Firm Yield of Seattle's Existing Water Supply Sources

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Operating Board

December 1, 2016

Summary of Firm Yield Update

- Remains at average annual 172 million gallons per day (mgd)
- Extends stream flow record to include 2015 drought year
- Reflects current operations to refill reservoirs when snowpack is low
- Meets 98% reliability standard

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Firm Yield

- used for long-range water supply planning purposes
- includes water from all water supply sources
- meets instream flow requirements
- uses 98% reliability standard

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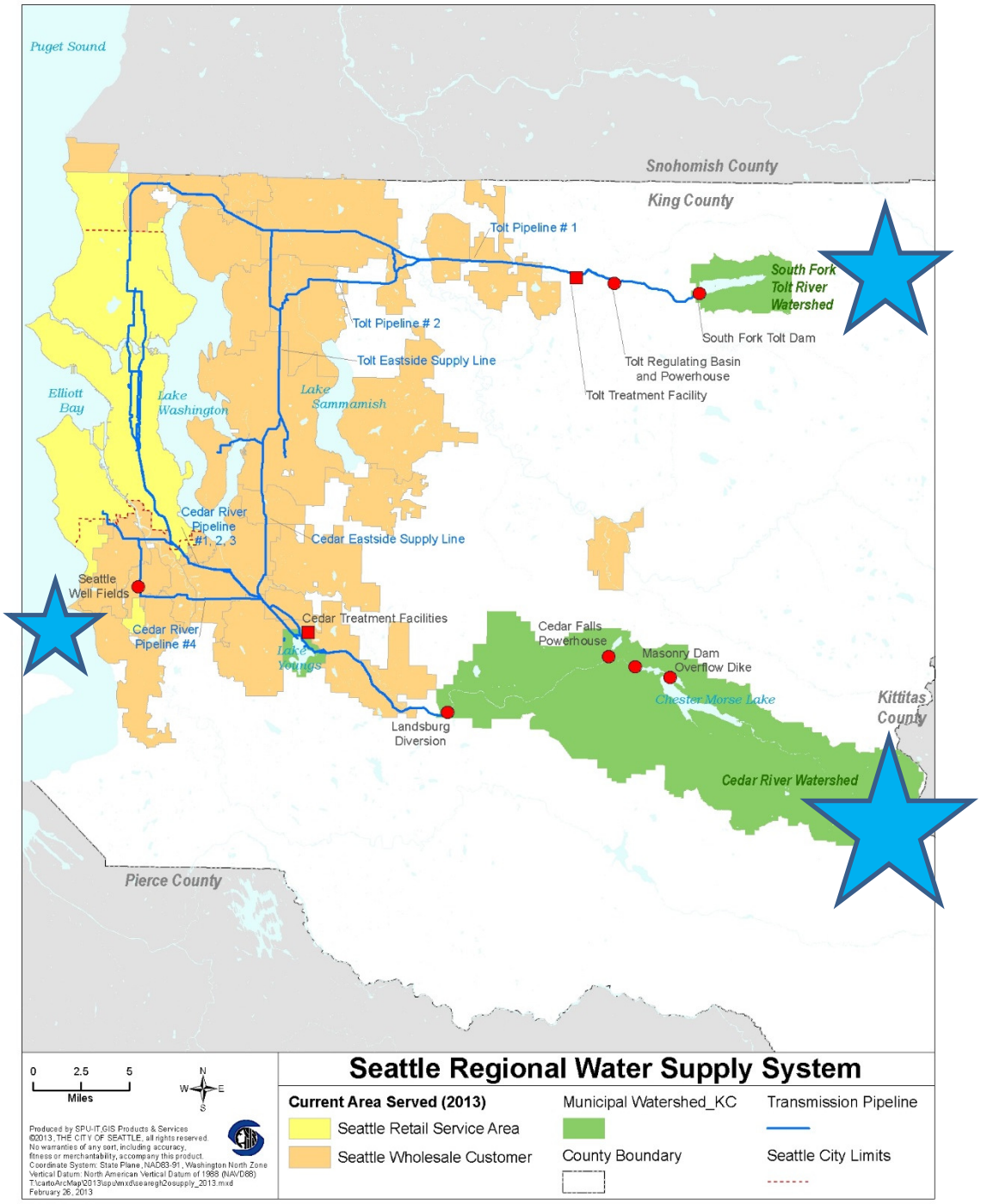

Water Supply Sources:

Surface Water:

- South Fork Tolt River
- Cedar River

Ground Water:

- Seattle Well Fields

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Impact of 2015 drought on Firm Yield

- second worst drought year in the analysis
- record low snowpack
- record low spring and summer stream flows
- firm yield is 159 mgd using generalized reservoir refill rule curve on the Cedar system (2013 Water System Plan model assumption)
- firm yield is 164 mgd by changing model reservoir refill rule curve to match actual 2015 reservoir operations (allows higher reservoir refill targets in early spring to capture and store more water in low snowpack years)

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98% Reliability Standard and Firm Yield

- 98% reliability standard allows 1 shortfall to occur in a 50-year period of record

- a shortfall occurs when the water supply system is not able to meet uncurtailed water demands and/or critical instream flow requirements in the firm yield analysis

- see handout about the 98% reliability standard – what it means, and what it does *not* mean

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98% Reliability Standard and Firm Yield

- extending the historical stream flow record to include the 2015 drought year creates 87 years of record
- analysis shows that 2015 is now the second worst hydrologic drought year in the record, following 1987 which remains the worst and bumping 1941 down to third worst
  - firm yield is 164 mgd when we allow 1 shortfall to occur in the 87-year period of record
  - firm yield is 172 mgd when we allow 2 shortfalls to occur in the 87-year period of record

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98% Reliability Standard and Firm Yield

- allowing 1 shortfall in 87 years produces a 98.9% reliability
- allowing 2 shortfalls in 87 years produces a 97.7% reliability
- decision is to say, “97.7% is closer to 98% and therefore firm yield is 172 mgd”

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Firm yield is expressed as an average annual amount of water.

