American Water Resources Association

Updating the Washington Irrigation Guide

October 15, 2013

DEPARTMENT OF ECOLOGY
State of Washington

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Aspect CONSULTING

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Overview

- Past Irrigation Guidance Documents
- Why Update the WIG
- Methodology for New WIG
- Preliminary Results
- Statutory Framework
- Policy Issues
- Next Steps

Circular 512

- Published in 1969
- Crop irrigation requirements for 38 locations for 18 different crops
- Modified Blaney-Criddle method
- 30 years of weather data

Washington Irrigation Requirements

Estimates and Methodology (XB 0925 / EB 1513)

- Published 1982, still in print today
- Crop irrigation requirements for 40 locations for 39 different crops
- Doorenbos and Pruitt Blaney-Criddle method
- 26 years of weather data

Washington Irrigation Guide

- Published 1985, supplemented in 1997, in use today
- Crop irrigation requirements for 90 locations for 40 different crops
- SCS Blaney-Criddle Modified method and FAO 24 Blaney-Criddle method
- 29 years of NOAA weather data

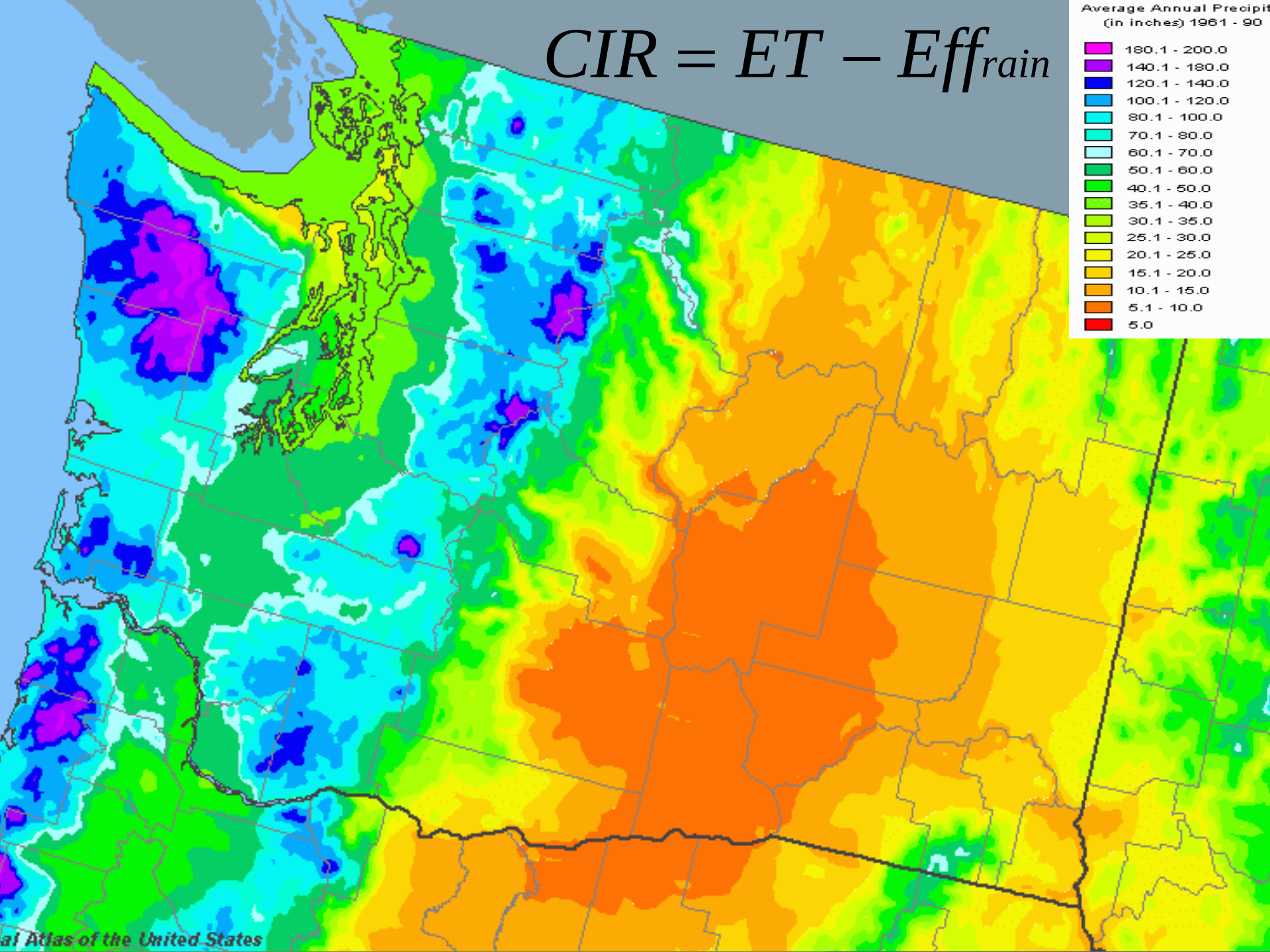
Example Comparison (Alfalfa)

- Crop Irrigation Requirement @ Omak
  - Circular 512 (1965) = 34 inches
  - EB 1513 (1982) = 33 inches
  - WIG (1985) = 25.39 inches
- Crop Irrigation Requirement @ Kennewick/Richland
  - Circular 512 (1965) = 44 inches
  - EB 1513 (1982) = 42 inches
  - WIG (1985) = 39.56 inches

Why Update the WIG

- New climate data available (1986 to now)
- Standardized ET methodology adopted (ASCE Standardized Penman-Monteith)
- Emerging crops
- More stations
- Old WIG assumptions lost to time
- New crop coefficients

$$CIR = ET - Eff_{rain}$$



Estimating Crop Water Use

(Evapotranspiration)

Reference ET
(Weather and climate)
Water use of harvestable alfalfa

$$ET_c = K_c \times ET_r$$

Crop ET

Crop Coefficient
(Crop and growth stage)

Reference ET: From Weather

Standardized ASCE Penman-Monteith

$$ET_{ref} = \frac{0.408\,\Delta(R_n - G) + \gamma \dfrac{C_n}{T+273}\,u_2(e_s - e_a)}{\Delta + \gamma(1 + C_d\,u_2)}$$

