

COLUMBIA RIVER BASIN 2016 LONG-TERM WATER SUPPLY & DEMAND FORECAST

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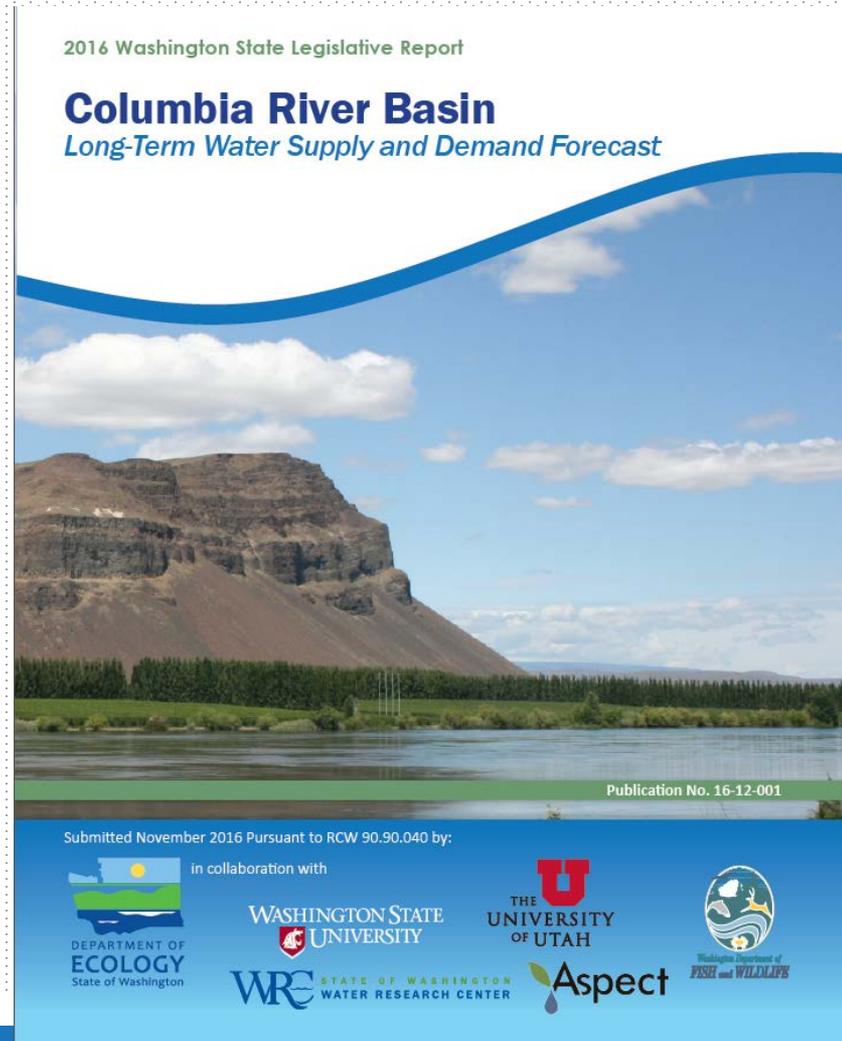
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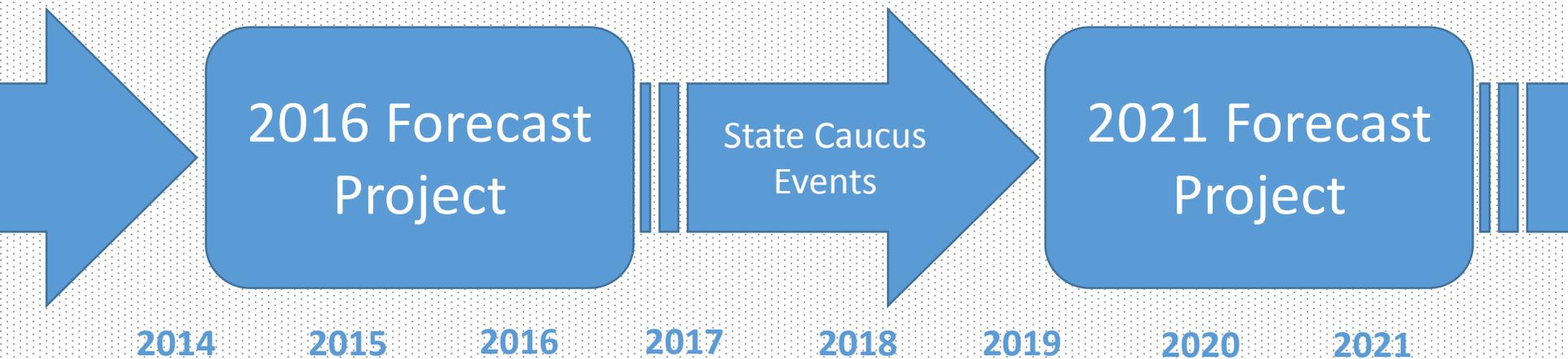
Background

- Every 5 years, the Washington State Department of Ecology's Office of the Columbia River (OCR) is required to submit a long-term (20-year) water supply and demand forecast to the State Legislature
- Washington State University (WSU) was assigned to develop the forecast for water supply and out-of-stream demand
- The forecast helps improve understanding of where additional water supply is most critically needed, now and in the future



Timeline of Water Supply/Demand Forecasts

- **State Caucus: to collect data and discuss improvements for 2021 Forecast**
 - July 31, 2017 (completed)
 - ~January, 2018 (target)
 - ~July, 2018 (target)
 - ~January 2019 (target)



Meeting Objectives

- **Discuss Recommendations from July 31, 2017 State Caucus**
 - filling data gaps
 - prioritizing model refinement
 - policy considerations

