Cascade Natural Gas Corporation

2020 Integrated Resource Plan

Technical Advisory Group Meeting #3

Wednesday, November 6th, 2019

Cascade's Offices in Deschutes Room

Kennewick, WA

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Agenda

- **Introductions**
- **Ruby Presentation**
- **Distribution System Planning**
- **Cascade Gas Supply Overview**
- **Planned Scenarios and Sensitivities**
- **Alternative Resources**
- **Price Forecast Results**
- **Avoided Cost Methodology and Calculation**
- **2020 IRP Remaining Schedule**

Ruby Pipeline Overview

Distribution System Planning

Linda Offerdahl, PE – Engineer II

Technical Advisory Group
November 6th, 2019

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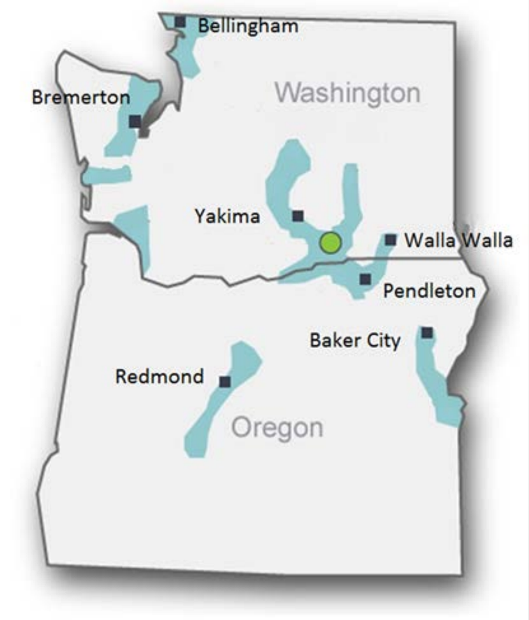
Summary

- System Overview
- Software Tools
- Data Gathering
- Synergi System Model
- Distribution Enhancement Options
- Project Process Flow
- Future Projects


Bellingham
Washington
Bremerton
Yakima
Walla Walla
Pendleton
Baker City
Redmond
Oregon

System Overview

Pipelines:

- Diameter – ½” to 20”
- Material – Polyethylene and Steel
- Operating Pressure – 20 psi to 900 psi
- Washington – approx. 4,744 miles of distribution main
- Oregon – approx. 1,604 miles of distribution main

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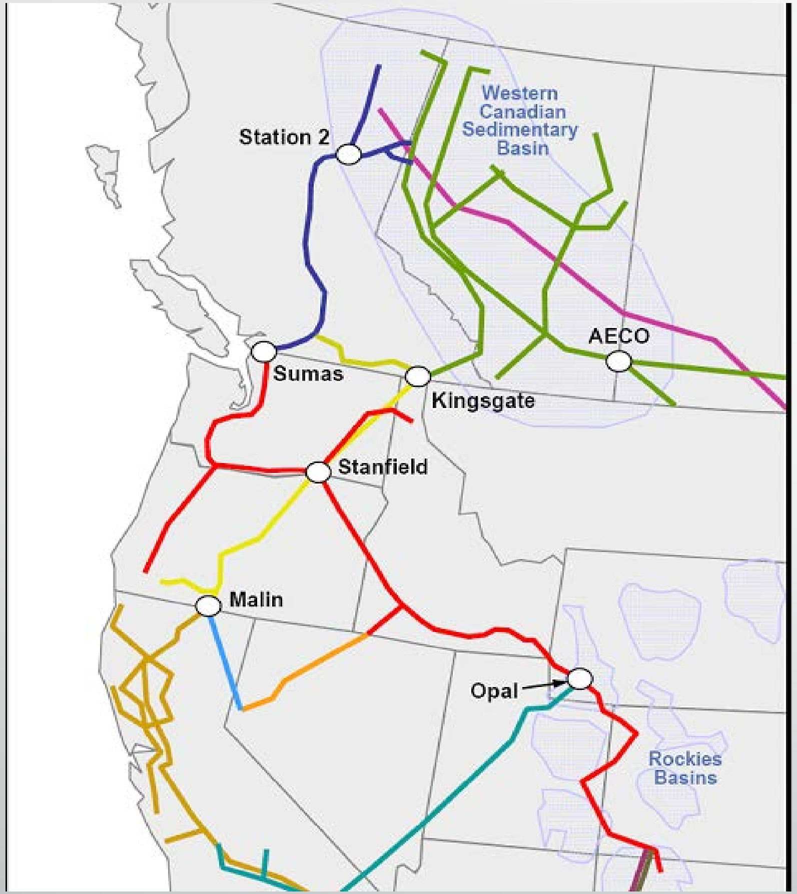
System Overview

Facilities:

- Regulator stations – Over 700
- Valves – Over 1,600
- Other equipment such as heaters, odorizers and compressors

RELIEF STACK FOR ODORIZER TANK
CONDUIT RUN FOR POWER TO ODORIZER
CONDUIT RUN FOR LIGHTS
YZ

Where do we get our gas?


Western Canadian Sedimentary Basin
Station 2
AECO
Sumas
Kingsgate
Stanfield
Malin
Opal
Rockies Basins

- Many interstate pipeline companies
- Williams Northwest Pipeline (red)
- TransCanada Pipelines (yellow)

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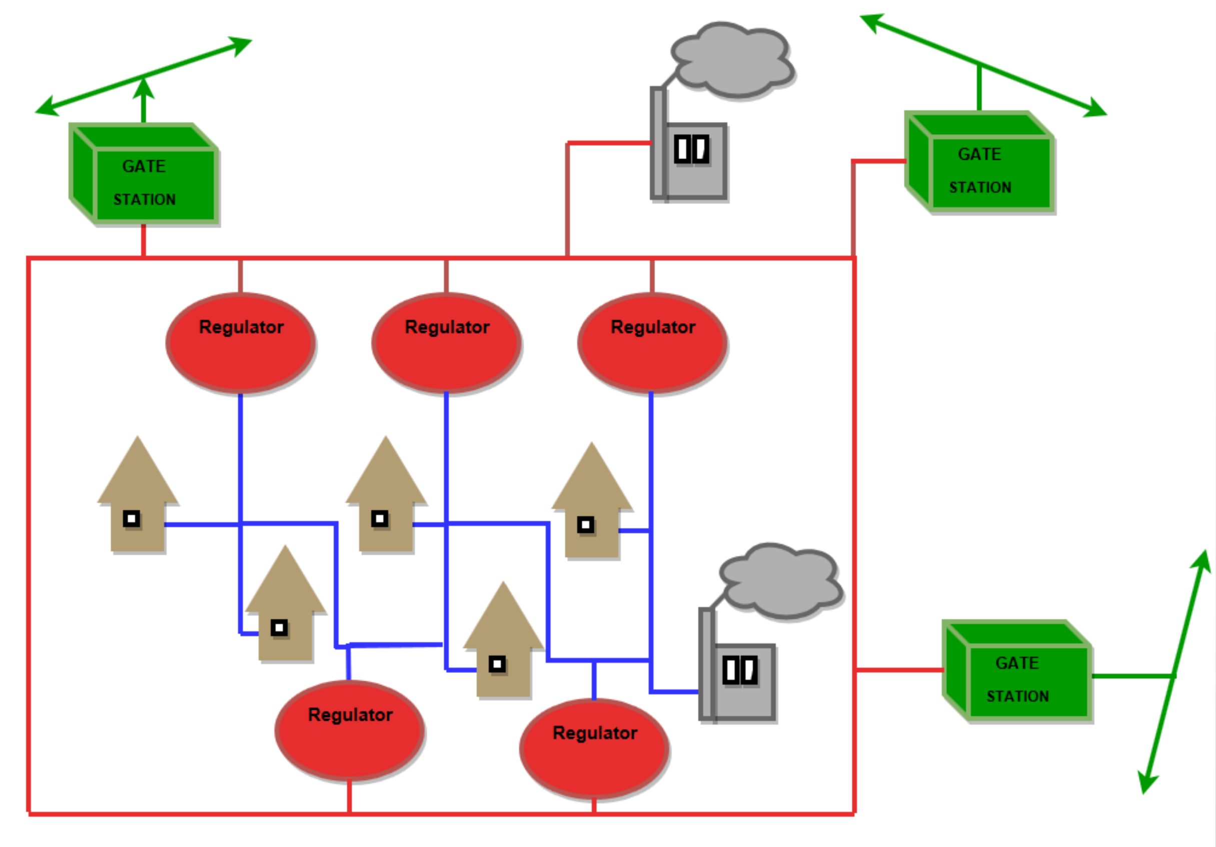
Network Design Fundamentals


GATE
STATION
GATE
STATION
GATE
STATION
Regulator
Regulator
Regulator
Regulator
Regulator

Keys:

- Gate station capacity
- Reg station placement
- Pipe size and grid

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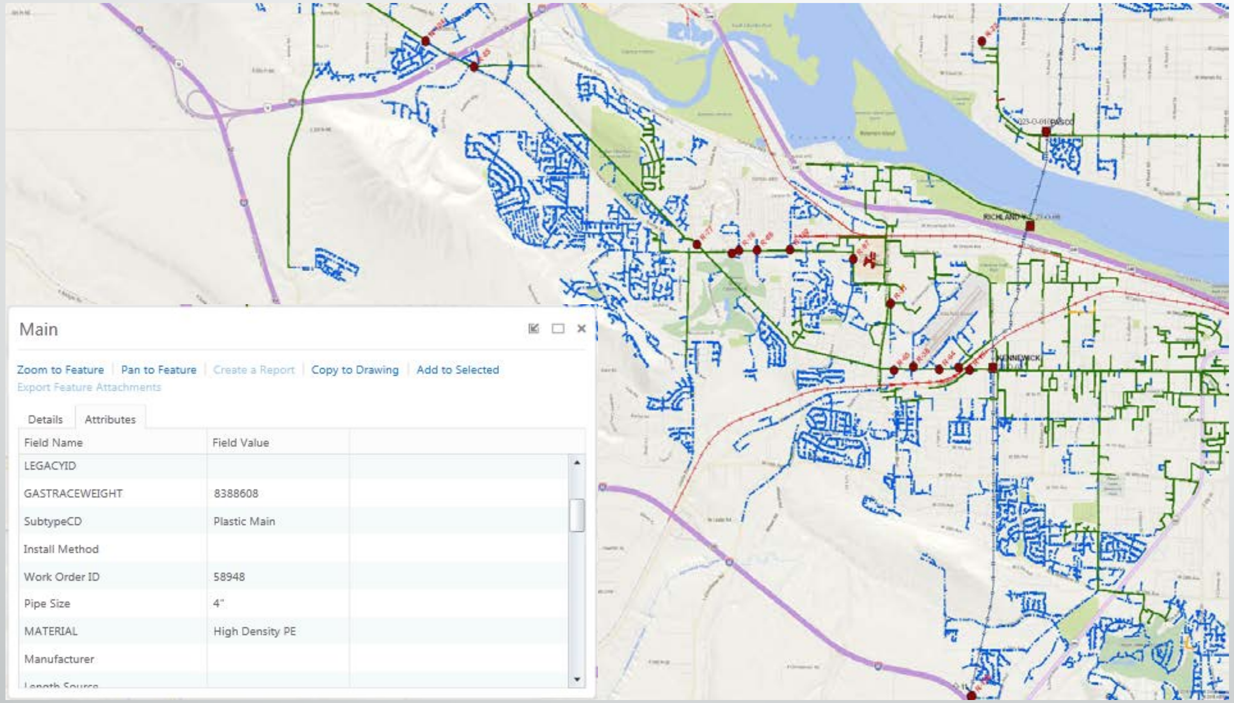
GIS – Geographic Information System

- GIS System keeps an up to date record of pipe and facilities complete with all system attributes.


Main
Zoom to Feature
Pan to Feature
Create a Report
Copy to Drawing
Add to Selected
Export Feature Attachments
Details
Attributes

Field Name	Field Value
LEGACYID	
GASTRACEWEIGHT	8388608
SubtypeCD	Plastic Main
Install Method	
Work Order ID	58948
Pipe Size	4"
MATERIAL	High Density PE
Manufacturer	
Length Source	

- Pipe Size
- Material
- Date of Install
- Operating Pressure
- Work Order

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System Modeling

- Using internal GIS environment and other input data, CNG is able to create system models through the software – Synergi.

What is Synergi?

- Software to model piping and facilities to represent current pressure and flow conditions while also predicting future events and growth.

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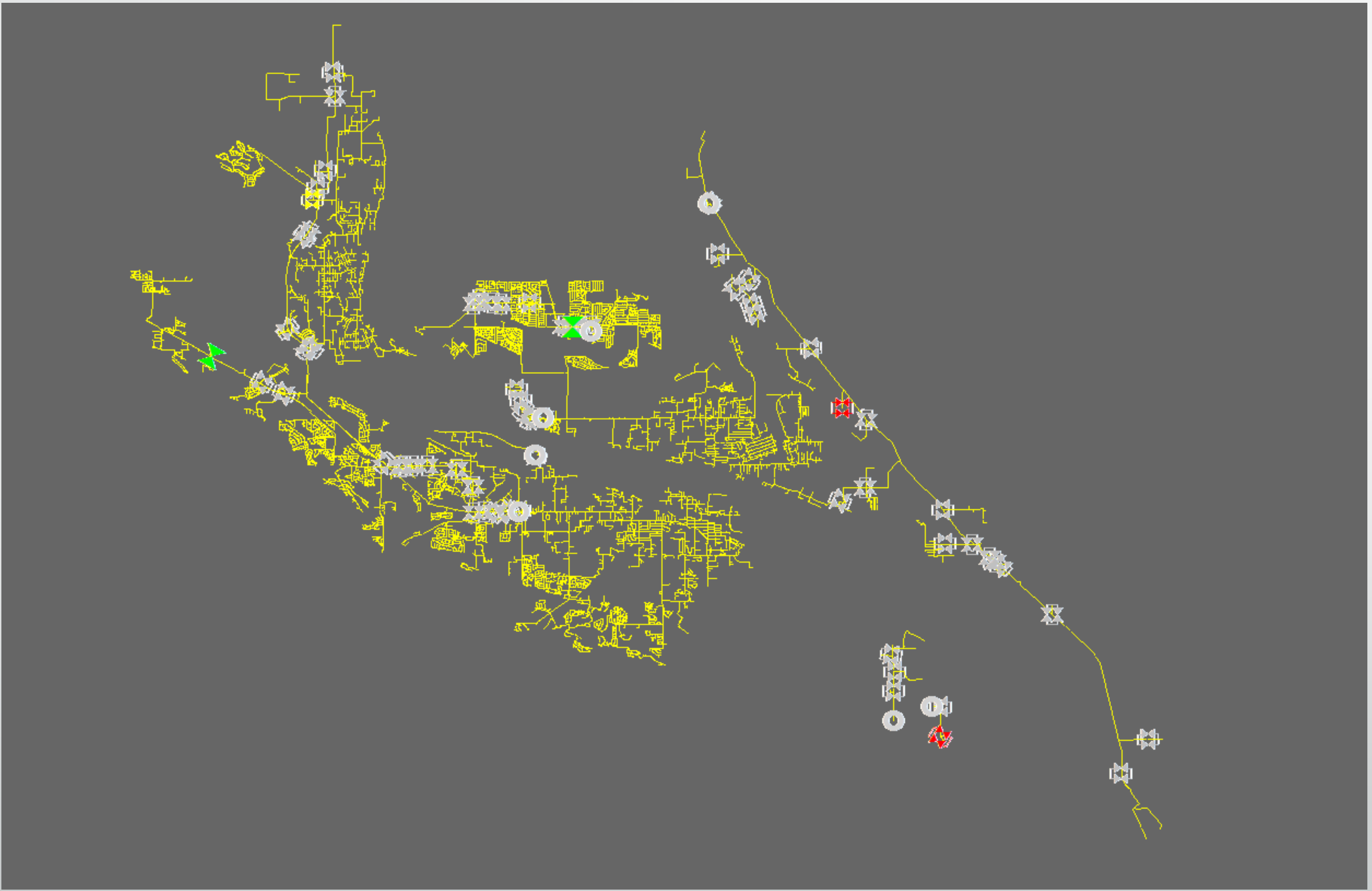
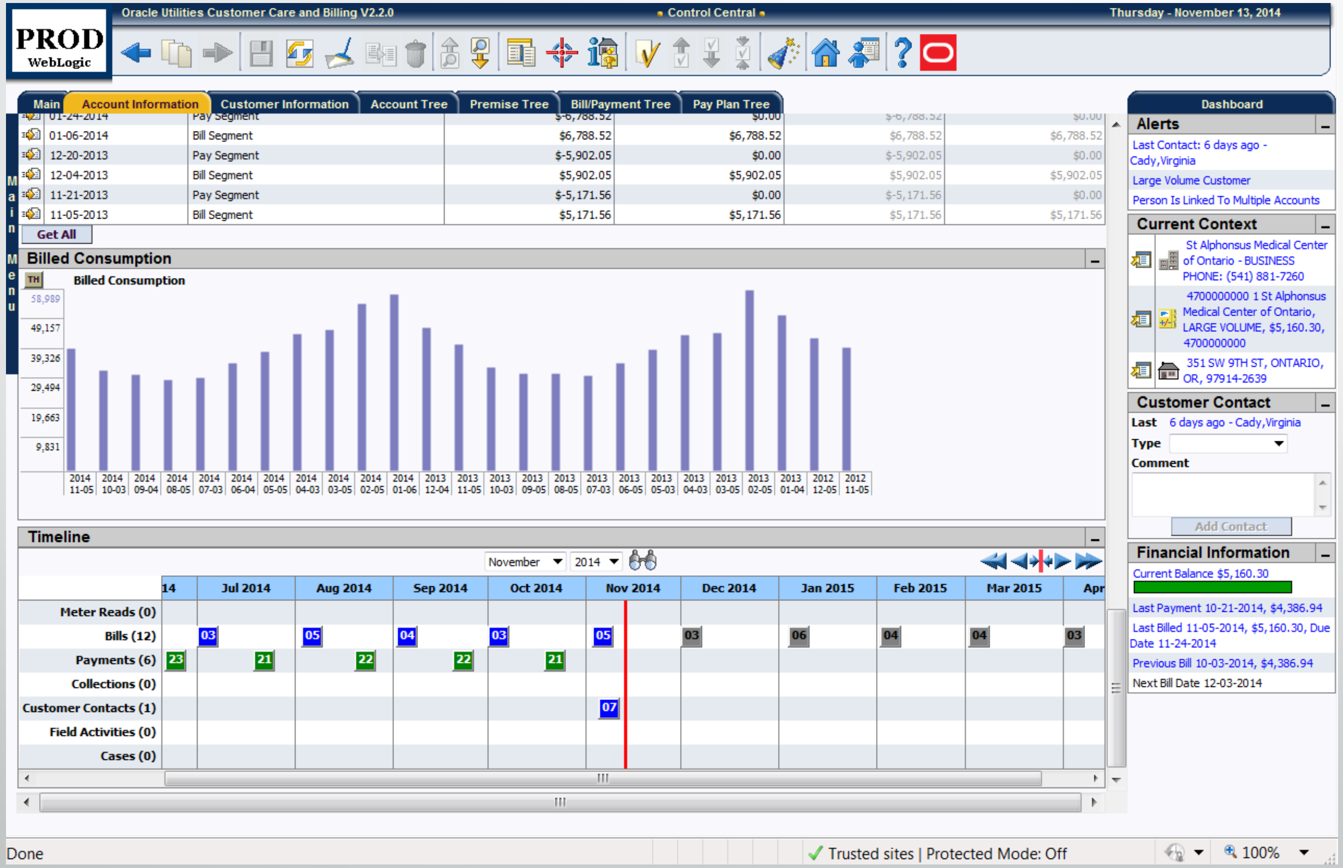
Synergi Model Example



- How do we make this model accurate?

Data Gathering

- CC&B (Customer Billing Data)



Oracle Utilities Customer Care and Billing V2.2.0 · Control Central · Thursday - November 13, 2014

PROD WebLogic

Main | **Account Information** | Customer Information | Account Tree | Premise Tree | Bill/Payment Tree | Pay Plan Tree

01-24-2014	Pay Segment	$-6,788.52	$0.00	$-6,788.52	$0.00
01-06-2014	Bill Segment	$6,788.52	$6,788.52	$6,788.52	$6,788.52
12-20-2013	Pay Segment	$-5,902.05	$0.00	$-5,902.05	$0.00
12-04-2013	Bill Segment	$5,902.05	$5,902.05	$5,902.05	$5,902.05
11-21-2013	Pay Segment	$-5,171.56	$0.00	$-5,171.56	$0.00
11-05-2013	Bill Segment	$5,171.56	$5,171.56	$5,171.56	$5,171.56

Get All

Billed Consumption

Main Menu
TH
Billed Consumption
58,989
49,157
39,326
29,494
19,663
9,831
2014 11-05
2014 10-03
2014 09-04
2014 08-05
2014 07-03
2014 06-04
2014 05-05
2014 04-03
2014 03-05
2014 02-05
2014 01-06
2013 12-04
2013 11-05
2013 10-03
2013 09-05
2013 08-05
2013 07-03
2013 06-05
2013 05-03
2013 04-03
2013 03-05
2013 02-05
2013 01-04
2012 12-05
2012 11-05

Timeline

November · 2014

	14	Jul 2014	Aug 2014	Sep 2014	Oct 2014	Nov 2014	Dec 2014	Jan 2015	Feb 2015	Mar 2015	Apr
Meter Reads (0)											
Bills (12)		03	05	04	03	05	03	06	04	04	03
Payments (6)	23	21	22	22	21						
Collections (0)											
Customer Contacts (1)						07					
Field Activities (0)											
Cases (0)											

Dashboard

Alerts

Last Contact: 6 days ago - Cady,Virginia

Large Volume Customer

Person Is Linked To Multiple Accounts

Current Context

St Alphonsus Medical Center of Ontario - BUSINESS PHONE: (541) 881-7260

4700000000 1 St Alphonsus Medical Center of Ontario, LARGE VOLUME, $5,160.30, 4700000000

351 SW 9TH ST, ONTARIO, OR, 97914-2639

Customer Contact

Last 6 days ago - Cady,Virginia

Type

Comment

Add Contact

Financial Information

Current Balance $5,160.30

Last Payment 10-21-2014, $4,386.94

Last Billed 11-05-2014, $5,160.30, Due Date 11-24-2014

Previous Bill 10-03-2014, $4,386.94

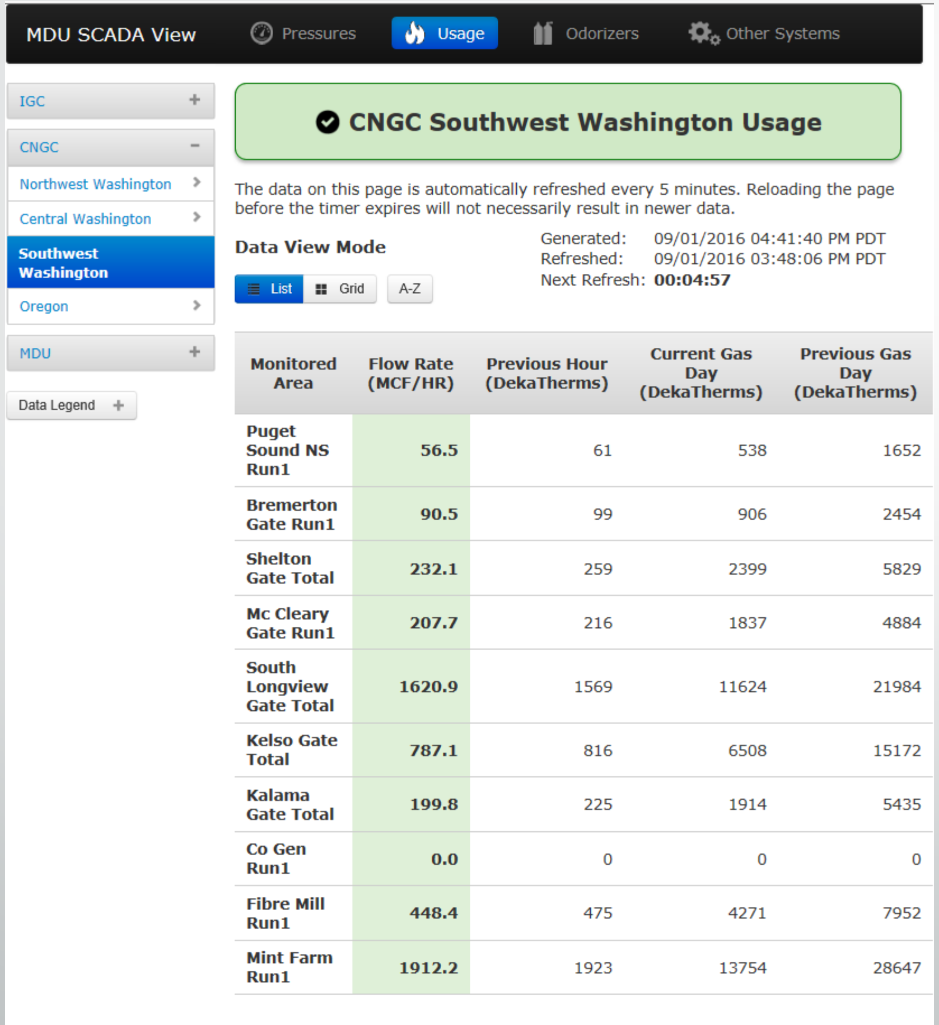
Next Bill Date 12-03-2014

Done

Trusted sites | Protected Mode: Off

100%

Data Gathering


MDU SCADA View
Pressures
Usage
Odorizers
Other Systems
IGC
CNGC
Northwest Washington
Central Washington
Southwest Washington
Oregon
MDU
Data Legend
List
Grid
A-Z

CNGC Southwest Washington Usage

The data on this page is automatically refreshed every 5 minutes. Reloading the page before the timer expires will not necessarily result in newer data.

