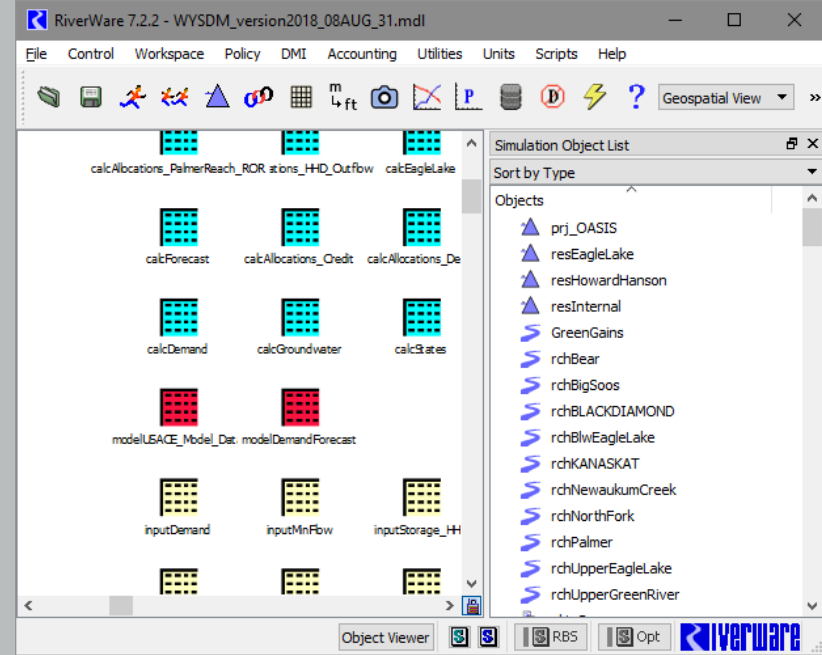


HDR

INTEGRATED RESOURCE PLAN

2018

TACOMA WATER
TACOMA PUBLIC UTILITIES



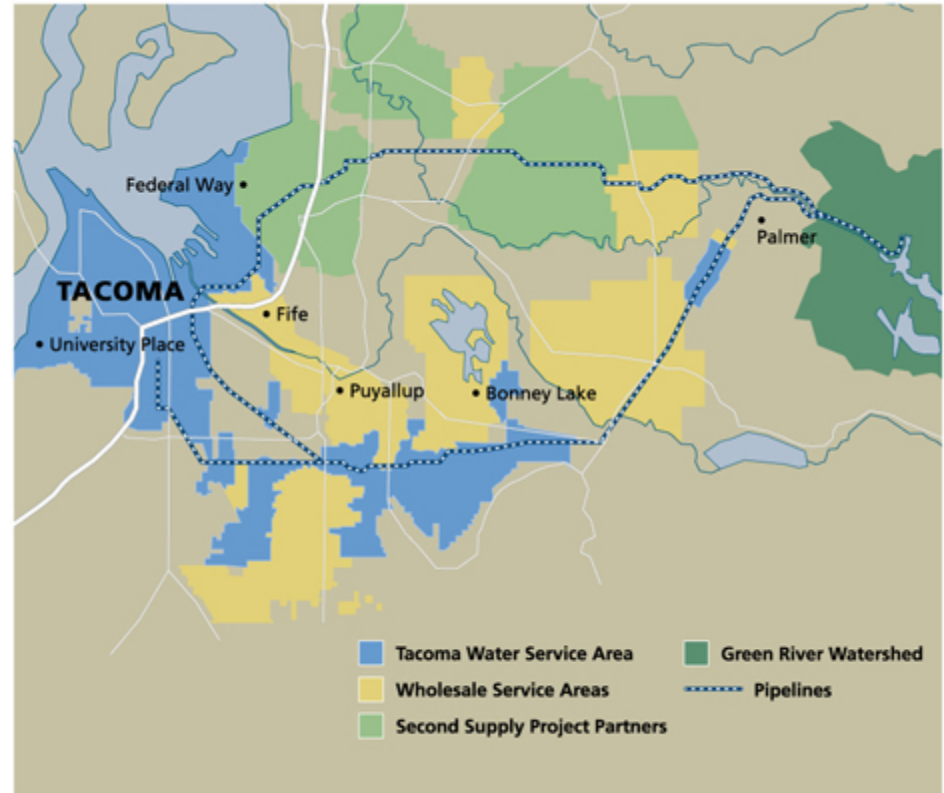
Tacoma Water's Water Yield, Supply and Demand Model for Analyzing Reliability of the Water Supply System

