

Written Public Comments Submitted to PCAST

May 15, 2024 to July 3, 2024

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WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

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GROUNDWATER PUBLIC COMMENTS



WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 1: Louis Manuta, People for the Playa

Written: 5/22/2024

Subject: Groundwater

Attached please find comments drafted by People for the Playa to your groundwater protection questions.

Please let us know if you have any questions.

Louis Manuta

Member of the People for the Playa leadership tea

Attached: People for the Playa Comments

People for the Playa
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**Comments of People for the Playa
to the Groundwater Working Group of the
President's Council of Advisors on Science and Technology**

Background/Statement of Interest

People for the Playa is a group of residents in the Willcox Water Basin in southeastern Arizona who are united in their opposition to the creation of a lithium mine in the Willcox Playa in Cochise County, Arizona. Our opposition is due to the negative impact the proposed lithium mine would have on the pristine beauty of the area, the destruction of a recognized sandhill crane habitat, and the irreversible spoilage of the groundwater resource. Preserving and protecting our groundwater is essential for residents to continue to survive and thrive in this irreplaceably beautiful high desert environment.

By way of background, the Willcox Playa is the largest “dry lake” in Arizona, a remnant of the ancient Lake Cochise. It is 2,369 acres of federally owned land and is a night-time roosting area for 4,000-8,000 sandhill cranes. It was named a National Natural Landmark in 1966 due to its rich fossil record.

(<https://www.nps.gov/subjects/nnlandmarks/site.htm?Site=W IPL -AZ>)

Lithium extraction poses a significant threat to water resources and wetlands, primarily because lithium mining is mostly carried out via lithium brine extraction and then deposited into evaporation pools. The resulting concentrate is then removed for processing into lithium carbonate. Each ton of lithium requires around two million liters of water to be evaporated, resulting in enormous quantities of water being lost every year and putting underground freshwater reserves in danger of salinization by getting in contact with brine. Therefore, evaporation-based lithium brine mining methods are unsustainable. (<https://europe.wetlands.org/blog/world-water-day-the-water-impacts-of-lithium-extraction/#:~:text=Each%20tonne%20of%20lithium%20requires,getting%20in%20contact%20with%20brine>)

With this backdrop, People for the Playa is pleased to offer our “boots on the ground” insight into the groundwater questions posed by the Groundwater Working Group on April 25, 2024 as they apply to southeastern Arizona.

Questions Posed and Responses

(1) How can we enhance the timely collection of data on groundwater inventory, use, recharge and flow across the United States to gain a whole-of-the-country picture of the nation's groundwater resources?

The Federal government should deploy individuals to the affected areas to measure, often for the first time, the volume, depth, and capacity of the aquifers. Once this data is received, an analysis of current usage must be conducted to determine the projected lifespan of the aquifers. By doing so, bad actors will be identified, such as out-of-the-area industrial agriculture conglomerates who have established facilities in drought-prone areas where their selected operation is incompatible with the realities of the groundwater situation in the area.

In the Willcox Water Basin, for example, an out-of-state industrial agriculture firm is raising close to 200,000 head of cattle in our high desert communities, requiring an inordinate amount of water for the herds to not only drink, but for the crops to feed them (primarily alfalfa and winter wheat). This is outstripping the water usage of all of the residents, family farmers, ranchers, and vintners combined and the firm is increasing the depth of its wells to 2000+ feet.

According to reports published by the Arizona Department of Water Resources (“ADWR”), Willcox Water Basin users can use about 50,000-acre feet of water annually and still have a stabilized water table. An acre-foot is defined as “the amount of water it takes to cover one acre of land to the depth of one foot, approximately 325,851 gallons.” Residential users currently account for about 6,000 of those acre feet, leaving 44,000-acre feet for all other uses. Industrial agriculture firms here are currently using more than 200,000-acre feet of water per year. Subsidence and fissures are occurring at an increasing rate due to these activities. “The storage volume is now negative”, states ADWR, because, on average, the water table has been drawn down to below the average well depth. (https://www.azwater.gov/sites/default/files/2023-12/2023_WillcoxBasin.pdf)

By monitoring the usage of operations such as this, we would be able to accurately calculate aquifer depletion and identify why recharge is not occurring. Next steps could then be determined.

In such a fragile ecosystem, it is easy to understand our opposition to the proposed lithium mine. While we recognize the world's thirst for lithium to power the technology we rely on, the amount of water required to extract the lithium, combined with the high potential of groundwater contamination inherent in the extraction process, makes it a no-go in an environment such as the Willcox Water Basin. (https://ecolink.com/info/lithium-mining/?gad_source=1)

Further, a strict deadline should be established for completing and collating the necessary data - no later than two years after the date of authorization and funding appropriation for this important project. It should then be shared with state and local governments and all interested stakeholders.

(2) How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

As proposed, a two-year period to measure both the size of the water resource in a particular area and the current and anticipated usage of that resource is the correct place to start to properly model and predict changes. Having an objective and accurate assessment of these measurements, backed by the US government, is the type of yardstick needed by all stakeholders, including state and local governments, residents and family-owned commercial water users, as well as those industrial users who ply their vast financial resources to drain the primary water resource that brings life to the desert.

In our situation, the State of Arizona would be able to rely on this proposed resource compiled by the US government to work with all stakeholders to determine the best methods to conserve groundwater in our area. Since we, and most of the southwest, are mired in a decades-long drought, the time is now to address these issues.

(3) How can we efficiently scale groundwater recharge while mitigating risks?

Scaling groundwater recharge would be a herculean task in the Willcox Water Basin. Currently, recharge in our area is the equivalent of a tablespoon recharged for every gallon used. This would undoubtedly improve should the industrial agriculture entity leave the area and the proposed lithium mine not come to fruition. Until overall usage decreases and annual rainfall consistently increases for decades, groundwater recharge could not be scaled in our area.

(4) How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

The groundwater in the Willcox Water Basin is over 10,000 years old, is pure and sweet, and is one of the primary reasons early settlers in this area stayed and thrived with their now-generations-old family farms. While the population of the Willcox Water Basin has certainly increased over the years, our groundwater has continued to be clean and safe. Its continued abundance has become our primary concern, provided projects such as the lithium mine do not become reality and spoil our water.

The industrial agriculture conglomerate has single-handedly exacerbated groundwater depletion, but fortunately has not yet contaminated this vital resource. Lithium extraction most definitely would do both – deplete and contaminate the groundwater.

People for the Playa believes the most effective ways to prevent groundwater contamination and depletion is to have the proposed documentation in hand from the US government's analysis, and for state and local officials to work with residents in a united front to make industrial agriculture firms unwelcome, and not permit any proposed projects that would, by definition, contaminate our groundwater resource, such as a lithium mine.

(5) How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

Trust is a primary factor. The most effective means to establish and maintain trust is to consistently provide accurate, scientifically proven data and share it with all stakeholders. If not, people of different sides of an issue will rely on their own set of "facts" in an attempt to prove their point. Groundwater is far too important and precious to allow that to happen.

Agriculture is an important industry in Arizona and in the Willcox Water Basin, but just because it's an "industry" does not mean industrial agriculture is acceptable or is a boon to the local economy. It is far from it.

- Do profits from the industrial agriculture conglomerates leave the state (or the country)? YES!
- Do the industrial agriculture conglomerates hire a measurable number of local residents? NO!
- Can the industrial agriculture conglomerates pack up and leave the area when their 2000+ foot wells go dry then go somewhere else to spoil a different pristine part of the country? YES!

If you answered YES to two of these questions and a NO to the middle one, these entities have no business operating in an area like the Willcox Water Basin.

Generations of locals, family-owned farmers, ranchers, and vintners are not the problem – they are our neighbors, our friends and would be financially ruined should their wells go dry.

We need the common set of facts People for the Playa is advocating for the US government to develop and then use those facts in meetings with state and local decision-makers, and all local stakeholders to determine the best path forward for our area. With accurate data, we can take it from there.

(6) What strategies and incentives can help limit groundwater over-use?

People for the Playa proposes the following:

(1) There should be significant financial penalties imposed on industrial agriculture firms in groundwater-reliant areas to create a disincentive for them to operate in areas such as ours.

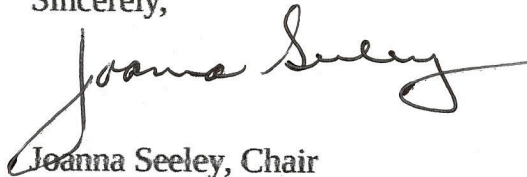
(2) There should be moratoriums on corporate mining and expansions in groundwater-reliant areas where the operations will use excessive amounts of groundwater that would accelerate aquifer depletion and/or contaminate groundwater.

(3) There should be a limit on the number of wells one entity can own and restrictions on how many gallons of water can be pumped out of the ground per day by the same entity.

(4) There should be financial incentives, tax and/or otherwise, for residents, family-owned farmers, ranchers, and vintners to invest in rain catchment systems to reduce reliance on groundwater usage.

We thank you for the time to express our concerns and to offer our recommendations.

Sincerely,

A handwritten signature in black ink that reads "Joanna Seeley". The signature is fluid and cursive, with a large initial 'J' and 'S'.

Joanna Seeley, Chair

On Behalf of the Members of People for the Playa

DATED: May 22, 2024

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 2: Amy Lewis, Geological Society of America

Written: 6/4/2024

Subject: Groundwater

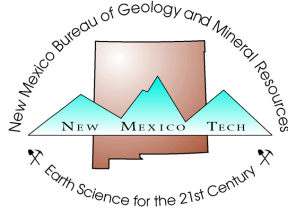
As a practitioner of hydrology for more than 40 years in New Mexico, including developing groundwater models for water rights administration, conducting water planning for cities, counties, pueblos, and the state of NM, and a customer on a small water system I have many concerns and ideas.

1. First of all, we need to collect data. I know that doesn't sound very exciting and state-of-the-art, but we need information on the water levels in wells, particularly from public water systems (the small ones, run by one guy who might not be paying attention). Can we require that depth to water is measured at least annually in supply wells? Can we fund public agencies to measure water levels?
2. We do need state-of-the-art groundwater models that are capable of simulating observed water levels and stream flows. Many of our models were developed (decades ago) without consideration to the sources of recharge, they are just super position models that evaluate the impacts on stream flow from moving pumping from one place to another. We need to understand how the entire system works and how it will be impacted by climate change...for New Mexico that's a 5% decline in recharge and stream flow per decade (Dunbar, et al., 2022, ><http://mainstreamnm.org/wp-content/uploads/2024/01/Leap-Ahead-Report.pdf><).
3. We need to meter all water use before we have any faith in a numerical model.
4. Recharge rates are tricky to measure, but improved and additional stream gaging could help. Most of our recharge occurs from the mountain front and along arroyos and losing sections of streams.
5. Our water infrastructure is vulnerable to climate change and so many of our small community water systems (public and private) do not have an emergency supply if their one well goes dry. For more information on the factors impacting resilience, see >http://mainstreamnm.org/wp-content/uploads/2024/01/ResilienceAssessmentAnalysis_Final.pdf<
6. Improved maps of our aquifers is also critical to understanding our groundwater supply. Provide more funding to the NM's Aquifer Mapping Program ([Aquifer Mapping Program \(AMP\)](#)).
7.).

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New Mexico Bureau of Geology & Mineral Resources

remove preview



Aquifer Mapping Program (AMP)

Aquifer mapping is a scientific process wherein a combination of geologic, geophysical, hydrologic, and chemical field and laboratory analyses are applied to characterize the quantity, quality, and "sustainability" of groundwater in aquifers. New Mexico Office of the State Engineer and Interstate Stream Commission New Mexico Environment Department New Mexico Energy, Minerals and Natural Resources State Lands Office Federal Agencies (e.g.

[View this on New Mexico Bureau of Geology & Mineral Resources >](#)

Hope this is helpful.

Amy Lewis
Hydrologist
HydroAnalytics
Santa Fe, NM USA

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 3: Chibuzo Chilaka, New Mexico State University Department of Water Resources Management

Written: 6/27/2024

Subject: Questions for PCAST on Groundwater Challenges and Management

Dear Groundwater Working Group Co-Leads and Members,

I appreciate the opportunity to contribute to the discussion on America's groundwater challenges. I have several questions I would like to submit for consideration to the PCAST Groundwater Working Group.

Regarding data collection and integration, what are the most critical gaps in current groundwater data collection efforts, and how can these be addressed to create a comprehensive national inventory of groundwater resources? Additionally, are there plans to integrate existing state and local groundwater data systems into a unified national database? If so, what would this integration process entail?

On the topic of modeling and prediction, what advancements in technology and methodology are needed to improve the accuracy of groundwater flow and recharge models? Furthermore, how can predictive models better account for the impacts of climate change on groundwater resources?

Considering groundwater recharge, what are the most effective artificial recharge techniques currently being used, and what are their respective advantages and risks? How can large-scale groundwater recharge projects be implemented without adversely affecting the surrounding ecosystems?

In terms of groundwater quality and safety, what are the primary sources of groundwater contamination, and what strategies are being considered to mitigate these risks? Additionally, how can we ensure that marginalized and rural communities, which often depend solely on groundwater, have access to clean and safe water?

For community engagement, what are the best practices for engaging local communities, including agricultural and Tribal communities, in groundwater conservation and management efforts? How can we effectively communicate the importance of sustainable groundwater use to diverse stakeholders?

Regarding regulation and policy, what policy measures or incentives could be introduced at the federal level to reduce groundwater over-extraction and promote sustainable use? Additionally, how can state and local regulations be harmonized to support a national groundwater management strategy?

Lastly, in the area of research and innovation, what areas of research do you believe are most critical for advancing our understanding and management of groundwater resources? How can federal agencies and academic institutions collaborate more effectively to drive innovation in groundwater management?

Thank you for considering these questions. I look forward to the outcome of your efforts and am eager to contribute in any way possible.

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Sincerely,

Dr. Chibuzo Chilaka

New Mexico State University Department of Water Resources Management

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 4: Deirdre White, Association of State Drinking Water Administrators

Written: 6/27/2024

Subject: Groundwater

Dear PCAST Working Group Members,

The Association of State Drinking Water Administrators (ASDWA) comments on PCAST's important questions related to the nation's groundwater challenges are attached for your consideration.

Please let me know if you have any questions and/or would like to discuss our recommendations.

Sincerely,
Deirdre White

Deirdre White, Project Manager
Association of State Drinking Water Administrators

Attached: ASDWA's Input on America's Groundwater Challenges



June 27, 2024

President's Council of Advisors on Science and Technology (PCAST)
Emailed to pcast@ostp.eop.gov

RE: ASDWA's Input on America's Groundwater Challenges

Dear PCAST Working Group Members,

The Association of State Drinking Water Administrators (ASDWA) appreciates this opportunity to provide responses to the [PCAST's important questions related to the nation's groundwater challenges](#). ASDWA is the independent, nonpartisan, national organization representing the collective interests of the drinking water program administrators in the 50 states, five territories, the District of Columbia, and the Navajo Nation. ASDWA's members implement the Safe Drinking Water Act (SDWA) by regulating and providing technical assistance and funding for the nation's public water systems (PWS) and coordinating with many partners to protect both surface and groundwater sources of drinking water.

Beyond the Federal Underground Injection Control (UIC) program regulations for groundwater under the SDWA, each state has different laws, regulations, and policies in place for groundwater quality and quantity. The states also collaborate with many partners to assess and address groundwater needs. These partners include other state and Federal agencies and programs, local governments, water systems, community engagement groups, universities, associations, the private sector, and other experts and stakeholders.

The most important actions the President and the Federal government can take to optimize groundwater quality and quantity strategies and actions are to promote collaboration with states and other new and existing partners, to support the expansion and enhancement of tools and resources, and to ensure that Federal agencies provide flexibility for allowing current Federal funding programs to be directed toward groundwater. For more information about the importance of, and special considerations for, protecting groundwater sources of drinking water, read the [ASDWA – GWPC Groundwater-Based Source Water Protection Paper \(September 2019\)](#).

For your consideration, below are a series of overarching recommendations, as well as specific responses to the PCAST questions for building a better understanding of total groundwater use, recharge, and storage across the U.S., and for developing national groundwater stewardship strategies.

Overarching Comments: ASDWA recommends that the PCAST Working Group broaden the focus of this effort to develop strategies to assess and address groundwater challenges throughout the entire U.S., beyond water conservation and drought resilience in the Colorado River Basin and across the West, as is stated in [the White House briefing](#). These nationwide strategies should ensure deference to and consultation with the state programs that have exclusive authority over the allocation and administration for groundwater within their borders. These strategies should also focus on hydrologic and regional areas of scale for decision-making, by examining the water cycle across all sectors, including groundwater and surface water connections. These strategies should consider impacts to

groundwater from agriculture and energy laws, policies, and funding, as well as economic and community development factors that drive depletion and contamination of the nation's groundwater resources, while at the same time continuing to ensure food, energy, and economic security. Groundwater quality and quantity impacts must be considered as part of these Federal, state, and local decision-making processes aimed at providing for the needs of the nation's citizens and communities.

ASDWA Comments in Response to PCAST Questions:

How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

- Develop a method for registering the location and construction of all wells for the entire country. Many states do not or did not require all wells to be registered and therefore are unable to mitigate groundwater quality impacts from unknown wells.
- Expand research and funding for groundwater modeling, monitoring, and mapping.
- Promote data collection and research to better understand the water cycle and impacts from energy and food production demands.
- Support funding for the USGS [National Water Quality Monitoring Network](#) and [National Ground Water Monitoring Network \(NGWMN\)](#) and other state and tribal efforts and opportunities to collect, manage, and share groundwater data.

How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

- Expand and build upon the USGS [National Water Census](#) and NGWMN that is directly coordinated with states and other stakeholders.
- Ensure that surface and groundwater interconnections are included, especially for shallow groundwater areas.
- Conduct research and develop and deploy technologies for accurately mapping and modeling hydrogeography/geology and groundwater levels.

How can we efficiently scale groundwater recharge while mitigating risks?

- Promote regional collaboration across all state programs that looks at the whole water cycle, in coordination with water and wastewater utilities and stakeholders to ensure buy-in and funding for including recharge and reuse as potential solutions to address groundwater needs.
- Support research and funding, and the development of resources and guidance for aquifer recharge projects that consider risks from floods and excess instream flows; from emerging contaminants such as per- and polyfluoroalkyl substances (PFAS) in stormwater capture and infiltration; and from additional groundwater discharges beyond UIC wells.
- Implement aggressive pollution prevention initiatives for PFAS and other emerging contaminants.
- Incentivize coordinated, cost-effective, and sustainable recharge and reuse solutions.
- Support and promote municipal land use controls that limit the development of new impervious surfaces while requiring clean artificial recharge.

How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

- Support state groundwater protection efforts and coordination with Federal, state, local governments, water utilities, and communities.

- Support planning and education in water-rich states that have also experienced increased competition for groundwater resources and impacts from contamination, including emerging contaminants such as PFAS.
- Take federal action to remove chemicals such as PFAS from commerce so they do not end up in waste streams and impact drinking water wells and septic systems.
- Work with states to share data and examples for addressing groundwater impacts from septic systems.
- Support funding for orphaned well plugging and cleanup and well decommissioning, particularly in source water protection areas and for old poorly constructed wells and irrigation wells built for maximum capacity that are gravel packed to the surface and act as direct conduits for contaminants to enter groundwater used for drinking water.
- Provide technical assistance, resources, and funding to help these communities with long-term, holistic, and sustainable financial and environmental solutions for groundwater quality and quantity.
- Support municipal water supply resources planning, zoning, ordinances, and health regulations, including protections where the geology supports natural separations between aquifers such as clay layers between unconfined and confined aquifers.
- Support collaborative community efforts to incentivize voluntary actions and best management practices, including set-back distances between well houses and lands where chemigation or irrigation occurs along with the application of pesticides and fertilizers.

How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

- Ensure continued deference to states that have exclusive authority over the allocation and administration of rights for the protection, control, and management of groundwater within their borders.
- Support funding for states to administer UIC, source water protection, and other groundwater programs. Encourage opportunities for training, coordination, sharing examples, and communication between all levels of government including interstate and intrastate programs.
- Coordinate efforts to partner with states, local governments, universities, and technical assistance providers who are already known and trusted by communities.
- Impacts to groundwater also often occur outside the jurisdiction of local communities. Encourage regional and interstate water resource planning coordinated with multiple communities across jurisdictional boundaries in a way that supports individual state resource planning efforts.
- Encourage coordination and policy-making between state agencies on approvals for aquifer storage and recovery projects. Existing water planning, reuse, and aquifer storage and recovery efforts throughout the U.S. can be used as examples for other areas.
 - The [Sustainable Water Initiative for Tomorrow \(SWIFT\)](#) is an innovative water treatment project in southeast Virginia designed to further protect the region’s environment, enhance the sustainability of the region’s long-term groundwater supply and help address environmental concerns such as Chesapeake Bay restoration, sea level rise and saltwater intrusion.
 - The [Tampa Bay Florida water supply projects](#) include aquifer storage and recovery and desalination for meeting the region’s future drinking water needs.

