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science for a changing world

Update on the Next Generation Water Observing System

Interstate Council on Water Policy
Annual Meeting
October 10, 2019

Groundwater and Streamflow Information Program

USGS Water Mission Integrated Priorities

Water Hazards

Water Hazards develops tools to support improved planning and decision-making before, during, and after extreme hydrologic events and water emergencies like floods, droughts, and contaminant spills.

Integrated Water Availability Assessments

IWAAs examine the supply, use, and availability of the nation's water. These regional and national assessments evaluate water quantity and quality in both surface and groundwater, as related to human and ecosystem needs and as affected by human and natural influences.

Water Prediction Work Program

2WP builds a powerful set of modeling tools to predict the amount and quality of surface and groundwater, now and into the future. These models use the best available science to provide information for more rivers and aquifers than can be directly monitored.

Next Generation Water Observing System

NGWOS collects real-time data on water quantity and quality in more affordable, rapid, and widespread ways than has previously been possible. The flexible monitoring approach enables USGS networks to evolve with new technology and emerging threats.

NWIS Modernization

NWIS data systems that house USGS water information are being modernized to maximize data integrity, simplify data delivery to the general public, and automate early warning to enable faster response times during water emergencies.

Advanced Water Models Require High-Density Data

Nearly 30 million stream reaches in U.S.

USGS operates about 10,000 streamgages

(about 3/100 of one percent of reaches)

- Modern models require high-density data describing all of the major hydrologic characteristics that the models represent, such as streamflow, evapotranspiration, water storage in snowpack, soil and groundwater, and many others.

- The density of our current monitoring networks limit the ability to accurately understand and predict water-resource conditions with these advanced models (i.e. National Water Model)

Components of the Next Generation Water Observing System

Identify water monitoring gaps and data needs related to integrated water modeling and stakeholder decision-making.

Establish integrated set of fixed and mobile monitoring assests in the water, ground, and air.

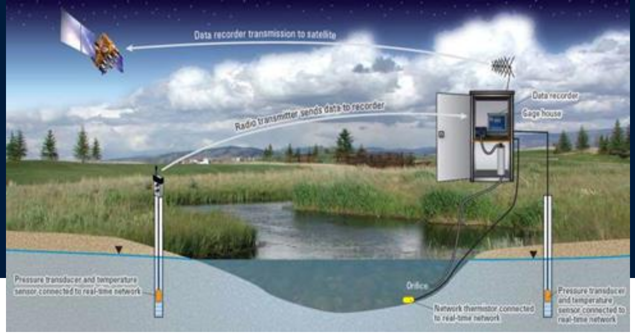
Integrate delivery of water quantity, quality, and use data

Work with partners and stakeholders to inform modern water prediction and decision-support systems

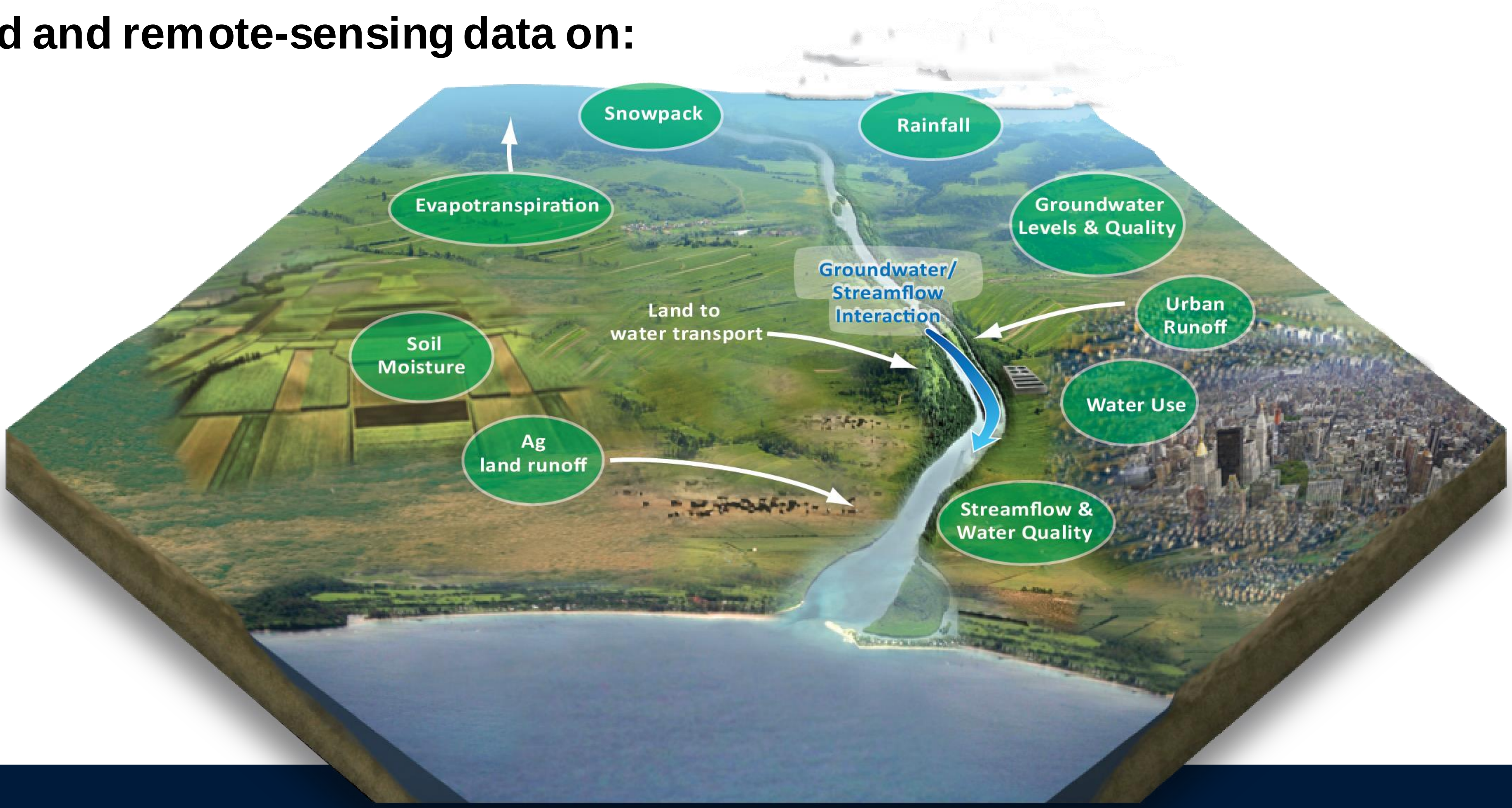
Characteristics of the Next Generation Water Observing System

- State-of-the-art measurements
- Dense array of sensors at selected sites
- Increased spatial and temporal coverage
- New technology testing and implementation
- Improved operational efficiency
- Modernized and timely data storage and delivery

What will the Next Generation Water Observing System Monitor?



When fully implemented, NGWOS will provide high temporal and spatial resolution real-time field and remote-sensing data on:



Design Strategy and Basin Selection

- We can't afford to monitor everywhere…

- Implement NGWOS in ~10 medium-sized watersheds (10,000-20,000 mi^2 each) that are representative of larger water-resource regions and augment the existing streamgage network elsewhere in the region with modest enhancements.

- Leads to more accurate predictions of streamflow, aquifer levels and water-quality conditions at unmonitored locations across the nation.