Data View Mode

Generated: 09/01/2016 04:41:40 PM PDT
Refreshed: 09/01/2016 03:48:06 PM PDT
Next Refresh: **00:04:57**

Monitored Area	Flow Rate (MCF/HR)	Previous Hour (DekaTherms)	Current Gas Day (DekaTherms)	Previous Gas Day (DekaTherms)
Puget Sound NS Run1	**56.5**	61	538	1652
Bremerton Gate Run1	**90.5**	99	906	2454
Shelton Gate Total	**232.1**	259	2399	5829
Mc Cleary Gate Run1	**207.7**	216	1837	4884
South Longview Gate Total	**1620.9**	1569	11624	21984
Kelso Gate Total	**787.1**	816	6508	15172
Kalama Gate Total	**199.8**	225	1914	5435
Co Gen Run1	**0.0**	0	0	0
Fibre Mill Run1	**448.4**	475	4271	7952
Mint Farm Run1	**1912.2**	1923	13754	28647

- SCADA Data
- Real time and historical flow characteristics at specific locations in the system

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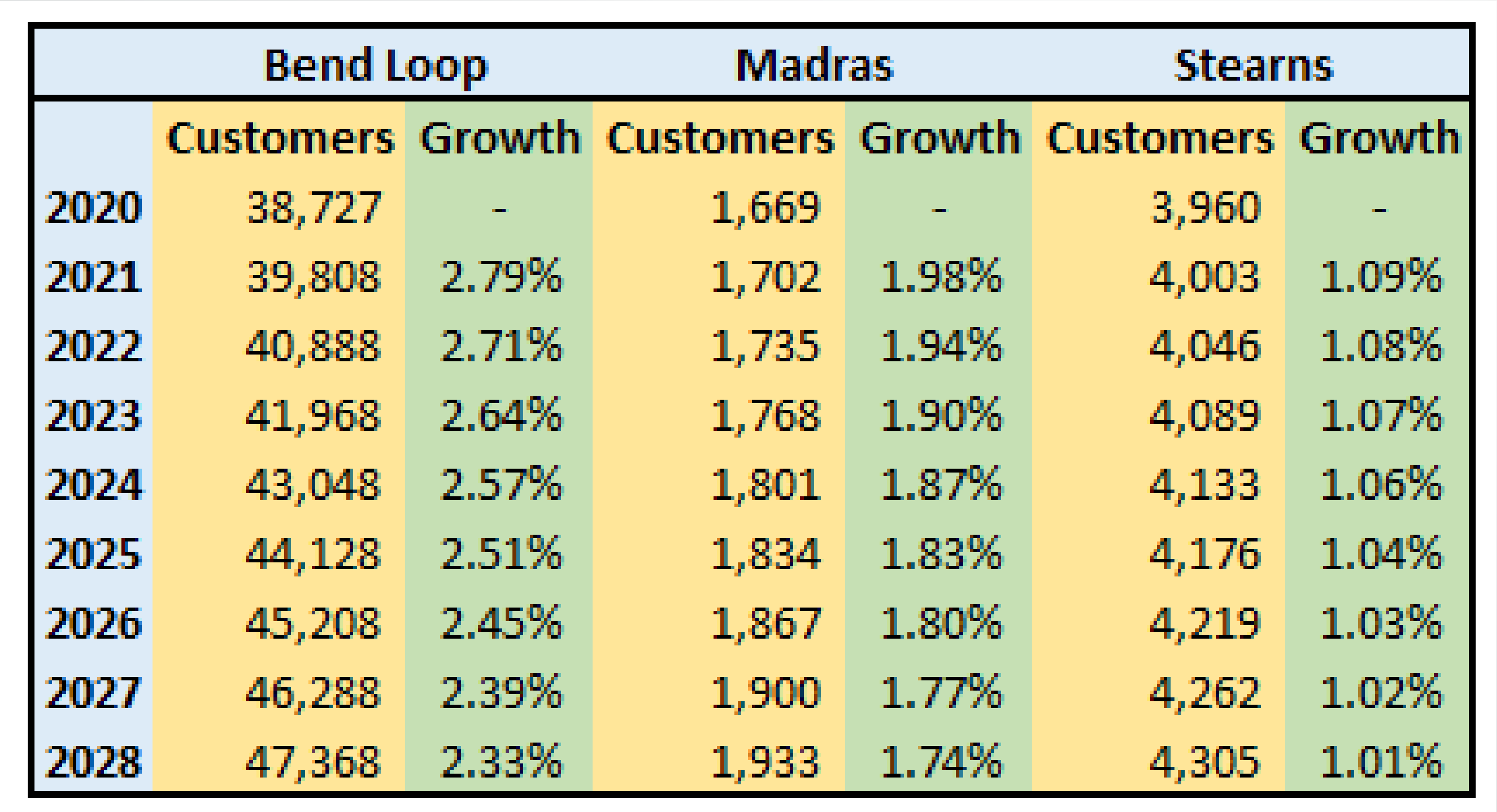
Data Gathering

- IRP Customer Growth



	Bend Loop		Madras		Stearns	
	Customers	Growth	Customers	Growth	Customers	Growth
2020	38,727	-	1,669	-	3,960	-
2021	39,808	2.79%	1,702	1.98%	4,003	1.09%
2022	40,888	2.71%	1,735	1.94%	4,046	1.08%
2023	41,968	2.64%	1,768	1.90%	4,089	1.07%
2024	43,048	2.57%	1,801	1.87%	4,133	1.06%
2025	44,128	2.51%	1,834	1.83%	4,176	1.04%
2026	45,208	2.45%	1,867	1.80%	4,219	1.03%
2027	46,288	2.39%	1,900	1.77%	4,262	1.02%
2028	47,368	2.33%	1,933	1.74%	4,305	1.01%

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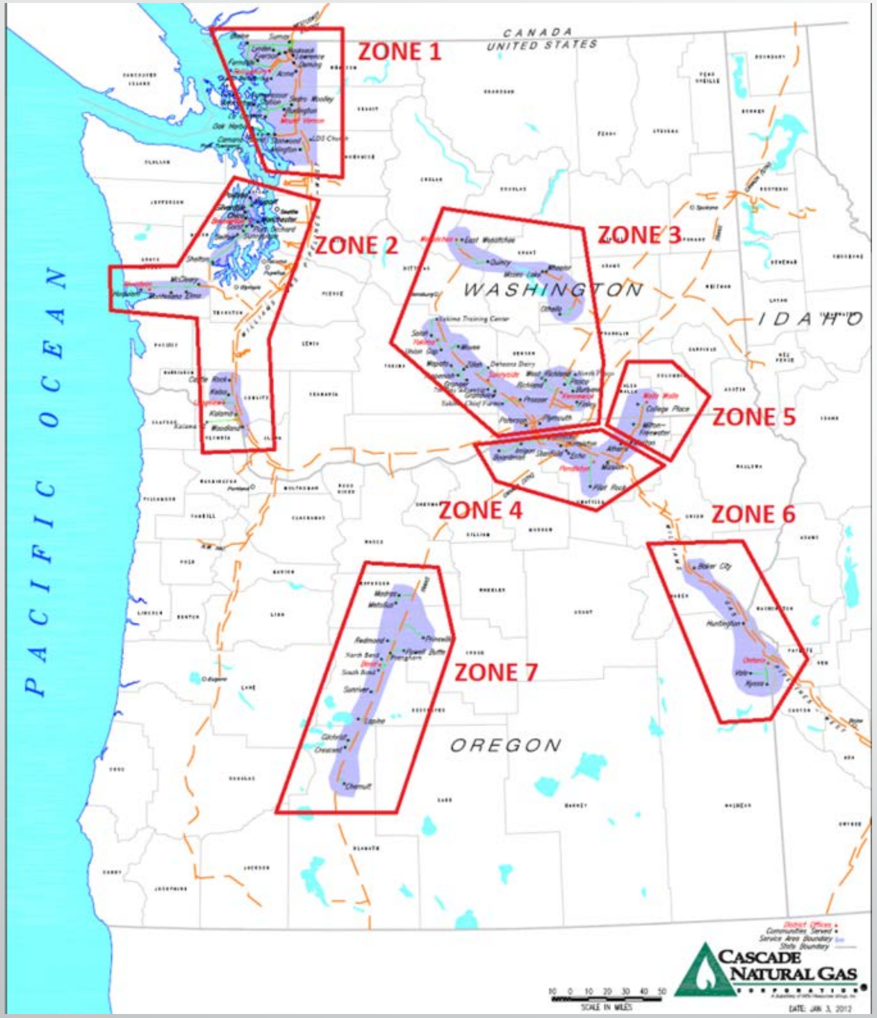
Data Gathering

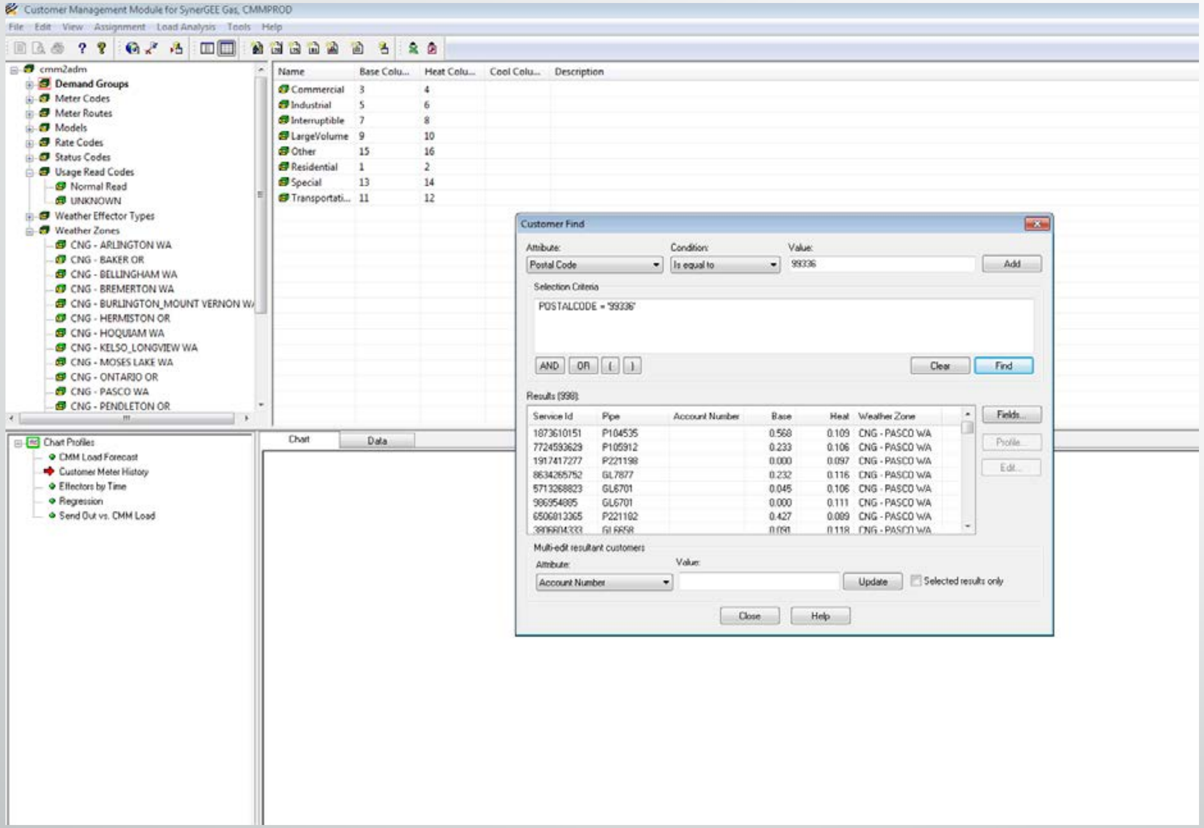

ZONE 1
CANADA
UNITED STATES
ZONE 2
ZONE 3
WASHINGTON
IDAHO
PACIFIC OCEAN
ZONE 5
ZONE 4
ZONE 6
ZONE 7
OREGON
CASCADE NATURAL GAS CORPORATION
SCALE IN MILES
DATE: JAN 3, 2012

- Peak Heating Degree Day (HDD) modeled by CNG weather zone based on historical weather data

Peak HDD = 60 – Average Daily Temp

System Peak Day	12/21/90
System Peak HDD	56
Zone 1	46
Zone 2	46
Zone 3	58
Zone 4	67
Zone 5	65
Zone 6	70.5
Zone 7	70.5

Customer Management Module (CMM)


Customer Management Module for SynerGEE Gas, CMMPROD
File
Edit
View
Assignment
Load Analysis
Tools
Help
cmm2adm
Demand Groups
Meter Codes
Meter Routes
Models
Rate Codes
Status Codes
Usage Read Codes
Normal Read
UNKNOWN
Weather Effector Types
Weather Zones
CNG - ARLINGTON WA
CNG - BAKER OR
CNG - BELLINGHAM WA
CNG - BREMERTON WA
CNG - BURLINGTON_MOUNT VERNON WA
CNG - HERMISTON OR
CNG - HOQUIAM WA
CNG - KELSO_LONGVIEW WA
CNG - MOSES LAKE WA
CNG - ONTARIO OR
CNG - PASCO WA
CNG - PENDLETON OR
Chart Profiles
CMM Load Forecast
Customer Meter History
Effectors by Time
Regression
Send Out vs. CMM Load
Chart
Data
Customer Find
AND
OR
(
)
Clear
Find
Add
Fields...
Profile...
Edit...
Update
Close
Help

Name	Base Colu...	Heat Colu...	Cool Colu...	Description
Commercial	3	4		
Industrial	5	6		
Interruptible	7	8		
LargeVolume	9	10		
Other	15	16		
Residential	1	2		
Special	13	14		
Transportati...	11	12		

Attribute: Postal Code
Condition: Is equal to
Value: 99336

Selection Criteria
POSTALCODE = '99336'

Results (998):

Service Id	Pipe	Account Number	Base	Heat	Weather Zone
1873610151	P104535		0.568	0.109	CNG - PASCO WA
7724593629	P105912		0.233	0.106	CNG - PASCO WA
1917417277	P221198		0.000	0.097	CNG - PASCO WA
8634265752	GL7877		0.232	0.116	CNG - PASCO WA
5713268823	GL6701		0.045	0.106	CNG - PASCO WA
986954885	GL6701		0.000	0.111	CNG - PASCO WA
6506813365	P221182		0.427	0.089	CNG - PASCO WA

Multi-edit resultant customers
Attribute: Account Number
Value:
☐ Selected results only

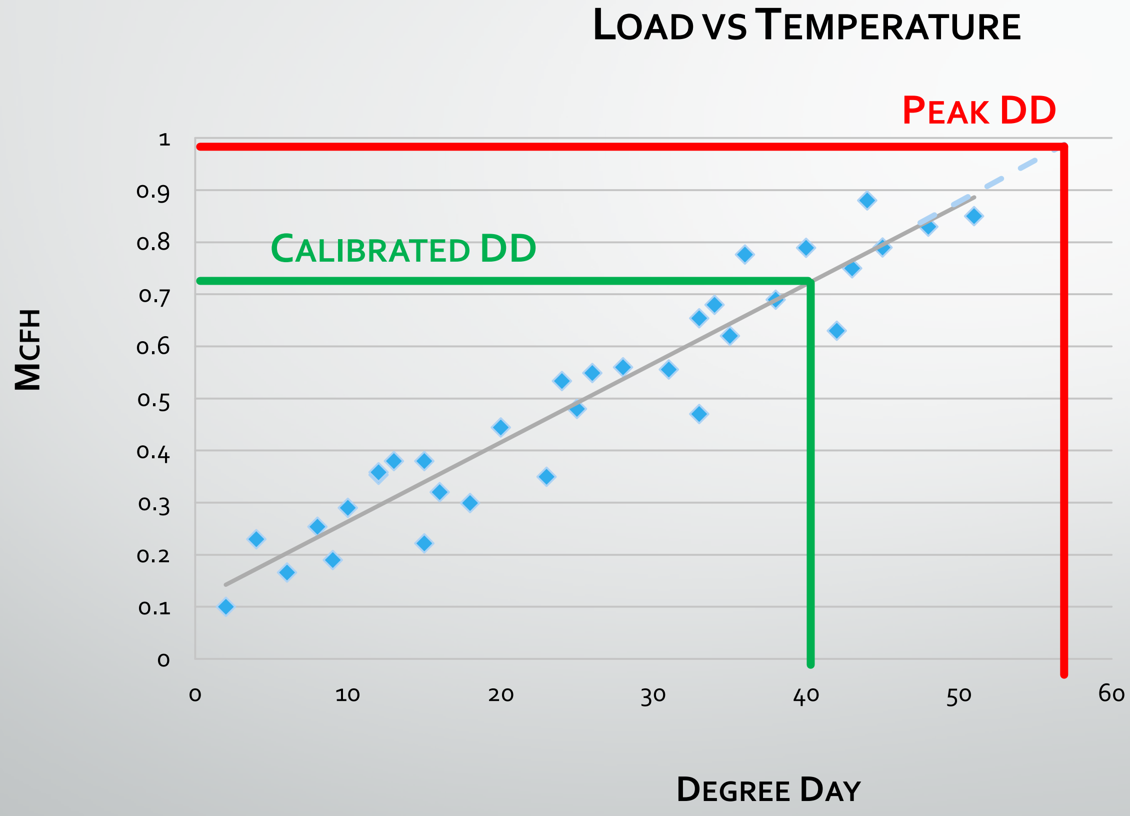
- Software that compiles data from CC&B and HDD to manage customer loads
- Works directly with Synergi to input customer data and represent pressures and flows in the model

CMM → Synergi System Model

- Conversion can result in 3 model types:
  - Calibrated Model – Model to represent a specific date and time.
  - Design Day Model – Uses the peak HDD for selected areas to simulate a cold weather event (worst case scenario).
  - Growth Model – Uses design day model along with growth data to predict future projects.

Calibrated vs Peak Degree Day

- Different loads will be applied to each customer



y = 0.0152x + 0.1118

HEAT BASE

40 DD = 0.72 MCFH

58 DD = 0.99 MCFH

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Synergi System Model

- All customers are loaded based upon base and heat trend.
- Growth model – works with design day model and customer growth numbers to simulate pressures and flows in the future.
- Benefits of the models:
    - Customer requests
    - Future planning
    - System reliability
    - Optimizing distribution enhancement options

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Distribution Enhancement Options

- Pipeline:
  - Replacements
  - Reinforcements
  - Loops

- Regulator Stations

- Compressors

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Pipeline Enhancements

Pros

- Reliable capacity
- Low maintenance
- Permanent

Cons

- Can be expensive
- Potential land acquisition and/or permitting issues

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Reg Station Upgrades/Installs

Pros

- Adds source pressure to alternate system location
- Increases flow control
- Increases pressure control

Cons

- Long term regulator and valve maintenance
- High installation/fabrication costs
- Potential land acquisition issues

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Compressor Stations

Pros

- Adding capacity at lower initial cost
- Less land required
- Situational operation

Cons

- Continuous maintenance/training
- Cost of fuel consumption
- Emissions/permitting
- Beneficial only on transmission/HP lines

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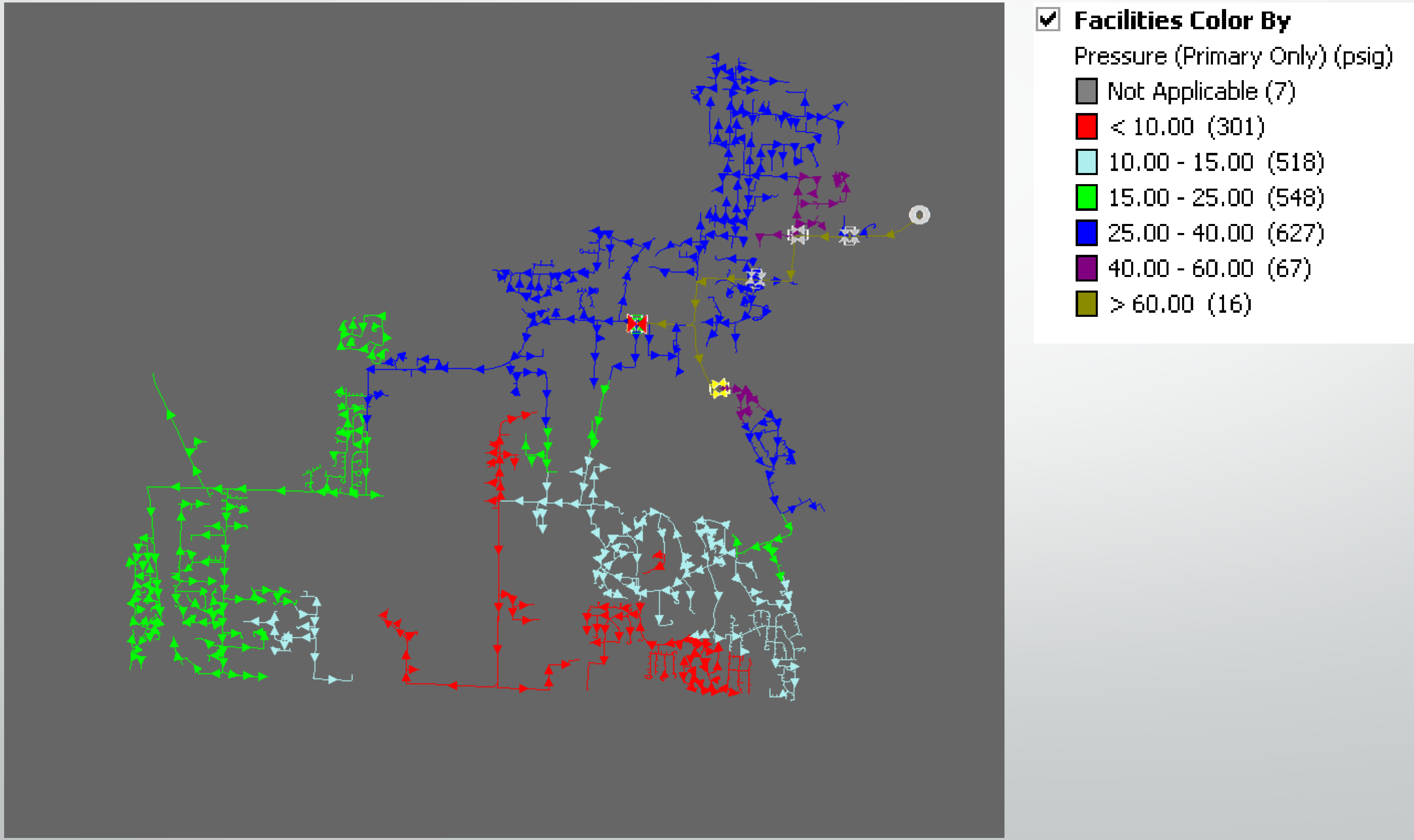
Distribution Enhancement Options

- Theoretical low pressure scenario



☑ **Facilities Color By**

Pressure (Primary Only) (psig)

⬛ Not Applicable (7)

🟥 < 10.00 (301)

⬜ 10.00 - 15.00 (518)

🟩 15.00 - 25.00 (548)