- The [Central Arizona Groundwater Replenishment District \(CAGR\)](#) was created in the mid-1990s to help water providers and landowners comply with Arizona's groundwater laws. CAGR plays an important role in Arizona's groundwater management by replenishing groundwater pumped by its members.
- See additional suggestions in the [GWPC Groundwater Report to the Nation Call to Action](#) on page 5.

What strategies and incentives can help limit groundwater over-use?

Strategies and incentives are needed to:

- Encourage and support water reuse and the [Water Reuse Action Plan](#), as well as research for the treatment and reuse of marginal quality waters, including oil and gas produced waters.
- Support research and coordination efforts that aid the development of state laws and regulations for reuse, recycling, recharge, and recovery, as well as state permitting and pilot projects.
- Directly coordinate with state programs that manage consumptive use and assess supply and demand for groundwater basins.
- Promote better integration between surface and groundwater programs and ensure that national water strategies address both quality and quantity issues.
- Promote coordination among water quality and water use agencies and programs and encourage water resource planning aimed at ensuring the long-term sustainability of groundwater sources.
- Ensure that Federal laws, policies, and funding for food and energy production such as natural gas and ethanol consider impacts to groundwater quality and quantity.
- Promote the use of the U.S. Department of Agriculture (USDA) Inflation Reduction Act funding for climate smart agriculture and forestry practices that can be used to address water quality and quantity.
 - For example, ASDWA and GWPC are working with the [Source Water Collaborative](#) to promote the use of this funding for protecting the quantity and quality of drinking water sources.

Thank you for your consideration of these recommendations to ensure safe drinking water and the protection of groundwater quality and quantity. Please contact Deirdre White at dwhite@asdwa.org or Alan Roberson at aroberson@asdwa.org or 703-812-9507 for questions or comments. We look forward to discussing these recommendations with you in more detail.

Sincerely,



J. Alan Roberson, P.E.
ASDWA Executive Director

cc: Jennifer McLain – EPA OGWDW



Recommended Actions

To USEPA:

- ▶ Support state efforts to develop guiding principles that state and local water-planning and water-use entities should take into consideration when conserving the integrity of watersheds and ensuring adequate water supplies.
- ▶ Require better integration between surface and ground water programs and ensure that the national water strategy addresses both quality and quantity issues, including interaction between surface and ground water.

To USGS and State Geological Surveys:

- ▶ Continue to conduct research and provide information—at a scale that is useful to states and local entities—about such matters as the safe, or sustainable, yield of aquifers (and methods for determining that yield); water-use data; and delineating boundaries and water budgets of three-dimensional watersheds, including scientifically based and cost-effective methods of quantifying interaction between ground water and surface water.

To Governors and State Legislatures:

- ▶ Authorize water supply planning at the state level and encourage water supply planning at regional and local levels to conserve the integrity of watersheds and ensure adequate water supplies.
- ▶ Consider adopting ground water protection and management laws that:
 - Recognize and manage the impact of ground water withdrawals on surface water.
 - Link development to sustainable availability of water and other water supply infrastructure.
 - Allow for and encourage techniques such as transfer-of-development rights for the purpose of ground water conservation and protection.
 - Ensure coordination among agencies responsible for water quality and water use in order to determine watershed water budgets and base water withdrawal and recharge policies.

- Regulate the interbasin transfer of water in order to protect ecosystem integrity.
- Require water conservation practices for all new construction (e.g., agricultural, industrial, residential) by changing plumbing codes so that they require water conservation.

To State Agencies:

- ▶ Ensure coordination among water-quality and water-use agencies/programs and associated surface water and ground water policies/programs. Benefits of this strategy can include:
 - Integration of ground water resource characterization and monitoring into state water-monitoring strategies.
 - Development and implementation of water-reuse policies.
 - Development of tools and policies to match water sources of various quality with the most suitable use (e.g., domestic, agricultural, industrial).

To Local Governments:

- ▶ Conduct water resources planning for long-term resource sustainability, focusing on 5- to 50-year water availability projections and plans. Incorporate this information into local comprehensive and infrastructure plans, zoning, and other local ordinances, as well as incentive programs, including:
 - Ordinances that tie development to sustainable water availability.
 - Ordinances and best management practices (BMPs) that provide for sustainable ground water recharge and improved stormwater management practices.
 - Transfer-of-development rights and development of property tax incentive programs to encourage land owners and developers to maintain recharge areas as open spaces, helping to achieve ground water protection and conservation goals.
 - Ordinances and plumbing codes designed to conserve water through improved efficiency, water reuse, water rationing, and gray water-use requirements.

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 5: Kathy Jacobs, Arizona Institute for Resilience, University of Arizona

Written: 6/28/2024

Subject: Groundwater

PCAST:

Please find attached my comments related to your request for input on Groundwater.

Many thanks for this opportunity.

Kathy Jacobs

Center for Climate Adaptation Science and Solutions

Arizona Institute for Resilience

Department of Environmental Science

University of Arizona

Attached: PCAST Input from Jacobs – Groundwater



Input from Kathy Jacobs, Director,
Center for Climate Adaptation Science and Solutions
Arizona Institute for Resilience
Professor, Environmental Science
University of Arizona
jacobsk@arizona.edu; 520-405-7395 (cell)

6/24/2024

Greetings, PCAST Groundwater Working Group:

I have worked on groundwater management issues since 1981, and worked for the Arizona Department of Water Resources for 23 years while the Arizona Groundwater Management Act was being implemented. I was the appointed director of the Tucson Active Management Area for 15 years, and led the verification of groundwater rights; the establishment of mandatory conservation requirements for all sectors of the economy; the development of the Assured Water Supply Rules which require 100 years of renewable supplies prior to subdivision of land; and I contributed to the development and implementation of the Recharge and Recovery Act. I also served in the Obama White House for four years in OSTP as the director of the National Climate Assessment and the lead for the Subcommittee on Water Availability and Quality (SWAQ), which was the interagency committee charged with addressing water science and policy issues across the federal government. In that role I worked with all the federal water agencies towards more effective management and coordination on water issues. As a result of all of these experiences I have a number of perspectives in answer to your questions, and some documents that might be of interest to you.

1. How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

In September of 2013, SWAQ produced a summary slide deck on the topic of "You Can't Manage What You Don't Measure" which was an attempt to identify: 1) the state of in-situ observational data networks supporting decisions (including groundwater); 2) Current methods of collecting, storing, managing data and decision tools; 3) Current institutional context for water data, along with options for revising and strengthening institutional capacity. Among the proposed recommendations were: 1) Improve specific observational data systems most needed to support *critical* water decisions; 2) Develop new/improved data delivery systems, metrics and decision

support tools; 3) Better coordinate Federal agency water data collection and management to generate an integrated data/tools/decision support products; and 4) Strengthen institutional capacity for stakeholder input to water data and management systems. I am not certain whether SWAQ actually produced a final report on this after I left the administration but it is worth finding out.

Among the gaps identified in the slide deck were 1) observational data gaps; 2) linking selected data gaps to most critical decisions; 3) data accessibility issues; and 4) ways to connect federal and state data systems and 5) ways for states, data users and other stakeholders to contribute to coordinated water data/tools/decision support products. These are not exactly groundbreaking pieces of information but I thought worth sharing...

My own personal perspective on this, based on many years in this field, is that since the states manage water allocation they are always going to object to federal interference in what they perceive as their territory, whether it is groundwater or surface water. The only way to convince the states to set up systems that are coherent with a national framework is to provide funding in return for their efforts to do so. A good example is the Coastal Zone Management Act, which rewards states for the development of plans and actions that meet federal standards. Emergency preparedness funds are also doled out in response to advance planning for emergencies.

A critical issue is that though there have been many attempts by the main federal water agencies (USGS, USACE, NOAA, Reclamation, etc.) to work on shared information systems and interoperability, this effort has never been finalized or implemented to the degree that is necessary. Agencies continue to protect their own data and data systems because they need to justify their own budgets. This is not something that can be fixed in one administration – there needs to be legislation requiring this kind of shared data system and a broad advisory group that assesses whether agencies are following the requirements.

- One important reference worth reviewing is ACWI. 2013. A national framework for groundwater monitoring in the United States.
https://cida.usgs.gov/ngwmn/doc/ngwmn_framework_report_july2013.pdf
- Another is the USGS website on Water Resources, <https://www.usgs.gov/water-resources/programs>, but I understand this website is incomplete because the Trump administration disbanded the committee working on it.

2. How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

Because we now have a national water model, we have the backbone of a system that can do this. However, it is my perspective that such large models are unlikely to be truly useful in regional contexts, and clearly groundwater conditions are not well represented as it stands today. A combination of models and remote sensing (e.g. GRACE) is required to project future climate conditions, assess the changes in precip and temperature within watersheds, and evaluate the implications for groundwater. We will need much more ground truthing in a wide array of different

aquifers and hydrologic conditions before these models and integrated observing systems can be truly useful.

I am currently engaged as PI for the Arizona Tri-University Recharge and Water Supply Reliability project, which includes 28 hydrologists, ecologists, climate modelers, snowpack experts, groundwater modelers etc. This project is attempting to understand current partitioning of precipitation between ET, runoff and recharge in every basin in Arizona, and looking to identify places to capture a larger percentage of the water currently lost to evaporation and store it underground. The client is the Arizona Department of Water Resources and the funding is from the Arizona Board of Regents. The website is at <https://ccass.arizona.edu/arizona-tri-university-recharge-and-water-reliability-project>

3. How can we efficiently scale groundwater recharge while mitigating risks?

The primary risk associated with groundwater recharge is mobilization of contaminants in the aquifer, or introduction of new contaminants such as PFAS. Although PFAS has been a dramatic game-changer in our understanding of the safety of recharge, we do have a good understanding from hundreds of recharge sites across the country where it is safe to recharge and where it is likely to cause problems. Clearly the source water needs to be carefully evaluated in the context of the aquifer conditions, depth to water, native water quality, intended use, etc. And proximity to landfills or native sources of contamination needs to be ruled out prior to recharge. It is also important to assess whether the water will be recovered for future use or whether it is being recharged for other purposes, e.g. reducing salt-water intrusion. Finally, it is critical to match the type of recharge (e.g. spreading, injection, etc) to the quality of the source water and the intended use of the recovered water.

4. How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

“Clean and safe” in the context of human consumption means that the water, when recovered, will meet drinking water standards and that the recharge itself will not cause downstream flooding or water quality problems. “Ensuring” clean and safe groundwater for every community in the country is a massive undertaking that would require dramatic investments in water quality testing and monitoring as well as improved infrastructure from the federal government. It seems currently unlikely that there would be an opportunity of that kind, but clearly just replacing the existing antiquated delivery systems and upgrading existing treatment plants would be a good start.

5. How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

It is unclear who “we” is in this case, and what the objectives of the engagement are. Understanding community preferences when there are well defined options and resources available is a very different thing than having major public arguments over water supply options that may not be feasible in the first place. After 40 years of working on water issues in a public context, it is very clear that there is no one-size-fits-all approach to public engagement. Further, if the “we” has really clear objectives that are well supported by trusted community leaders then it is very

different from having “outsiders” come into communities with an agenda that doesn’t fit their idea of the facts. More often than not, the facts are not well understood, and that makes for a very difficult conversation. Lofty and important as this objective is, there needs to be a VERY SPECIFIC REASON for engaging the public – around specific decisions, in a specific watershed or location, that can be described up front. Otherwise, it is much more fruitful to engage with water managers and community leaders in these conversations. I have seen well-intended and highly orchestrated public meetings about water turn into food fights as a result of failure to understand the nature of the problem and the nature of the people in the Tucson community. We have a long history of strong public reactions to water management decisions and many city managers and water directors have lost their jobs as a result.

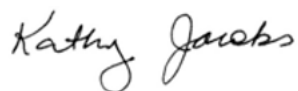
6. What strategies and incentives can help limit groundwater over-use?

Though there continue to be some arguments around the edges, there is no doubt that the Arizona Groundwater Management Act has made huge contributions to limiting groundwater overuse within Active Management Areas (through limitations on new agriculture, mandatory conservation for all sectors, and limitations on the use of groundwater for new development). Even in the context of massive growth, the AMAS generally have maintained 100 years of renewable water to support growing cities and there has been a gradual transition from agricultural to urban use. The fact that the majority of the State is not in an AMA has come back to haunt us, with rural parts of the state targeted for increased agriculture. And climate impacts on the Colorado River flows were not well anticipated; there is no serious requirement to consider climate change in the GWMA. A further serious consideration is that the AZ GWMA does not in any way acknowledge the connections of groundwater to surface water or make any attempt to protect aquatic and riparian habitat. Despite its failings, it is widely hailed as the foundation of water management in Arizona and as a standard for other states to follow.

Though it is not yet fully implemented, the California Sustainable Groundwater Act is also making significant progress, and in many ways may be more effective than the Arizona approach because it forces basins to come up with their own plans to get to sustainability. Both of these state models are worth considering in areas where groundwater depletion is currently occurring or anticipated.

Thanks very much for encouraging input. Good luck with your quest!

Best regards,



Kathy Jacobs

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 6: Libby Spekhardt, Banner Public Affairs

Written: 6/28/2024

Subject: Groundwater

Good afternoon,

I am reaching out on behalf of my client, Commission Shift, to submit their letter to the PCAST Groundwater Working Group. We thank you for your important work on protecting groundwater resources in the U.S. If you have any questions, please contact Virginia Palacios, Executive Director at Commission Shift, at vpalacios@commissionshift.org.

Best,

Libby Spekhardt
Associate
Banner Public Affairs

Attached: Commission Shift PCAST Letter



Commission Shift applauds the Biden Administration for launching the PCAST working group on groundwater to evaluate the challenges and opportunities to protect one of our most critical resources. As the working group works with federal agencies and local stakeholders to analyze the merits of various approaches to conserving groundwater supply across the West, it is important to find solutions that would ensure the reliability of clean and safe groundwater, particularly for communities most affected by groundwater contamination and depletion.

Commission Shift would like to emphasize the critical need for protecting groundwater resources, particularly in the context of Class VI wells used for carbon capture and sequestration. Class VI wells are used to inject carbon dioxide (CO₂) into deep rock formations. This long-term underground storage is called geologic sequestration, which is one of many tools that can be used to dispose of CO₂ emissions that are removed from the atmosphere and potentially mitigate climate change. The EPA is authorized by the Safe Drinking Water Act (SDWA) to develop requirements and provisions for the Underground Injection Control (UIC) Program. This program regulates the injection of fluids (such as wastewater, hazardous liquids, brines from oil and gas production, and CO₂) into the subsurface for the purposes of storage or disposal. Class VI wells are permitted under the UIC program.

As the nation advances efforts to mitigate climate change through innovative technologies, ensuring the safety and sustainability of our groundwater must be paramount. While Class VI wells are one tool that may play a crucial role in reducing greenhouse gas emissions, the process of carbon capture and sequestration (CCS) carries significant potential risks to groundwater quality and availability. As an organization based in Texas, we are particularly concerned about the state's efforts to gain primacy to permit and oversee Class VI wells, particularly because Texas has a history of poor oversight and enforcement under the Safe Drinking Water Act. EPA Region 6 recently acknowledged our petition regarding the Railroad Commission of Texas' (RRC) Class II program as raising "substantial concerns" that EPA "will need to evaluate through extensive and thorough technical and legal review." The RRC is Texas' oil and gas oversight agency, and is currently applying for Class VI primacy from EPA.

We urge PCAST to consider not only the benefits, but also the harms to the climate, of granting Class VI oversight to a state agency that does not apply rigorous decision making criteria to siting or permitting UIC wells.¹ These wells can cause permanent changes to the chemistry in underground sources of drinking water if not sited, permitted, maintained, and monitored properly. If any slow, minor leaks in injection wells occur, CO₂ and water can combine to form carbonic acid, which can leach metals out of subsurface rock formations, leading to the potential for permanent contamination of groundwater with arsenic, lead, copper, mercury, cadmium, selenium, and more. These contaminants can be fatal to humans, and the damage to groundwater from contamination can be permanent, forcing communities to spend millions or billions of dollars to find an alternative source of water. **Groundwater supplies the drinking water of about 106 million people in the U.S.**

An oil and gas well operator testified to the Texas Senate in 2023 that a CO₂ acid gas plume ate through his five-inch heavy duty drill bit within 12 hours. It follows that this kind of strong acid could also eat through well casings in nearby unplugged wellbores, potentially affecting drinking water supplies.^{2, 3}

Further, as we consider the long-term groundwater supplies in drought-vulnerable locations across the West, it is possible that even more communities will need to tap into groundwater supplies in the coming decades. Because of this, we must ensure the maximum possible protections are in place to defend groundwater quality.

It is crucial to adopt stringent measures to safeguard groundwater resources, which are vital for agriculture, industry, energy production, and drinking water supplies for millions of Americans. As PCAST's working group on America's groundwater considers the challenges surrounding our most precious natural resources, we urge you to find solutions that would ensure the safety and reliability of drinking water for over 100 million Americans.

Thank you,

Virginia Palacios

Executive Director, Commission Shift

¹ Virginia Palacios' Testimony to the Railroad Commission, June 2024. June 27, 2024. Commission Shift. Retrieved from: <https://youtu.be/ODzbMOKB3ic?si=D6jDywQksTjc7aBz>

² Webb, Shelby. April 17, 2023. Why injecting CO₂ underground is a legal morass. E&E News by Politico. Retrieved from: <https://www.eenews.net/articles/why-injecting-co2-underground-is-a-legal-morass/>

³ Bruce Gates Testifies against SB 2107. Commission Shift. April 7, 2023. Retrieved from. <https://youtu.be/k8kFru3tBjI?si=CyGy1oiHsKwKRiVt>

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 7: Dan Yates, The Ground Water Protection Council

Written: 6/28/2024

Subject: Groundwater

Thank you for the opportunity to provide comment on America's Groundwater Challenges.

-Dan

Dan Yates

He/Him/His

Executive Director

The Ground Water Protection Council

Attached: GWPC Responses to White House PCAST Groundwater Working Group



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Dedicated to protecting our nation's ground water

June 28, 2024

The GWPC appreciates the opportunity to provide responses to the President's Council of Advisors on Science and Technology (PCAST) on important questions related to the Nation's Groundwater Challenges.

GWPC's membership consists of representatives of state groundwater and underground injection control (UIC) regulatory agencies that mutually work toward the protection of groundwater nationwide. Our focus is specifically on protecting groundwater supplies, conserving groundwater resources for all beneficial uses, and recognizing groundwater as a critical component of the ecosystem. GWPC is unique among state associations in that its members are the state officials who set and enforce regulations on groundwater protection and UIC.

GWPC's overarching comment to PCAST is to continue to recognize that groundwater is a **water of the states** and to encourage, promote, and provide tools to states to manage this important water supply. A vast network of State, Tribal, and local government officials, private sector participants, community engagement groups, scientists, associations, and other experts focused on this issue already exists. The most important actions the President and the federal government can take to promote groundwater quality and quantity are to:

- encourage and support connectivity within this networked population
- provide tools and resources (allow states to choose the ones that best fit their need)
- encourage federal agencies to allow current related funding to be directed toward groundwater
- promote education on hydrogeology, the water cycle, and geologic sciences, including encouraging students to enter these fields

GWPC's comments on the questions posed April 25, 2024, by PCAST are provided below (reference PCAST questions at <https://www.whitehouse.gov/pcast/briefing-room/2024/04/25/pcast-welcomes-public-input-on-americas-groundwater-challenges/>).

How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

- Support funding for the National Ground Water Quality Monitoring Network (NGWMN) administered by USGS and other state and tribal efforts to collect and share groundwater data and other state data-management funding opportunities
- Support additional research and funding for groundwater modeling, monitoring, and mapping
- Support research to generate new data and better understand the water cycle and impacts from energy and food production demands, using a cross-programmatic approach to research with USGS, NOAA, DOE, and USDA. This could include additional uses of Interferometric Synthetic Aperture Radar (InSAR) to evaluate groundwater related land deformation.

