Rebooting Your Demand Forecast for Better Decision Making

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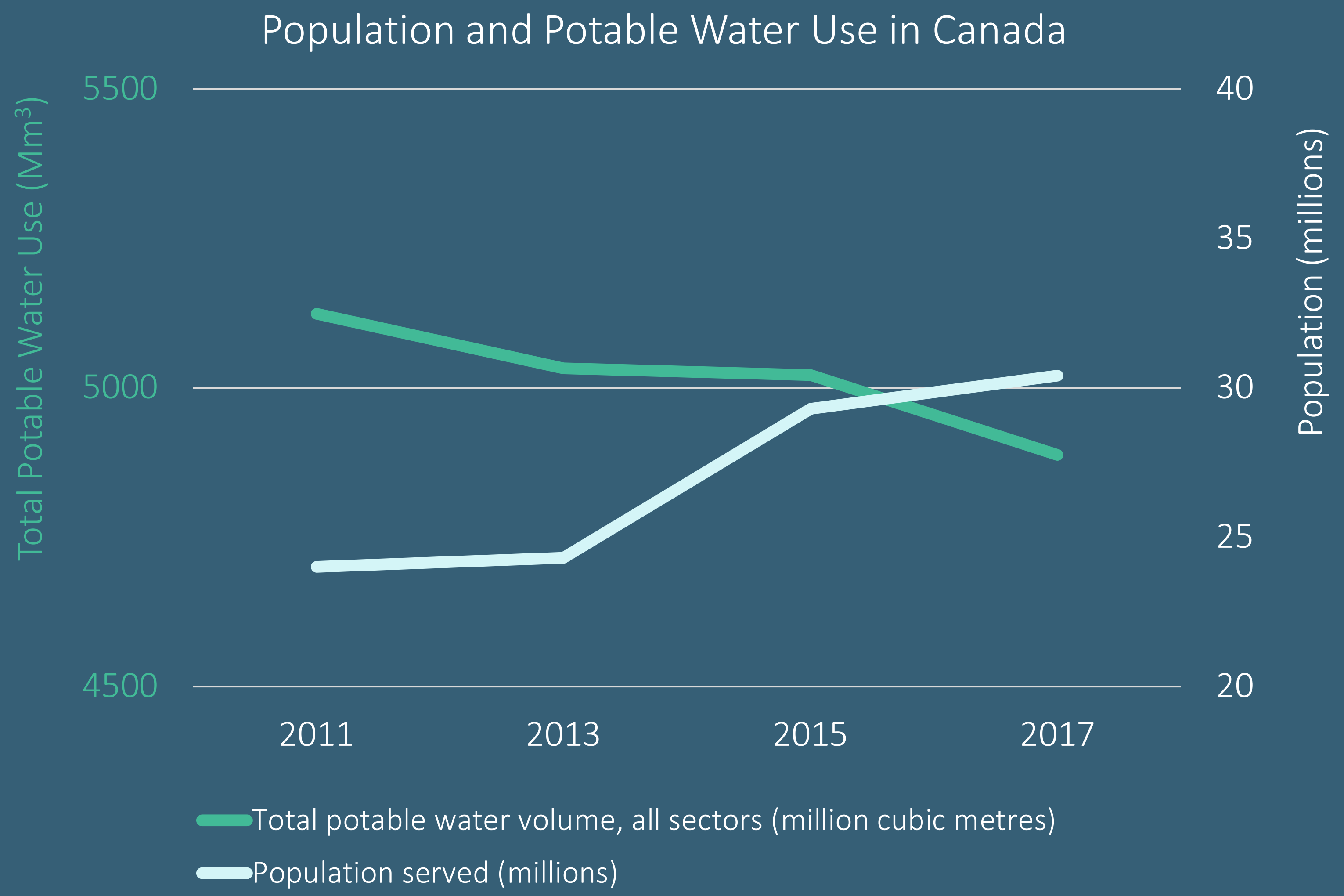
Overview

- This presentation will provide an overview of what we have learned and applied in our approach to water demand forecasting.

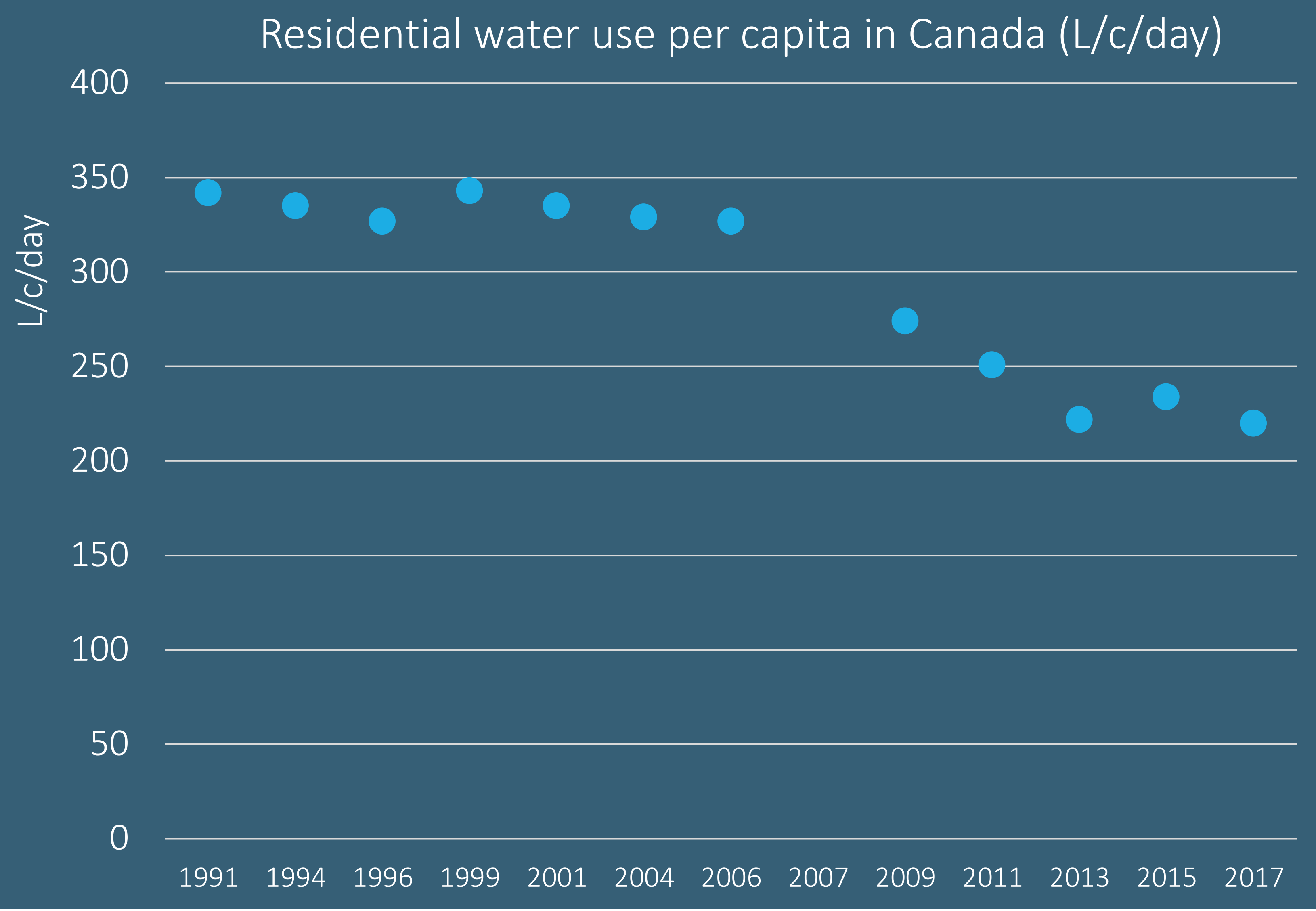
We will use real-world examples to illustrate the benefits that improved forecasting can provide for utility planning and decision-making.