Outline

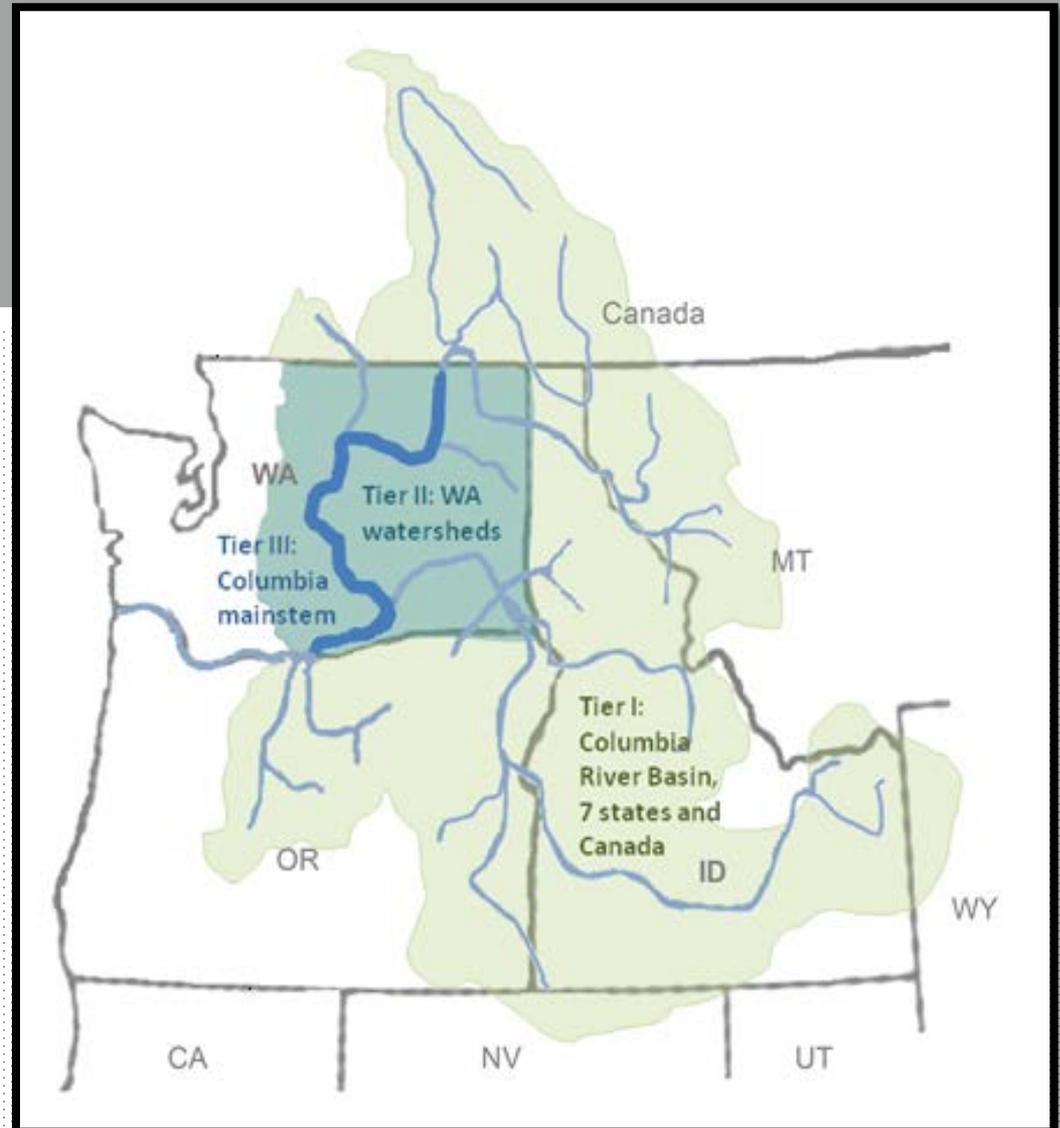
- **Brief Review of Key Results from 2016 Forecast**
- **Improvements being Discussed for 2021 Forecast**
- **Summary of Material Presented and Recommendations Made at the July 31 State Caucus**

2016 Forecast: Approach

1. **Overview of Integrated Modeling**
2. **Biophysical Modeling of Water Supply and Irrigation Demand**
3. **Economic Modeling of Future Crop Mix**
4. **Municipal Demand**
5. **Hydropower Demand**



201 Forecast: Results



2016 Forecast: Summary of Changes in Water Supply and Demand

Supply:

- Average annual increase at Bonneville: **+14.6%**
- Average shift in seasonality:



-10.3% between June and October



30.8% between November and May

Demand:

- Average decrease in eastern WA irrigation demand:
 - **-5.1%** (historical crop mix)
 - **-6.9%** (future crop mix)
- Average shift in seasonality (future crop mix):



-13.3% between July and October



5.7% between March and June

2016 Forecast: Summary of Water Demand Results

Water Use or Need	Estimated Volume (AF) (average of climate scenarios)
Projected changes in Eastern WA Agricultural Demand by 2035	-332,837 to -250,027
Projected changes in Agricultural Demand by 2035 with 10% Double Cropping	-272,837 to -130,027
Projected changes in Agricultural Demand by 2035 with 10% Double Cropping and Planned Water Supply Projects	27,163 to 169,973
Projected changes in Eastern WA Municipal and Domestic Demand (including municipally-supplied commercial) by 2035	80,000
Projected changes in CRB Hydropower Demand by 2035	35,000 to 75,000
<i>Water Use or Need to be Met with Surface Supplies</i>	
Unmet Columbia River Instream Flows in 2001 at McNary Dam	13,400,000
Unmet Tributary Instream Flows (historical droughts)	659,918
Unmet Columbia River Interruptibles (historical droughts)	40,000 to 310,000
Yakima Basin Water Supply (pro-ratables, municipal/ domestic and fish) (from 2011 Yakima Report)	450,000
Alternate Supply for Odessa (from 2010 Odessa Report)	155,000
Declining Groundwater Supplies (other than in the Odessa Subarea)	750,000