Solar Radiation

Temperature

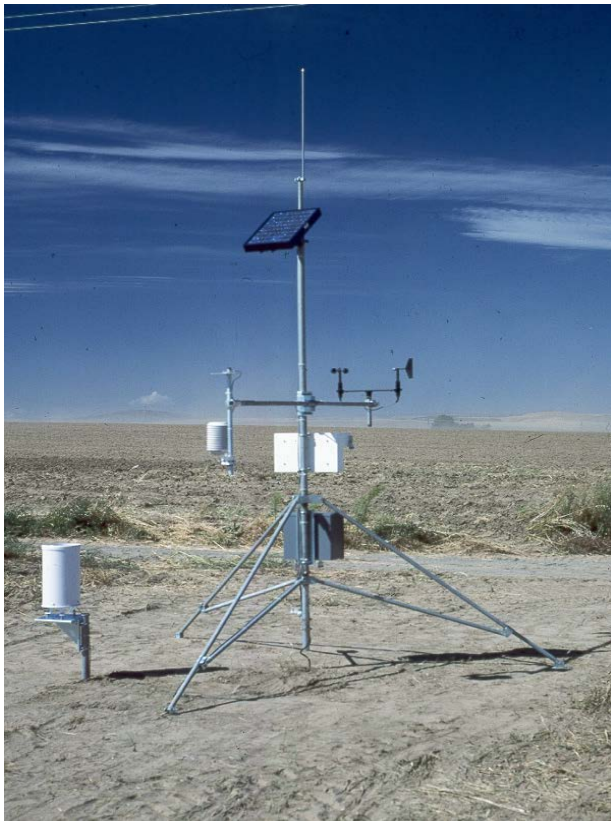
Wind Speed

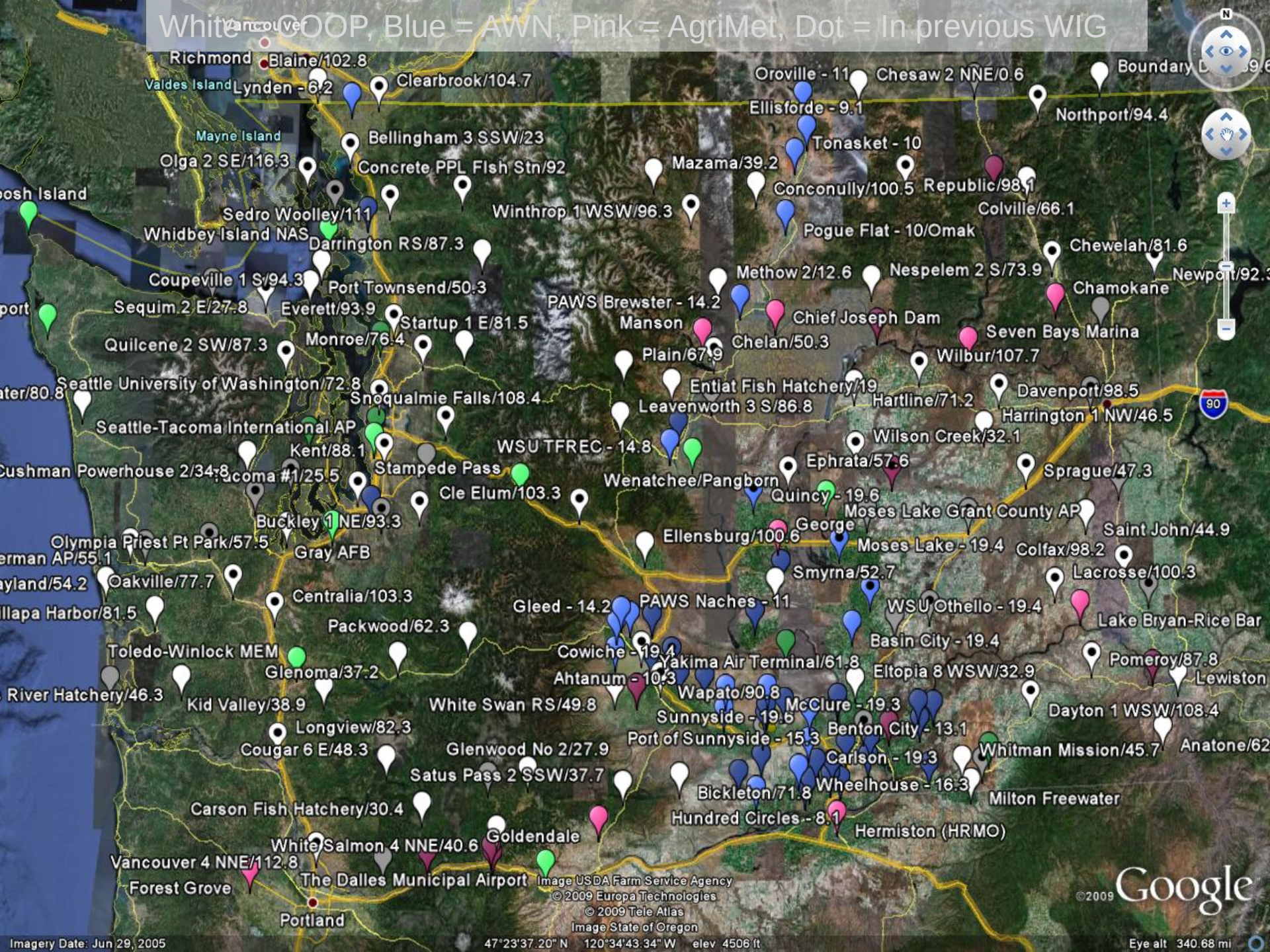
Humidity

Credit: Richard Allen, University of I

Weather Data Sources

- NCDC COOP Stations
  - Best coverage / longest history (>100 yrs)
  - Temperature and precipitation only
- NCDC ASOS
  - Full data set
  - Airport Tarmacs – RH data only
- Agrimet
  - Full data set and good locations
  - Limited coverage
- Washington AgWeatherNet
  - Full data set and good locations
  - Growing coverage
  - Limited data history (5-20 yrs)