For example, if we supply 62.8 billion gallons of water in one year:

62.8 billion gallons per year

divided by 365 days per year

172 million gallons per day (mgd)

Therefore, average annual firm yield = 172 mgd

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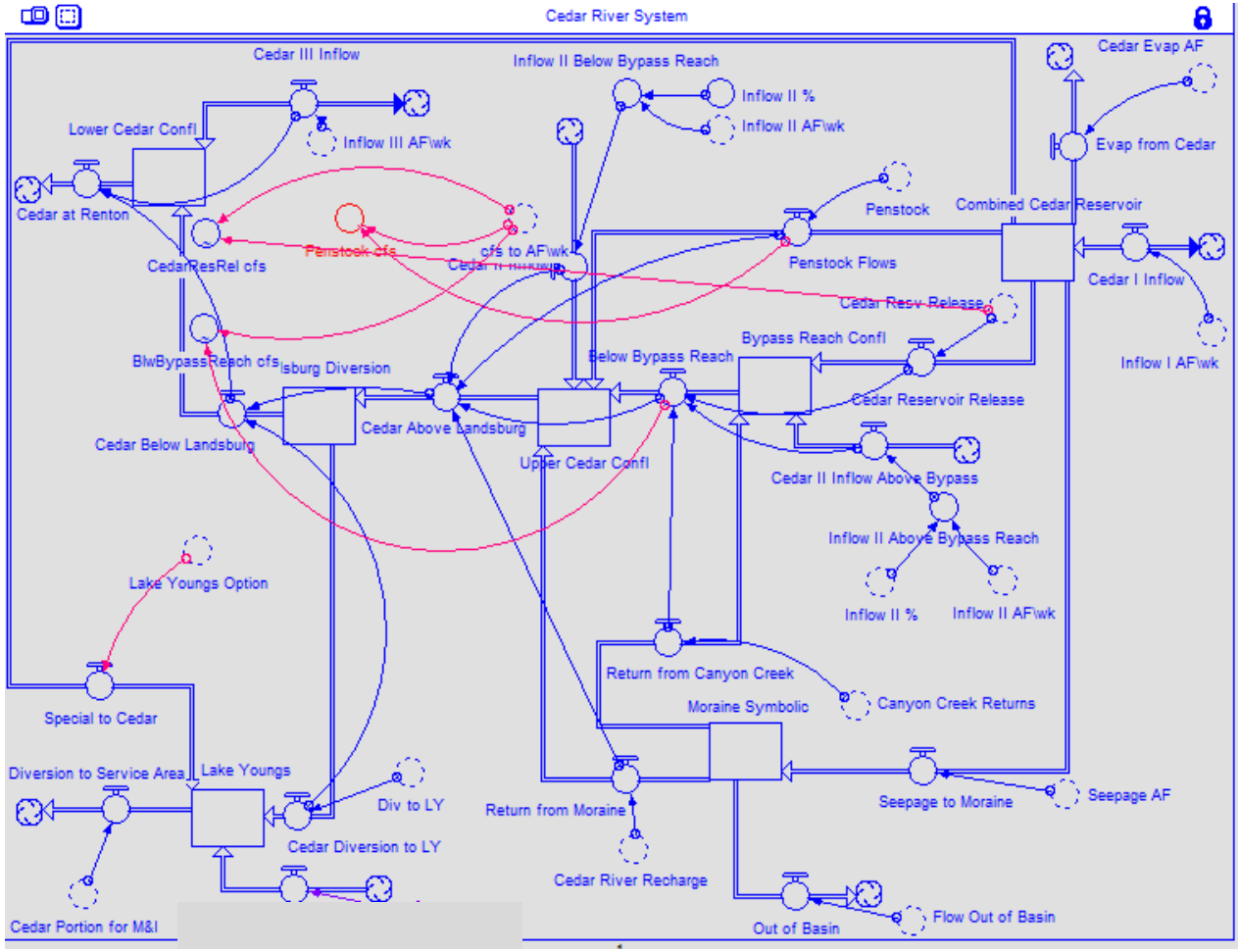
We use a complex computer simulation model to calculate the system-wide firm yield of our water supply sources.



Example screenshot of our Conjunctive Use Evaluation Model (CUE Model)