2016 Forecast: Causes of Projected Decrease in Irrigation Demand

In Response to Climate Change

- **Water Supply:** Springs are getting wetter
- **Water Demand:** shifting of irrigation requirements earlier in the season
 - Earlier planting and shorter irrigation season for most crops
 - Higher water-use efficiencies due to increases in CO₂

In Response to Economic Drivers

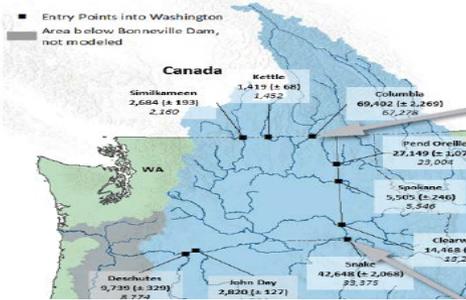
- Shift towards more water-use efficient crops

Note that many adaptive actions were not considered

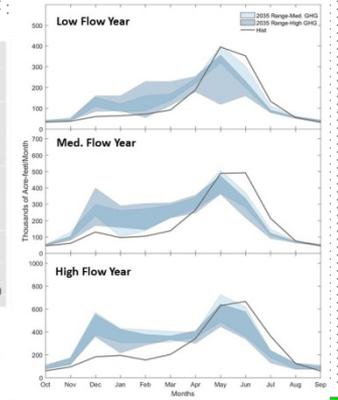
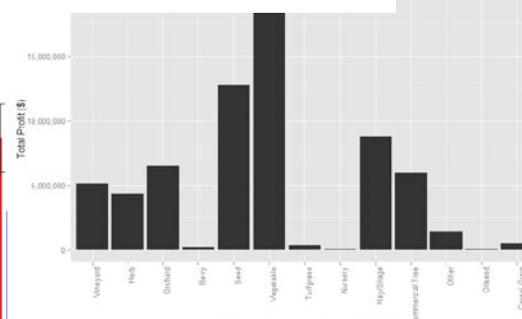
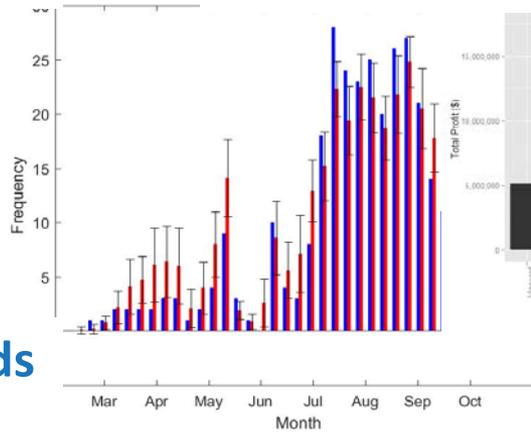
- ❑ Increases in double/cover cropping
- ❑ More slowly-maturing crop varieties (e.g., corn)
- ❑ Expanded irrigated acreage
- ❑ Changes in irrigation technology/management

2016 Forecast: Wealth of Other Results, Tools, and Ongoing Work

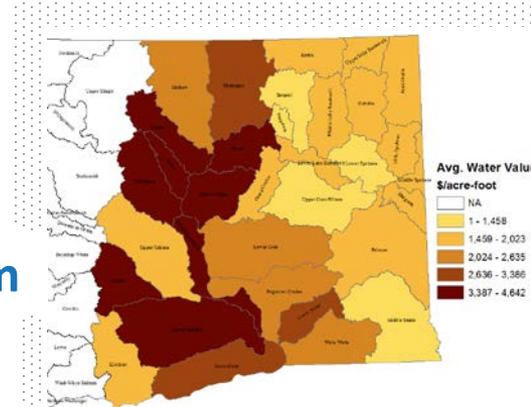
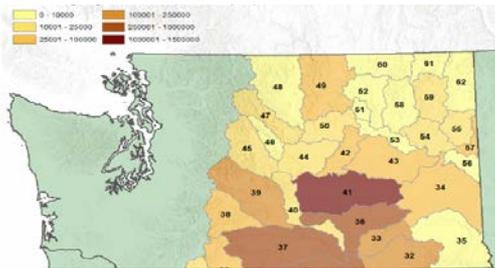
Columbia River Basin