2019 RiverWare Users' Group
Meeting



Setting

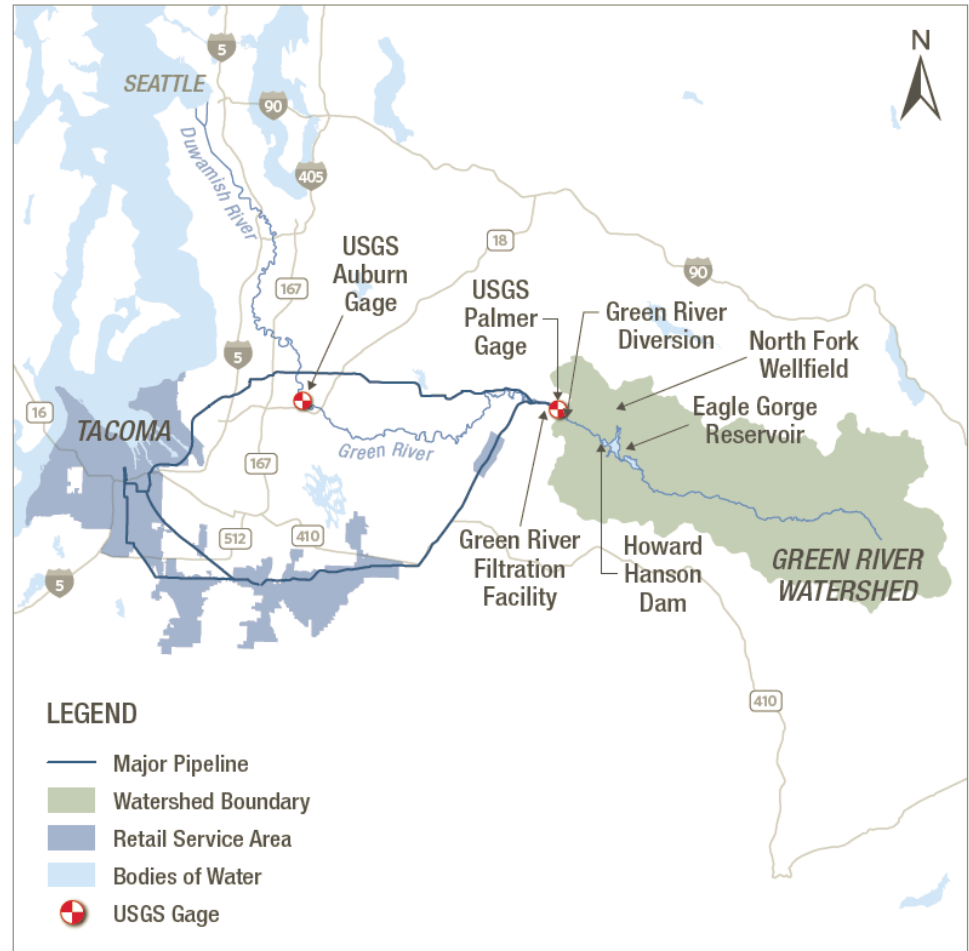
- City of Tacoma – incorporated in 1875
- Tacoma Water – incorporated in 1893
- Serves City of Tacoma and communities in Pierce and King County
- Retail service to 330,000 people
- Wholesale service to ~200,000 connections
- Tacoma service area typical demands:
 - 44 mgd winter demand
 - 90 mgd peak summer demand