How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

- Look to state water planning programs that have been modeling and predicting groundwater availability and changes, such as Arizona's Active Management Areas program and the Texas Groundwater Availability Models program, and in coordination with federal agencies such as USGS, help states to develop similar programs and data management systems to accessibly house the data
- Expand and build on the USGS Census and NGWMN that is administered in coordination with states and other stakeholders
- Conduct research and develop/deploy technologies for accurately mapping and modeling hydrogeology/geology and groundwater levels

How can we efficiently scale groundwater recharge while mitigating risks?

- Increase funding for states to administer Underground Injection Control (UIC) programs (many groundwater recharge projects are authorized under the UIC program).
 - Current funding does not cover a full staff position for each state
 - Funding has not changed for decades
 - Funding does not allow for the appropriate level of effort to adequately administer the UIC program – especially with new PFAS MCLs
 - The task of addressing emerging contaminants that are widespread, mobile, and persistent is beyond the current capacity of state UIC programs, which have been stunted under federal funding that has been stagnant for 40 years
- Develop and provide water quality assessment guidance for aquifer recharge projects that may use flood flows and excess in-stream flows
- Provide funding for and encourage partnerships between the USACE/USBR, local water utilities, and forecasters to support groundwater recharge projects at

dam sites where excess flows can be timely released to downstream recharge facilities, such as has been done in southern California at the Prado Dam.

- Encourage and support state/local programs such as the Hampton Roads Sanitation District's SWIFT program in Virginia, where large-scale groundwater recharge is being conducted to address multiple coalescing goals, including providing advanced treatment of municipal wastewater, reuse of the highly treated wastewater for groundwater recharge, and mitigate the impacts of land subsidence, rising sea levels and saltwater intrusion (<https://www.hrsd.com/swift/about>).
- Support pollution prevention initiatives for PFAS
- Support research on Constituents of Emerging Concern such as PFAS in Stormwater Capture and Infiltration for aquifer recharge
- Foster communication and potential collaboration so that efforts aren't needlessly redundant.
- Complete a follow-up to USEPA's 1999 Class V Underground Injection Control Study to include PFAS and 1,4-dioxane
- Promote regional collaboration across all state programs that looks at the whole water cycle, in coordination with water and wastewater utilities and stakeholders to ensure buy-in and funding for managed recharge and water reuse as potential solutions to address groundwater needs.
- Incentivize coordinated, cost-effective, and sustainable groundwater recharge and water reuse solutions.

How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

- Continue to recognize groundwater as a water of the states
- Support existing state groundwater management efforts and state agency personnel
- Provide training and encouragement for people to seek geoscience degrees and provide incentives for water sector jobs
- Provide connectivity between state, local, and federal agencies on existing regional, state, and local groundwater protection efforts
- Encourage federal agencies to allow existing grant funds to be utilized for groundwater protection purposes
- Support water and wastewater operator apprentice programs with a goal of facilitating long-term, rewarding careers in these important sectors, which should result in better quality treatment of drinking water and wastewater
- Identify additional funding support for Orphan Cleanup Sites
- Provide technical assistance, resources, and funding to help communities with long-term, holistic, and sustainable financial and environmental solutions for groundwater quality and quantity.
 - Support water resource planning, zoning, ordinances, and collaborative community efforts to incentivize voluntary actions and practices.

How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

- Continue to recognize States have exclusive authority over the allocation and administration of rights to the use of the groundwater within their borders and States and their political subdivisions are primarily responsible for the protection, control and management of the resource
- Support States financially to allow more robust groundwater program staffing and provide staff training opportunities
- Highlight state and local successes with programs and projects focused on groundwater sustainability
- Foster communication between all levels of government including interstate and intrastate program communication.
- Realize that impacts to groundwater also often occur outside the jurisdiction of local communities. Encourage regional and interstate water resource planning coordinated with multiple communities across jurisdictional boundaries in a way that supports individual state resource planning efforts.

What strategies and incentives can help limit groundwater over-use?

- Encourage water reuse
- Support the Water Reuse Action Plan (<https://www.epa.gov/waterreuse/water-reuse-action-plan>)
- Encourage and support efforts and research on the reuse of marginal quality waters including the treatment and reuse of oil and gas produced waters
- Promote the use of the USDA Inflation Reduction Act funding for climate smart agriculture and forestry practices that can be used to address water quality and quantity.
 - For example, ASDWA and GWPC are working with the Source Water Collaborative to promote the use of this funding for protecting the quantity and quality of drinking water sources.
- Promote better integration between surface and groundwater programs and ensure that national water strategies address both quality and quantity issues
- Promote coordination among water quality and water use agencies/programs

Thank you for the opportunity to comment. The GWPC stands ready to participate in any related efforts.

Contact: Dan Yates, Executive Director, dyates@gwpc.org, 405-516-4972

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 8: Vicki Kretsinger Grabert, Luhdorff & Scalmanini, Consulting Engineers

Written: 6/28/2024

Subject: Groundwater

Dear PCAST Groundwater Working Group:

In response to the April 25, 2024 PCAST announcement welcoming public input on America's groundwater challenges, on behalf of Napa County, we are pleased to submit the attached information on the importance of approaches to achieve future water resources sustainability under a changing climate. The attached submittal titled, "Climate Adaptation and Interconnected Surface Water and Groundwater Stewardship: An Example in California's Napa Valley" especially addresses the PCAST's question: "How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and diversity?" The attached paper has many elements that relate to this question and also many other interests that the PCAST Groundwater Working Group expressed in the announcement. We have also included several links in the attached paper that provide additional relevant documents, including detailed documentation pertaining to state and Napa County-specific programs and work underway in California.

We would be pleased to address any questions you may have.

Thank you,

Vicki

Vicki Kretsinger Grabert
Senior Principal Hydrologist
Luhdorff & Scalmanini, Consulting Engineers

Attached: Climate Adaptation and Interconnected Surface Water and Groundwater Stewardship: An Example in California's Napa Valley

Climate Adaptation and Interconnected Surface Water and Groundwater Stewardship: An Example in California's Napa Valley

Submitted to PCAST Groundwater Working Group on June 28, 2024

California was the last state in the nation to regulate groundwater statewide. One hundred years after regulating surface water in 1914, in September 2014, California adopted the [Sustainable Groundwater Management Act](#) (SGMA), a three-bill legislative package codified in Section 10720 et seq. of the California Water Code. This was a truly phenomenal accomplishment; effective January 1, 2015, this led to very comprehensive groundwater sustainability plan regulations that provide for the sustainable management of California's groundwater resources. SGMA encourages groundwater management at the local level. Local agencies formed groundwater sustainability agencies (GSAs) to develop and implement groundwater sustainability plans (GSPs) to guide sustainable management of state-defined groundwater basins.

SGMA's first 10 years brought huge steps towards better understanding of California's water budgets, surface water and groundwater connectivity, subsidence, subsurface characterization, groundwater quality, and seawater intrusion. However, the ongoing work of the GSAs and other partners and collaborators to implement GSPs represents significant future challenges. SGMA and the GSP regulations accounted for consideration of pre- and post-drought conditions; yet daunting climate uncertainties will compound and complicate efforts to achieve and maintain sustainability. Navigating future sustainability will require more sophisticated tools and approaches, innovation, outreach and education, multidisciplinary teams to address multifaceted complex problems, and ongoing adaptation.

This paper presents an example of a California groundwater basin (Napa Valley Subbasin) where surface water and groundwater are intricately connected, and groundwater levels are generally quite shallow (3 to 20 feet deep). Napa Valley is a narrow valley drained by the Napa River and is highly responsive to precipitation and temperature conditions. The relatively high permeability of the principal aquifer, the Quaternary alluvium, and overlying soils enable infiltration of precipitation and surface waters, which constitute the primary sources of groundwater recharge. Surface water and groundwater are interconnected throughout much of the Napa Valley Subbasin, although the nature and degree of connection varies based on many factors. For almost a century (since the 1930s), lower reaches of the Napa River have periodically experienced low to no-flow conditions during the fall. This is largely a function of seasonal fluctuations of shallow groundwater levels resulting in decreases in groundwater discharge into the stream channel.

Although temperatures have been subtly increasing for decades, since 2012, temperature, evaporative drought demand, and corresponding water demands (including pumping) have mostly increased. Very dry years occurred in 2020 and 2021 followed by a slightly below average water year in 2022 that had very dry conditions during January and much of the rest of that water year. The way these conditions occurred amplified the stress on the interconnected surface water and groundwater system and led to increased streamflow depletion. Aquatic and terrestrial ecosystem impacts, and heat extremes in the valley and the upper watershed, highlighted the need for adaptive management approaches that will mitigate future climate effects. GSP implementation includes completion of three workplans in March 2024 that involve characterizing ecosystem habitats and streamflow needs to establish and/or refine water management criteria, promote more water conservation, and incentivize groundwater pumping reduction.

Historical water management approaches have been beneficial to maintaining water resources, but these efforts will be insufficient for achieving future sustainability under a changing climate. New nature-based solutions, including collaborative efforts to rehydrate the watershed, restore natural river system function, adapt to climate change, reduce drought vulnerability, and promote watershed stewardship are underway.

Napa Valley Subbasin

The Napa County Groundwater Sustainability Agency (NCGSA, or GSA) was created in December 2019 to manage groundwater resources consistent with SGMA for the Napa Valley Subbasin. A 25-member Groundwater Sustainability Plan Advisory Committee (GSPAC) was formed in June 2020 to advise the NCGSA

Board of Directors on the preparation of the GSP with policies and recommendations to manage and ensure the long-term protection and availability of groundwater resources within the Napa Valley Subbasin. On January 11, 2022, the NCGSA adopted the [Napa Valley Subbasin GSP](#) as recommended by the GSPAC. The GSP was submitted to the California Department of Water Resources (DWR) on January 31, 2022, and approved by DWR on January 26, 2023. In 2022, the NCGSA appointed a 5-member Technical Advisory Group (TAG), which is involved with GSP implementation, including addressing data gaps, considering groundwater conditions and actions needed to achieve groundwater sustainability, and assessing adaptive management approaches.

The sustainability goal for the Napa Valley Subbasin is:

- *To protect and enhance groundwater quantity and quality for all beneficial uses and users of groundwater and interconnected surface water in the Napa Valley Subbasin both now and in the future.*
- *The NCGSA will implement sustainable management criteria and an adaptive management approach supported by the best available information and best available science, resulting in the absence of undesirable results within 20 years from GSP adoption.*

The purpose of the GSP is to provide a detailed road map for achieving and maintaining sustainability in the Napa Valley Subbasin. The GSP development process involved key elements including:

- Characterizing geologic and groundwater conditions
- Developing historical, current, and projected (50-year) water budgets and estimating sustainable yield
- Defining sustainable management criteria for avoiding undesirable results (significant and unreasonable adverse impacts caused by groundwater conditions) related to six sustainability indicators:
 - chronic lowering of groundwater levels
 - reduction in groundwater storage
 - water quality degradation
 - land subsidence
 - depletion of interconnected surface water
 - seawater intrusion
- Identifying projects and management actions to achieve and maintain sustainability and avoid undesirable results.

Sustainable Management Criteria and Monitoring

Each sustainability indicator was evaluated and assigned quantitative minimum thresholds (MTs) and measurable objectives (MOs) to avoid undesirable results. MOs and MTs are metrics assigned for sustainability indicators at Representative Monitoring Sites (RMS) across the Subbasin. MTs represent values at which undesirable results may be occurring in the Subbasin; MTs are set to enable the NCGSA to avoid significant and unreasonable adverse impacts on beneficial users, including drinking water users, agricultural users, and environmental users. MOs represent the long-term target for conditions in the Napa Valley Subbasin. RMS networks in the Subbasin consist of wells, streamflow gages, remote sensing data, and land subsidence monitoring benchmarks. Data associated with groundwater conditions and the six sustainability indicators are stored in a Data Management System (and visualized here: [Napa County Groundwater Webmap](#)) to support ongoing assessment and reporting on groundwater conditions. Annual reports are submitted to DWR annually by April 1 and include information on groundwater levels, groundwater pumping, water use, changes in groundwater storage, and status of any projects and management actions being implemented. A periodic evaluation (i.e., a comprehensive GSP update) is required at least every five years.

Napa Valley Subbasin Sustainable Yield

GSP regulations require the GSP to quantify the sustainable yield for the Subbasin. Section 10721(w) of the California Water Code states that sustainable yield is defined as “the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result”. The sustainable management criteria described and defined above for the avoidance of undesirable results provide an important basis for determining sustainable yield. Once those criteria were established, the Napa Valley Integrated Hydrologic Model (NVIHM) was used to determine the amount of groundwater that can be withdrawn over a period representing long-term conditions while accounting for any temporary surplus. A critical aspect of the sustainable yield determination was consideration of interconnected surface water and ensuring that streamflow depletion would be similar to or less than occurred during the period from 2005-2014 (which includes dry water years). The sustainable yield of the Napa Valley Subbasin is approximately 15,000 acre-feet per year, which accounts for sustainable management criteria through the historical baseline and future model scenario periods.

GSP Implementation

The GSP is a living, dynamic document that guides expanded monitoring, including efforts to address data gaps, and implementation of projects and management actions as needed to achieve the Napa Valley Subbasin sustainability goal. Adaptive management approaches are an integral part of GSP implementation, including forward looking monitoring, water budget refinements, reporting and outreach, evaluation of sustainable management criteria, and assessments of the effectiveness of projects and management actions.

Interconnected Surface Water and GDEs, Water Conservation, and Groundwater Pumping Reduction Workplans

In coordination with the TAG, the NCGSA has prepared five workplans as part of GSP implementation, including the [Napa County Water Conservation Workplan](#), [Groundwater Pumping Reduction Workplan](#), [Stormwater Resource Plan](#), [Interconnected Surface Water and Groundwater Dependent Ecosystems \(GDEs\) Workplan](#), and a [Communication and Engagement Plan](#). Protecting and enhancing streamflow conditions, especially during the dry season, is of paramount importance to stakeholders and environmental users, including groundwater dependent ecosystems. Groundwater use has increased during the recent drier and hotter years leading to undesirable results (as defined in the GSP), including intensified streamflow depletion. Concurrently with workplan implementation, groundwater use policies are under development to achieve the Subbasin sustainability goal, including to protect and enhance groundwater quantity and quality for all beneficial uses and users of groundwater and interconnected surface water in the Subbasin both now and in the future.

Climate Change: Hotter and Drier Conditions

California’s first recorded six-year drought began in 1987. The 2020-2021 very dry, two-year period is just one part of a changing California climate where “we are experiencing extreme, sustained drought conditions in California and across the American West caused by hotter, drier weather. Our warming climate means that a greater share of the rain and snowfall we receive will be absorbed by dry soils, consumed by thirsty plants, and evaporated into the air” ([California’s Water Supply Strategy](#), Adapting to a Hotter, Drier Future. Governor’s Office, August 2022). In addition to the Water Supply Strategy, the [California Water Plan](#), the [Water Resilience Portfolio](#), and the draft [Climate Adaptation Strategy](#) recognize the importance of water conservation in safeguarding water resources and preparing California communities for more extreme drought and precipitation conditions.

Like elsewhere in the United States and the world, Napa County is experiencing weather extremes. Napa Valley groundwater pumping, temperature, and evaporative drought demand (a thirstier atmosphere) for the period from 1988 to 2022 showed increasing trends, especially during the recent hotter, drier years.

Temperatures, compared to the 20th century average, have increased since the 1960s. Historically, the Napa Valley experienced typical cycles of drier and wetter conditions where groundwater levels would correspondingly decline and replenish in response to greater and lesser water demands and/or supply augmentation. The NCGSA can no longer rely on such cycles; there is no “new normal”. However, over many decades, there are obvious signs that there is a building global, state, and local climate urgency that brings:

- Extreme weather
- Changed hydrology
- Shifting patterns of precipitation and streamflow
- Thirstier air, increased temperatures
- Changes to how groundwater recharge occurs
- More potential hazards (e.g., flooding, fires, extreme drought)

The [Fifth National Climate Assessment](#), published in Fall 2023, presents current conditions as well as multiple climate scenarios for the United States. Four climate scenarios were assessed, which are based on 1.5°C (2.7°F), 2°C (3.6°F), 3°C (5.4°F), and 4°C (7.2°F) increases in global temperature. All four climate scenarios predict Napa County is likely to experience higher hot temperatures, higher low temperatures, more precipitation, and more extreme precipitation events.

Climate Adaptation: There is No “New Normal” – There is Uncertainty

In 2023, the California Governor’s office continued to emphasize that “while recent storms have helped ease drought impacts, regions and communities across the state continue to experience water supply shortages, especially communities that rely on groundwater supplies that have been severely depleted in recent years.” The Governor’s office also said that “next winter’s hydrology is uncertain and the most efficient way to preserve the State’s improved surface water supplies is for Californians to continue their ongoing efforts to make conservation a way of life” (Governor’s Executive Order N-5-23). On March 28, 2023, a presentation to the NCGSA on the Water Year 2022 Annual Report concluded with the recommendation --whether it’s drought or deluge – that **“Conservation be a Napa Way of Life.”**

In May 2023, TAG members provided feedback on GSP implementation efforts, including their perspectives on climate change adaptation and building resiliency to climate variability and future drought. Key points from those deliberations include:

1. The need for conservation will not go away.
2. There is a need to think beyond just water conservation towards building a buffer and resilience.
3. During wet years, it is important to hold some water over either in the ground or in surface water for sustaining the drier years.
4. Educate the public that this is an ongoing effort that does not depend on the type of water year.
5. Think beyond SGMA and how the County is going to manage water resources for many decades.
6. The groundwater and interconnected surface water system is very responsive; the system receives some amount of recharge annually during the rainy season and then that water is extracted and used in the dry season. However, the groundwater system and surface water reservoirs have limited storage capacity, so there is a need for behavioral change.

Public education is critical to shift the thinking and actions of groundwater users from short-term views of conditions (drought or no drought) to long-term stewardship by:

1. Embracing water conservation as a way of life;
2. Adopting permanent changes in lifestyles or business practices relating to water use and management;
3. Reframing the mindset around promoting and enhancing natural groundwater recharge to appreciate the environmental benefits and climate adaptation provided through such actions instead of focusing on individual benefits from water that could be available to pump; and

4. Establishing measures to build resilience to hotter and drier conditions and achieve long-term sustainability.

On July 3, 2024, the California State Water Resources Control Board will consider a [Draft Resolution](#) to adopt a proposed Regulation to [Make Conservation a California Way of Life](#).

Subbasin Recharge and Watershed Rehydration

While the degree of change resulting from future climate change is uncertain, national, state, and local data show shifting climate patterns and trends. Long-term adaptive management strategies and measures implemented to optimize recharge opportunities and conserve water can help minimize the local impact. Increases in extreme precipitation events offer potential opportunities to increase recharge through best management practices and on-farm strategies to retain precipitation, enhance infiltration, and augment groundwater supplies. Vineyard managers and operators are evaluating opportunities to retain water on the landscape and increase infiltration including cover crops that build soil health and biodiversity, tile drainage capture and reuse, onsite rainwater storage and in lieu use of that water to lessen or delay groundwater use, and other best management practices that achieve increased water conservation. If many growers implement new or expanded approaches that work best for their operations, these efforts could scale up to significant Subbasin benefits. Grower education, collaboration, and commitments to watershed stewardship are critical aspects of these activities.

ABUELITOS Foundation

The ABUELITOS Foundation, newly formed in 2023, is a Napa grapegrower and landowner collaborative focused on addressing groundwater recharge, forest fuel management, and habitat enhancement. The primary goal is to enhance climate resilience and promote regional cooling by restoring natural hillside infrastructures designed to detain water, thereby increasing and prolonging its flow throughout the entire watershed system. The Foundation along with a diverse coalition of community, state, and federal partners, including Napa County, the Napa County Resources Conservation District, U.S. Geological Survey researchers, vineyard managers and others, are spearheading a pioneering initiative focused on ecological stewardship and sustainability. Project planning for one or more test sites in the Napa Valley and upper watershed is underway for implementing a catchment-scale, proof-of-concept model aimed at addressing a range of ecological objectives, including soil health and stability, watershed rehydration through innovative interventions spanning from uplands to floodplains, and the enhancement of forest health and resilience. Building upon established methodologies of integrating rehydration interventions with carbon management across landscapes, this project stands to make significant strides in mitigating climate extremes and fostering landscape-level stewardship.