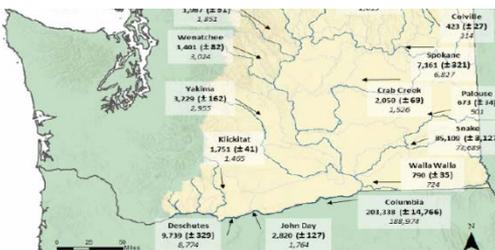
CURTAILMENT MODELING



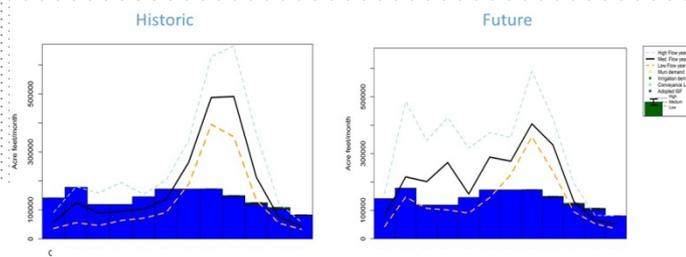
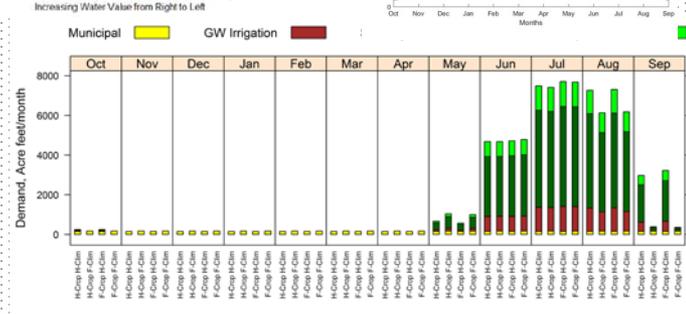
Washington's Watersheds



Columbia River Mainstem



WATER CAPACITY SCENARIOS



WRIA-Specific Supply and Demand

2016 Forecast: Modules

1. **Columbia River Instream Flow Atlas**
2. ***Integrating Declining Groundwater Into The Forecast**
3. **Pilot Application of METRIC Crop Demand Modeling**
4. **Water Banking Update**
5. ***Effects of User-Pay Requirements on Water Right Permitting**
6. **West Side Forecast Scoping**

(*was discussed in detail during the July 31 state caucus)

Improvements in Discussion for the 2021 Forecast

- *Incorporating groundwater dynamics that impact surface water availability
 - *Improving municipal demand forecasting
 - *Columbia River system operations and instream flows
 - *Economic impacts (specifically cost of developing water) to future water demands and water management
 - *Capturing the impact of double cropping / cover cropping in the state
- Refining water right curtailment data into a useable modeling format
- Expanding the use of METRIC
- Future Instream Atlas needs
- Developing a statewide forecast
- *will be discussed today

General State Caucus

Questions/Recommendations

- **Climate Change:** Should Ecology proactively seek legislative approval to address season of use restrictions on water rights as crops emerge and require irrigation water earlier in the year?
- **Irrigation Water Budget:** Should Ecology coordinate survey key entities to estimate pre-and-post irrigation for integration into the 2021 Forecast?
- **Double-Cropping:** Can irrigation district delivery records, METRIC, or surveys be used to refine estimates of double-cropping in use today?
- **Irrigated Extent Expansion:** Should WSU perform a study to model the demand for irrigated acres at the extensive margin?

Incorporating groundwater dynamics that impact surface water availability into modeling efforts



Groundwater Integration

New component for 2016 Forecast

- **Why:**

- 2011 Forecast did not evaluate effects of declining groundwater on demand
- Users who rely on declining groundwater supplies may rely on surface water in the future
- Groundwater can buffer drought
- Surface and groundwater interactions can lead to water rights conflicts



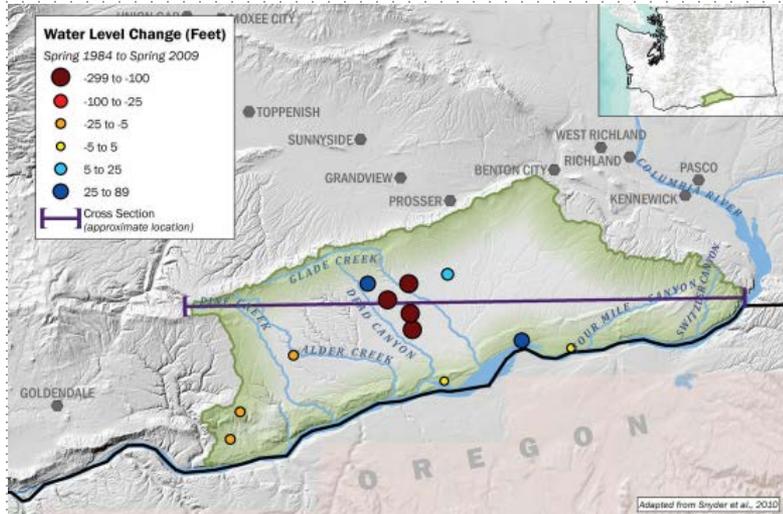
Photo: Dept. of Ecology

“Hot spot” comparison

Easier to solve

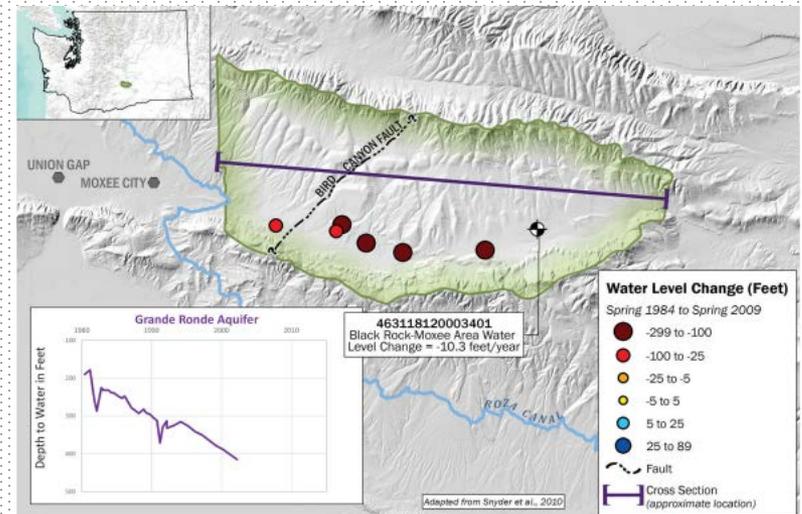


Harder to solve



Horse Heaven Hills

- ~50 years?? before curtailment
- Mostly vineyard
- Solutions available:
 - Direct aquifer recharge
 - Switch to surface water



Black Rock – Moxee

- ~10-20 years?? before curtailment
- Curtailment impact on small residential uses
- Limited viable solutions

Groundwater Integration - Recommendations

- Greater monitoring of extent and declines needed.
- Increased public outreach warranted to promote conservation.
- State and County government coordination needed.
- Effects of declining groundwater can be modeled through more robust curtailment modeling.