Source: Tacoma Public Utilities

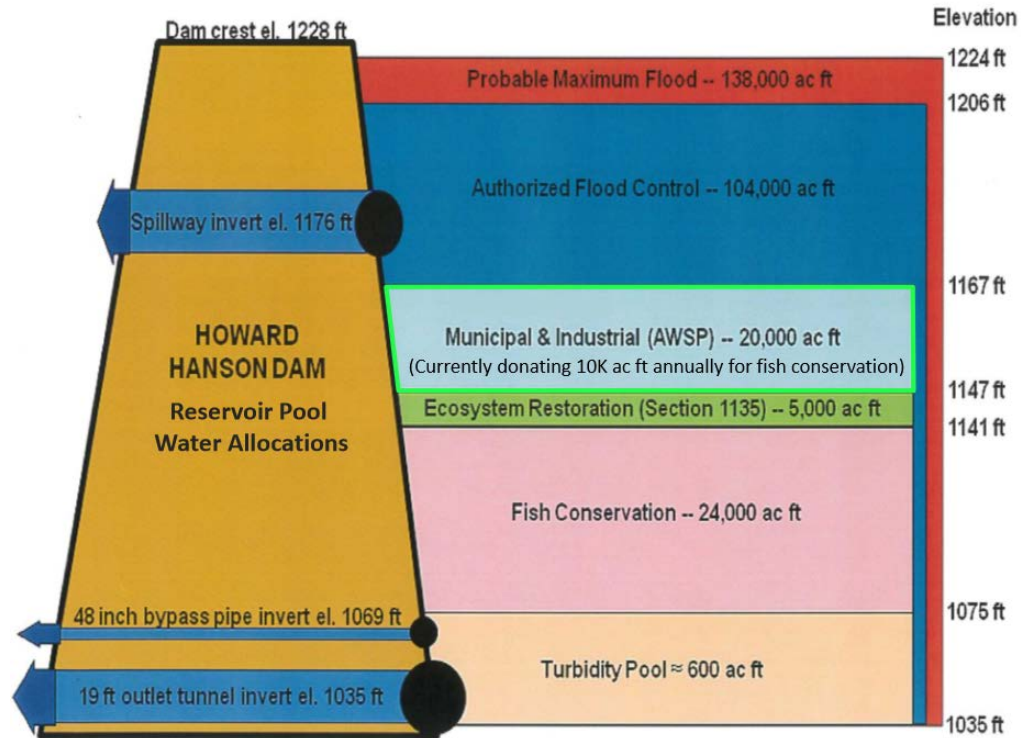
Water Supply

- Sources: Green River, groundwater
- First Diversion Water Right
 - 1906 priority date, 113 cfs
 - Run-of-River right
 - Initial service via Pipeline #1
- Second Diversion Water Right
 - 1933 priority date, permitted in 1986
 - 100 cfs
 - Storable in Eagle Gorge Reservoir
 - Second Supply Project Partners fund costs of operations in exchange for share of water produced
- TW manages upper Green River Watershed
- Stakeholders manage and coordinate lower Green River ecosystem flows



Howard A. Hanson Dam and Eagle Gorge Reservoir

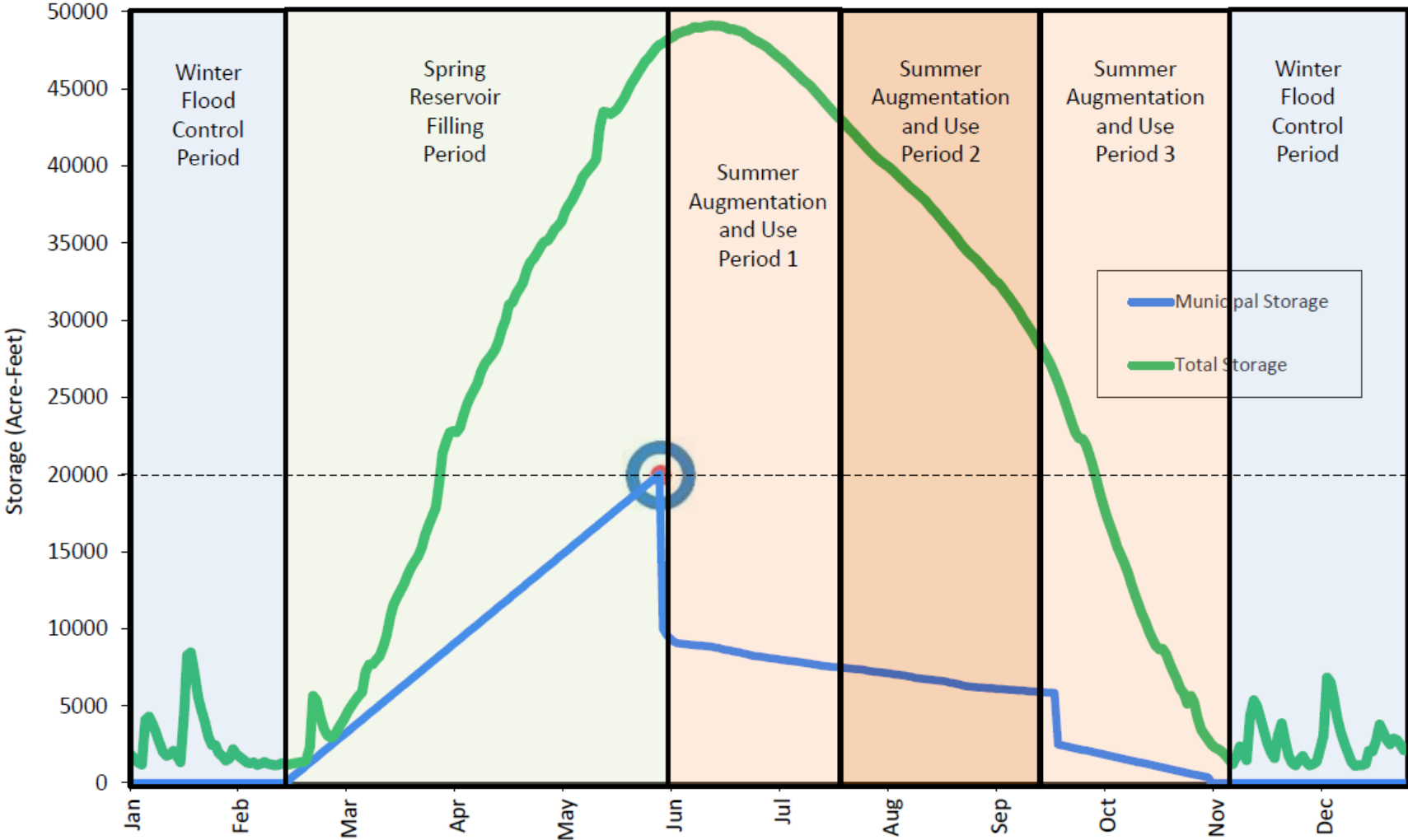
- Completed in 1961/1962
- Owned-Operator: USACE
- Authorized purposes: flood management, water supply
- Supply Stakeholders:
 - USACE – Conservation for Palmer minimum flows
 - Natural resource agencies – Auburn minimum flows, fall freshet, and adaptive management
 - Second Supply Partners – Municipal water supply
 - Tacoma Water – Auburn minimum flows