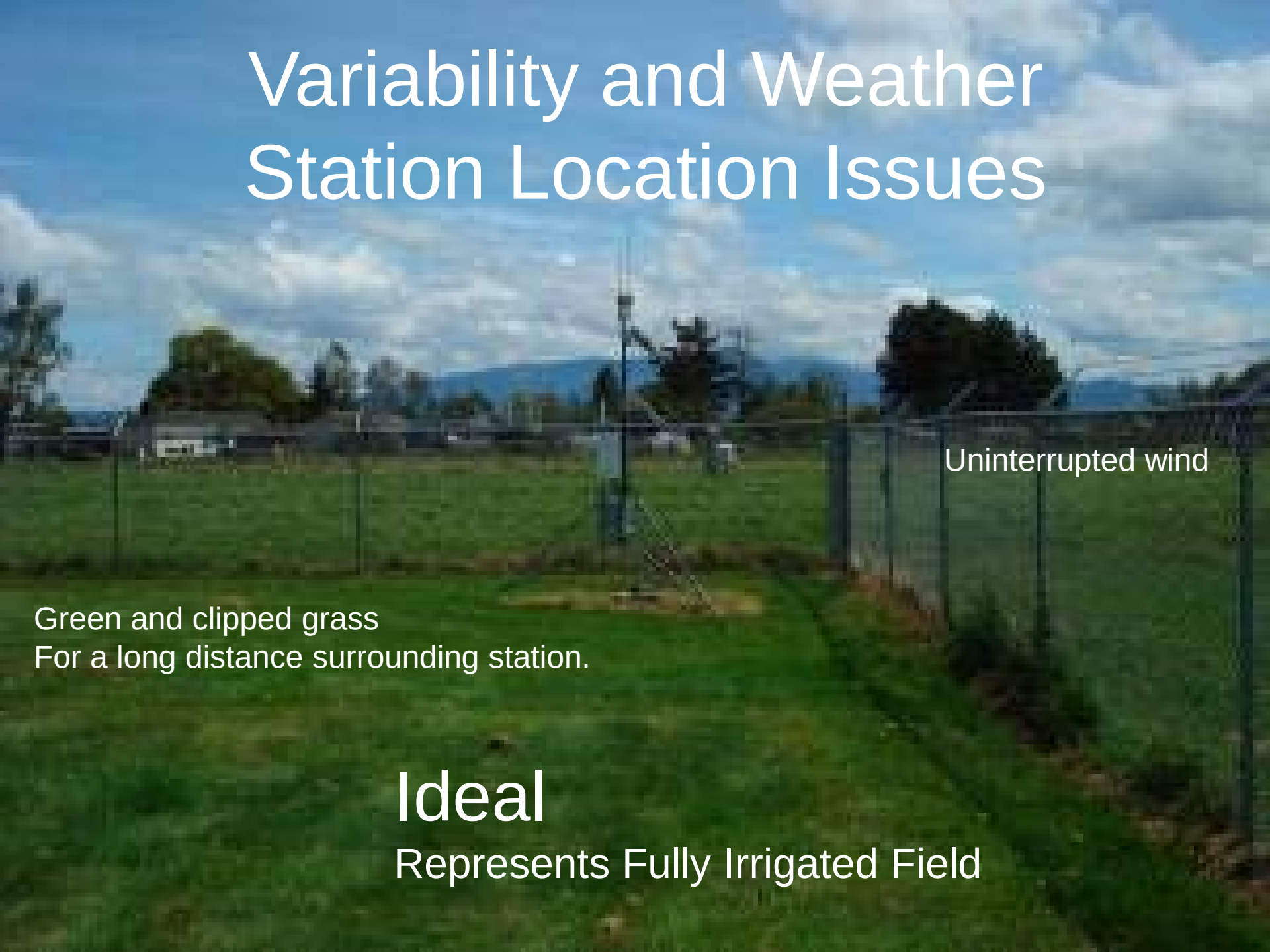

White = COOP, Blue = AWN, Pink = AgriMet, Dot = In previous WIG
Vancouver
Richmond
Blaine/102.8
Valdes Island
Lynden - 6.2
Clearbrook/104.7
Mayne Island
Bellingham 3 SSW/23
Olga 2 SE/116.3
Concrete PPL Fish Stn/92
Sedro Woolley/111
Whidbey Island NAS
Darrington RS/87.3
Coupeville 1 S/94.3
Port Townsend/50.3
Sequim 2 E/27.8
Everett/93.9
Startup 1 E/81.5
Quilcene 2 SW/87.3
Monroe/76.4
Seattle University of Washington/72.8
Snoqualmie Falls/108.4
Seattle-Tacoma International AP
Kent/88.1
Stampede Pass
Tacoma #1/25.5
Buckley 1 NE/93.3
Olympia Priest Pt Park/57.5
Gray AFB
Oakville/77.7
Centralia/103.3
Packwood/62.3
Toledo-Winlock MEM
Glenoma/37.2
Kid Valley/38.9
Longview/82.3
Cougar 6 E/48.3
Carson Fish Hatchery/30.4
White Salmon 4 NNE/40.6
Vancouver 4 NNE/112.8
Forest Grove
Portland
The Dalles Municipal Airport
Goldendale
Satus Pass 2 SSW/37.7
Glenwood No 2/27.9
Cle Elum/103.3
Wenatchee/Pangborn
Mazama/39.2
Winthrop 1 WSW/96.3
Darrington RS/87.3
Methow 2/12.6
PAWS Brewster - 14.2
Manson
Chelan/50.3
Plain/67.9
Entiat Fish Hatchery/19
Leavenworth 3 S/86.8
WSU TFREC - 14.8
Ephrata/57.6
Quincy - 19.6
George
Ellensburg/100.6
Moses Lake - 19.4
Moses Lake Grant County AP
Smyrna/52.7
Gleed - 14.2
PAWS Naches - 11
Cowiche - 19.4
Yakima Air Terminal/61.8
Ahtanum - 10.3
Wapato/90.8
White Swan RS/49.8
Sunnyside - 19.6
Port of Sunnyside - 15.3
Bickleton/71.8
Hundred Circles - 8.1
Oroville - 11
Ellisforde - 9.1
Tonasket - 10
Conconully/100.5
Pogue Flat - 10/Omak
Chesaw 2 NNE/0.6
Northport/94.4
Republic/98.1
Colville/66.1
Chewelah/81.6
Nespelem 2 S/73.9
Chamokane
Chief Joseph Dam
Seven Bays Marina
Wilbur/107.7
Hartline/71.2
Davenport/98.5
Harrington 1 NW/46.5
Wilson Creek/32.1
Sprague/47.3
Saint John/44.9
Colfax/98.2
Lacrosse/100.3
WSU Othello - 19.4
Lake Bryan-Rice Bar
Basin City - 19.4
Pomeroy/87.8
Eltopia 8 WSW/32.9
McClure - 19.3
Benton City - 13.1
Carlson - 19.3
Wheelhouse - 16.3
Milton Freewater
Hermiston (HRMO)
Whitman Mission/45.7
Dayton 1 WSW/108.4
Image USDA Farm Service Agency
© 2009 Europa Technologies
© 2009 Tele Atlas
Image State of Oregon
©2009 Google
Imagery Date: Jun 29, 2005
47°23'37.20" N 120°34'43.34" W elev 4506 ft
Eye alt 340.68 mi

Data Cleaning by WSU

- Weather station data screened for anomalies:
  - Solar radiation
  - Wind speed
  - Temperature
  - Rainfall
- Missing data interpolated
- WSU methodology peer reviewed

  "*Consumptive Use and Irrigation Water Requirements for Washington*", Peters, Nelson & Karimi, 2013.