Odessa Subarea (Grant, Lincoln, Adams, and Franklin Counties)

Overview
Groundwater development on water supplies for irrigation began in the Odessa Subarea in the early 1940s, in part as a temporary water supply until surface water was made available via expansion of the Columbia Basin Project. Groundwater declines have been recorded since the late 1960s within the Subarea in portions of Adams, Grant, Lincoln, and Franklin Counties, with declines ranging from 5 ft to in excess of 300 ft since 1960, and up to 25 ft in certain wells in recent years.

In 2006, the Legislature charged Washington State Department of Ecology's (Ecology) Office of Columbia River with a mission to find "alternatives to groundwater for agricultural users in the Odessa Subarea aquifer." RCW 90.30.020. In 2013, Ecology and the Bureau of Reclamation released the Odessa Subarea Impact Study (Environmental Impact Statement) (EIS). The EIS provided a preferred alternative to supply 584,000 ac-ft of surface water from Banks Lake to irrigate 76,000 acres of land currently irrigated with groundwater. This will be in addition to 20,000 acres being supplied from groundwater to surface water sources in the area. Additional conservation and conservation projects are also being funded to reduce demand on aquifers within the Odessa Subarea.

Surface and Groundwater Interaction in the Odessa Subbasin
The primary surface water bodies in the Odessa Subarea are Upper and Lower Columbia Creek, and the East Low Canal (Columbia River). The East Low Canal conveys water from Lake Roosevelt to the Columbia Basin Irrigation Project. In addition, intermittent streams occur in several locales:

- Surface water bodies are in hydraulic connection with overbank aquifers and portions of the Wanagan Basin in some locations within the Odessa Subarea.
- Reduction in groundwater discharge to surface water has been observed in response to declining shallow groundwater levels.
- The Grande Ronde aquifer is not connected to local surface water, but does contribute discharge to the Snake and Columbia Rivers to the south.

Management Context
Subarea Boundary: WAC 173-120A, Subarea Management Rule 173-120A
Present current static water table from November 8, 2007

Odessa Subarea (Grant, Lincoln, Adams, and Franklin Counties)

Available Groundwater Models
There are three known groundwater models for the Odessa Subarea. Any of these models would need refinements to be adequate for decision-making to address declining groundwater users in the Odessa Subarea. A recent model that may be a suitable candidate for modification is the MODFLOW model prepared by the Columbia Basin Groundwater Management Area (2011). This is a regional model that includes the Odessa Subarea, however, its resolution (grid spacing) may be too coarse for detailed simulations of Odessa Subarea groundwater flow. The model does contain significant information on hydrogeologic units and properties that could be built upon to provide a management tool for the Odessa Subarea. A second recent model was created by the U.S. Geological Society (USGS, 2014) that covers a larger area and has better resolution than the 2011 model. Model references include: OGBWMA et al., 2011; Ely et al., 2014; Lucey and Steves, 1975; Hazare et al., 1994; and Vecore, 1999.

Potential Solutions
Demand Approaches
Conservation: Improve irrigation efficiencies, predominantly through canal lining, leveling, and on-farm efficiency. In 1990, 30,000 ac-ft had been conserved through conservation efforts from 2000 to 2024. Some additional use of municipal and industrial reclaimed water may exist, although much is land-applied from. Usage change could further reduce demand.
Administrative: Use management policy tools incorporated into Odessa Groundwater Management Subarea WAC 173-120A (See Management Policy in Management Context Table).

Supply Approaches
Surface Water Reclamation (Irrigation): A project is underway for source change from groundwater to surface water for 76,000 irrigated acres ~55 percent of groundwater-irrigated acres in the Odessa Subarea (Ecology, 2014). East Low Canal will be used for conveyance.
Surface Water Reclamation (Domestic): Additional reclamation supplies are needed for municipal groundwater use (OGBWMA, 2012).
ASR: Feasible in portions of Subarea based on study of two wells (Osborn and Langston, 2014).
DES: Feasibility studied, but may be physically feasible for Wanagan basin. Not likely to be feasible for Grande Ronde basin due to depth.

Odessa Subarea (Grant, Lincoln, Adams, and Franklin Counties)

Conceptual Hydrogeologic Model
Key considerations in developing the conceptual hydrogeologic model include:

- The Odessa Subarea is located on the Palouse Slope of the Columbia Plateau Regional Aquifer System.
- It is a large regional aquifer system comprised of the Columbia River Basalt Group.
- The Palouse Slope is distinguished by minimal faulting, and an associated lack of the fault-block isolation of aquifer zones that is often found in other basalt areas in Eastern Washington.
- Prior to aquifer development, groundwater typically flowed toward shallow surface waters, and the Snake and Columbia Rivers.
- Groundwater withdrawals in recent years have induced significant groundwater declines and altered flow paths.
- The Wanagan Basalt receives limited groundwater recharge, while recharge to the underlying Grande Ronde Basalt is minimal.
- Most wells are screened across both the Wanagan and Grande Ronde zones due to unreliable yield in the Wanagan zone.
- Key references include: Kahle, 2011; Luster and Burr, 1974; Burns et al., 2012; and OGBWMA, 2009.