This collaborative effort has the potential to harness the collective power and influence of diverse stakeholders, including the wine industry, community groups, natural resource agencies, and Indigenous communities, in designing a stewardship model that fosters resilience across multiple domains. Project insights will inform other landowners and communities seeking to replicate these practices, thereby contributing to the broader goals of sustainable land management and environmental stewardship. The initiative will not only set a precedent for viticulture but also amplify the reach and impact of sustainable practices on a global scale, influencing policies and practices far beyond its borders.

The entire community shares the responsibility for water resources sustainability. Napa County is encouraging collaboration and innovation to build pathways for a sustainable future, including increasing water conservation, advancing multi-benefit recharge and restoration efforts, adapting to climate change, reducing drought vulnerability, and promoting watershed stewardship by all who live and work in the county.

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 9: Eva Dominguez, Self Help Enterprises

Written: 6/28/2024

Subject: Groundwater

Hello PCAST members,

Attached are responses to your questions from Self-Help Enterprises, a housing and community development nonprofit organization based in Visalia, California. We thank you for the opportunity to provide these ideas and hope that they are useful in your endeavor to seek more information on groundwater across the nation. For follow up questions, feel free to respond to this email or call me at 559-802-1634.

Thank you,

Eva Dominguez

Eva Dominguez

Manager

Self Help Enterprises

Attached: PCAST Groundwater – SHE Response



**Self-Help
Enterprises**

A Nonprofit Housing and Community Development Organization

June XX, 2024

RE: PCAST Welcomes Public Input on America's Groundwater Challenges

Submitted via email to: pcast@ostp.eop.gov

Dear PCAST members,

Thank you for the opportunity to provide ideas and comments on addressing groundwater challenges across the country. Self-Help Enterprises (SHE) is a nationally recognized housing and community development nonprofit organization based in California's San Joaquin Valley with over 45 years of experience working with historically underserved, rural disadvantaged communities to improve their drinking water and wastewater infrastructure. In addition to our work directly with disadvantaged communities, we have been engaged with California's Sustainable Groundwater Management Act (SGMA) since its inception ten years ago. SGMA is a law that was established to halt overdraft and bring basins into balanced levels of pumping and recharge, thereby reaching sustainability.

We provide the following comments and ideas based on our experience with the implementation of SGMA as well as our work with communities.

How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

Data collection and sharing of data should be coordinated with various state agencies, universities and other research facilities, and non-governmental organizations (NGOs), such as environmental groups or drinking water advocates. It has been our experience in California that aligning data from these different groups and the cross-sharing of data has given a good picture of the current state of groundwater in various areas. Where data was unavailable, local Groundwater Sustainability Agencies (GSAs), formed through SGMA, have worked to install monitoring well networks, encourage or require agricultural users to install meters on their wells, and coordinated with the state agencies to complete airborne electromagnetic (AEM) surveys to gain a better understanding of current groundwater conditions.

Time and funding may be the most important resources that can be provided for data collection purposes as data collection systems can take years to set up and produce actual data. We encourage the allocation of funds specifically for the development of data collection systems at the local and regional level as well as data analysis and storage at the state level.

How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

Effective statistical models can be created using historical data from differing state's topography to forecast inventory and recharge of groundwater. First, known/validated historical data should be gathered into one accessible location with recent/current data findings added per topographical regions.

Standardized data reporting systems and a process for current and future data should be established. Land use data, current and planned, should also be included; this would consist of information on whether land could be used for agricultural use, current or future environmental rehabilitation, current or planned housing or other development, and other planned updates to the area. Models would then be developed for predictability that include land use changes, existing and/or future policies for land and water use, and water rights.

It is important to ensure that adequate water quality monitoring is conducted to be included in the model and that soil testing be conducted prior to recharge. Recharge goals should be based on statewide water availability taking into consideration local and regional needs and should include buffers for short term climate changes and long-term drought resiliency.

How can we efficiently scale groundwater recharge while mitigating risks?

Recharge efforts should be coordinated with state agencies and other stakeholders to obtain data to create maps to better direct recharge. Maps could help to find areas where recharge may be more favorable and avoid impacts to drinking water.

Studies should be conducted to identify the potential benefits, such as reducing flood risk, or negative impacts to neighboring communities and private well users. If potential negative impacts are identified, security considerations should be provided to ensure that recharge projects do not cause or increase groundwater contamination. This could include planning for additional monitoring sites for water quality near recharge sites. Additionally, projects and programs should be registered and validated to be eligible to receive credits. Projects that provide specific benefits to disadvantaged communities could also be incentivized to receive state or federal funding.

How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

There are various efforts that could be implemented to ensure that groundwater is safe and clean for communities. Limiting the number of agricultural or industrial wells near community water systems will ensure that sources are not depleted near a community and may help ensure contaminant plumes do not make their way to areas where communities are located. Placing particular attention that water used in recharge basins or other recharge efforts does not contain contaminants of concern or is percolating through contaminated soils will help reduce the risk of water quality issues for communities and domestic well users. Proper monitoring networks around recharge basins neighboring communities should be set up to monitor the water quality, especially for contaminants of concern. Wherever possible, natural infrastructure should be used for recharge near communities, and projects that are implemented should be beneficial for all types of users.

Domestic well users and communities should be informed and included in decision making spaces when a recharge project is being planned and should be aware of any potential contamination risks. Where it is known that contamination could be a potential side effect to recharging water, a mitigation program should be developed to provide domestic well users and communities with interim water supplies and funds for permanent solutions. Grant funding from federal and state sources should be provided in conjunction with funding from local agencies to supply water treatment filtration systems in case of an

emergency and contaminant exceedances. SHE has worked with the State Water Resources Control Board (SWRCB) to implement programs that provide interim solutions and support with securing permanent solutions for domestic well users in the San Joaquin Valley and is working to establish partnerships with GSAs to implement mitigation programs through SGMA. Recently, a new agreement was established with the Kaweah Subbasin GSAs to begin SHE's support in implementing their mitigation program for their region.

How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

It is essential to keep communities informed and involved in decision-making when it comes to groundwater issues. In the San Joaquin Valley, the majority of small rural communities are fully reliant on groundwater for their water source and have historically been excluded from decision-making spaces. Some key strategies for keeping community residents informed and involved are:

- **Making meetings accessible:** Hosting meetings within communities on days and times that maximize participation, such as weekday evenings or Saturdays. Having a hybrid meeting with a virtual option may also increase participation as those without the ability to travel to the meeting or with other obligations may be able to attend. Additionally, providing a light meal or childcare during meetings can alleviate familial obligations that make it difficult for some residents to attend.
- **Language accessibility:** Ensuring language accessibility for residents within the community will increase understanding of available materials and during presentations. Hiring interpreters for public meetings to provide access to other languages spoken by a significant percentage of residents is critical. Gauging language needs for the communities in different areas should be included as part of any effort.
- **Working with community leaders:** Connecting with existing community leaders will allow the opportunity to work with an individual or group that have gained trust with residents. Building a relationship with community leaders and partnering with them to share information will create a line of communication with residents. Programs have been developed in the public health realm where community leaders are provided with capacity building and training on a specific topic, and those leaders become Community Navigators or Promotores/Promotoras that help to share information with communities. Providing funding to build a similar program of Community Navigators to support in distilling information on groundwater could provide not only a better opportunity for engagement but also employment for those community leaders who are typically volunteers.
- **Compensating participation:** Providing stipends for community residents to participate in decision-making spaces and discussions around groundwater would help with improving engagement. Agencies, NGOs, and some private companies often send paid staff to meetings, and this opportunity is not widely available to members of the public. Many of the residents are unable to take time off work without risking losing that day's wages or have familiar obligations that prevent them from attending meetings. While a stipend may not end every obstacle that residents have to overcome, it is incredibly helpful to increase engagement.
- **Transparency:** Ensuring that there is full transparency and information available on the potential harms related to projects, like recharge, that are implemented in their area. Residents should be informed of potential degradation of groundwater quality, increase in mosquitos due to

standing water, plans for what will happen when sites are not in use, and any other decision that could have an impact on their health and well-being.

- **Groundwater education from early ages:** Establishing a K-12 program that educates students about groundwater at all levels is essential in ensuring that future leaders are fully educated on the various issues and decisions that have been made around groundwater management. Developing a robust groundwater science program that could be used across the country would be a good first step towards preparing future leaders to take over the various roles in managing groundwater.
- **Investing in local NGO support:** As an NGO that educates and supports communities in engaging with groundwater management, additional funding for NGOs to continue that type of work is needed. SHE's work specifically focuses on providing workshops to community residents and leaders and working with communities to ensure they are aware of and engaged with efforts in their area that may impact them. Additionally, we provide comments and work with agencies to ensure communities and domestic well owners are considered when planning and implementing new projects and policies.

What strategies and incentives can help limit groundwater over-use?

Much of the over-use in California is caused by increased pumping by agricultural and industrial users, especially during periods of drought. As the users with the most resources, agricultural and industrial users can more easily drill new wells compared to disadvantaged communities or low to moderate income domestic well users. There are often times that agricultural wells, in particular, have major impacts on community or domestic wells causing the wells to go dry or become contaminated. Our recommendation would be to apply more restrictions to agricultural and industrial wells to ensure drinking water is being more protected.


Additionally, incentivizing growers to plant crops that require less water instead of crops that are more water-intensive, such as almonds and pistachios. Disincentivizing giant corporate land purchasing, particularly by foreign companies for investment gain, is highly encouraged as these giant corporations tend not to consider, nor be held accountable for, negative impacts on local communities, over-pumping, exporting groundwater, and opportunities for local employment and training.

Incentivizing other land use efforts can also reduce the amount of over-use. Consider opportunities for multi-benefit projects that could create a buffer between agriculture and community drinking water. Recharge efforts should be paired with efforts to curb and control overpumping of groundwater. Under SGMA, agencies are planning for sustainable groundwater use at the local/regional level by implementing fee structures for those who continue to overpump in addition to recharge efforts. Additional support may be needed from state agencies to successfully implement those fee structures. Ensuring that all wells are metered is a key first step, which has proven to be difficult.

Decisions and policy should be based on actual, sound, and ground-truthed science using appropriate data. Local agencies should be encouraged to collect as much as data as possible early in the process to avoid impacts to neighboring agencies. State agencies should provide technical support to agencies to ensure that data is accurately analyzed and is not being misconstrued for any personal gain.

Thank you once again for the opportunity to provide our ideas and comments on these questions. We hope that they are helpful as you begin your effort. If you have any questions or need to follow up on any of the items above, please contact Eva Dominguez at EvaD@selfhelpenterprises.org or 559-802-1634.

Sincerely,

DocuSigned by:

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WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 10: Ryan Flickner, Kansas Farm Bureau

Written: 6/29/2024

Subject: Groundwater

Groundwater Working Group,

I am submitting these responses on behalf of Kansas Farm Bureau (KFB) members. KFB is the state's largest general farm organization representing more than 30,000 farm and ranch families through our 105 county Farm Bureau Associations. As an organization, our members have spent considerable time and energy over the past decade taking a deep dive and discussion into ground water issues in the state of Kansas.

Q How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

Groundwater is a state issue. We do not support the federal government creating any regulatory program to control groundwater use, levels, elements, or flow in any way. Partners such as USGS and the Kansas Geological Survey (KGS) have assisted in identifying both water quality and quantity items to consider. Our Kansas Department of Agriculture-Division of Water Resources (KDA-DWR) has been a leader in requiring water usage reporting (WUR) for all non-domestic use going back to 1988. Annual WUR's include options for reporting groundwater information on static water levels. The state, through agreements with Groundwater Management Districts (GMDs), KGS and KDA-DWR, measures over 1,400 ground water wells annually to collect static water level information over the High Plains Aquifer. KGS also maintains a handful of index wells that continuously record water levels and provide near real-time telemetry which is available to view online. Kansas leads the nation in collecting water use information, and we are proud to be an active participant in these collections.

Q How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

Kansas collects detailed annual water use, static groundwater level and instantaneous streamflow measurements. Most of the High Plains Aquifer is hydrologically modeled. Efforts are underway by the KGS to use electromagnetic imagery technology to get a 3D view of the aquifer. Kansas is using the "Q-stable" approach (a model depicted by KGS) to depict the percentage in pumping reduction required to get short-term (5-15 year) stable water levels. This information can help define future/further reduction goals. State Water Plan (SWP) strategic implementation meetings are currently underway across Kansas.

Q How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

We must promote communication between federal, state, and local water officials – including regulators, planners and research scientists. We believe the coordination of various programs to voluntarily monitor water quality, implement best management practices (BMPs), provide easy, public access to water quality test results, and incentivize water treatment to achieve drinking water quality standards will be beneficial. These efforts should focus on not only public water supply systems but also **private, domestic water**

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supply systems. Testing must be voluntary and information sharing should protect confidentiality of individuals and not jeopardize property values.

Q How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

Statewide State Water Plan (SWP) implementation strategic planning is currently underway. Kansas has mature water law granting all water right holders a **priority number** (prior appropriations doctrine) to help distribute the available water supply in the event of shortage. **These water rights are real property rights.** Once all the data is assessed and goals are defined then all available resources to incentivize voluntary reductions must be utilized. If these efforts do not achieve the goal, then water rights administration should be implemented. Programs should be created to help establish markets for the right to use water to offset reductions. **These markets will never develop unless water rights priority, as granted in Kansas water law, is respected.** Kansas water law **prohibits preferential use** in the distribution of water. By creating a market to buy, sell and trade water, water will migrate to its highest and best use and conservation will be rewarded.

Q What strategies and incentives can help limit groundwater over-use?

Creation and utilization of voluntary, incentive-based conservation practices. Education on the economic return of water consumption.

Please do not hesitate to reach out if we can be of further assistance.

Ryan Flickner
Senior Director, Advocacy
Kansas Farm Bureau

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 11: Justin Iverson, Oregon Water Resources Department

Written: 6/29/2024

Subject: Groundwater: Actionable Idea

PCAST Groundwater Working Group,

In response to your invitation for public input on America's Groundwater Challenges, and specifically regarding your question, "How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?"

The Oregon Water Resources Department has developed groundwater flow models in four groundwater basins and uses them to inform groundwater resource management. These modelling efforts and their foundational studies were conducted in collaboration with the U.S. Geological Survey (USGS) with support from the Cooperative Matching Funds (CMF) program. The Water Availability and Use Science Program (WAUSC-CMF) currently and effectively supports such applied, collaborative science across the country. The results of these studies conform to the USGS Fundamental Science Practices (FSP) and are made publicly available to stakeholders and decision-makers through the USGS Scientific Publishing Network (SPN).

In Oregon, as in other states, the demand for CMF funding exceeds the current federal appropriation of CMF funds. Increasing CMF funding for the USGS Water Availability and Use Science Program (WAUSP) budget area will directly and efficiently provide additional capacity to meet this identified need. This federal investment is directed and leveraged through cost-share cooperative agreements with State, regional, Tribal, and local partners. Cooperative projects allow the "USGS and its partners to respond to significant or emerging water issues in a timely manner. ... Because consistent USGS national protocols are used to monitor and assess water resources, water data are directly comparable at the regional and national scale and water issues in a specific location, watershed, or aquifer can be compared to those in other geographic regions and across different time periods. Such comparisons allow for large-scale synthesis and problem-solving across state lines, in regional watersheds or aquifers, and nationally." - [USGS Cooperative Matching Funds | U.S. Geological Survey](#)

I urge you to consider advancing federal government action on groundwater by recommending increased support for the USGS Cooperative Matching Funds program.

Thank you,

Justin Iverson

GROUNDWATER SECTION MANAGER

Oregon Water Resources Department

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 12: Sarah Palmer, Colorado Open Lands

Written: 6/30/2024

Subject: Groundwater

To Whom it May Concern,

On behalf of Colorado Open Lands, I would like to offer input on an innovative incentive to voluntarily and permanently reduce groundwater pumping. Just this past week, I was invited to give testimony to the Senate Subcommittee on Conservation, Climate, Forestry, and Natural Resources on this concept and our work to date, which I believe could be replicated.

Thank you for your commitment to exploring this challenging issue. I welcome any questions or follow-up you may have.

Sincerely,
Sarah Parmar

SARAH PARMAR
DIRECTOR OF CONSERVATION

Attached: COL PCAST Groundwater Letter

June 28, 2024

President's Council of Advisors on Science and Technology
pcast@ostp.eop.gov

Re: Groundwater

Ms. Fung, Mr. Kiani, Mr. Pacala, Ms. Greene and Ms. Woteki:

Colorado Open Lands wishes to submit the following input for your consideration regarding the advance of government-wide action on groundwater; specifically incentives for voluntary, permanent reduction of groundwater by current users. Colorado Open Lands works to preserve the significant open lands and natural heritage of Colorado through private and public partnerships, innovative land conservation techniques and strategic leadership. We are pioneering the tool of groundwater conservation easements to strategically incentivize landowners to limit groundwater over-use and to protect important groundwater resources in Colorado's San Luis Valley. We hope that our innovative work in this field could be replicated at scale across the United States.

Groundwater conservation easements are an adaptive modification to the trusted and widely-utilized land conservation tool of the conservation easement. These easements are voluntary and perpetual legal agreements between a land trust and a landowner, tailored to each property, which restrict certain uses of a property in order to maintain the public benefits that property and its water provide, such as agricultural production and wildlife habitat. A landowner is eligible for different financial incentives for donating or selling a conservation easement to a governmental entity or other eligible conservation easement holder (such as a nonprofit land trust, like mine).

Characteristics of all conservation easements:

- Voluntary: between a willing land and water rights owner and a willing holder, like Colorado Open Lands
- Permanent: they are binding on the landowner that completes the easement and future owners
- Specifically tailored to a property: there are some parts of a conservation easement that are consistent across holders and different properties, but the main terms of the agreement are based on the characteristics of a particular farm and ranch
- Land Ownership and Access: ownership of the land and water rights remains in private hands, but it is now subject to certain restrictions. Landowner retains the right to control access to their property.

Conservation easements are a trusted tool for protecting land from development, but for many communities, threats to water resources, including groundwater, overshadow the threat of land development. The groundwater conservation easement uses the same overall premise and legal authority as a land easement, but the primary focus of the agreement is to restrict the amount of groundwater consumed on a property to address aquifer sustainability. The amount of reduction

can be tailored to each individual easement; anything from full retirement of a well or wells, to a smaller percentage reduction in annual pumping based on previous pumping rates.

Groundwater Conservation Easements benefits:

- Voluntary tool for farmers and ranchers that addresses the most urgent threat as their communities are impacted by a changing climate
- Flexible terms allow easements to be regionally tailored and support water reduction with agricultural production
- Aquifer recovery can boost stream flows and enhance wetland function, maintain and improving critical habitat

Groundwater conservation easements are unique in that they allow landowners great flexibility around how groundwater-use reductions are achieved; for example, it could be done by switching to a lower water use crop, or by rotationally fallowing a field. This incentivizes water savings while supporting the agricultural economy. This voluntary tool supports farmers and ranchers who want to be part of the solution and wish to continue farming or ranching. The conservation easement ensures water remains in the aquifer (and cannot be pumped by another user) and can provide protection for the land.

Alternatively, the USDA's Conservation Reserve Enhancement Program (CREP) is currently the only federal program available to incentivize farmers to use less groundwater. This program pays a landowner to fallow (retire) their field from agricultural production. While effective at reducing groundwater use, this program can have a negative effect on agricultural economy by requiring that no production occurs and may have a threshold of enrollement within an agricultural community where many irrigators hope to continue to farm while using less water.

As the Rio Grande journeys from its headwaters within the San Juan Mountains, it flows through Colorado's San Luis Valley, the largest alpine valley on earth and the highest valley capable of sustaining large scale crop production. While the San Luis Valley is unique in many ways, it shares a common resource challenge with many places around the United States – a declining groundwater aquifer. Groundwater pumping for irrigation beyond the recharge capacity of the basin is causing injurious depletion to senior surface water rights holders and may be impacting riparian ecosystems. A historic drought in 2002 revealed the unsustainable nature of the current level of groundwater withdrawals, leading the state of Colorado to impose a deadline for the community to come to a solution or face a shutdown of groundwater wells. If the state's mandate to replace injurious well pumping and to bring the aquifers back to sustainable production levels cannot be met, there is a serious risk that thousands of wells will be shutdown. Such an order was just announced in Idaho within the last month, when the state's water agency ordered the shutdown of wells which could impact half a million acres of agricultural land, in what is being described as the largest curtailment in the state's history. If a similar sudden shutdown of wells were to occur in the San Luis Valley, it will have catastrophic socioeconomic and environmental impacts.