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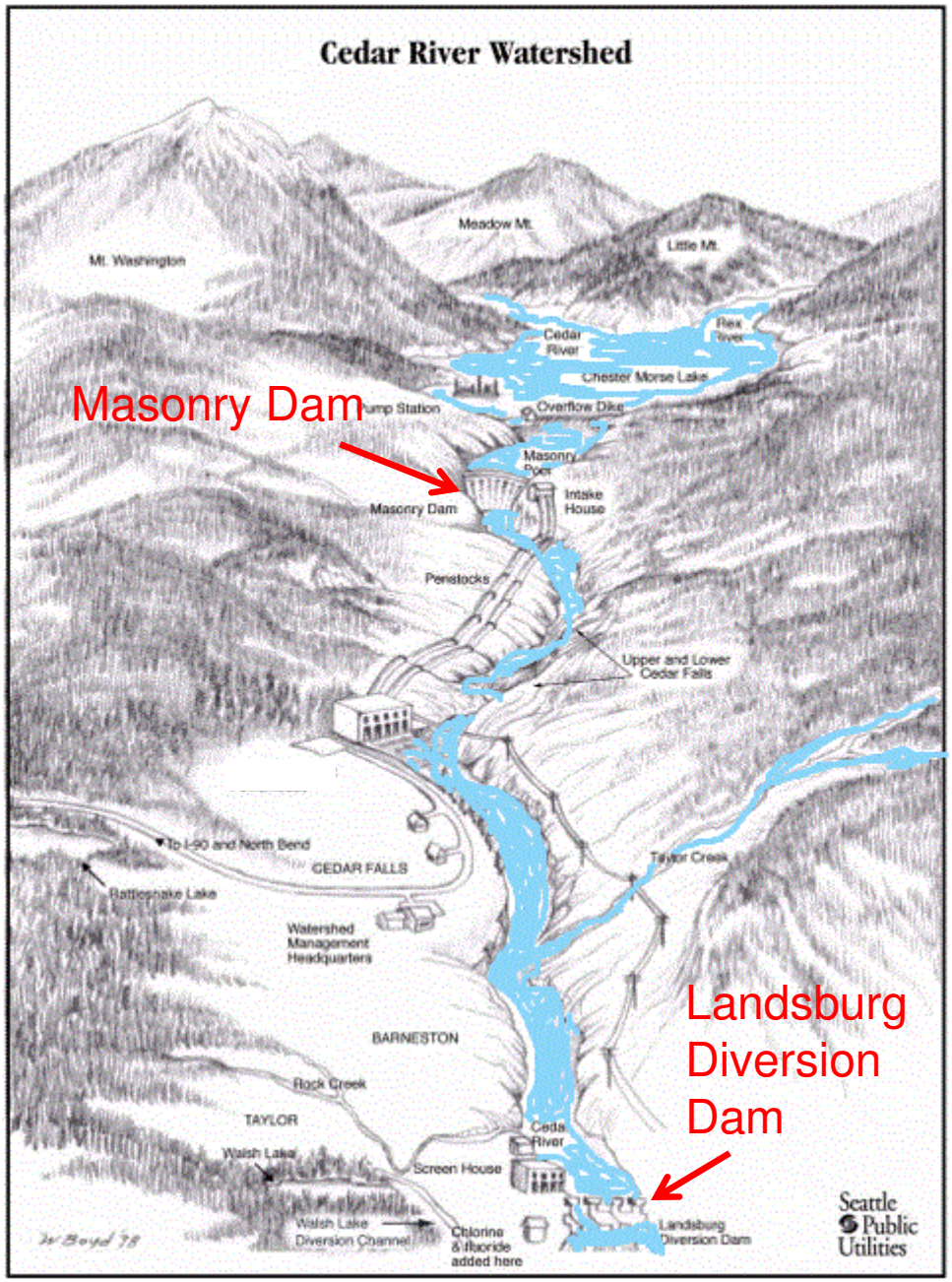

Bird's eye view of Cedar River Watershed

The CUE Model is designed to simulate Seattle's water supply sources and water supply operations using long-term planning assumptions.

Example reservoir water balance equation:

inflow minus outflow = change in storage

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The CUE Model:

- network of rivers, wells, reservoir and diversion facilities (Seattle Well Fields = 10 mgd capacity)
- 87 years of historical stream flows to represent past weather and hydrologic variability (previously used 81 years)
- instream flow requirements (includes maximum annual diversion limits from Cedar River)
- water demand pattern based on 2006 - 2014 actual water use records (previously used 2005 – 2009 record)
- minimum service area delivery for each source of supply (Cedar = 30% of demand, Tolt = 26%)
- reservoir operating rules to store water and allocate water releases (revised to reflect current operations to refill reservoirs when snowpack is low)

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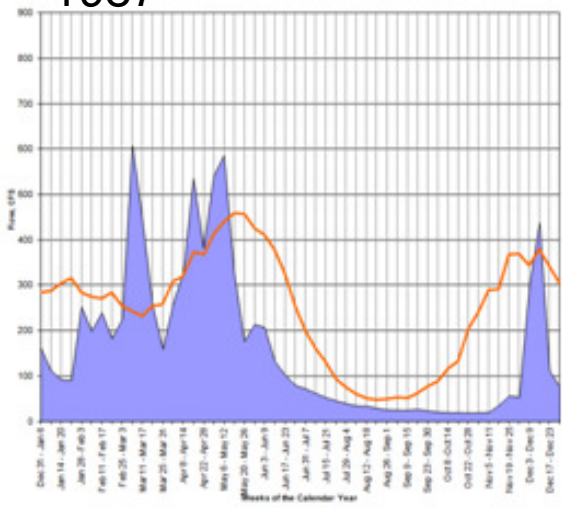
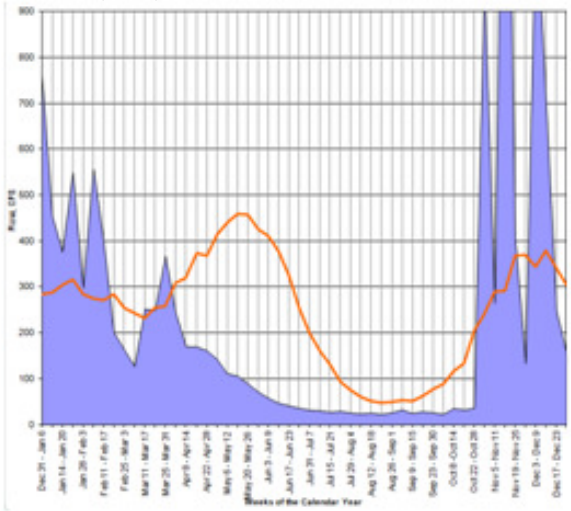
With 2015 drought included in historical stream flow dataset:

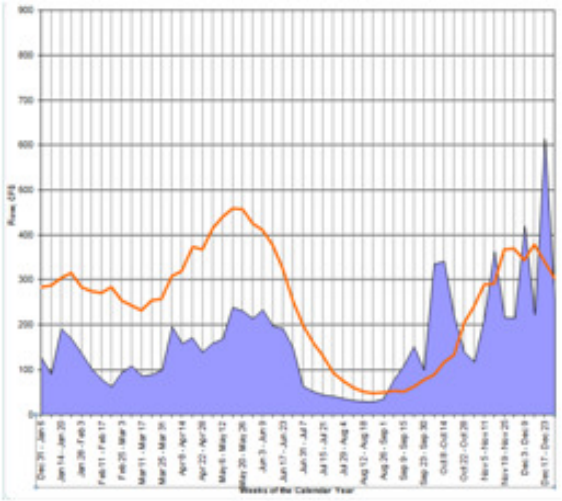
1987



2015



1941



worst drought year -
low summer and fall flows

second worst drought year -
low spring and winter flows

third worst drought year -
low winter and spring flows

Graph Legend:
Measured reservoir inflows at Cedar River near Cedar Falls (blue area, US Geological Survey)
Statistical stream flow median (orange line, based on past records)