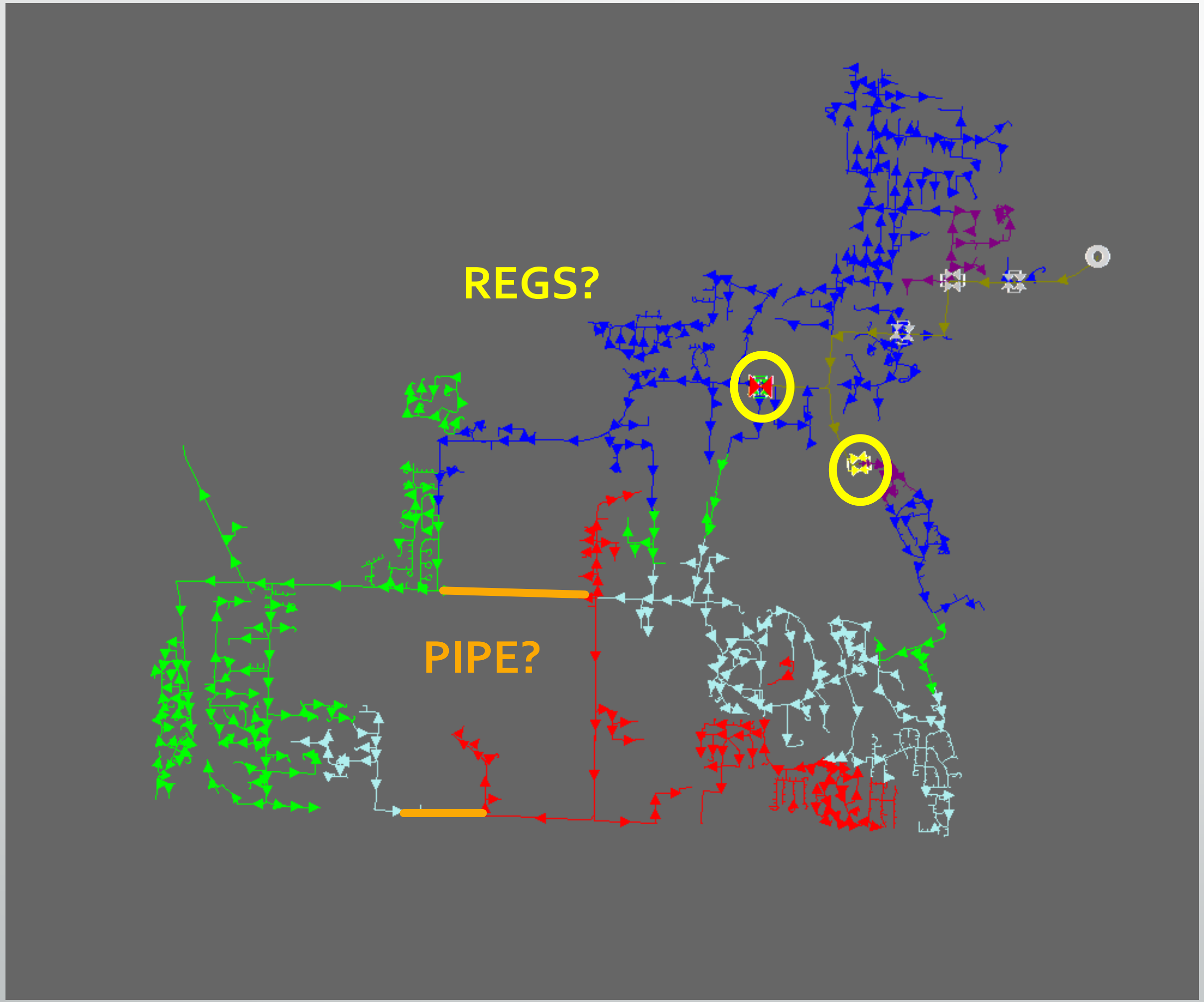
🟦 25.00 - 40.00 (627)

🟪 40.00 - 60.00 (67)

⬛ > 60.00 (16)

Distribution Enhancement Options

- Low pressure scenario



☑ **Facilities Color By**

Pressure (Primary Only) (psig)

⬛ Not Applicable (7)

🟥 < 10.00 (301)

⬜ 10.00 - 15.00 (518)

🟩 15.00 - 25.00 (548)

🟦 25.00 - 40.00 (627)

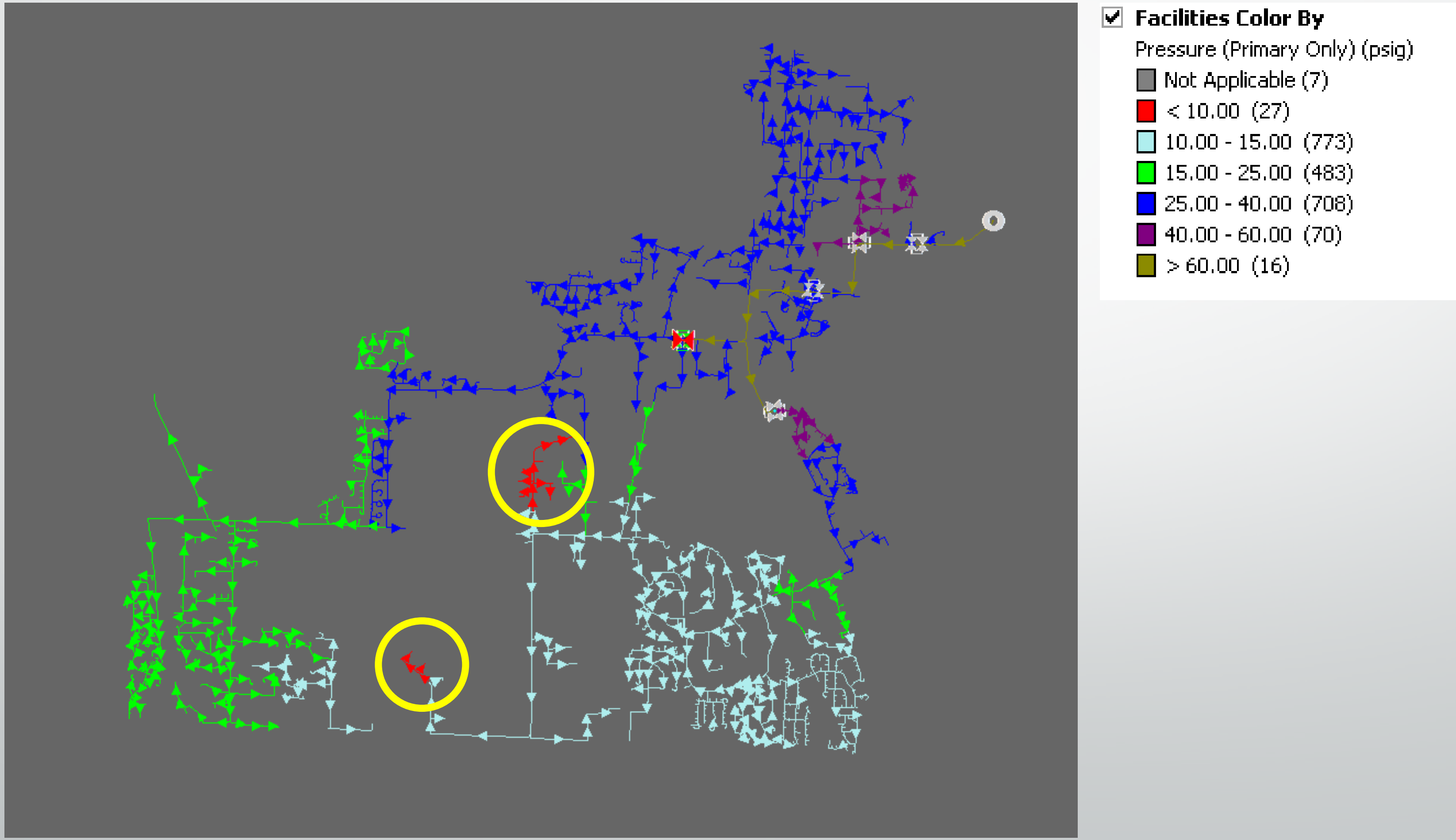
🟪 40.00 - 60.00 (67)

🟫 > 60.00 (16)

- Compressor station infeasible
- Other Solutions?

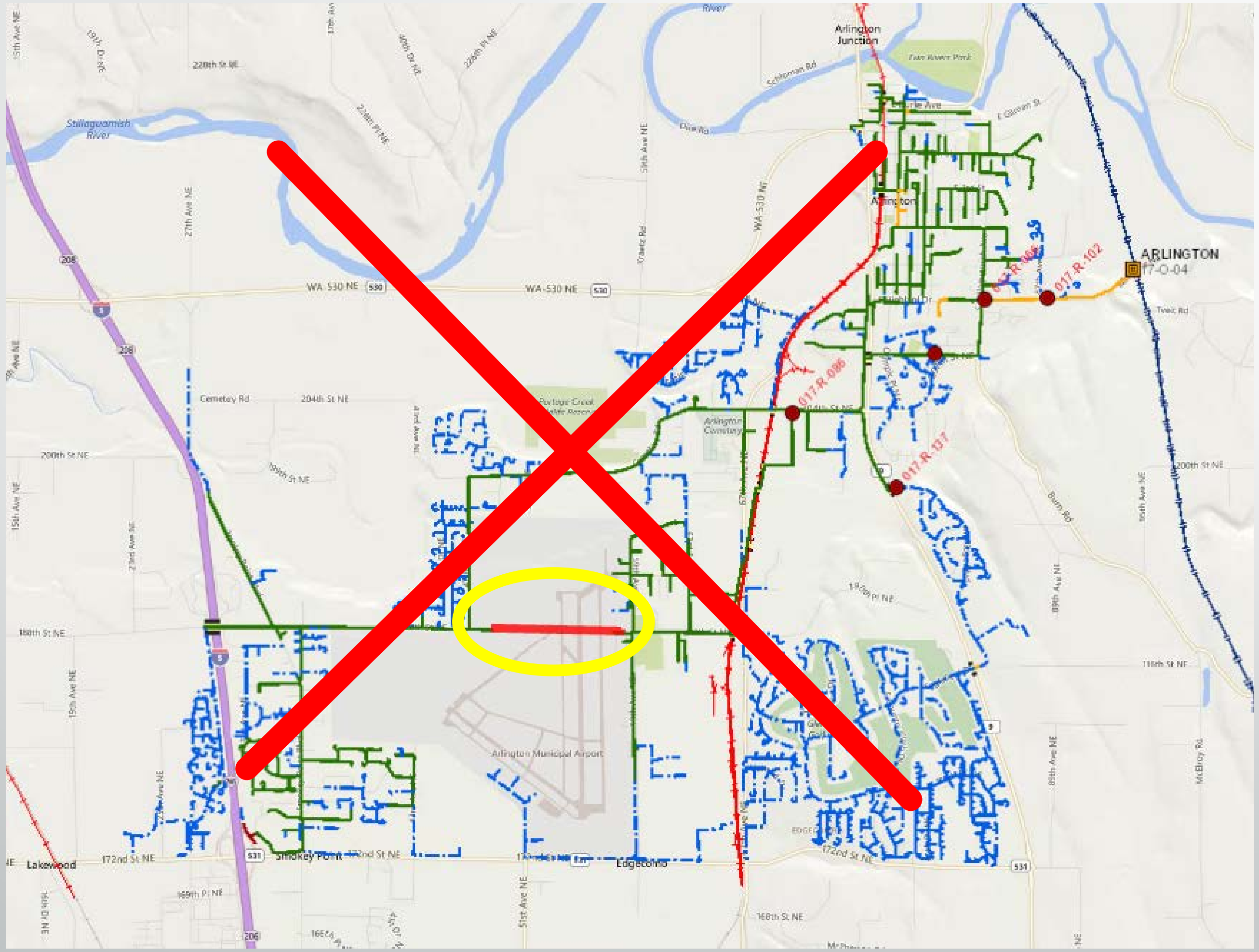
Distribution Enhancement Options

- Possible solutions – raising reg station set points


☑ Facilities Color By
Pressure (Primary Only) (psig)
▨ Not Applicable (7)
🟥 < 10.00 (27)
▨ 10.00 - 15.00 (773)
🟩 15.00 - 25.00 (483)
🟦 25.00 - 40.00 (708)
🟪 40.00 - 60.00 (70)
▨ > 60.00 (16)

Distribution Enhancement Options

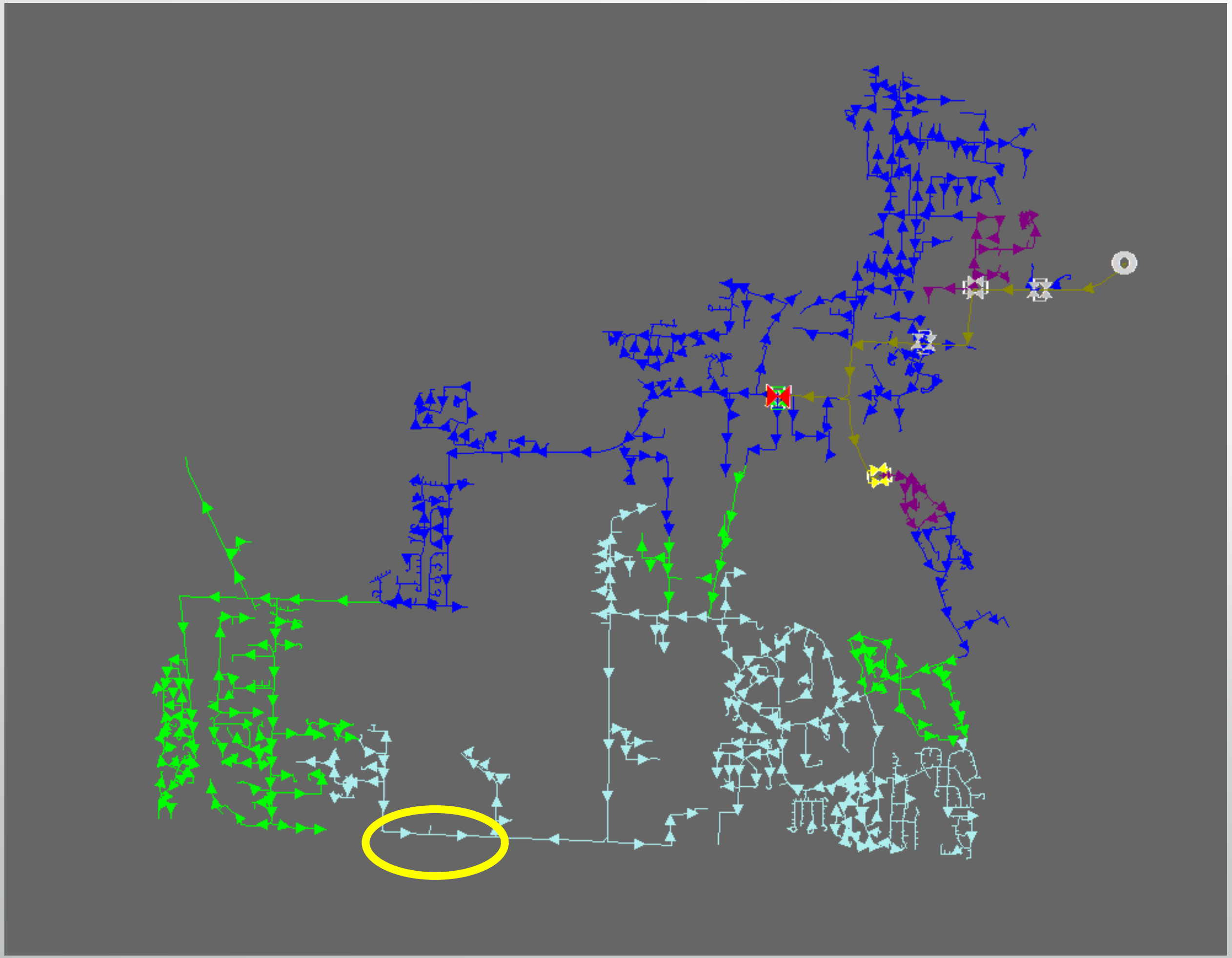
- Reinforcement option #1



Arlington Junction
Twin Rivers Park
Stillaguamish River
Schloman Rd
E Gilman St
ARLINGTON
17-O-04
017-R-102
017-R-096
017-R-137
Tveit Rd
WA-530 NE
228th St NE
Cemetery Rd
204th St NE
200th St NE
188th St NE
Arlington Cemetery
Arlington Municipal Airport
Smokey Point
Lakewood
172nd St NE
Edgecomb
168th St NE
200th St NE

Distribution Enhancement Options

- Reinforcement option #2

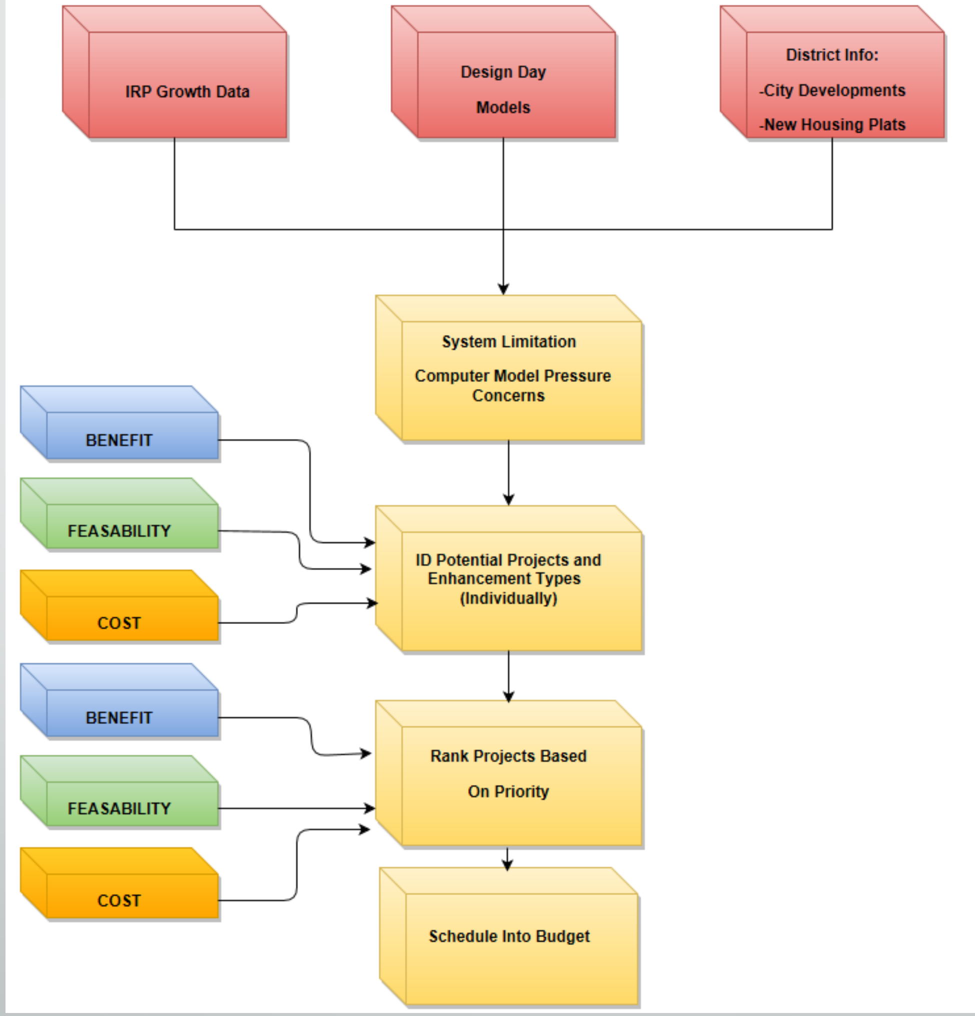


☑ **Facilities Color By**

Pressure (Primary Only) (psig)

- ⬛ Not Applicable (8)
- 🟥 < 10.00 (0)
- 🟦 10.00 - 15.00 (780)
- 🟩 15.00 - 25.00 (367)
- 🟦 25.00 - 40.00 (844)
- 🟪 40.00 - 60.00 (71)
- 🟫 > 60.00 (16)

Project Process Flow



IRP Growth Data

Design Day Models

District Info:
-City Developments
-New Housing Plats

System Limitation
Computer Model Pressure Concerns

BENEFIT

FEASABILITY

COST

ID Potential Projects and Enhancement Types (Individually)

BENEFIT

FEASABILITY

COST

Rank Projects Based On Priority

Schedule Into Budget

Info & Data

Project & Schedules

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Future Projects

- Planned distribution enhancement projects in Oregon for next 4 years:
  - Pendleton 4” IP & HP Reinforcements Ladow Rd
  - Pendleton 4” IP Reinforcement Korvola Rd
  - South Hermiston HP Reinforcement Feedville Rd
  - Bend 8” HP Reinforcement Bear Ck Rd
  - Bend Gate Station Rebuild
  - Redmond 6” HP Reinforcement Veterans Way
  - Bend 6” HP Reinforcement Shevlin Pk
  - Bend 6” IP Reinforcement Ponderosa St
  - Baker Gate Station Rebuild
  - Prineville Gate Station Rebuild

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Conclusion

- CNG strives to use technology to gather data, analyze, plan, and design a reliable, safe, and economical distribution system.

Questions ?

Cascade Gas Supply Overview

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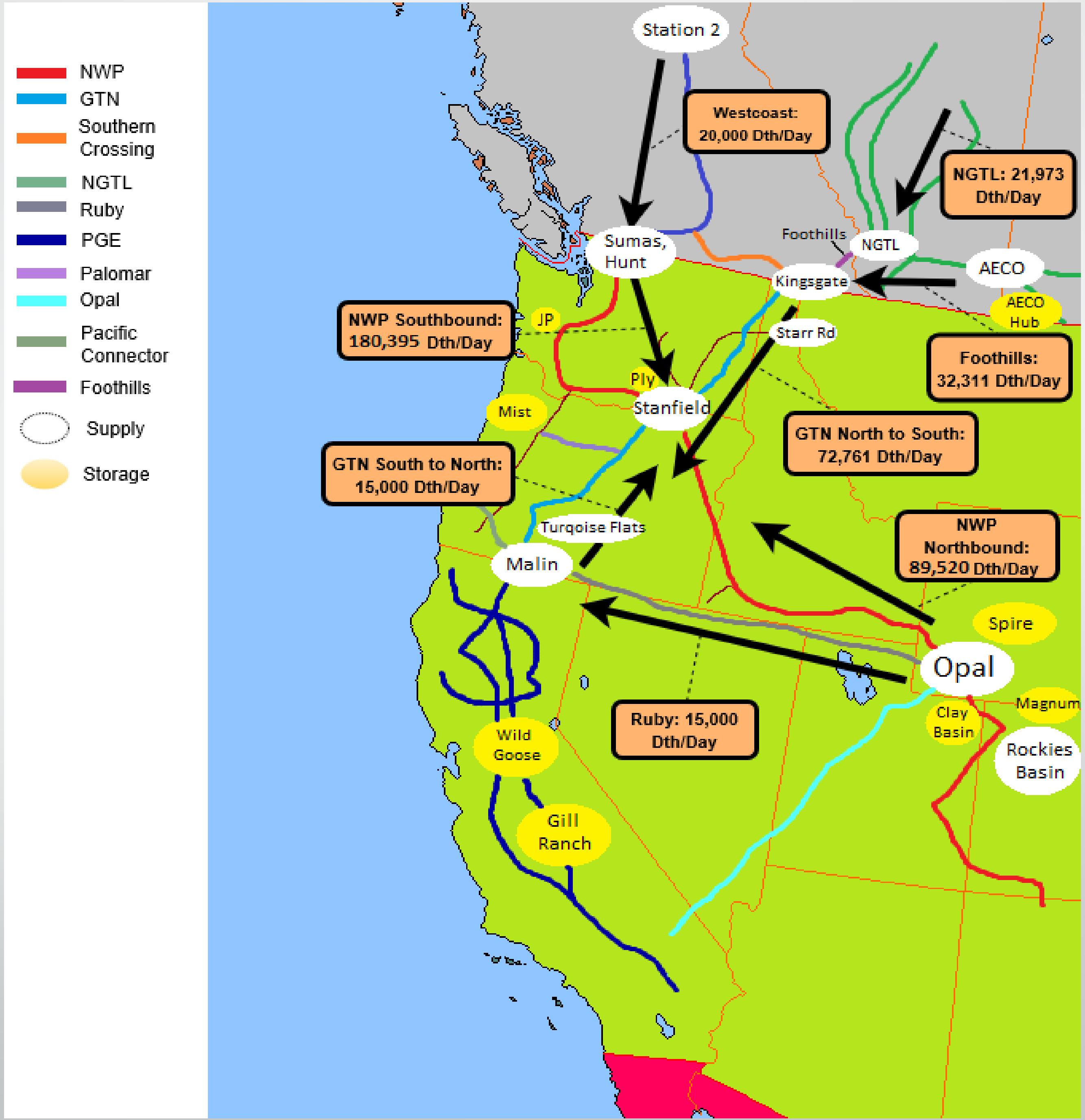
Pipeline transport flow


NWP
GTN
Southern Crossing
NGTL
Ruby
PGE
Palomar
Opal
Pacific Connector
Foothills
Supply
Storage
Station 2
Westcoast: 20,000 Dth/Day
NGTL: 21,973 Dth/Day
Sumas, Hunt
Foothills
NGTL
AECO
Kingsgate
AECO Hub
NWP Southbound: 180,395 Dth/Day
JP
Starr Rd
Foothills: 32,311 Dth/Day
Ply
Stanfield
Mist
GTN North to South: 72,761 Dth/Day
GTN South to North: 15,000 Dth/Day
Turqoise Flats
Malin
NWP Northbound: 89,520 Dth/Day
Spire
Opal
Magnum
Clay Basin
Rockies Basin
Ruby: 15,000 Dth/Day
Wild Goose
Gill Ranch

