



How We Built an Automated Recommender with Real-Time Data Using PI AF

Presented by: David Nguyen
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California Resources Corporation (CRC)

130+ M

BOEPD

137

Operating
fields

2.2 M

Largest privately-held
mineral acreage

0.34 IIR – Best in class among industry peers



Dedicated to sustainable & safe energy production

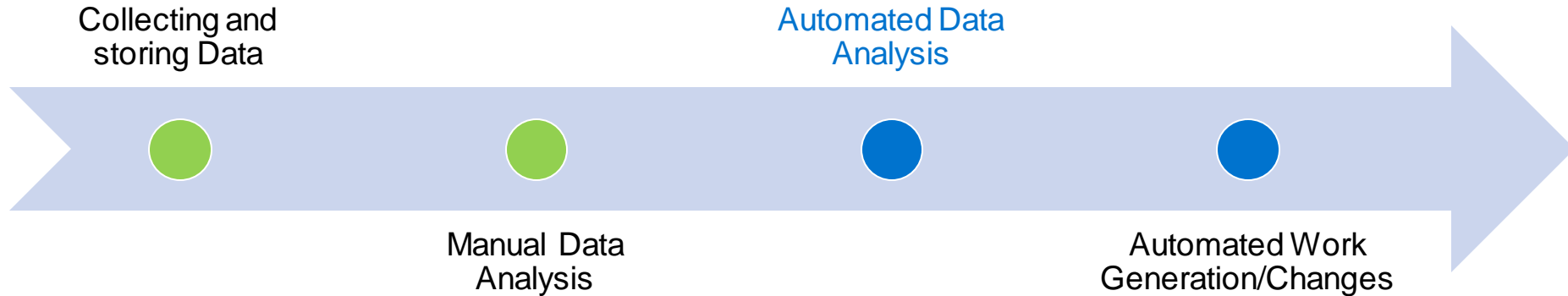


Energy for California by Californians



CALIFORNIA
RESOURCES CORPORATION

CRC's Digital Journey



Business Challenge

Market pressure forces CRC to continually find innovative ways to reduce cost and increase process efficiency



Engineers spending majority of their time looking for information instead of analyzing



Massive amount of data, of varying quality, in different systems and models that don't communicate with each other



Tedious and non-standardized manual processes

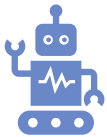
Smart Operations Initiative

“Codification of organizational intelligence”

Can we leverage existing systems to reduce time and money while also improving performance?