Source: Tacoma Public Utilities

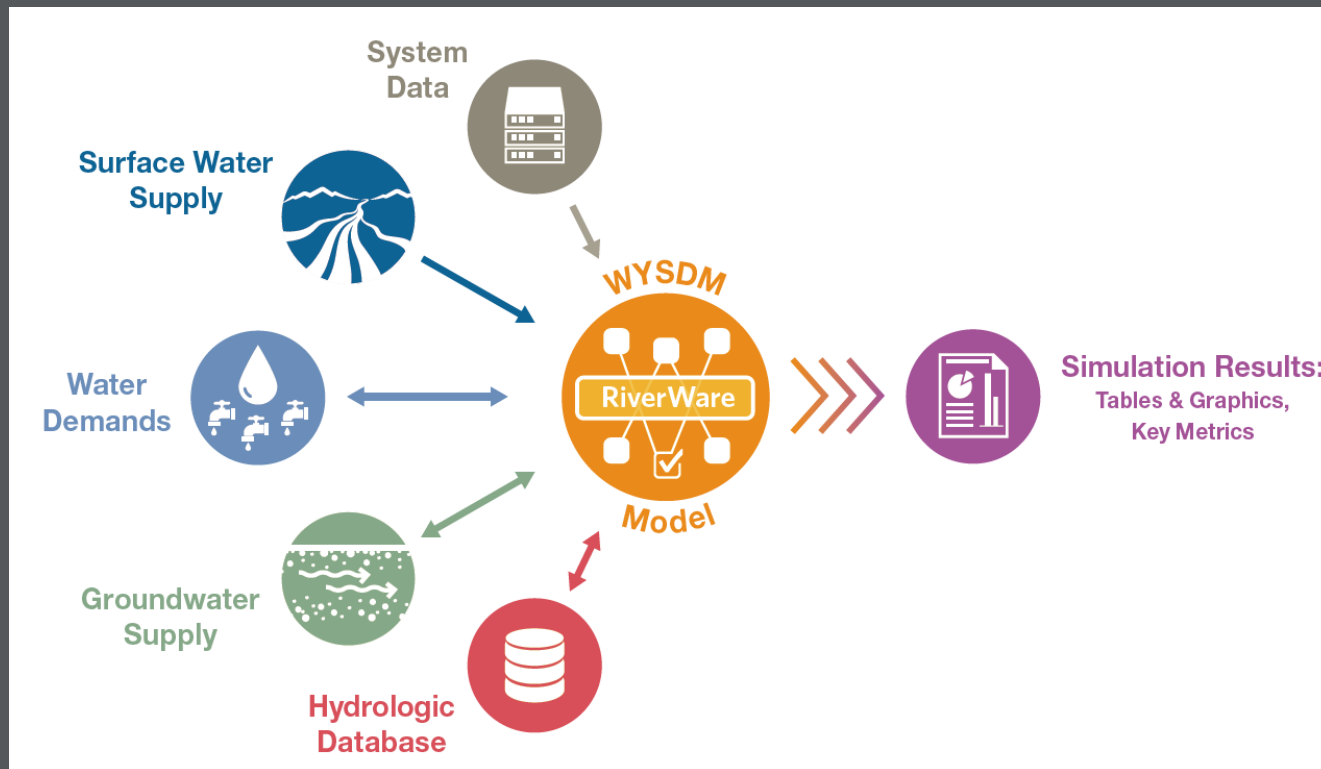
Typical Storage Fill and Use

STORAGE AT HOWARD HANSON DAM



Water Yield Supply and Demand Model (WYSDM)

- Developed for the Integrated Resources Plan
- Established a Resource Adequacy Standard (RAS)
- Evaluated future population growth, conservation, and climate change
- Examined future projects to address conditions to improve RAS performance



Hydrologic Data

- Historical
 - Reconstructed from 1915 to 2017 (103 years)
 - Water budgets, regression analysis
- Synthetic
 - ARMA seasonal hydrology
- Future Climate
 - Leveraged King County Green River flooding study (2010) and USACE Howard Hanson Dam Climate Adaptation Study (2014)