Project Context



Urban water use has been declining everywhere…

Project Context



Urban water use has been declining everywhere…

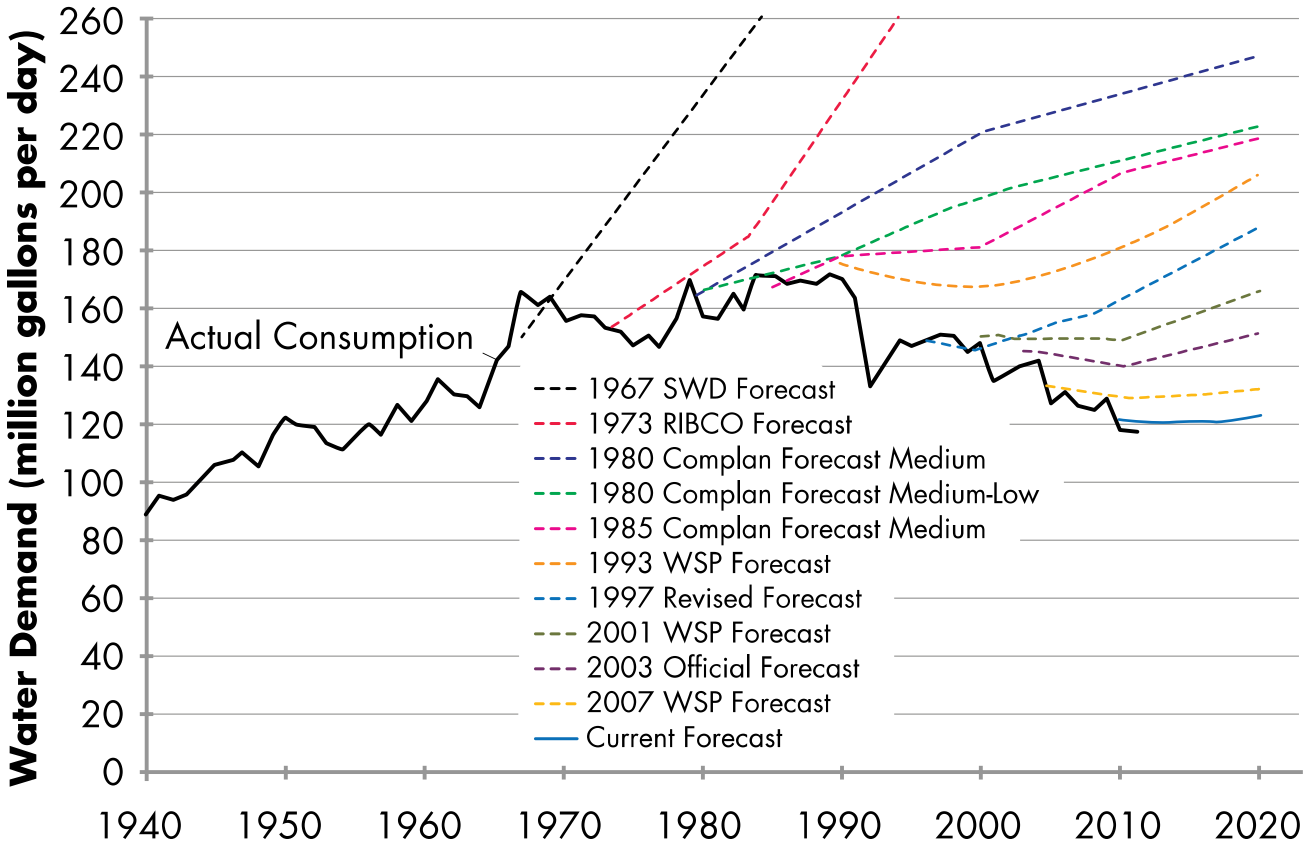
Old forecasting methods don't work.

"Porcupine chart"

We can't just assume that:

- Historical trends will continue
- Water use will change in proportion to population

We may be oversizing infrastructure when we plan and design infrastructure based on extrapolating historical trends.



Historical water demand forecasts for Seattle

(image: Heberger et al., Pacific Institute, 2016)

Best Practices[1]

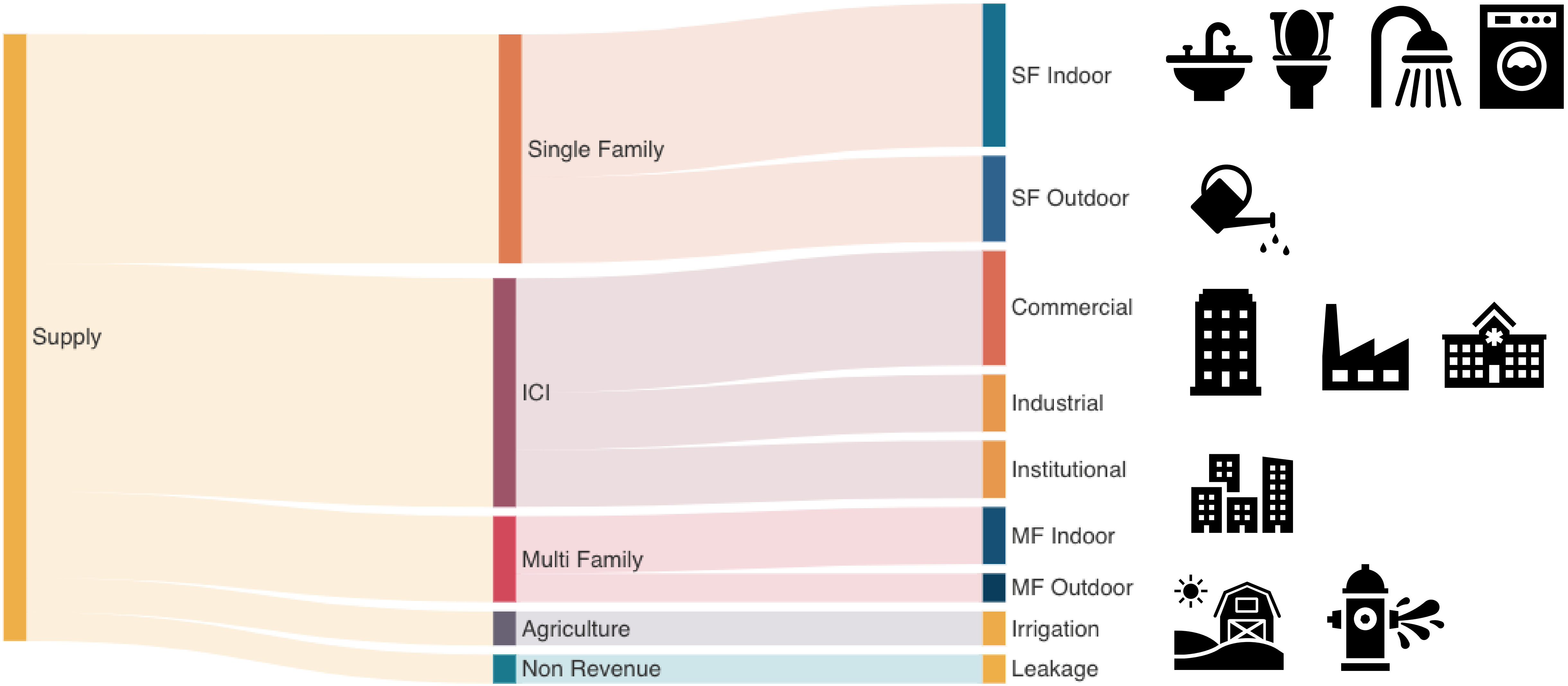
1. Account for Water Conservation and Efficiency
2. Account for Changes in Economic Activity
3. Account for Changes in Water Price
4. Consistency with Other Planning Documents
5. Account for Expected Land Use Changes
6. Account for Climate Change and Drought
7. Account for Uncertainty
8. Ensure Transparency and Review

We expand on these to:

- Account for land use through sector and end use analysis
- Account for land use through base and seasonal demand breakdown
- Model climate change, population, economic and policy changes through scenario analysis
- Incorporate non-revenue water for universally metered and unmetered systems
- Calibrate to real data for uncertainty assessment using Monte Carlo simulation

[1]Pacific Institute. (2016). A Community Guide for Evaluating Future Urban Water Demand

+ A good forecast begins with a good model of community water use.



+ Account for land use through sector and end use

Example: Capital Regional District (BC)

Goal: Understand sources of demand for informed decision making

Outcome: Sector and end use analysis allows us to see demand drivers and target demand side management initiatives

Industrial, Commercial, and Institutional Inputs

Water Demand Forecast Tool
Capital Regional District
Version 2
Tuesday, October 12, 2021

