MINUTES
of the
WATER RESOURCES COMMITTEE
Peppermill Resort Spa Casino
Reno, Nevada
May 23, 2023

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MEMBERS AND ALTERNATES PRESENT *(*30 including those *via zoom*)

ALASKA	*Julie Pack* *Tom Barrett* *Emma Pokon*
ARIZONA	*Trevor Baggiore* *Amanda Long* *Ayesha Vohra*
CALIFORNIA	Jeanine Jones
COLORADO	Jojo La
IDAHO	Jerry Rigby John Simpson
KANSAS	Connie Owen
MONTANA	*Anna Pakenham Stevenson*
NEBRASKA	Tom Riley Jim Macy
NEVADA	*Jennifer Carr* Adam Sullivan Melissa Flatley
NEW MEXICO	
NORTH DAKOTA	Jennifer Verleger Andrea Travnicek
OKLAHOMA	Sara Gibson
OREGON	

SOUTH DAKOTA	Nakaila Steen
TEXAS	Jon Niermann
UTAH	John Mackey Sarah Shechter Todd Stonely
WASHINGTON	Buck Smith
WYOMING	Chris Brown Brandon Gebhart Jennifer Zygmunt *Jeff Cowley*

GUESTS (58)

Luke Tipton, DOWL, LLC
Lisa Fong, USDA Forest Service
Stacey Jensen, Army Civil Works
Gretel Follingstad, NOAA-NIDIS
Anna Johnston, USDA Forest Service
Micheline Fairbank, Fennemore Craig
Nicole Bringolf, USDA Forest Service
Tim Newman, U.S. Geological Survey
Kevin Mayes, Texas Parks and Wildlife
Gabriel Venegas, USDA Forest Service
Stephanie Granger, NASA/JPL-Caltech
Matt Bromley, Desert Research Institute
Norm Semanko, Parsons Behle & Latimer
Jaron Ming, U.S. Fish and Wildlife Service
Melissa Roberts, American Flood Coalition
Ayse Kilic, University of Nebraska - Lincoln
Justin Huntington, Desert Research Institute
Christian Dunkerly, Desert Research Institute
Michael Whitehead, Bureau of Indian Affairs
Josephine Axt, U.S. Army Corps of Engineers
Kirsty Bramlett, U.S. Fish and Wildlife Service
Brian Frazer, Environmental Protection Agency
Melissa Roberts, The American Flood Coalition
Richard Allen, Evapotranspiration Plus, LLC
Corey Buffo, Environmental Protection Agency

AJ Jensby, Nevada Division of Water Resources
Erica Gaddis, SWCA Environmental Consultants
Christopher Estes, Chalk Board Enterprises, LLC
Jen Kramer, Nevada Division of Water Resources
Bridget Bliss, Nevada Division of Water Resources
Alex Fragoso, Nevada Division of Water Resources
Keith Conrad, Nevada Division of Water Resources
Chad Walling, Nevada Division of Water Resources
Christi Cooper, Nevada Division of Water Resources
Bunny Bishop, Nevada Division of Water Resources
Lauren Bartels, Nevada Division of Water Resources
Jared McCrum, Nevada Division of Water Resources
Jordan Beamer, Oregon Water Resources Department
Wayne Skladal, Oregon Water Resources Department
Hannah Singleton, Southern Nevada Water Authority
Thomas Pyeatte, Nevada Division of Water Resources
Kelly McGowan, Nevada Division of Water Resources
Malcolm Wilson, Nevada Division of Water Resources
Nicole Goehring, Nevada Division of Water Resources
Henry Brooks, Alaska Department of Natural Resource
Ashton McIntosh, Nevada Division of Water Resources
Caitlan McCartin, Nevada Division of Water Resources
Christopher Thorson, Nevada Division of Water Resources
Cara McCarthy, NRCS National Water and Climate Center
Kathy Alexander, Texas Commission on Environmental Quality
Chad Stephens, Nevada Department of Conservation and Natural Resources
Kristen Averyt, Council on Environmental Quality, Executive Office of the President

WESTFAST (13)

Lauren Dempsey, U.S. Air Force
Mike Eberle, USDA Forest Service
Travis Yonts, Bureau of Reclamation
Mindi Dalton, U.S. Geological Survey
Chad Abel, U.S. Fish and Wildlife Service
Christopher Carlson, USDA Forest Service
Paula Cutillo, Bureau of Land Management
Forrest Melton, NASA Ames Research Center
John Powderly, Federal Emergency Management Agency
Heather Hofman, NRCS National Water and Climate Center
Joe Casola, National Oceanic and Atmospheric Administration
Roger Gorke, Environmental Protection Agency (WestFAST Chair)
Madeline Franklin, U.S. Bureau of Reclamation (WestFAST Liaison)

STAFF

Tony Willardson
Michelle Bushman
Adel Abdallah
Ryan James

WELCOME AND INTRODUCTIONS

Andrea Travnicek, North Dakota, Chair of the Water Resources Committee, called the meeting to order. Introductions were made around the room.

APPROVAL OF MINUTES

The minutes from the Fall meetings held in Sulphur, Oklahoma in October 2022 were moved, seconded and the minutes were unanimously approved.

SUNSETTING POLICIES

Position #441 – Sub-Seasonal to Seasonal Weather Research, Forecasting, and Innovation

Tony Willardson noted updates to the position in Tab C regarding legislation and a NOAA report that was submitted to Congress. The motion to approve the revised position was seconded and the committee unanimously approved forwarding the position on to the Full Council.

Position #442 – The Bureau of Reclamation's Maintenance, Repair and Rehabilitation Needs

Tony noted the new recommendations of the April 2021 Asset Management Report and the needs identified in that report. He said over the next 30 years, they've identified 2800 major rehabilitation and replacement activities at an estimated cost of nearly $12 billion dollars. We'll see how some of the recent funding impacts those needs. A motion and second to approve the position as revised was offered. The Committee approved the position for consideration by the Full Council.

Position #443 – The Reclamation Safety of Dams Act of 1978

The proposed changes to this longstanding position include a new paragraph recognizing that many state and federal agencies follow FEMA's hazard potential classification system for failures and defining "high hazard" as causing potential loss of life. In the fifth whereas clause the changes recognize that in the FY 2024 budget request, Reclamation noted about half of their 489 dams were built between 1900 and 1950. Approximately 90% of their dams were built before modern design and construction practices. The eighth whereas clause notes the need to provide continuing resources for dam safety. The position expresses the WSWC's support for the Administration and Congress to work together to determine how much money may be necessary for Reclamation to effectively carry out their dam safety program.

There was a motion to approve the position as amended. The motion was seconded and all were in favor of moving the position forward to the Full Council for approval.

Position #444 – The Transfer of Federal Water and Power Projects and Related Facilities

There were no significant changes to this resolution. The Committee moved in favor of re-adopting the position.

Position #445 – The National Levee Safety Act of 2007, and Levee and Canal Structures

Tony reported that this position was adopted in part due to some changes related to levees that might impact irrigation canals. A number of years ago, a Reclamation canal in Fallon, Nevada failed, damaging many homes. At the time, Senate Majority Leader Harry Reid (D-NV) sheparded legislation through the Congress directing Reclamation to looked at the construction of their conveyance facilities, which found changes that were needed. This resolution supports those efforts and updates to some of the US Army Corps of Engineers' engineering circulars that established policies for implementing their dam safety program. However, we recognize that Reclamation canals are not flood control conveyances and should not be subject to the same standards as levees. The only changes are in the whereas clauses to update some of the information.

Without opposition, the Committee voted in favor of the position and recommended it be forwarded to the Full Council for approval.

Position #447 – Rural Water and Wastewater Project Infrastructure Needs and Programs

No changes were proposed. The Committee approved re-adoption of the position with no opposition.

Position #448 – Supporting National Dam Safety Programs

Tony Willardson reported that this position required updates as found in the red-lined version in the briefing materials to recognize existing needs and what FEMA defines as high hazard dams. It also notes recommendations related to deferred maintenance and dam safety.

Committee Chair Travnicek received a motion and second in favor of approving the position and sending it on to the Full Council.

Position #450 – Supporting NOAA Data, Forecasting, and Research Programs

Tony Willardson stated that minimal changes were made to this resolution to update some of the information in the sixth whereas clause, which relates to noting some of the recent flooding and other natural disasters.