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Worst hydrologic drought year

- 1987

- Let's look at the CUE Model output assuming 172 mgd system-wide demand

  - Instream flow requirements are met
  - Demand shortfall occurs at 172 mgd
  - Reservoirs draw down to minimum levels

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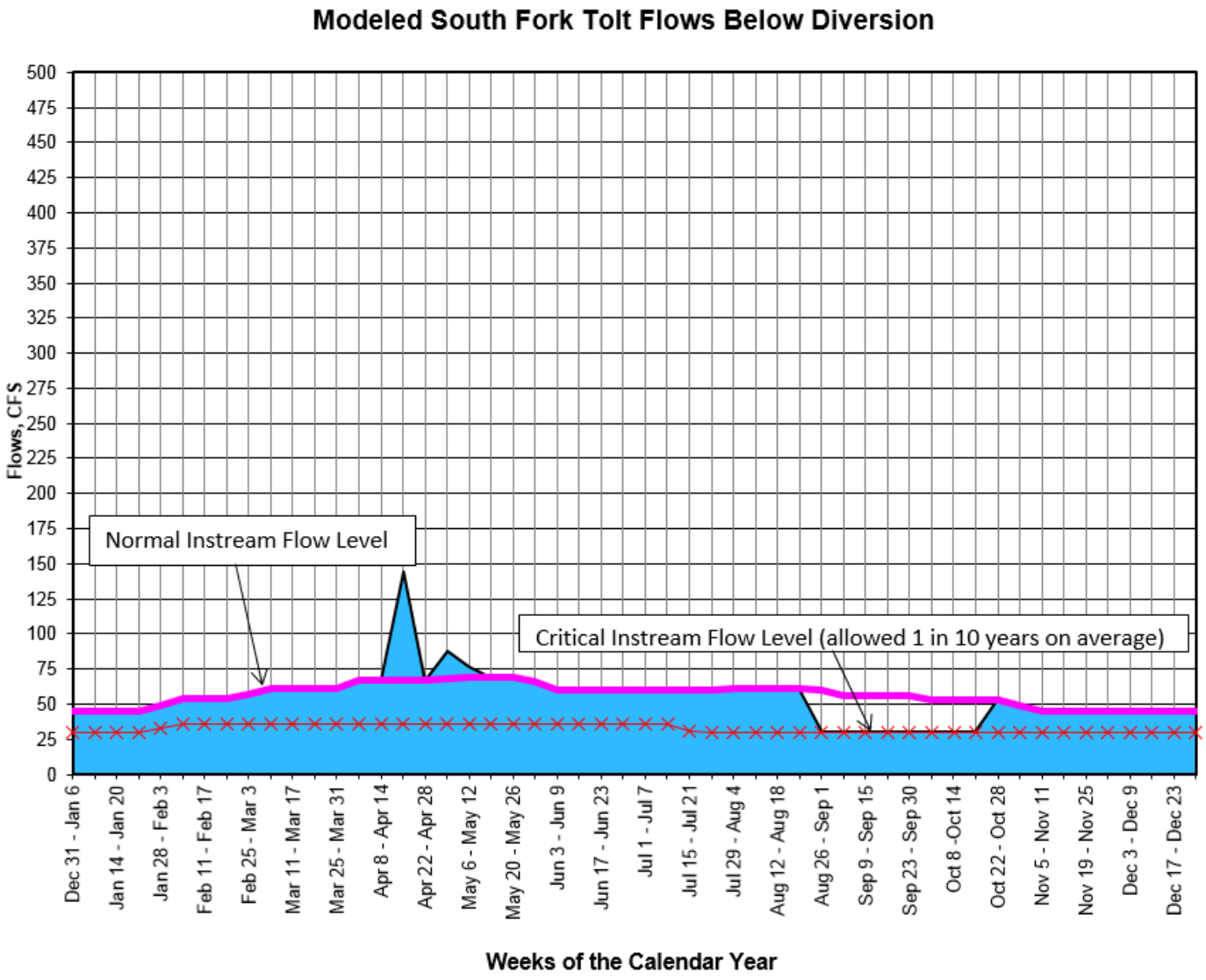

Modeled SF Tolt River minimum instream flow requirements and model output using 1987 hydrologic conditions and assuming 172 mgd system-wide demand.