Hydrologic Database

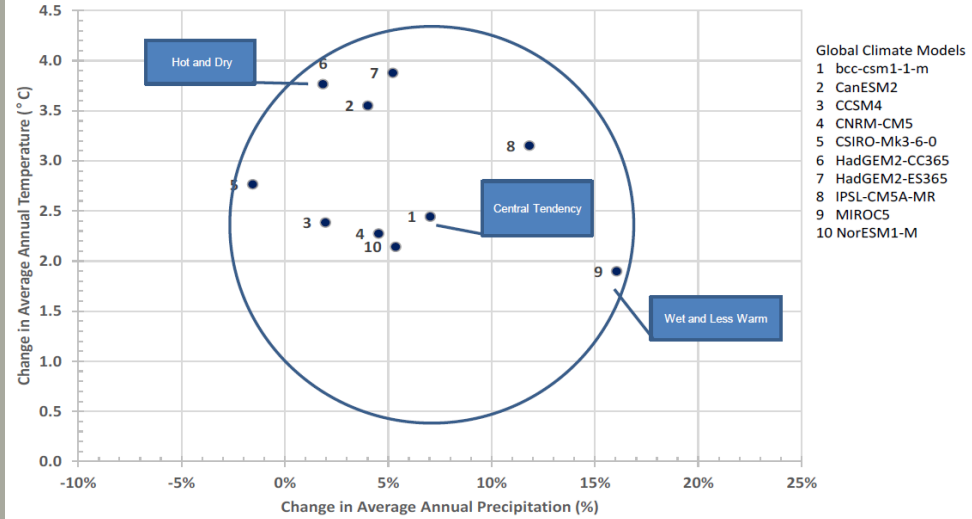


Surface Water Supply

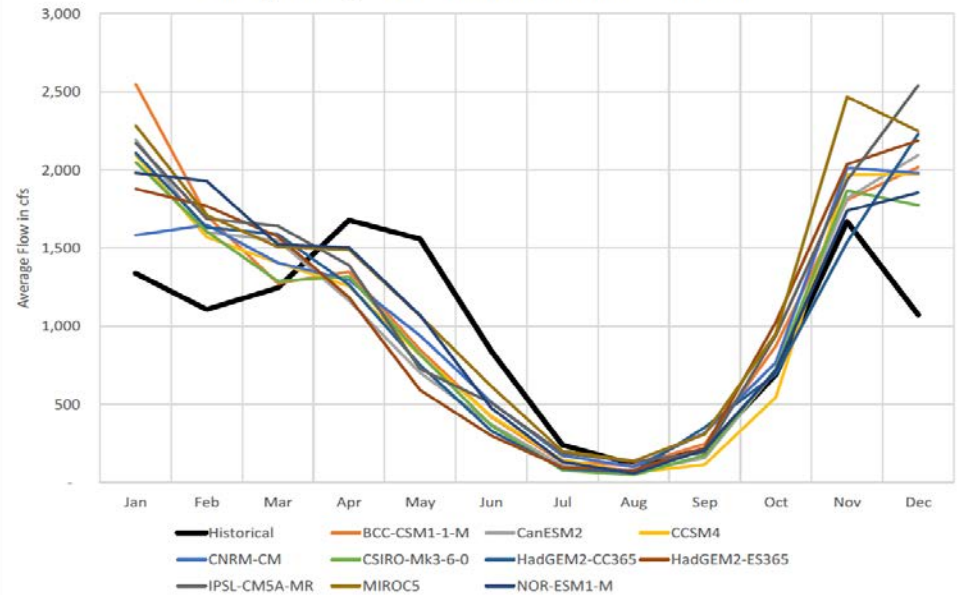


Climate Change Hydrology

Change in Precipitation and Temperature near Puyallup
for 10 Global Climate Models
(RCP 8.5, MACA 2050s)
Compared to Historical (1984 to 2013)



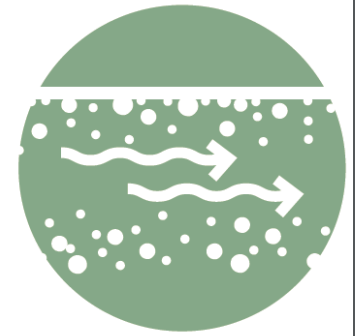
Average Monthly Simulated Natural Howard Hanson Dam Inflow



Well Use

- North Fork wells – water quality blending
- City well fields – supplemental supply
- Operational Modes:
 - Automatic
 - Manually specified

Groundwater Supply



inputGroundwater.PrioritySet0

File Edit Row Column View Adjust

PrioritySet0

Value:

	FieldSet	January mgd	February mgd	March mgd	April mgd	May mgd	June mgd	July mgd	August mgd	September mgd	October mgd	November mgd	December mgd	
0: 1B	NONE	2.00	0.03	0.17	4.27	0.00	4.12	3.48	3.01	2.74	3.48	2.59	0.00	4.49
1: 3A		2.00	0.00	0.00	4.62	0.00	4.85	4.43	4.03	4.58	4.68	4.39	4.72	4.90
2: 5A		2.00	5.76	6.15	5.70	0.00	5.49	4.55	4.50	4.29	5.45	5.32	5.04	5.79
3: 8B		2.00	0.00	0.00	4.54	0.00	4.53	4.63	4.72	3.95	4.02	4.89	5.00	5.10
4: 10C		2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.50	0.44	0.00	0.00	0.54
5: 7B		2.00	0.00	0.00	0.93	0.00	0.89	0.91	0.88	0.84	0.77	0.00	0.85	0.80

Show: Description

Summary: A priority set of well use using 2015 maximum pumping rates and assigning pumping to most energy efficient wells

Settings: Each row is a specific well. The row name is the name of the well. The modeler can add rows for new wells or delete rows if wells are retired.