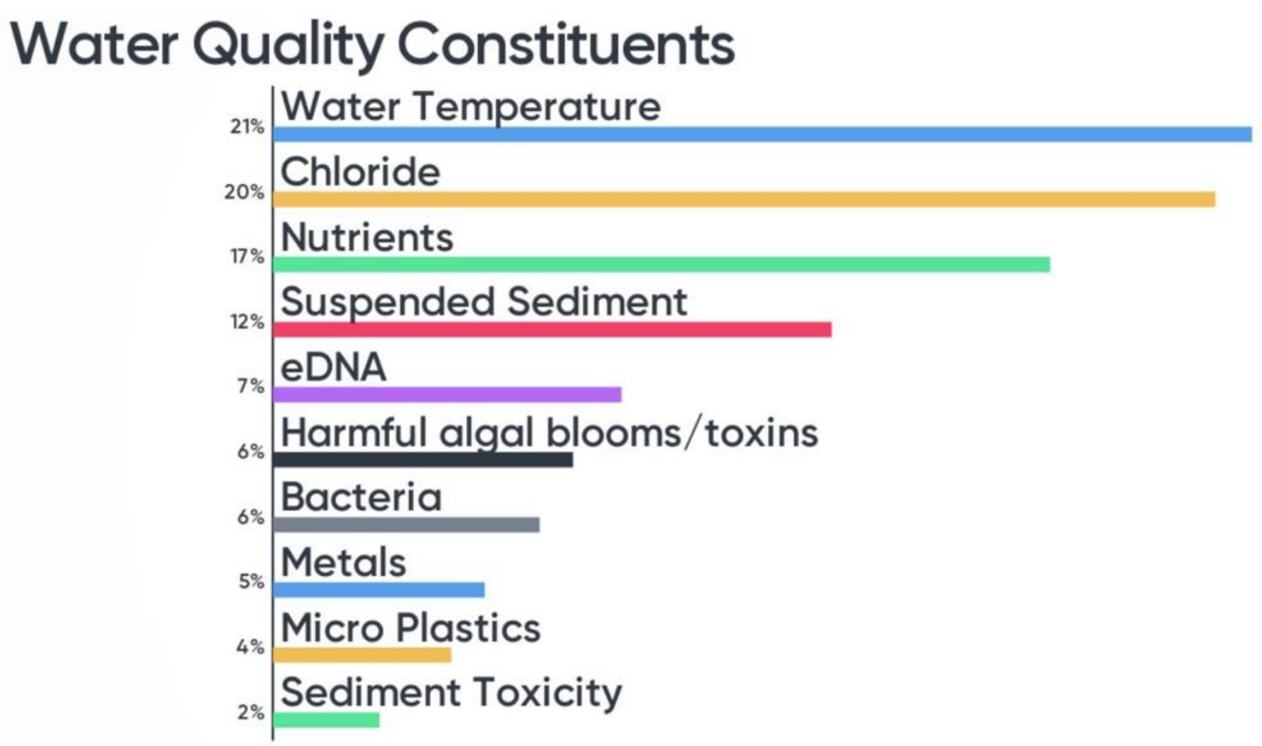
Next Generation Water Observing System (NGWOS) Pilot in the Delaware River Basin

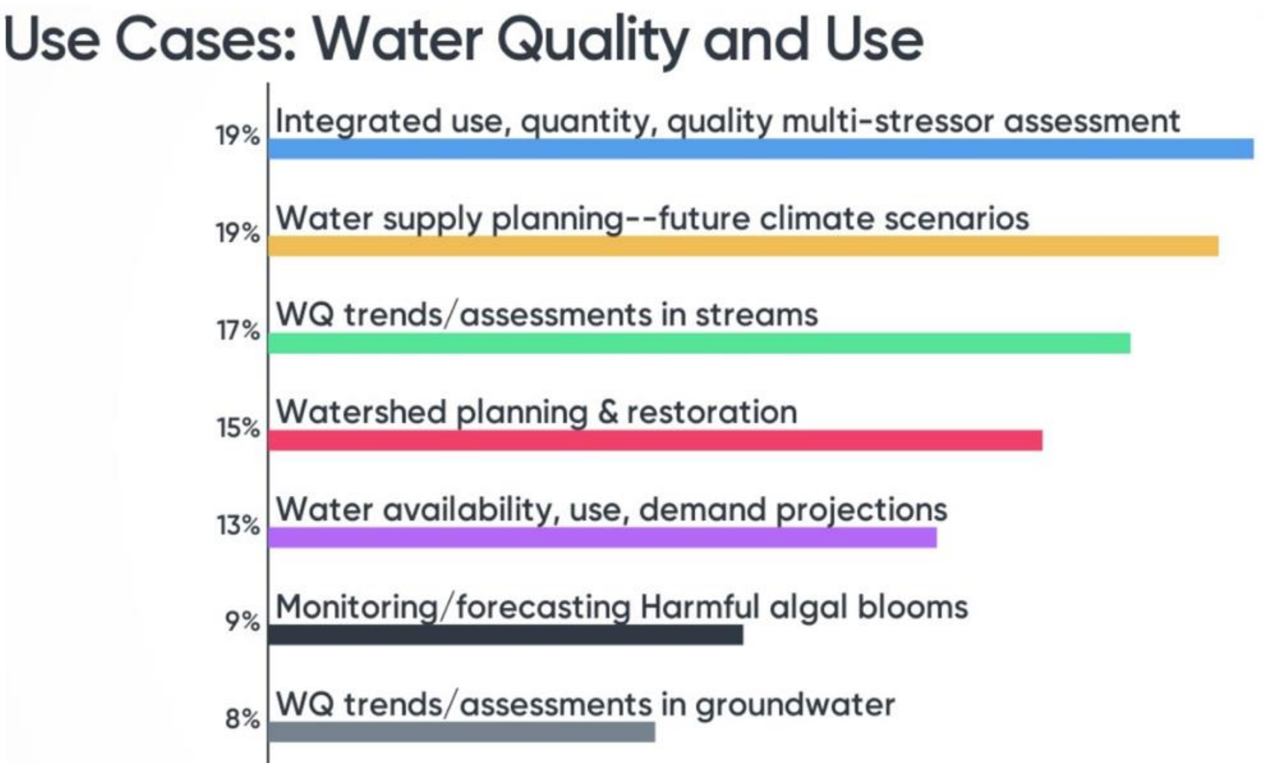
An opportunity to develop an integrated water observing system to support innovative modern water prediction and decision support systems in a nationally important, complex interstate river system.

The Delaware River Basin

- Ecologically diverse and critical to the regional and national economy;
- Provides drinking water to over 15 million people;
- Long history of innovative, regional solutions to insure the long-term sustainability of this treasured resource.

Feedback from Delaware River Basin Stakeholder Meeting





Stakeholder Feedback—
What big issues keep you up at night?