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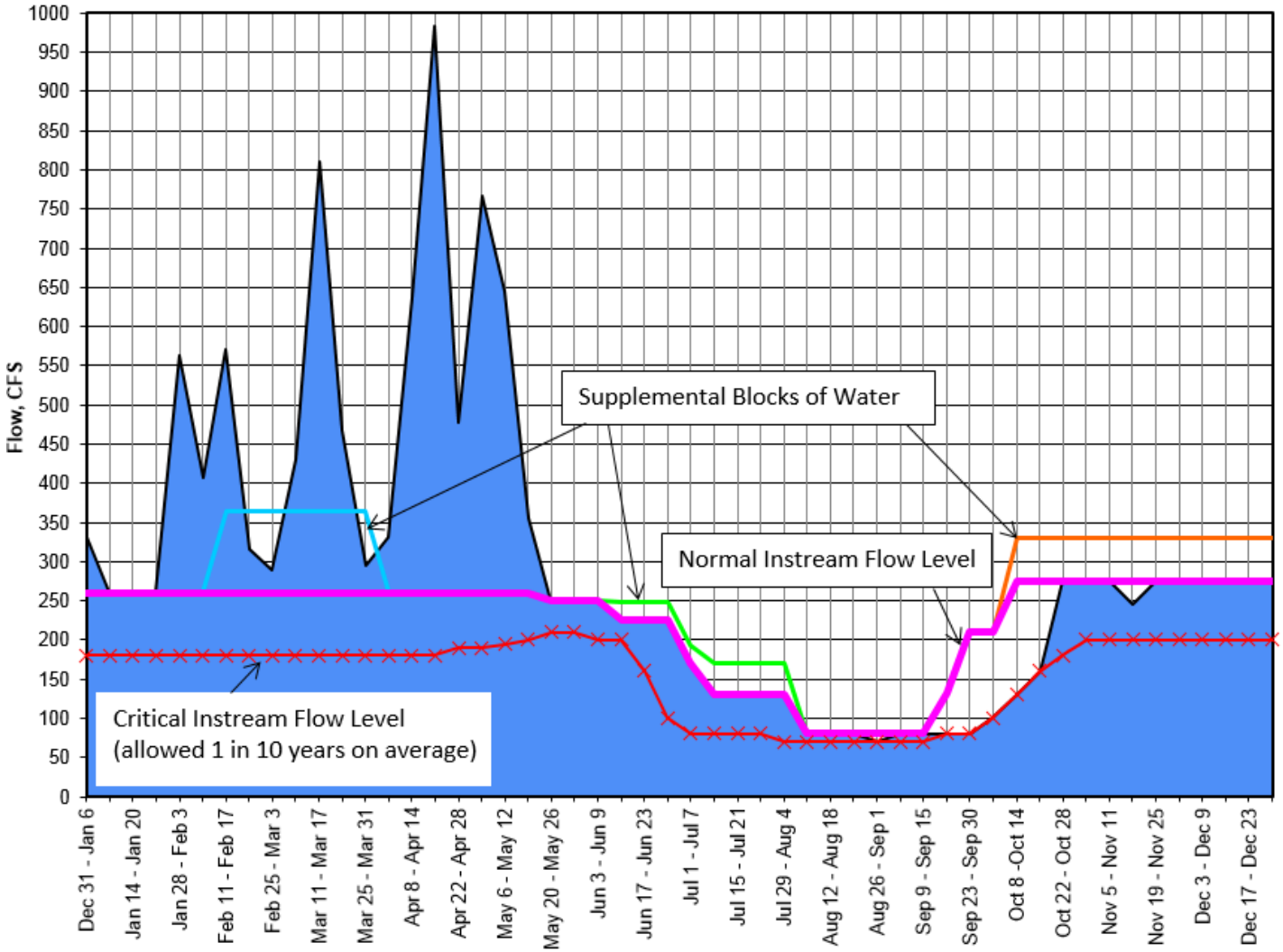
Modeled Flows below Landsburg



Modeled Cedar River minimum instream flow requirements and model output using 1987 hydrologic conditions and assuming 172 mgd system-wide demand.

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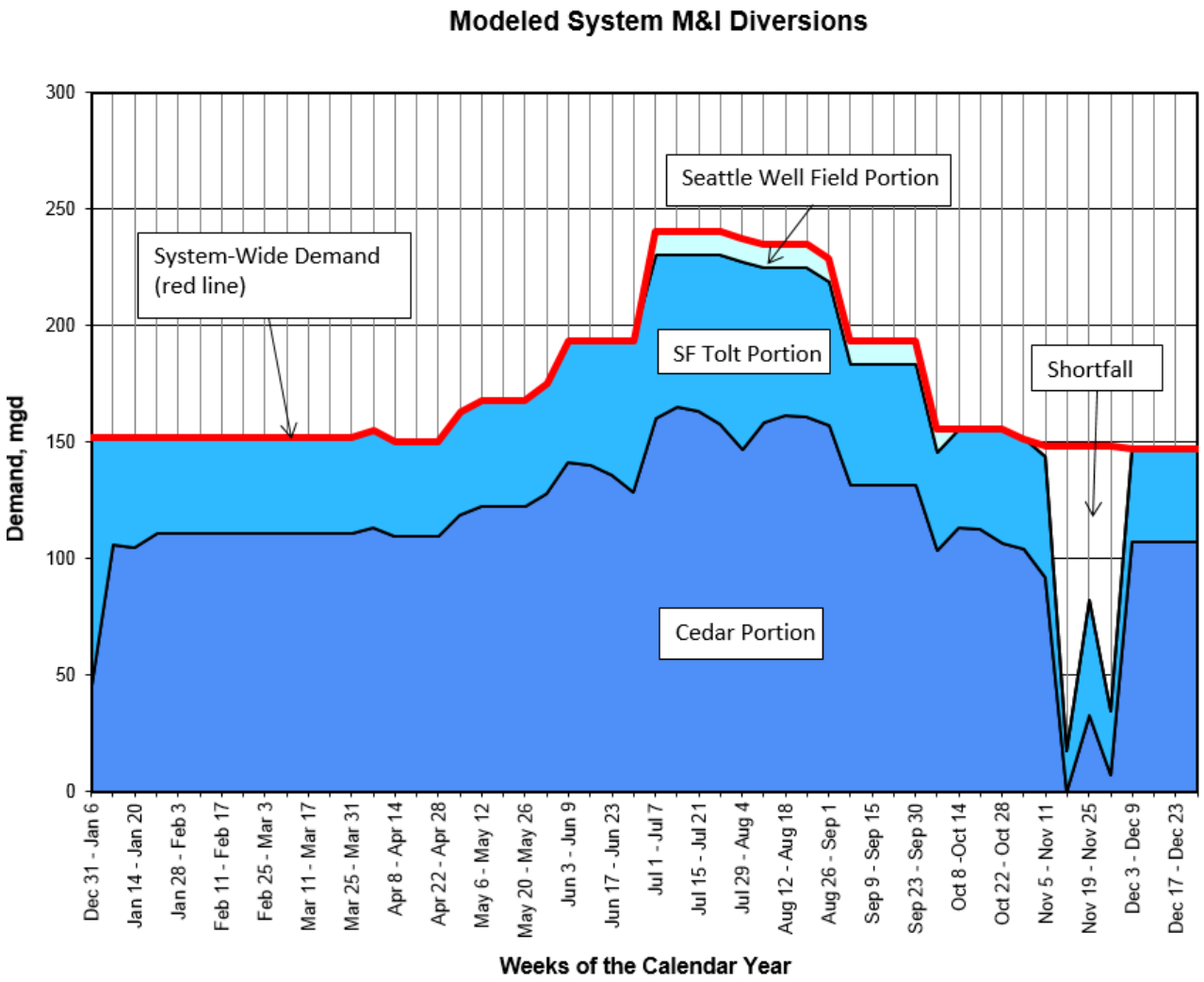

Modeled system-wide demand pattern and model output showing components of water supply sources using 1987 hydrologic conditions and assuming 172 mgd system-wide demand. Shortfall occurs in the model. Real-world we initiate curtailment contingency plans and have emergency backup water supplies.