		Victoria/Esquimalt		Oak Bay		Saanich	
Model Input	**Input Description**	**Value**	**Units**	**Value**	**Units**	**Value**	**Units**
Total ICI Connections	Total number of ICI Connections	2809		143		1084	
% of System Serviced	% of System Serviced from CRD data	100	%	100	%	100	%
Serviced ICI Connections	Total number of serviced ICI Connections	2809		143		1084	
Data Year	# of connections data year used	2019		2019		2019	
Industrial Connections%	Estimated % of Industrial Connections of total	3	%	3	%	2	%
Commercial Connections %	Estimated % of Commercial Connections of total	68	%	59	%	50	%
Institutional Connections %	Estimated % of Instituitonal Connections of total	29	%	38	%	48	%
Industrial Connections	Calculated Ind connections/# of Ind connections	84		4		26	
Commercial Connections	Calculated Com connections/# of Com connections	1910		85		539	
Institutional Connections	Calculated Inst connections/# of Inst connections	815		54		519	
Industrial Growth Rate	Adjusted annual expected growth of industrial connections	0.00	%	0.00	%	0.00	%
Commercial Growth Rate	Adjusted annual expected growth of commercial connections	0.75	%	-0.13	%	0.63	%
Institutional Growth Rate	Adjusted annual expected growth of institutional connections	0.75	%	-0.13	%	0.63	%
Industrial FAR	Industrial Gross Floor Area Ratio	0.75		0.4		0.8	
Commercial FAR	Commercial Gross Floor Area Ratio	0.21		0.2		0.4	
Institutional FAR	Institutional Gross Floor Area Ratio	0.2		0.2		0.2	
Industrial Lot Size	Average Industrial lot size	0.5	ha	0.4	ha	0.8	ha
Commericial Lot Size	Average Commercial lot size	0.175	ha	0.05	ha	0.2	ha
Institutional Lot Size	Average Institutional lot size	0.3	ha	0.4	ha	0.2	ha
Ind Fixture Replacement Rate	Rate at which old industrial fixtures are replaced	1	%	1	%	1	%
Com Fixture Replacement Rate	Rate at which old commercial fixtures are replaced	3	%	3	%	3	%
Inst Fixture Replacement Rate	Rate at which old institutional fixtures are replaced	3	%	3	%	3	%

Cover Sheet | General Inputs | Residential Inputs | ICI Inputs | Agricultural Inputs | Non-Revenue Inputs

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CRD Demand Forecasts, Past and Present

April 2008 forecast update (blue)

Actual population and 2021 update (red)

Water Use and Conservation Update 2008

April 2008

CRD

Making a difference...together

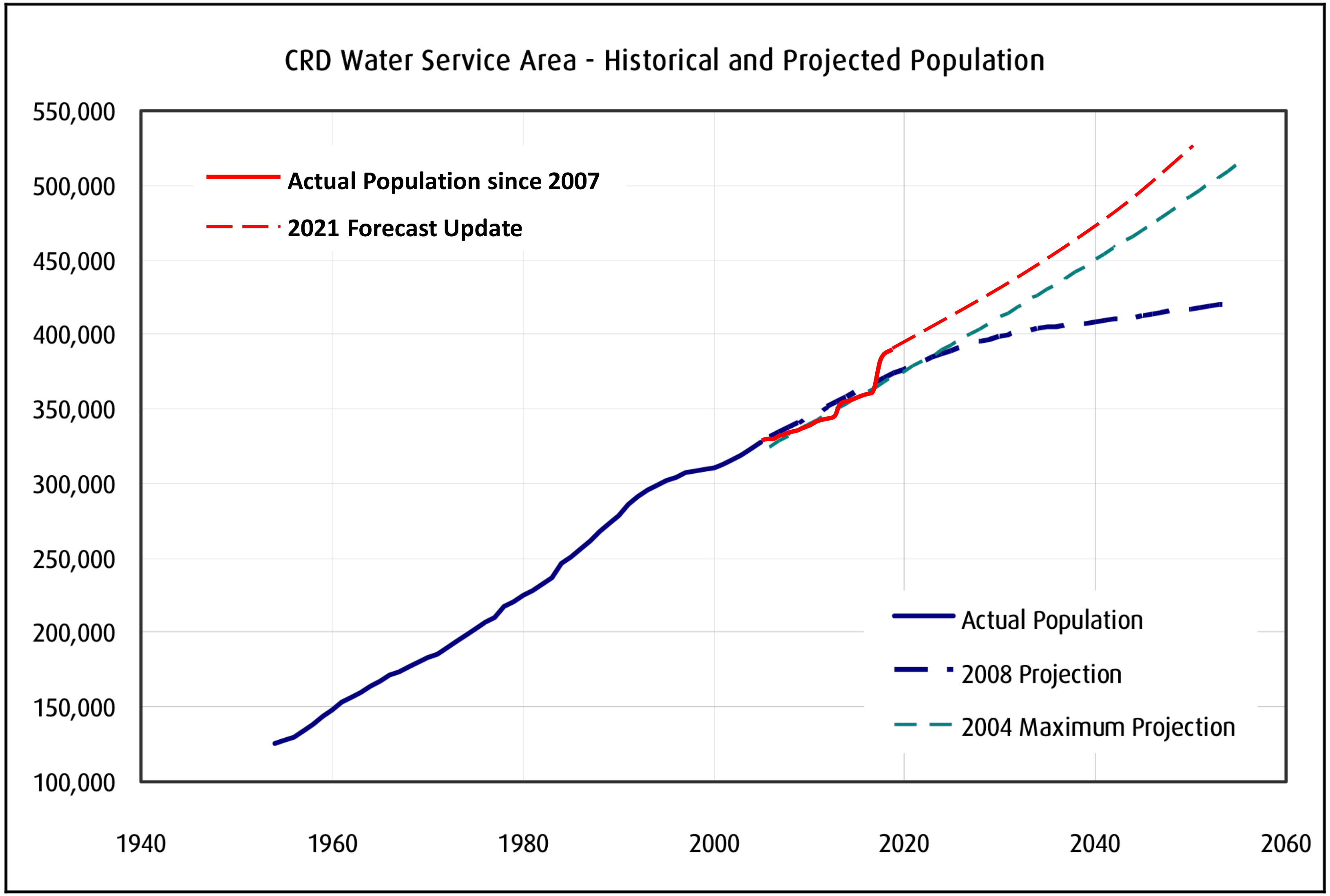

Figure 2. Revised Population Forecast

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CRD Demand Forecasts, Past and Present

April 2008 forecast update (blue)

Actual demand and 2021 update (red)