- Climatic drought events vs operational/administrative drought declarations.
- Climate change, drought, balanced reservoir operations
- Climate change, estuarine modeling, threatened and endangered species, drought management and salinity interactions, balanced uses, integrated management
- Ecological flows for native species; ecological function and structure under changing climate and water management
- Too numerous to mention but a very pressing "issue" is road salt/chloride.
- Climate change, sea level rise, salt water intrusion, road salt usage, flow management
- Climate change, sea level rise, salt water intrusion, road salt usage, flow management
- Flood/drought forecasting. Timeliness of data retrieval.
- Pollutant spill travel prediction velocity and time of travel for public heath risk management with respect to drinking water!
- I've been working in watersheds for almost 20 years and steadily watched the Cl levels climb. It seems like an intractable problem that isn't getting a lot of attention. Increased stormwater due to climate change also worries me.
- How to improve stormwater runoff quality by better understanding BMP and land use planning performance.
- Salinity in the lower Delaware basin
- Drought in the DRB
- Insufficient communication between basin effort and actual decision making
- Holistic support for aquatic community
- Groundwater quality and quantity
- How to utilize the National Water Midel for the Delaware Valley Early Warning System spill prediction model, with loose coupling to DBOFS.
- Capturing instream sedimentation, mapping fluvial erosion hazard areas, understanding groundwater recharge,

NGWOS Delaware River Basin Pilot – FY19

Enhanced Mainstem Monitoring

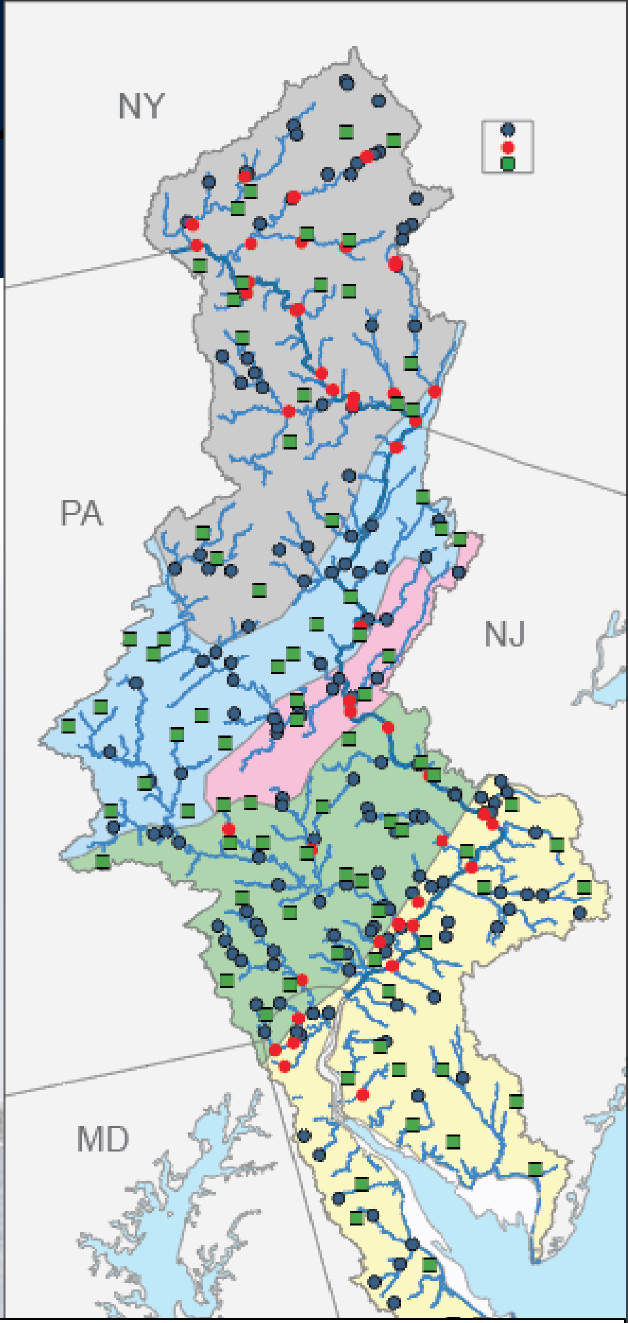
- Additional temperature & salinity monitoring at more sites and new communication platforms. 2 new sites at C&D canal and Museum

Intensive Sub-Basin Monitoring

- 20 new gages in areas in basins less than about 50 mi2 to characterize hydrologic dynamics and improve hydrologic and ecologic models (includes water temperature and conductance)
- Added water temperature and conductance at 20 existing gages.

Test Beds

- Innovation test beds for water quality and hydrologic budget
- Operational test beds for LoRa, non-contact sensors, cameras, SW-GW interactions



Enhanced Streamgages in FY18
New Streamgages in FY19

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NGWOS Delaware River Basin Pilot – FY19

Additional monitoring on a limited scale

- sw/gw interactions
- Evapotranspiration
- Snowpack
- Soil Moisture
- Remote Sensing

Monitoring Network Modernization

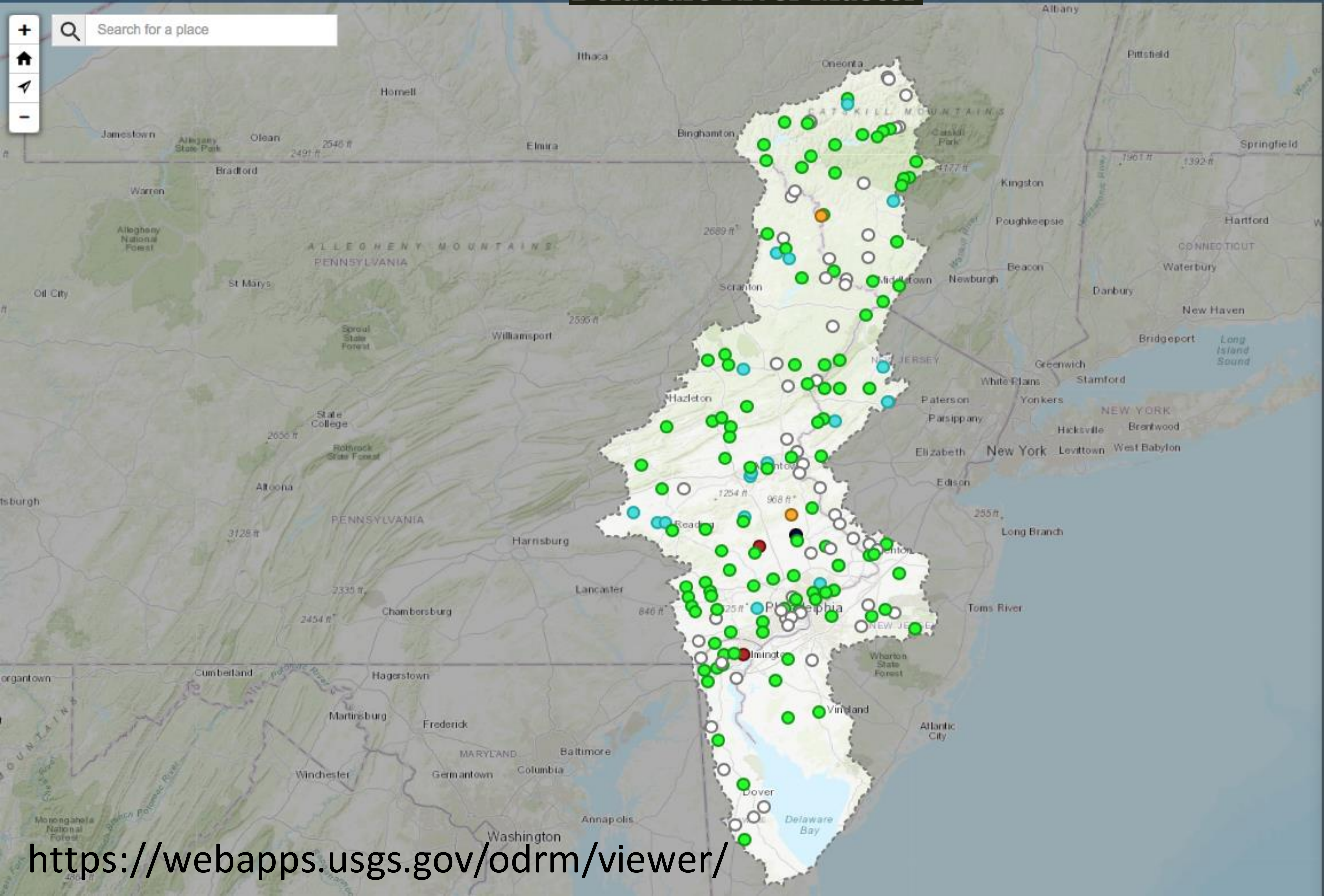
- new communication platforms
- Faster, adaptable, and interconnected; plug-n-play
- Continued R2O into NextGen technologies