The Committee approved the motion to approve the position as amended, and to forward it to the Full Council.

Position #451 – Regarding the Reclamation Fund

Tony Willardson explained that the Reclamation Fund was created with the Reclamation Act of 1902. Deposits to the Fund primarily come from federal mineral leasing – oil, gas, and coal – as well as federal land sales and some other miscellaneous receipts. That money was directed towards the Reclamation Fund, and a portion of it also went to state land trusts for public education. Reclamation's needs, as we've discussed, are tremendous.

The only change in the position is in the fourth whereas clause in an effort to update the information. At the time that much of the construction was being undertaken by Reclamation, there was not enough money in the Fund to pay for large projects such as Hoover Dam and Grand Coulee Dam. Thus, those projects were funded from direct appropriations by the Congress. Around 1995, the WSWC did a report noting that given the increasing revenues from energy and mineral leasing, that there was a point at which the demands and the supply of funds from the Reclamation Fund would cross.

Congress eventually deleted the authority for this to be a revolving fund. Now while monies continue to are accrue, expenditures have to be appropriated by Congress. Just as with everything else, if Congress doesn't spend the money, they don't have to borrow more money. You'll note that at the end of this current fiscal year, there will be an estimated unobligated balance of over $23 billion in the Reclamation Fund. I would say about the only increase in access to this money that we have been able to accomplish is that some of those funds have been dedicated for tribal settlements. The WSWC has consistently urged the Congress to appropriate funds accruing to the Reclamation Fund for their intended purpose.

A motion to renew and approve the position was offered, along with a second. The Committee approved advancing the position to the Full Council for consideration.

Position #452 – Water Resources Research Institutes and the USGS Water Resources Research Act Program

Tony Willardson remarked that there were no changes recommended to the position as presented in the briefing materials. The position simply expresses WSWC support for the USGS Water Resources Research program that provides funding to the States' Water Resources Research Institutes.

A motion to forward the position to the Full Council for consideration was approved.

S2S PRECIPITATION FORECASTING & FLOOD RISK MANAGEMENT

Jeanine Jones, California Department of Water Resources (CDWR) used a powerpoint presentation and began by providing a definition of subseasonal and seasonal (S2S) precipitation forecasts. A weather forecast is typically 10 days to two weeks maximum. Weather forecasters

hare pretty good skill especially in the first week. Subseasonal forecasts range out to about 60 days and seasonal forecasts range beyond that. The National Weather Service produces products over a wide range of timescales, though most of their timescales are short term – often seven to 10-day weather forecasts. The Climate Prediction Center (CPC) prepares seasonal outlooks, as they call them, that go out longer. That timescale is the focus of what we're talking about with S2S.

The National Oceanic and Atmospheric Administration (NOAA) began producing such outlooks in the mid 1990s, roughly about the time the science community discovered the "El Nino Southern Oscillation." Jeanine displayed a graphic containing a skill map produced by NOAA of their seasonal forecasts at the three-month period for December, January, and February, which is normally a wet time period for the West. She did not attempt to explain the CPC's Heidke skill score, but noted that one should understand that white areas on the map mean no more skill than just predicting average weather conditions. The color is most of the map -- indicating no skill. The warm color tones indicate where they have a little bit of skill, a perfect skill will be 100. The highest score for "this mountain" is 40. So, they're obviously not doing too well. That's why I choose to describe these outlooks as for entertainment value, because a water manager is not going to use it to make a decision.

Jeanine raised a couple of example years in which the projected forecasts were really inaccurate. One such example was water year 2016. On the left-hand side is the forecast and on the right-hand side is what happened. This shows a prediction of wet average or below average, basically, and this is what is known as a two category error for most of the area. This error factor was because they bet on the big El Niño, which they really did not understand as well as they thought they did. For those of you who may remember, there was a lot of talk on the news at the time about the "Godzilla" El Niño which was predicted to drench drought-ravaged California. Unfortunately, this was a busted forecast, and it was at an important time from a water management standpoint. In California, year 2016 was year five of a drought. It would have been really nice to know that the drought was going to continue. Instead the news media was predicting it was going to be so wet that Southern California would need "Noah's Ark." Obviously, this did not support California's Department of Water Resources' (DWR) messaging for water conservation.

Looking at forecasts for this year, it is another good example of a complete bust in the forecast. Again, the forecast is on the left side, and the observed is on the right. Basically, they forecasted dry weather for much of the West. And my goodness, look what happened. Clearly conditions have been opposite of forecasts. In California this spring, we actually were in the interesting situation of simultaneously running a drought emergency and a flood emergency. For example, we just had the driest three consecutive years of our historical record. At the largest reservoir of our State Water Project, Oroville Reservoir, it fell to a record low elevation. They were unable to generate power through the power plant. DWR is the fourth largest electrical energy generator in California. In a normal year, a lot of electricity is generated.

Another slide showed a picture of one of California's snow survey cabins – the big mound of snow in the middle of the picture is the cabin. You can just barely see the stovepipe poking out

in the middle of the snowdrift. This year in the southern Sierra Nevada Mountains in California, we had an all-time record of 300% of average snowfall. Thus, we are now dealing with a flood situation. We went from a record low level at Lake Oroville for the past couple of years to now experiencing flooding in a normally dry lake bed, Tulare Lake – in which they now farm over most of its "modern" existence. From a state water management perspective, we went from a couple of years in which water agencies were doing emergency drought grants, to the tune of about $500 million a year, to at the moment, water agencies are looking at $290 million in flood emergency grants, including some funding to raise a levee. So from a water management perspective, that's a very challenging swing in situations.

What's the thing about S2S forecasting? It has had very little federal research due to very little research funding. Therefore, the forecast skill has been pretty bad. There is only a small research community focused on the issue because historically the focus has been at the short-term weather scale. The absence of or too much water supply is much more of a western states' problem. Forecasting lead times are very important for many things from a water agency's perspective. Contracts cannot be negotiated overnight. For example, think about how much money is being spent or allocated now to deal with Colorado River water shortage issues. Obviously, this is not an inexpensive problem. Water managers would like to have as much lead time as possible. The later we go into the water season, the more we lose the time and the discretion to make some of the decisions that are very consequential with respect to how water is managed throughout the year.

Furthermore, S2S supports things that help us operate infrastructure more efficiently. Many have heard about Forecast Informed Reservoir Operations (FIRO), which is a similar concept except as applied to manage aquifer recharge. FIRO is a flexible water management approach that uses data from watershed monitoring and improved weather forecasting to help water managers selectively retain or release water from reservoirs for increased resilience to droughts and floods. FIRO applies emerging science and technology to optimize water resources and adapt to climate change without costly infrastructure. One of the pilot projects was in Sonoma, California, and in one season by implementing FIRO, they were able to save almost 20% additional storage in the reservoir. That is a relatively cheap water supply, in comparison to having to build new facilities, which can take many years to put in place in terms of financing and construction. So if we can push out forecasting to longer timescales, we can use the existing infrastructure more efficiently and basically save money.

The National Academy of Sciences prepared a couple of reports (see presentation) indicating what will be needed to improve forecasting. California DWR has put a fair amount of money into this effort. Jeanine quipped: "And we're the Department of Water Resources, not the Department of Weather Research! We're not meteorologists." This is where DWR would really like the federal government to step in, since they are the experts in the weather forecasting area.

In 2017, we supported legislation entitled the Weather Research and Forecasting Innovation Act. The legislation has now been reauthorized a couple of times. A new reauthorization is coming up. The legislation required NOAA to submit a report to Congress in

2020 identifying what would be necessary for NOAA to improve its forecasting. One of the recommendations was to stand up some pilot projects. We have been following up trying to get federal appropriations for those pilot projects. Is there hope for improvement? Yes, there is.

Jeanine showed some work that DWR actually funded related to NOAA research. It showed at a watershed scale skill scores from an experimental statistical forecast. This is sort of a cheap and easy forecast as compared to the more expensive forecasts made with the complex dynamical models that NOAA and the research community run. In a nutshell, this shows the skill from this simple statistical forecast is 100% better than NOAA's national multi model ensemble (MME), which is their research tool of dynamical models. Of course, the caveat is if your skill is only this good, it's not hard achieve a 100% improvement. Jeanine mentioned that the statistical model, this year, did not predict a nearly wet enough year. It didn't do much better than predicting normal precipication. So the good news is that we know there is an opportunity to improve forecasts. The bad news is that we have a very hard time getting NOAA to do this.