Build tools to combine data across systems and improve analysis



Replace manual processes with more effective automated systems

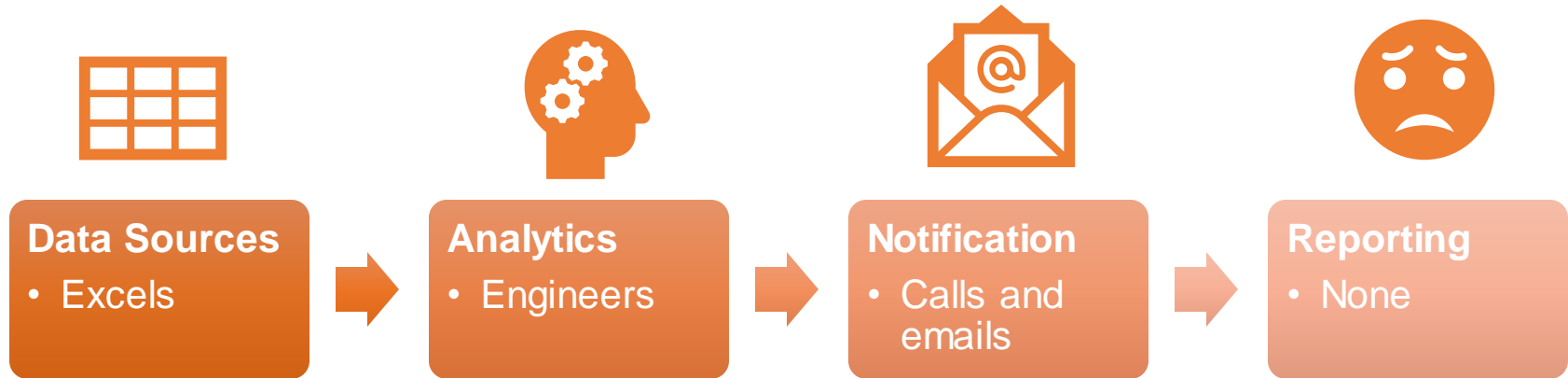


Make decisions and actions transparent with KPIs and reports

Project Use Case: Maintenance of Water Injection Wells

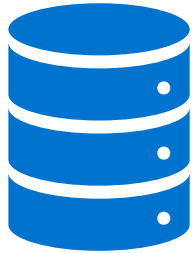
How do you determine when to service 1000s of wells that are running 24/7 with different operating requirements?

Old Process: Engineers manually review each well



Components Used

New Process: Standardize and automated the collection of data, the monitoring and analysis of candidates for maintenance and creation of a ranked recommendation list.