USGS science for a changing world — Delaware River Dashboard

Office of the Delaware River Master

Overview | Layers | Legend 2 | Tools | Home

Search for a place



https://webapps.usgs.gov/odrm/viewer/

LEGEND

CLOSE

Streams: Status

CLEAR

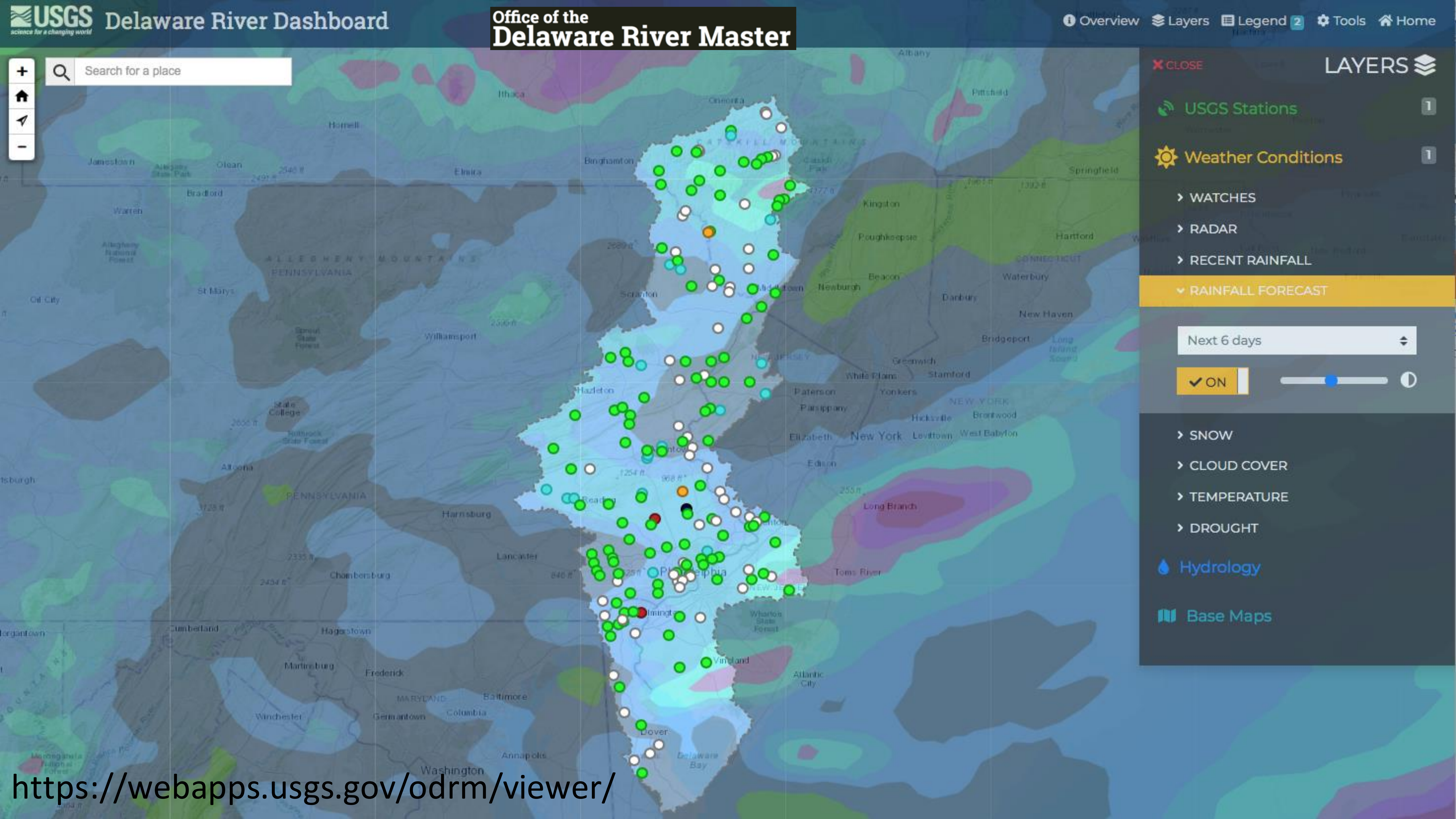
All-Time Low for this Day	0^{th} percentile (minimum)
Much Below Normal	<10^{th} percentile
Below Normal	10^{th} – 24^{th} percentile
Normal	25^{th} – 75^{th} percentile
Above Normal	76^{th} – 90^{th} percentile
Much Above Normal	>90^{th} percentile
All-Time High for this Day	100^{th} percentile (maximum)
Not Flowing	0 cubic feet per second
Above NWS Flood Stage	See Comments
Not Ranked	See Comments

Comments: Marker color indicates the current streamflow condition. Categories are based on the percentile of existing streamflow record on this day-of-the-year. A streamgage is not ranked when there is less than 20 years of record or a current streamflow measurement is unavailable. Flood stages are maintained by the National Weather Service (NWS) and are not established for all USGS streamgages.

Data Source: USGS Water Data for the Nation

TIP Click stream stations to access real-time data, time-series graphs, and station information