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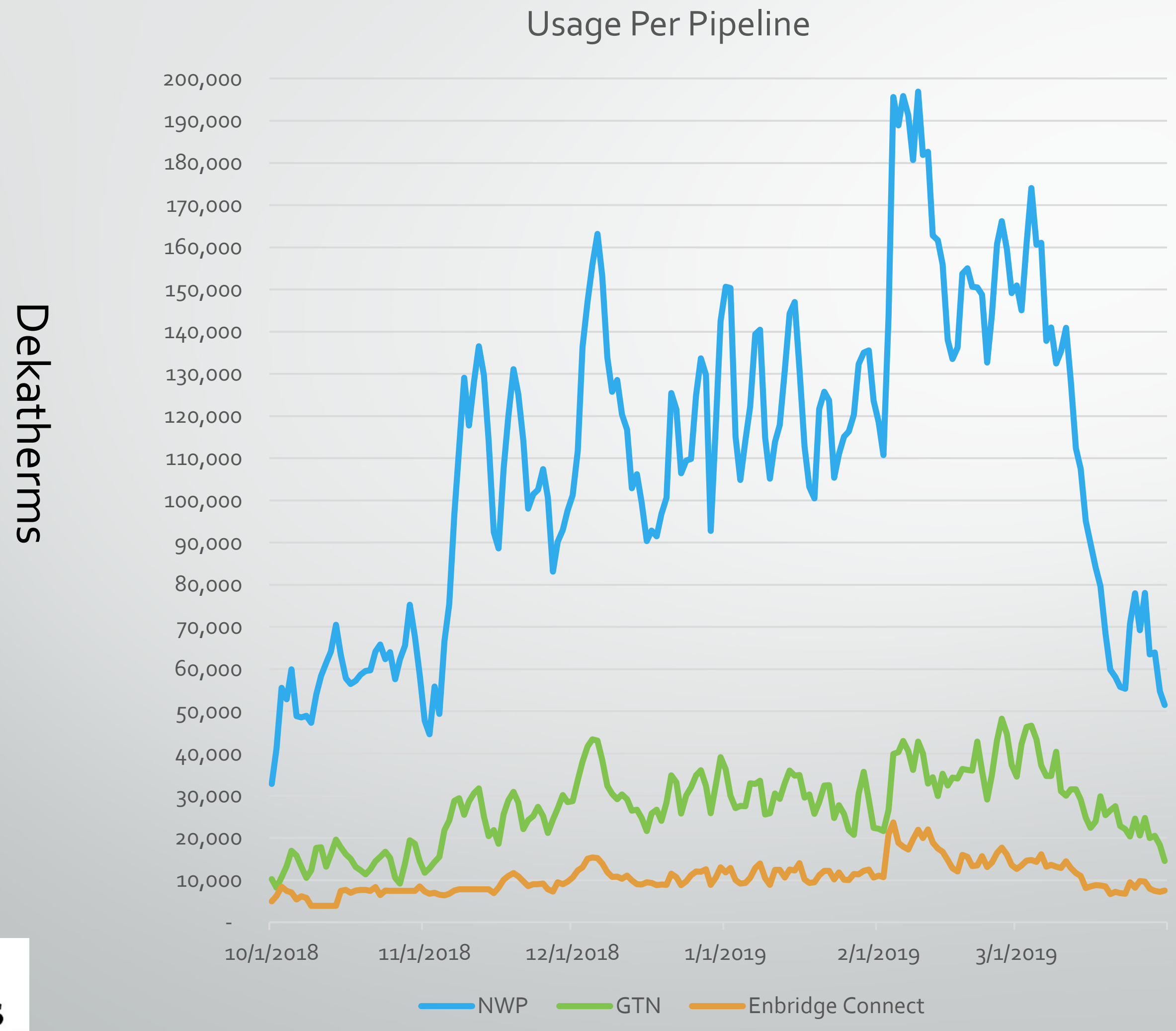
Winter Usage



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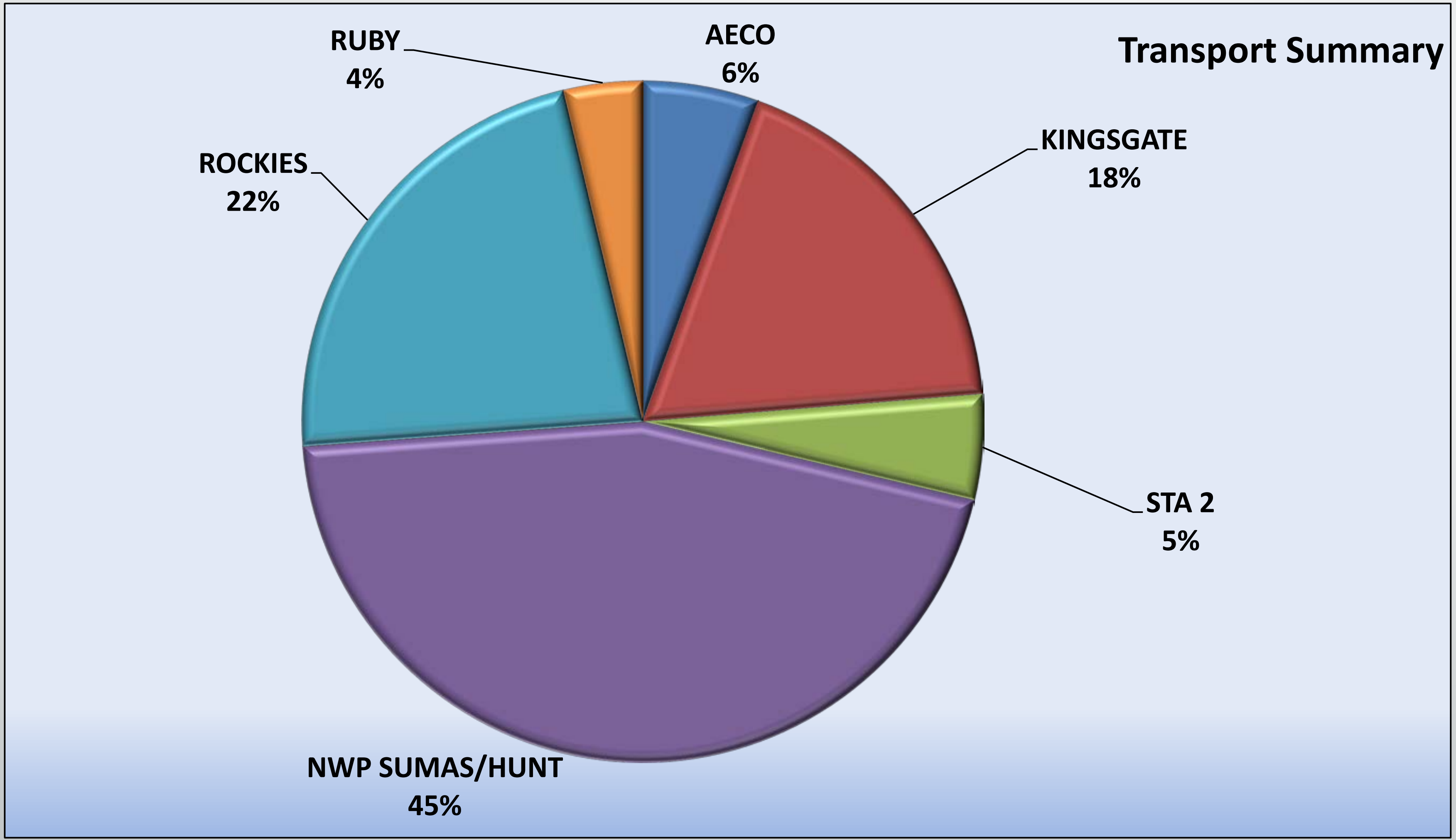
Transport Summary



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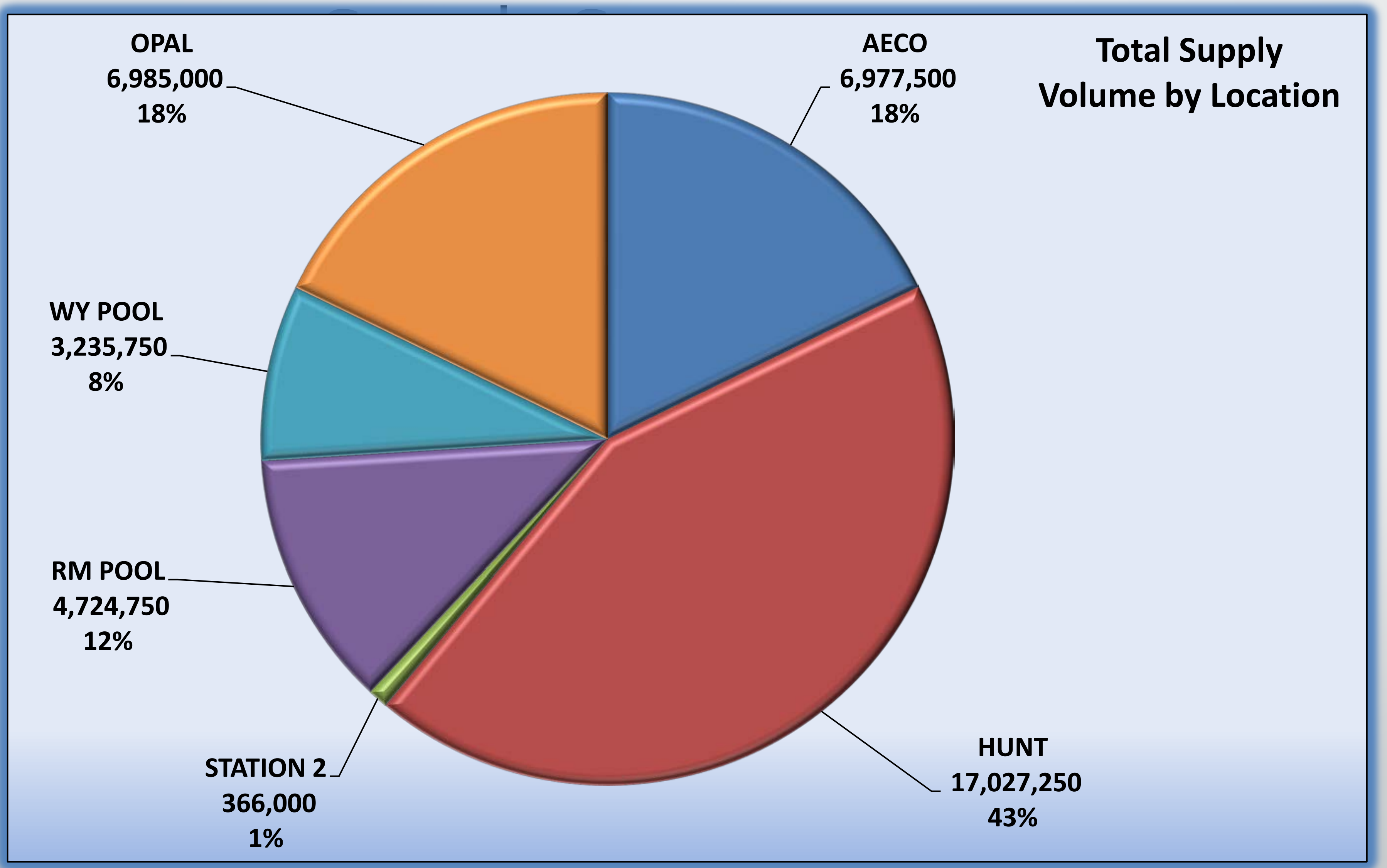
Total Supply Volume by Location
OPAL
6,985,000
18%
AECO
6,977,500
18%
WY POOL
3,235,750
8%
RM POOL
4,724,750
12%
STATION 2
366,000
1%
HUNT
17,027,250
43%

Storage Resources

- Jackson Prairie
    - 4 accounts with 1,235,593 dth capacity, 56,366 dth of demand
    - CNGC cycled approximately 95% of Jackson Prairie storage over the past winter season
    - CNGC targets cycling Jackson Prairie
- Plymouth
    - 2 accounts with 662,200 dths capacity, 78,125 dth of demand
    - In addition to above we have TF-2 (Firm Redelivery Transportation) of 10,675 dths
    - CNGC remains committed to using Plymouth as a peaking resource
- MIST
    - Added in the spring of 2019
    - 600,000 dth of capacity, 30,000 dth of demand

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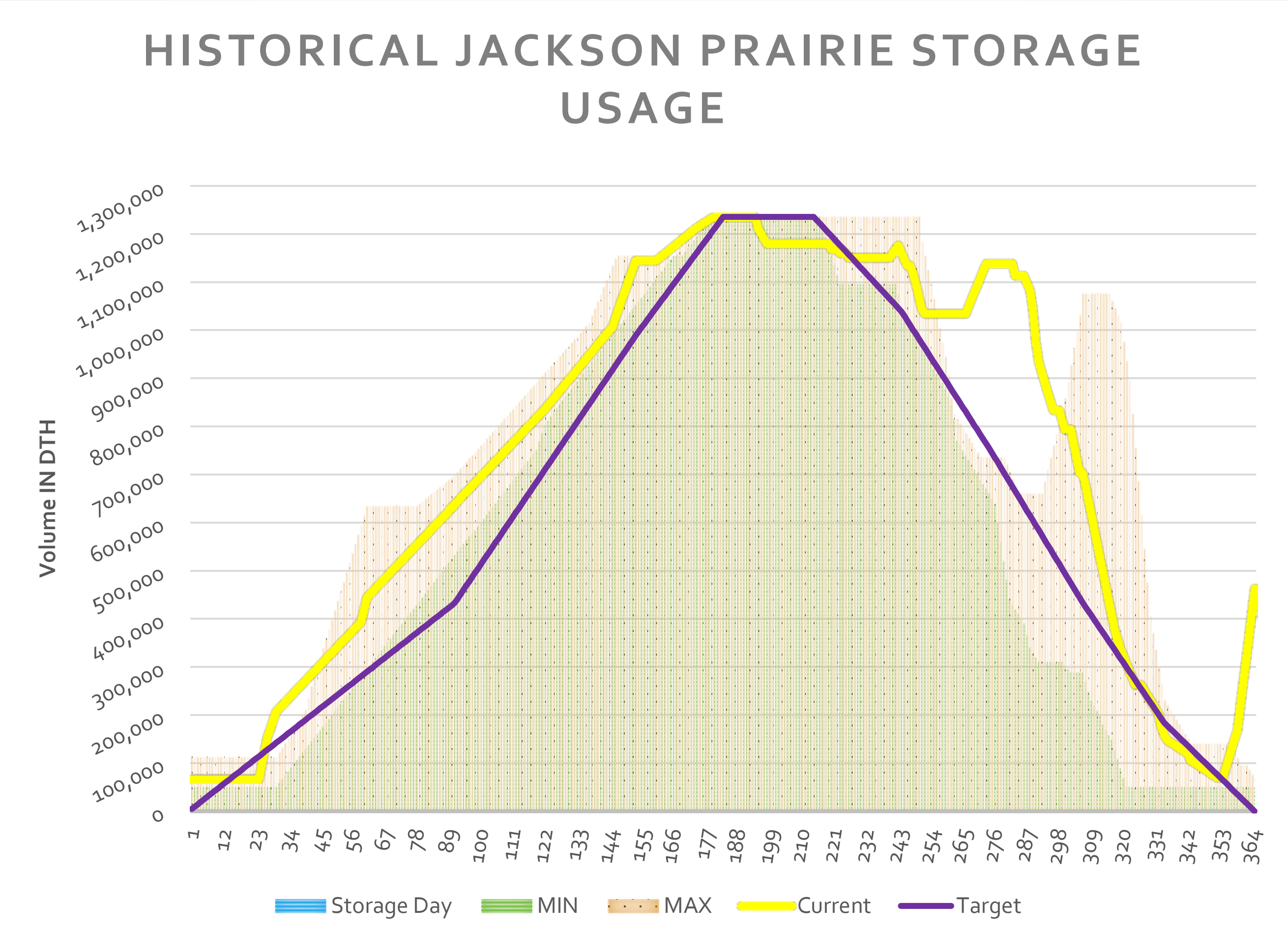
2018/2019 JP Storage Utilization



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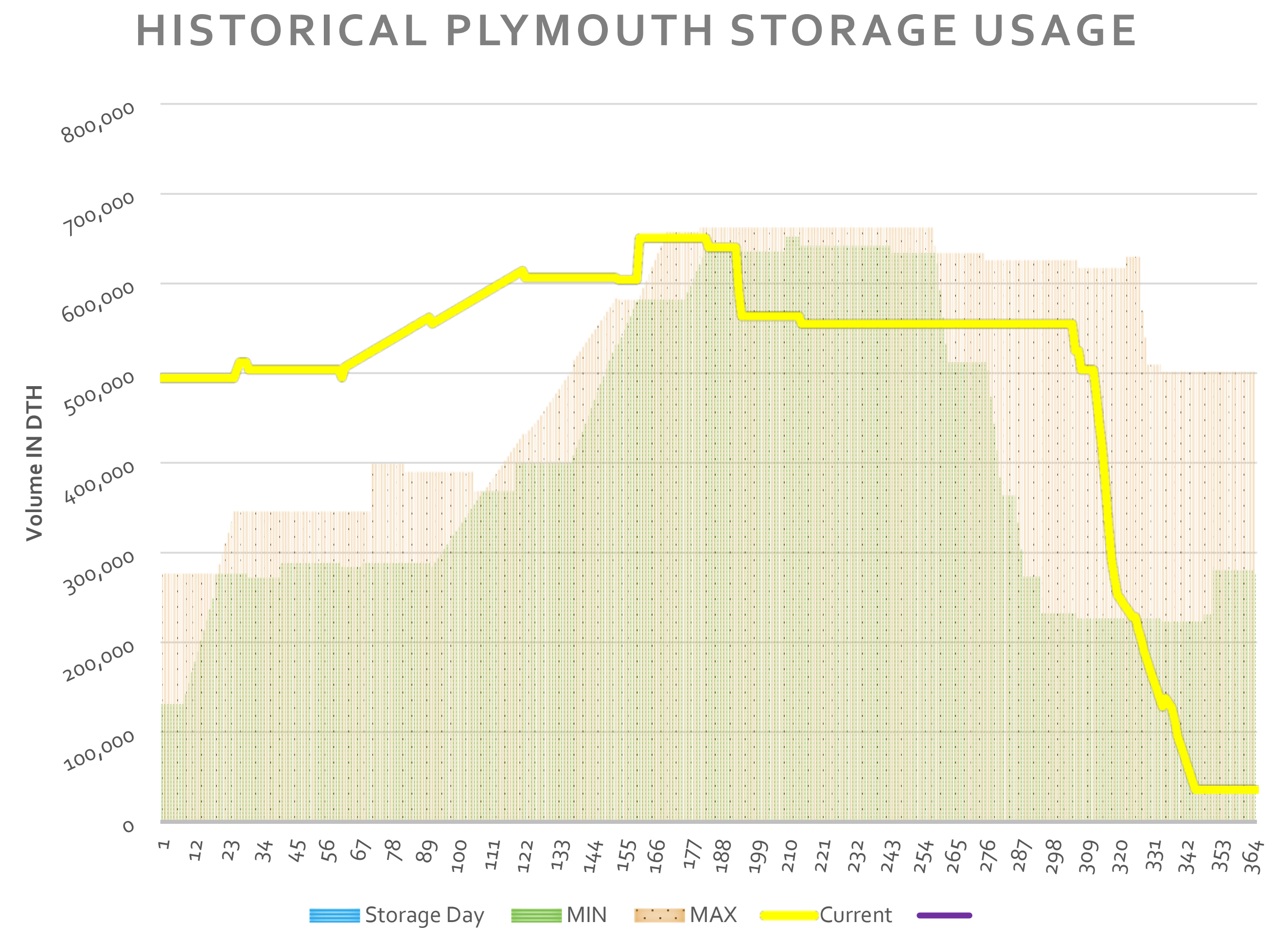
2018/2019 Plymouth Storage Utilization



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HIGHLIGHTS FOR THE 2019 PORTFOLIO DESIGN

- PORTFOLIO PROCUREMENT DESIGN BASED ON A DECLINING PERCENTAGE EACH YEAR, ACCORDINGLY: Year 1: Approximately 80% of annual requirements; Year 2: 40%, Year 3: 20%.
  - 80% allows more flexibility operationally
  - Allows us to be in the market monthly through FOM purchase or Day Gas purchases
- Hedged Percentages (fixed-price physical) Currently max 60% of annual requirements. Second year max is set at 40%, and 20% hedged volumes for year three. GSOC bumped up the 1st year percentage to mitigate upside risk at Sumas/Hunt .
  - Cascade has executed on one Financial Swap in Year 2.
  - Hedging may need to be more flexible as policy develops
- CNGC's Gas Supply Oversight Committee (GSOC) would consider a modification of this plan if the outer year 3 year forward price is 20% higher/lower than the front month over a reasonably sustained period.
- Annual load expectation (Nov-Oct) is approximately 34,000,000 dths, consistent with recent load history.

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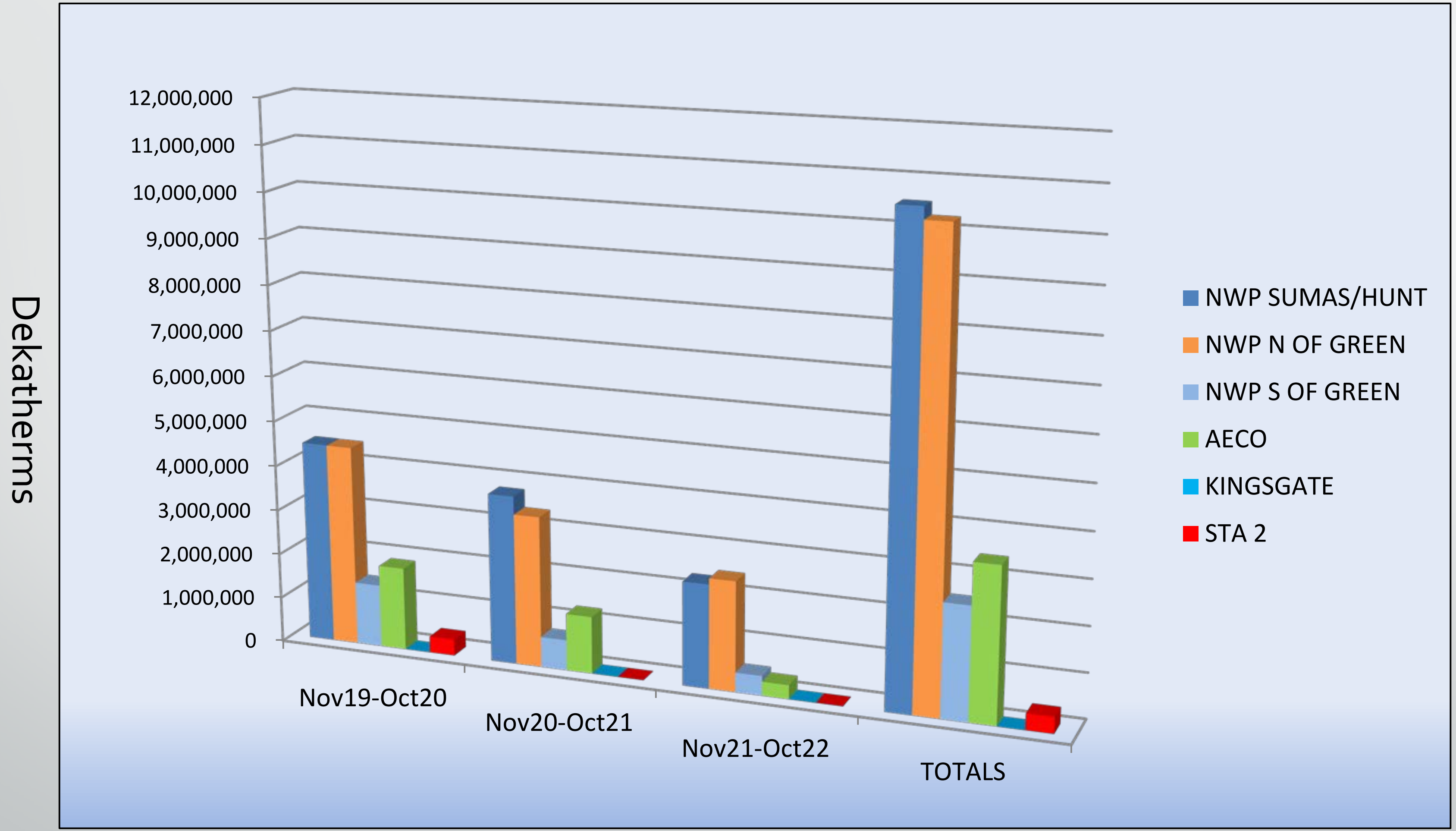
Total RFPs