An excerpt from the report to Congress explaining the western pilot project was shown on a slide. There are four pilot projects recommended in the report to Congress, one of which is for Midwest summer precipitation, which is for the ag community. Another is on Arctic sea ice. The fourth is for tropical precipitation. If they were to move on these, that would be a step towards improvement. Since the delivery of this report to Congress, NOAA has not requested any funding in the President's budget request for the pilot projects. Frankly, the biggest obstacle to making progress is NOAA. It has been very difficult to move forward or to even get the basic step of asking for some seed money in the President's budget for research. Under Tab H in your briefing materials, you'll find documents related to trying to get federal appropriations, including forming an S2S coalition to work on appropriations for Fiscal Year 23 and FY24.

Lastly, Jeanine pointed out that there is an upcoming S2S workshop, to be held in San Diego, California in collaboration with the WSWC. We invite anyone who is interested, including WestFAST member agencies, and in particular the Bureau of Reclamation, since you operate large water infrastructure for which better forecasts could be useful.

Questions:

Tony Willardson: Jeanine, when we were in DC, with the Sonoma County Water Agency, they were mentioning at least one example of FIRO related to the value of the water that the Army Corps of Engineers is releasing. Do you want to share that?

Jeanine Jones: The number was roughly $15 million or something like that in one season. My recollection was in 2013, they had a big December rain event, which raised the level of the reservoir into the flood control space. The Corps released something like 20,000 acre-feet of water. We've been asking for $15 million for the pilot project. Sonoma estimated that that was about what they lost in revenue from the water that was released. So obviously, improving these projections is a big benefit. Sonoma's reservoir is a small reservoir, so multiply that by many larger groups, of course.

Would you share your thoughts on the Wagner Institute in Colorado? What are your thoughts on their research and operations?

Jeanine Jones: It is a cooperative institute. For those who aren't familiar, it is a mechanism that NOAA has for essentially funding a center at a university. There are a number of cooperative institutes across the country, including for example, a big one at the University of Colorado, Boulder. Each institute is usually focused on a particular thing more or less.

THE AMERICAN FLOOD COALITION

Andrea introduced Melissa Roberts, Founder and Executive Director of the American Flood Coalition addressed the group. She noted that the Coalition is a nonprofit that focuses on the frontlines of flooding. It is comprised of elected officials at all levels in cities and towns, from mayors to county commissioners to state representatives, all the way through members of Congress on both sides of the aisle, businesses, military and civic groups. These folks deal with higher seas, stronger storms, and more frequent flooding, and try to think about how they can adapt their communities with respect to things like planning and zoning and infrastructure projects. They consider what it means to adapt state and federal policies, and how to be proactive and prepare for flooding.

The Coalition's work is on the ground in communities helping to pilot innovative, new templates and models for planning and infrastructure projects. And then, we share the challenges again, and again. We're really interested in how to make it easier at the state and federal levels to update policies. We are a broad-based coalition across the country, and we bring together community leaders to collaborate with a broad set of allies.

The Coalition is driving innovation in terms of how new models can help. How do we think about the economics? How do we think about tools and resources? Then we try to lift up the preparations with lessons learned, especially between states. We think States have the pivotal role, especially regarding resilience on the water side of the scale. Of course, as you all know, water moves across watersheds, so we cannot just work at the local level. We discern the best outcomes based on broader geographic units for water. Thus, States have a pivotal role that is sometimes overlooked, especially in Washington, D.C., where they may not realize how important the state role is.

We really think the State has five pivotal roles that are key. They may seem quite simple although historically States have not been given all of the resources they need for their roles. The roles include: (1) leadership and accountability – Who's in charge? Do the right set of folks have both the authority and the accountability they need to holistically deal with the issues? (2) Data and risks – What is at risk? (3) Do we have data modeling and interoperability of strategic planning? How do we know what we need to prioritize at the state level? (4) How do we actually pay for flooding with funding and financing? (5) How do we set statewide standards to

institutionalize change and make sure that we're not making the issue worse on one hand while we try to fix it with the other?

Since this crowd is focused on the data side, I'll give an example. For instance, we have to think about how we can work with and lift up examples. There is a series of building blocks to consider ranging from data governance and standards, data collection, aggregation, modeling and risk assessment, and data-driven decision making. The takeaway we've learned in working with States and hearing from States is – there is no one size fits all solution. It is important that these building blocks build in sequence across these areas as we don't want to have super sophisticated modeling without quality data collection, or else we get garbage in, garbage out. Conversely, we don't want to have really sophisticated data collection and modeling without any thought about how to do data governance or data-driven decision making. So we try to create templates and best practices based on great work States are already doing for each of these building blocks. We want to help States put all of these pieces in place realizing, of course that not everyone is going to have everything in place. This is the type of work we think about for each of the five areas.

The Coalition is trying to support and lift up examples where state and local leaders are taking steps toward innovative flood solutions. There are many great examples of the work you all are doing. To highlight a couple, from other parts of the country, in Florida, we''ve been working on the Florida flood hub. This is a $15 million investment from the legislature to set up one centralized hub that can integrate all of the data and modeling across the Atate. They work on products like statewide sea level rise curves that can be used by agencies and in local project engineering.

North Carolina is just starting to use data and modeling to inform decision making on a watershed basis, to determine what projects come to the top of the list.

Texas is an amazing example with a flood infrastructure fund using the state plan as a way of prioritizing projects.

In South Carolina, they are putting out a full state plan, determining all of the levers they have and all of the things they can do, while adding – here's the cost and we think about this holistically with a plan of action. There is so much innovation happening.

Our goal is to bring together leaders who can have an open dialogue and share their challenges and learn from each others' experiences. As Andrea mentioned, we have brought together groups from a set of states. We met first in Aspen, Colorado, and then in Miami, Florida to discuss water and resilience challenges. We want to create a space that's helpful for folks like the space you have here, to talk about these challenges and to think about what shared challenges across states have risen up to the federal level, and how to make improvements.

I saw on your meeting agenda how deep you all are getting into the data. Thus, I figured I could bring out an example which we are thinking about the timeline for NOAA's Atlas 15. This is one example of the type of work we do on federal policy driven by our work with state and local

leaders. We know that data is the foundation for infrastructure. Atlas 15 estimates will provide critical information to support the design of state and local infrastructure nationwide under a changing climate.

Congress gave NOAA the funding for Atlas 15, at the same time they passed the Inflation Reduction Act (IRA). That creates a bit of a challenge, right? We're spending more money on infrastructure than ever. This is a moment in time with an immense amount of potential and resources. Atlas 15 is going to be the first update to include forward looking projections. Most of our infrastructure isn't going to be out until 2026 and 2027, by which time most of IRA resources will have been spent or allocated. A lot of projects will have been designed to be in the ground for 50 years,. So we see this is a real challenge. That's the kind of challenge we are hearing about from state and local interests. I would love to follow up with anyone thinking more deeply about such issues.

How we can give state and local leaders the option of looking at data earlier? A couple of recommendations are, first, making sure that Atlas 15 follows the full process, but there is precedent for releasing experimental data earlier for provisional use. We would really like to see that out by next year. We think that there's more that could be done to tap into the amazing network of cooperative institutions and institutes to speed up this work. Secondly, ensuring that the engineering community is ready to cooperate in the design standards and to work at how they might be able to use experimental or provisional data. This is one issue on our list of work at the federal level, which covers everything from the Farm Bill to Federal Emergency Management Agency (FEMA) programs, to the post disaster process at FEMA and Housing and Urban Development (HUD), and then to appropriations.

At the American Flood Coalition, we have 30 folks that focus on all forms of flooding. We have a deep bench of knowledge on our team, from oceanographers to landscape architects, to state hazard mitigation officers, and finance folks. Our mission is to help local and state leaders with this challenge and to be able to lift up and amplify the great work that is being done. We wanted to introduce our group and start a conversation. I will be available for any follow up.

Questions:

Can you describe the role of your federal champions?

Melissa Roberts: Sure. It includes members on both sides of the aisle, Democrats and Republicans, that want to learn more about this issue and commit to thinking about it. We are really trying to make sure this issue actually hits the radar. We find that federally there is not a lot of activity or solutions. We are trying to raise the profile of this issue with federal folks and get a set of Congressional representatives who want to work on this issue with a bipartisan group. We are open to bringing on more folks, but it's really consisting of folks that are interested in learning more on this issue and those who see it as a priority in their district.