Water Use and Conservation Update 2008

April 2008

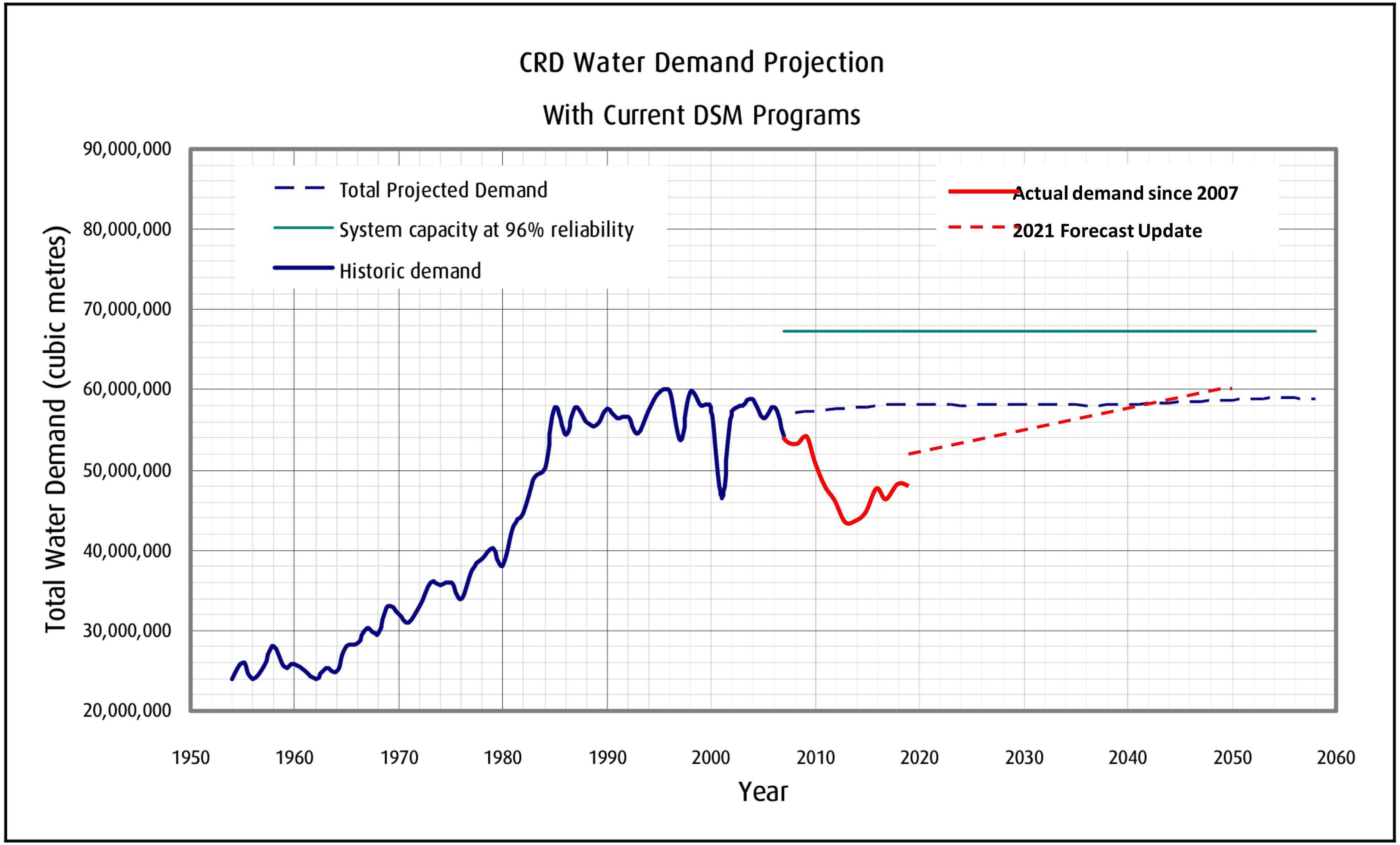
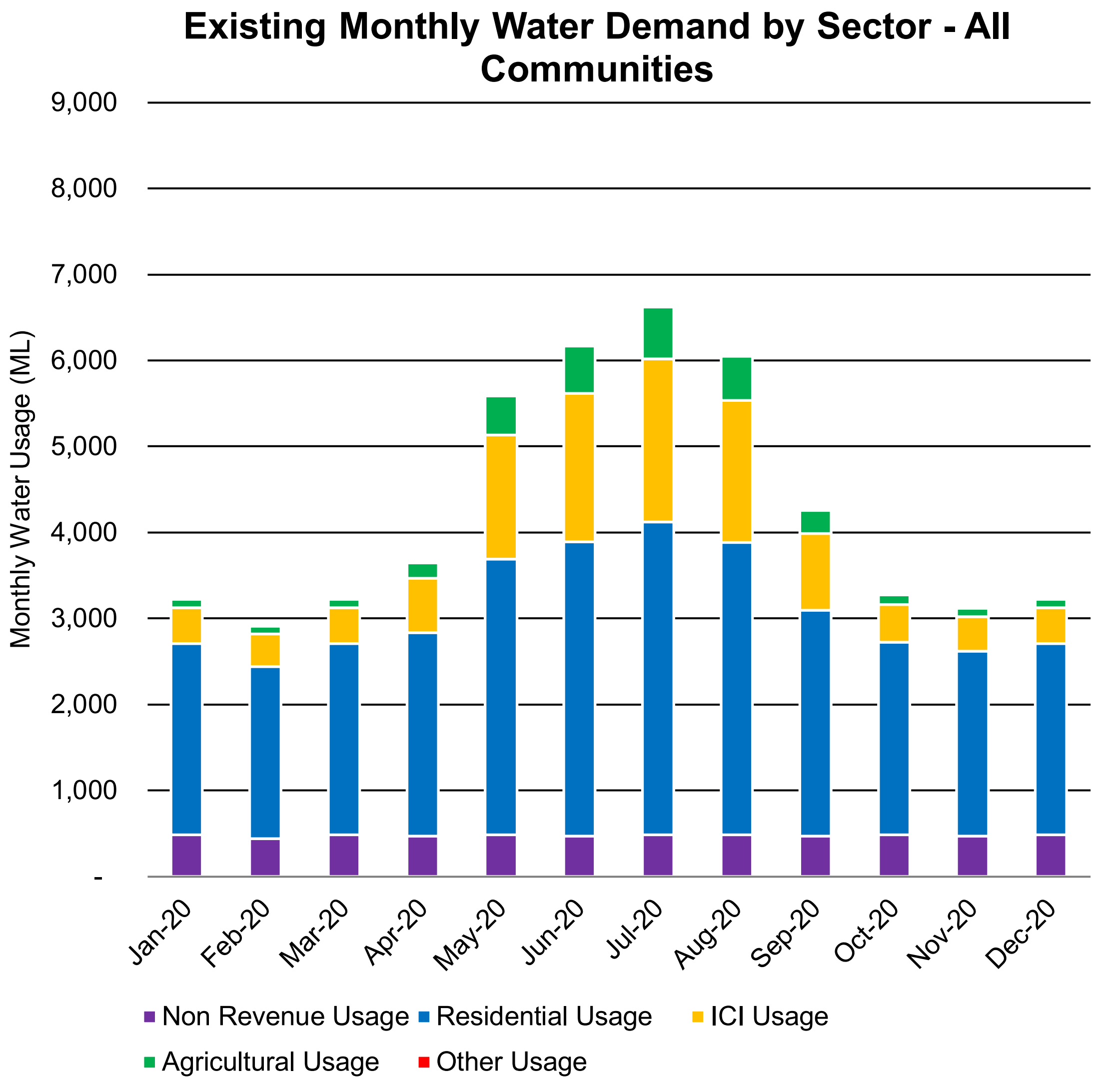
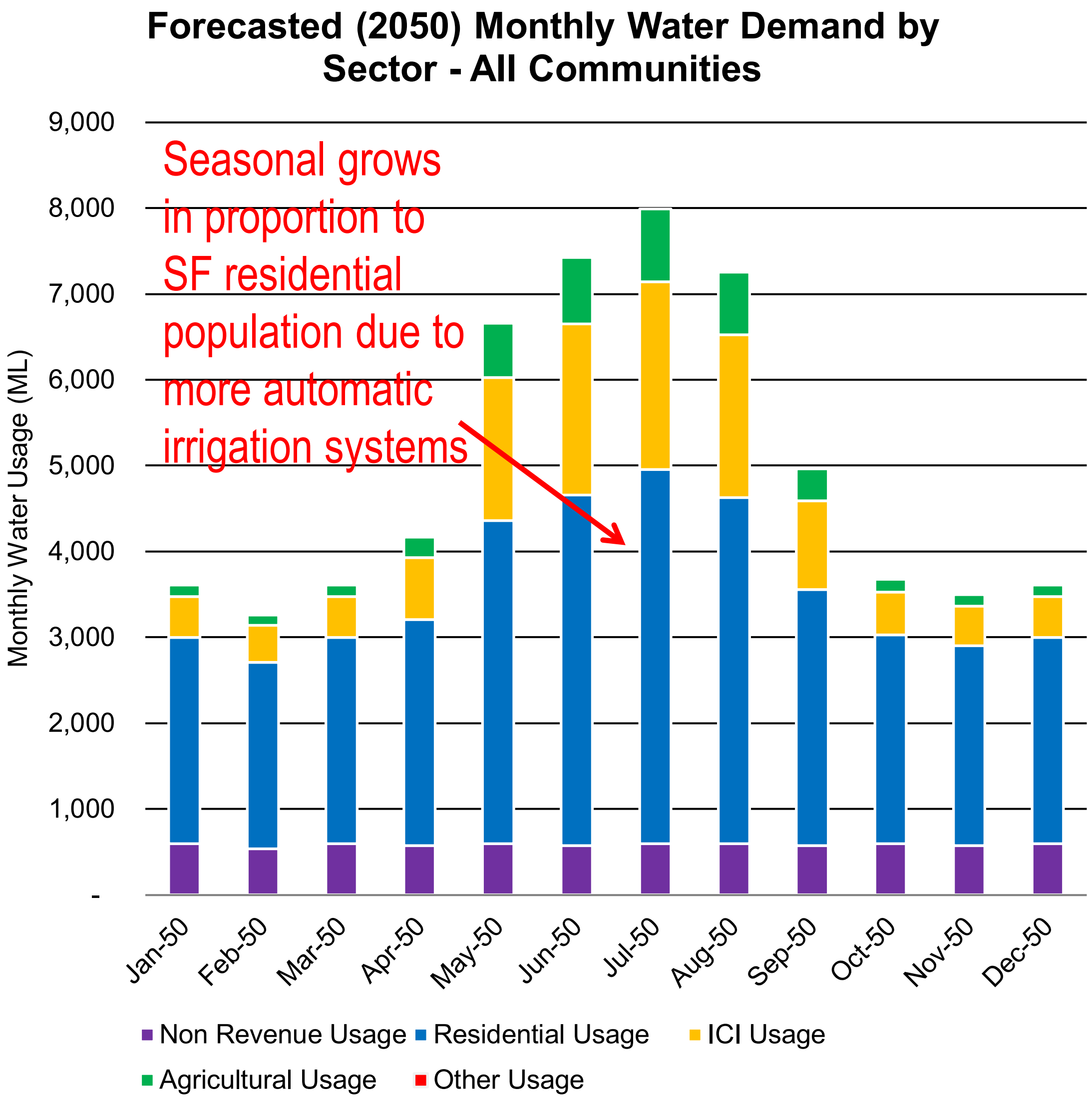


Figure 3. Total Water Demand Forecast for Greater Victoria

Sector Analysis Allows Us to See Demand Drivers

Residential and ICI base demands grow slightly as fixture and appliance replacements will no longer fully offset population growth