FieldSet = Well field number that a well is part of. There are four City of Tacoma wells fields.
Field 1 is the northern portion of the South wellfield.

Scenarios and Infrastructure

- Flow, climate, and demand data
- Dam operations
- Storage accounts and water rights
- Account transfers
- Section 1135 operations
- Other supplies
- Future supply projects

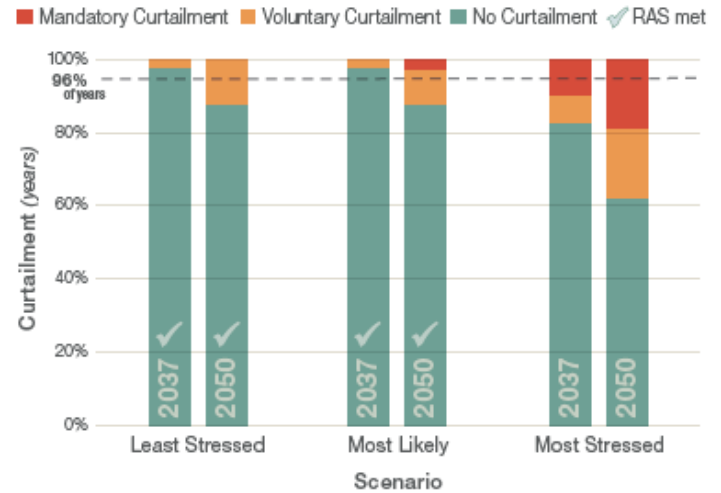
System Data



IRP Results – Existing System

- Examined combination of population growth, conservation adoption, and future climate change
- RAS goals:
 - No demand delivery failures
 - Meet maximum four-consecutive days demand
 - Mandatory curtailment frequency: once in 25-years
 - Voluntary curtailment frequency and groundwater use reported but not part of RAS

Resource Adequacy Standard Achievement

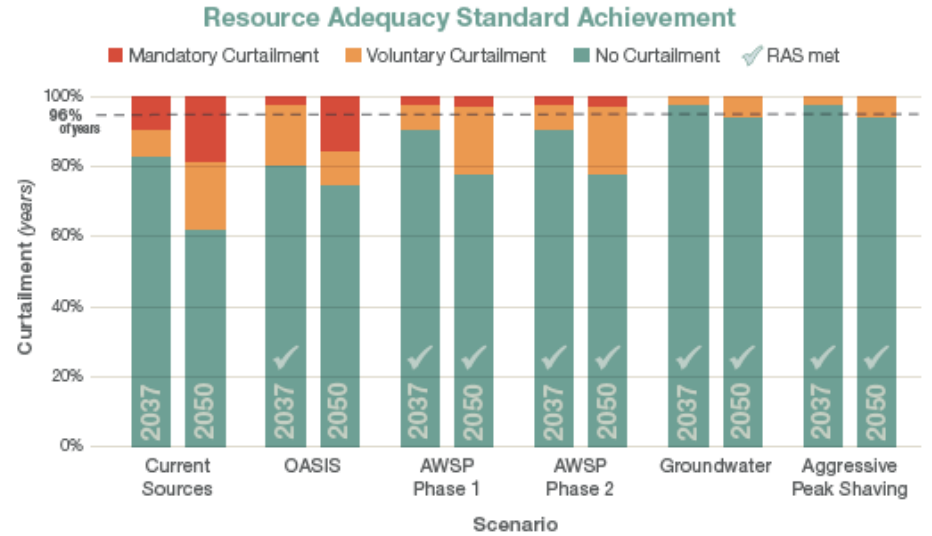


2037 results 2050 results

	Least-Stressed	Most-Likely	Most-Stressed
Number of voluntary curtailments <i>(out of 25 years)</i>	<1	<1	2
	3	2	5
Number of mandatory curtailments <i>(out of 25 years)</i>	0	0	3
	0	<1	5
Is the RAS met?	Yes	Yes	No
	Yes	Yes	No
Percent of groundwater rights utilized	50%	55%	60%
	60%	60%	70%

IRP Results – Future Projects

- Future Projects:
 - OASIS – regional aquifer storage and recovery
 - Future AWSP phases – fish passage at dam (Phase I) and use additional reservoir storage (Phase II)
 - Fully develop groundwater well fields
 - Conceptual demand “peak shaving”