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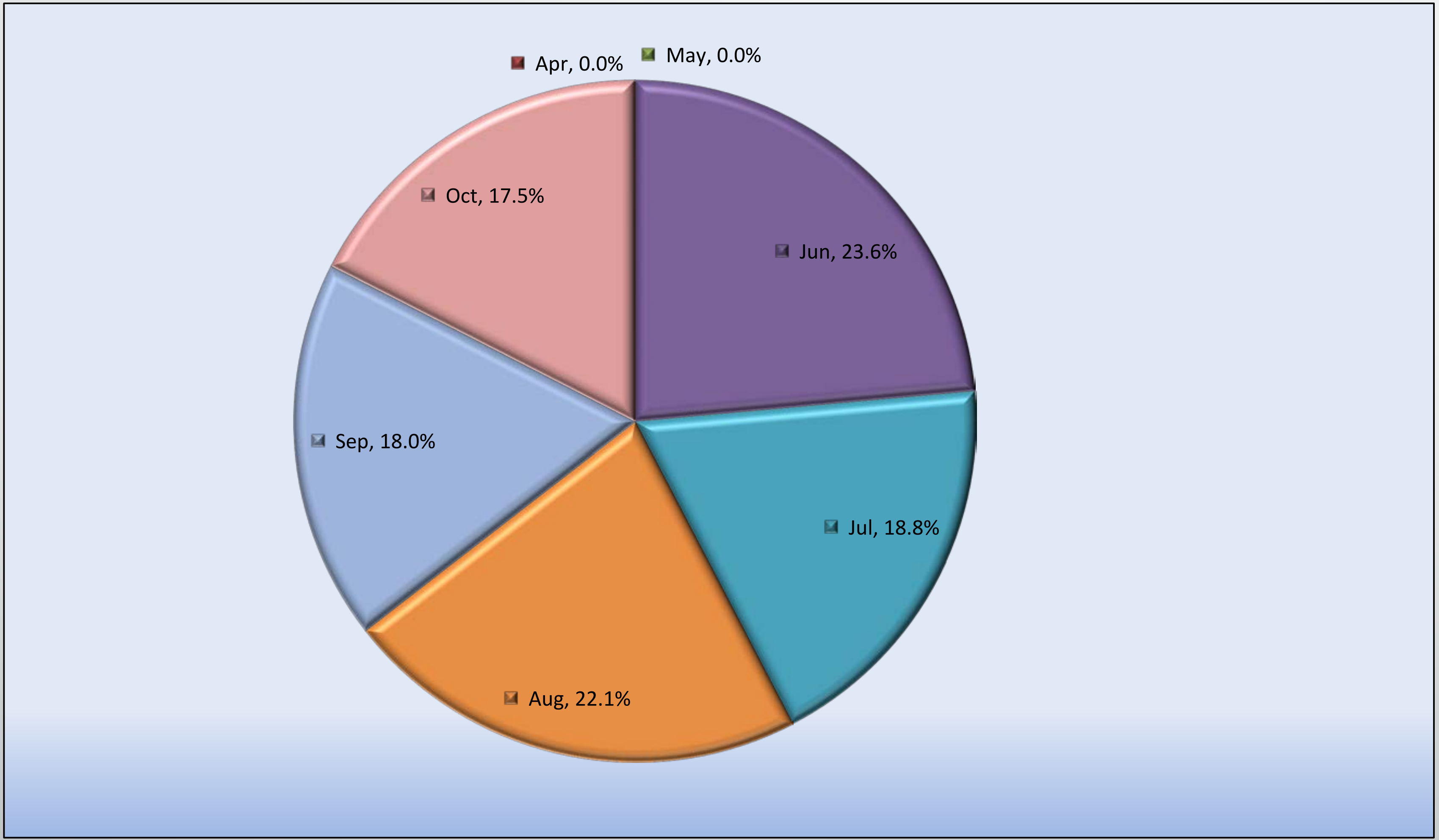
RFP Percentage by Month



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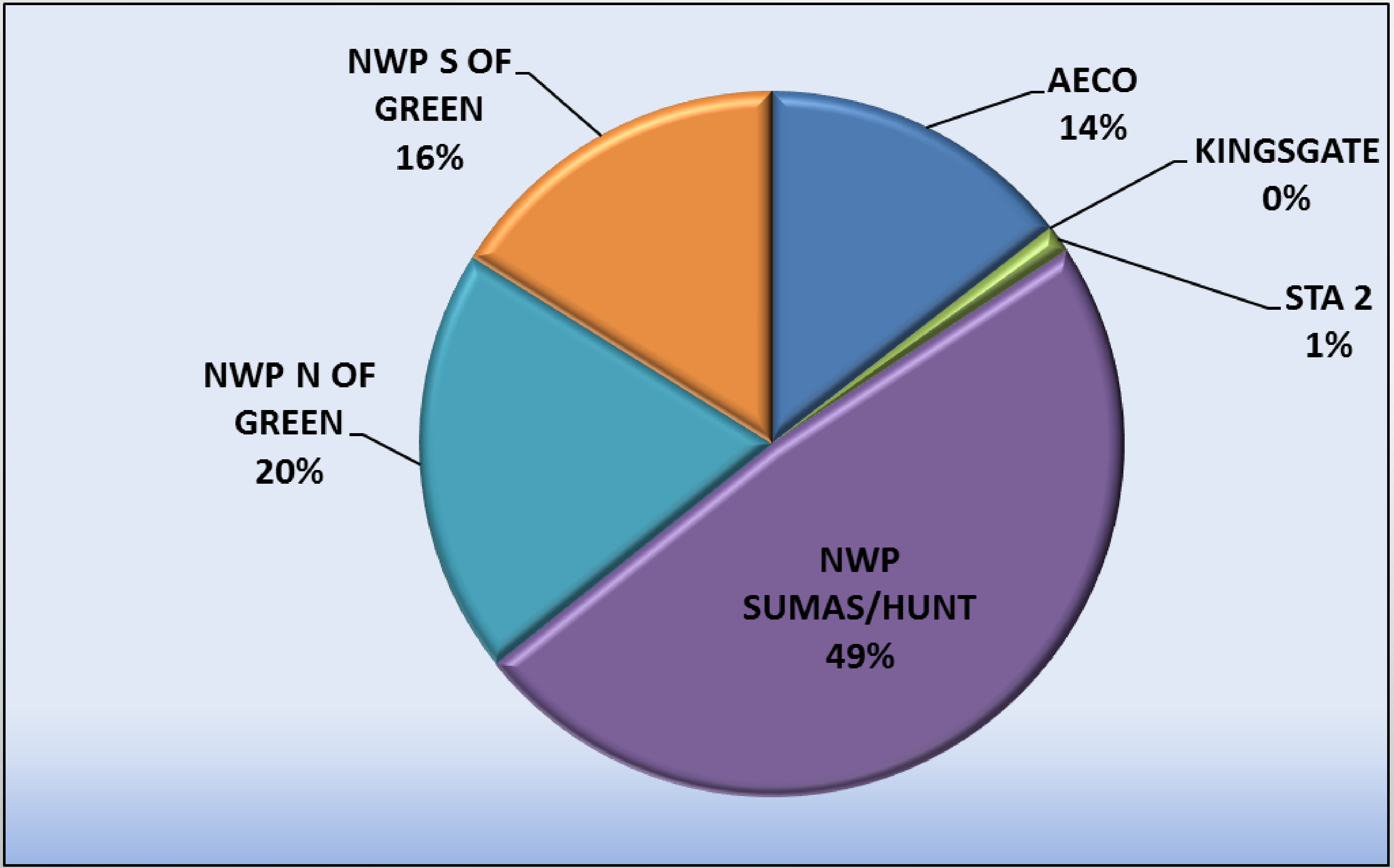
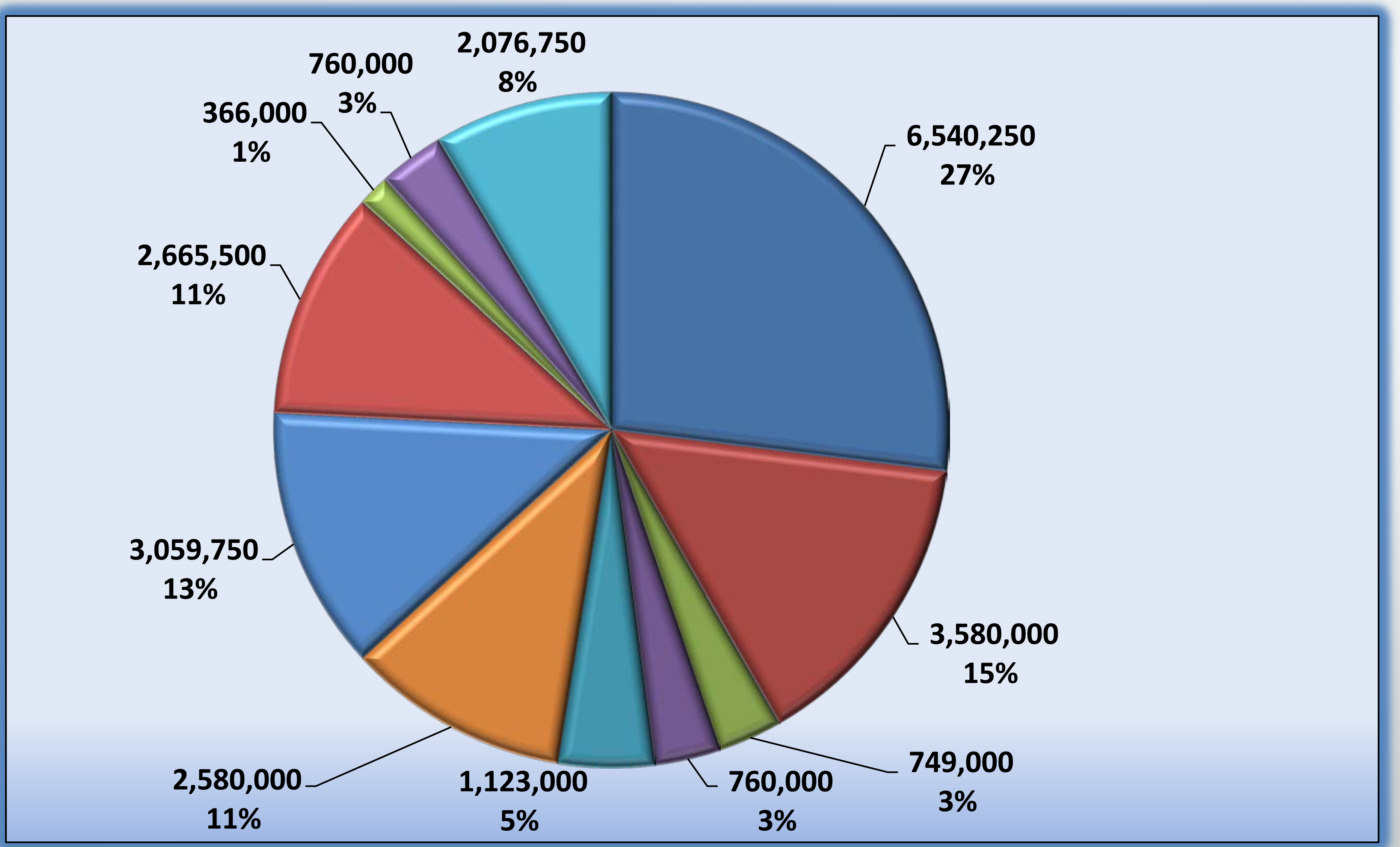
RFP Percentage By Basin



Current Supply Percentage by Supplier



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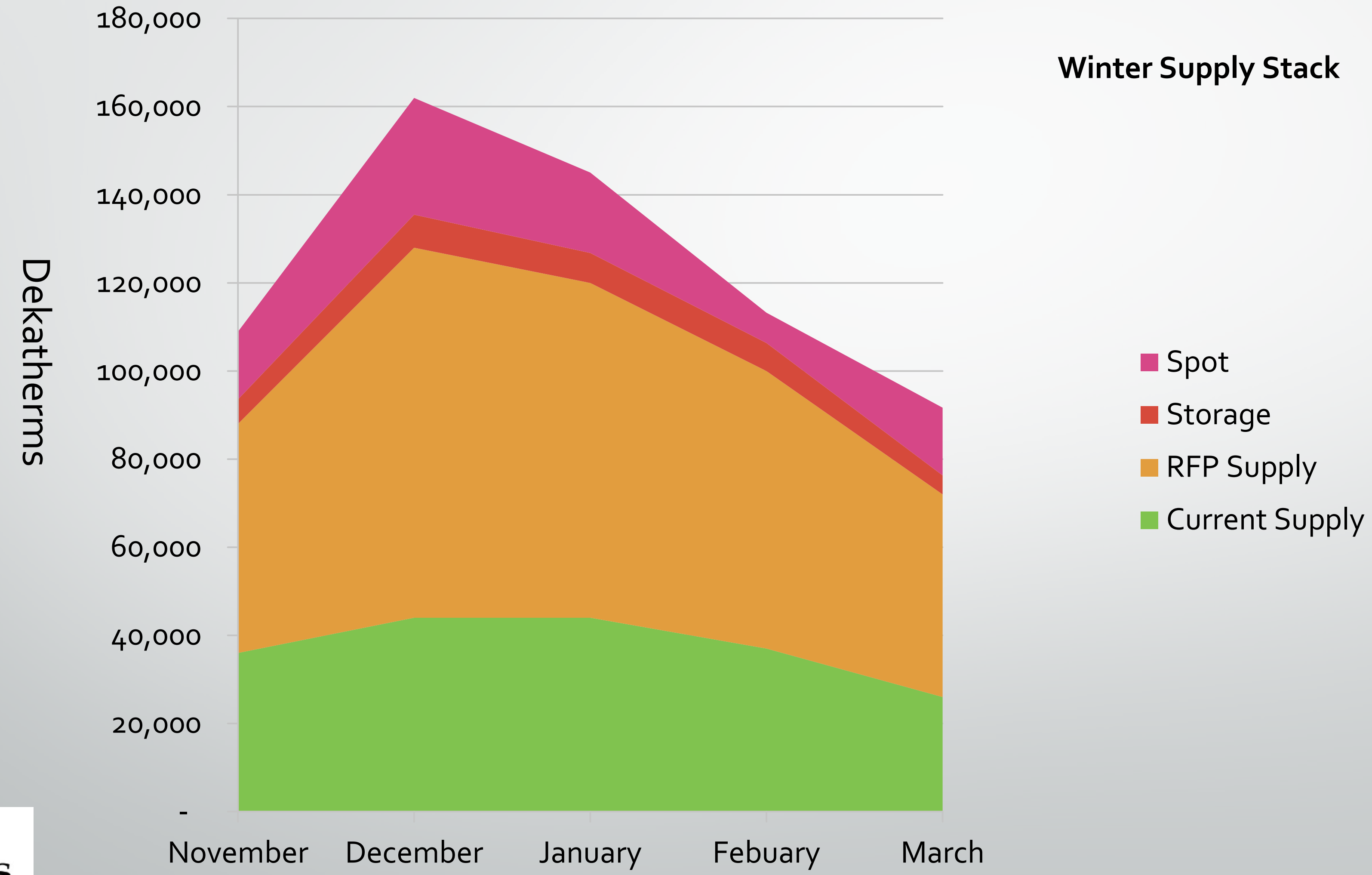
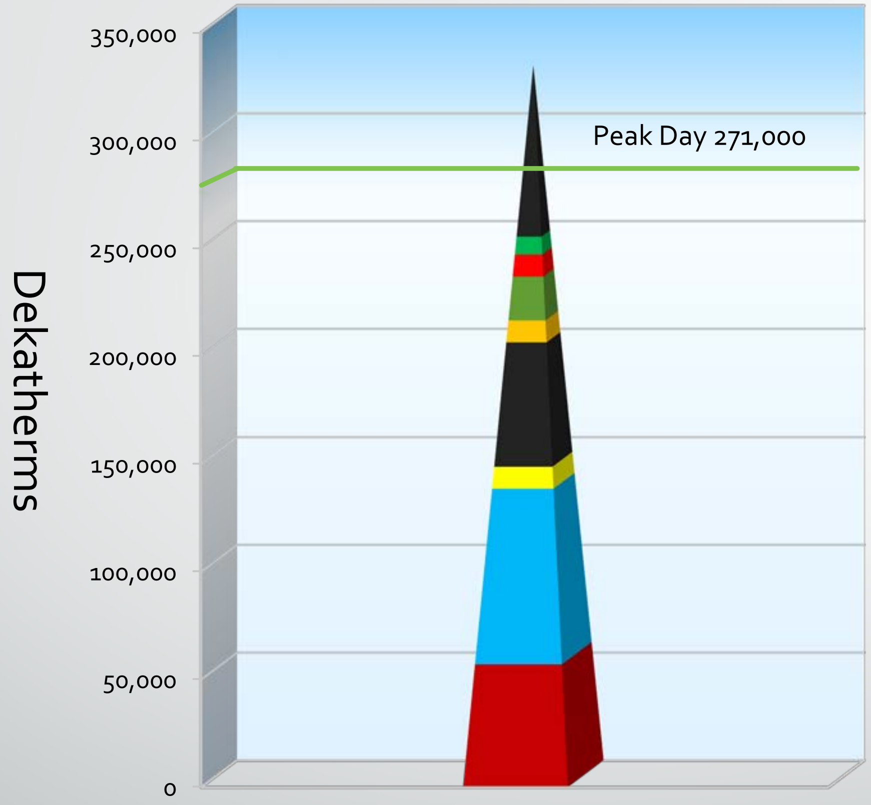
Winter Supply Stack



Peak Day Stack Example



Peak Day Stack Example

78,125	⬛	LS Storage
8,156	🟩	Pipeline Pack
10,000	🟥	3rd Party Citygate
20,000	🟩	Peaking Deal
10,000	🟧	Daily Spot Gas
56,366	⬛	SGS Storage
10,000	🟨	FOM Spot Gas
80,000	🟦	RFP Supply
56,000	🟥	Current Supply

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Planned Scenarios and Sensitivities

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SENDOUT® Model

- Cascade utilizes SENDOUT® for resource optimization.
- This model permits the Company to develop and analyze a variety of resource portfolios to help determine the type, size, and timing of resources best matched to forecast requirements.
- SENDOUT® is very powerful and complex. It operates by combining a series of existing and potential demand side and supply side resources, and optimizes their utilization at the lowest net present cost over the entire planning period for a given demand forecast.

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SENDOUT® Model Cont’d

- SENDOUT® utilizes a linear programming approach.
- The model knows the exact load and price for every day of the planning period based on the analyst’s input and can therefore minimize costs in a way that would not be possible in the real world.
- Therefore, it is important to acknowledge that linear programming analysis provides helpful but not perfect information to guide decisions.

Modeling Challenges

- Supply needs to get gas to the citygate.
- Many of Cascade's transport agreements were entered into decades ago, based on demand projections at that point in time.
- Sum of receipt quantity and aggregated delivery quantity can help identify resource deficiency depending on how rights are allocated.
- The aggregated look can mask individual citygate issues for looped sections, and the disaggregated look can create deficiencies where they don't exist.
- In many cases operational capacity is greater than contracted.
- SENDOUT® has perfect knowledge.

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Supply Resource Optimization Process

- **Step 1: As-Is Analysis**
  - Run a deterministic optimization of existing resources with a three-day peak event to uncover timing and quantity of resource deficiencies.
- **Step 2: Introduce Additional Resources**
  - Include incremental supply, storage, and transportation to derive a deterministic optimal portfolio, additional portfolios.
- **Step 3: Stochastic Analysis of All Portfolios Under Existing Conditions**
  - Run all portfolios through a Monte Carlo weather simulation, using expected growth, supply and storage accessibility. Record the probability distributions of total system costs for each portfolio.
- **Step 4: Ranking of Portfolios**
  - Determine the preferred portfolio based on the mean and Value at Risk (VaR) of the total system cost and unserved demand of each portfolio. This resource mix will be the best combination of cost and risk for Cascade and its customers.

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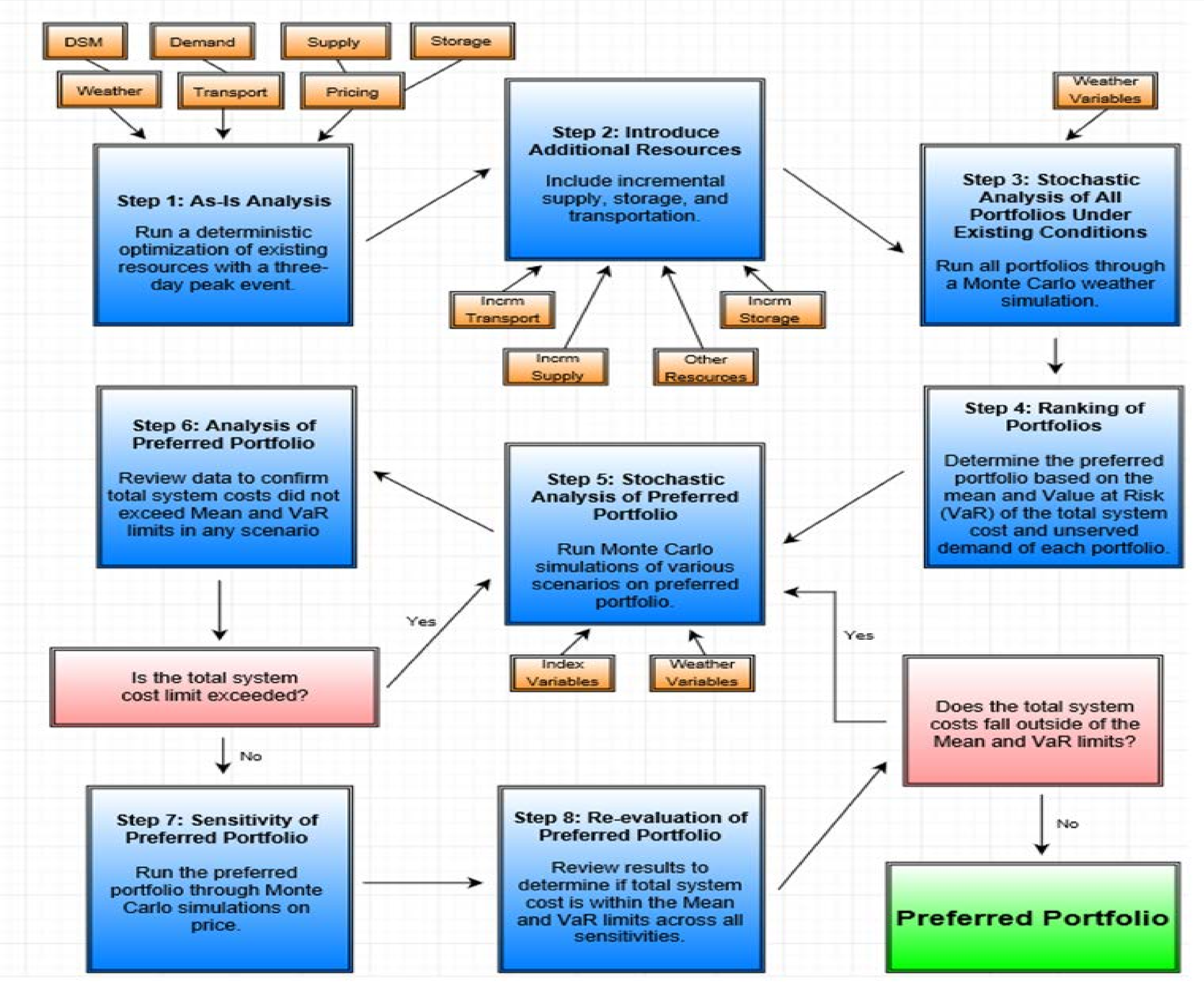
Supply Resource Optimization Process (Cont'd)

- **Step 5: Stochastic Analysis of Preferred Portfolio**
  - Run Monte Carlo simulations of various scenarios on preferred portfolio; comparing Mean and VaR to a managerial limit.
- **Step 6: Analysis of Preferred Portfolio**
  - Review data to confirm total system costs did not exceed Mean and VaR limits in any scenario. If limit is exceeded, repeat step 5 with next highest ranked portfolio.
- **Step 7: Sensitivity of Preferred Portfolio**
  - Run the preferred portfolio through Monte Carlo simulations on price. Review results to determine if total system cost is within the Mean and VaR limits across all sensitivities.
- **Step 8: Re-evaluation of Preferred Portfolio**
  - If the total system costs fall outside of the Mean and VaR limits in sensitivity analysis, select the next most optimal portfolio to run scenario and sensitivity analysis on. Repeat as needed.

Supply Resource Optimization Process Flow Chart


DSM
Demand
Supply
Storage
Weather
Transport
Pricing

Step 1: As-Is Analysis

Run a deterministic optimization of existing resources with a three-day peak event.

Step 2: Introduce Additional Resources

Include incremental supply, storage, and transportation.

Incrm Transport
Incrm Supply
Other Resources
Incrm Storage
Weather Variables

Step 3: Stochastic Analysis of All Portfolios Under Existing Conditions

Run all portfolios through a Monte Carlo weather simulation.

Step 4: Ranking of Portfolios

Determine the preferred portfolio based on the mean and Value at Risk (VaR) of the total system cost and unserved demand of each portfolio.

Step 5: Stochastic Analysis of Preferred Portfolio

Run Monte Carlo simulations of various scenarios on preferred portfolio.

Index Variables
Weather Variables

Step 6: Analysis of Preferred Portfolio

Review data to confirm total system costs did not exceed Mean and VaR limits in any scenario

Is the total system cost limit exceeded?

Step 7: Sensitivity of Preferred Portfolio

Run the preferred portfolio through Monte Carlo simulations on price.

Step 8: Re-evaluation of Preferred Portfolio

Review results to determine if total system cost is within the Mean and VaR limits across all sensitivities.

Does the total system costs fall outside of the Mean and VaR limits?