MAPPING EVAPOTRANSPIRATION USING GOOGLE EARTH ENGINE

A. OpenET – Forrest Melton, NASA Ames Research Center

Forrest Melton expressed thanks for the invitation to address the group with respect to why OpenET was developed. He began his presentation by saying a little bit about the National Aeronautics and Space Administration (NASA) Flight Sciences Program, which was tasked with translating advances in NASA scientific and technical capabilities into societal benefits. In particular, the NASA Western Water Applications Office (WWAO), which is a program office within NASA, has focused on developing applications of NASA Science and Technology for water management in the western United States. Stephanie Granger from NASA WWAO is here today. WWAO was a key partner along with the plant sciences in helping to develop the origins of OpenET and fund a lot of the basic research that made it possible. One of the things that WWAO does is to conduct needs assessments with water management agencies at the local, state, federal and tribal levels in the western U.S.

One thing that kept coming up over and over was a key data gap for water management at the field scale was evapotranspiration. Over the last five to six years, we have developed our capabilities working with a broad consortium of partners to develop OpenET, which is a system for consistently mapping evapotranspiration taken from satellite data at field scales across the 17 western states. We have recently added the Mississippi River Basin as well – which is the next set of States to the east. So we've covered 23 western States. Currently, data is available at daily, monthly, and annual timescales from 2016 through last week. We will be working backward to potentially build maps back to 1985. Technically, we started with the Landsat 5 data record. The system allows access both to the data at the original satellite resolution of 30 meters by 30 meters per pixel, as well as for precomputed summaries for millions of agricultural fields across the western U.S. It is a ton of work to pull all the publicly available data together and make it a usable, consistent dataset.

Forrest demonstrated the Data Explorer web browser. The point of this is that instead of having to request data, wait weeks to get it, and hire a consultant, anyone with a web browser can access the data. We have worked hard to make sure that information is easily accessible to users, resource managers and conservation groups so they can look for themselves. The data can be used in irrigation scheduling, for deciding which irrigation system to use, and it can also be used for evaluating management best practices. With just a click of a mouse, we can see a time series. Forrest showed the monthly ET for 2016 (which is available in the presentation slides). He showed how the data can be used to show how things differ, for example, from 2017 to 2018 –, to see how the total consumptive water use was affected. The producer, the program administrator, the water rights holder or others should all see the same information during the same time period and with the track mappings.

Open science and open data access is a really important benefit. OpenET was founded on an open science approach. It has been a community-driven effort to develop these capabilities. It has involved federal agencies and universities, as well as partners in the nonprofit sector and the private sector. It has been working not only to make the data available, but also using the

underlying science and law to code the available water supply. Six models are available as open source software.

OpenET uses an ensemble approach. We're taking advantage of more than 20 years of research and mapping evapotranspiration with satellite data. Over that period, there have been at least six models and approaches that have been not only developed but also used or evaluated by a state or federal agency in the Western U.S. Using an ensemble approach, we can get an estimate of the uncertainty even in locations where we don't have a flux tower or other ground-based measurement.

The gray shaded area on the slide depicts where we're calculating the median absolute deviation from the ensemble. This gives us some idea of the rough uncertainty, the disagreement across the ensemble models, and allows us to easily compare all of the models, and begin to take advantage of the strengths of the different approaches to provide the most accurate and consistent information we can about evapotransporation and consumptive use across the Western U.S.

We have conducted and completed the largest accuracy assessment to date for the U.S. for field scale evapotranspiration data. We conducted accuracy assessments for all six models. The phase one comparison is complete and published, and that included 70 of these at covariance or flux tower sites to provide a picture of all of the data derived from instrumentation at these sites, at a cost of $55,000 per tower. It requires specialized expertise to run and process the data. We have also completed the phase two comparison with more than 150 sites and four main lysimeters in Texas. A manuscript is just about done.

To give a sense as to what things look like for agricultural lands, Forrest showed a slide that depicted the accuracy metrics for the ensemble and the ET value. One can pick your favorite metric, and see the slope and the bias error – and obtain the mean absolute error. We've looked at this value across different time periods as well as water years, on monthly and daily time steps. Overall, we are meeting the accuracy targets that were specified by the user community with the exception of the daily set. That's a place where we know we have more work to do, and it is important to be transparent about it. It acknowledged that the ground-based measurements we use to qualify the accuracies are correct. See the presentation slides for more data on where they are providing conservative estimates of the accuracy of the data for the user community.

What can we do with OpenET and why? What are the applications being developed from this type of data across the western U.S.? OpenET has made easily available evaopotranspiration data to help rural communities to design locally driven water conservation and training programs. It can help improve investment in more accurate water budgets as well as the development of incentive programs and other innovative conservation strategies. OpenET can help policymakers more accurately track water supplies, reduce the burden of regulatory compliance, and develop solutions working with local communities to balance water supply and the demand for water. One application that is near and dear to my heart, OpenET can help farmers to expand the use of data driven irrigation management to maximize the benefits of water supplies for crop production and reduce costs for water, electricity and fertilizer.

OpenET took a co-production approach from the very beginning. The system was designed through a dozen use cases across the western U.S. In the interest of time, I'll share two use cases today. The first is in the Upper Colorado River Basin. OpenET is being used now to support quantification of consumptive uses and losses. Last year, the Upper Colorado River Commission (UCRC) unanimously adopted the metric model within the OpenET framework. So that is proceeding with support from the Bureau of Reclamation and the UCRC, as well as the State of Utah.

We will talk about the applications in California and in particular, its use to support quantification of total water use and streamline the water reporting process in the Sacramento San Joaquin Delta in just a moment.

I want to acknowledge in particular our partners from Utah, Oregonand California, and the state agencies we are working with to develop a strategy for sustaining this capability over the long-term. It has been essential, and would not be possible without those partnerships and the support from these agencies. I also want to thank and acknowledge our partners in Idaho, Montana and New Mexico, who have also reached out to begin to develop mechanisms for support and joint activities, including accelerating the production of the historic data for key watersheds in these States.

We are also working with the United States Geological Survey (USGS), which is a really important partner. USGS is fantastic to work with as we develop plans for long-term operations that support these applications. Many of these applications use open data services. Thus, the use cases that we're developing for the long-term have to be automated and easy for the state agencies to operate and use. We have developed the OpenET Application Programming Interface (API). Many of our state agency partners have been critical in helping us test and develop this application. The API follows open API standards and provides support for automated data retrieval. This facilitates integration with other water data management systems, as well as with other applications, whether these are farm-level applications for irrigation and nutrient management, or tools like the Columbia River Basin evapotranspiration mapping tool that was developed jointly by Oregon, Washington and Idaho to pull data from Open ET and created a separate water data management system for the Columbia River basin. This is what the API is designed to support.

I also want to highlight a recent application in California to streamline water use quantification reporting. A few years back, theSstate passed a bill requiring monitoring and reporting of all diversions greater than 10 acre-feet per acre. The California Delta was really tricky. It's a hydrologically complex region. Many of the farms are behind levees and are below the water levels of the adjacent surrounding waterbodies, such as canals, and the water surface elevation in the Delta. They would have to include every point of diversion, every point of return flow, quantified seepage, and this is really expensive.

The growers in the Delta actually asked the California Delta Watermaster if they could use OpenET to meet this requirement. The watermaster proposed this approach as an alternative for compliance, and it was accepted by the State Water Resourcces Control Board (SWRCB). A

system was developed that helps farmers meet part of the vision that the Western States Water Council developed in workshops – linking open data services with Statesthrough tools like Open ET to really streamline this process. The water rights holder will first define the place of use boundary and link it with water rights. Then the Delta user interface is integrated with the California SWRCB report, water management system API, and OpenET. This process used to take about half a day to a day. Now they log into the system, enter their data, and click to verify the fields. One form is used. The water use data is automatically pulled and entered for them from the OpenET API. The function of recording now takes about ten minutes to complete. Once they've done it, the information is stored and will be pre-populated for the report next year, which further streamlines the process.

It is an efficient way to quantify water use and report it, and it is also open and reproducible. I'm really excited about this. I certainly see applications in other areas. I'm looking forward to talking to Adel Abdallah and Tony Willardson about integration.