Data Sources

- PI Data Archive
- SQL Server
- Static Files



Analytics

- PI AF



Notification

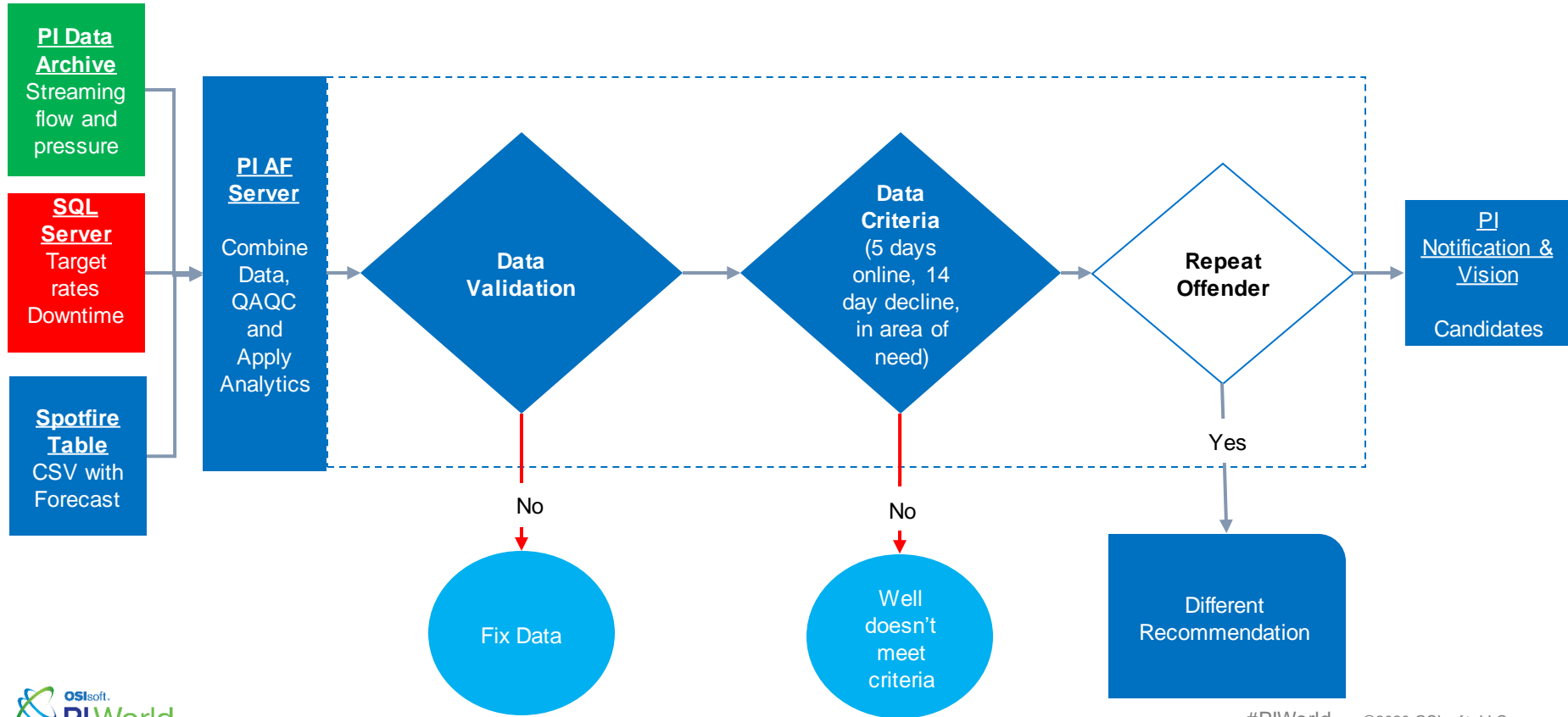
- PI Notification



Reporting

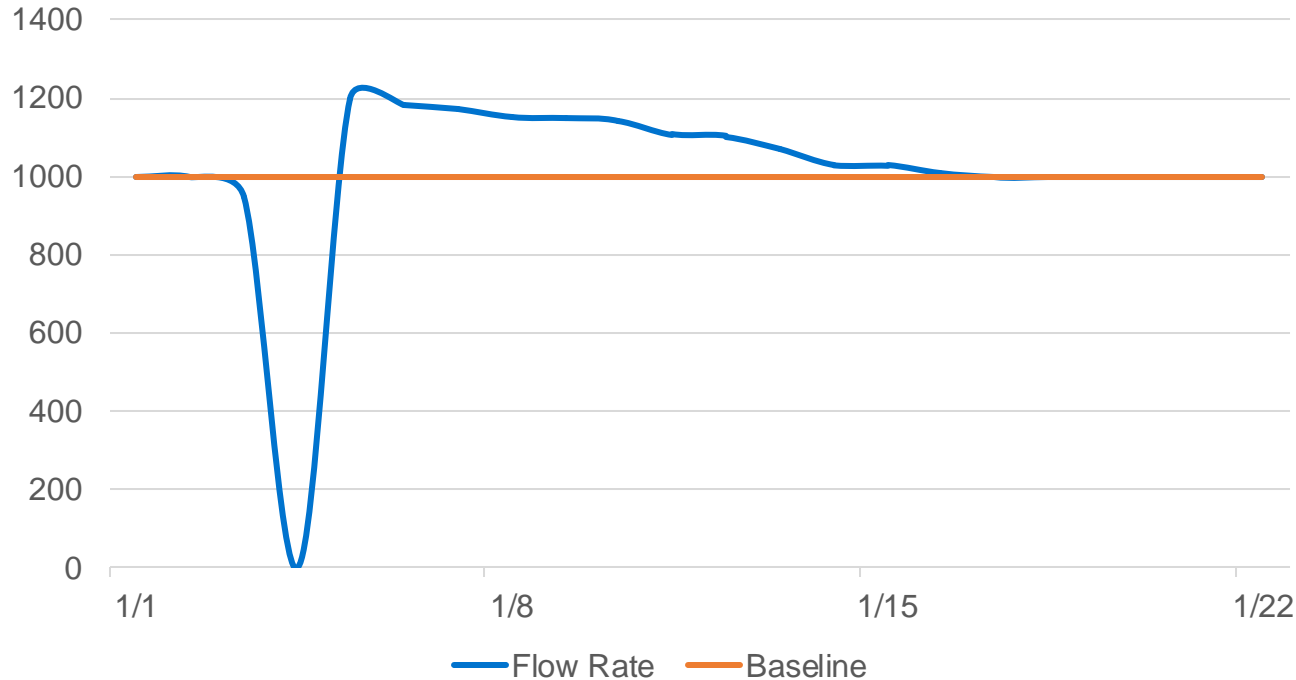
- PI Vision
- Tibco Spotfire

Recommender Data Flow



Tracking Value: Automated KPI

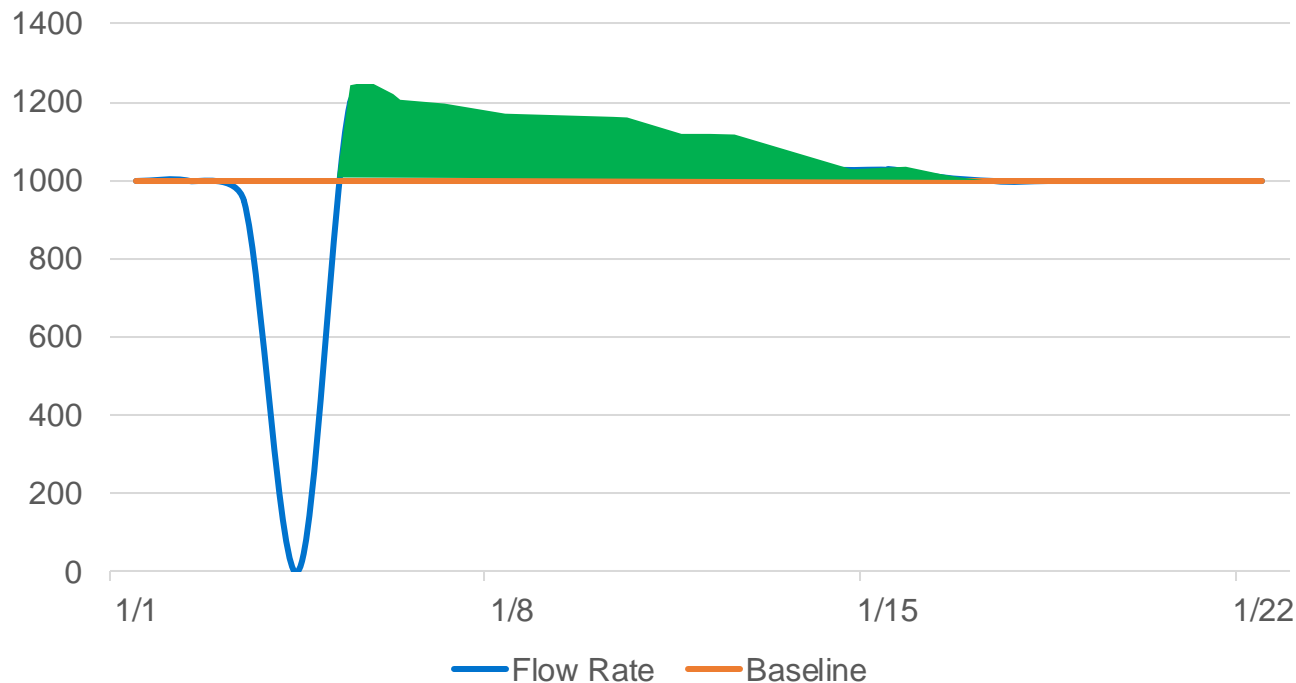
Example Chart



Net gain/loss
per event

Tracking Value: Automated KPI

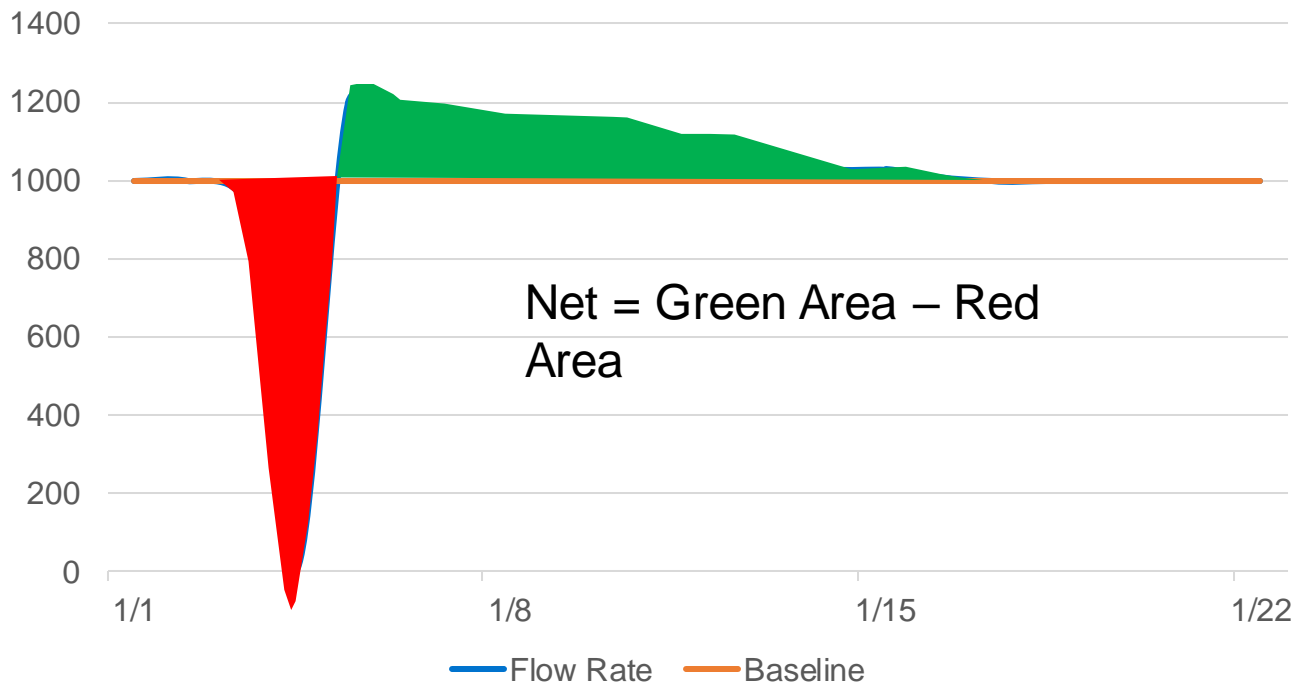
Example Chart



Net gain/loss
per event

Tracking Value: Automated KPI

Example Chart



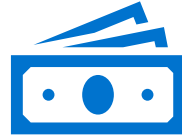
Net gain/loss
per event

2019 Results



22%

of Jobs



15,000

Bbls of oil



\$1 M

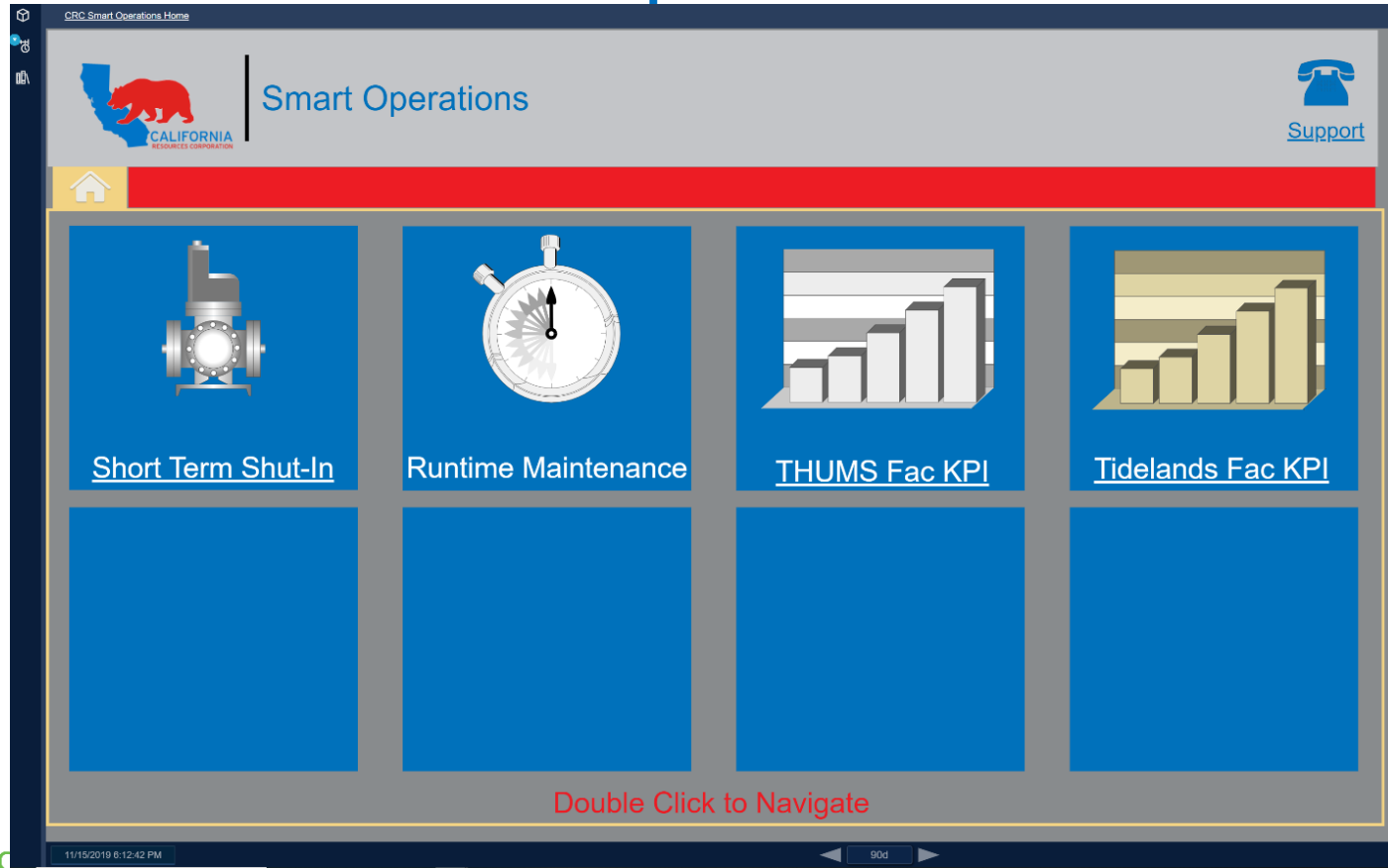
Wellwork Cost

- Built process framework for future projects