In the San Luis Valley, irrigated agriculture is critical because it drives the majority of the region's economic activity and creates food sources and habitat for migrating birds and wildlife. A recent comprehensive wetland conservation survey found that 70% of wetland acres in the San Luis Valley are found on private lands fed by irrigation; this rich wetland network, supported by irrigation and impacted by groundwater levels, provides critical habitat for a variety of waterfowl

and most prominently, for the thousands of Sandhill Cranes that stopover in fall and spring ¹. Irrigated agriculture contributes over \$357 million in production and accounts for one-third of the region's base economy.² With a forced well shutdown looming from the state engineer's office, producers face the prospect of receiving no payment to retire wells. A forced shutdown from the state could be devastating to the interconnected web of producers, local businesses and households. One study estimated a 24,500 (AF) reduction equally split between irrigators without landowner compensation could reduce the economic output of the region by approximately \$30 million – a devastating blow in a region with limited alternative economic opportunities.³ While a regulatory shutdown could solve the singular issue of unsustainable groundwater pumping, it would create other issues, impacting wetlands, and inequitably harming farm families, especially those on the margins.

Producers in the San Luis Valley have not had their heads in the sand, but instead have been working for decades to avoid direct state intervention in the form of well shutdowns. Irrigators from six groundwater subdistricts of the Rio Grande Water Conservation District and one subdistrict of the Trinchera Water Conservancy District are participating in voluntary programs to reduce groundwater pumping. To achieve pumping reductions, the subdistricts currently utilize the Conservation Reserve Enhancement Program (CREP) and short-term fallow programs and drought contracts. However, in the context of ongoing droughts and given the necessary volume of recharge, the scale of these efforts is insufficient to achieve basin sustainability as quickly as needed.

In 2018, Colorado Open Lands and the Rio Grande Headwaters Land Trust, two Colorado non-profit land conservation organizations focused on land and water conservation in the San Luis Valley, began conversations with the Rio Grande Water Conservation District, San Luis Valley Water Conservancy District, and Conejos Water Conservancy District to explore whether and how traditional land conservation tools, especially conservation easements, might be modified to focus on groundwater depletion.

As partners, we began by hosting listening sessions in each of the seven groundwater subdistricts to understand what kind of a program would be of interest to irrigators to support their voluntary reduction of groundwater. The feedback from producers was that many of them are not interested in a program that requires full fallow of their land. They want to be part of the solution, but many want to remain in agriculture, so are interested in compensation for reduction, but with the ability to use less water, and especially the flexibility to shift water across their farm fields. What we heard from water managers was that permanence of water savings in the aquifer would be critical to avoid a yo-yo effect in storage. All agreed that certainty is valuable for

¹ Wetland Dynamics, LLC. "San Luis Valley Wetland and Wildlife Conservation Assessment, Second Edition." May 8, 2019. https://wetlanddynamics.com/wp-content/uploads/2020/04/SLVWetlandWildlifeConservationAssessment_Final_Edition2.pdf

² San Luis Valley Development Resource Group and Council of Governments. "2022 Annual Comprehensive Economic Development Strategy (CEDS) and Progress Report." December 31, 2022. <https://www.slvdr.org/wp-content/uploads/2023/06/2022-SLVDRG-EDA-Annual-Report.pdf>.

³ Rebecca Hill James Pritchett. "Economic Impact Analysis and Regional Activity Tool for Alternative Irrigated Cropping in the San Luis Valley." Colorado State University. August 2016. <https://watercenter.colostate.edu/wp-content/uploads/sites/33/2020/03/SR28.pdf>

planning and investment and that investment could not come from the community alone, when already, the median household income in the San Luis Valley is much lower than that of the average household in Colorado (60% lower in 2010).⁴

A working group consisting of the partners, together with staff of the Colorado Division of Water Resources, water attorneys, a conservation easement attorney, and appraiser with expertise in both water rights and conservation easements, embarked on a feasibility study to adapt a traditional conservation easement as a tool to address aquifer decline. We believe that we have created a tool with the following qualities: a conservation easement can be permanent and legally enforceable in perpetuity, it can qualify for tax incentives and/or funding incentives, including Farm Bill programs, it can be tailored to a specific region and a specific property, and it can support water reduction with agricultural production, specifying a permanent amount of pumping reduction, while allowing the landowner to manage how they achieve water savings.⁵

Colorado Open Lands completed the first groundwater conservation easement on a farm in the northern part of the San Luis Valley which will save 1,700 acre-feet per year (enough to support approximately 3,500 households). The water savings from this farm allows the other farms in that groundwater district to continue irrigation. The farm is hydrologically connected to San Luis Creek, supporting wetlands and key habitat. The groundwater pumping reductions on the farm will help in the recovery of the confined aquifer and, in turn, help support resilient habitat communities on significant wildlife lands to the south, including the Baca National Wildlife Refuge. Compensation for this conservation easement was determined through an appraisal, which considered comparable sales of fully irrigated farms to sales of farms which were water-short, to determine the value of the foregone groundwater pumping. This landowner utilized Colorado's state income tax credit for conservation easements, claimed a federal tax deduction, and was partially compensated by a state grant to Colorado Open Lands, as well as funding from a private foundation.

Colorado Open Lands explored funding for groundwater conservation easements under the Agricultural Conservation Easement Program (ACEP); however, because the purpose of that program has been to maintain agricultural viability, national staff had concerns that reducing irrigation or changing the type of agricultural production that is feasible through a groundwater conservation easement could be incompatible. Colorado Open Lands was encouraged to pursue a Regional Conservation Partnership Program (RCPP) grant as an alternative and was awarded funds to partially purchase voluntary groundwater conservation easements that will restrict pumping to allow for aquifer recovery with continued agricultural use and to pay for land management expenses to transition agricultural operations under different scenarios that will protect soil health and wildlife habitat. However, despite our phenomenal NRCS partners here in Colorado and our organizational experience successfully implementing Farm Bill Programs, we have found the Regional Conservation Partnership Program to be exceptionally challenging to utilize for conservation easements, and an impediment to achieving the impacts we hoped to see with regard to aquifer recovery in the San Luis Valley.

⁴ Early Childhood Council of the San Luis Valley. "Community Assessment of the San Luis Valley." 2016. <https://www.slvdrg.org/wp-content/uploads/2017/05/Economic-Impact-Analysis-and-Regional-Activity-Tool-for-Alternative-Irrigated-Cropping-in-the-San-Luis-Valley.pdf>.

⁵ Colorado Open Lands. "Water Conservation" 2024. <https://coloradoopenlands.org/water-conservation/>.

On the other hand, the Agricultural Conservation Easement Program, or ACEP, is widely known and utilized and has program staff who understand real estate transactions. I believe that the creation of a Groundwater Conservation Easement Program under ACEP, as called for in the Voluntary Groundwater Conservation Act sponsored by Senator Bennet, would create the necessary purpose and provide an impetus for the agency to build expertise in water rights (or delegate authority to State Conservationists who can work with entities like COL to demonstrate compliance with state water law in order to enact and enforce groundwater conservation easements). The creation of even a pilot program in the upcoming Farm Bill reauthorization would enable NRCS and partners to undertake the necessary trial and error inherently involved in the development and successful implementation of a new tool under different water law and administrative regimes. State block grant funding could also allow for adoption of accurate and precise measurement of groundwater withdrawals.

In the last two years, I have spoken with dozens of water managers and land trusts across the majority of western states who are interested in groundwater conservation easements as a tool they might bring to their region or community. A groundwater conservation easement is not a silver bullet, but it is another arrow in what needs to be a growing quiver to address a critical natural resource issue. More tools, including groundwater conservation easements, are needed to support farmers across the west who want to keep farming with less water. We need to facilitate reduction with production, to keep farm communities alive while we recover aquifers.

Support at the federal level to scale the implementation of groundwater conservation easements is needed. Reauthorization of the Farm Bill with the inclusion of a Groundwater Conservation Easement program under the Agricultural Conservation Easement Program (ACEP) is an important step to further the abilities of federal agencies and conservation partner organizations to further explore and implement this tool across a number of aquifer geographies where groundwater depletions are a significant concern.

Thank you for your consideration.
Regards,

Sarah Parmar

A handwritten signature in black ink, appearing to read 'Sarah', with a stylized flourish at the end.

Director of Conservation
Colorado Open Lands

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 13: Raelynn Parmely, Illinois Farm Bureau

Written: 7/1/2024

Subject: Groundwater – Comments to PCAST

To whom it may concern,

Please accept the attached comments for PCAST's call for input on groundwater challenges.

Thank you,

Raelynn Parmely
Environmental Program Manager
Governmental Affairs and Commodities Division
Illinois Farm Bureau

Attached: Groundwater_June 2024



June 28, 2024

President's Council of Advisors on Science and Technology (PCAST)
Submitted via pcast@ostp.eop.gov

RE: PCAST Welcomes Public Input on America's Groundwater Challenges

Illinois Farm Bureau (IFB) respectfully submits these comments on behalf of our farmer members, in response to the President's Council of Advisors on Science and Technology (PCAST) request for information on groundwater use, recharge, and storage.

IFB is a member of the American Farm Bureau Federation (AFBF), a national organization of farmers and ranchers. Founded in 1916, IFB is a non-profit, membership organization directed by farmers who join through their County Farm Bureau (CFB). IFB has a voting membership of more than 73,000.

IFB Policy

IFB policy states the following with regard to water resources:

We believe that the ability of a landowner to reasonably use water on or beneath is a right to be enjoyed. This right should not be taken without due process of law. Just compensation should be given to those regions or individuals whose ability to use the water is diminished.

We believe agricultural uses must receive a high priority in the allocation of water supplies. Consideration should be given to businesses or consumers which would feel an economic impact from water restrictions.

IFB policy supports the development of programs and resources that focus on providing technical assistance and education to farmers. These programs must provide financial incentives and other non-punitive means to encourage voluntary compliance to addressing water resource concerns. Water supply issues, including those for groundwater, remain a priority among our membership and will remain a point of discussion in future policy development processes.

Groundwater Challenges

IFB agrees that groundwater is a critical resource and that numerous challenges exist regarding its use and recharge. Groundwater is an important resource for rural communities and farmland across Illinois, including for providing drinking water for

families and livestock, irrigation, and supplying water to industrial processes. It is crucial that agricultural stakeholders are included in conversations about groundwater and that the voices of farmers are heard.

1. How can we enhance the timely collection of data on groundwater inventory, use, recharge and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

IFB supports farmers owning the information generated on their farming operations. Any government-wide actions involving data collection of groundwater use, recharge, and flow on farming operations should make diligent efforts to protect farmer privacy. To manage this, any adopted data collection efforts should:

- Explicitly identify all data that will be generated and shared.
- Identify the purposes for any data collection, who will receive the data, who the data could potentially be shared with, and whether the farmer can limit the use and disclosure of information.
- Not require sharing information without consent.
- Should be kept private the maximum extent possible. If a government entity were to become a collector of farm-scale groundwater data, individual farmer's information should be protected from being disclosed pursuant to Freedom of Information Act requests.

State-led groundwater data collection programs and resources, such as those at state land grant universities and geological and water surveys, should be prioritized. For example, the Illinois State Water Survey already oversees several groundwater data collection efforts across the state, often utilizing preferred data privacy practices and coordinating outreach to other organizations across the state, such as IFB. Priority should be given to those entities to support state-led data collection programs.

2. How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

Generally, concerns exist about the balance between modeled predictions and actualized impacts. The variables which are incorporated into ground water modeling are often highly geospatially specific and may vary greatly from on-the-ground observations. For agriculture in particular, this variability in decision-making tools has the potential to create significant levels of distrust. Wherever possible, modeling efforts should not be prioritized as decision making tools, but instead be used as support tools to be paired with on-the-ground data collection.

Additionally, several state-developed groundwater models already exist to support local stakeholders with decision-making processes, including several produced by the Illinois State Water Survey, for example. If national efforts are developed to support modeling

efforts, they should exist to primarily offer guidance and additional resources to the state-led entities.

3. How can we efficiently scale groundwater recharge while mitigating risks?

Groundwater recharge rates are highly dependent on numerous factors including precipitation, soil and vegetation types, geology and topography. By effect, recharge rates are also variable based on these and many other factors. Efforts to scale groundwater recharge should emphasize regionally specific, voluntary, and incentive-based approaches to implementing groundwater recharge practices. Supporting state-led programs should be prioritized.

Additional research on scaling groundwater recharge should also be conducted, with the primary target of developing new practices and technologies, while not discounting tried-and-true methods, to further develop the toolbox of practices that a farmer could implement to support groundwater recharge.

4. How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

Illinois has extensive state-led efforts to support groundwater. In particular, the Illinois Groundwater Protection Act (IGPA) exists to manage groundwater quality by state and local partnerships. This comprehensive law protects groundwater as a natural and public resource, with special provisions targeted toward drinking water wells. The IGPA has established unified groundwater protection which guides actions such as establishing water well protection zones, establishing authority for recharge area protection, requiring groundwater quality standards, and more.

Any government-led actions on groundwater should consider supporting new research on groundwater contamination and depletion, as these will remain critical components to ensuring safe groundwater supplies. Any national-scale funding mechanisms should also prioritize providing grant funding to state agencies and community water supplies for research and other groundwater management-related activities.

5. How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

The significance of groundwater across the agricultural industry cannot be understated. Access to adequate water supplies is imperative to crop and livestock production, as well as for processing commodities for end-markets. Of agricultural producers in Illinois, a large share also inhabit rural areas, which present additional, unique groundwater access concerns. Based on this, when considering how best to engage with agriculture, priority should be given to collaborating with entities that are viewed as trusted partners by farmers and landowners, including organizations that already provide vital services for them.

It is important to remember that the perceived and actual risks for engaging with agencies and other entities are often diverse. For some, groundwater is a secondary source of drinking or non-potable water and the risks of engaging with government entities are seen as low. For others, groundwater supplies are vital to production and any actions that could lead to changed access could be seen as higher risk. Given this, having support from trusted partners is critical to helping alleviate uncertainty among farmers and ranchers, as well as overcoming barriers that inhibit their ability to produce agricultural goods.

As previously mentioned, it is also imperative that any new efforts also find ways to support existing programs, such as universities and state geological and water surveys. These entities often engage with diverse stakeholder groups and serve as key partners in on-the-ground implementation.

6. What strategies and incentives can help limit groundwater over-use?

Transparency and multi-faceted outreach will go far in encouraging adoption of new practices or engagement in new programs. The ability for producers to make informed decisions before committing to practices and programs will help ensure success. To that end, any new strategies should prioritize affordable technologies that individual users can implement to monitor their individual groundwater use. For example, numerous barriers exist for irrigators to utilize various types of monitoring equipment. These technologies can help monitor day-to-day use of water but are often cost prohibitive and rely on internet stability that rural irrigators may not have.

Conclusion

Agriculture plays a vital role across the United States and rural America, especially in Illinois. Ensuring secure resources across the value chain of agricultural goods is essential for food, fiber, and fuel production. Farmers continue to build upon a strong foundation of voluntary stewardship investments and practices, including in groundwater management, looking for ways to further advance the sustainability of the agricultural industry.

We appreciate the opportunity to submit these comments. If you should have any questions, please do not hesitate to contact Sanjay Sofat, Director of Environmental Policy, at ssofat@ilfb.org or (309) 557-3153.

Sincerely,



Brian Duncan, President
Illinois Farm Bureau
1701 Towanda Avenue
Bloomington, IL 61701-2050

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 14: Sharon B. Megdal, University of Arizona Water Resources Research Center

Written: 7/1/2024

Subject: Input on America's Groundwater Challenges

The attached letter includes my input on America's Groundwater Challenges.
Thank you for the opportunity.

Sharon B. Megdal, Ph.D.

Director, University of Arizona Water Resources Research Center
Subscribe to the WRRC's Weekly Wave e-new digest [here](#).

Attached: PCAST_Input from Sharon B. Megdal

July 1, 2024

Re: Response to Request for Public Input on America's Groundwater Challenges

Dear PCAST Groundwater Working Group Members,

I appreciate the opportunity to provide input on the six questions included in this [post](#), which was recently brought to my attention. My comments are informed by my work on groundwater, which ranges from local to international and includes involvement in the federally authorized U.S.-Mexico Transboundary Aquifer Assessment Program since its inception. My perspectives draw upon my extensive groundwater policy and management experience, which includes on-the-ground involvement, along with academically oriented analyses of groundwater governance, managed aquifer recharge, and more. Additional information about my body of work can be found [here](#).

Question 1: How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

Enhancement of timely collection will be incentivized by establishing data collection practices, a community of data providers and users, and adequate funding over time. Because groundwater is local, much information is locally generated. While satellite imagery is helping with groundwater quantity information, it alone is not sufficient. With advances in cloud storage of and access to data, a key challenge is in the collection of data on both quantity and quality. Groundwater is more of a stock than a flow resource. A complete picture is needed spatially, and data must be collected over time. A single snapshot will not be sufficient to advance sound management of groundwater resources. Should USGS' National Water-Quality Assessment Project (NAWQA), which I understand has been canceled, be reinstated? If a goal of the working group on America's groundwater is to advance timely, whole-of-country collection of data on groundwater, which is a very big task, I suggest that a broad working group representing states and Native Nations, along with other water experts be formed (if you have not already done so).

Question 2: How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

Groundwater is a local resource, and it is not visible. Questions about the details of effective modeling can best be answered by modelers. A key question relates to the metrics that useful for stakeholders and decision-makers. As a member of the (Arizona) Governor's Water Policy Council, I was the recipient of information of groundwater declines based on data gathered from index wells. However, in some groundwater basins, very few index wells exist. Can just a few wells be relied upon to provide information about a basin? Wells are most often under private ownership, meaning sharing data from these wells is up to the owners. I provide this as just one example. There is need is for reliable data that feed into the modeling.

Question 3: How can we efficiently scale groundwater recharge while mitigating risks?

A theme of these responses is that groundwater is local. Aquifer conditions are aquifer specific. Recharge infiltration rates associated with basin recharge projects, such as those deployed in Arizona, can vary from basin to basin for an individual project. So, modeling of recharge conditions and recharge

performance will be specific to the location of the basins. Injection recharge will have different/additional considerations. In May 2022, the Boards of Earth Sciences and Resources and the Water Science and Technology Board, National Academies of Science, Engineering, and Medicine, convened a workshop on the future of Managed Aquifer Recharge in the United States. There was some mention of a panel being formed to do a NAS-style report. I do not know if such a panel was formed. UNESCO's [volume](#) on successful MAR includes five cases from the United States. I have been involved in other collections of MAR experiences. A global expert in recharge told me that there are few researchers focused on the water quality implications of groundwater recharge. The International Association of Hydrogeologists (IAH) has a group specifically focused on Managed Aquifer Recharge. There is a ready cadre of MAR experts (both here in the U.S. and internationally) who would be excited to participate in answering this question in some detail.

Question 4: How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

Ensuring clean and safe groundwater is so important yet can be elusive. Sufficient monitoring is needed. Note that water quality testing is expensive and difficult to accomplish not only for communities but also for the many individuals who own their own wells. I have received many inquiries over the years from individuals who are looking for assistance in assessing the water quality of their wells. Unfortunately, they are usually on their own. Water management regulations can affect groundwater availability for municipal use, whether at the community or individual level. This is another big issue and one that must be addressed at the state and/or local level. Groundwater quantity is not managed federally, but minimum water quality standards for drinking water and water discharges are federally established. The connection between surface water and groundwater is highly relevant, whereas many states do not regulate/manage the two water sources conjunctively. Federal-state-local partnerships and cooperation will be required. Sharing the assessment experience of the Transboundary Aquifer Assessment Program along the U.S.-Mexico border, where there is a federal role, could also be relevant.