Topographic Base Map



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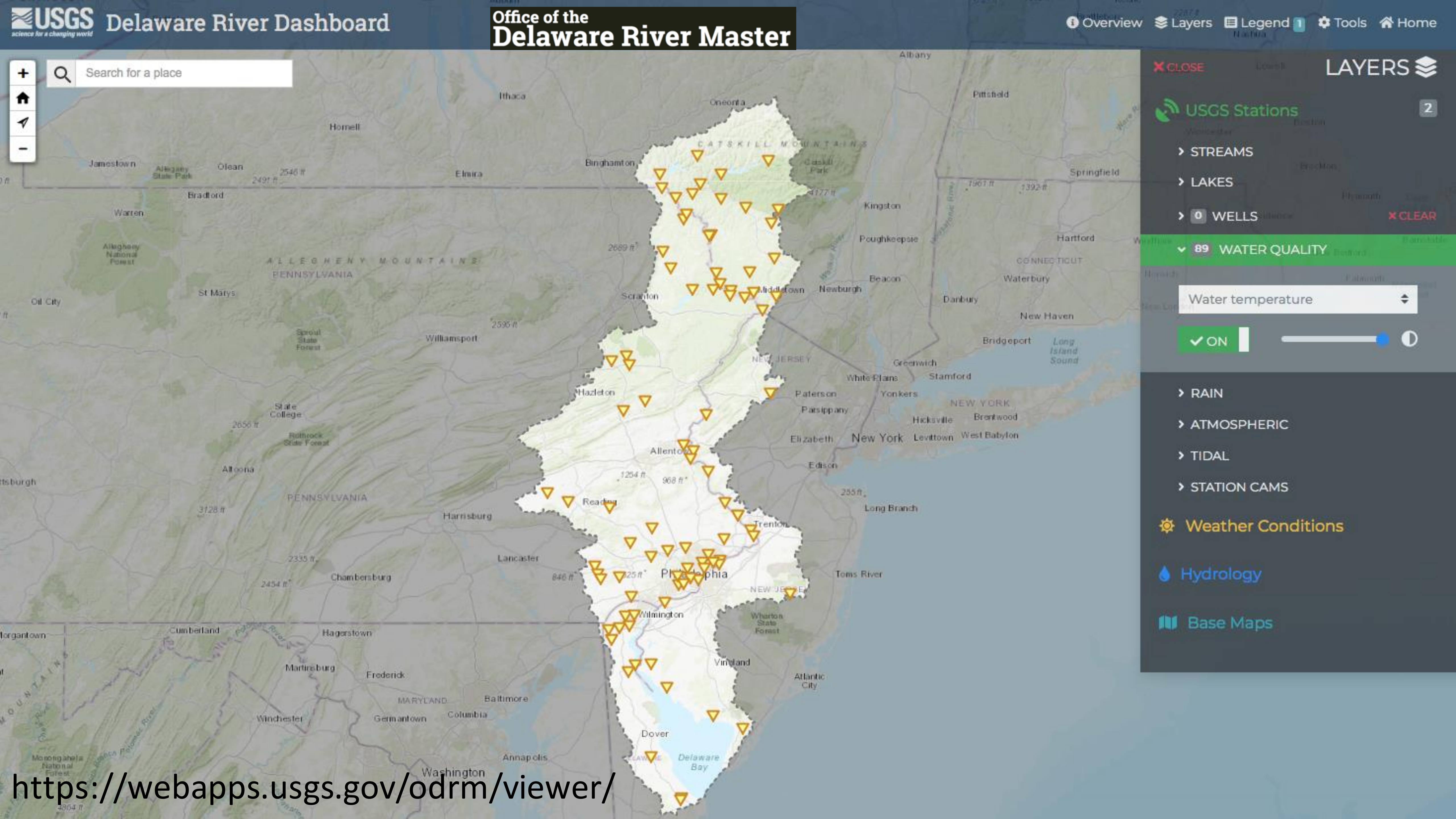

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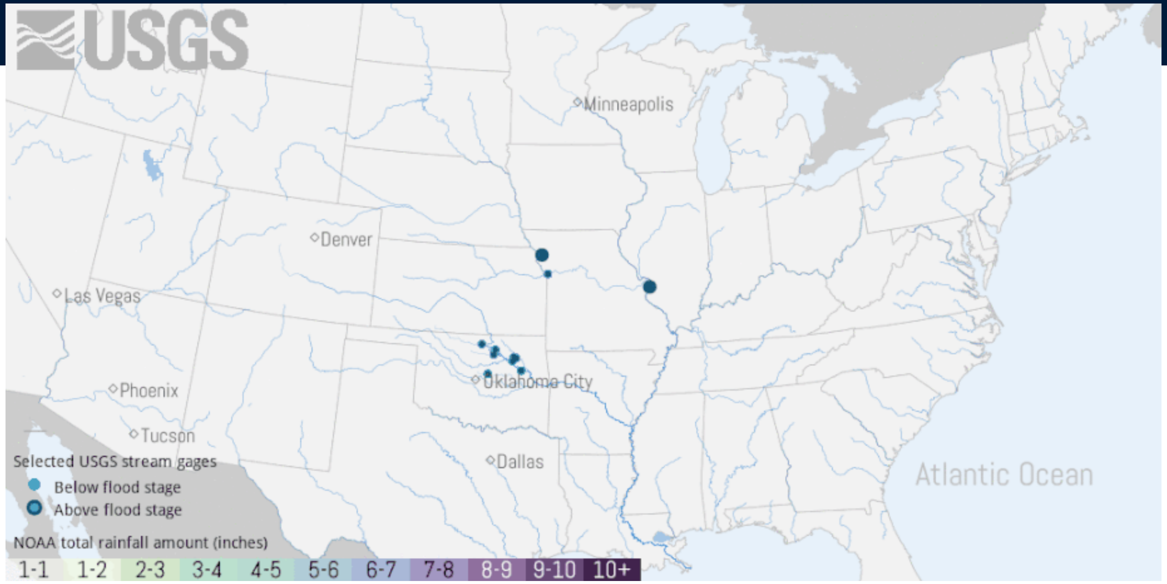
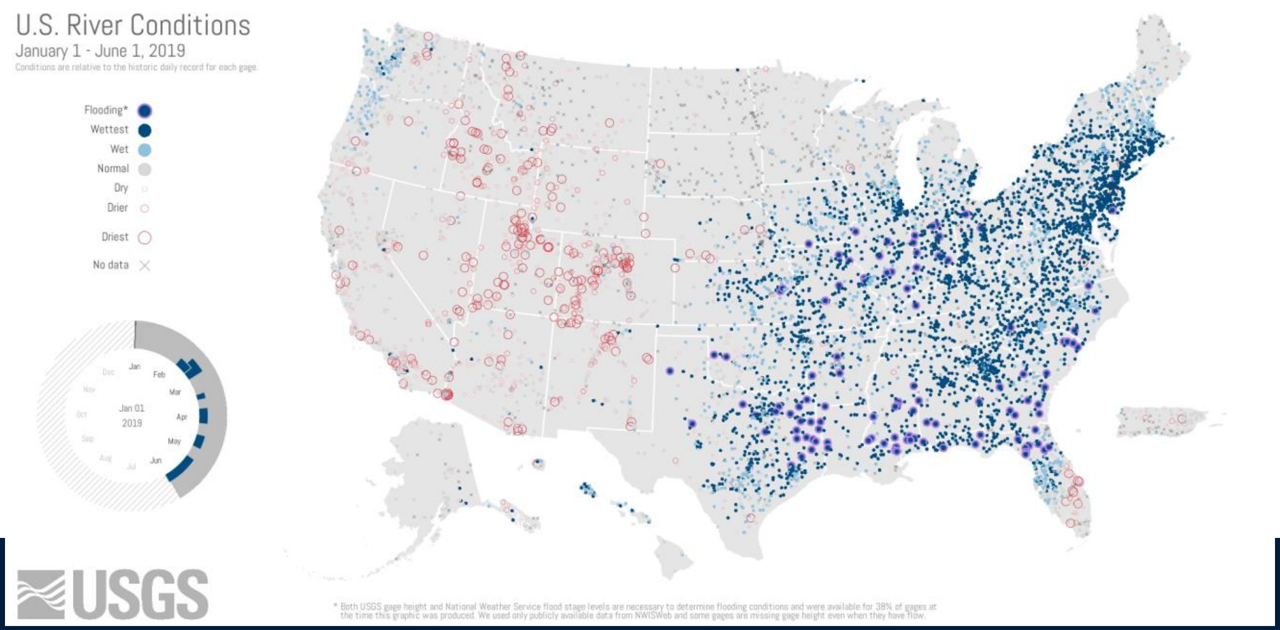
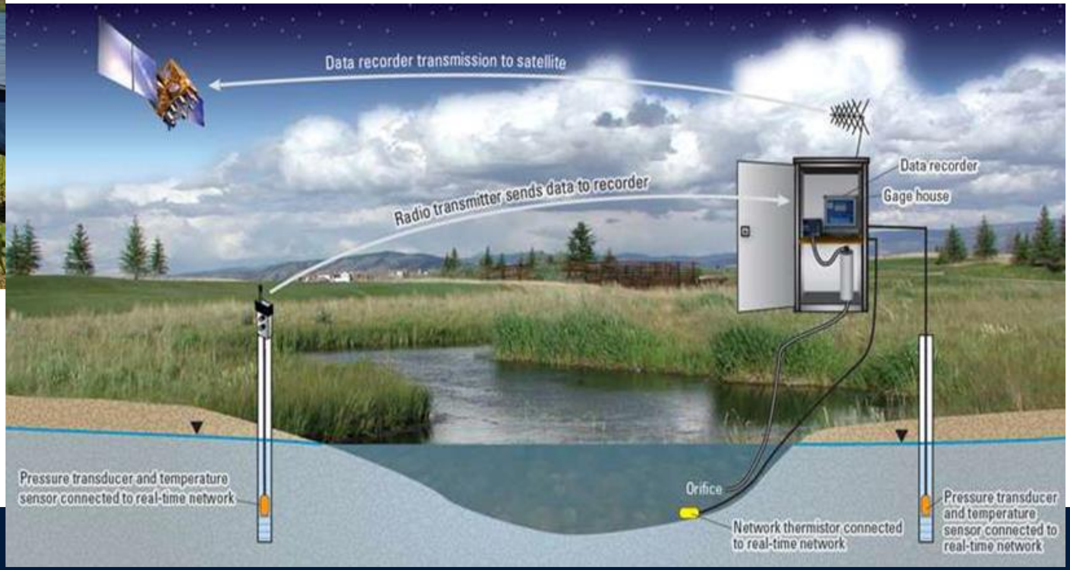
Data Delivery – New Approaches