Preferred Portfolio

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Additional Preferred Portfolio Considerations

- Does it get supply to the citygate?
- Is it reliable?
- Does it have a long lead time?
- How much does it cost?
- New build vs. depreciated cost
- The rate pancake
- Is it a base load or peaking resource?
- How many dekatherms are needed?
- What is the “shape” of resource?
- Is it tried and true technology, new technology, or yet to be discovered?
- Who else will be competing for the resource?

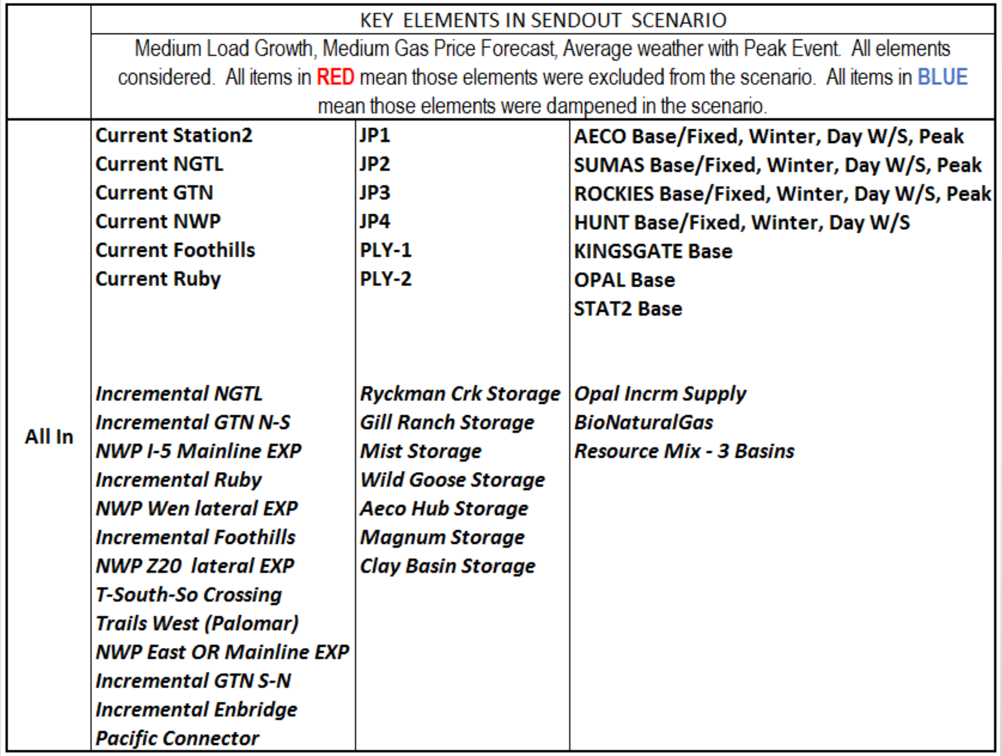
Scenarios and Sensitivities

- Scenario:
  - Change in projected demand
  - Change in availability of existing resources to serve demand
  - Change in availability of supply

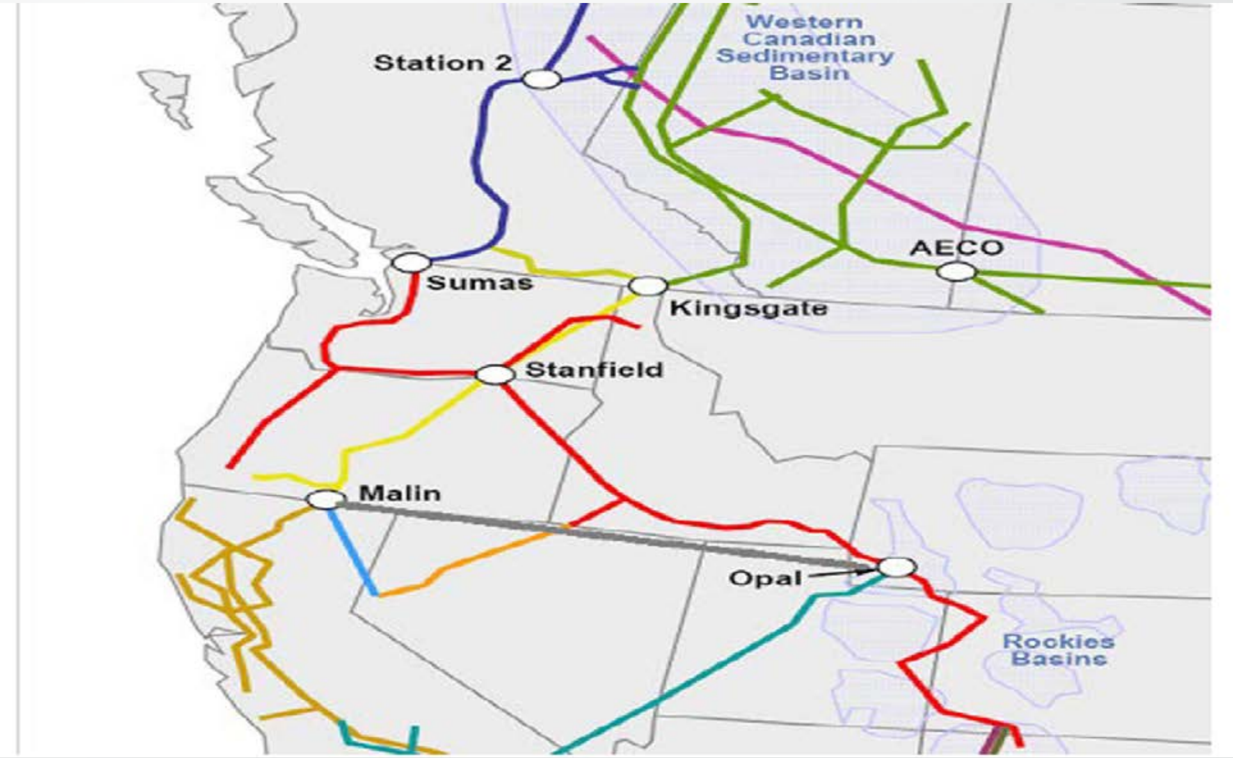
- Sensitivity:
  - Change in price forecast
  - Change in environmental adder
  - Change in carbon forecast

Both carry the same importance, failure to pass either of them can lead to a portfolio being rejected

All In Case

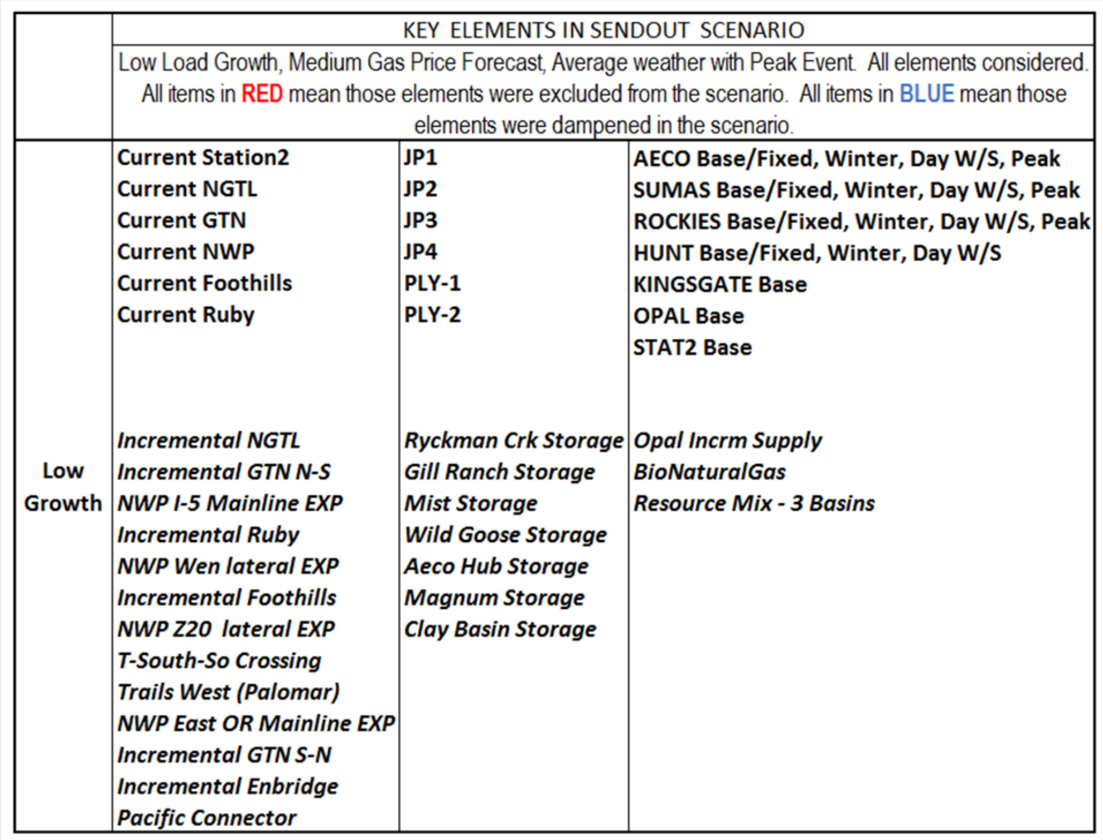


	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
All In	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

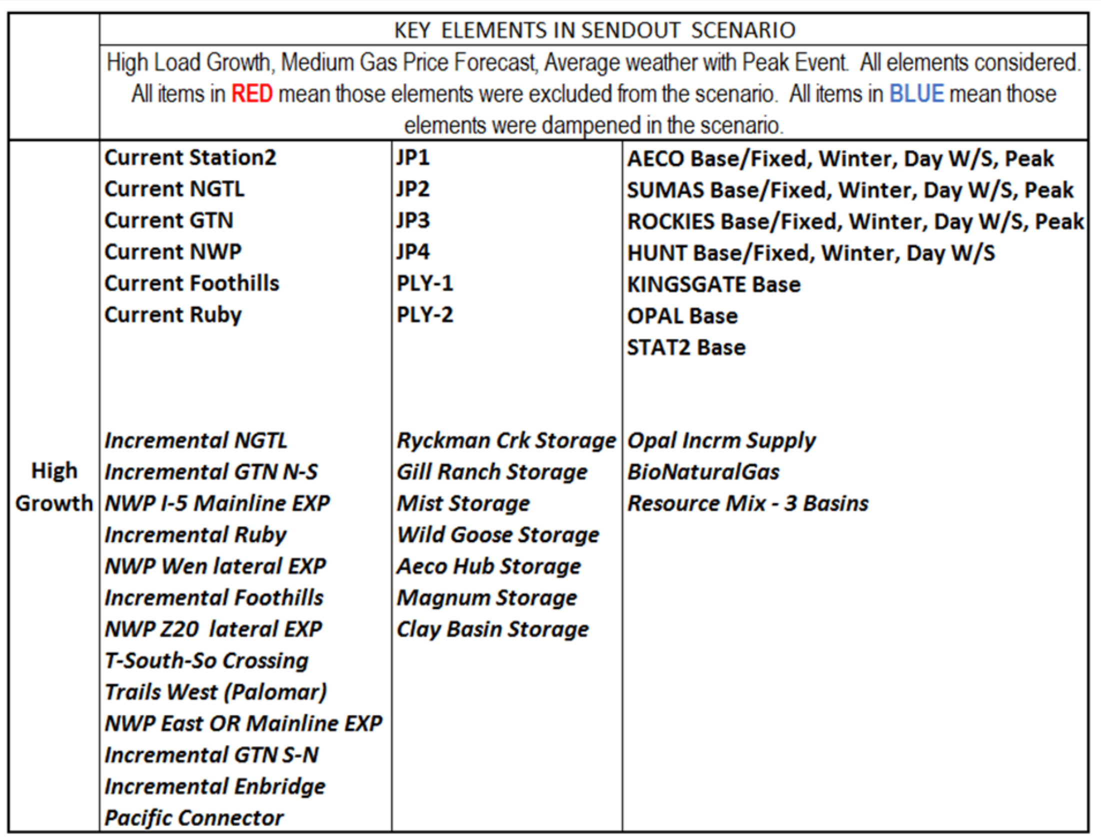


The All In Case run allows the Company to see what the model would select if all current and probable resources are available.

Low Growth and High Growth



	KEY ELEMENTS IN SENDOUT SCENARIO		
	Low Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
Low Growth	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		



	KEY ELEMENTS IN SENDOUT SCENARIO		
	High Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
High Growth	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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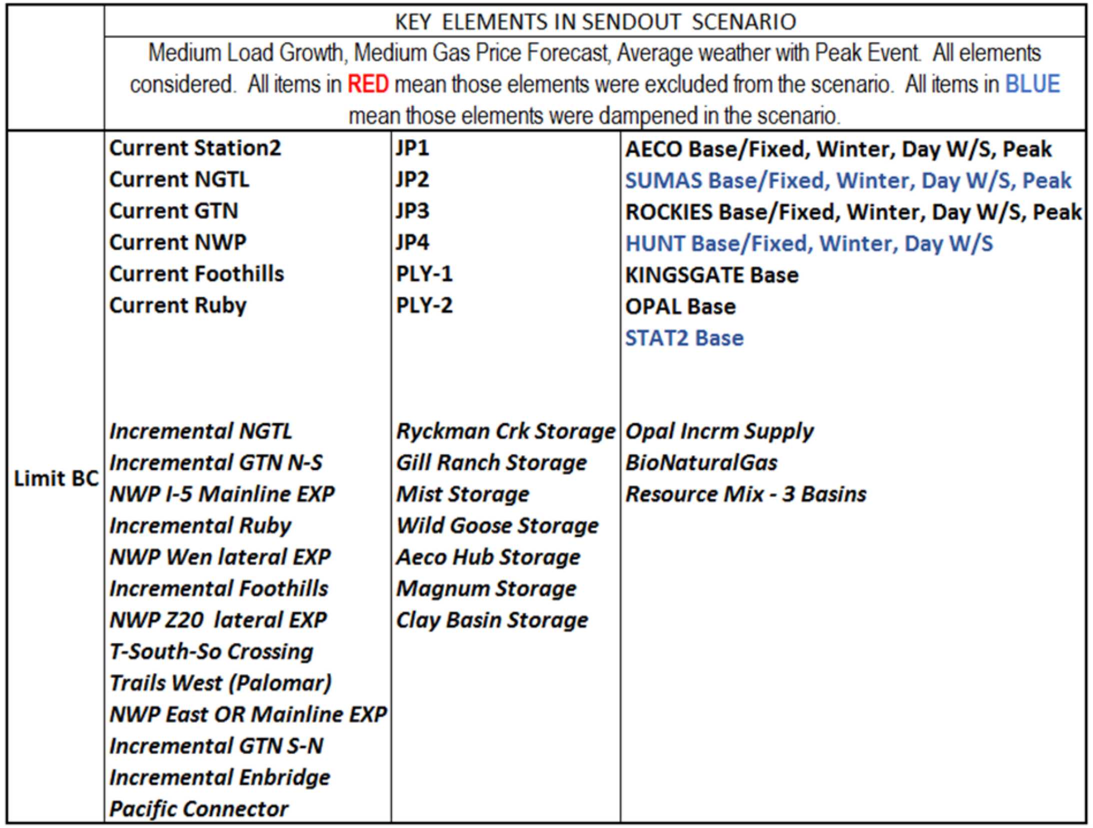
Limit BC and Limit Alberta



	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
Limit BC	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
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	NWP Wen lateral EXP	***Aeco Hub Storage***	
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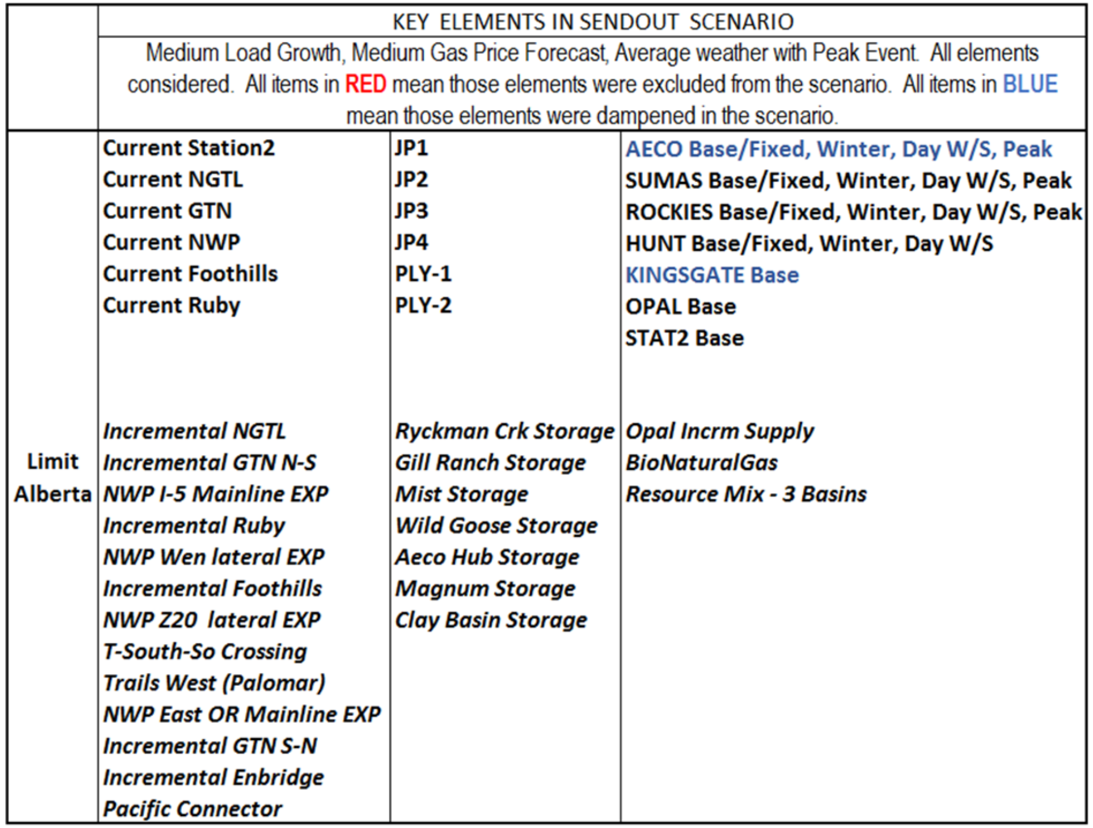
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		



	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
Limit Alberta	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
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	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
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	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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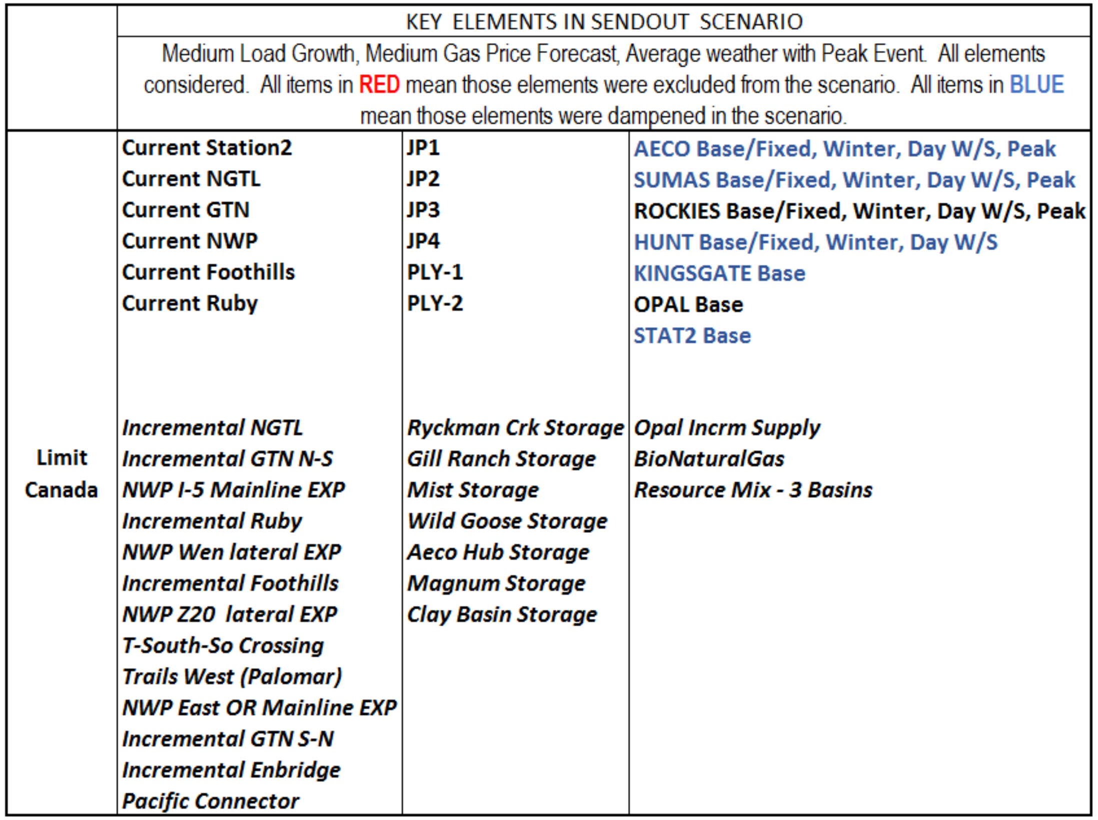
Limit Canada and Limit Rockies



	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
Limit Canada	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
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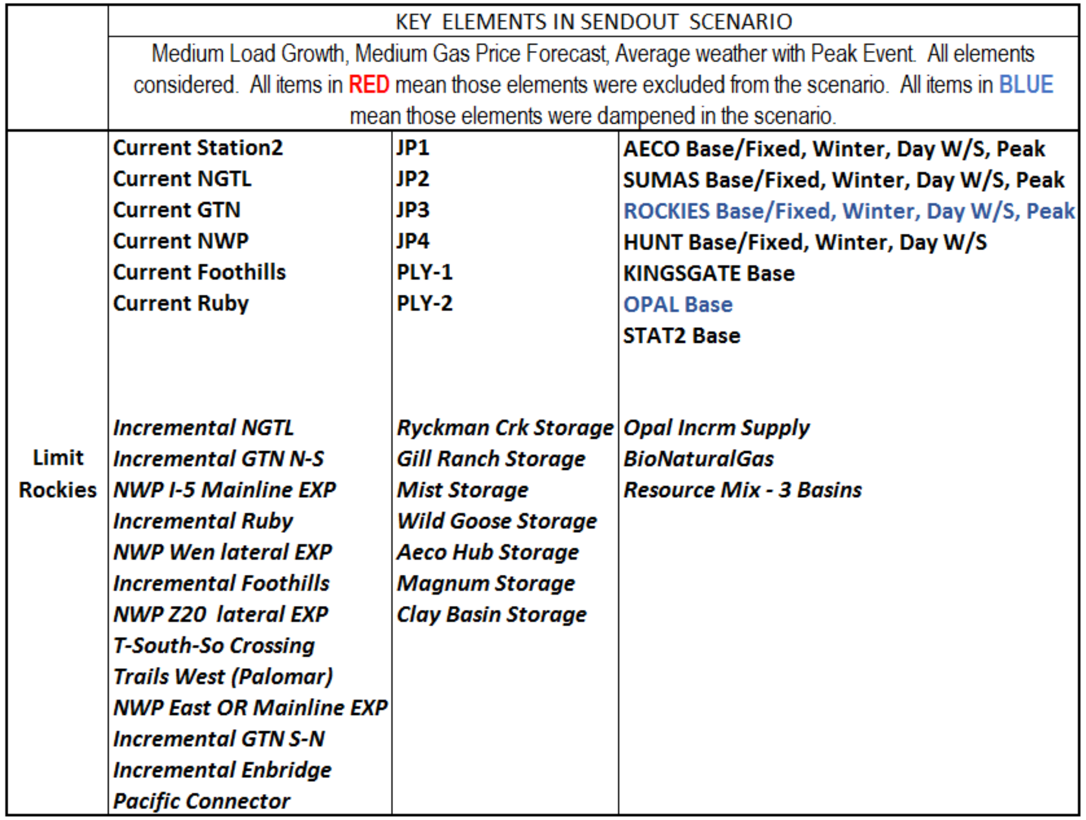
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		