So what's next? We have established a nonprofit for OpenET to help with long term operations and sustainability. The monthly data has been added to the public data catalog. Daily data is available both through the API and the Data Explorer, and that is being integrated with irrigation scheduling tools being developed by extension agency partners and the Natural Resources Conservation Service. We are working towards the public release of the OpenET API, hopefully in the next month or two, and certainly by this summer. Completion of custom reporting tools will allow folks to work to complete a best practices manual with the automated calculation of effective precipitation. so we can derive the ET applied water and the total actual ET which it produces. We continue to work on historic data production and geographic expansion. Let's stop there and I would again like to acknowledge all the partners. I'd also like to thank the Council for the invitation to talk with you today.

Questions:

Jeanine Jones: It looked like with the Delta project, a lot of the lands have been sub-irrigated. Is that true? And have you tried to separate that out? This is showing a lot more use than I actually see.

Forrest Melton: That's one of the tricky things. There are places where you can get a full crop of alfalfa without surface irrigation.Then there are other places where you get nothing. So for this first year, the master decided we're just going to call for total ET. The farmers said, sure. Sounds good. We'll start there. Then we'll work on deriving the actual ET later to track and separate subirrigation. This is really tricky, because it really depends on where the field is on the gradient relative to low elevations, low adjacent water levels and some of the higher land areas within the Delta . The Delta is unique in that all of the percolation and return flows go back to the water source. There are plenty of places where we could take this approach, where you have to have the diversion information to quantify total water use. The Delta is a unique hydrologically and allows us to do this.

Anna Packenham Stevenson: Forrest, that's an amazing presentation. Thank you. Montana is actually looking to use 30 years of historic open ET data to look at consumptive uses associated with our change process. I'd be interested in your perceptions, or those of anyone in the room,

about people's concerns with losing their water rights – abandonment, forfeiture – with open ET. This is something we anticipate will be a challenge for Montana, and I just would appreciate thoughts on how to navigate that.

Forrest Melton: Sure. Concerns and reservations about having evapotransportation open and easily accessible have been raised. So far, the OpenET consortium has worked really hard to ensure that applications of open data have commitments for agriculture, and we have not seen any, any applications to date that have been detrimental. We work carefully and closely with state and local agency partners as we develop these applications to be sensitive to concerns from agricultural producers. We have involved agricultural partners from the very beginning. My recommendation would be to work closely with agricultural partners in developing or designing a program and to listen carefully to their concerns. Maintain open lines of communication and look for the movement toward opportunities. Look for the opportunities that both benefit the water supply while protecting the sustainability of agriculture productions. We do the best we can to ensure the long term sustainability of water supplies for agricultural producers from the West. I'm happy to talk more about that.

B. Open Access Evapotranspiration Data Act (H.R. 2429)

Forrest Melton said he wanted to clarify that NASA does not have a position on the Open Access Evapotranspiration Data Act. That bill was developed by elected representatives to the House and Senate. University partners have led the outreach and engagement with congressional staff to help them understand why this type of information system is important. But NASA does not have a position on this.

Tony Willardson remarked that one of the challenges for NASA is that they are a research entity, not an operational entity. We've had discussions on where to find a home for Open ET. In your briefing materials under Tab J, is a bill by Representative Susie Lee (D-NV) that would create an open access ET program within the Department of the Interior, led by the U.S. Geological Survey. It notes that there would be collaboration with other federal agencies, including NOAA, Reclamation, and others. A component of the program directs outreach to a number of other entities. Interestingly, the Western States Water Council is specifically mentioned in the legislation, as is the Western Federal Agencies Support Team (WestFAST). It states that the Secretary may continue to coordinate data analysis, use and collection efforts with other federal agencies, States, and tribal governments through existing coordination organizations. This bill would actually authorize $23 million over four years for the support of an OpenET program within USGS.

CLIMATE ENGINE

Justin Huntington, Research Professor of Hydrology at the Desert Research Institute (DRI) addressed the Committee and showed a powerpoint presentation. He expressed thanks for the opportunity to present some of the work he's been doing for nearly a decade, and commented that it's a pleasure to be in his own home State of Nevada. He started his career at the Nevada State Engineer's Office, and thus comes from the perspective of trying to do things as efficiently, timely, and accurately as possible. That involves a lot of water rights hearings and rulings. Ten years ago, it was quite challenging to get the data that was needed to make decisions in a timely manner, especially since they had to pay $600 per Landsat image at that time. Other data was not available at their fingertips.

Justin has been on a mission to bring new technologies to state agencies and to help advance technical tools. Stakeholder engagement on a project was begun in 2015, as part of the Governors' Drought Summit held in Las Vegas, Nevada. At that time, Nevada did not have a drought early warning system within the National Integrated Drought Information System. Justin became the lead for Nevada. A common theme across the Department of the Interior, USDA and stakeholders was basically to consider both vegetative and hydrologic drought impacts, and to develop and integrate huge datasets and tools for place-based drought monitoring forecasts. In order to get to that place, along with forecasts, they needed satellite-based climate and vegetation data, new data storage facilities, and visualization technologies, and as Jeanine Jones has noted, sub-seasonal forecasts.

The strategic plans specifically called for development and delivery of state of the art cloud computing tools to provide user-friendly drought monitoring data. That was the goal. This was inspired by the State Engineer being invested on teams through the Western Governors' Drought Forum series. One size does not fit all. How do variations in the hydrology and legal structure play out in different places? This drove place-based assessments and due diligence. We really needed to figure out who was being impacted, and who was not. For example, it matters if there is a change in groundwater use. Groundwater pumping can impact waterways and other systems as depicted on the slide.

Congressman Mark Amodei (R-NV) decided that we needed to use more advanced technologies in figuring out place-based drought impacts. He suggested working with folks at DRI and using Landsat. So that's really when the momentum began. Using a product with the Google Earth engine research program, we officially launched the project at the White House Water Summit in 2016. Since then, it has been primarily supported by NOAA and the Bureau of Land Management. The project reflects a nice public private partnership where the private sector started it, and then the federal government saw a lot of value in what we're doing. Thus, climate engine.org is a DRI led project in collaboration with the University of California Merced that essentially helps academic, public, non-commercial users develop and deliver satellite remote sensing data to provide actionable insights in the natural resource sector. We were humbled and honored to get the front cover of the bulletin of the American Meteorological Society in 2017. That made a big impact.

We built this platform on top of Google Earth. Now Google Earth Engine holds the world's largest archive of 700 native datasets. This means you don't have to code all this from scratch to test trends. You can use a segment of a typical trend and process your data. We also have access to open ended commercial data metrics the best available science. Because this is cloud based, we're bringing our algorithms to the process instead of downloading Landsat images and files, climate datasets, and other datasets rather than downloading all that information to our local machines at the state office, and having to maintain all of that data on a state server, which is expensive. We take our algorithms and calculations to the data rather than spend all that time downloading data. We also need to be able to process this data quickly. Google Earth engine is a massive parallel cloud computing platform where the pixels are all independent, so we can basically break up the pixels in 256 by 256 pixel blocks and process those pixels in parallel. We don't have to worry about parallel lines or writing the codes to do this. Apparently, it does it behind the scenes. The challenge is not the lack of data. It's really converting the data into insights. And Google Earth engine helps us to do that.

When I worked at the state level, and even as a research professor at DRI, I didn't want to have to code this stuff myself. Google Earth engine has an API. DRI can develop in JavaScript and Python. We wanted a user interface so that a state employee and a researcher could fill out a

form, hit the button and make a map. It's very nice. And that's what we did. There are over 80 different datasets for hydrology or remote sensing. We can do on-demand processing for values, anomalies, driving distance, trends, probabilities, and they are interoperable. If we're comparing 30 meter resolution Landsat data, and want to pull in the climate data, we don't have to map things onto the same grid to do that. It does that for us. So it's interoperable which is most important to download the maps and the time series, and also to be able to share links.

NOAA has been using this from what we're calling "from research to operations." They are using our API to compute and download 400 different drought maps every single day. A lot of the maps are computed with climate change with the APIs. This has been a game changer because they put their own data into a Google bucket, we access their data in a Google bucket, process it in Google Earth engine, and then export the maps. Justin demonstrated the difference in available maps in his slide presentation. It is the exact same calculation using different products. This has really opened the door for more research. We are now able to rapidly create and disseminate information in ways previously not possible.

