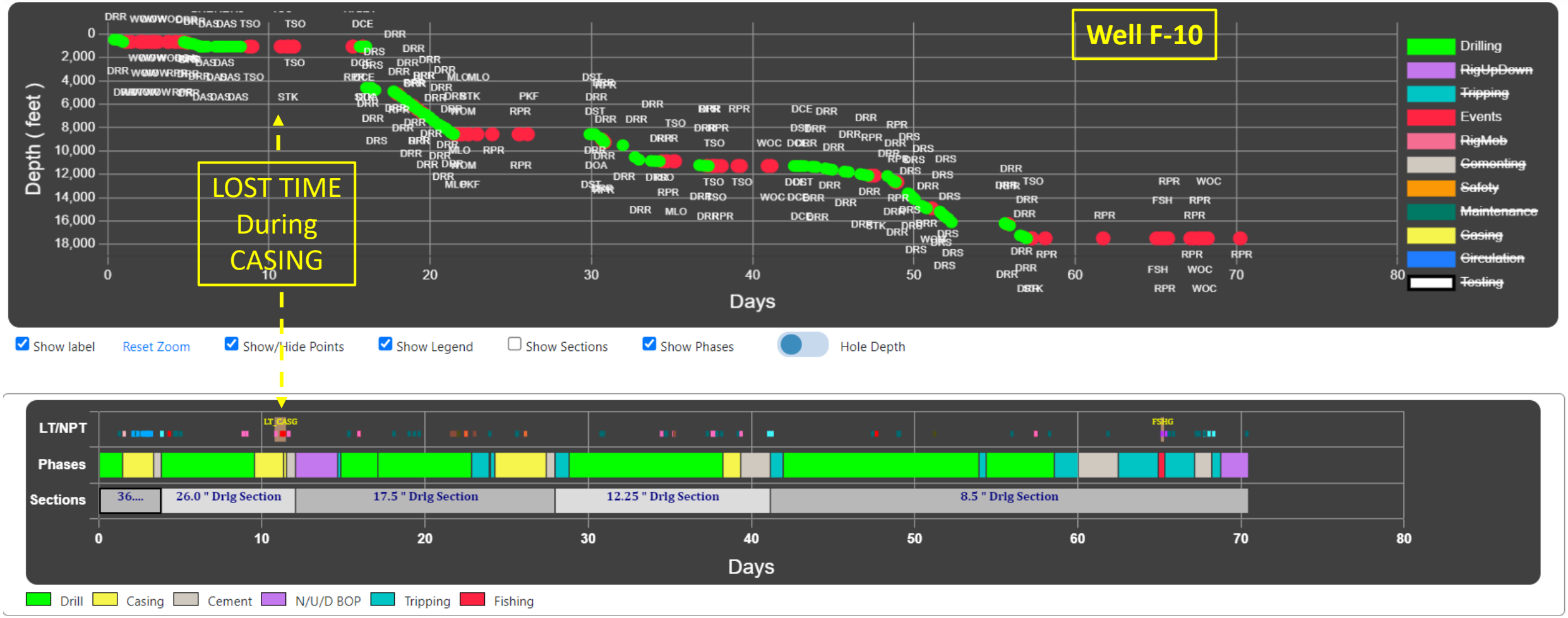
Example: Automated Risk Analysis Deep Dive





Data source for cognitive analysis: Volve Field, publicly available DDRs from Equinor