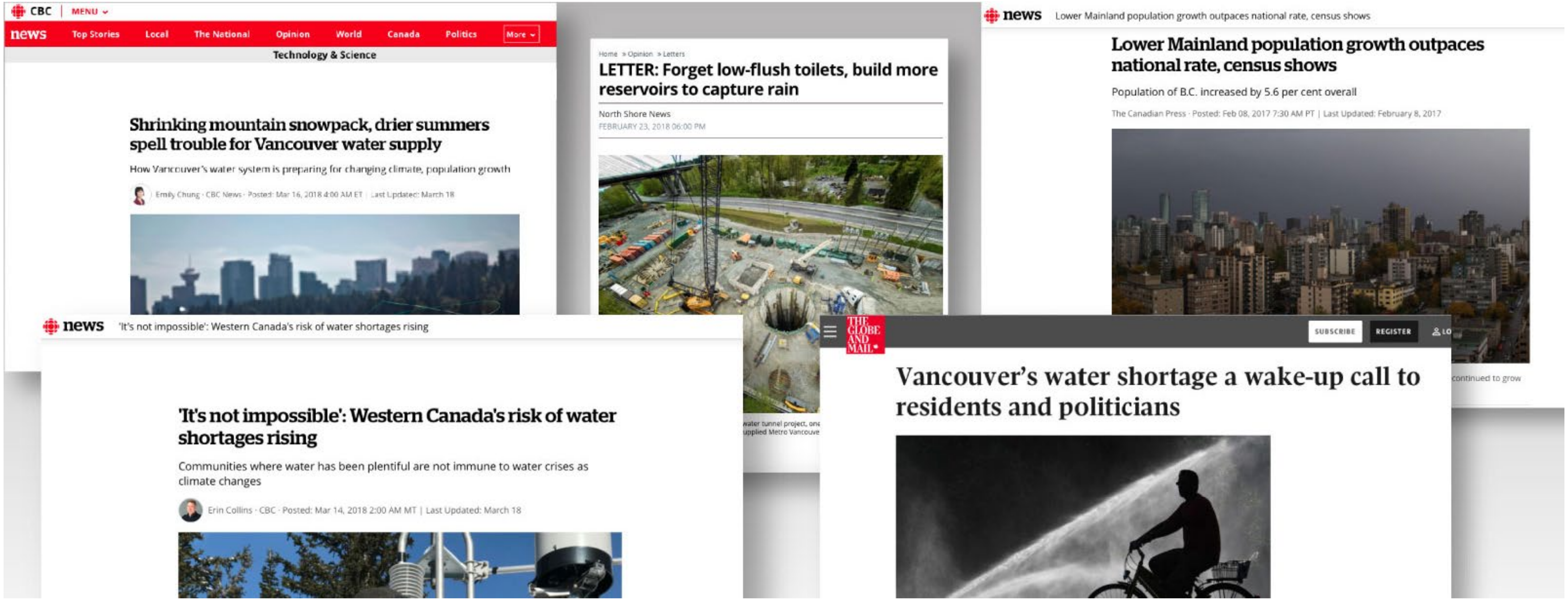


+ Account for land use through base and seasonal demand breakdown

Example: Metro Vancouver

Goal: establish effective seasonal watering restrictions that address water supply risks

Outcome: Breaking peak week into base/seasonal allows us to explore how policy shifts impact demand patterns



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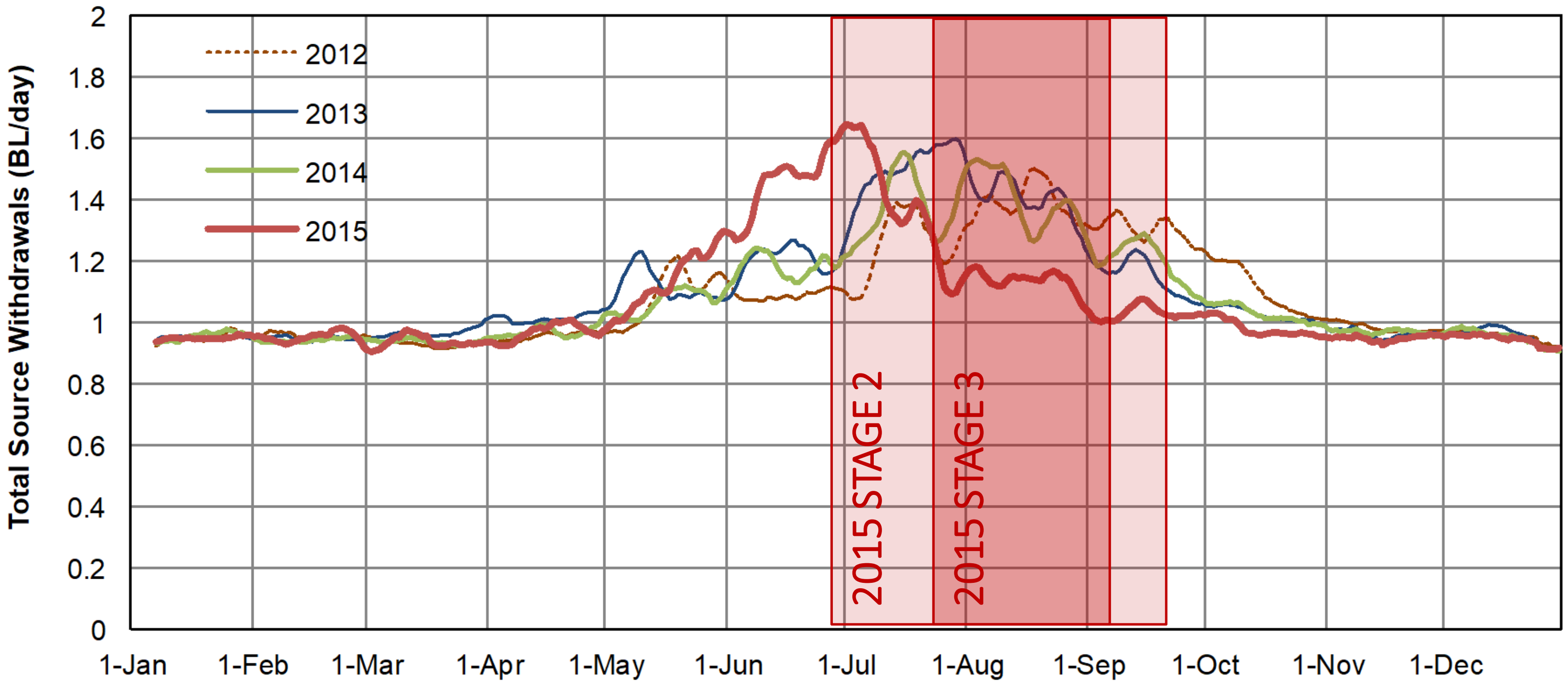
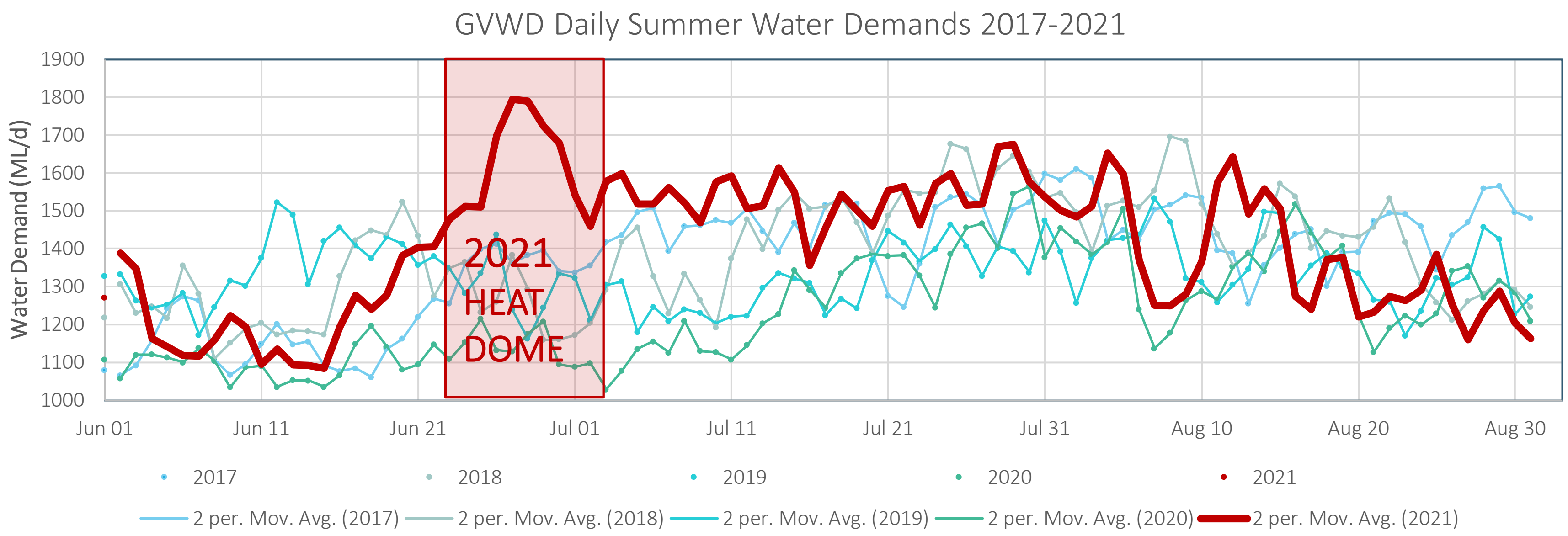
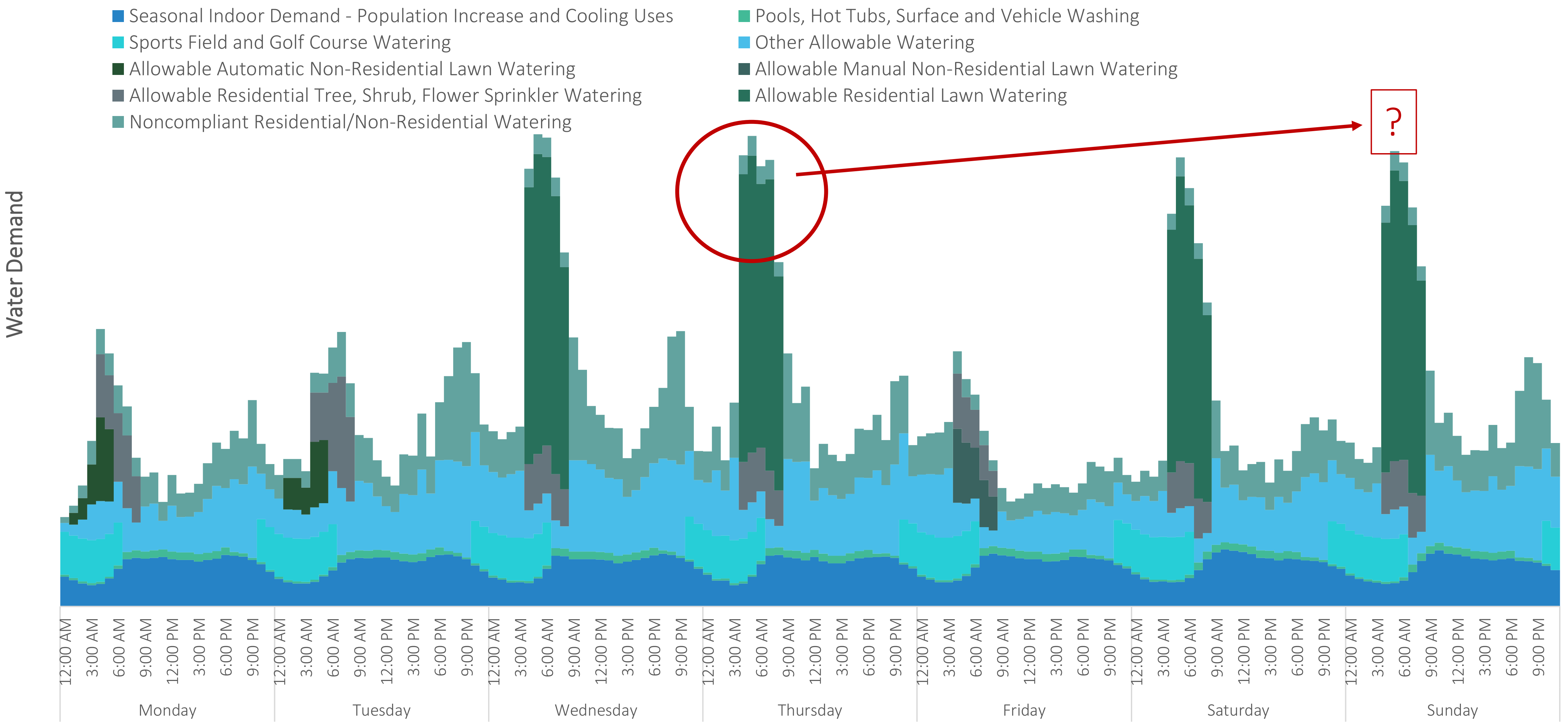