	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
Limit Rockies	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
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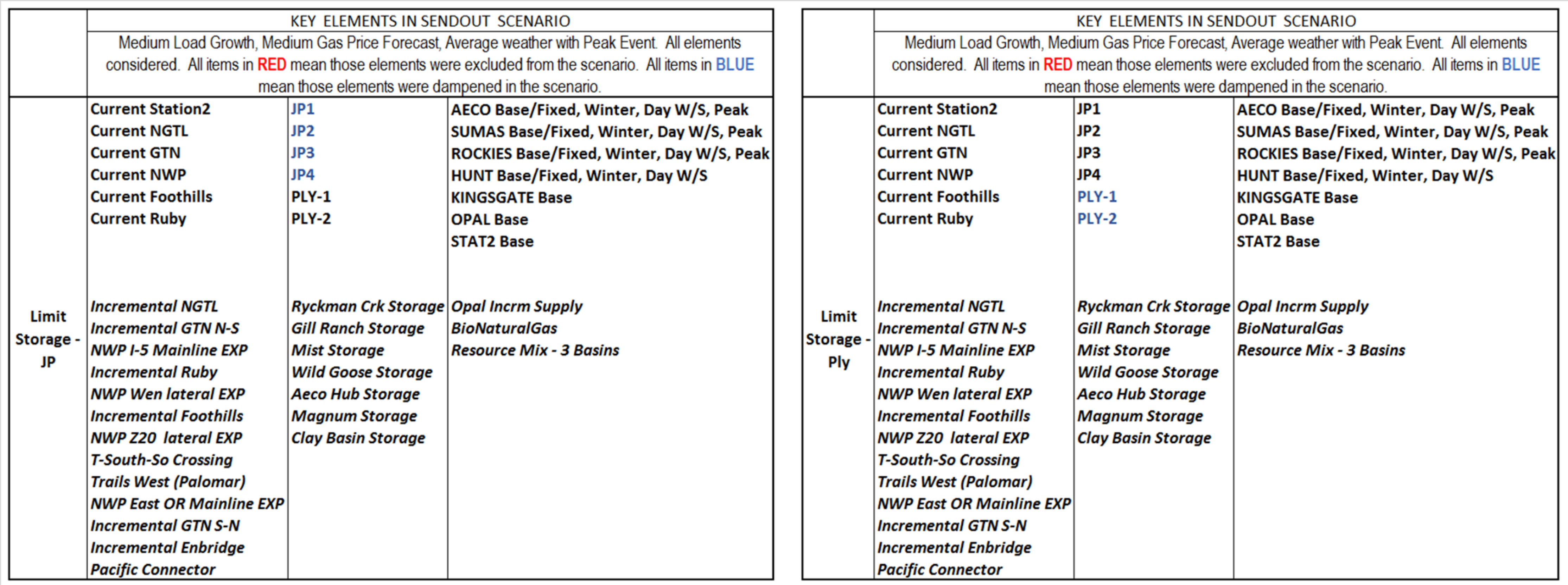
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

Limit JP and Limit Ply Storage



	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
Limit Storage - JP	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
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	Incremental Foothills	***Magnum Storage***	
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	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
Limit Storage - Ply	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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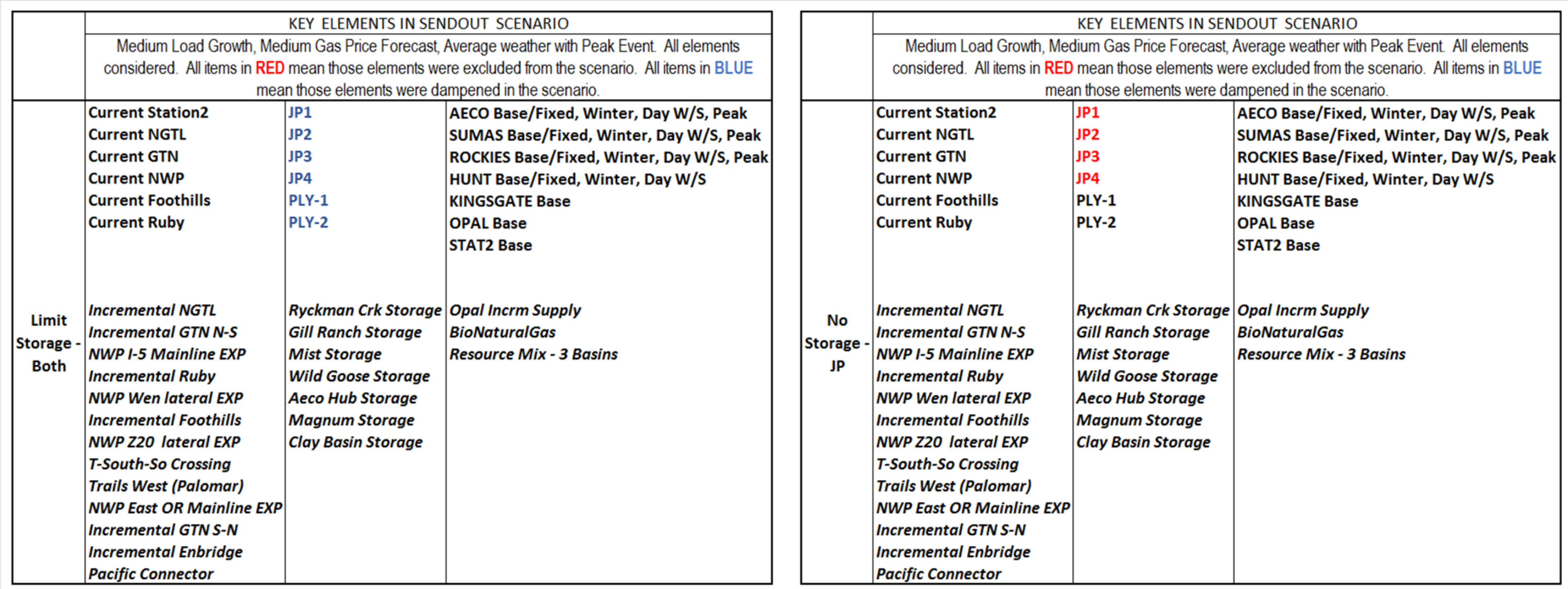
Limit Both Storage and No JP



	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
Limit Storage - Both	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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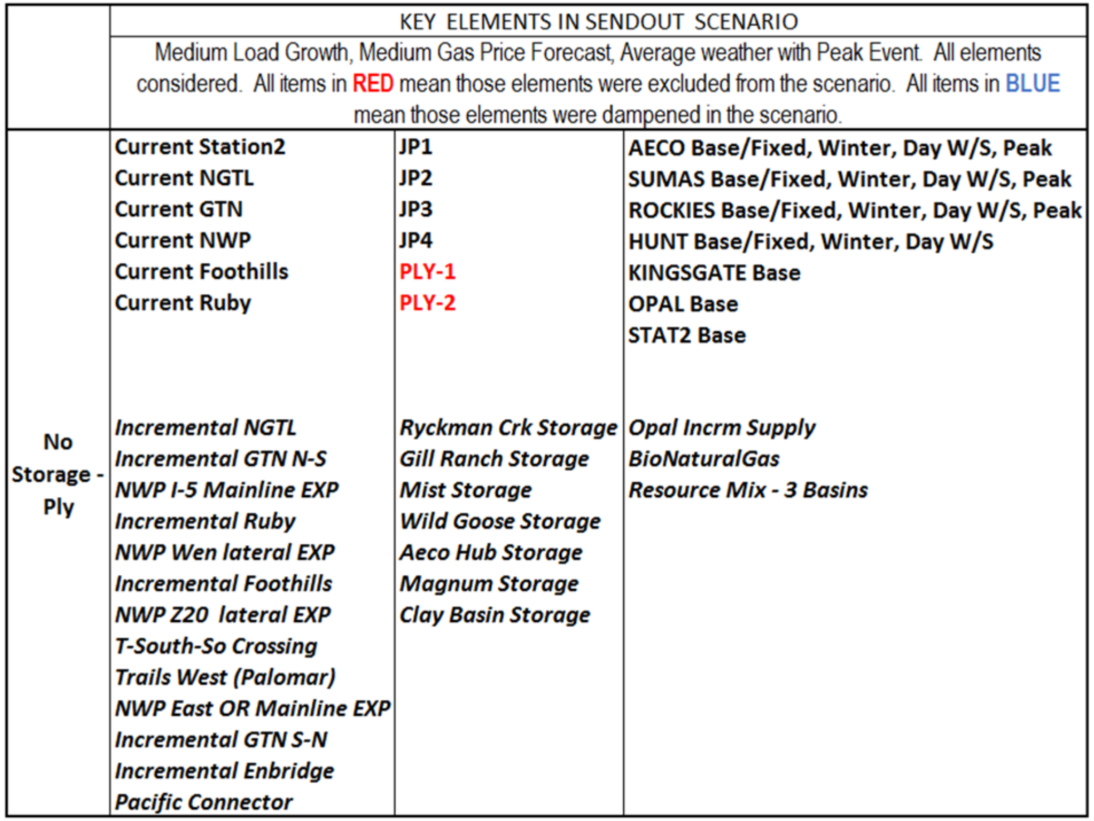
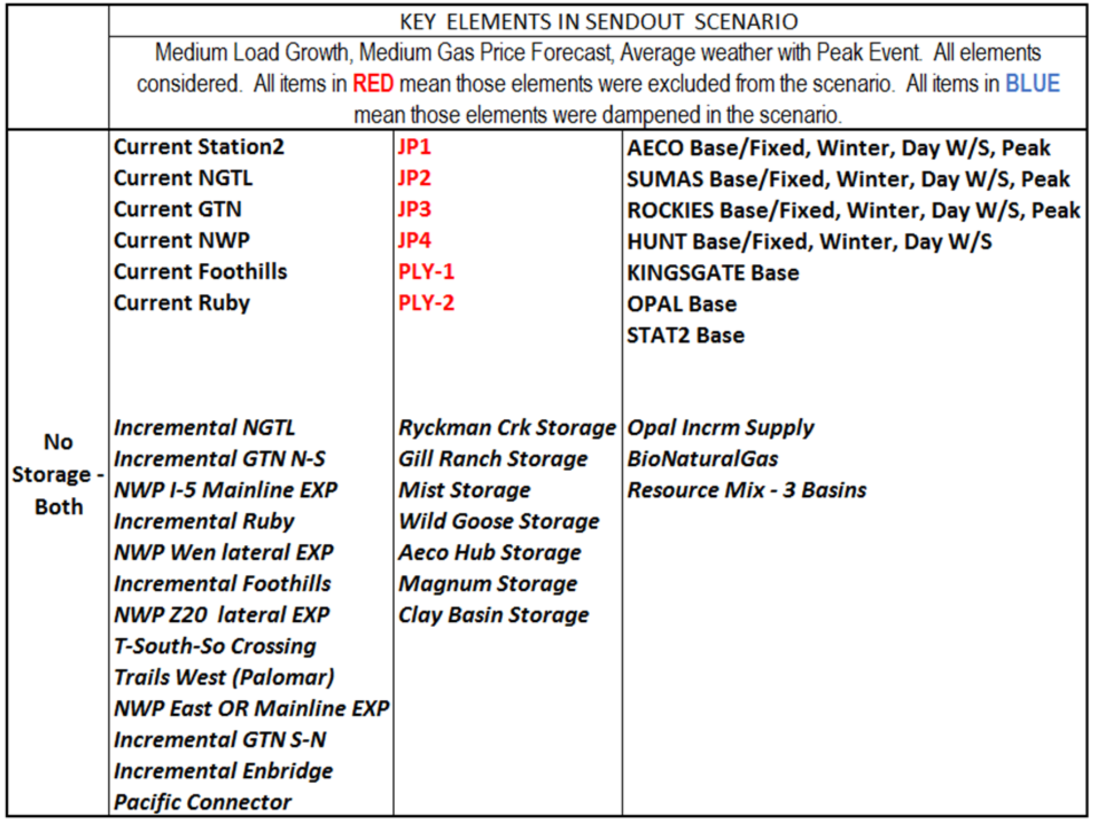
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
No Storage - JP	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

No Ply Storage and No Storage



	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
No Storage - Ply	Current Station2	JP1	AECO Base/Fixed, Winter, Day W/S, Peak
	Current NGTL	JP2	SUMAS Base/Fixed, Winter, Day W/S, Peak
	Current GTN	JP3	ROCKIES Base/Fixed, Winter, Day W/S, Peak
	Current NWP	JP4	HUNT Base/Fixed, Winter, Day W/S
	Current Foothills	PLY-1	KINGSGATE Base
	Current Ruby	PLY-2	OPAL Base
			STAT2 Base
	Incremental NGTL	*Ryckman Crk Storage*	*Opal Incrm Supply*
	Incremental GTN N-S	*Gill Ranch Storage*	*BioNaturalGas*
	NWP I-5 Mainline EXP	*Mist Storage*	*Resource Mix - 3 Basins*
	Incremental Ruby	*Wild Goose Storage*	
	NWP Wen lateral EXP	*Aeco Hub Storage*	
	Incremental Foothills	*Magnum Storage*	
	NWP Z20 lateral EXP	*Clay Basin Storage*	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		



	KEY ELEMENTS IN SENDOUT SCENARIO		
	Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in RED mean those elements were excluded from the scenario. All items in BLUE mean those elements were dampened in the scenario.		
No Storage - Both	Current Station2	JP1	AECO Base/Fixed, Winter, Day W/S, Peak
	Current NGTL	JP2	SUMAS Base/Fixed, Winter, Day W/S, Peak
	Current GTN	JP3	ROCKIES Base/Fixed, Winter, Day W/S, Peak
	Current NWP	JP4	HUNT Base/Fixed, Winter, Day W/S
	Current Foothills	PLY-1	KINGSGATE Base
	Current Ruby	PLY-2	OPAL Base
			STAT2 Base
	Incremental NGTL	*Ryckman Crk Storage*	*Opal Incrm Supply*
	Incremental GTN N-S	*Gill Ranch Storage*	*BioNaturalGas*
	NWP I-5 Mainline EXP	*Mist Storage*	*Resource Mix - 3 Basins*
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	Incremental Foothills	*Magnum Storage*	
	NWP Z20 lateral EXP	*Clay Basin Storage*	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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Sensitivities Analyses

Sensitivities		Assumpitons
Price	High	Medium Load Growth, Average Weather with Peak Event, High Gas Price Environment
	Low	Medium Load Growth, Average Weather with Peak Event, Low Gas Price Environment
Env. Adder	0%	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with No Adder for Unknown Regulatory Impacts
	20%	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with 20% Adder for Unknown Regulatory Impacts
	30%	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with 30% Adder for Unknown Regulatory Impacts
Carbon Adder	Various	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with Various Potential Carbon Futures Modeled

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Alternative Resources

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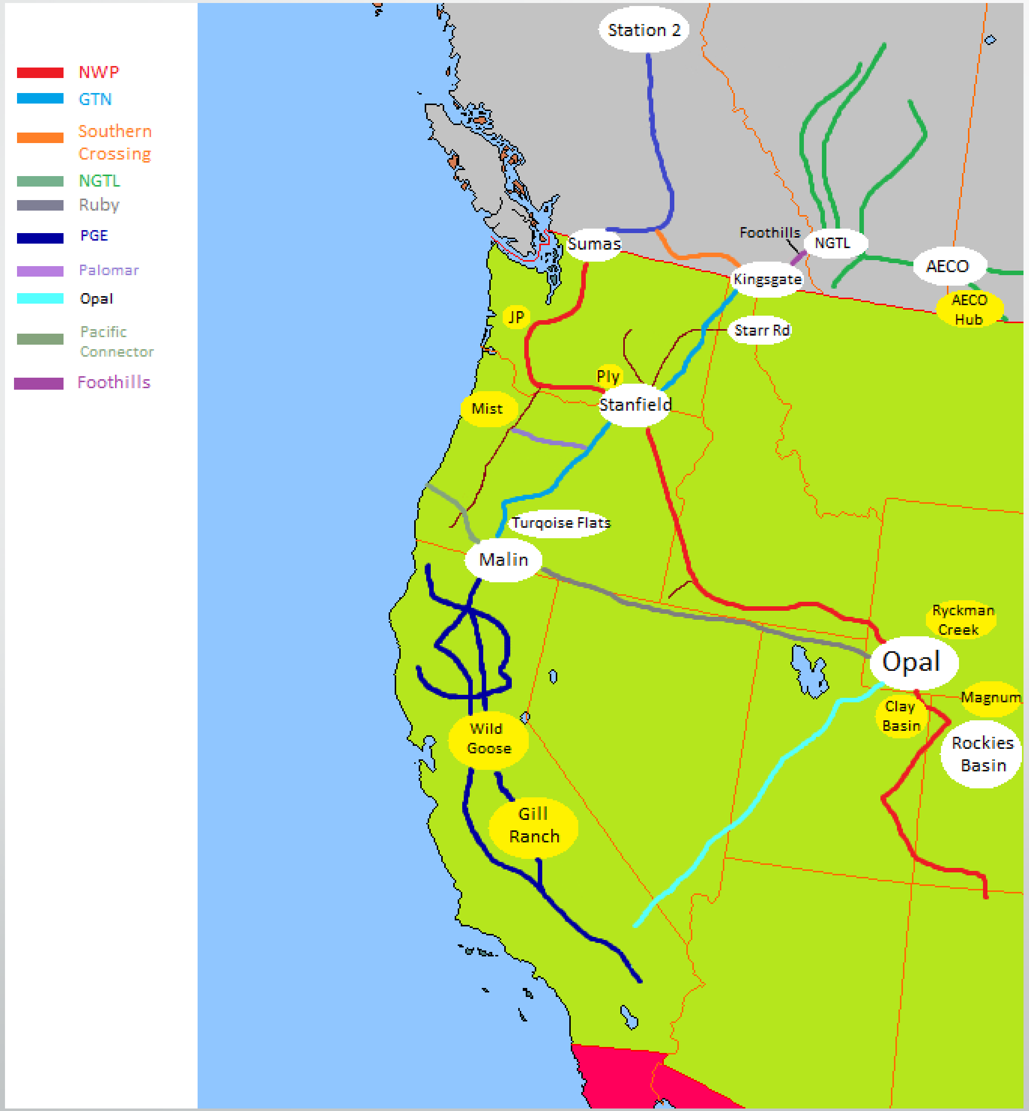
Major resource issues on the horizon

- Once a deficiency is identified, Cascade must analyze potential solutions to ensure service over the planning horizon.
- Conversations with partners at various pipelines, storage facilities, new supply sources.
- SENDOUT® is used to ultimately derive the optimal mix of resources, referred to as the "preferred portfolio."

Location of Current & Alternative Resources


NWP
GTN
Southern Crossing
NGTL
Ruby
PGE
Palomar
Opal
Pacific Connector
Foothills
Station 2
Foothills
NGTL
Sumas
Kingsgate
AECO
AECO Hub
JP
Starr Rd
Ply
Stanfield
Mist
Turqoise Flats
Malin
Ryckman Creek
Opal
Magnum
Clay Basin
Rockies Basin
Wild Goose
Gill Ranch

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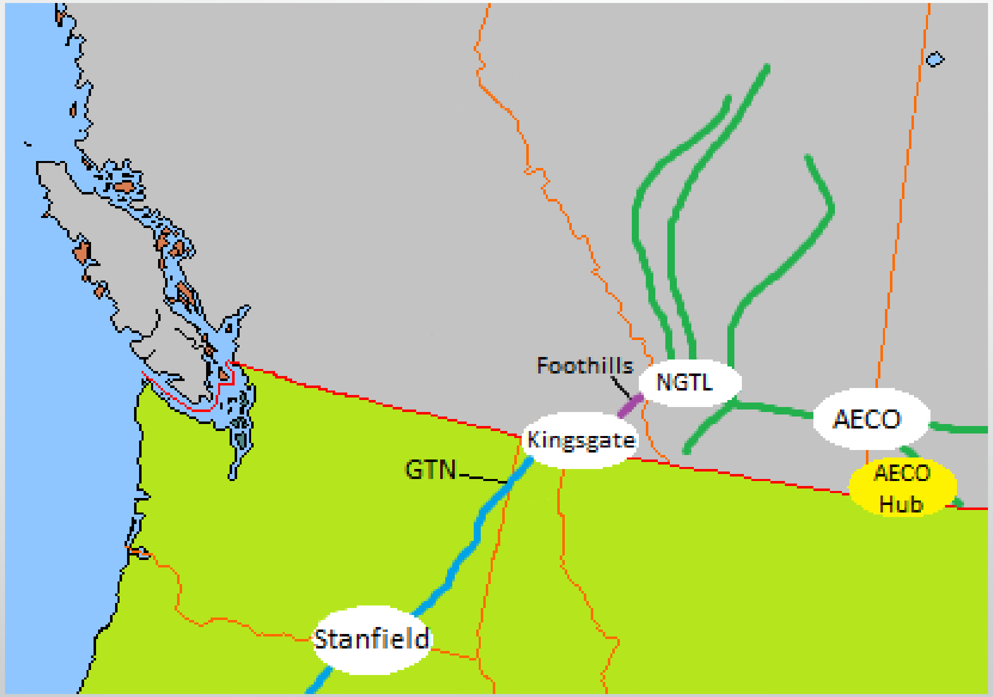
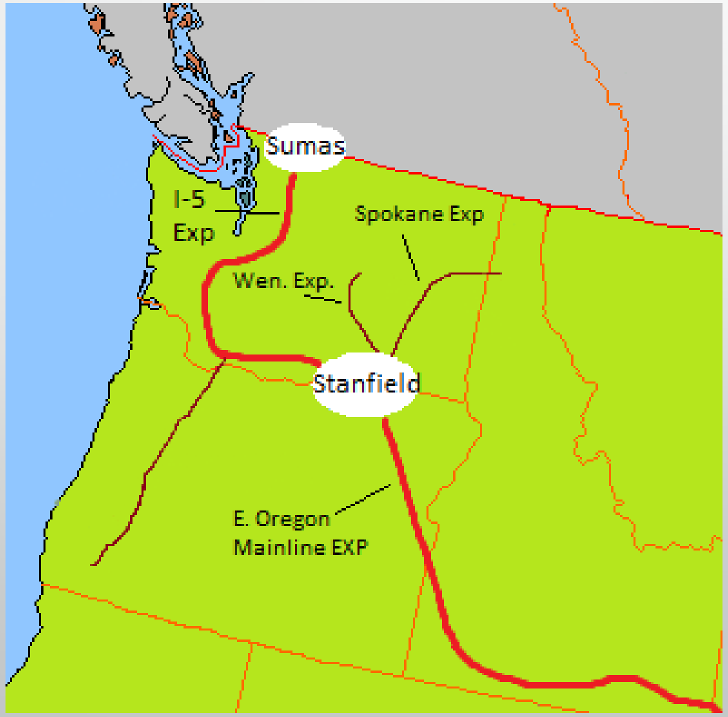
Incremental Transport – North to South

- Incremental NGTL – Additional capacity to move gas from AECO basin to Alberta/BC border
- Incremental Foothills – Additional capacity to move gas from Alberta/BC border to Kingsgate
- Incremental GTN N/S – Additional capacity to move gas from Kingsgate to various citygates along GTN


Foothills
NGTL
AECO
Kingsgate
GTN
AECO Hub
Stanfield

Incremental Transport – Northwest Pipeline

- I-5 Mainline Expansion – Additional capacity to move gas along I-5 corridor in western Washington
- Wenatchee Lateral Expansion – Additional capacity to move gas along Wenatchee Lateral to central Washington
- Spokane Lateral Expansion – Additional capacity to move gas along Spokane Lateral to eastern Washington
- Eastern Oregon Mainline Expansion – Additional capacity to move gas along Eastern Oregon Lateral to Oregon citygates



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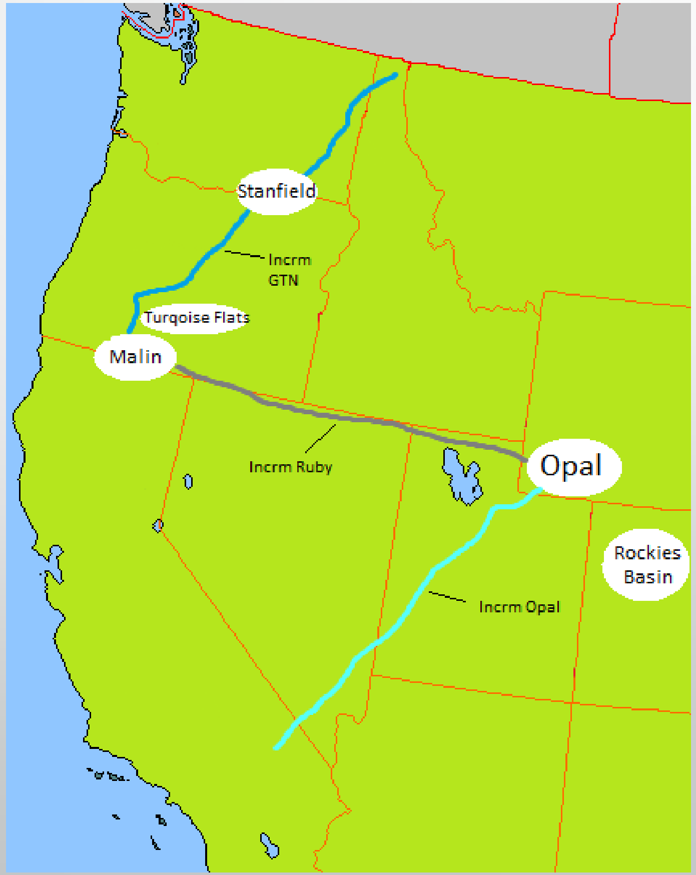
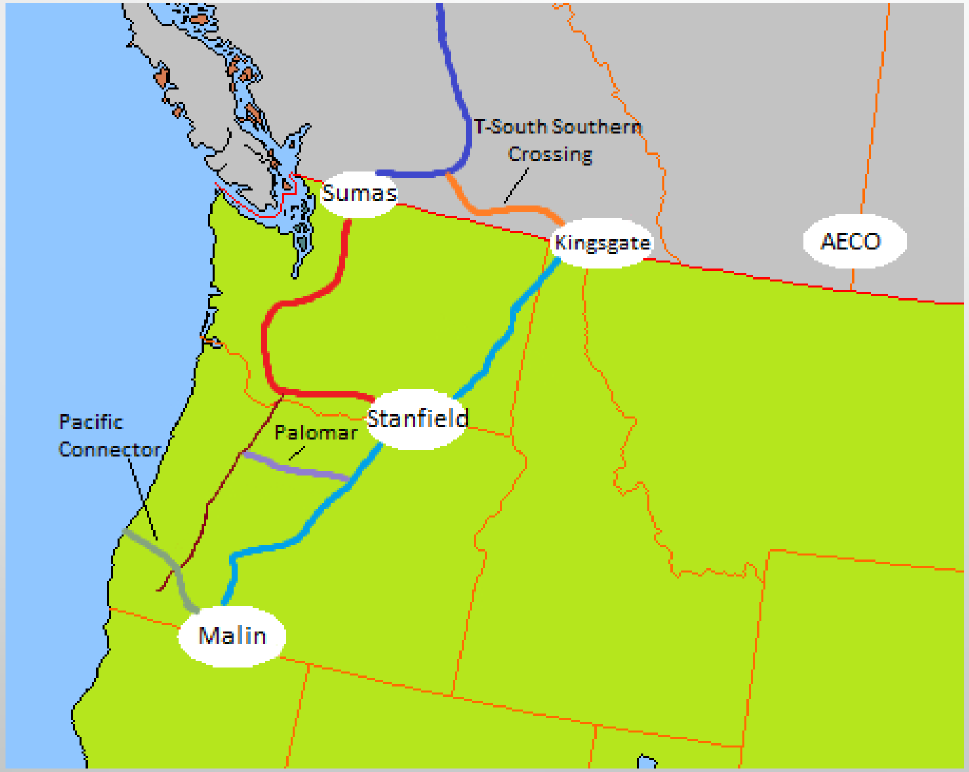
Incremental Transport – South to North