Data Gap Analysis
Data Needs Model calibration and integration (estimated costs yet to be determined).

Station Name	Station Number	Operating Since
1240000	FRB-006 of City, WA	1948
1250000	Regional Office of Central, WA	1948

Number of Groundwater Rights	Including OGBS			Not Including OGBS		
	Total	Allowed	Percentage Allowed	Total	Allowed	Percentage Allowed
2,000	110	5%	5.5%	800	113	14%
245,000	30,000	11%	11%	215,000	30,000	14%

Water Level Data Availability
Though it would be better to have water levels monitored from multiple wells that each have several measurements collected over a long time period, the following chart summarizes water level monitoring data available in state databases based on aquifer and time period selected, and the number of measurements.

Risk Factors in Odessa Subarea
Many Washington State water rights in the Odessa Subarea rely on a groundwater source. The following table presents groundwater use information obtained from water rights data available from the Ecology, water system data from Washington Department of Health, 2010 census, and EIS for the Odessa Groundwater Management Subarea (Ecology and U.S. Bureau of Reclamation, 2010).

Groundwater Use	Groundwater-Irrigated Acres
Population Served by Group B Water Systems	280,000
Population Served by Group B Water Systems	12,000
Population	13,800
Industry	20% agriculture and 35% manufacturing. Primary crop is potatoes.

A study of municipal water systems in the area found that of 96 municipal wells, 35 had at least one risk factor and 18 had two or more (OGBWMA et al., 2012). Risk factors include:

- Static and dynamic groundwater level declines more in excess of 2 feet/year;
- Dynamic drawdowns of over 100 feet;
- Current and predicted groundwater levels dropping below 700 feet below ground surface;
- Geotechnical data that indicates wells are pumping from groundwater with little or no modern recharge; and
- Projected future water demand predicted to exceed current pumping capacity by for some areas by 2030 unless supply-side or demand-side actions are taken.

Possible approaches for 2021 Forecast

Increasing complexity



Identify “hot spot”
regions and
conduct trend
analysis at
available wells

Expand
curtailment model
to include
transition from
surface water to
groundwater

Use USGS
groundwater flow
model to inform
groundwater
irrigation demand
and aquifer
response as input
to VIC-CropSyst

Fully couple USGS
groundwater flow
model and VIC-
CropSyst

State Caucus Discussion Topics

- **Identify key questions for 2021 groundwater analysis.**
- **Discuss available methodologies to address key questions.**
- **Discuss current data availability and new data targets to support chosen methodology.**

State Caucus Questions/Recommendations

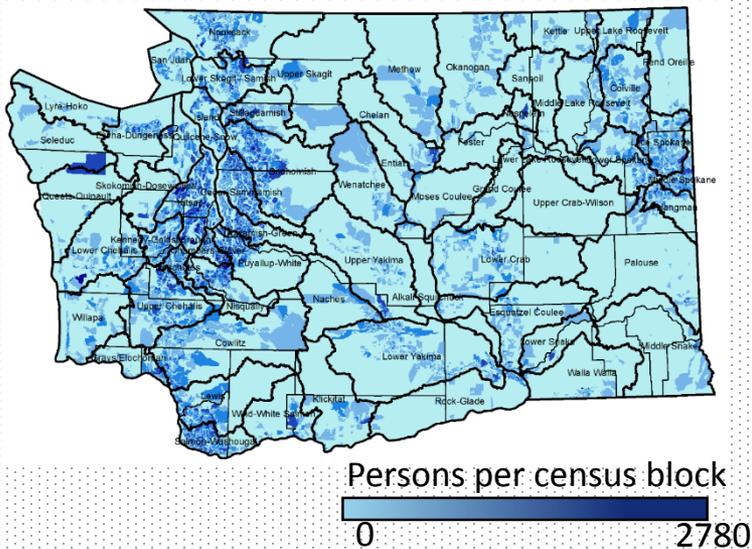
- **Should Ecology proactively coordinate to improve the number of monitoring wells in declining groundwater areas through cooperative agreements with local and state government?**
- **Should WSU pilot multiple methods to address groundwater integration in the future?**
- **Should there continue to be a more detailed analysis for hot spot areas or simpler analysis for the whole region, or a combination?**

Improving municipal demand forecasting



Municipal Demand: Overview of Approach

Consumptive Use = Population x Per Capita Use - Wastewater Returns



Data:

U.S. Census Bureau 2010 Block Estimates;
2010 USGS Estimate Use of Water Report

Historical population:

2015 population (OFM and DOH)

Future population:

Estimated via logistic curve model

Limitations:

- No accounting for seasonal or regional variations in water use
- Assumed no change in consumptive use per capita

Municipal Demand: Proposed Alternate Methodologies

Improving Unit Demand Analysis

- Improved population forecasting & consumptive use estimates
- Address regional differences, but not seasonality or sectoral differences

Aligning Existing Regional Forecasts

- Adopt currently existing methodology (Oregon)
- Account for seasonality & sectoral differences, data-intensive

Statistical Demand Modeling

- Statistical approach to defining relationships between physical and socioeconomic factors driving demand
- Complete overhaul of methodology, very data-intensive

State Caucus Discussion Topics

- **Which methodology should be focused on for future forecasts?**
- **Are the data available to implement the chosen methodology?**
- **Are there other components that need to be incorporated?**