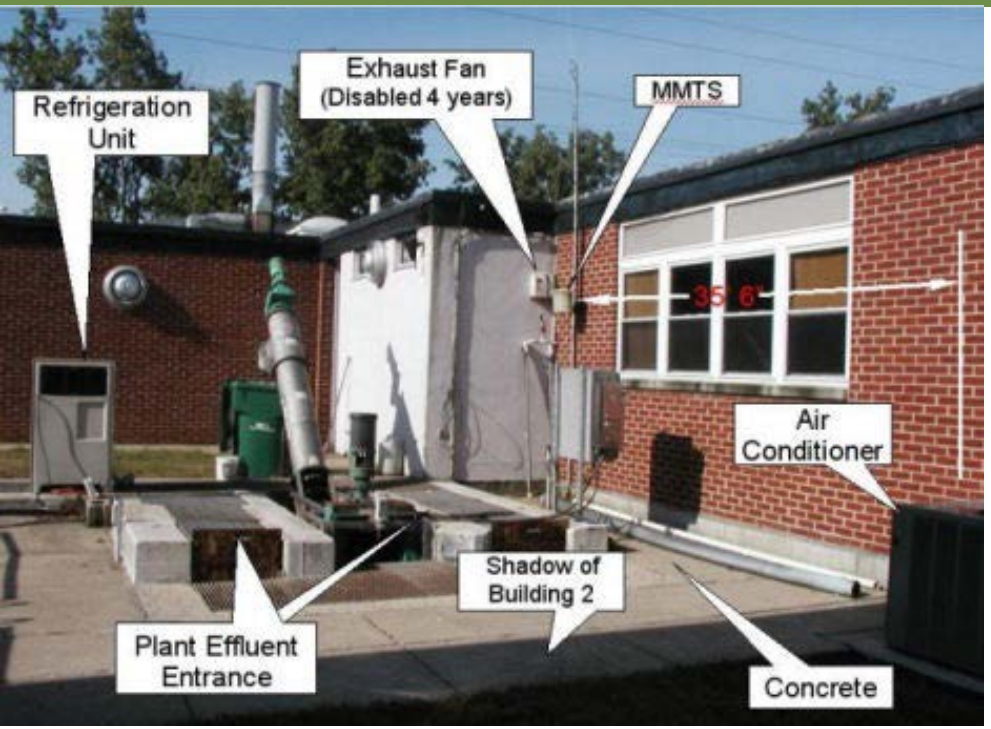
Variability and Weather Station Location Issues

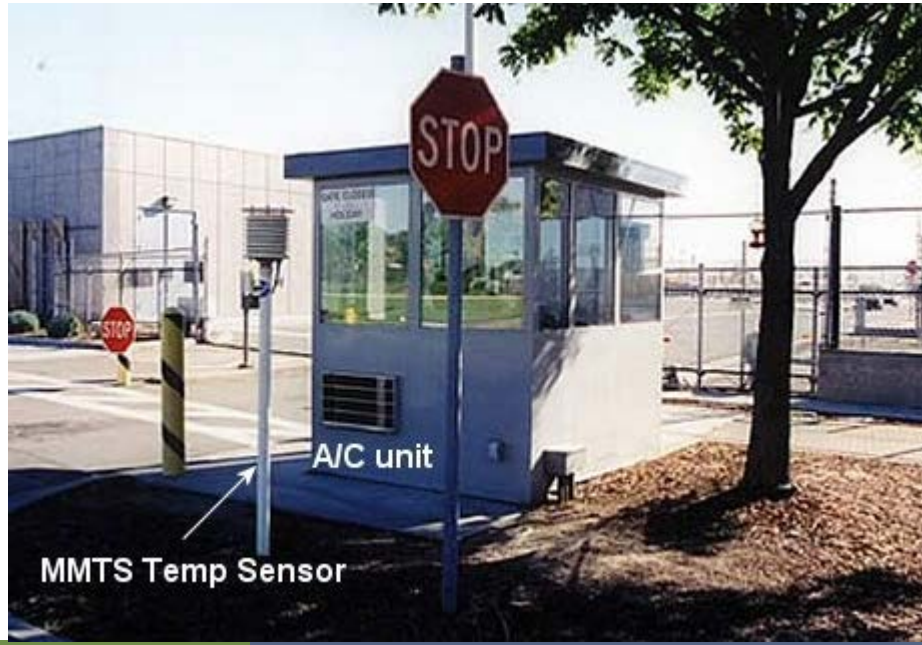


Ideal

Represents Fully Irrigated Field

AgWeatherNet

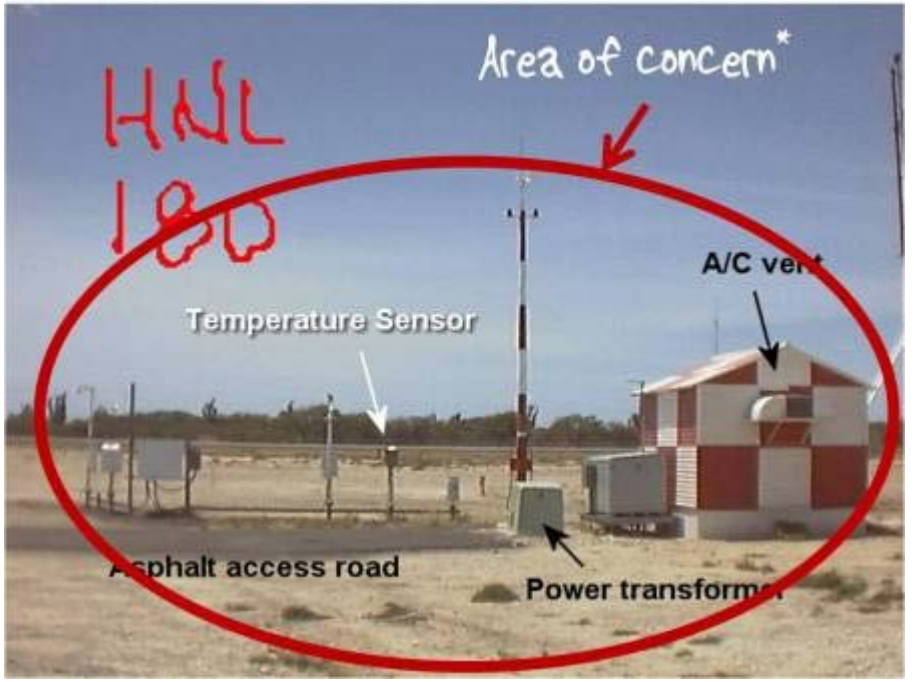

Refrigeration Unit
Exhaust Fan (Disabled 4 years)
MMTS
Air Conditioner
Shadow of Building 2
Plant Effluent Entrance
Concrete