- Incremental Opal– Additional capacity to move gas from Utah to Opal
- Incremental GTN S/N – Additional capacity to move gas from Turquois Flats to various citygates along GTN
- Incremental Ruby – Additional capacity to move gas from Rockies Basin to Turquoise Flats


Stanfield
Incrm GTN
Turqoise Flats
Malin
Incrm Ruby
Opal
Rockies Basin
Incrm Opal

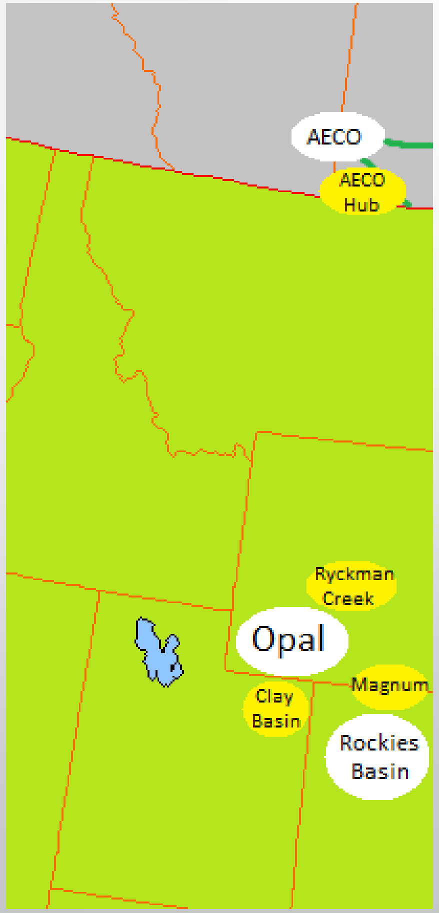
Incremental Transport – Bilateral

- T-South Southern Crossing – Price arbitrage opportunity to move gas between Sumas and AECO basins bilaterally
- Trails West (Palomar) – Additional capacity to move Rockies gas to the I-5 corridor
- Pacific Connector – Pipeline that will feed LNG facility on Oregon coast, increasing liquidity at Malin


T-South Southern Crossing
Sumas
Kingsgate
AECO
Stanfield
Palomar
Pacific Connector
Malin

Incremental Storage - North and East

- Ryckman Creek Storage – Additional storage in southwest Wyoming serving the system, primarily Oregon
- Magnum Storage – Additional storage near Rocky Mountains, serving the system, primarily Oregon
- AECO Hub Storage – Additional storage near AECO Hub, serving the system
- Clay Basin Storage – Additional storage near Opal


AECO
AECO Hub
Ryckman Creek
Opal
Magnum
Clay Basin
Rockies Basin

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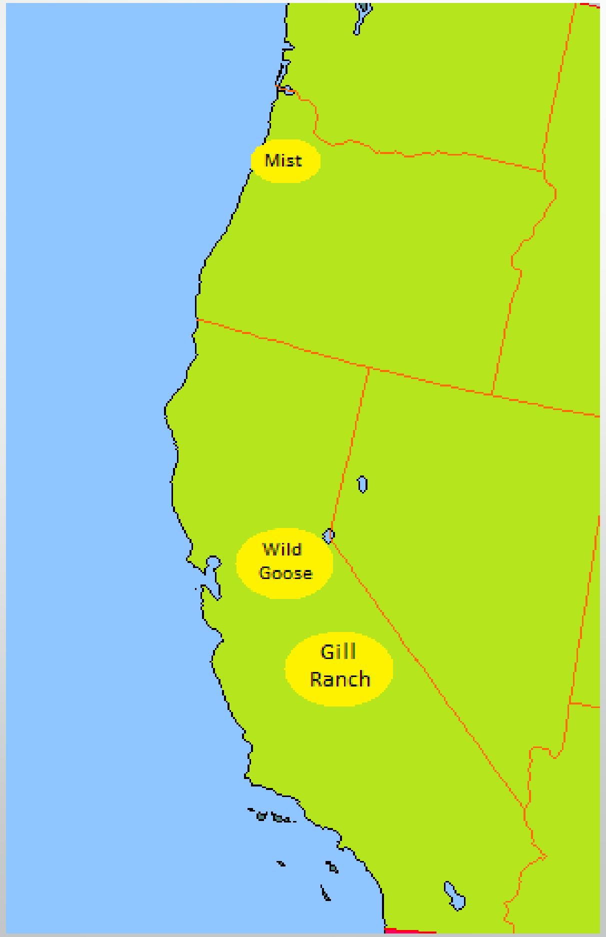
Incremental Storage - South and West

- Gill Ranch Storage – Additional storage in central California, serving the system, primarily Oregon
- Mist Storage – Additional storage in northern Oregon, serving the system, primarily Washington
- Wild Goose Storage – Additional storage in northern California, serving the system, primarily Oregon



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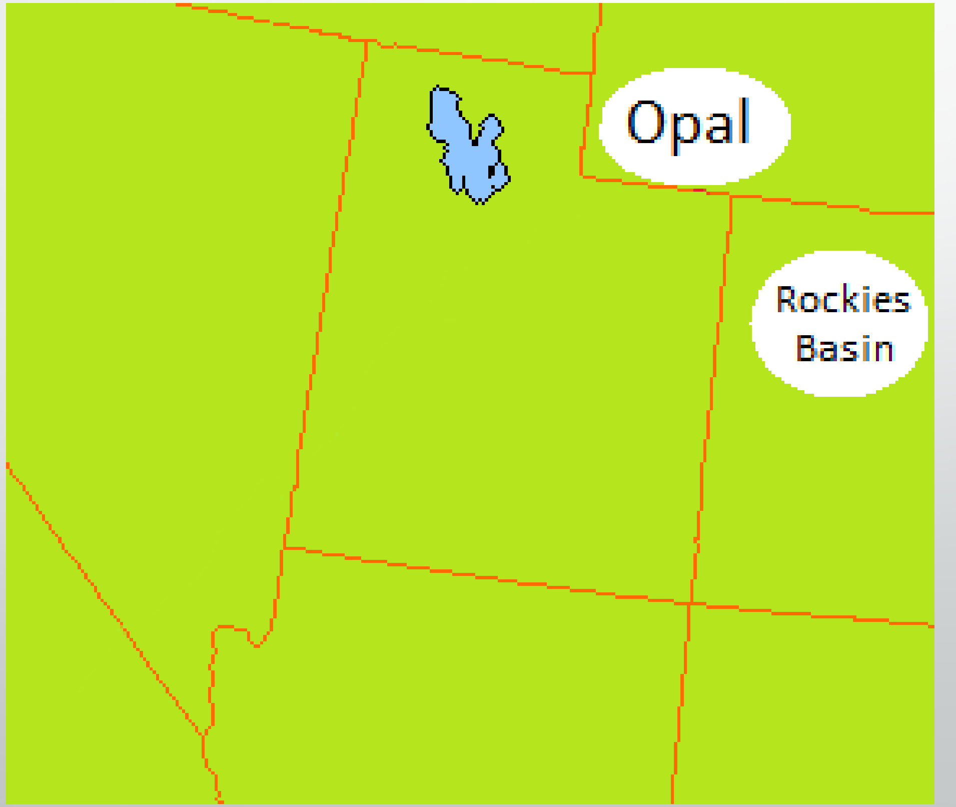
Incremental Supplies

- Incremental Opal Supply – Additional supply around the Rockies Basin
- Renewable Natural Gas – Incremental biogas supply directly to distribution system



Price Forecast Results

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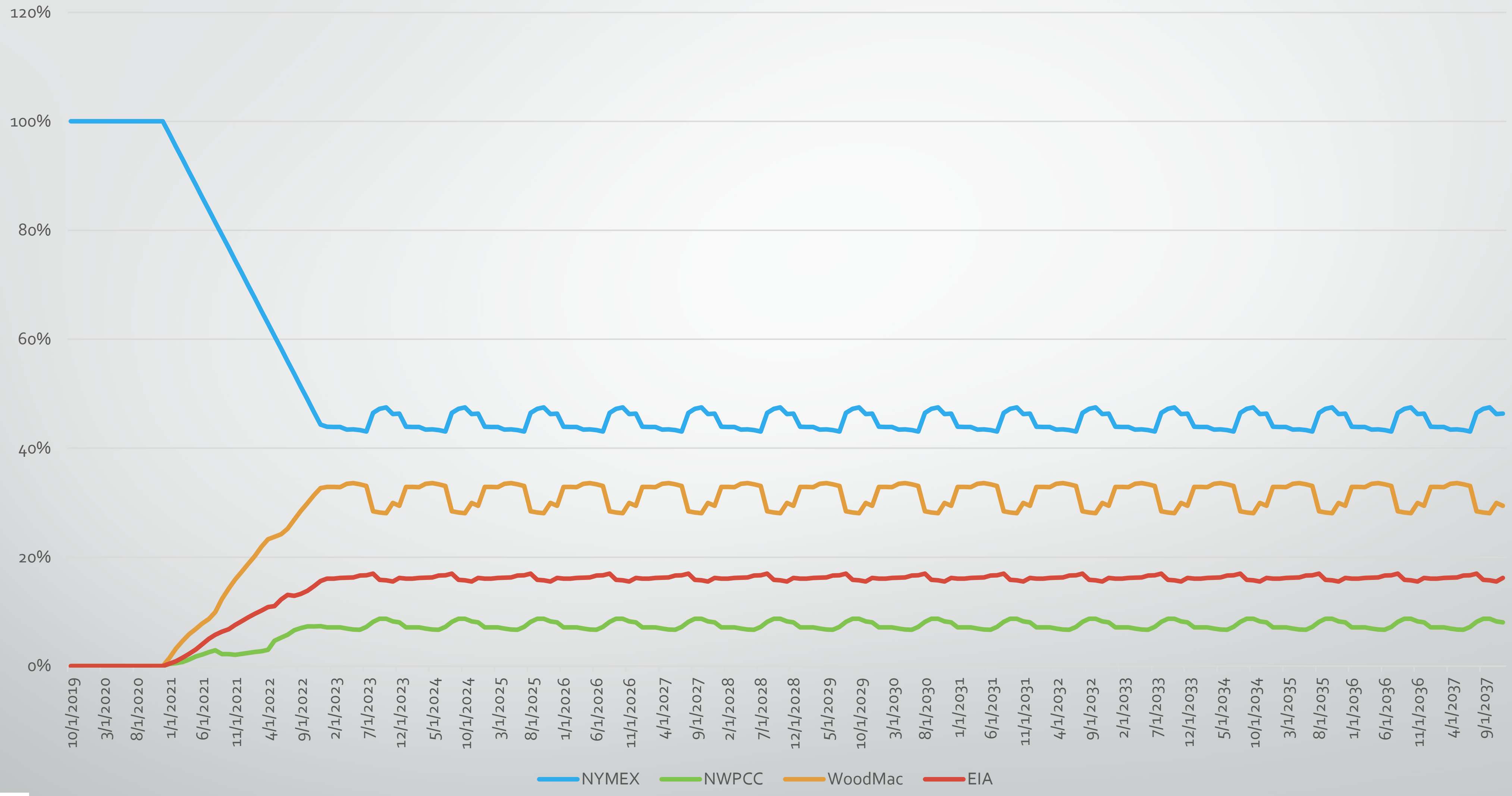
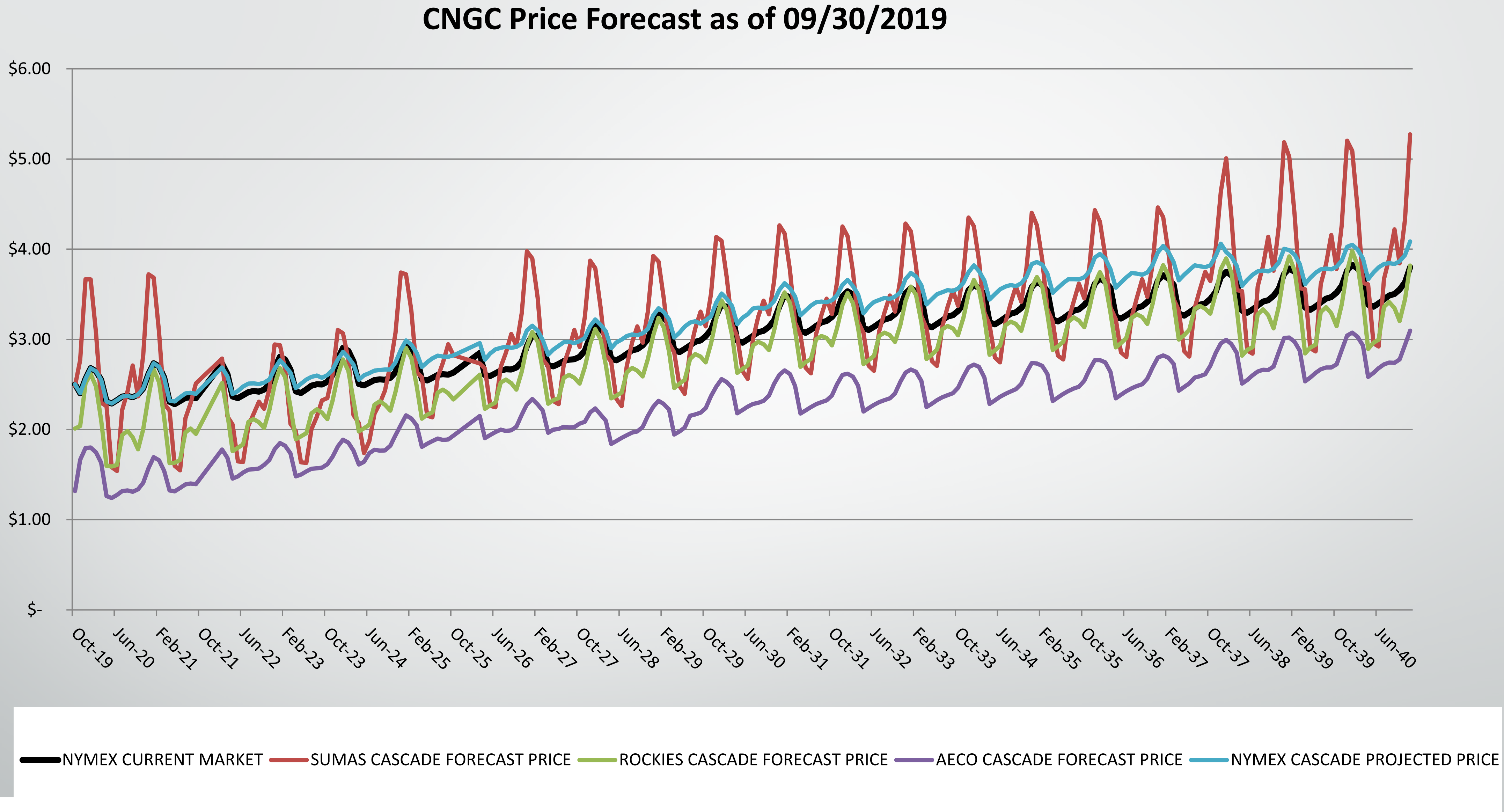
Interpolated Age Dampened Final Weights





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Avoided Cost Methodology and Calculation

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Avoided Cost Overview

- As part of the IRP process, Cascade produces a 20-year price forecast and 45 years of avoided costs.
- The avoided cost is an estimated cost to serve the next unit of demand with a supply side resource option at a point in time. This incremental cost to serve represents the cost that could be avoided through energy conservation.
- The avoided cost forecast can be used as a guideline for comparing energy conservation with the cost of acquiring and transporting natural gas to meet demand.

Avoided Cost Overview

- For the 2020 IRP, Cascade has continued to evolve its avoided cost formula to create a more transparent and intuitive final number.
  - Cascade has also calculated distribution system costs and a risk premium for the first time in the 2020 OR IRP
- Cascade evaluates the impact that a range of environmental externalities, including CO_2 emission prices, would have on the avoided costs in terms of cost adders and supply costs.
- The Company produces an expected avoided cost case based on peak day and, in the case of distribution system costs, peak hour.

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Avoided Cost Formula

The components that go into Cascade's avoided cost calculation are as follows:

$$AC_{nominal} = TC_v + SC_v + ((CC + C_{tax}) * E_{adder}) + DSC + RP$$

Where

- $AC_{nominal}$ = The nominal avoided cost for a given year. To put this into real dollars you must apply the following: Avoided Cost/(1+inflation rate)^Years from the reference year.
- TC_v = Variable Transportation Costs
- SC_v = Variable Storage Costs
- CC = Commodity Costs
- C_{tax} = Carbon Tax
- E_{adder} = Environmental Adder, as recommended by the Northwest Power and Conservation Council
- DSC = Distribution System Costs
- RP = Risk Premium

Methodology

- Transportation costs are pulled directly from the major pipelines that Cascade utilizes (NWP, GTN, Enbridge, Ruby, Nova Gas Transmission (NGTL) and Foothills).
- Storage costs are only captured if there is an avoidable future storage cost (ie. On system storage).
- Commodity Costs are taken from Cascade’s 20-year price forecast.
- Risk Premium is the cost associated with hedging.
- Distribution System Costs only look at costs associated with growth. Pipeline integrity cannot be avoided.

Methodology - Carbon

- Modeling carbon compliance costs is a challenge because the future of carbon is uncertain.
- As discussed during scenarios and sensitivities, Cascade will model the impact of a variety of potential carbon pathways.
- Cascade's primary carbon forecast is based on the California Cap and Trade marketplace. This is not an endorsement of this policy, but rather a qualitative assessment of what the resource planning team believes is the most probable carbon future in the state of Oregon.

Methodology – Distribution System Costs

- Cascade's distribution system costs are calculated as a function of the Company's authorized margin, weighted by the load share of each rate class.
  - Authorized margin is defined as the applicable cost of service including authorized rate of return.
- The weighted margin number is then multiplied by the percentage of projects of Cascade budgeted projects specifically related to growth.
- Since Avoided Cost is based on peak day, the margin calculation is then multiplied by the ratio of peak day demand to an average day's demand to get the margin impact on peak day.
- Distribution system analysis is concerned with the pressure during peak hour, so the daily number must then be multiplied by the ratio of peak hour demand to that day's total demand.

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Example of Distribution Cost Calculation

Data Item	Value
Weighted Margin (Dth)	0.084967
* Growth Share (37%)	0.031438
*Peak Day Impact (Peak Demand/Average Demand)	0.119075
*Peak Hour Impact (Peak Hour/Peak Day Demand)	0.006112

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Methodology – Risk Premium

- Cascade defines risk premium as the additional cost the Company would have to pay for a fixed price to fully hedge its portfolio versus open market FOM prices.
- Theoretical fixed pricing comes from the company's AMA Partner, Tenaska Marketing Ventures.
- Pricing is received at all three basins Cascade purchases gas from, and then blended based on expected supply needs at the basins.
- Following regional best practices, if this value is negative the Company records the risk premium as zero, as described in the following table.

2020 Avoided Cost Risk Premium

Year #	Calendar Year	Risk Reduction Value (Real $/Dth)
1	2020	-$0.159
2	2021	-$0.139
3	2022	-$0.108
4	2023	-$0.067
5	2024	-$0.104
6	2025	-$0.245
7	2026	-$0.301
8	2027	-$0.221
9	2028	-$0.109
10	2029	-$0.078
11	2030	-$0.105
12	2031	-$0.069
13	2032	$0.000
14	2033	-$0.001
15	2034	-$0.016
16	2035	-$0.030
17	2036	-$0.057
18	2037	-$0.141
19	2038	-$0.459
20	2039	-$0.304

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Avoided Cost - Conclusion

- Cascade has filed its new avoided cost inputs as a proposed alternative in its UM 1893 filing.
- Cascade has also provided current avoided cost inputs to the Energy Trust of Oregon, who will be sending back a conservation potential assessment based on these inputs.
- Annualized avoided cost in real 2019 dollars range from $2.49/dth in a non-carbon environment to $7.93 in a carbon environment in 2040.

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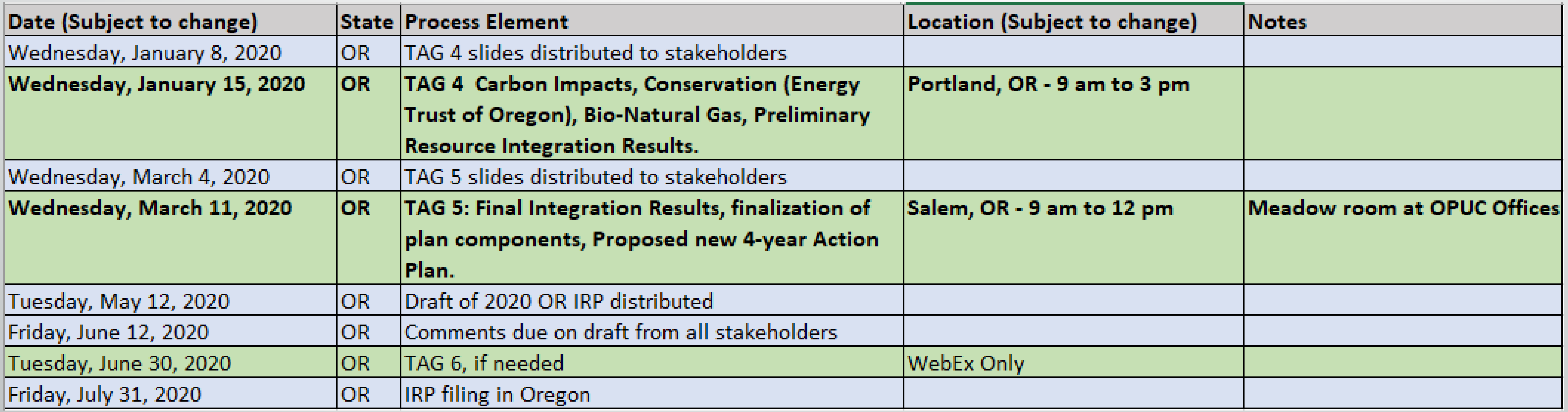
2020 IRP Remaining Schedule



Date (Subject to change)	State	Process Element	Location (Subject to change)	Notes
Wednesday, January 8, 2020	OR	TAG 4 slides distributed to stakeholders		
Wednesday, January 15, 2020	**OR**	**TAG 4 Carbon Impacts, Conservation (Energy Trust of Oregon), Bio-Natural Gas, Preliminary Resource Integration Results.**	**Portland, OR - 9 am to 3 pm**	
Wednesday, March 4, 2020	OR	TAG 5 slides distributed to stakeholders		
Wednesday, March 11, 2020	**OR**	**TAG 5: Final Integration Results, finalization of plan components, Proposed new 4-year Action Plan.**	**Salem, OR - 9 am to 12 pm**	**Meadow room at OPUC Offices**
Tuesday, May 12, 2020	OR	Draft of 2020 OR IRP distributed		
Friday, June 12, 2020	OR	Comments due on draft from all stakeholders		
Tuesday, June 30, 2020	OR	TAG 6, if needed	WebEx Only	
Friday, July 31, 2020	OR	IRP filing in Oregon		

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ADDITIONAL QUESTIONS?

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Resource Planning Team Email – irp@cngc.com

Bruce Folsom - Consultant

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Cascade Natural Gas Corporation

2020 Integrated Resource Plan
Technical Advisory Group Meeting #3

Wednesday, November 6th, 2019
Cascade's Offices in Deschutes Room
Kennewick, WA

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