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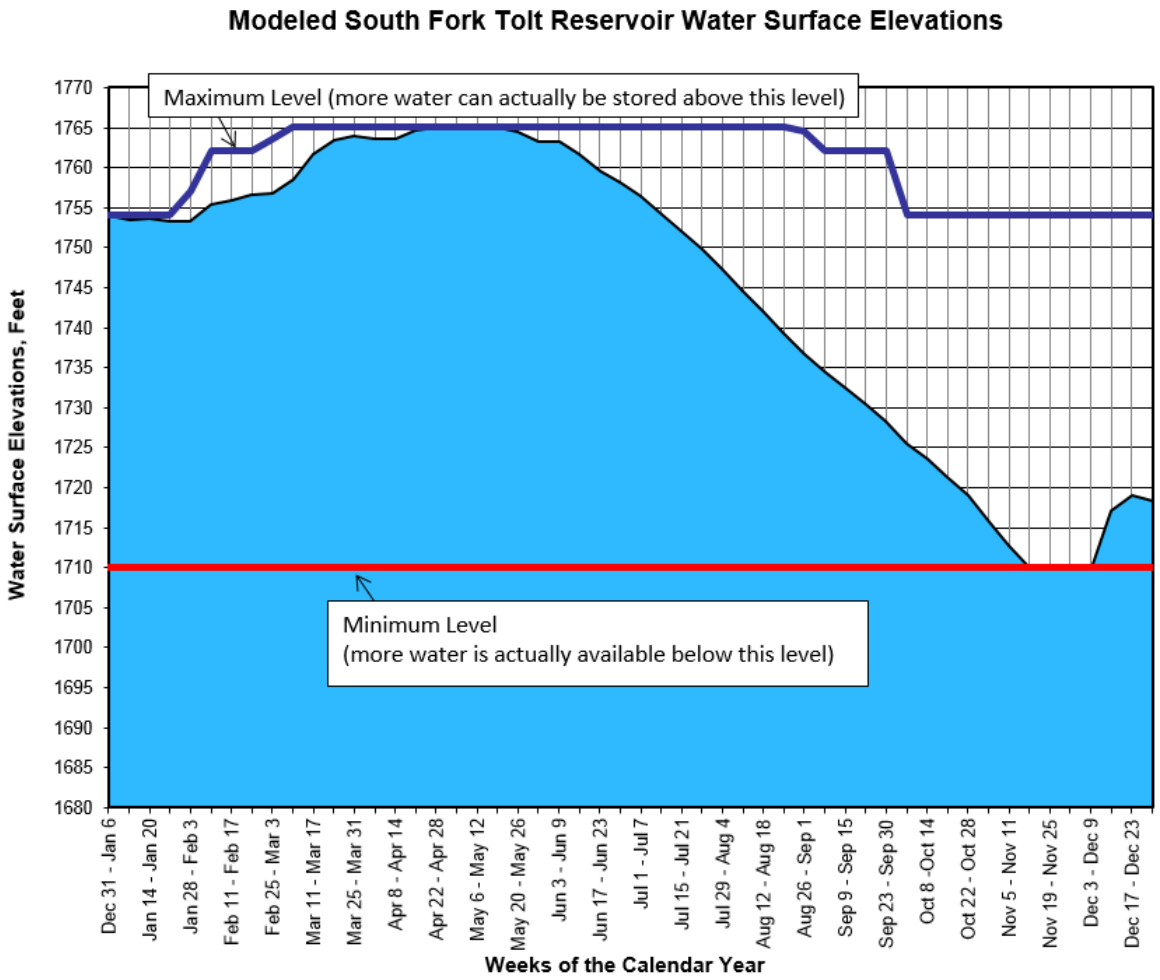

Modeled SF Tolt Reservoir operating zones and model output using 1987 hydrologic conditions and assuming 172 mgd system-wide demand. More water is available below the modeled minimum level and further investigative studies are planned to ensure reliability from water quality and treatment perspectives before changing this model assumption.