Another example is how we're engaging with the BLM, and how BLM can build resilience and improve awareness and assessment of drought conditions and impacts. It incorporates job sites into layman's planning and NEPA, and then combines in situ observations with remote sensing. They can prioritize riverscape connectivity for restoration and protect industry and institute uses. We are using Climate Engine with the BLM to really better understand how remote sensing products correspond with climate data to develop baseline assessments and relationships (shown on a slide) between a long-term drought plan and perennial herbaceous production. It gets to that next step where we have a freely available climate data system to achieve the objectives that the BLM has set out to achieve. It's relatively easy to do a pretty sophisticated in-depth analysis to look at impacts.

We have recently added OpenET, which is quite a big deal for a lot of users who don't know how to code in Python. One of the state agency collaboratives said, non Python users can rejoice, because they can now use OpenET and climate data to do some pretty sophisticated analysis, draw polygons, upload a shapefile and spatial averaging and time, see trend anomalies, and also look at differences between the models. That is really important. They can draw a polygon and see which models respond to drought more than other models, and then draw comparisons to provide agencies with an idea of which was more direct. They derive rangeland health assessments. It has been used in a water rights ruling at the State Engineer's office. These tools, and Landsat specifically, are being accepted at all levels within state and federal government.

Regarding engagement, outreach and support, Justin shared a quote from the State of Idaho, who has analyzed massive amounts of Landsat data for use in recent water rights disputes, and were able to do in a few minutes what previously would have taken weeks.

Next steps? In-person training and engagement with the States of Nevada, Oregon, Washington, and others to really start to do some hands on exercises for how to use this data.

In summary, Climate Engine and meeting with others really provides the place-based data we need to move things ahead and to advance natural resource management. The explosion of Earth observations and data integration operations is really just a start. We need to buckle up. We need adequate support and adoption from agencies. That is going to be key, especially with adminstrative and IT support – those that really promote in-house use of these technologies, and secure time for research and special projects. Finally, Landsat is key for water and natural resource monitoring and planning. Thank you.

LANDSAT NEXT STATUS

Tim Newman, Program Coordinator for the National Land Imaging Program (NLIP) and the Acting Program Coordinator for the Land Change Science Program for USGS thanked the Council for the invitation to provide an update on Landsat. He remarked that the presentations by Forrest and Justin were a great lead in for what is coming next for Landsat.

Using a powerpoint presentation, he provided an update on what Landsat is, where it is headed and generally what is going on.

Users all around the world rely on Landsat data for a large number of applications, not just evapotranspiration, but many other applications. It has really become ingrained into society – kind of like GPS. GPS is everywhere. Landsat is everywhere. I am continually amazed to see that Landsat data was used for some product that led to finding ships off the coastline of Norway, and so forth. It is a great program to work on, and I have been with the program for 17 years.

We now have a fleet of satellites. NASA develops them, watches them, checks them out on orbit, and then they hand them over to us at USGS. So we actually fly the satellites. USGS is a space agency and it's really cool. Two Landsat missions, eight and nine, are going strong. We get something like 1500 new images everyday that we collect and put into the archive. It is a global system. All the data is available on Earth Explorer, and we have also now put it on the Amazon cloud, so you can go onto Amazon, and find all the data.

The number of accesses has gone through the roof. This year we are on course for ten billion accesses of Landsat data via the Amazon cloud. So it just speaks to the broader use of this system.

Landsat is scannable imaging of the planet. NASA and USGS have a partnership to work on future missions. The duties are broken out so that NASA builds the space segment with USGS right alongside and we build the ground system. Once the mission is launched NASA hands it over to us, and we handle operations for the lifetime of the mission. These missions are expensive. Landsats 8 and 9 cost roughly a billion dollars for each of those missions when we consider the development of the space segment over eight or nine years before launch, and then maybe 10-20 years of operations work. It involves a lot of people all across the country. Several years ago we set up the structure – the partnership, rules and responsibilities for each agency – and it is working pretty well.

There is a great video out. It shows an animation of what the construct looks like. Today, we have eight physical satellites. Users want a lot more of the spectrum for various applications. They also want better spatial resolution. The present 30 meters is inadequate for some applications, so we're moving down to 10 meters. We worked with NASA for a couple of years to develop a mission concept called the triplets. These are three identical satellites, smaller than today's since we can take advantage of newer technologies. We launch them all together, and then space them out in their orbits. It should make a huge difference with applications, while the new bands are looking at things we haven't seen before with Landsat. They track changes on the Earth's surface that you can't track with the current spectral bands. We are very excited by this. We've been getting really good user feedback on this solution.

Tim shared how long it takes to develop and make progress on matters within the federal government. In 2017, it was suggested an architecture study was need to find out about the mission following Landsat 9. That set up a whole series of actions for architecture studies, project

teams, setups, and so forth. That process eventually landed at this triplet super spectral mission. It covers twice as many bands as today's Landsat, and some are at 10 meters resolution, which should make a difference for various applications.

A request for proposals will go out to industries, and vendors will make bids. They will send in their best responses to how they can build that suite of instruments. The government will then decide which entity to award the contract to. Hopefully, within six months to a year, we will be building the instruments. That is a key milestone. Once you're "bending the metal," as they say, and moving forward, then the mission becomes more real. Right now, it's still all on paper.

Tim summarized the biggest benefits across the science applications that the program can deliver across water resources, and the improvements that advanced spatial resolution should provide to the user community. A lot of users are very excited by this process.

In February 2023, the USGS budget was presented for the President's budget consideration. It includes a Landsat next funding line for NASA for the first time. Previously, they have not requested specific Landsat next funding. For USGS, it includes a plus up to our budget. Because of all those new bands and better spacial resolution, there is a lot more data volume, which means our ground systems are going to be a challenge. We are going to need more funding in order to handle 15 times the data that we're getting today. We want to get this word out to the user community as much as possible, because this is the time when Congress has started to mark up the "gets."

Tim provided an update with respect to a new communications architecture. NASA and USGS work together to develop this mission. NASA gets its funding from the Commerce Justice Science and Related Agencies Committee. USGS receives funding through the Interior Committee. So, they both have to get funding in order for this to go forward. If only one agency gets funding and the other doesn't, then there is a problem. So an important aspect of this communications effort is that we need to be able to communicate broadly across all of these sectors to let people know what the value of the mission is and why it matters. A slide showed the names of the Appropriation Committee members for both the House and the Senate. These are the people with the power of the purse, and they are from all across the country. Many of you probably interact with some of these folks. Another slide gave a more specific list of Committee members with jurisdiction over NASA.

There are many different sectors for which this system is going to provide improvements. It is a new system for a new generation. We are taking advantage of new technologies and adding capabilities. The next generation of folks are going to be watching the earth, looking at this data, and trying to understand the changes that are happening. That is why it is important.

He thanked the Western States Water Council for its support

Questions:

Tony Willardson: OpenET would not be possible without Landsat. Can you say a little bit more about coordination with the European Space Agency (ESA) and any updates on plans for comparable free flyers and future plans to complement USGS observations? I know you highlighted the importance of maintaining consistency across the multispectral bands. Can you say anything about another possible thermal infrared band?

Tim Newman: Sure. The next ESA mission will not have thermal. But there is another mission that has been developed by the Europeans that will have some thermal capability. It will have an afternoon orbit rather that a morning orbit. Hopefully the data will be compatible so that we can get an even better view of what's happening in both the morning and afternoon with the thermal data. We have been working with the Europeans since before the launch of Landsat 9 to try to cover some of those bands together. Although ESA's Sentinel II doesn't have thermal, it does have a lot of the other multispectral bands. We have been working to try to harmonize our datasets. There's a great NASA project called harmonize Lancet Sentinel HLS, which brings those datasets together and it has proven very valuable. It just gives you more looks over an area. Clouds get in the way, so with more looks, you're more likely to see what's happening on the surface.

Tony Willardson: I would just note that, as Tim mentioned, with Landsat 8, NASA dropped the thermal sensor from its plans. The Council had the opportunity to work with our Senators to ensure its inclusion and continuation. I don't know if we could ever do this again, but we got a letter from 12 Western senators sent to the Appropriations Committees that this was important. The reason I say I don't know if we could do it again, was there were six Democrats and six Republicans. So the letter was effective, and the thermal band got back on schedule with NASA. I think that what we are seeing now with Open ET and other tools is an outgrowth of the Landsat program. They still need our support.