STOP
A/C unit
MMTS Temp Sensor

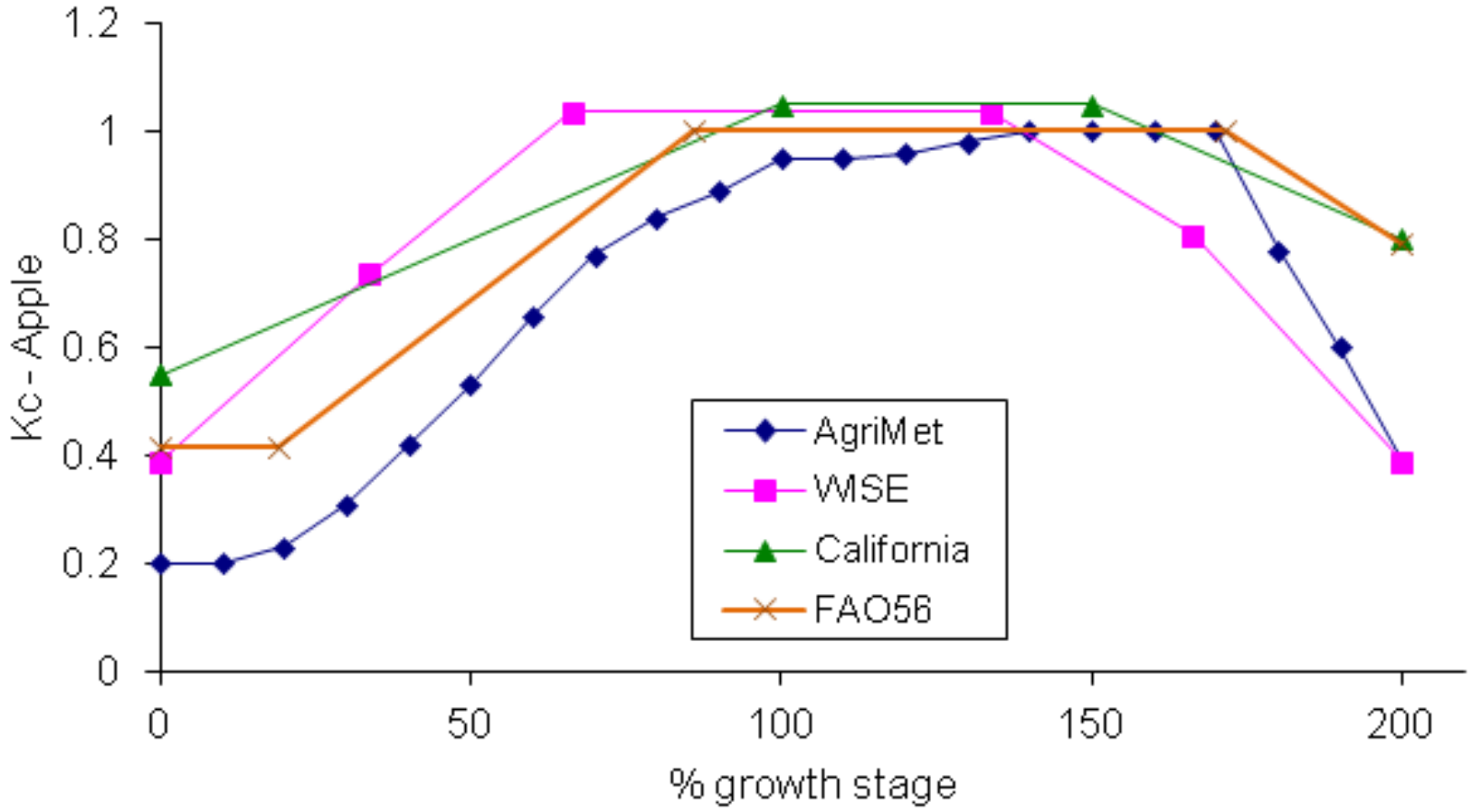

NOAA MMTS
Temperature
Sensor
A/C
A/C
A/C
A/C
A/C
A/C


A/C
A/C
A/C
NOAA MMTS
Temperature
Sensor
A/C

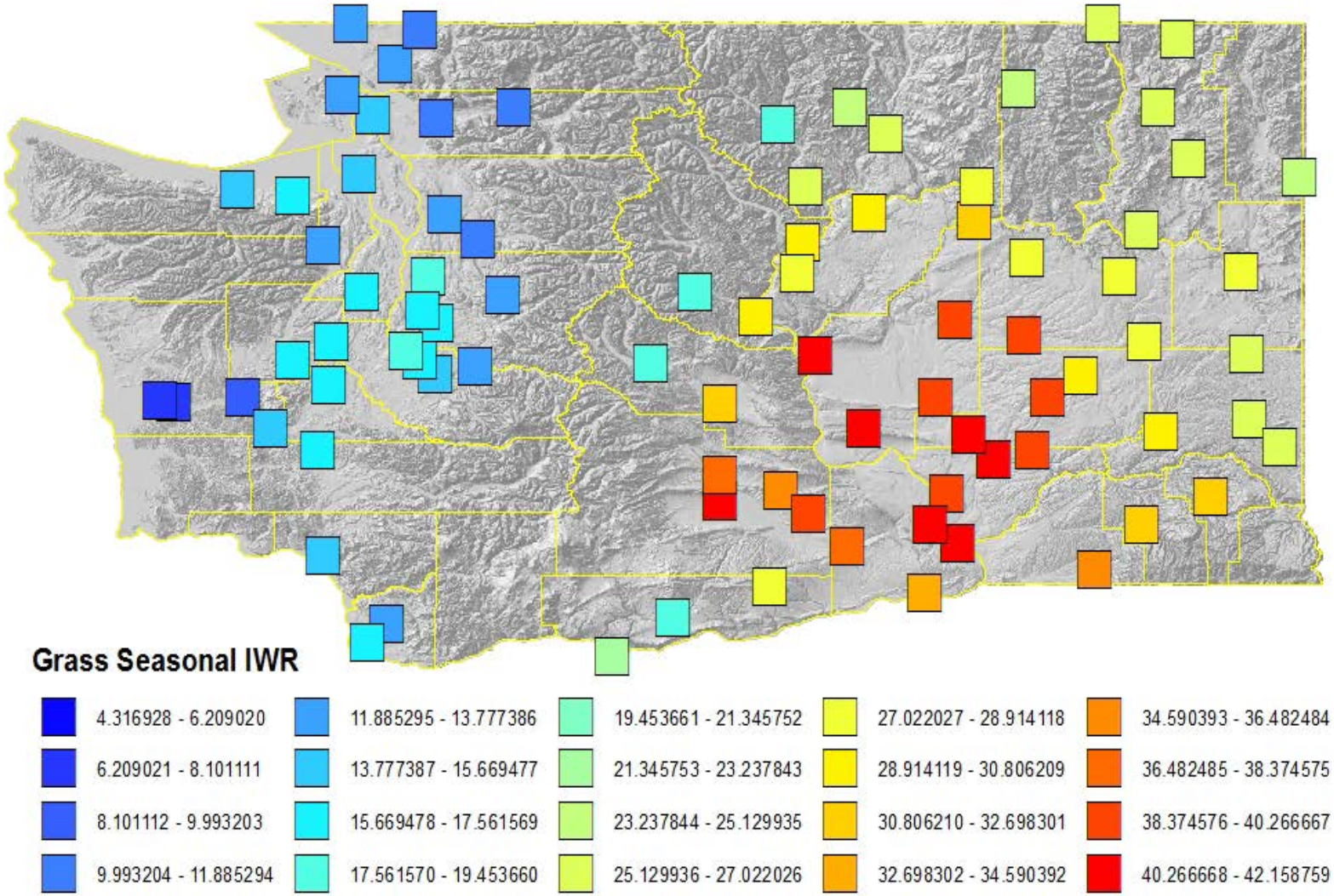
ASOS Stations



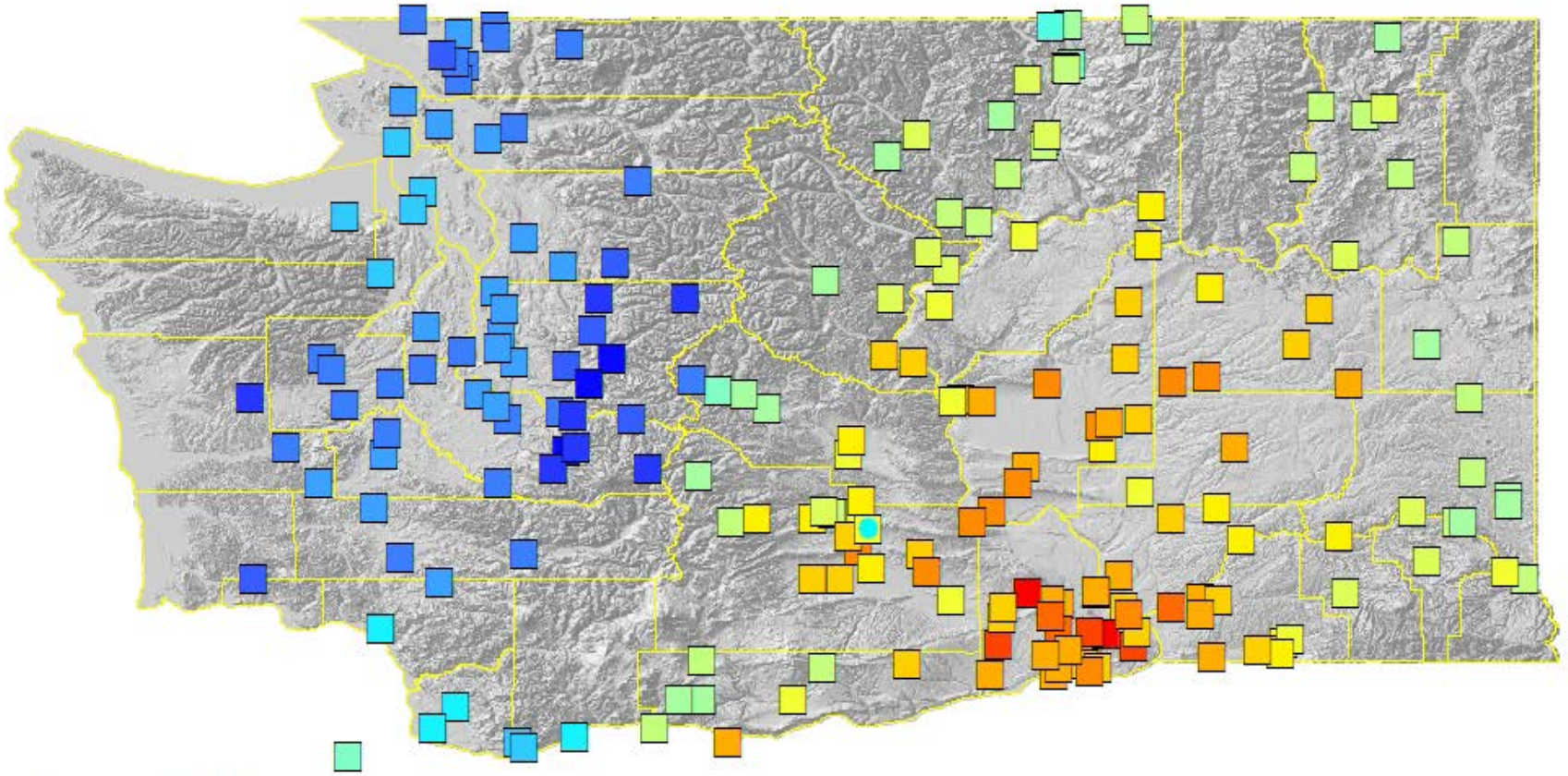
WSU Used Crop Coefficients



Existing WIG

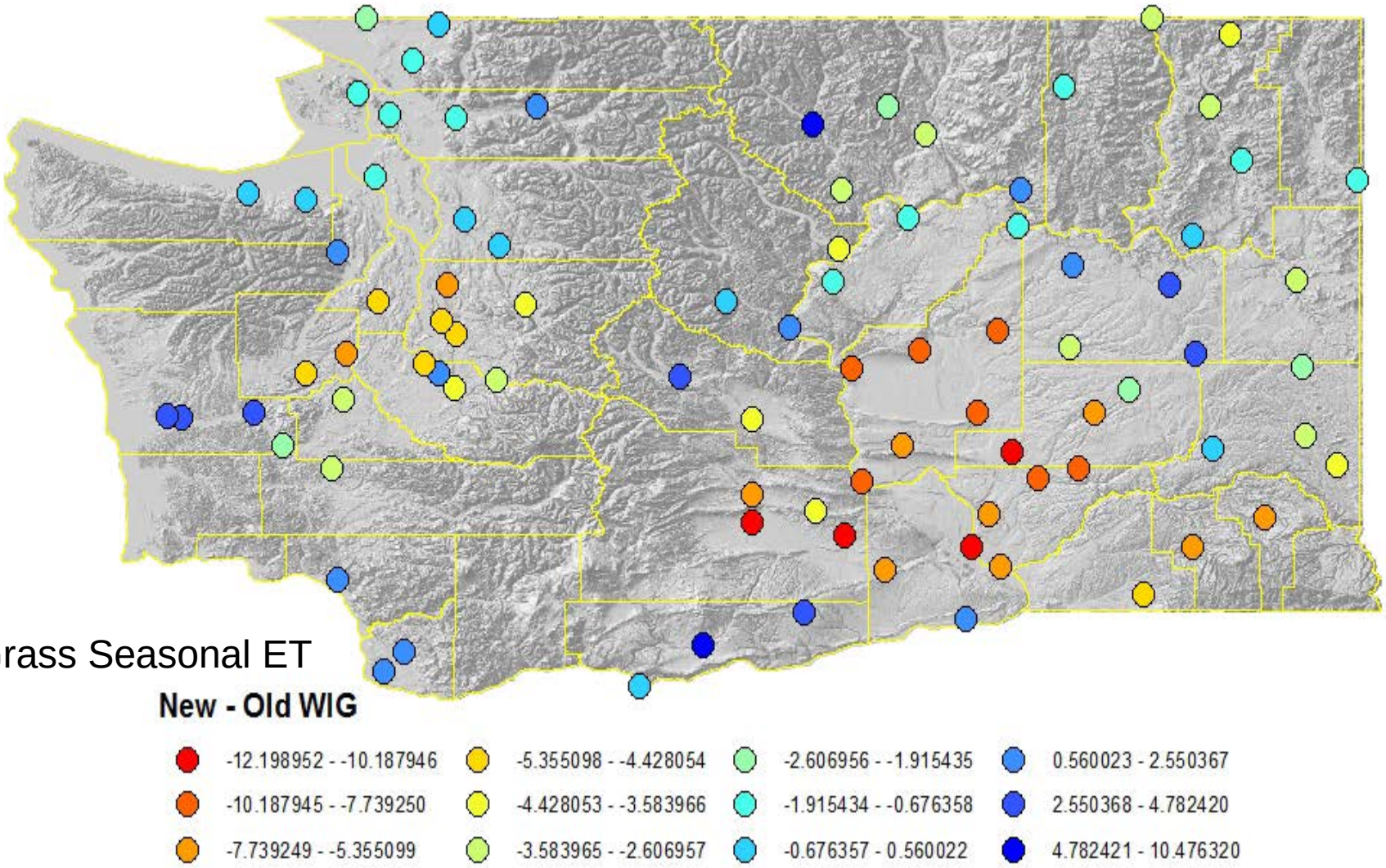


New Full Penman-Monteith



Grass Seasonal IWR

4.316928 - 6.209020	11.885295 - 13.777386	19.453661 - 21.345752	27.022027 - 28.914118	34.590393 - 36.482484
6.209021 - 8.101111	13.777387 - 15.669477	21.345753 - 23.237843	28.914119 - 30.806209	36.482485 - 38.374575
8.101112 - 9.993203	15.669478 - 17.561569	23.237844 - 25.129935	30.806210 - 32.698301	38.374576 - 40.266667
9.993204 - 11.885294	17.561570 - 19.453660	25.129936 - 27.022026	32.698302 - 34.590392	40.266668 - 42.158759


Grass Seasonal ET
New - Old WIG
-12.198952 - -10.187946
-10.187945 - -7.739250
-7.739249 - -5.355099
-5.355098 - -4.428054
-4.428053 - -3.583966
-3.583965 - -2.606957
-2.606956 - -1.915435
-1.915434 - -0.676358
-0.676357 - 0.560022
0.560023 - 2.550367