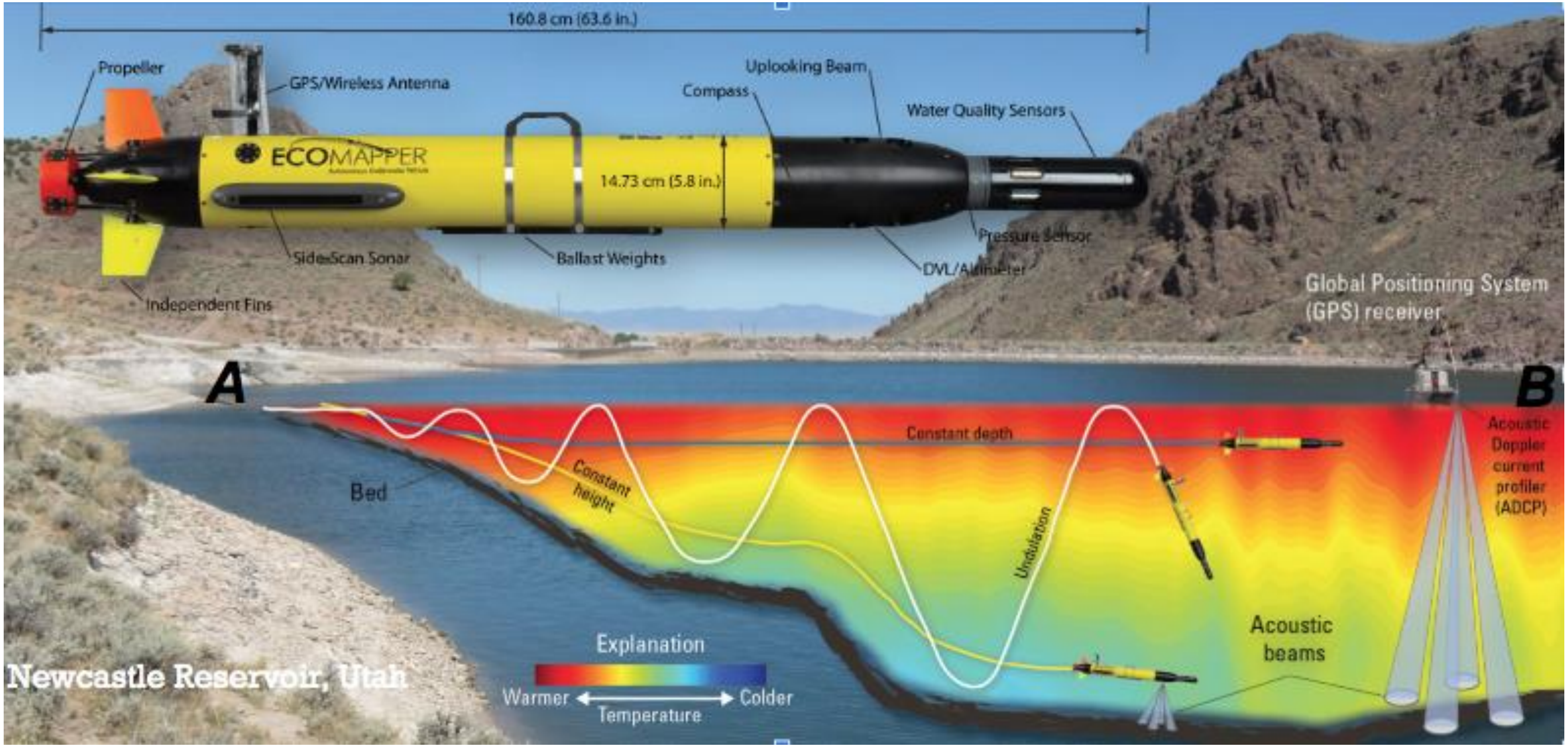


Water Level, Velocity, Discharge from Radars and Video

Integration of Drones and Satellites to Monitor Water Quality, Quantity and Use

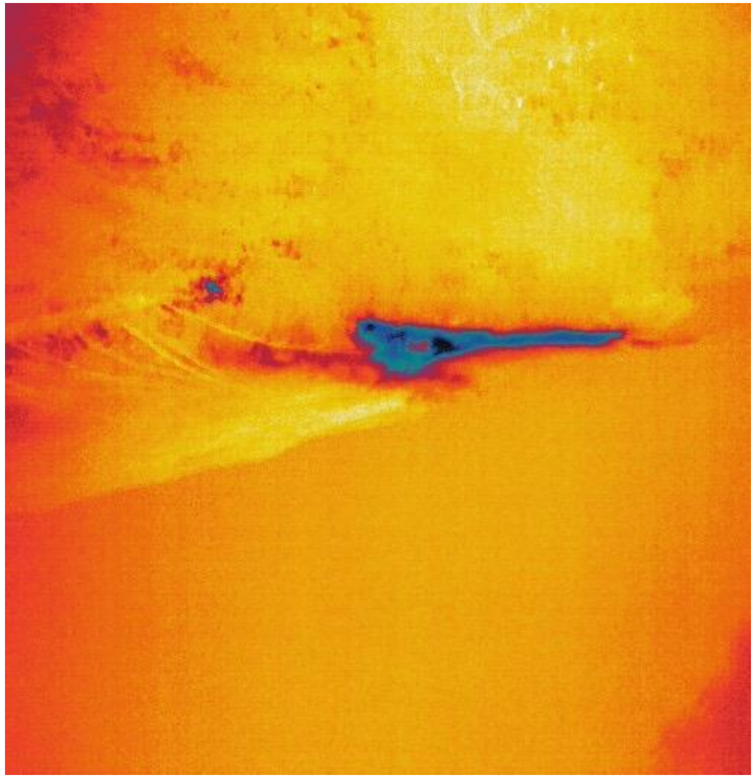


Autonomous Underwater Vehicle (AUV) Surveys



Thermal IR Camera

FLIR Camera Deployment at Claryville NY for GW-SW Interactions



Marty Briggs (Hydrogeophysics), Chris Gazoorian (NY WSC)

Tracking GW Discharge to Streams

Used thermal infrared imaging to locate areas where GW is discharging to streams. Installing wells to better understand how GW influences river chemistry and temperature—which are important to trout and dwarf wedge mussels in the Upper Delaware River Basin.