	2037 results		2050 results			
	Current Sources	OASIS	AWSP Phase 1 <i>(Howard Hanson Fish Passage)</i>	AWSP Phase 2 <i>(Reservoir Pool Raise)</i>	Develop Full Groundwater Rights	Aggressive Peak Shaving
Number of voluntary curtailments <i>(out of 25 years)</i>	2	4	2	2	<1	<1
	5	2	5	5	2	2
Number of mandatory curtailments <i>(out of 25 years)</i>	3	<1	<1	<1	0	0
	5	4	<1	<1	0	0
Is the RAS met?	No	Yes	Yes	Yes	Yes	Yes
	No	No	Yes	Yes	Yes	Yes
Percent of groundwater rights utilized	60%	60%	60%	60%	75%	55%
	70%	70%	70%	70%	95%	67%

Graphical User Interface

- Purpose:
 - Assist experienced modelers with scenario modeling and analysis
 - Expose other staff to capabilities of WYSDM
- Automates scenario management: input, model run, and display of results

Tacoma Water WYSDM

home

| Home

Capacity Planning


Drought Management

Integrated Plan

Firm Yield

About

On-line Help


WYSDM
Water Yield, Supply, and Demand Model
version 1.1.0
City of Tacoma 2019

WYSDM is Tacoma Water's water supply and reliability computer model. WYSDM is capable of evaluating water supply from the entire Green River watershed, Howard Hanson reservoir, and the City's groundwater wells. The City's relationships with wholesale customers, supply partners, the Army Corps of Engineers, and natural resource agencies are part of this modeling platform.

WYSDM can provide answers to these types of questions:

- Capacity Planning
Is Tacoma's physical infrastructure and legal water rights sufficient to meet expanding population demands?
How much extra supply capacity is available?
How might future climate change affect this supply?
- Drought Management
What is the outlook for Tacoma's supply this year?
How much groundwater might be needed to make it through this year?
How much risk is there of having to ask customers to reduce their water use?
- Integrated Resource Plan
HDR Engineering developed an Integrated Resource Plan that examined future conditions and possible future water supply options.
- Firm Yield/Level of Service
What reliable amount of water is available for delivery to customers given reservoir operations and minimum flow requirements?

To Start:
Select a mode from the list on the left side of the screen.
Capacity Planning evaluates long-term risks associated with population growth and climate change
Drought Management evaluates challenges from August 26, 2019 to the end of the year
Use the On-line Help feature for more information

Example of Scenario Parameters

Tacoma Water WYSDM

integrated resource plan model > Scenario Configuration
current model: Future_Climate2037_LeastStressed_00Baseline [home\modelruns\riverware\irp\Future_Climate2037_LeastStressed_00Baseline]

- Back
- Available Models
- | Key Parameters
- Run Model
- IRP Project Results
- Metric Results
- Spreadsheet Results
- Chart Results
- Probability Results

Runoff and Climate

Select a runoff and climate datasource to use:

{30}bcc-csm1-1-m 2015 to 2070

Tacoma System Demands

Which Population Projection should be used:

{1}Most Likely Forecast

Do you want to use specific year for population data optional
if left blank, WYSDM varies the population during the simulation.

2037

Conservation Projections

Source of projection data:

{2}Estimated by HDR Engineering

Indoor Conservation Projection:

{1}Most Likely Forecast

Outdoor Conservation Projection:

{1}Most Likely Forecast

General Demand Settings

Partner Demands

Base partner demands on which year 2006 to 2070:

2037

Scale the partner demands to total this amount:

Note: This is optional; if blank, WYSDYM does not scale the demands.

3.3 BG

Spreadsheet Template Output

Tacoma Water - WYSM Simulation Run Summary

Scenario: **Baseline Most Stressed Conditions (Year 2037)**

Date: **Saturday, May 19, 2018**
 Purpose: **Establish baseline for Most Stressed Scenario for Year 2037**

Assumptions and Input

Hydrology and Climate Dataset: **Bias-Corrected CanESM2 RCP 8.5 climate change (2010-2070)**

Start Date: **1/1/2015**

End Date: **12/31/2054**

Number of Years: **40**

Model Settings

Use Demand Forecasting Module: **YES**
 Allow Curtailment of Tacoma Demands: **YES**
 City of Tacoma Service Area Population Estimate: **414,603**
 Service Area Population projected to occur in year: **2037**
 End of flood control: **14-Feb**
 Start of flood control: **14-Nov**
 Allow donations between Partners: **NO**
 Allow donations to Section 1135: **YES**

Other Scenario Assumptions and Notes

Changes from 5/9/2018:

Constant demand for Partners and Wholesale;
 revised filling of AWS Phase 2 project;
 Employ more groundwater to avert Auburn flow deficits
 Revisited calculation curtailment calculation method

Demands

Annual Demands (MG)

	Min	Average	Max
Tacoma	19,876.7	21,604.5	22,299.9
Wholesale	5,881.8	6,418.0	6,500.0
Partners	3,300.0	3,300.9	3,303.6
Total	29,058.5	31,323.4	32,092.3

Note: Tacoma Conservation Adoption is 440 MG per year.