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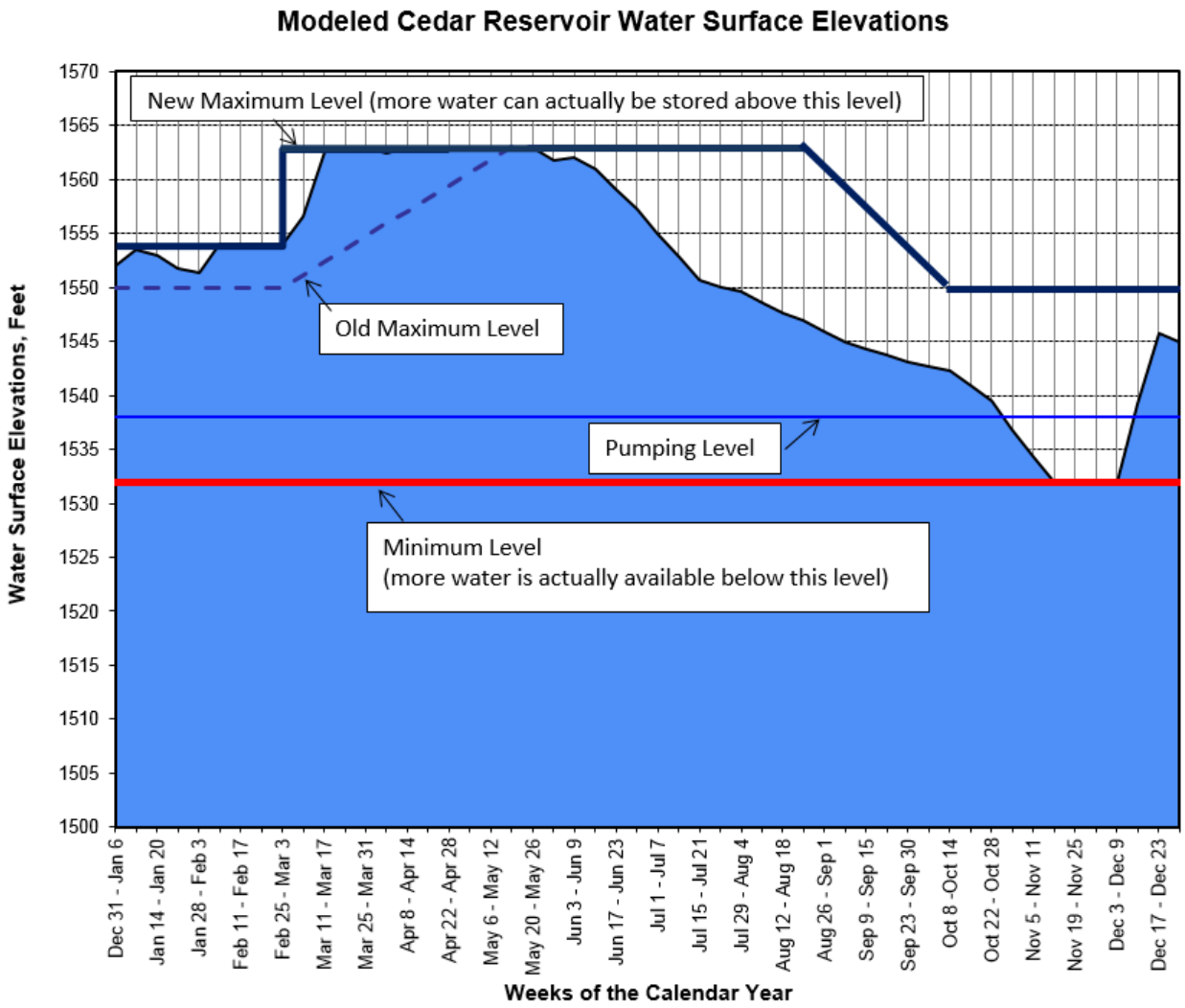

Modeled Cedar Reservoir operating zones and model output using 1987 hydrologic conditions and assuming 172 mgd system-wide demand. Modeled reservoir refill rule curve changed to capture and store more water in early spring. More water is available below the modeled minimum level and in real-world is accessible as an emergency backup source of supply.

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Second worst hydrologic drought year

- 2015

- Let's look at the CUE Model output assuming 172 mgd system-wide demand

  - Instream flow requirements are met
  - Demand shortfall occurs at 172 mgd
  - Reservoirs draw down to minimum levels

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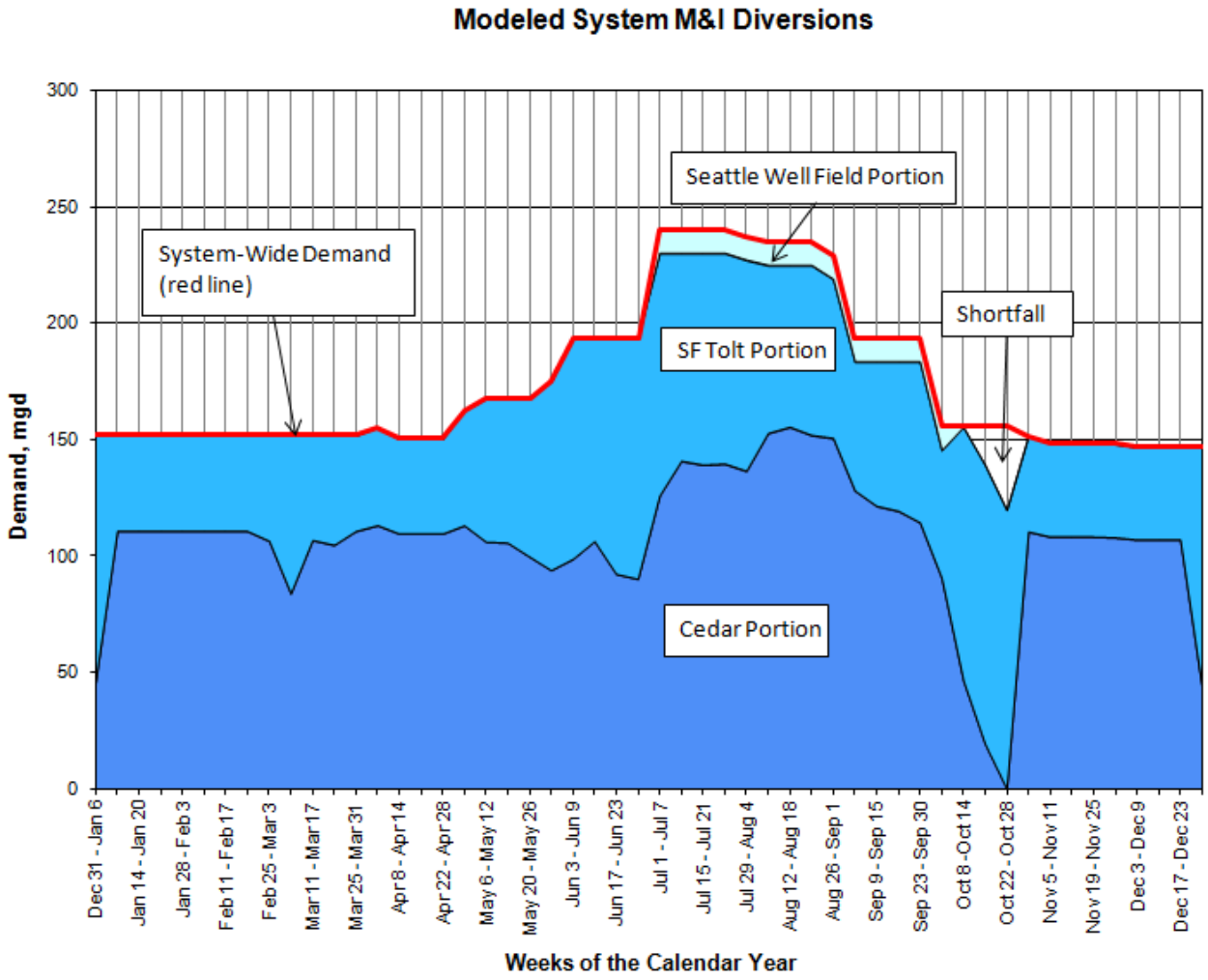