Total Source Withdrawals (BL/day)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2012
2013
2014
2015
2015 STAGE 2
2015 STAGE 3
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec



GVWD Daily Summer Water Demands 2017-2021
Water Demand (ML/d)
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
2021
HEAT
DOME
Jun 01
Jun 11
Jun 21
Jul 01
Jul 11
Jul 21
Jul 31
Aug 10
Aug 20
Aug 30
2017
2018
2019
2020
2021
2 per. Mov. Avg. (2017)
2 per. Mov. Avg. (2018)
2 per. Mov. Avg. (2019)
2 per. Mov. Avg. (2020)
2 per. Mov. Avg. (2021)

Breaking Peak Week Into Base/Seasonal Allows Us to Explore How Policy Shifts Impact Demand Patterns



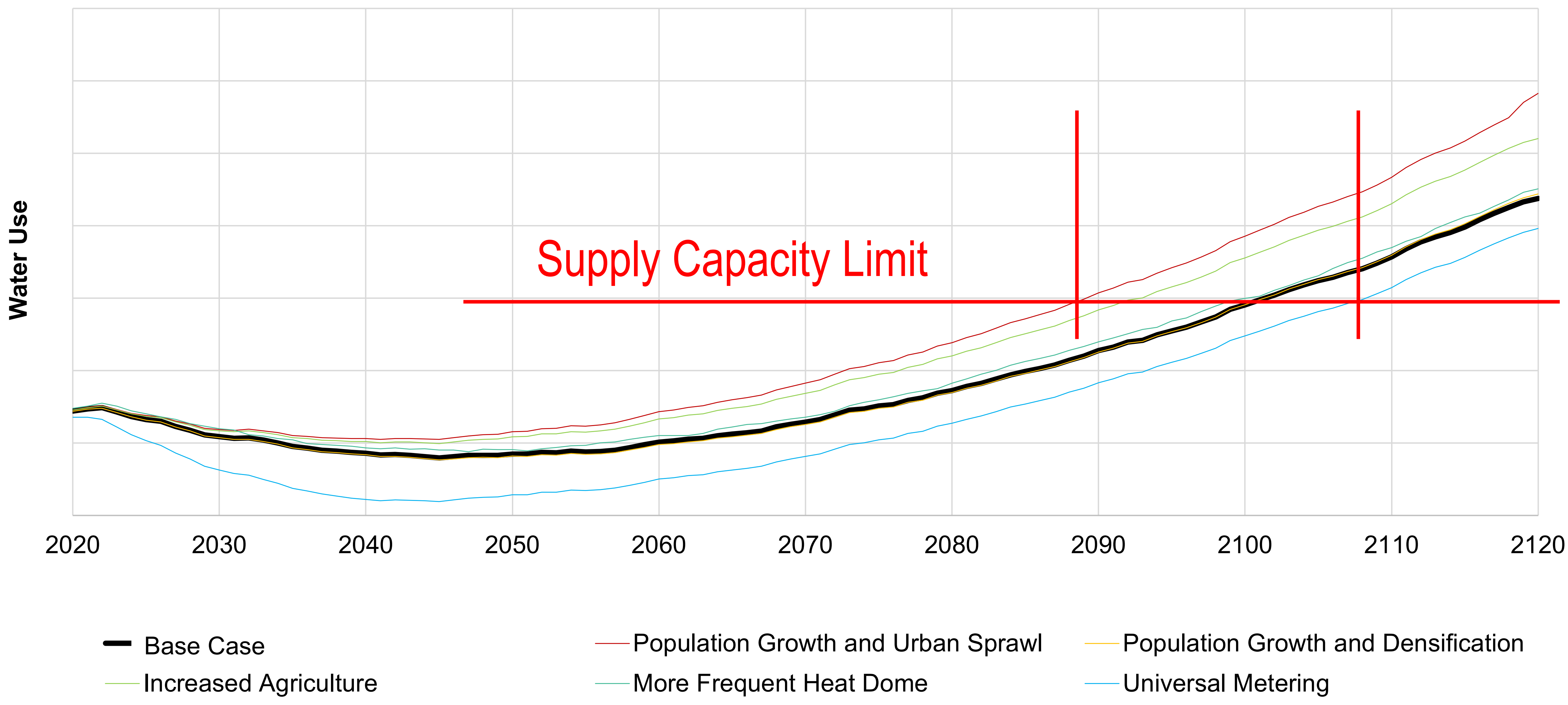
Model climate change, population, economic and policy changes through scenario analysis