State Caucus Questions/Recommendations

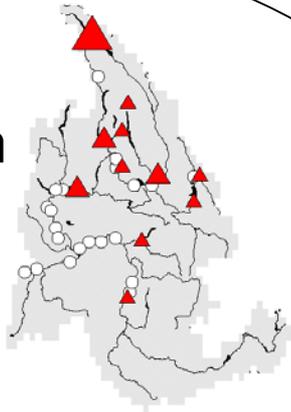
- **Can we agree on the level of sophistication needed for improving municipal demand methodology?**
- **Numerous data sources exist to support improved municipal demand forecasting (e.g., local calibration, etc.); need for improved collaboration with other agencies to acquire and apply these data**
- **Determine book-end projections (high and low estimates)**

Columbia River system operations and instream flows



The Reservoir Model (CoISim)

Physical System
of Dams
and Reservoirs

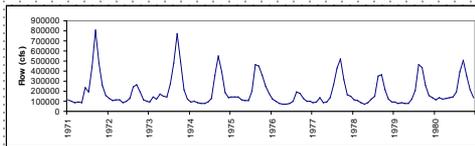


Reservoir Operating Policies



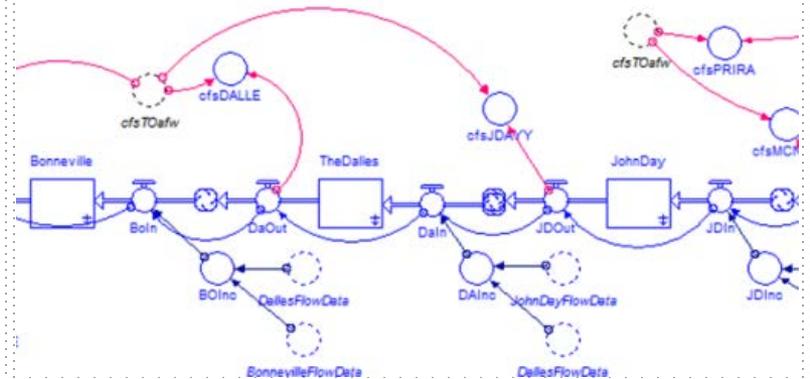
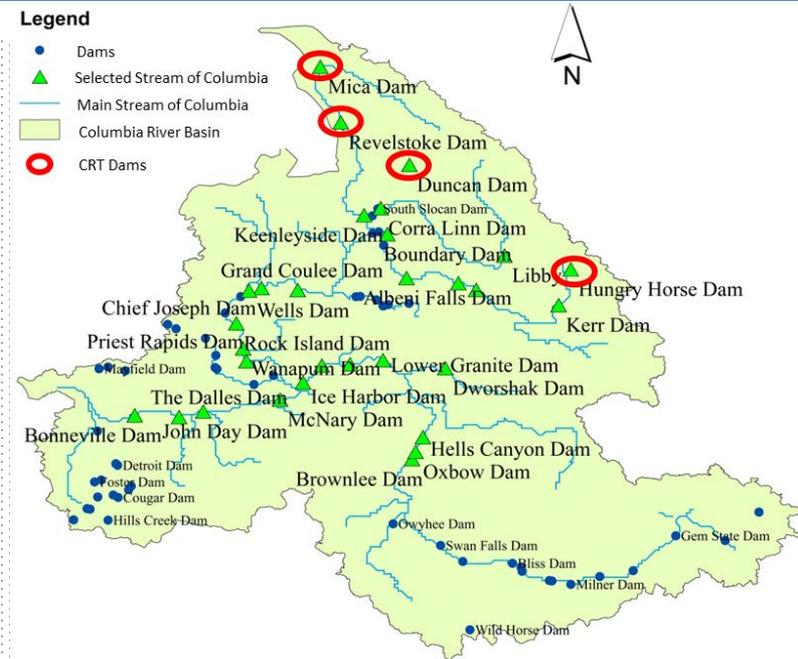
Reservoir Storage
Regulated Streamflow
Flood Control
Energy Production
Irrigation Consumption
Streamflow Augmentation