2.550368 - 4.782420
4.782421 - 10.476320

Example Comparison (Alfalfa)

**Application Efficiency Extra*

- Crop Irrigation Requirement @ Omak
  - Circular 512 (1965) = 34 inches
  - EB 1513 (1982) = 33 inches
  - WIG (1985) = 25.39 inches
  - New Provisional WIG (2013) = 26 inches
- Crop Irrigation Requirement @ Kennewick/Richland
  - Circular 512 (1965) = 44 inches
  - EB 1513 (1982) = 42 inches
  - WIG (1985) = 39.56 inches
  - New Provisional WIG (2013) = 37.8 inches

Example Comparison (Apples w/o cover)

**Application Efficiency Extra*

- Crop Irrigation Requirement @ Wenatchee
  - Circular 512 (1965) = 31 inches
  - EB 1513 (1982) = not provided
  - WIG (1985) = 26.74 inches
  - New Provisional WIG (2013) = 31.2 inches
- Crop Irrigation Requirement @ Yakima
  - Circular 512 (1965) = not provided
  - EB 1513 (1982) = 31 inches
  - WIG (1985) = 32.32 inches
  - New Provisional WIG (2013) = 34.9 inches

Example Comparison (Potatoes)

**Application Efficiency Extra*

- Crop Irrigation Requirement, Ellensburg
  - Circular 512 (1965) = 22 inches
  - EB 1513 (1982) = 25 inches
  - WIG (1985) = 24.64 inches
  - New Provisional WIG (2013) = 18 inches
- Crop Irrigation Requirement, Othello/Quincy
  - Circular 512 (1965) = 27 inches (Othello and Quincy)
  - EB 1513 (1982) = 31 inches (Othello) / 29 inches (Quincy)
  - WIG (1985) = 30.21 inches (Othello) / 30.35 inches (Quincy)
  - New Provisional WIG (2013) = 19.8 inches (Quincy)

Comparison to Old WIG, Accuracy

- Both above and below old estimates in various locations, but in general 10 – 20% *lower*
- Based on the variability between stations that "should have been the same", WSU estimates the results are within 10-15% of actual.

Ecology Policy and Practice

- Why is this irrigation guidance needed?
- Where has Ecology been?
  - Washington Irrigation Guide (WIG) only
- Where is Ecology going?
  - WIG, LandSat, Meters, and Other Tools

Why Is Guidance Needed?

- New Water Rights

  "Beneficial use has two elements:

  (1) the purposes or types of activities for which the water may be used *and*

  (2) the amount of water that may be used as limited by the principle of reasonable use." *Grimes v. Ecology, 1993*.