Question 5: How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

The quest for groundwater sustainability is noble. Understanding the role of groundwater in all these arenas is critically important. As a participant in global discussions of groundwater, where the end-goal is all that is mentioned in this question, I can attest to the difficulty of even getting on the same page as to the role of groundwater. Some see it mainly as a buffer in times of surface water shortage. They see groundwater use as an adaptation to climate change. In some water dialogues, groundwater is barely mentioned. For example, groundwater is hardly mentioned at annual meetings of the Colorado River Water Users Association. Yet, for some communities it is and has been "the" or a major source of water. Understanding of groundwater and aquifer conditions is necessary. Common understanding of the implications of the various uses of water, both groundwater and surface water is a prerequisite to moving toward sustainability. But sustainable use of groundwater may be difficult in many settings because groundwater is finite. Even in California, where the goal is sustainable groundwater use, meeting the goal is expected to take many years. Some have focused on the concept of "managed depletion". However, a difficult question to answer relates to establishing an acceptable rate of managed depletion. What is acceptable? The answer will likely vary depending upon whom you ask, and the answer may change over time as the implications of pumping rates are realized. Ensuring all of what is in this question is our big water challenge, regardless of the water source. I prefer to stay away from using the word "ensure" because I do not think it's possible for anyone to ensure all of this. Regarding engagement, which is central to all that I do, I would offer that engagement must be an ongoing effort and meaningful. It cannot be just a one-stop "helicopter in" type exercise. Engagement is two-way. I like to distinguish between expert engagement and more general engagement, which is how I read the words "community engagement". They need to believe devoting time on water matters is worth taking time from their jobs

and/or personal lives. Sometimes engagement is more forthcoming due to crisis or urgent conditions. Relationships and networks must be built. Resources must be provided to those coordinating and carrying out engagement activities.

Question 6: What strategies and incentives can help limit groundwater over-use?

Again, you ask a fundamental question, one that many have grappled with for some time. I include groundwater over-use as an example of a wicked water problem. Wicked problems do not have single, easily implementable solutions. Work on identifying and implementing solutions pathways takes broad, interdisciplinary involvement. Monitoring groundwater use and quality is needed but difficult to accomplish broadly due to the underlying regulatory framework(s), costs, and possibly other considerations. Then the strategies to limit groundwater use have to be developed. Once approved, then implementation and reporting/monitoring for compliance must occur. It could be useful to look at Arizona's recent experience at developing a rural groundwater management framework. Here, after many months, efforts to identify a bipartisan approach to establishing a locally tailored framework continue. The experience shows some of the difficulties of getting on the same page in terms of characterizing and addressing the issue(s) of groundwater over-use. Raising public awareness can be very helpful. It is important that people know where their water comes from, the answer not being "from the tap", recognizing that, even in the U.S., not all have ready access to tap water to meet household needs. Regarding public awareness, I will note that the Football (Soccer) for Peace effort has identified groundwater as a focal area for its international efforts. I can make an introduction if you would like to learn more. Football for Peace hosted an event on the Capitol Mall on World Water Day (March 22, 2024). School programs, such as those of Project WET (Water Education for Teachers) can be effective at changing behavior of students and their families. Incentives often are financial, which requires funding, but can also be in the form of highly visible competitions and award programs. It may sound trite, but we do need all hands on deck.

Thank you for the opportunity to provide input. Please let me know if you have any questions or would like further information.

Sincerely,



Sharon B. Megdal, Ph.D.
Director, University of Arizona Water Resources Research Center
Professor, Department of Environmental Science
C.W. and Modene Neely Endowed Professor
Distinguished Outreach Professor
Mobile phone: 1-520-241-0298
smegdal@arizona.edu

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 15: Claire Ruffing, The Nature Conservancy in Oregon

Written: 7/1/2024

Subject: Groundwater

Dear Members of the President's Council of Advisors on Science and Technology,

Thank you for the opportunity to provide input on the challenges and stewardship opportunities facing our nation's groundwater resources. In the attached memo, we share responses to the Council's prompts as well as additional resources for more information. This memo was drafted collaboratively by members of The Nature Conservancy's Global Groundwater Group, a community of practice dedicated to advancing groundwater conservation, science, and policy across the world.

Thank you again for this opportunity. Please reach out if we can be of further assistance.

Sincerely,
Claire Ruffing

Claire Ruffing
Water Scientist
The Nature Conservancy in Oregon
nature.org

Attached: PCAST Groundwater Comment Letter

Groundwater Working Group
The President's Council of Advisors on Science and Technology (PCAST)
The White House
1600 Pennsylvania Avenue NW
Washington, DC 20500
Via - pcast@ostp.eop.gov

Re: The Nature Conservancy's Submission to PCAST on America's Groundwater Challenges

Dear Members of the Groundwater Working Group:

The Nature Conservancy (TNC) is a non-profit, non-governmental organization working *to protect the lands and waters on which all life depends* in every state and in over 70 countries worldwide. We are pleased to hear that the President's Council of Advisors on Science and Technology (PCAST) has launched a working group on groundwater in the United States that is looking at the challenges and opportunities to improve understanding and stewardship of groundwater. We also appreciate the opportunity to provide input about these challenges and opportunities to PCAST.

Groundwater is a valuable hidden resource that provides nearly half of the world's drinking water and is critical for biodiversity, food production, and economic development. Groundwater touches our conservation work nationwide, so TNC has created a [Groundwater Resource Hub](#) that shares our work, including maps of groundwater-dependent ecosystems (GDEs)¹, as well as literature, tools, and other resources. Some examples of groundwater issues we have addressed include:

- As soon to be published in *Nature* by Rohde et al. (in press), the first ever global map of GDEs in arid regions around the world has revealed that there are likely more than 0.5 million km² of GDEs in arid parts of North America, with over 65% of these areas experiencing groundwater storage loss.
- In rural arid Arizona effluent is intentionally evaporated instead of being more productively recharged or returned to surface streams by resource-constrained localities, so TNC is providing support to study groundwater recharge feasibility.
- In the [Arkansas](#) Delta Region TNC has piloted a successful program that installs pump shut-off timers that reduce on-farm groundwater usage by 20% and is leading a market-based floodplain reforestation project increasing regional groundwater recharge.
- In [California](#), TNC engages with state agencies and local groundwater sustainability agencies to identify and protect groundwater dependent ecosystems, and interconnected surface water-groundwater resources.
- In [Florida](#), TNC has worked with partners to map nutrient hotspots that are linked to the decline of water quality in Florida's groundwater dependent springs, and engages in policy to prevent the overallocation of groundwater in the Central Florida region.

¹ Groundwater-dependent ecosystems are ecosystems that rely on groundwater for some or all their water needs.

- In [Nevada](#), the driest state in the United States, we have mapped likely GDEs across the state, assessed stressors and threats to them, and developed strategies to manage and sustain GDEs.
- In [Oregon](#), TNC helped develop the state's first-ever Community-Based Voluntary Groundwater Plan to implement voluntary solutions for unsustainable groundwater use. That plan includes a Groundwater Conservation Reserve Enhancement Program which incentivizes reductions to pumping where it would be most beneficial for ecosystems.

With the lessons learned from these recent examples and TNC's more than 70 years of conservation experience, we are providing the following responses to PCAST's questions.

How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources? Understanding the groundwater resources supporting the nation starts with robust data collection, effective data reporting and monitoring, and the development of modeling tools at local and regional levels. It is essential that the federal agencies responsible for groundwater science and monitoring efforts, such as the U.S. Geological Survey (USGS) and the U.S. Department of Agriculture's Agricultural Research Service, receive adequate and sustained funding to support their water science efforts and their network of monitoring wells. Additionally, federal agencies and research institutions should continue strong collaborations with state entities who manage groundwater resources. Effective monitoring will also help us to learn from management actions and reduce risks from future management actions. Monitoring needs to be at appropriate frequencies and in locations that can detect impacts before they become irreversible ([Saito et al. 2021](#)). The interaction of surface water and groundwater also needs to be monitored, with data used in models like capture models (e.g., [Leake and Pool 2010](#); [Nadler et al. 2023](#)) that can illuminate the impacts of pumping from aquifers influenced by surface waters.

How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers? Predictive, locally relevant, and actionable modelling is critical to managing groundwater amidst groundwater use pressures as the climate continues to change. Modeling groundwater involves uncertainties that need to be considered and accounted for, but the uncertainties associated with groundwater are also why predictive groundwater modeling based on good data are essential ([Saito et al. 2021](#)). There is also a need to understand streamflow depletion impacts due to groundwater pumping, which requires integrated surface water-groundwater modeling that can be difficult to communicate and use for decision-making. Collaborative, government-led efforts are one way to promote wide scale outreach to stakeholders and decisionmakers. In Florida, a highly groundwater dependent state for both nature and people, five regional water management districts are charged with producing regional water supply plans with a 20-year horizon that are updated every five years. The three districts in Central Florida monitor and develop sophisticated groundwater modeling efforts to determine groundwater availability. The districts are charged with public outreach efforts through stakeholder meetings that allow a wide range of interested parties to participate in the planning process including identification of region wide alternative water supply projects and water conservation strategies.

Unfortunately, many state and local agencies often lack formal technical guidance, hydrological modeling capacity, and decision-support tools. TNC has a proven track record of providing science and decision support to agencies and partners by developing and integrating groundwater models with policy and management practices. In Arizona, the Bureau of Reclamation funded an Applied Science Grant to TNC and the Yavapai-Apache Nation that enabled TNC to commission a multi-scale hydrologic model for the Verde Valley – Oak Creek region of Arizona to understand ways to preserve baseflows in the region. Although the findings are still preliminary, the results indicate that in the context of the overall water cycle, under certain scenarios there may be opportunities to capture more stormwater from increasingly “flashy” precipitation events. In California, TNC is developing unified modeling approaches and decision support tools that use statistical, analytical, and numerical groundwater modeling methods to increase analytical capacity for local decision-makers. In Oregon, TNC is expanding a groundwater model published by the USGS ([Gingerich et al. 2024](#)) to test alternate groundwater pumping scenarios and provide results directly to stakeholders to facilitate management discussions. These examples highlight the importance of engaging local stakeholders and leveraging local expertise in model selection and development. In addition, these examples demonstrate how closely coordinating groundwater science and groundwater management can lead to water-smart policies and practices that are rigorous and transparent.

How can we efficiently scale groundwater recharge while mitigating risks? More work is urgently needed to develop state and regional inventories of potential recharge sites and sources where effective groundwater recharge projects can be implemented to improve groundwater security in a durable way. For example, the Arizona Department of Water Resources is supporting a multi-university team to develop a statewide assessment of locations and methods for protecting and enhancing groundwater recharge to study the issue at the scale equal to the challenge.

Evaluating the sources used for potential groundwater recharge also represents an opportunity to bolster groundwater supplies. For example, many rural communities lack shared sewer services. While septic was once the only alternative with low housing density, shared sewer services can now be considered for environmental protection and as a potential resource for groundwater recharge. This requires regulatory certainty and incentivization for infrastructure investments to site wastewater treatment plants and extend sewer services to already developed areas. Increased regulation to reduce high density septic systems should be considered along with land use planning discouraging sprawl.

Increasing stormwater and flood recharge while protecting environmental flows also represents an opportunity for additional groundwater recharge. Throughout the nation, land use change has increased the speed of runoff and reduced opportunities for natural recharge. In developed areas, using nature-based approaches to managing stormwater can provide an array of environmental benefits, such as flood control, improved habitat conditions, and aquifer replenishment ([Vigerstol et al. 2021](#)). In rural and agricultural areas, high flows can be intentionally spread over agricultural fields or recharge basins to recover some of this recharge while reducing the risk of downstream flooding. In California, recent state executive orders and the “[Flood-MAR](#)” program have sought to encourage managed aquifer recharge using floodwaters. To mitigate risks, recharge projects should be encouraged on historical floodplains, where it is likely to provide habitat and streamflow benefits. Recharge projects should also carefully consider potential harm to the environment through altering and reducing surface flow, and explicitly protect environmental flows. In

California, TNC is encouraging recharge projects to protect ecologically important flows (including some flood flows) in stream.

How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion? Groundwater depletion and contamination can be difficult to remediate without substantial management interventions. Importantly, when groundwater stays within the reach of ecosystems, it also remains within the reach of domestic well owners. Promoting policies and interventions that are mutually beneficial to communities and ecosystems will have the highest likelihood of success. For example, in Oregon, TNC worked with state agencies to secure state and federal funding for a Groundwater Conservation Reserve Enhancement Program (CREP) that is one of the few CREPs to provide specific incentives to landowners who voluntarily reduce water use to benefit groundwater-dependent ecosystems like springs. The [Harney CREP](#) will pay landowners to permanently retire their groundwater rights, saving up to 50,000 acre-feet per year and reducing the threat to domestic and stock water users who rely on groundwater as their only source of water. Implementation of the program was coupled with policy changes to prevent future groundwater rights from being allocated in the region, ensuring that the investment will achieve full benefit for ecosystems and domestic well owners.

How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity? There is growing recognition of the importance of GDEs for people and for healthy ecosystems. Better understanding and mapping of GDEs, and groundwater management strategies that protect GDEs will be critical to maintaining a healthy environment and supporting human water needs. Given the ecological importance of springs, seeps, wetlands, and other GDEs as biodiversity hubs, we must work locally and collaboratively toward groundwater management solutions.

We encourage PCAST to promote the integration of water management and breaking down silos amongst agencies, institutions, and stakeholders. Collaborative water planning can be an important part of achieving this integration. For example, Colorado and Texas have statewide multiyear water planning frameworks, yielding holistic periodic planning documents fostering local control and engagement and creating space to consider healthy ecosystems and biodiversity. Integrated management of surface water and groundwater is also critical. In Texas, local Groundwater Conservation Districts have the power to curtail groundwater pumping to reduce impacts on connected surface water flows. We also advocate for considering how to couple addressing groundwater over-use with other benefits. For example, TNC recently collaborated with local entities on a feasibility [study](#) on retiring some groundwater rights while converting the previously irrigated land to [agrivoltaics](#) (agriculture located adjacent to or underneath solar panels) in Nevada's Diamond Valley.

What strategies and incentives can help limit groundwater over-use? The TNC Nevada Chapter recently assembled [strategies for managing and sustaining GDEs](#) and the services they provide. The ten strategies collectively address stressors and threats facing GDEs, many of which also address groundwater overuse. For example, policies are needed to reduce current excessive groundwater withdrawals and to prevent future groundwater withdrawals that can affect GDEs. Regulations, codes, laws, permitting guidance, and large-scale planning documents can also identify and prioritize areas for protection and management to limit or reduce groundwater over-

use. Collaboration between groups with shared interests, including public and private entities, may be useful for reducing financial risks of implementing actions or incentivizing desired outcomes for groundwater sustainability.

Implementing strategies to reduce groundwater demand is a critical path to increasing groundwater security. Federal programs have provided incentives to *temporarily* reduce groundwater use, which have been effective in the short-term in some cases. However, in many parts of the United States, groundwater levels are declining steadily, affecting access to groundwater for domestic well users and GDEs, and requiring costly deepening of wells. *Permanent* reduction of consumptive use of groundwater is needed in many of these cases. An example of incentives to address permanent reduction of groundwater use was the use of American Rescue Plan Act funds in [Nevada](#) and [Colorado](#) to permanently retire groundwater rights. Other tools include community-developed groundwater management plans to permanently reduce groundwater use (e.g., [Diamond Valley groundwater management plan](#)), groundwater conservation easements, the Farm Services Agency's [Conservation Reserve Enhancement Program](#), and other market-based tools. It is critical that funding mechanisms are provided to continue to enable these tools while ensuring they are crafted in a way that permanently reduces consumptive use of groundwater.

Integrating land and water management can also be an effective way to limit groundwater use to sustainable levels and is increasingly important as development pressures rise in water-scarce areas. For example, many states are facing pressure for increased mining and infrastructure development to support the green energy transition, but it is important that such activities are done thoughtfully to avoid or minimize impacts to environmental resources, including groundwater and GDEs ([Parker et al. 2024](#); [Wu et al. 2023](#)). Fee mechanisms can be considered to limit groundwater over-use. For example, Colorado enables counties to consider a broad array of environmental, community and wildlife impact factors to plan for and regulate land use, and to charge impacts fees². County- or city-level planning and zoning conditions subdivision development on sourcing sufficient water in quantity, quality and dependability in many places.

Thank you for the opportunity to share these ideas and comments in support of PCAST's efforts to promote America's groundwater security. Please contact Claire Ruffing (Claire.ruffing@tnc.org) or Ryan Smith (ryan_smith@tnc.org) if you have any questions or need more information

Sincerely,

Claire Ruffing, Co-Chair
TNC Global Groundwater Group

Ryan Smith, Co-Chair
TNC Global Groundwater Group

² The "Local Government Land Use Control Enabling Act" C.R.S. Sections 29-20-101 to 29-20-205.

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 15: Jeffrey Longworth, Earth & Water Law

Written: 7/1/2024

Subject: Groundwater

Request for information and comments per <https://www.whitehouse.gov/pcast/briefing-room/2024/04/25/pcast-welcomes-public-input-on-americas-groundwater-challenges/>

Please see attached.

Jeffrey S. Longworth, Partner | Earth & Water Law

Attached: FSWA PCAST Groundwater Comments

July 1, 2024

Via Electronic Mail

pcast@ostp.eop.gov

The Honorable Arati Prabhakar, PhD.
Director, White House Office of Science and Technology Policy and Assistant to the
President for Science and Technology
1650 Pennsylvania Avenue, N.W.
Washington, D.C. 20502

**Re: Comments of the Federal StormWater Association on the President’s
Council of Advisors on Science & Technology (PCAST) Request for
Public Input on America’s Groundwater Challenges, April 25, 2024
[[https://www.whitehouse.gov/pcast/briefing-room/2024/04/25/pcast-
welcomes-public-input-on-americas-groundwater-challenges/](https://www.whitehouse.gov/pcast/briefing-room/2024/04/25/pcast-welcomes-public-input-on-americas-groundwater-challenges/)]**

Dear Dr. Prabhakar:

The Federal StormWater Association (FSWA) submits the following comments in response to the President’s Council of Advisors on Science and Technology (PCAST) Groundwater Working Group request for public comments on challenges to groundwater management.¹ FSWA appreciates the opportunity to work with the PCAST on addressing concerns with groundwater conservation. However, in considering the Administration’s role in groundwater management, FSWA encourages the PCAST to work with the States and Tribes to understand existing authorities and programs governing how groundwater rights are administered, including monitoring withdrawals and replenishments.

Similarly, the PCAST should seek to understand how water-dependent industries currently use, reuse, and conserve groundwater and use that information to inform discussions on developing a national groundwater strategy. Further, and of primary importance, the PCAST must clarify that any federal role in groundwater management must not interfere with the States’ and Tribes’ longstanding regulatory authority over land and water. The Clean Water Act currently envisions the federal role in managing groundwater as limited to studying the issue, sharing information and collecting information from the States and issuing grants.

¹ The White House “PCAST Welcomes Public Input on America’s Groundwater Challenges”, (April 25, 2024), available at <https://www.whitehouse.gov/pcast/briefing-room/2024/04/25/pcast-welcomes-public-input-on-americas-groundwater-challenges/> (last visited July 1, 2024).

The PCAST should advise the President that any federal involvement in groundwater management should be focused on supporting state or tribal-led efforts through providing information and funding targeted toward states or tribes with the most need.

I. FSWA's Interest

FSWA is a group of industrial, municipal, and construction-related entities that are directly affected, or which have members that are directly affected, by regulatory and policy decisions made by federal and state permitting authorities under the Clean Water Act (CWA), including potentially the Biden-Harris proposal to develop national stewardship strategies for groundwater.² FSWA has been engaged in stormwater regulatory and litigation matters across the country for over 20 years. Its members include coalitions and trade associations representing airports, general contractors, railroads, auto, scrap recycling, homebuilders, pavement coatings, and western states petroleum industries.

FSWA members operations are located in most states, including the Western states within the Colorado River Basin which appears to be a primary focus of the Administration's concern. As the Administration points out, groundwater is a critical resource for agriculture, manufacturing, mining, energy production, and more.³ FSWA members use and reuse groundwater, consistent with state regulatory programs, and regularly employ groundwater conservation efforts in their operations. FSWA members also engage in green infrastructure that helps to recharge and increase groundwater resources.

II. The President's Advisory Committee Failed to Adhere to Important Transparency and Open Meeting Requirements

Protection of the nation's water resources is of utmost importance to FSWA. However, we have concerns with the lack of transparency surrounding the Administration's initiative on groundwater. First, FSWA questions the Administration's use of a federal advisory committee to implement the Administration's agenda, particularly where Congress has specifically delegated the authority to regulate groundwater to the States under the Clean Water Act (CWA). Any change in how groundwater is regulated will require consistency with the CWA and surprisingly, the Administration appears not to have consulted with the U.S. Environmental Protection Agency or the States/Tribes in this development. Instead, the White House groundwater initiative is being led the President's science and technology advisory committee, PCAST, a federal advisory committee under the Federal Advisory Committee Act (FACA). 5

² Id.