- Demonstrated potential of digital transformation

DEMO

Smart Operations

PI Vision - Smart Operations Dashboard



Well Maintenance Dashboard



AF and Analytics

Comments		C-208	
		General Child Elements Attributes Parts Analyses Notification Rules Version	
		Filter	
		P 1 x x x Items	Value
<ul style="list-style-type: none"> Gas Compressor Injection Pumps Injection Wells Chaffee Injection Wells Trinidad Injection Wells Trinidad Quarry Well Grossen Injection Wells 	A-101	90 Day Downtime Net BBL Effect	Calc Failed
	A-104-1	90 Day Downtime Net BPO Effect	Calc Failed
	A-108	90 Event Count	3
	A-118-1	Daily Calculations_daily_psi	1282 psi
	A-118-2	Daily Calculations_cumulative_days	Calc Failed
	A-121	Down Wells Criteria	Shutdown
	A-122	DeltaBPO	Shutdown
	A-126	Down Wells Criteria	True
	A-129	Downtime 1 hour	True
	A-130	Downtime 1 hour flag	Shutdown
	A-141	Downtime 1hr flag	Shutdown
	A-144	Downtime Check	0
	A-148	Downtime Hours	0.75 h
	A-151	Downtime duration	Shutdown
	A-170	Hourly Calculation_hourlypsi	649.03 psi
	A-171	Inj BPO Below Target	0 bbl/d
	A-211	Injection Well Calculations_DailyFlowRate	2039 bbl/d
	A-214	Injector Downtime_NetBPO	Shutdown
	A-215	Injector Downtime_NetVolume	Shutdown
	A-218	PI Archive	pi.bgspec.oc.com
	A-220-1	Short Term Shut-in Counter	0
	A-220-2	Short Term Shut-in_Deviation	39
	A-221	Short Term Shut-in_DeviationPercent	0.0035
	A-234-1	Shut-in Start Time Stamp_ShutStartTime	Shutdown
	A-234-2	Shut-in Time Stamps_ShutEndTime	Shutdown
	A-238	Asset Identification	
	A-239	Cellar Number	0
	A-240	Location	Chaffee
	A-242	Location Number	3
	A-243	Pool	R00N
	A-252-1	Pool B Code Trigger	R00N
	A-257-2	Pool IWR Trigger	1
	A-261	Pool_comp1	Shutdown
	A-262-1	Well Name	C-208
	A-271-1	Calculations	
	A-271-2	Daily Total	997 bbl/d
	A-306-1	Ingress 1q Rate - Data	No Data
	A-309	Intricacity	1.583
	A-311	PI Data Check_pilotals_check	1
	A-329	PI Data Check_Yesterday's_Total_Diff	602 bbl/d
	A-350	Yesterday Total	2039 bbl/d
	A-354-1	Yesterday Total - Ingress Table	99999 bbl/d
	A-359-2	Flow	
	A-362	Average Daily Flow Rate	2041 bbl/d
	A-364-1	Flow Rate	0 bbl/d
	A-364-2		

View Go Tools Help Database Query Date < > Refresh New Template -

Injection Web Templates
General Attribute Templates Ports Analysis Template Notification Rule Templates