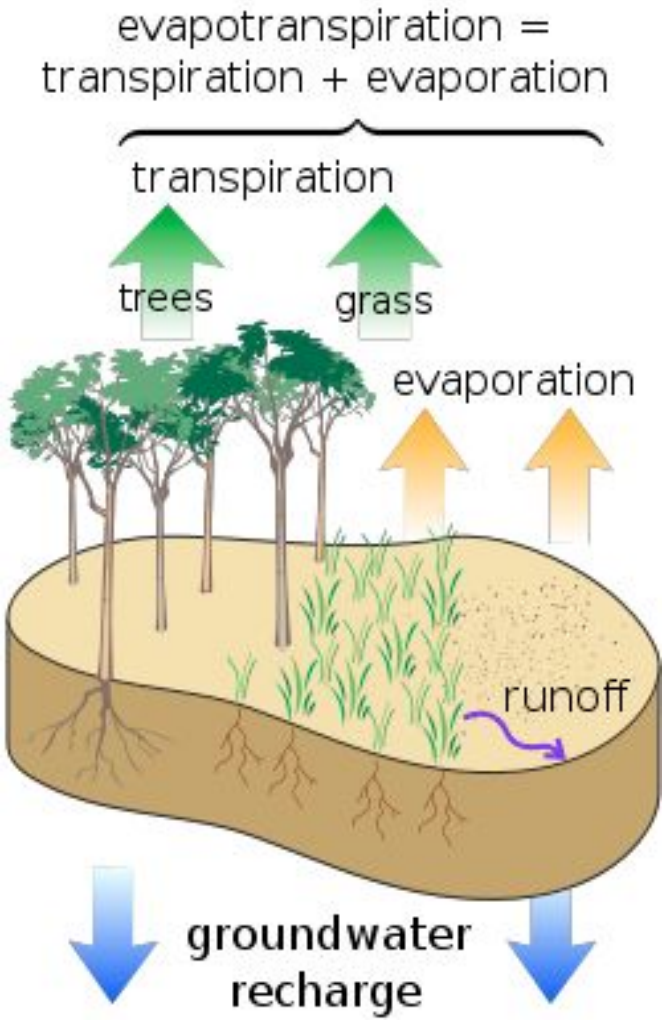
Why Is Guidance Needed?

- Changes to Existing Water Rights

  "If a right has not been beneficially used to its full extent . . . then issuance of a certificate of change, in the amount of the original right, could cause detriment or injury to other rights." *OWL v. Twisp, 1997.*

Why Is Guidance Needed?

- Consumptive Use Evaluations
  - Annual Consumptive Quantity (ACQ) RCW 90.03.380(1)
  - Impairment RCW 90.03.380(1)
  - Trust Water RCW 90.38 and RCW 90.42



Ecology Policy 1120

Policy for Conducting Tentative Determinations of Water Rights

Evidence of the extent of the beneficial use may include:

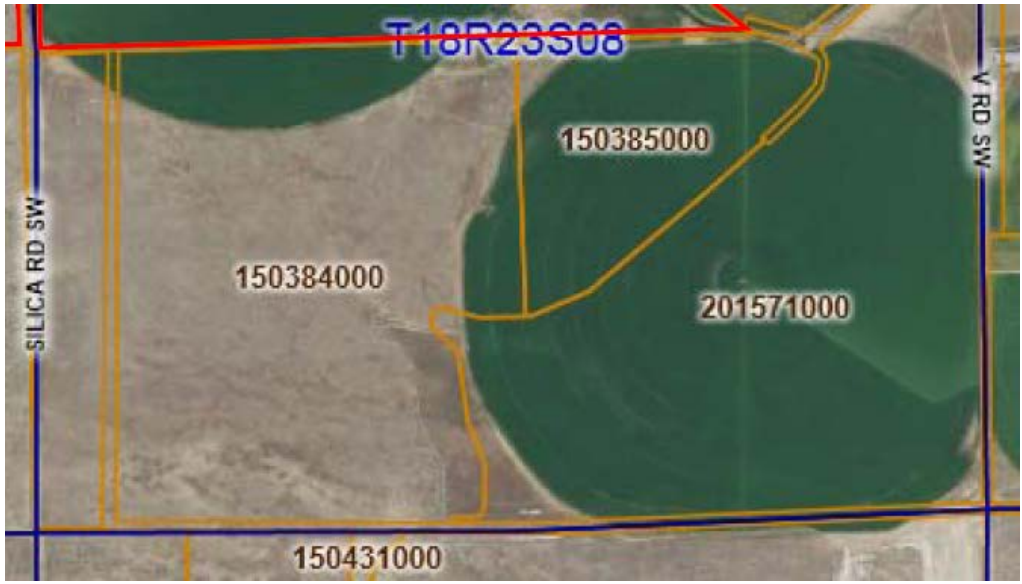
- water and power meter records.
- crop or product sales records.
- crop irrigation guides and water duty publications.
- observation by the investigator.
- declarations and affidavits.
- water billing records.
- aerial photos, historic photos, remote sensing imagery.
- population estimates, county assessor records, land use or tax records.

In Practice, Often Equates to…

WIG Crop Need x Acres ÷ Efficiency

Example: 100-Acre Hay Farm in Ellensburg
Irrigated with Sprinklers

100 x 31.46 inches / (12 inches/foot) / 75%
 = 350 acre-feet



New Information Brings New Scrutiny

- Water supplies are becoming more scarce
- Meter data more common today
- LandSat now publicly available
- WIG being updated

Out with the Old, In with the New

- Old WIG still used today.
  New data is provisional until approved.
- Once new WIG finished, it will govern unless there is a compelling scientific basis to use something else.

In other words, no cherry-picking. 

How Will New WIG Be Used?

- Effective date?
- What if the answer is different?
- What about peak crop needs?
- Can I “redo” old decisions?

Can I Redo An Old Decision?

- Changes are permissive and can be withdrawn
- Ecology determinations are “tentative” whereas adjudications are “final”
- Considered on case-by-case basis
- Corroborating evidence to confirm historical water use under the water right

Stakeholder Concerns

- Can new ET formula can be a good predictor given the incomplete data set available for all parameters?
- How does lack of calibration of the existing stations affect data accuracy?
- Does the use of so many new stations prevent apples-to-apples data?
- How will the data will be used by regulatory agencies?

Next Steps?

-  Technical Peer Review
  - ✓ Academia counterparts from across the country provided input to WSU and NRCS
  - ✓ Local technical experts provided input to NRCS
- On-going public outreach
- Adoption by the NRCS

Questions?

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Ecology WIG Website

http://www.ecy.wa.gov/programs/wr/wig/wig.html

NRCS State Technical Advisory Committee (STAC) Website

http://www.wa.nrcs.usda.gov/partnerships/STAC/

Special Thanks & Slide References: Troy Peters, WSU

Department of Ecology
Central Regional Office

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