Baseline Most Stressed Conditions (Year 2037)

Simulation Results

M&I Delivery Shortages

Average Annual Shortages

	Volume (MG)	Percent	Number of Years
Tacoma	0.0	0.0%	0 out of 40
Wholesale	0.5	0.0%	1 out of 40
Partners	428.9	13.0%	40 out of 40
Auburn Flow Target Deficit	125.6	n/a	2 out of 40

Highest Annual Shortages

	Volume (MG)	Percent
Tacoma	0.0	0.0%
Wholesale	19.9	0.3%
Partners	1,090.4	33.0%
Auburn Flow Target Deficit	241.8	n/a

Storage in Howard A. Hanson Reservoir

Average Annual Maximum Municipal Storage: **18,094 acre-feet**

Average Annual Maximum Total Storage: **46,827 acre-feet**

Percent of Years that Municipal Storage is:

Full	30%
75% to 99% full	55%
50% to 75% full	15%
25% to 50% full	0%
0% to 25% full	0%

Corrective Actions Taken

	Annual Volume			
	Min	Average	Max	
City Well Water Used	2,132.3	8,045.8	10,157.8	MG
	6,543.9	24,691.6	31,173.1	ACFT
Eagle Lake Pumping	-	-	-	MG

Demand Curtailment (MG)

	Annual Volume		
	Voluntary	Mandatory	Total Years
Commercial/Industrial		235.9	4 out of 40
Other Retail	609.2	1,976.7	7 out of 40
Wholesale	203.8	610.7	7 out of 40

Potential Extra Water Available

	Annual Volume			
	Min	Average	Max	
Extra Storage Donations	-	680.6	1,558.1	MG
	-	2,088.5	4,781.8	ACFT
Run-of-River water	8,206.0	11,230.0	16,173.2	MG
Firm extra water	-	4.3	15.5	mgd

Charts

Tacoma Water WYSDM

Back

Available Models

Key Parameters

Run Model

IRP Project Results

Metric Results

Spreadsheet Results

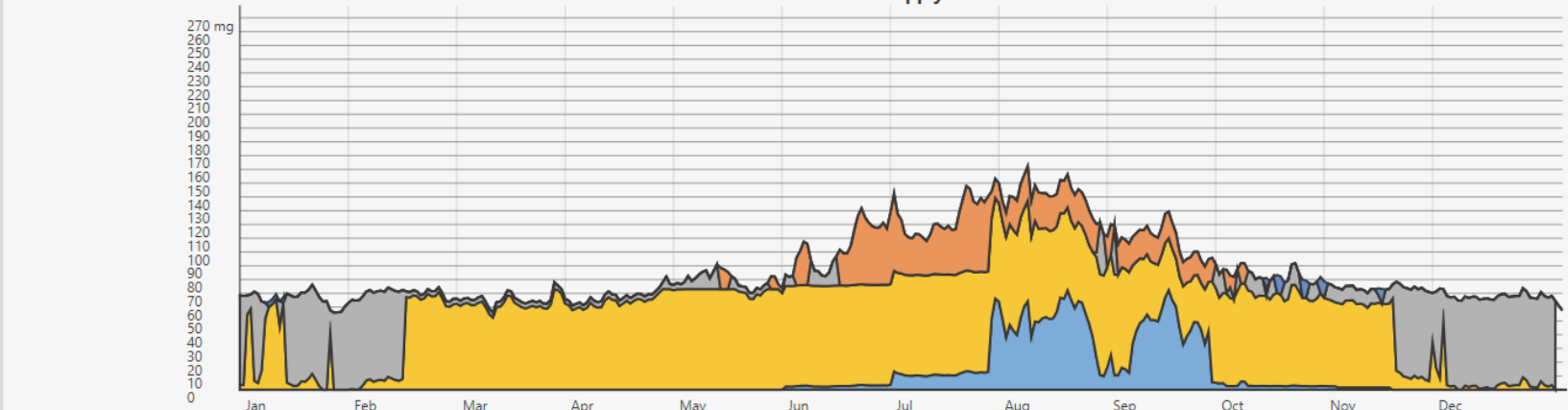
[| Chart Results](#)

Probability Results

capacity planning model > Chart Results
current model: Future_Climate2037_MostStressed_00Baseline [home\modelruns\riverware\irp\Future_Climate2037_MostStressed_00Baseline]

- Chart CA001: FDWR Use
- Chart CA002: SDWR Use
- Chart CA003: Surplus Water by Month
- Chart CA004: Surplus Water by Year
- Chart CA005: Pumping from Eagle Lake
- Chart CB001: Storage
- Chart CB002: Municipal Pots
- Chart CC001: Auburn Minimum Flows
- Chart CD001: Groundwater use
- Chart CD002: City Wellfield Pumping by Month
- Chart CD003: City Wellfield Pumping by Year
- Chart CD004: Peak City Wellfield Pumping
- Chart CE001: System Demands
- Chart CE002: Water Supply

Chart CE002: Water Supply - Year 2054



Legend: Well Water First Diversion Water Right Second Diversion Water Right Storage ^Shortages

Year:

Probability Charts