VIC Streamflow Time Series



ColSim (Columbia Simulation) Model

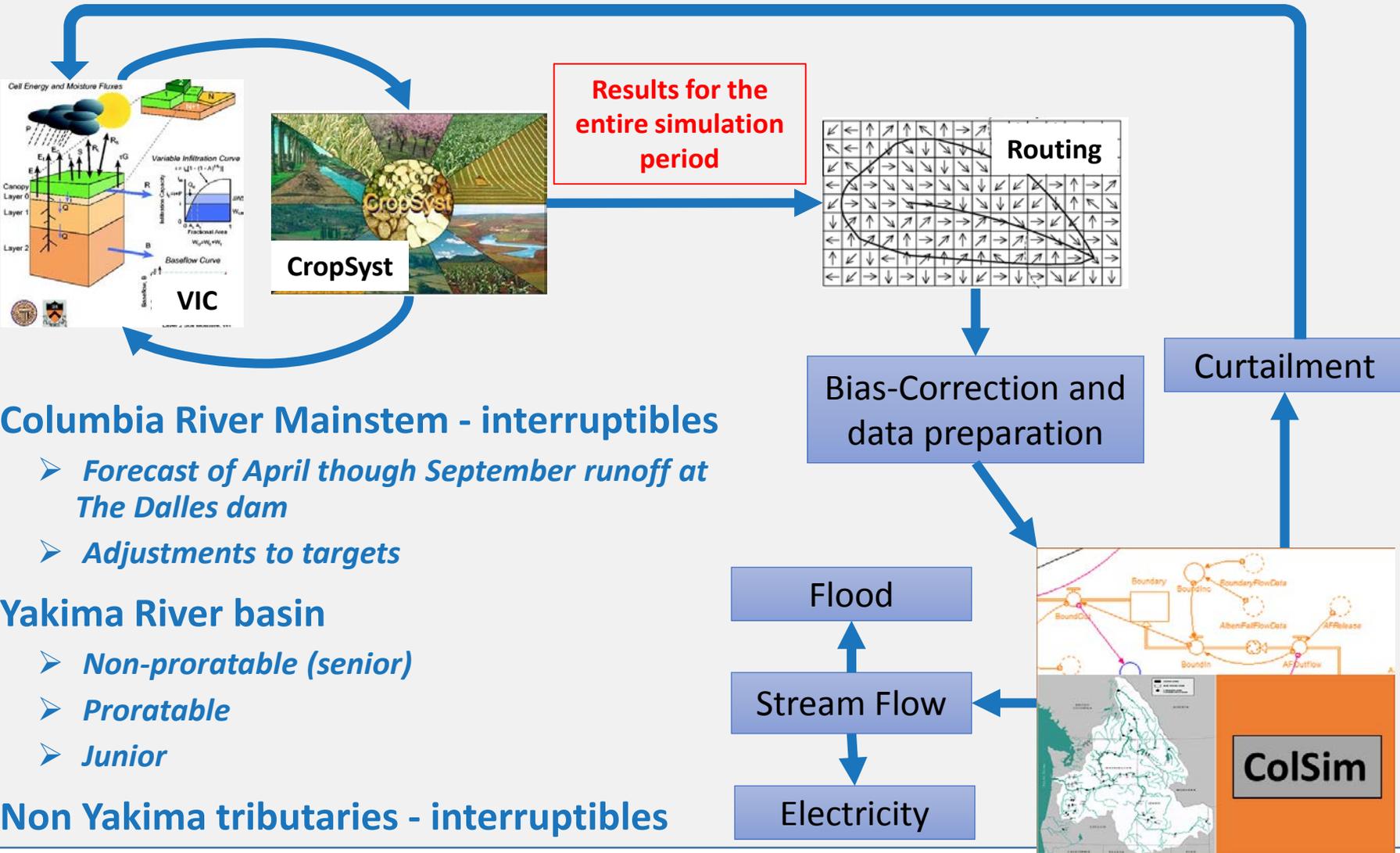
- **Dam-specific operational rules:**
 - 31 dams across CRB
 - 4 CRT dams
- **Based on CRT's goals and details**
- **Two operational planning periods**
 - **Fixed period (Aug-Dec):** rule-curves are based on historical flows and does not change
 - **Variable period (Jan-Jul):** based on forecast and CRT's operational goals
- **Operational goals**
 - **Main goals:** Hydropower and flood protection
 - **Other goals:** Irrigation, ecological flow, recreation



Instream Flows in ColSim

- **Fish Protection Targets:**
 - A minimum outflow from each dam
 - System flow targets for fish protection at
 - Columbia Falls (using Hungry Horse available storage)
 - Priest Rapids (using Grand Coulee available storage)
 - Lower Granite (limited storage at multiple reservoirs)
 - McNary (limited storage at multiple reservoirs)
- **Recreational Targets:**
 - Grand Coulee Dam

Integrating with Curtailment Decisions: 2016 Forecast



➤ Columbia River Mainstem - interruptibles

- Forecast of April through September runoff at The Dalles dam
- Adjustments to targets

➤ Yakima River basin

- Non-proratable (senior)
- Proratable
- Junior

➤ Non Yakima tributaries - interruptibles

State Caucus Discussion Topics

- **Feedback on approach currently taken to capture CRT and integrate instream flows into the modeling framework**
- **Status on CRT negotiation and possible scenarios we might include in the 2021 Forecast**
- **If new water becomes available as part of a CRT renegotiation, how can we shape these flows to better meet fish needs?**

State Caucus Questions/Recommendations

- **Should water temperature (e.g., in response to climate change and water management) be included in the Forecast modeling activities?**
- **Should a different metric be used to estimate instream flow demand other than current instream flow rules?**
- **Improved/tighter collaborations between DFW and WSU to capture ecological/fish needs and modeling capacity.**

Cost recovery for water supply development and willingness to pay



How Payment Affects Demand

Why?

- **Legislature has moved towards an applicant-pays system**
- **Some applicants are choosing to defer or postpone rather than receive new water rights when offered**

How?

- **We surveyed 500 applicants from various programs (Lake Roosevelt, Wenatchee, Yakima, Cabin Owners, etc.) to understand how time and financial terms of a program are affecting processing and demand for new service.**

Paying for Water – Survey Data

LOCATION	Sample size	Number completed	Response Rate
Sullivan Lake	8	0	0%
Lake Roosevelt	214	58	27%
Wenatchee Basin	37	2	5%
Yakima Basin	383	85	22%
Port of Walla Walla	6	1	17%
Yakima Cabin Owners	37	22	59%
Overall	859	168	19.5%

How Payment Affects Demand – Recommendations

- **Paying for water makes some projects unfeasible.**
- **The long time period between applying for a water right and receiving a permit creates project uncertainty.**
- **Some participants could not participate because of unique program requirements.**
- **A regulatory imperative (e.g. groundwater closure, court order) is a driver to participate in cost-recovery programs even if costs are perceived to be high.**

State Caucus Discussion Topics

- **What pressing questions were not addressed in the previous analysis?**
- **What are the most pressing questions related to water supply development cost recovery?**
- **What are the promising opportunities for cost recovery programs to support water supply programs?**
- **What types of analyses would be most useful to address cost-recovery needs?**
- **Which of the recommendations from the 2016 Study is Ecology prioritizing for action now?**

State Caucus Questions/Recommendations

- **Potential rule changes to expedite resolving existing (especially old) applications. What process can be used to eliminate old applications?**
- **To understand willingness to pay: collect ongoing data for individuals who decline or participate any water programs. How can these data best be collected?**