Example: BC south coast

Goal: Establish design standards for efficiently sized future infrastructure

Outcome: Breaking apart explanatory variables allows us to assess future scenarios

+ Breaking Apart Explanatory Variables Allows Us to Assess Future Scenarios



+ Incorporate non-revenue water in universally metered and unmetered systems

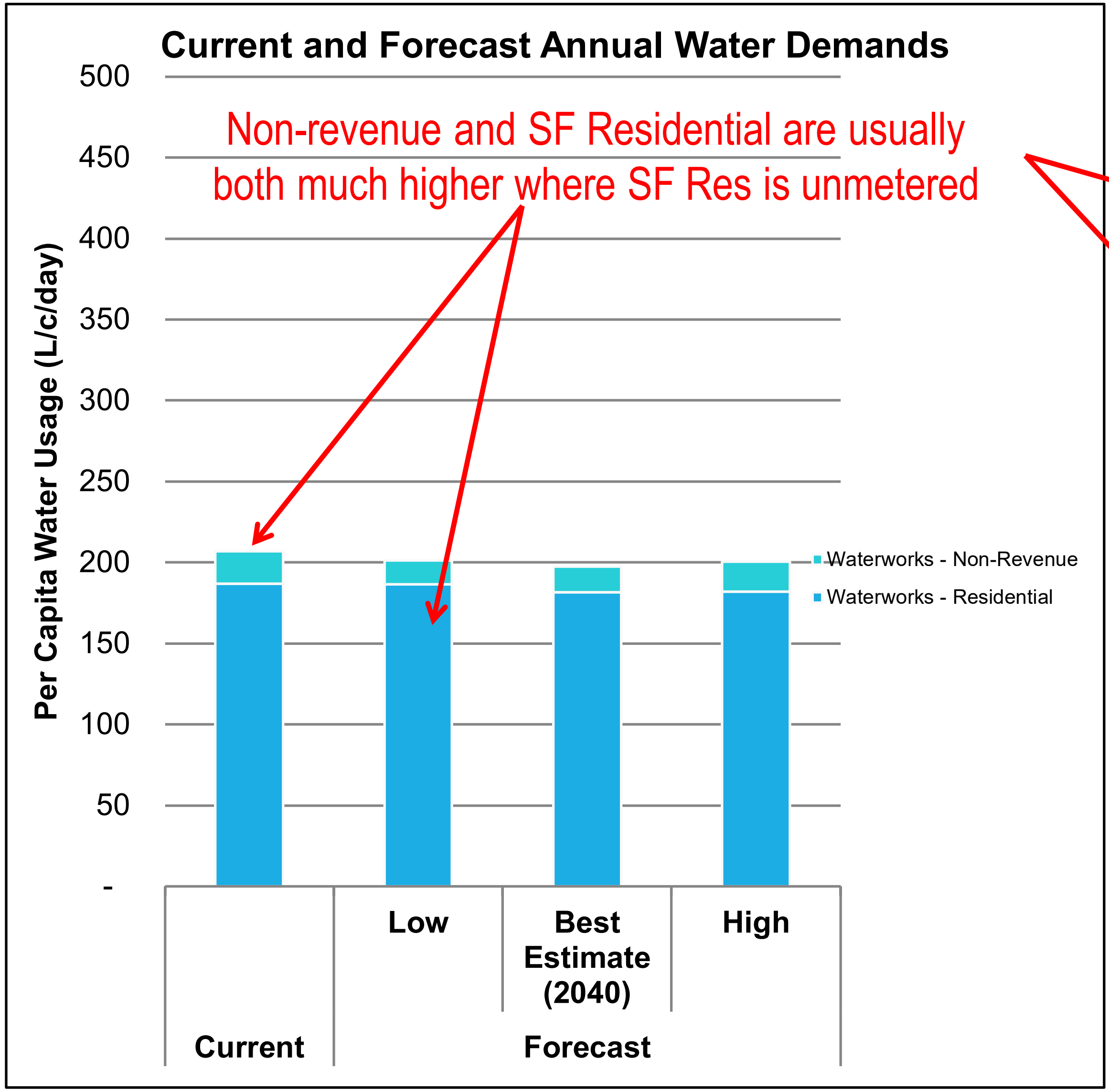
Example: "Tale of Two Cities"..one system supplying a universally metered municipality and one without SF residential residential meters

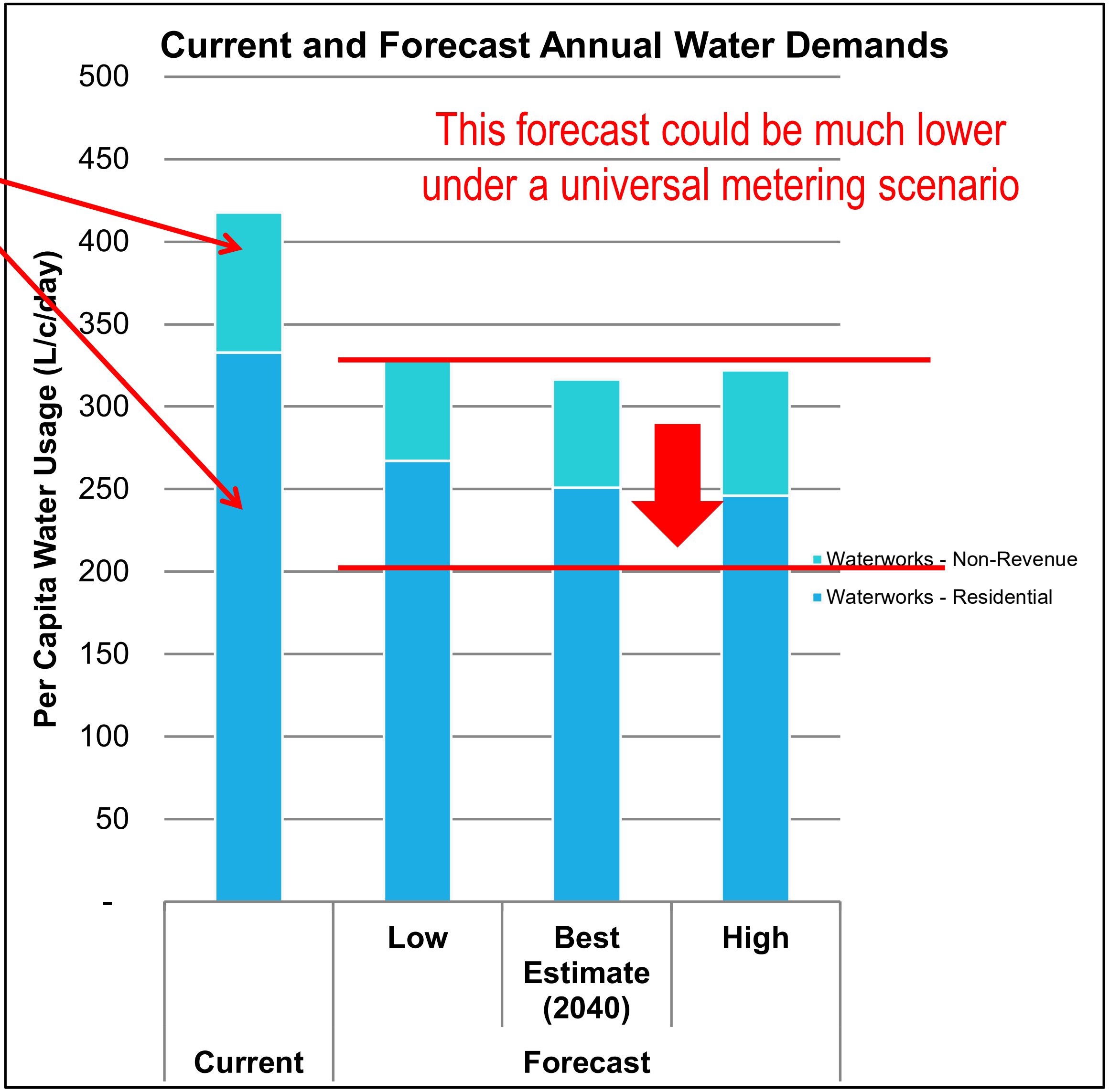
Goal: Avoid or defer capital and operating costs of water supply and wastewater treatment

Methods Applied: Understand that the ratio of Non-Revenue to Base Single-Family Residential (not measurable) is less important than the sum of the two (measurable)

Outcome: Side by side comparison of two adjacent BC communities allows for assessment of the impact of universal metering on non-revenue water demand

Side by Side Comparison of Two Adjacent BC Communities Illustrates the Impact of Metering on Non-Revenue Water