WATER SUPPLY OUTLOOK

Cara McCarthy, Program Manager for the National Water & Climate Center (NWCC) provided an overview of the current conditions and snow water equivalent (SWE) as a percent of median and used a powerpoint presentation which she will make available on the Council's website.

At this particular time of year, the SWE is not that effective because the snowpack is diminishing and the medians can be kind of crazy. Of course, you all have heard about what is happening in Utah and California with their snowpack this season. See graphics showing the records.

Since the beginning of May it has been dry in the Pacific Northwest and semi-dry in the interior western states, like Utah and the Great Basin. In the Pacific Northwest, during April, temperatures were fairly cool, so the snowpack did not melt much. However, it was wetter on the eastern side of the Rockies in Colorado and New Mexico. Precipitation has been picking up in some areas, specifically along the Front Range. With respect to temperatures, it has been warm in the Pacific Northwest. Alaska had a cool and snowy winter. In the Columbia Basin, in Washington, Oregon, and Idaho it has been dry.

The runoff forecasts are for below to average runoff in the northern areas of the West, and then to the south, much above average. In the Missouri River Basin, in Montana and Wyoming the forecasts are a little bit above average to average in most areas. Along the South Platte, things are average-ish to somewhat dry. In the upper Arkansas, SWE conditions are 106% of median, so about average. The upper Rio Grande is mostly above average. Precipitation has been above average since May 1, so the flows are going to be going up in these areas.

In the Great Basin, there has been big, big news. See graphs show that the water supply is much above the median peak in many areas. In others the SWE was the highest since 2011. They

received a lot of snow. The May 1 forecast for the entire Great Basin is 50% exceedance. Sites in the Walker River Basin and Upper Carson River are also at record levels.

Cara's presentation also contained slides showing river flow levels. There are sites with 300-400% of median for the remaining runoff forecasted from May through July. Other graphics overlay snow water equivalent historical information and streamflow historical information. She gave kudos to the River Forecast Center for their efforts. A lot of reservoirs are emptying right now, so that they can take the inflow. Graphics indicated metrics for Shasta and Oroville Reservoirs in California. Further, she mentioned the deal made by the Colorado River Basin States with the federal government which runs through 2026.

Cara added that the Snow Survey and Water Supply Forecasting Program got a $7 million increase to expand the snow survey network. They are awaiting approval for staff. So they are looking at a lot of coordination and plans on network expansion, network design, working with other agencies, getting feedback, adding sensors, different sensors for various reasons, climate studies, and so on. They have been getting support from the U.S. Bureau of Reclamation for forecasting – trying to incorporate Airborne Snow Observatory (ASO) information and also converting snow courses to what they call snow lite sites, and adding sensors to sites.

Lastly, the NWCC has a new website and it is great. Thank you.

GREAT SALT LAKE/UPPER COLORADO RIVER SYSTEM CONSERVATION

Todd Stonely, Assistant Director of Utah's Division of Water Resources (DWR), expressed thanks for being invited to talk about the Colorado River and conservation efforts. Of course, many of the States in the West are dealing with Colorado River issues and you all are aware of those.

Utah is a bit unique in that they have the Great Salt Lake, which is very stressed and is an important resource to the State and the entire Intermountain West for migratory birds. shore birds, and mineral extraction. It is a significant resource for the State of Utah and the West, as well as the Nation (about $1.3 billion). Given the megadrought in the West, the Great Salt Lake has been severely impacted and required us to change our perspective on how we manage the resource.

Todd used a powerpoint presentation to provde an overview on the Great Salt Lake. The lake reached a record low level in 2021 and again in 2022. That is a concern because the exposed lakebed also exposed some toxic metals. Dust storms can affect the population along the Wasatch Front with potentially severe health impacts.

A report was put together by some professors and other stakeholders indicating that the Great Salt Lake could disappear within five years if no action is taken. The DWR didn't necessarily agree with their assessment, although clearly, we agree that action needs to be taken to help preserve and protect it. You may have heard about some articles, interviews and documentaries that have been promoted and received national attention. Everyone is looking at Utah and what we're going to do to help preserve the Great Salt Lake.

The DWR has a water budget program that we've been doing since the early 1990s, and data that goes back to 1989. A slide graphic showed depletions from the Great Salt Lake. It showed depletions by agriculture. municipal and industrial, managed wetlands, mineral extraction, as well as reservoir evaporation. Agriculture takes the highest amount of water that would

otherwise reach the lake. That is no surprise. Throughout the West, 70-80% of depletions are related to agriculture.

A Greast Salt Lake Strike Team that includes academics and state agencies was put together. They compiled an analysis of the Great Salt Lake data to inform the state legislature. They estimate that evaporation from climate warming is impacting the lake level. The estimated impact is about 8-11% of the water. Natural variability from precipitation and runoff efficiency is estimated at 15-23%. Natural and human consumptive use estimated impacts are about 67-73%. So the human consumptive use part of that is where we can adjust policy and try to have some impact.

Good things are happening to help protect the lake. Over the last two years, the state legislature has authorized or allocated $270 million tforagriculture optimization projects. A total of $200 million of that was allocated this year. The sustained contribution, the other $70 million, came from the previous year from federal funding. Secondary water meters received $250 million in ARPA funding last year, and another $68 million this year.That is to meter, what we call secondary irrigation systems for municipal and industrial areas. Basically, it's a dual water system. The Utah Legislature put in $40 million to create the Great Salt Lake Trust. This Trust will be working on habitat for the lake, as well as acquiring water rights and devoting those to the lake. Last year's legislative session recognized water in the Great Salt Lake as a beneficial use. This is a very important designation so that we can devote water to the lake. Another $13 million was put in last year for landscape conversion – converting from turf to more drought tolerant species. There is a program that has a website for anyone in the State of Utah to see if they are eligible for turf replacement. We believe it is the first project of its type that is statewide.

The legislature also put in $5 million for water agencies to get together and study the Great Salt Lake water budget and to make some policy recommendations on how we can protect the lake. There was also a new nonprofit called Utah WaterWays that received $3 million in funding $1 million of which is ongoing for water conservation and education programs. We are working to help set up that foundation. Additional money was put aside for air quality monitoring and data enhancements, which is essential in looking at what we can do to protect this important water resource.

The brine shrimp was designated as the Utah State Crustacean. This was an effort by school students to emphasize the importance of the brine shrimp in the Great Salt Lake and its ecosystem.

The key takeaways through these legislative efforts are that the Great Salt Lake is a vital resource worth protecting. Actions are being taken. Water conservation is key. We certainly appreciate the help from Mother Nature this year given our historic snowpack. The lake has risen about five feet to date. There is still about a third of the SWE in the snowpack to runoff, so the lake level will continue to rise. However, the problems are not yet solved. This is a long-term issue.

Separately, the Colorado River Authority of Utah has introduced a 2023 System Conservation Pilot Program (SCPP). The SCPP is an an opportunity for a temporary, voluntary, and compensated consumptive water use reduction in the Upper Colorado River Basin. It is open to municipal, industrial, and agricultural water users. The program is federally funded and administered by the Upper Colorado River Commission (UCRC).

A slide showed the project timeline. In December 2022, the program was authorized and a request for proposals were released. Information sessions were held in January 2023. The proposals were reviewed, and in March of this year, proposals were selected. The contractorg and Reclamation review just ended in April. We are looking forward to implementation and verification this summer.

Some of the selected proposed project types are municipal and industrial, and of course, agriculture. It has many additional options,including lakes and storage change, and maintenance. This summarizes what is going on across the Upper Colorado River States. There are more than 20 projects in Utah, Colorado, and Wyoming, and just one in New Mexico. See slide #10 for a summary of the proposals. Utah has contracted 21 projects of the total 72 projects that cover all of the States. The conserved volume in Utah is about 39% of the total at a cost of $5.7M. The price per acre-foot in Utah is about $367, whereas comparatively, the statewide average for the four states is about $418 per acre-foot.

The Bureau of Reclamation made a pricing decision after implementing this program where they reduced the per acre-foot compensation cap from the original UCRC offer. The State of Utah has stepped up to fill that gap as shown in slides #12 and #13 of the presentation.

Todd turned the time to Sarah Schechter, Legal Counsel with the Utah Attorney General's Office, Natural Resources Division, to explain the water right network.