Name Short Term Shutdown

Description:

Categories: ShortTermShutdownNotification

Analysis Type: ☒ Expression ☐ Rollup ☐ Event Frame Generation ☐ SOC

☒ Exclude analyses auto-created from template

Example Element: Equipment Based Hierarchy Injection Web/Cases Injection VMMSA-354-1

Name	Expression	Output Attribute
deviation	"Injection Well Calculations_DailyFlowRate"- "Target Rate"	Short Term Shutdown Deviations
deviationpercent	Deviation/"Target Rate"	Short Term Shut-In DeviationPercent
undershootCriteria	//20% deviation below baseline for 3 consecutive days if (TimeOf("Short Term Shut-In DeviationPercent", "t-5d", "t", -0.25) > 0) then 0 else 1	Map
undershootRate	//check to see if there has been a downtime event in the last 14 days if (TimeOf("Downtime Check", "t-14d", "t", 0) > 0) then 0 else 1	Map
shutdownCriteria	//check to see if well is currently down if ("(Downtime Hours">=4 AND "Downtime End Date" > ""&"&" OR "Downtime End Date" > ""&"&" then 0 else 1	Down Wells Criteria
shutInCriteria	//if shut-in criteria is met, deviation value is returned (more negative in worst well) + 11/6/13 added b-nose and 70% target wells only deviationCriteria*wellshutindownCriteria*NoWellshutCriteria*PZ Data Check_pzData_check*"Max(Pool B Code Trigger", "Pool D/R Trigger")	Log EDC Active Legend
shortInCounter	if shortInCriteria = 0 then 1 else 0	Short Term Shut-In Counter

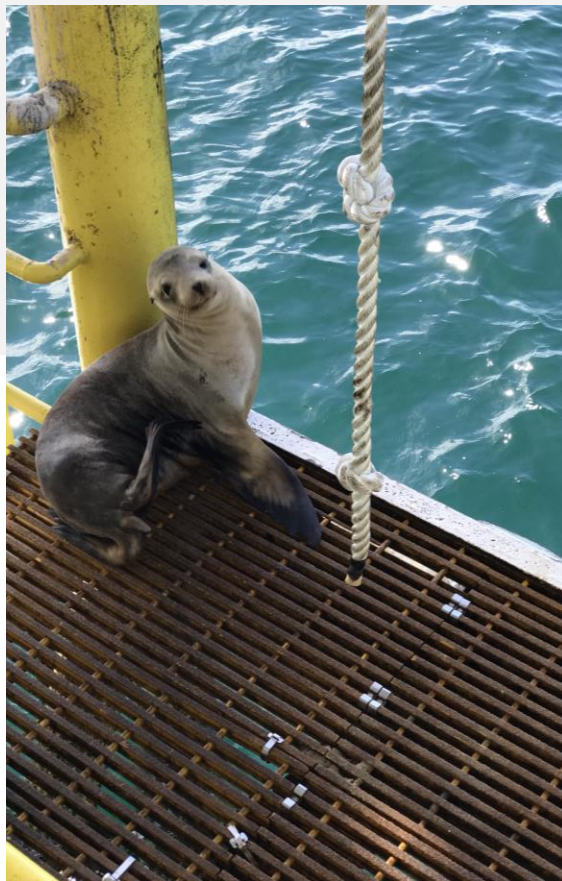
Spotfire Report





Next Phase

- Expand PI Asset Framework
- Condition based maintenance
- Drilling analytics
- Data quality validation
- Reservoir forecasting



Automated Recommender System



CHALLENGES

- Consume real-time data from 1000s of wells, each with different operating parameters to determine maintenance requirements

SOLUTION

- Combine different data sources into PI AF to analyze and auto-generate a recommendation list
- Regularly scheduled publishing of recommendation with PI Notifications

BENEFITS

- Reduced man hours needed to review wells
- Completed 22% more jobs than before
- Increased injection = Increased oil, save \$1M on maintenance



To find a successful use case, we focused on a pre-existing process but is manual, tedious, inconsistent and time consuming. From there, we automated and standardized the data collection, data validation, and analysis leveraging systems and technology we already had, to optimize the process, reduce the man hours and improve the results.



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THANK YOU



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