Modeled system-wide demand pattern and model output showing components of water supply sources using 2015 hydrologic conditions and assuming 172 mgd system-wide demand. Shortfall occurs in the model. Real-world we have curtailment contingency plans and emergency backup supplies.

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Third worst hydrologic drought year

- 1941
- This is also known as the “yield-defining” year
- 172 mgd is the amount of water available for municipal use
- At 173 mgd system-wide demand, a shortfall occurs in this year
- Let’s look at the CUE Model output assuming 172 mgd system-wide demand
  - Instream flow requirements are met
  - No shortfall occurs at 172 mgd
  - Reservoirs draw down close to minimum levels

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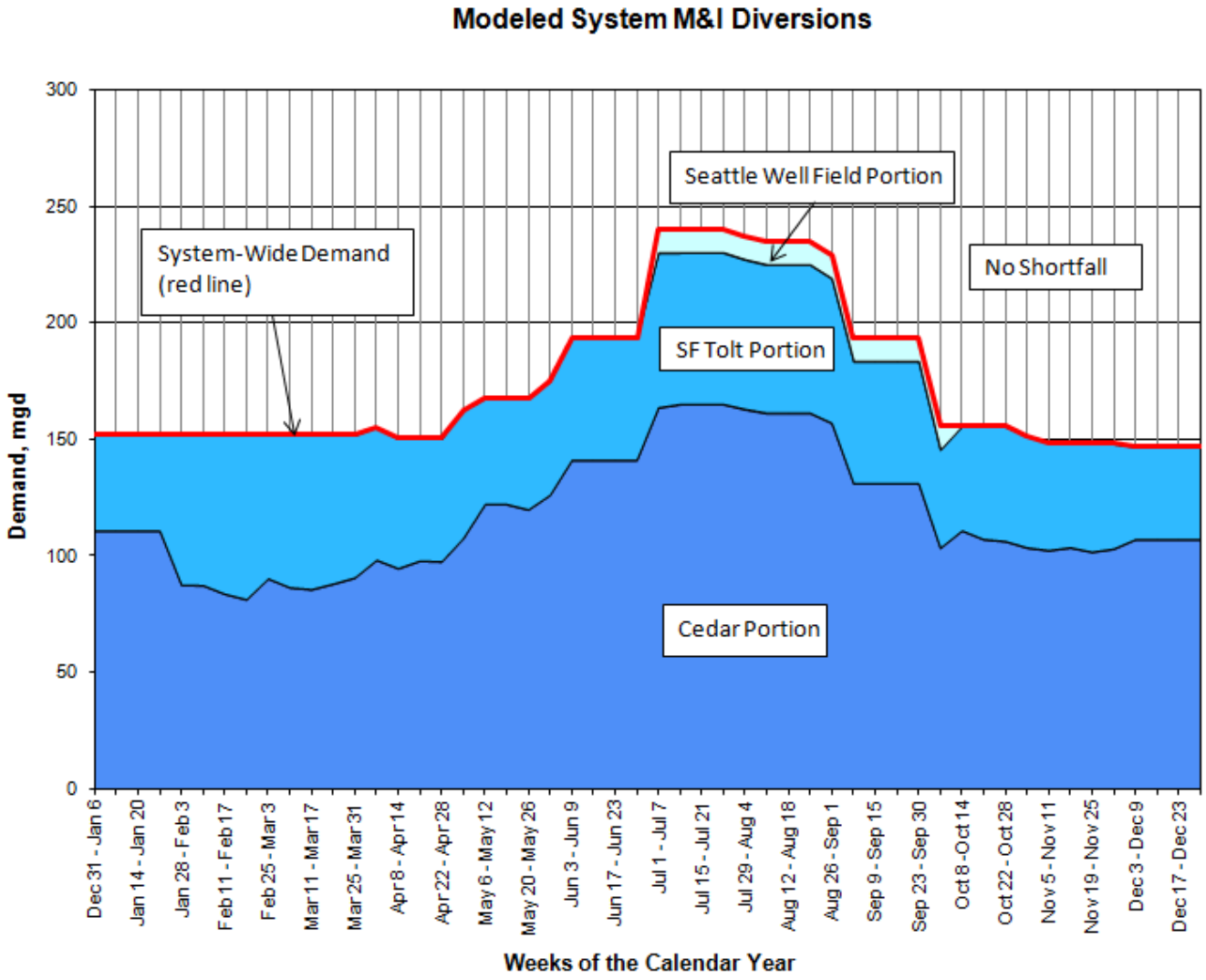

Modeled system-wide demand pattern and model output showing components of water supply sources using 1941 hydrologic conditions and assuming 172 mgd system-wide demand. No shortfall occurs in the model.

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Conclusions

The system-wide firm yield of Seattle's existing water supply sources remains at 172 mgd

- Meets 98% reliability standard
- 1987 remains the worst hydrologic drought year in the historical stream flow record
- 2015 becomes the second worst drought year
- 1941 is the yield-defining year at 98% reliability

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Thank you!

Photo Credit: Lloyd Buster, SPU Watershed Inspector.

End

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