Sarah noted that the idea behind the water right network is that the Division of Water Rights and the State Engineer want to develop a program that links several water rights related types of data and create a network that will be useful not just to the State Engineer, but also to other users.

There are five types of water data involved. The first is the water right information and it is available on our website. You can go to any water right within the State and obtain place of use information, priority information, volume, flow rates, etc. One can take that information and do hydrographic mapping to show GIS coverage of streams, diversions, canals, etc., and that will be the base layer onto which they map the other data. The idea is that anyone can download the points of diversion and have it mapped onto the network. This will allow a computer to do computations that it couldn't normally do, because it will know the interconnections within the network. It will be able to place this water right information into a more integrated mapping system. It will also include the place of use mapping, such as where water is used for irrigation, or where a municipality is using its water. It will then integrate the diversion and flow data, what has actually been delivered over time, to the water right in one place of use. The final step will include accounting models.

The network is first going to be implemented in the Colorado River Basin. The reason for that is that if under a situation where Utah might face curtailment, we need to know what our depletions are, as well as what water rights are associated with those depletions. Are the water rights that are being diverted under the Compact subject to curtailment or not? Ultimately, the idea is to develop a depletion schedule with latest priorities at the top using actual data for what water is actually used, not just the on paper, information that we already have. By putting all of that information onto the network, then the Division of Water Rights can build logic programs that will perform the computations for us to determine how much water is available within the Colorado River Basin under our allocation, the water right priority, how much is delivered, and how much depletion that ultimately results in.

This requires quite a lot of work. It's going to require the division to revamp their data infrastructure, including how they collected it, how it is stored, and then how to served it to the world with a user interface, with the goal of making it much more accessible and understandable. The idea is that it would be open source. The data would be available to anyone to download. This should be useful for modelers, not just within the division or the State, but for anyone. We would like this program to be available to people who can write computer scripts using our data, but then they can access it periodically to update whatever their project might be.

The timeline for this project is multi year. We received some funding this year from the legislature for new positions to focus on creating this program. We anticipate six to eight full time people, which is quite a lot for the division. We are also working with Utah State University (USU) on the data infrastructure piece, because USU's computer folks are experts, whereas our water agencies are not. They are currently building the team. The next step will be to develop a work plan, and then they will begin to work. I believe by the end of the year, they intend to at least have a plan in place.

Questions

For the Great Salt Lake. I was wondering what portion of that is groundwater use? A second question relates to a bill that allocated a lot of money for the USGS to do a report on a science strategy for saving lakes in the Great Basin. I was wondering how you're integrating with that?

Todd Stonely: The first question is how much groundwater is being depleted from the Great Salt Lake? That's a good question. I don't have that right off hand. For municipal system uses of groundwater in the Wasatch Front region, there is more surface water use, and groundwater is a little less. To your other question and the USGS study, we participated in their information gathering forums. We're meeting with them regularly as part of our basin integrated plan. They are at the table with us. The U.S. Army Corps of Engineers is also at the table with us and we're making sure we're integrated.

Justin Huntington: Are you planning on using satellite based ET to check the conserved consumptive use?

Todd Stonely: As part of the agriculture optimization program, we are supposed to estimate the effectiveness of those actions at saving water in the agriculture sector. So we are likely to use ET in some way or other. I appreciated your presentation because it gave me some ideas of how we might do that. Yes, I think what we need to do is identify savings roughly within the errors that exist. That is a great tool, and we appreciate that.

WADE/WESTDAAT PROGRAM UPDATE

Adel Abdallah, WSWC WaDE Program Manager, mentioned he appreciated the presentations given this morning on OpenET and Landsat. All of these technological toola make our job easier. Adel acknowledged his colleague Ryan James, who is the WaDE Data Analyst and does a lot of work behind the scenes to make this work possible. We also contract with an IT consultant, and their assistance is greatly appreciated. Adel's powerpoint presentation is available here.

Adel stated that the Water Data Exchange (WaDE) Program is committed to assisting WSWC member states in publicly sharing water rights, allocation, supply, and use data through a common streamlined and standardized service that enables regional analyses to inform water resources planning and policies. Our goal is to make the states' data Findable, Accessible, Interoperable, and Reusable. This is known as the FAIR standards.

The Western States Water Data Access and Analysis Tool (WestDAAT) was just recently launched with the help of the Internet of Water Coalition. The launch included a webinar that was attended by 175 people. It drove a lot of traffic to our website. Although the tool is live, we continuously make updates and revisions, so it is a living tool on both the code side and the data side. The Internet of Water launched a social media campaign and it has also driven more traffic to the Western States Water Council website.

With this public release, we're providing access to water rights data, including the owner, purpose of use, point of diversion, permitted flow or volume, place of use, water source name and type, and priority date. This is what we are calling Stage 1. It has taken about twelve years to get to this point. We are working on Stage 2, which will include other datasets that will help inform planning and management in the West including different regulatory overlays. We have some questions for you regarding how we will support these regulatory overlays and we will hold a discussion about this later today during the Legal Committee meeting.

The data types also include state site-specific time series and area aggregated time series data. We are working on sharing all of this data.

We have been working heavily on stakeholder engagement and the various levels were shown on slide #9. WSWC staff would like to get the States' input on the vocabulary or terms that are used in the system to compare data across the western states. The legal status is a very difficult term to define. Michelle Bushman is working to help get the status of water rights across the West described.

Adel noted that the WaDE team is always looking for feedback on ways they could make the tools easier to use and to help inform state decisions. They would not be at the point they are without the States' input and staff at various agencies that help and take the time to answer questions and guide us on how we collect the data.

Adel gave a live demonstration of the WestDAAT site-specific Reservoir and Observation Site Time Series Data. The data includes all sorts of instruments that the States operate, and collect data on, that otherwise would not be accessible through national data services such as from USGS. There is great value to add to water planning and informing operations. WestDAAT provides access to a landing page for each of 2.2 million water rights across the West. This program includes the basic metadata information to allow one to make sense of a water right. The information is accessible through the WestDAAT tool in a standardized way across the 18 western states.

We have been working with the Bureau of Reclamation to classify their own water rights in the western states. We found about 2,000+ water rights for which the western states recognize Reclamation is an owner. That has been an interesting project. Reclamation built an internal tool for their water asset management based on WestDAAT to track their water rights across the West. We are working with them on classifying contractors who receive water from Reclamation projects where the State recognizes the water right owner as the contractor for water delivered by Reclamation.

Tony Willardson noted that much of this has been funded through agreements with Duke University's Nicholas Institute for Energy, Environment and Sustainability. We have received around $1.3 million from Duke and philanthropic sources to develop this tool. We are moving forward and exploring how we are going to sustain it.

Tony noted after the public release of WestDAAT, we received an email about how great the tool is from Christine Nichols, who is the from family that funded the Nicholas Institute at Duke. The Nicholas Institute director said that email about the tool "not only made my day, but my week, and my year!" We are getting that kind of feedback from the foundations. The WSWC hopes that you all will continue to use this tool and provide us with more feedback.

He further noted that this experience has been "if you build it, they will come." It will be interesting to see how folks use this tool and the actual data. As Adel demonstrated, your actual state water right records are retrievable. In part, we built the tool so that you don't have to answer so many questions. Anyone who can access this tool can look westwide at water rights. Obviously there are bugs, and we anticipate improvements to the data. As Adel mentioned, it has taken us about ten years. In my opinion, we are the only ones who could have done this because of the commitment of the WSWC members and the western governors, and the support that you give us, so thank you!

Additionally, Adel remarked that they are scoping another extension to WestDAAT that would help farmers and water users in the Upper Colorado River Basin and westwide. It is generic enough. A farmer would be able to apply for temporary, voluntary compensation for taking water conservation measures. They literally can use WestDAAT and zoom in on a field, draw their boundary and click a connection to get an OpenET estimate of their consumptive use, and potential compensation. It has been very laborious and difficult for the Upper Colorado River Commission to go back and forth with these estimates using records and Word documents. This will streamline this process. We hope that other states may benefit from this integration if they want to look at compensation for reducing consumptive use.

SUNSETTING POSITIONS FOR FALL 2023 MEETINGS

Position #455, supporting U.S. Department of Agriculture (USDA) Conservation Programs and Water Resources will be considered at the Fall 2023 meetings. Please review it and inform Tony of any revisions you wish to suggest.

OTHER MATTERS

There being no other matters, the meeting was adjourned.