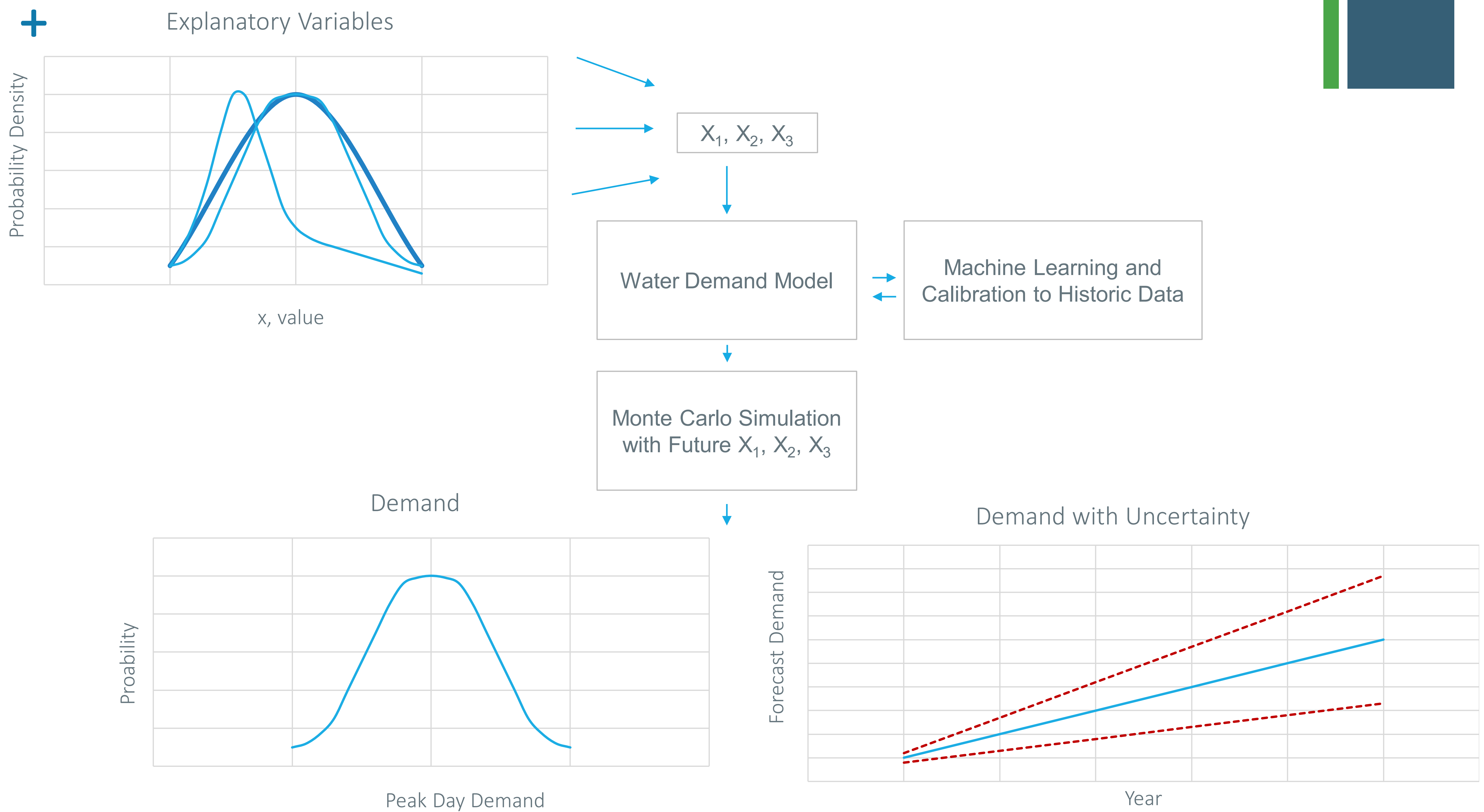
+ Calibration and uncertainty assessment using Monte Carlo simulation

Example: Two large western Canadian cities

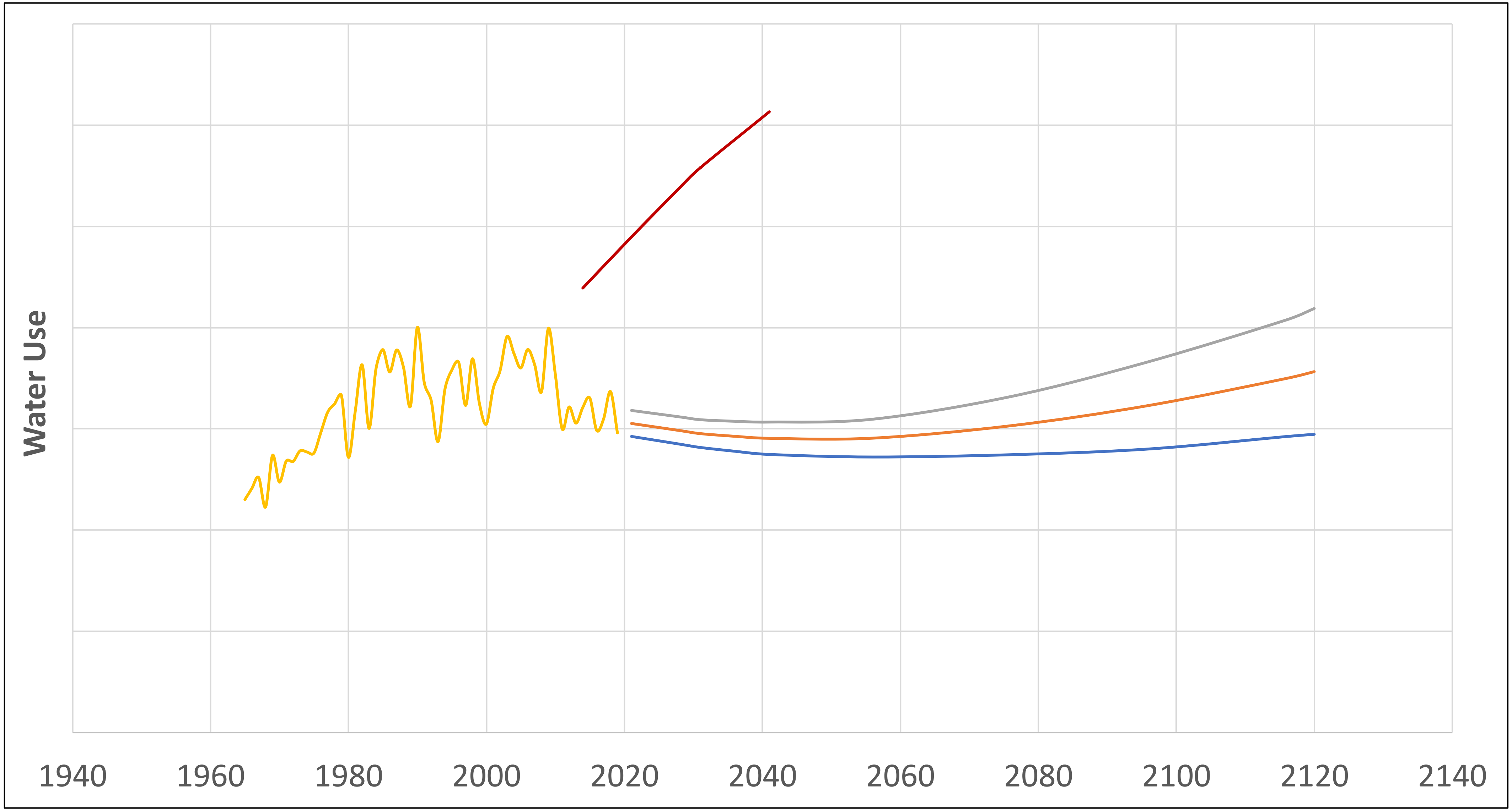
Goal: Avoid or defer capital and operating costs of water supply and wastewater treatment

Methods Applied: Apply probabilistic analysis to specific explanatory variables rather than the total recent historical demand

Outcome: Understanding the range of future potential scenarios allows us to apply risk-based methods when timing new supply and treatment projects


Explanatory Variables
Probability Density
x, value
X1, X2, X3
Water Demand Model
Machine Learning and
Calibration to Historic Data
Monte Carlo Simulation
with Future X1, X2, X3
Demand
Proability
Peak Day Demand
Demand with Uncertainty
Forecast Demand
Year

Extrapolating Variables vs. Extrapolating Historic Trends



+ Summary

- Forecast variables, don't forecast historic demand
- Use what you know about land use
- Drill down
- Consultant often deliver tools so utilities can vary inputs and assess scenarios
- Ensure Transparency and Review
  - Share across departments (let the engineers torture test it)
  - Share with retailers / big users
  - Track actual vs forecast and ask "why?"
- Why is this important?
  - Confident forecasting = confident decision making
  - Big projects are expensive and have long lead times
  - Your plans are only as good as your forecasts