Recent Work: Multi Activity Risk & Lost Time / NPT



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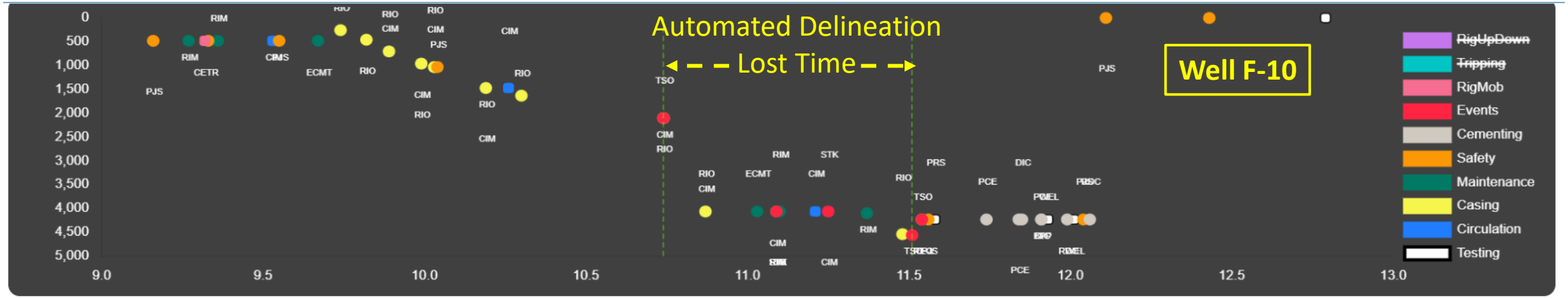
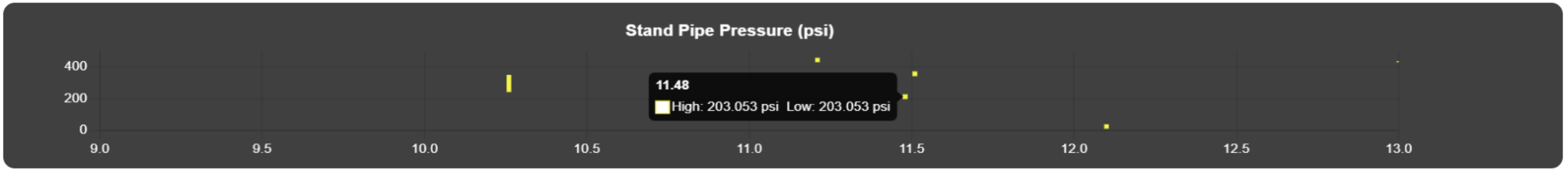
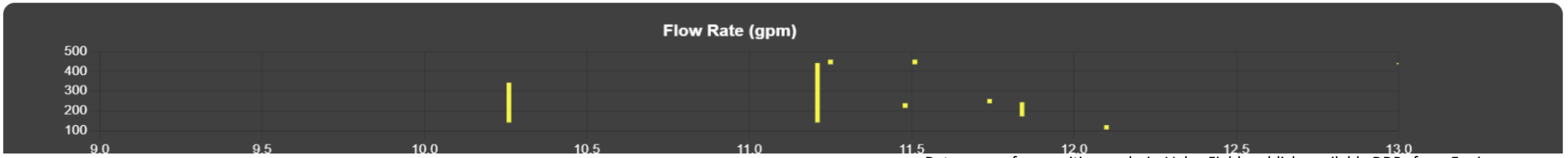
Automated Case 1: Lost Time (Casing)







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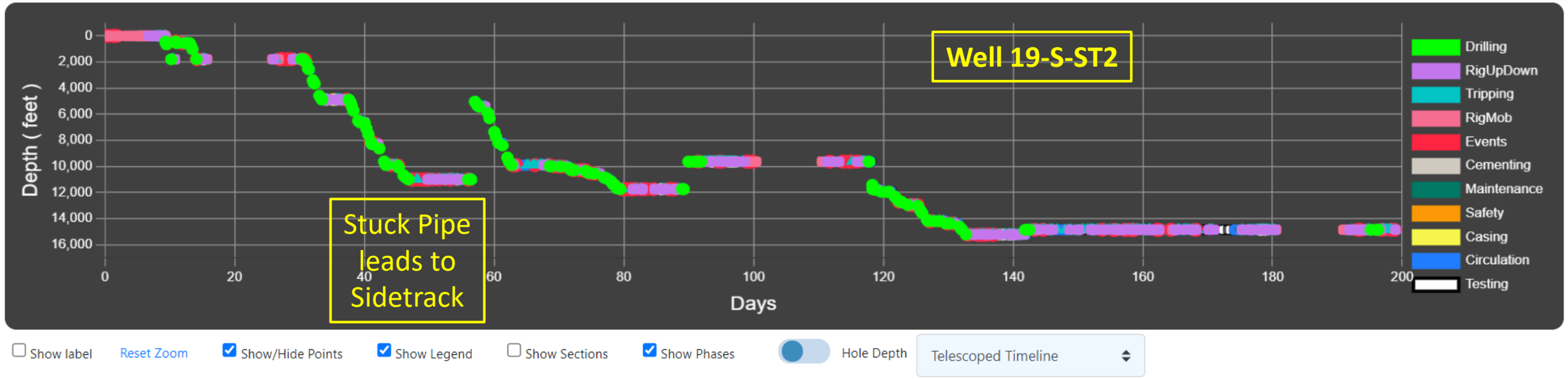
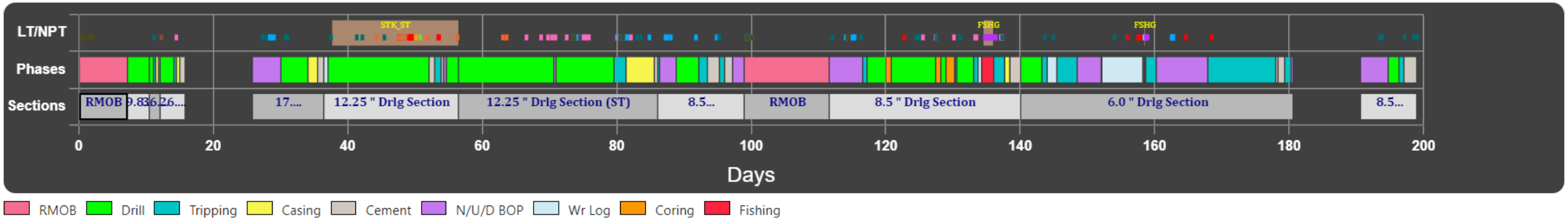
Automated Case 2: Stuck Pipe leading to Side Track