Selecting the Next NGWOS Basin in the Western U.S.

- **STREAMLINED process -** due to timeline
- **Internal selection process -** based on national ranking criteria and informed by NGWOS basin nominations from Water Science Centers.
- **Streamlined stakeholder engagement prior to selection**
- **Planning and Installations start in FY20, based on budget**
  - Stakeholder engagement in selected basin in FY20.
  - Planning and equipment installations in FY20

Basin Selection Design

18 Hydrologic Regions identified by applying cluster analysis to HUC-4 basins, based on proportions of the 20 Hydrologic Landscape Regions (Wolock, 2003) in each basin.

Basin Ranking Variables

Numerical ranking in each regions was based on 12 variables

A. Land use and land use change: (1) total urban, (2) urban change from 1974 to 2012, (3) projected urban in 2050, (4) total agriculture, and (5) agriculture change from 1974 to 2012.

B. Climate change: (6) change in precipitation modeled to 2070—2099.

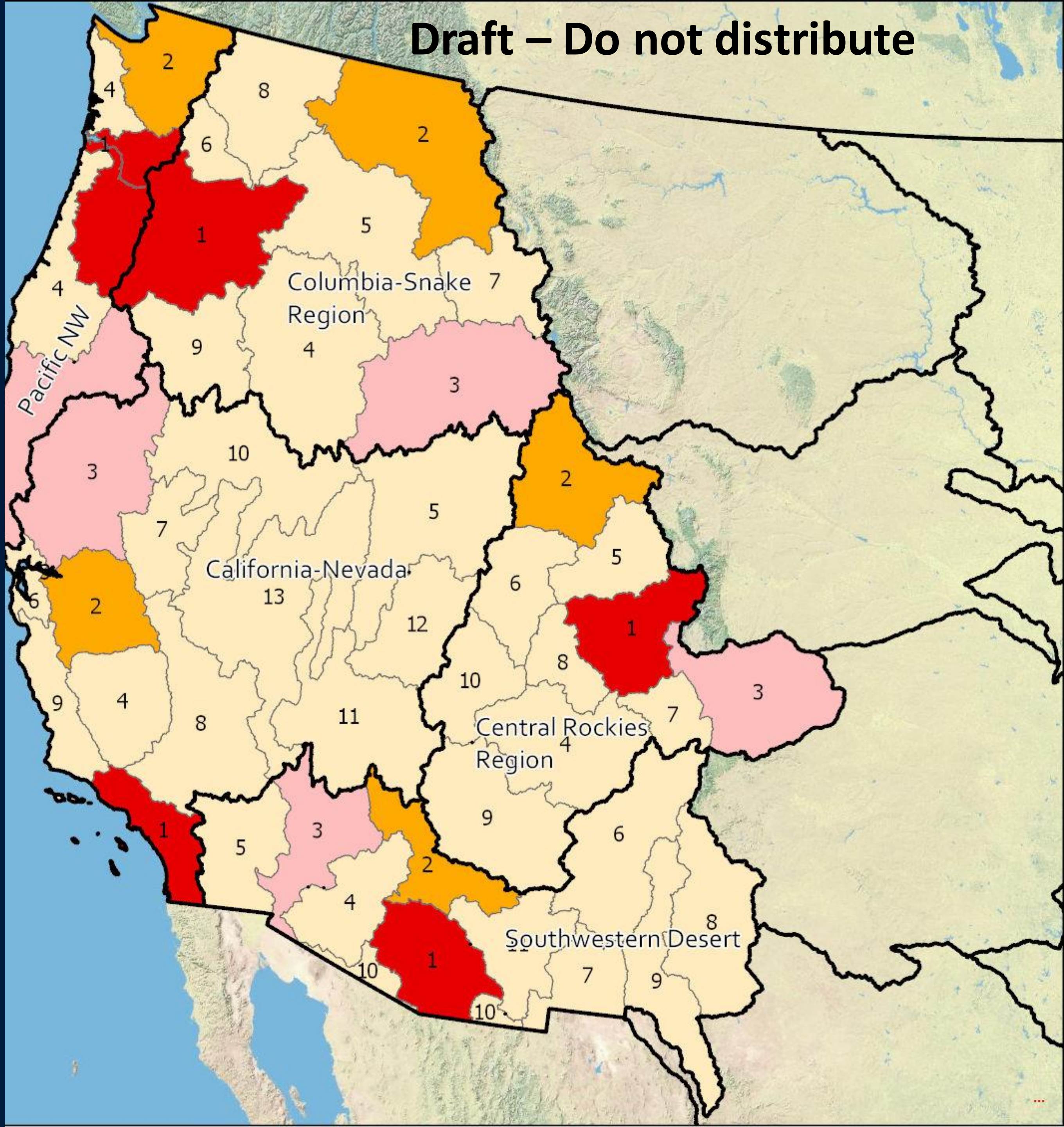
C. Water use, stress, and importance: (7) total freshwater withdrawals (WU), (8) runoff, (9) WU:runoff ratio, and (10) change in GW storage.

D. Flow alteration: (11) reservoir storage volume per area of basin.

E. Fire risk: (12) long-term risk of wildfire.

Rankings of Basins in each of the Hydrologic Regions in the West

- #1 Ranked Basins
- #2 Ranked Basins
- #3 Ranked Basins



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NGWOS Basin Team Proposed Basins in each Region

Columbia-Snake:

- Middle Columbia and Kootenai-Pend Oreille-Spokane

Central Rockies:

- Upper Colorado and Green

Southwest Desert:

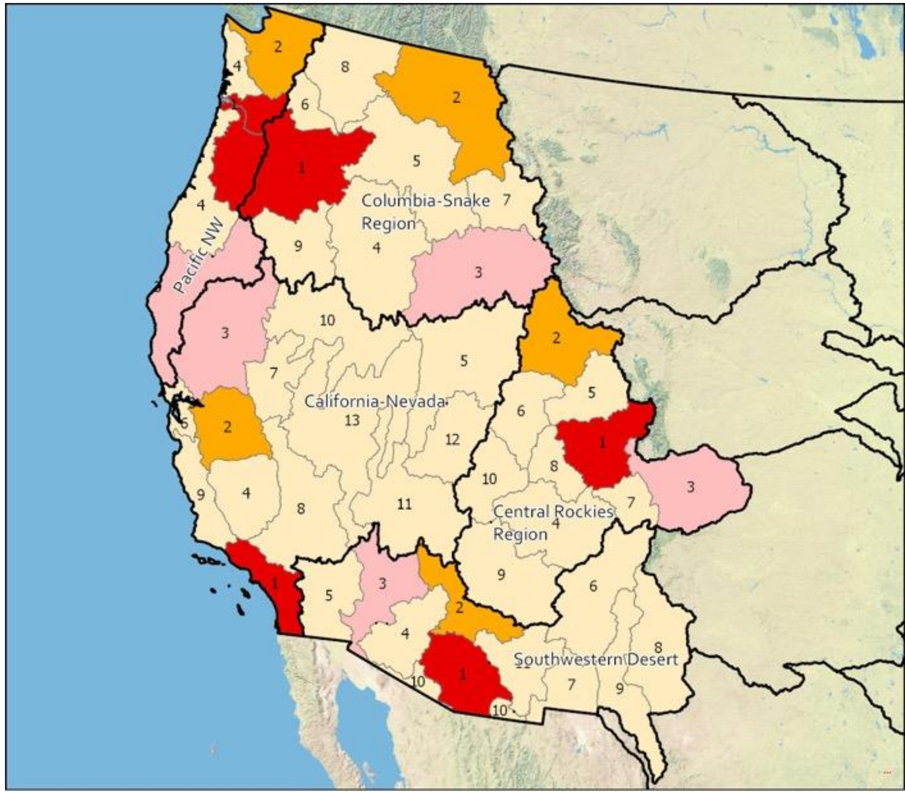
- Middle Gila and Salt

Pacific northwest:

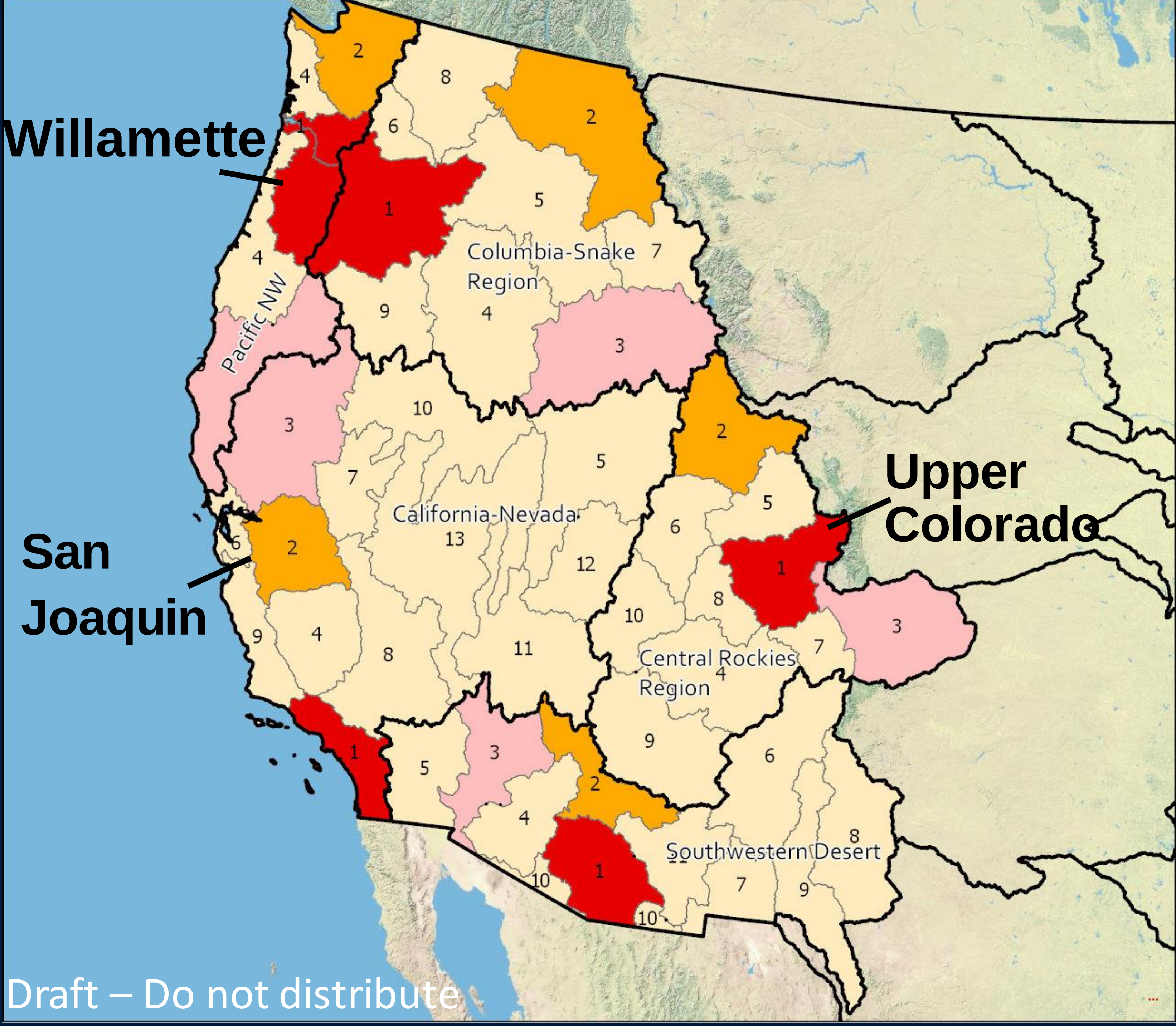
- Willamette and Puget Sound

California-Nevada:

- Southern California Coastal and San Joaquin



Three Proposed Basins for the Next NGWOS Basin in West…based on ranking criteria and input from Water Science Centers and USGS Regions



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Future Steps for Selecting NGWOS Basins #3 and Beyond

- **National Rankings of HUC04s** – Evaluate limited number of additional ranking variables and then rank all conus HUC04s by Hydrologic Landscape Region

- **Engage National and Regional Stakeholders** to understand science priorities and monitoring needs and inform ranking process

FY20 GWSIP Budget Marks

FY20 Budget House Mark

- Cooperative Matching Funds – $30.3M (+*$0*)
- Federal Priority Streamgages – $29.47M (+4.77M)
- National GW Monitoring Network – $4.0M (+*$0*)
- NextGen Water Observing System – $15.5M (+*$7M*)
- General GWSIP Reduction - $1.5M

FY20 Budget Senate Mark

- Cooperative Matching Funds – $30.3M (+*$0*)
- Federal Priority Streamgages – $24.7M (+0M)
- National GW Monitoring Network – $4.0M (+*$0*)
- NextGen Water Observing System – $7M (-*$.5M*)

Questions about GWSIP/NGWOS?

Groundwater and Streamflow Information Program

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Monitoring Budget Design

Dollars in millions	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Individual Watershed Costs
Delaware River Basin	$7.8	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$48.3
Western Basin		$7.8	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$43.8
Watershed 3			$7.8	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$39.3
Watershed 4				$7.8	$4.5	$4.5	$4.5	$4.5	$4.5	$4.5	$34.8
Watershed 5					$7.8	$4.5	$4.5	$4.5	$4.5	$4.5	$30.3
Watershed 6						$7.8	$4.5	$4.5	$4.5	$4.5	$25.8
Watershed 7							$7.8	$4.5	$4.5	$4.5	$21.3
Watershed 8								$7.8	$4.5	$4.5	$16.8
Watershed 9									$7.8	$4.5	$12.3
Watershed 10										$7.8	$7.8
Total Annual Cost	$7.8	$12.3	$16.8	$21.3	$25.8	$30.3	$34.8	$39.3	$43.8	$48.3	$280.5

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