³ Id.

U.S.C. Chapter 10. The PCAST was established by Executive Order on January 27, 2021 and expired two years later, on January 27, 2023.⁴

FSWA is concerned that the Committee is acting without consultation with important stakeholders on an Administrative initiative that falls within the jurisdiction of the States under the CWA. In addition, the PCAST has not fully adhered to important transparency and open meeting requirements by failing to provide notice in the *Federal Register* of the request for comments.⁵ Going forward, FSWA strongly recommends the PCAST should adhere to both the spirit and the transparency requirements of the FACA, including for solicitation of public comments. Furthermore, FSWA recommends a docket should be established where the public can access all relevant documents and information related to the Administration's groundwater initiative. To maximize public comment, any future opportunities should be widely publicized and published in the *Federal Register* and a corresponding docket set up on the federal government's www.regulation.gov.

III. The Clean Water Act Provides a Limited Federal Role in Regulating Groundwater

The Supreme Court has consistently held that in considering legislation that became the Clean Water Act, Congress rejected requests to grant federal authority (through the EPA) over ground waters. Instead, Congress required the States to maintain programs designed to protect ground waters.⁶ Similarly, the Courts established that the CWA currently envisions the federal role in managing groundwater as limited to studying the issue, sharing information and collecting information from the States and issuing grants.⁷

The Administration has not identified the authority under which a national groundwater strategy would be developed. Based on information presented at the PCAST December 1, 2023 public session on *Understanding Groundwater*, it is questionable whether the groundwater depletion concerns are national in scope. Indeed, all three presenters focused on a “global groundwater crisis,” and targeted irrigated agriculture as the primary cause, even suggesting we move agriculture to other parts of the country and consider restricting irrigation for certain agriculture uses, such as meat production.

⁴ See Executive Order establishing the PCAST, Section 5. Termination. The PCAST shall terminate 2 years from the date of this order unless extended by the President available at: <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-presidents-council-of-advisors-on-science-and-technology/>

⁵ 5 U.S.C. §1009 (a)(2).

⁶ *City of Maui, Hawaii v. Hawaii Wildlife Fund, et al.* 590 U.S. 165, 177 (2020).

⁷ *Id.* at 175.

However, presentation maps showed that U.S. groundwater depletion is located primarily in a few western states, including California, Arizona and Texas and parts of Colorado, Utah and Oklahoma.⁸ In other words, despite warnings of a global crisis, the maps depicted a regional problem that may be best addressed at the state level. This approach is consistent with the CWA and Congress' intent that groundwater regulation would be left to the States to manage. FSWA strongly encourages the Administration to consider the statutory framework Congress established for managing groundwater in making any decisions on establishing a national groundwater strategy. In addition, clarification is needed on the scope of the problem such a strategy would seek to address.

IV. State Legislatures Establish Requirements for Groundwater Management

Groundwater rights are governed by state, not federal laws. Many states, particularly the Western states establish state water districts and vest state water engineers with authority to determine groundwater rights, including managing withdrawal and replenishment limits. State water engineers regularly investigate basins and determine where replenishment appears inadequate, and use this information to adjust water diversions, including consideration of adequate flow for vested rights and wildlife. The PCAST should engage with the States to understand the longstanding, complex, state groundwater laws prior to any federal actions that would interfere with or infringe on state or Tribal government management of land and water resources.

V. The Administration Should Focus Available Resources on Supporting the States through Funding Research and Information Gathering in Coordination with the States

There is no question, groundwater is impacted by drought conditions and that certain of the Western states are currently experiencing groundwater depletion. FSWA encourages the Administration to work with the States, Tribes, Irrigation Districts, and groundwater conservation groups to identify additional research and funding opportunities to explore solutions such as irrigation efficiency, desalination, water recycling, and use of non-potable water for certain uses.

VI. Conclusion

FSWA appreciates the opportunity to provide comments on the Administration's effort to address America's groundwater challenges. We encourages the PCAST to work with the States and Tribes to understand how groundwater programs are administered. Similarly, the PCAST should not overlook that much can be learned from water-dependent industries that currently use, reuse, and conserve groundwater. Finally, the PCAST must ensure that any

⁸ https://www.whitehouse.gov/wp-content/uploads/2023/12/Famiglietti_PCAST.pdf;
https://www.whitehouse.gov/wp-content/uploads/2023/12/Scanlon_PCAST.pdf

federal strategy on groundwater must not interfere with the States' and Tribes longstanding regulatory authority over land and water.

If you have any questions or would like to engage with FSWA further on this issue, please contact me directly at jeffrey.longsworth@earthandwatergroup.com or (301) 807-9685.

Respectfully,

A handwritten signature in blue ink, appearing to read "Jeffrey S. Longworth". The signature is stylized and cursive.

Jeffrey S. Longworth
FSWA Coordinator and Counsel

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 16: Lydia Silber, WateReuse Association

Written: 7/1/2024

Subject: Groundwater – WateReuse Association

Dear President's Council of Advisors on Science and Technology,

We thank you for the opportunity to submit WateReuse Association comments on groundwater. Above, we have attached our comments.

We hope that this supports your report development process and we are excited to see the final product.

Thank you for your consideration of our input.

Best,

Lydia Silber (she/her/hers)

Technical Content & Regulatory Policy Manager

WateReuse Association

Attached: 2024 Groundwater Recharge Comments



WATERREUSE®

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Secretary

Jon Freedman

Veolia Water
Technologies & Solutions,
VA

Past President

Craig Lichty

Black & Veatch, CA

July 1, 2024

President's Council of Advisors on Science and Technology
Office of Science and Technology Policy
New Executive Office Building
725 17th Street NW, Washington, D.C.

Dear President's Council of Advisors on Science and Technology,

On behalf of the WaterReuse Association (WaterReuse), I am pleased to submit our comments on recycled water and groundwater protection.

The WaterReuse Association is a not-for-profit trade association for water utilities, businesses, non-profit organizations, and research entities that advocate for policies and programs that advance water recycling. WaterReuse and its state and regional sections represent nearly 250 water utilities serving over 60 million customers, and over 200 businesses and organizations across the country.

The Association appreciates that the President's Council of Advisors of Science and Technology (PCAST) is seeking to improve the Administration's understanding and stewardship of groundwater in the United States. Water recycling plays a critical role in revitalizing, enhancing, and protecting groundwater supplies across the country. Communities are using recycled water in lieu of and to reduce groundwater pumping, recharge aquifers, combat land subsidence, and prevent saltwater intrusion into freshwater supplies. Treatment technologies and processes used for recycling water can produce water that exactly matches the chemical and biological constituents that exist in a particular groundwater basin; and as such, water recycling can produce a safe and reliable groundwater supply.

The Biden Administration has championed water recycling as a water resource management tool through its work on the National Water Reuse Action Plan (WRAP), and through programs administered by the U.S. Environmental Protection Agency (EPA), Bureau of Reclamation, and other federal agencies. For example, through its work on WRAP Action 7.4 (*Increase Understanding of Current Aquifer Storage and Recovery Practices*), EPA and its partners launched an enhanced aquifer recharge resource library and published a report on the current state of practice and research associated with water reuse for aquifer recharge, storage, and recovery.

Across federal agencies and departments, financial and technical assistance programs have long supported projects that use recycled water to protect groundwater supplies. The Bureau of Reclamation's Title XVI Water Reuse Grants Program and EPA's Water Infrastructure Finance and Innovation Act (WIFIA) Program and Clean Water State Revolving Fund (SRF) Program are just three examples of federal programs that have helped communities produce and use recycled water for groundwater replenishment. These programs have also helped communities across the country build and implement enhanced aquifer recharge projects using recycled water.

As PCAST develops its report to advance government-wide action on groundwater, we urge you to consider the numerous ways in which water recycling can help protect and enhance this critical resource.

We encourage PCAST to review the wide range of projects, including federally funded projects, that are using recycled water to recharge and protect groundwater supplies. We offer the following examples:

- In southeastern Virginia, Hampton Roads Sanitation District's Sustainable Water Initiative for Tomorrow (SWIFT) will restore the Potomac Aquifer using 100 million gallons per day of drinking-quality recycled water, reducing land subsidence and mitigating flood risk.
- Hillsborough County, Florida uses recycled water to create barriers between salt water and their coastal freshwater aquifer. Since 2015, the effort has resulted in recovery of groundwater storage levels, a halt in saltwater intrusion, and the recovery of Tampa Bay's seagrass and fisheries.
- Orange County Water District in California has been purifying recycled water for groundwater recharge since 2008. The District's Groundwater Replenishment System (GWRS) produces 130 million gallons per day of purified water, enough to serve 1 million people. The purified water is injected or percolated into the local aquifer where it blends with the native groundwater. The project also injects recycled water to protect the groundwater basin from seawater intrusion.
- In Monterey, California, a WIFIA-funded project will produce up to 10,350 acre-feet per year of purified recycled water to replenish one groundwater basin while also reducing pumping from a second groundwater basin.
- In Big Bear, California, the local utility received funds through the Bureau of Reclamation to use purified recycled water to recharge groundwater for drinking water, municipal uses, commercial uses, and environmental restoration.
- The City of Chandler, Arizona expanded its aquifer recharge capabilities by turning to recycled water, allowing the community to bank water in times of low demand and withdraw in times of high demand.



- In El Paso, Texas, funding from the Title XVI Water Reuse Grant Program is supporting the conveyance of purified recycled water to recharge the Hueco Bolson Aquifer.
- Eastern Municipal Water District in southern California prices its recycled water to cost less than groundwater pumping so that agricultural customers have a financial incentive to utilize recycled water in lieu of groundwater.

These are just a few examples of significant municipal, state, and federal investments that have been made in projects and programs that protect and enhance groundwater using recycled water. Water recycling is a critical tool that must remain a key piece of the federal government's groundwater protection strategy.

In addition to these overarching comments, WateReuse offers the following responses to the specific questions posed by PCAST.

How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

As detailed above, water recycling is a proven tool for enhancing and protecting groundwater supplies. The Federal Government, through agencies such as EPA, the Bureau of Reclamation, and the Natural Resources Conservation Service, should scale up investments in water recycling projects and ensure that these types of projects are prioritized for federal funding opportunities. Moreover, the Federal Government should continue to invest in collaborative, interagency and interdisciplinary initiatives that advance water-reuse-based groundwater protection and recharge efforts; such initiatives include the EPA's National Water Reuse Action Plan and the Federal Interagency Working Group on Water Reuse.

How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

The WateReuse Association and its state and regional sections stand ready to partner with the White House and federal agencies and departments to ensure a sustainable supply of groundwater through water recycling. As PCAST develops its report, we encourage you to connect with our network of utilities, engineering firms, technology providers, universities, state regulatory agencies, and other experts to solicit expertise, data, and other feedback. WateReuse would gladly help PCAST organize a listening session or workshop. We also host several events throughout the year, including the annual WateReuse Symposium in March, which provides an opportunity to connect with practitioners and experts, present technical information, and collect feedback.

What strategies and incentives can help limit groundwater over-use?



Water recycling can prevent the overuse of groundwater by providing communities and industry with a safe, sustainable alternative supply; and can help restore and augment groundwater supplies through enhanced aquifer recharge. Water recycling projects, however, can be expensive. For municipal utilities and other water development authorities, federal funding programs such as the SRFs, WIFIA, and Title XVI provide cost-share to make these projects more attainable. As suggested above, the Federal Government, through agencies such as EPA, the Bureau of Reclamation, and the Natural Resources Conservation Service, should scale up investments in water recycling projects and ensure that these types of projects are prioritized in the President's Budget Request and in federal funding opportunities.

While supporting municipal investments in local and regional water recycling projects is critical, equally as important is advancing the adoption of water recycling by industry, including energy producers, manufacturers, and cloud computing companies, among other industrial verticals. According to the United States Geological Survey, in 2015, industry (not including agricultural irrigation) was responsible for nearly 50 percent of the groundwater and surface water withdrawals in United States. Given the outsized role that industry can play in protecting water resources, the Federal Government should seek to create opportunities and incentives for industrial water users to use recycled water to replenish groundwater.

EPA's Environmental Finance Advisory Board (EFAB) is currently conducting a study and report on the potential benefits of a federal investment tax credit to support greater industrial water recycling. We urge the Administration to work with Congress to enact a tax credit that supports (1) the adoption of onsite water recycling systems to treat and recycle industrial process water onsite, (2) the purchase of municipally produced recycled water in lieu of withdrawing groundwater, and (3) co-investments made by companies through public-private partnerships to build out municipal water recycling systems.

By prioritizing federal investments in water reuse, tax credits and other incentives to support the use of recycled water by industry and other sectors, and collaborative initiatives such as the WRAP and Interagency Working Group on Water Reuse, the Federal Government can help protect and enhance groundwater across the United States. Thank you for considering our views.

Sincerely,



Patricia Sinicropi
Executive Director



WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 17: Adam Pugh, National Association of Home Builders

Written: 7/1/2024

Subject: Groundwater

To the President's Council of Advisors on Science and Technology –

On behalf of the National Association of Home Builders (NAHB), I am submitting comments responding to the request for public input on America's groundwater challenges. If you have any questions about our comments or suggestions, please do not hesitate to contact me directly.

I hope the council has a great 4th of July!

Thank you,

Adam

ADAM PUGH

Program Manager, Environmental Policy

National Association of Home Builders

Attached: NAHB Comments to PCAST on Groundwater Challenges



July 1, 2024

Re: Input on America's Groundwater Challenges
Submitted to: pcast@ostp.eop.gov

To the President's Council of Advisors on Science and Technology:

On April 25, 2024, the President's Council of Advisors on Science and Technology (PCAST) published a request for information on America's groundwater challenges. The National Association of Home Builders (NAHB) appreciates the opportunity to provide these comments on PCAST's request for information. In addition to these comments, NAHB also submitted comments as part of a broader industry coalition. NAHB's comments here will focus on the groundwater issues impacting the home building sector.

NAHB is a nationwide federation of more than 700 state and local home builder associations. Our organization represents more than 140,000 members, including individuals and firms engaged in land development, single and multifamily construction, multifamily ownership, building materials trades, and commercial and industrial projects. Sufficient groundwater supplies are essential to support future economic development and meet the necessary housing needs all Americans deserve; NAHB has a keen interest as states and local governments develop policies ensuring their communities have a reliable groundwater supply. As such, NAHB has actively advocated for local, state, and federal initiatives to improve water infrastructure, promote water conservation practices, and urge communities to employ innovative water recycling and reuse approaches to ensure a sufficient groundwater supply.

NAHB members are industry leaders promoting water conservation measures for the residential construction sector by integrating proven water efficiency, reuse, sustainability, and green building practices. Our members strongly support voluntary water efficiency efforts like EPA's WaterSense program. NAHB believes that while addressing groundwater challenges, the PCAST must consider the ongoing work of states, local governments, industry, and federal agencies to incentivize water reuse and conservation practices to reduce demand and increase groundwater recharge efforts.

Water has become a critical issue for builders throughout the country, significantly impacting the pace of building, the ability to build in some areas, and housing affordability across the country. Home builders and developers are affected by ongoing challenges ranging from drought and aridification, flooding, water quality, stormwater management, and aging water infrastructure.

I. Groundwater is Effectively Managed by the States and Tribes

States and Tribes have effectively managed groundwater and water supply for over 100 years. Equally important, Congress has long recognized, under numerous federal laws, including the Clean Water Act, that states and not the federal government have the authority to effectively manage water resources within their own borders, including groundwater.¹ States and local governments effectively manage their water resources, including groundwater, through regional water plans, groundwater management plans, certification of drilling for drinking water wells, floodplain

¹ 42 U.S.C. §1251(b)

management and drought prevention. They use a “variety of management systems for determining the legal rights and liabilities pertaining to groundwater,” including addressing the complicated nature of water rights.² As a threshold matter, the future work of the PCAST must recognize the primacy of states, and not the federal government, to manage groundwater resources. Therefore, NAHB encourages PCAST to collaborate with states, local governments, and Tribes to better understand their actions in effectively managing groundwater and water supply.

II. Federal Agencies Already Work on Groundwater Challenges

NAHB urges the PCAST to provide better outreach to states and commit to better coordination with other federal agencies and ongoing interagency federal initiatives related to water conservation, reuse, and groundwater management. In February 2019, the EPA announced the development of its National Water Reuse Action Plan better to integrate federal policy and leverage industry and government expertise to use the nation's water resources effectively.³ The Action Plan identified 37 actions across 11 strategic themes to catalyze additional partnerships and subsequent actions to strengthen and diversify water resources.⁴ Since 2020, the Water Reuse Action Plan has created over 100 different resources to help advance water reuse and groundwater management nationwide. In 2022, Congress passed the Infrastructure Investment and Jobs Act that established an interagency working group consisting of the same federal agencies that participated in the Water Reuse Action Plan, including the U.S. Army Corps of Engineers, Bureau of Reclamation, Department of Energy, Environmental Protection Agency (EPA), United States Geographical Survey (USGS), Department of Health and Human Services, and the Federal Emergency Management Agency, recognizing the success of the National Water Reuse Action Plan.⁵ This interagency working group continues to drive technical, financial and institutional progress on water reuse to create a more resilient water future for communities of all sizes.⁶

We urge PCAST to consult and collaborate with existing interagency working groups and federal agencies that work on groundwater, water reuse and water conservation. Finally, as addressed in other industry coalition comments, NAHB urges the future work of the PCAST working group to coordinate with the USGS, which has been engaged in groundwater management for many decades, often predating federal environmental legislation.⁷

III. PCAST Should Assist States, Local Governments, and Voluntary Initiatives to Achieve Groundwater Management Goals

States and local governments are considering long-term strategies to achieve groundwater management goals. The work of the PCAST should assist states and local governments by providing credible data on groundwater monitoring as they consider different options and next steps. The work of the PCAST should focus on providing states and local governments with usable information and data on ways to improve water efficiency, promoting innovative stormwater management approaches, reuse, and efforts to recharge groundwater supplies.

The PCAST's future work should also promote voluntary water efficiency initiatives and programs, including those focused on the residential housing sector, to help states and local governments

² See *County of Maui v. Hawaii Wildlife Fund*, 140 S. Ct. 1462, 1476 (2020).

³ <https://www.epa.gov/waterreuse/water-reuse-action-plan>

⁴ Id.

⁵ P.L. 117-58, Section 50218

⁶ <https://www.epa.gov/waterreuse/water-reuse-interagency-working-group>

⁷ <https://www.usgs.gov/water-resources/programs>

effectively manage their groundwater resources. For example, a recent study by the EPA discovered that the EPA's WaterSense-Labeled Homes built in Las Vegas, NV, reduced water use by over 30% compared to a typical home.⁸ Furthermore, the EPA WaterSense program claims that retrofitting an existing home with WaterSense-labeled fixtures (e.g., toilets, faucets, and showerheads) can save \$380 per year in water utility bills.⁹ Beyond EPA's WaterSense program, NAHB's National Green Building Standard (NGBS) includes numerous water-efficient building practices, water conservation performance standards, and above-code voluntary water efficiency third-party rating approaches that independently confirm water-savings installed in either new or remodeled residential units.¹⁰ NAHB members who participate in voluntary programs like EPA's WaterSense program, the NGBS, or third-party water efficiency rating programs all improve the residential sector's overall water efficiency and thereby help further the goals of states and local governments in managing their groundwater supplies efficiently.

NAHB supports approaches and initiatives that encourage water conservation and efficiency in new and existing structures and properties as long as these programs are voluntary and not cost-prohibitive and recognize consumer preferences; are sufficiently flexible and include prescriptive options that do not require calculations or design professionals to apply, and include guidelines that can be applied independent of a specific home design; include low-cost options; where applicable, recognize multiple rainwater, greywater and landscaping options, and allow water savings at alternative locations to be credited to new homes; and recognize that the degree of concern with water supplies and decisions varies widely across regions and localities.

NAHB supports research on and technical advances in water efficiency and conservation. Further, NAHB supports incentives to facilitate the early adoption of water-saving products and practices that reduce construction fees, conservation tax credit programs, and rebates on efficient fixtures and appliances. Additionally, NAHB encourages the development and voluntary use of water calculation tools and formulas that account for total water consumption within the structure and the overall property and include both delivered potable water and water from precipitation.

Traditionally, stormwater has been seen as an issue that needs to be discarded as quickly as possible. Instead, it should be viewed as a valuable resource that can be managed effectively. The home building industry uses best management practices to encourage filtration rather than runoff. PCAST should encourage state and local governments to view stormwater as a valuable resource to recharge groundwater when developing and implementing their strategy on groundwater supply.