Show label | Reset Zoom | Show/Hide Points | Show Legend | Show Sections | Show Phases | Hole Depth | Telescoped Timeline



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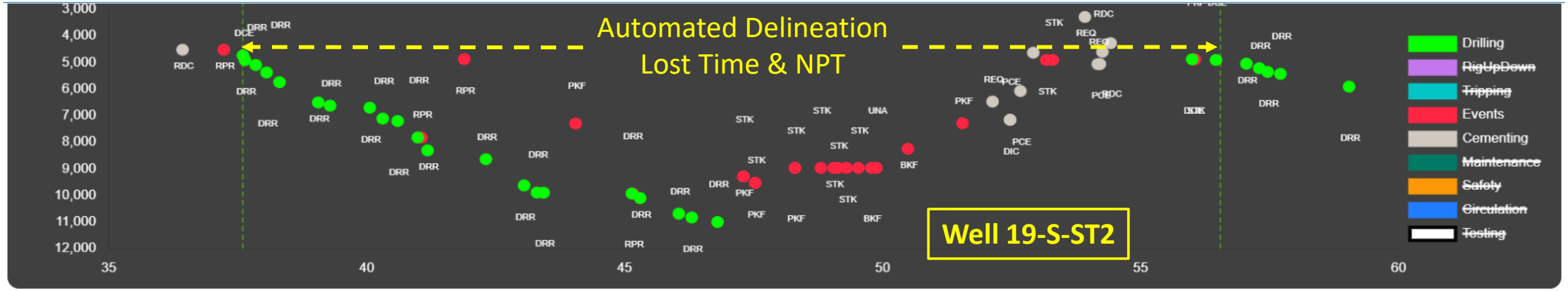

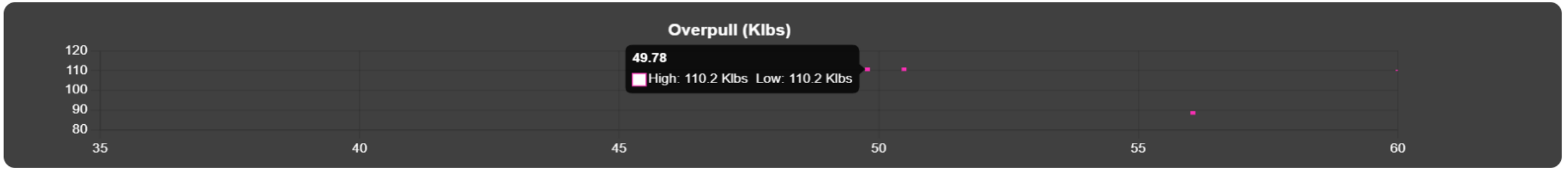

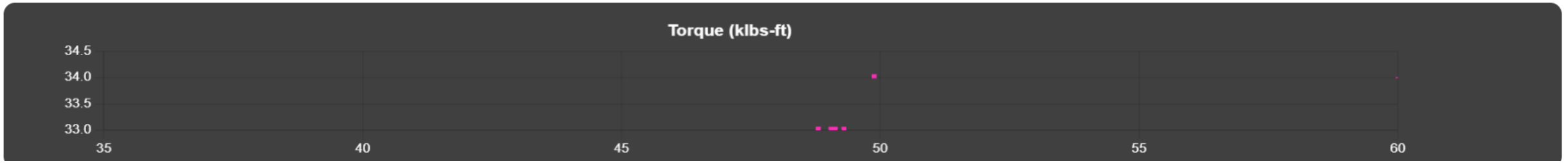

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Summary of Automatically Delineated Cases

Well	Lost Time / NPT Case	LT / NPT Multi- Activity Analysis (Days)	Corresponding LT / NPT via Single Activity Analysis (Days)	Comments
F-10	Lost Time (Casing)	**0.8** (10.7 – 11.5)	**0.17**	Tight Spots / Mini Stuck Pipe Phase
F-15A	Lost Time (Casing)	**2.4** (9.4 – 7.1)	**0.51**	Tight Spots & Occasional Stuck Pipe
19-S-ST2	Stuck Pipe leading to Side Track	**19** (37.6 – 56.6)	**1.29**	Pack off, Backoff, then Side Track
19-B-BT2	Stuck Pipe leading to Side Track	**17.7** (7.87 - 25.6)	**5.29**	Mud Loss, Stuck Pipe, Backoff, then Side Track
19-S-ST2	Fishing Operation	**1.5** (134.5-136)	**0.51**	Logical start/end of Ops
19-B-BT2	Fishing Operation	**0.6** (76.5 – 77.1)	**0.14**	Logical start/end of Ops

Take Aways & Future Work

- Cognitive Knowledge-Based A.I. delivers automated risk assessment & insights via multi-activity analysis of unstructured, complex well construction descriptions in DDRs & other sources
- The solution is fully automated, and operates at scale.
- Cognitive analysis improves accuracy in Lost Time and NPT quantification, along with instant deep dives at a click.
- Future work will add new cases for Lost Time & NPT – assisting Lessons Learned and Well Planning at scale.

Thank You

Questions & Discussion