IV. Next Steps

NAHB urges PCAST to ensure we are included in the development of this report and any new federal policy or action on groundwater. Our members are committed to environmental stewardship and the efficient use and reuse of groundwater resources. They have a deep understanding of and on-the-ground experience in diverse regions nationwide in efficiently using, reusing, and managing groundwater. To maximize public participation, PCAST should ensure that comment opportunities, public meetings, or other opportunities to provide input on this effort are well-publicized and published in the *Federal Register*.

⁸ <https://www.nahb.org/advocacy/public-toolkits/a-builders-toolkit-for-water/making-it-happen/exploring-water-usage-requirements-and-certification-programs>

⁹ <https://www.epa.gov/watersense/statistics-and-facts>

¹⁰ <https://codes.iccsafe.org/content/ICC7002020P1>

V. Conclusion

NAHB appreciates the opportunity to provide input and information on groundwater management, water reuse and conservation practices. We welcome the opportunity to discuss our comments and partner with you on this issue. If you have any questions regarding specific issues raised in these comments, please contact me at (202) 266-8662 or apugh@nahb.org.

Sincerely,

A handwritten signature in black ink that reads "Adam Pugh". The signature is written in a cursive, slightly slanted style.

Adam Pugh

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 18: Vijay Ramasamy, Kansas Governor Laura Kelly

Written: 7/1/2024

Subject: Groundwater

Dear President's Council of Advisors on Science and Technology (PCAST),

I am writing to submit a comment from the Administration of Kansas Governor Laura Kelly to your public input process for "the development of a groundwater report to advance government-wide action on groundwater." This comment was prepared by the Kansas Water Subcabinet, a collection of water-focused state agencies charged with ensuring collaboration and coordination on the state's most pressing water quantity and quality issues. Please let us know if you would like to meet with any of our respective agencies to discuss questions or concerns. We appreciate the opportunity to provide input and look forward to continued collaboration on this critical natural resource.

Sincerely,

Vijay Ramasamy
Special Advisor for Water, Kansas Governor Laura Kelly

Vijayasundaram (Vijay) Ramasamy | Special Advisor
Kansas Governor Laura Kelly

Attached: PCAST Letter 7.1.2024

July 1, 2024

President's Council of Advisors on Science and Technology (PCAST)
Inez Fung, ScD, Joe Kiani, MSEE, Steve Pacala, PhD
The White House
1600 Pennsylvania Ave NW
Washington, DC 20500

Groundwater Working Group Co-Leads:

Thank you for the opportunity to provide input on PCAST's plan to issue a report to "advance government-wide action on groundwater." In the United States, including in the state of Kansas, groundwater is a state allocated, managed, and regulated resource and has been recognized as a state led responsibility consistently by policy and legislation at the federal level. We discourage any attempt to substantively change this relationship.

In Kansas, water is essential to the economic vitality of our agricultural sector, sustaining the livelihoods of a significant portion of our population, including many regions of our state in which agriculture is by far the dominant employer and economic driver. In addition to facilitating our state's agricultural industry and other industrial uses, groundwater serves as a critical source of clean drinking water for communities and individuals across the state, including for our state's largest city, Wichita. Groundwater is also a part of both the water cycle and aquatic, terrestrial and subterranean ecosystems. These groundwater dependent ecosystems provide immense economic and environmental value to Kansas, influencing recreation, tourism and various ecosystem services including carbon and nutrient sequestration, soil stabilization, erosion control, and runoff capture.

Groundwater varies greatly in availability, quality, use, and reliability by location. Therefore, decisions about management or regulation of the resource must be made based on accurate information and with a focus on the people and systems that depend on that water. Kansas has allocated and regulated groundwater since 1945 under a prior appropriation system. Individual farmers, industries, and cities have developed state recognized private property rights under this system that must be respected when considering any potential changes.

There are, however, many opportunities for the federal government to support states that are managing this critical resource, and some examples of these partnerships are outlined in this comment.

How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

Because of the importance of groundwater resources for our industry and public and private water systems, several state and local entities work collaboratively to ensure adequate monitoring of this resource, including the Kansas Department of Agriculture's Division of Water Resources and Division of Conservation, the Kansas Water Office, the Kansas Department of Wildlife and Parks, the Kansas Geological Survey at the University of

Kansas, our local Groundwater Management Districts, and the Kansas Department of Health and Environment's Division of Environment, which oversees water quality for the state.

In addition, the Kansas Water Authority advises the Governor and Legislature regarding water issues, including through drafting the State Water Plan, providing budget recommendations, and representing diverse water interests throughout the state. Through these partnerships, the State of Kansas has some of the best data on our groundwater resources of any state in the country, and the above agencies use this data to monitor, disseminate information to water users and policymakers, engage in strategic partnerships, and regulate groundwater recharge, decline, and quality.

While each state handles data collection in a manner that fits their situation, there is a need for increased data and information sharing across the nation regarding interstate groundwater quality and quantity issues and the causes of and impacts on surrounding states. There is also a need for additional, sustainable funding for groundwater data and research for state and local entities.

How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

Kansas has developed groundwater models for each of its primary groundwater aquifers. These models are maintained primarily by the Kansas Geological Survey, local groundwater management districts, and state agencies. The primary uses are for evaluating various management scenarios with local units of government, agricultural producers, and industrial partners.

The groundwater models that have been developed in Kansas are built on MODFLOW, which was originally developed by the U.S. Geological Survey. Many improvements have been made to the modeling software over the years to make it more accurate. Additional improvement can continue to be made, particularly in the areas of presenting information in a manner that is more easily understood. We would encourage continued investment both through federal agencies to improve the software and in partnership with state and local governments to meet the needs to better understand and represent the aquifers which support our people and economy.

How can we efficiently scale groundwater recharge while mitigating risks? How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

Groundwater recharge opportunities need two things to be successful: an adequate source of clean water and infrastructure investment for recharge facilities. There is a successful and mature groundwater recharge project in Kansas operated by the City of Wichita within the Equus Beds Groundwater Management District. The project is a collaboration between local units of government with oversight by state agencies.

Protecting the groundwater from contamination is closely monitored and permitted by the Kansas Department of Health and Environment (KDHE). KDHE manages the delegated Environmental Protection Agency programs related to the Clean Water Act. The quantity of water recharged to the aquifer is regulated by the Kansas Department of Agriculture's Division of Water Resources. We encourage similar levels of management and regulation to be used for future projects whether in Kansas or elsewhere.

Projects of this nature require a significant investment in infrastructure. The Wichita Aquifer Storage and Recovery (ASR) project has been almost entirely funded by the City of Wichita. There is a broader benefit to

the region that is experienced by the public, state, and nation. In order to support local entities in implementing successful, large-scale recharge projects, federal financial support would help to ensure that this can remain a viable option to serve the region's needs for future generations.

How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

Engaging communities on groundwater issues starts with providing clear information in a manner that the average citizen can understand. In Kansas, we have dedicated significant resources and time to monitor, model, and present information to our private property holding users. Key to this success is trust, built over time, that the information is accurate and provided without agenda beyond proper management of the resource.

With groundwater management firmly established as a state and local authority, and all states and local governments organized differently with different legal structures for regulation, the state of Kansas works with regional and local partners in managing these issues. We have recently embarked on a local engagement process in which over 600 people across 6 different regions in the state will have the opportunity to provide input on existing and future investments to secure our water resources. This recent effort is in addition to annual consultation with Regional Advisory Committees, and significant attention dedicated to this issue by the Legislature.

Federal partners are participating in this state-led process. We would recommend that federal agencies look for opportunities to take the information gained from this effort and tailor programs and projects to meet local needs. These could include funding strategies for successful voluntary groundwater management programs, providing flexibility in the deployment of federal funds, and recognizing successful voluntary programs in other states and providing accelerated federal approval for redeployment in Kansas.

What strategies and incentives can help limit groundwater over-use?

At the federal level, the state has worked with federal partners to enhance state-level programs. One of the largest investments so far has been through the Regional Conservation Partnership Program of the Natural Resources Conservation Service to reduce water use by 10% across five Groundwater Management Districts. Another recent source of funding has been through the Bipartisan Infrastructure Law, which, in combination with state and local funding, is facilitating a water reuse project in Dodge City that will help secure groundwater resources for its water users.

In addition to these programs, the state has advocated for federal programs to ensure that water access is adequately secured across the United States, including for the dry and semi-arid regions that overlay the Ogallala Aquifer. Investing in incentives is needed so that agricultural producers in our region are empowered to use the latest irrigation technologies and biotechnology so that they can continue to sustain and improve their crop production while using less water and reducing input runoff.

Federal partners can also facilitate state-led work by continuing to provide and enhance voluntary, incentive-based opportunities for federal, state & local partnerships such as the USDA's Conservation Reserve Enhancement Program. Kansas has a very good track record of success with providing groundwater conservation results while simultaneously facilitating other concurrent natural resource benefits in targeted areas for specific objectives. However, additional flexibilities and financial incentives are necessary to meet

Letter to President's Council of Advisors on Science and Technology (PCAST)

July 1, 2024

Page 4 of 4

current land and crop market rate conditions for this program to continue to be successful in existing areas or expand into new geographic project areas without years of red tape and environmental assessment expenses. We also appreciate the federal government's continued support to improve the quality of our water data and research through funding and partnerships with the U.S. Geological Survey, the Kansas Geological Survey, and other university partners. We also appreciate the agricultural use and economic information provided by the U.S. Department of Agriculture's National Agricultural Statistics Service (NASS).

Thank you again for your interest in this issue. Please let us know if you would like to meet with any of our respective agencies to discuss some of our successful programs and the potential for federal assistance in securing one of our most important state and local resources.

Sincerely,



Vijay Ramasamy
Special Advisor for Water
Governor Laura Kelly

On Behalf of the Kansas Water Subcabinet:

Secretary Mike Beam, Kansas Department of Agriculture
Secretary Janet Stanek, Kansas Department of Health and Environment
Acting Secretary Christopher Kennedy, Kansas Department of Wildlife and Parks
Director Connie Owen, Kansas Water Office
Chief Engineer Earl Lewis, Kansas Department of Agriculture – Division of Water Resources
Deputy Secretary Leo Henning, Kansas Department of Health and Environment – Division of Environment
Director Kayla Savage, Kansas Department of Commerce – Community Engagement

Established by Kansas Governor Laura Kelly in November of 2023, the Kansas Water Subcabinet is a collection of water-focused state agencies charged with ensuring collaboration and coordination on the state's most pressing water quantity and quality issues.

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 19: Terry Morse & David Traut, National Ground Water Association

Written: 7/1/2024

Subject: Groundwater

Submitted on Behalf of Terry Morse, CEO, NGWA, and David Traut, President, NGWA, via Email
National Ground Water Association

July 1, 2024

Groundwater Working Group Co-Leads

Inez Fung, Joe Kiani, and Steve Pacala

The White House

1600 Pennsylvania Ave NW

Washington, DC 20500

SUBJECT: Groundwater

Dear Ms. Fung, Mr. Kiani and Mr. Pacala,

This letter and attachment respond to the White House Groundwater Working Group request for input on “America’s Groundwater Challenges” of April 25, 2024.

The National Ground Water Association appreciates the opportunity to provide responses to the questions you raised. The Association stands ready to provide further information, respond to other questions about groundwater management and collaborate in the stewardship of our nation’s groundwater resources.

The National Ground Water Association has a membership of over 10,000 professionals representing water well contractors, groundwater scientists and engineers, and equipment manufacturers and distributors. The Association’s mission is to advocate for and support the responsible development, management, and use of groundwater.

Thank you for considering our responses to your questions as a contribution to this significant collaboration for our Nation’s groundwater future.

Sincerely,

*****signed*****

Terry S. Morse, CAE, CIC
Chief Executive Officer
National Ground Water Association

*****signed*****

David Traut, MGWC, CVCLD
President
National Ground Water Association

Chuck Job | Regulatory Affairs Manager
National Ground Water Association

Attached: NGWA Response Addressing “America’s Groundwater Challenges”



National Ground Water Association

July 1, 2024

Groundwater Working Group Co-Leads
Inez Fung, Joe Kiani, and Steve Pacala
The White House
1600 Pennsylvania Ave NW
Washington, DC 20500

SUBJECT: Groundwater

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Thank you for considering our responses to your questions as a contribution to this significant collaboration for our Nation’s groundwater future.

Sincerely,

A handwritten signature in black ink, appearing to read "Terry Morse".

Terry S. Morse, CAE, CIC
Chief Executive Officer
National Ground Water Association

A handwritten signature in black ink, appearing to read "David Traut".

David Traut, MGWC, CVCLD
President
National Ground Water Association

Attachment: NGWA Response Addressing “America’s Groundwater Challenges” (5 pages)



Address 601 Dempsey Road, Westerville, Ohio 43081-8978 U.S.A.
Phone 800 551.7379 • 614 898.7791 **Fax** 614 898.7786
Email ngwa@ngwa.org **Websites** NGWA.org and WellOwner.org

ATTACHMENT: NGWA Response Addressing “America’s Groundwater Challenges”

Significant opportunity exists to raise awareness of the role of groundwater in climate adaptation and actions that can lead to a more sustainable and resilient water supply future. Just as there are examples of groundwater overexploitation, there are many examples of good groundwater management with timely, comprehensive data collection and analysis that provide insight to future directions.

Safeguarding groundwater is a global challenge, but the primary sustainable management solutions are found at the local and aquifer or groundwater basin level. Groundwater occurs in aquifers that are highly variable across the country in size, geology, climate, overlying land use, and water demands. Aquifers are [natural infrastructure](#) providing groundwater storage, subsurface conveyance, and surface water flow and often are sinks receiving [waste fluids](#). They require individualized attention at state and local levels, states to develop and implement regulations and laws to ensure best practices for management and monitoring, and to have the regulatory authority to step in where local groundwater management is ineffective. Effective groundwater management and governance also require active participation of groundwater users and stakeholders in the planning, decision-making and implementation processes. These key concepts are central to sustainable groundwater management. The science of groundwater is well established today with a large community of groundwater professionals.

As States are the resource managers of groundwater in the United States, they are responsible to enact and revise laws and regulations that apply the science within their legal-political frameworks. These frameworks must address the local needs of [40 million people](#) on private household wells and nearly 93 million that use publicly-supplied water from 38,000 groundwater systems, 36,000 of which serve 10,000 or fewer people. Additionally, groundwater is used in a range of agricultural, commercial, and industrial applications. Clearly, there are many stakeholders.

The quality of groundwater affects its availability for use. Emerging and legacy contaminants present continuing challenges to safe groundwater supply and use. Remediation of locations of concentrated contamination require continuing attention and funding support. Overpumping aquifers can induce water of lower quality to be abstracted. Saltwater intrusion from excessive pumping and sea level rise can impact coastal wells, requiring additional treatment. Conversely, utilizing deeper brackish and saline groundwater may be essential for chronically water-short communities willing to pay for treatment.

In many cases, significant improvements can be accomplished by recognizing and managing groundwater and surface water conjunctively. This includes working toward local and state laws, regulations and incentives that encourage use of surface water during wet periods, including storm and flood waters, for both supply and groundwater replenishment to prepare for increased groundwater use during droughts.

Considerable attention is currently being given to ways to purposefully recharge aquifers for later recovery when needed for supply or for environmental benefit—a practice known as [managed aquifer recharge](#) (MAR). It is a mature and growing approach worldwide that encompasses a wide variety of water sources (including stormwater and treated wastewater),

ATTACHMENT: NGWA Response Addressing “America’s Groundwater Challenges”

recharge methods (e.g., recharge wells and infiltration basins), and storage management practices. In the southwest US, the recent realization that hydrology has changed and there are more dry years and droughts has catalyzed a flurry of activity to increase recharge during the wet season and wetter years.

The sophistication of MAR has grown in the past 50 years with innovative strategies, institutional arrangements, scalable applications, and enhanced monitoring to improve performance and accounting of water recharged, stored, and recovered. Recycled water is also playing a much larger role as a reliable source water for MAR. Best practices must be implemented to ensure the compatibility of recharge water with the chemistry of the local groundwater and the geology of the groundwater basin or aquifer.

Data on the status of the U.S. groundwater resource is essential, as we cannot manage what is not measured. An important source of data is the [National Ground-Water Monitoring Network](#) (NGWMN). Operated by the U.S. Geological Survey (USGS), the NGWMN is composed of groundwater monitoring wells from Federal, State, and local groundwater monitoring networks across the nation. The data collected through the NGWMN play a crucial role in monitoring the health and supply of our nation’s groundwater and is an important tool when water policies are being considered. The USGS also maintains a national Climate Response Network of wells to monitor the effects of climate variability and change on groundwater levels.

A “[one-water](#)” approach views all water, including groundwater, surface water, wastewater, and stormwater, as a single resource. We should place a high social value on maintaining water resources at benchmarks set through evidence-based data-driven evaluation to protect human health and vital environmental systems.

Responding to specific questions regarding actions addressing groundwater challenges:

- How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation’s groundwater resources?

RESPONSE: Significant investment in groundwater monitoring has made water level and water quality data available across a range of programs supported by federal, state, and local governments. To pull these data together, the Advisory Committee on Water Information chaired by the Department of the Interior dismantled in the previous administration created the National Ground-Water Monitoring Network. Thirty-four states have connected data to the Network, a network-of-networks. The NGWMN is underfunded to meet its goals for a national network. Actions needed:

- Invest more in the National Ground-Water Monitoring Network, [USGS Climate Response Network](#) and related surface water monitoring to incentivize all states to participate in reporting their groundwater and related surface water data.
- Require other federal agencies to provide access to their groundwater data through a semantic translator to the NGWMN as states are already doing through this national network of state and local networks.

ATTACHMENT: NGWA Response Addressing “America’s Groundwater Challenges”

- Reestablish the Advisory Committee on Water Information (or similar entity) under the Department of the Interior with new objectives to meet this need, including the addition of groundwater recharge and flow. Consider adding state and local partners to bridge the state and local management with federal team members.
- Continue to support groundwater to benefit communities’ residents and businesses by means of enhanced federal support to local agencies and organizations who are best positioned to manage the resource.
- How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

RESPONSE: Modeling is a tool best developed and applied locally to groundwater basins and aquifers typically to address specific conditions and questions. Future climate scenarios need to be integrated into models to comprehensively predict changes in groundwater resources. States typically roll up their local information and data for statewide water planning. Actions to be taken are:

- Continue the role of the USGS and other federal agencies to inform continued development of groundwater models ([for example, MODFLOW](#)) and integrated groundwater-surface water models for the range of geologic conditions in which groundwater exists. Adding state and local partners to define and address the state and local management perspective with federal team members will support refinement of model application.
- How can we efficiently scale groundwater recharge while mitigating risks?

RESPONSE: Groundwater recharge is currently occurring on a range of scales, typically at the local level responding to local water needs. Efficient managed aquifer recharge is currently being done in many groundwater basins, especially in the southwest US using the latest technologies, including surface infiltration and underground injection wells. Potential risks to groundwater quality include emerging contaminants and mobilization of naturally occurring contaminants, both of which can be addressed by the application of best practices with currently available science. Actions to take are:

- Continued due diligence to test and address new contaminants as they are discovered in recharge source water and groundwater.
- For new chemicals annually registered in the Toxic Substances Inventory, have a process in place to reduce the toxic and recalcitrant chemicals that may enter the environment and create groundwater contamination and health problems.
- Continue the development of a robust National [Water Reuse Action Plan](#) including further research supporting protection from chemical and microbial contaminants.
- Compile best practices for managed aquifer recharge that addresses appropriate planning, investigation, monitoring, and pilot testing including case studies of MAR projects at a variety of scales.

ATTACHMENT: NGWA Response Addressing “America’s Groundwater Challenges”

- Forecast Informed Reservoir Operations ([FIRO](#)) is one way to help generate more usable water out of the surface water system from an existing dam on an annual and seasonal basis, which can then be used for recharge.
- How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

RESPONSE: Among the key concerns today is widespread contamination by per- and polyfluoroalkyl substances (PFAS) after decades of inaction to address these toxic and recalcitrant chemicals. This emphasizes the necessity of making groundwater protection a key priority in government policy. It is also important to maintain vigilance on other legacy contaminants. For example, in many rural areas, nitrate and naturally occurring contaminants such as arsenic are the major contaminants of concern and need continuing attention.

Groundwater depletion can be mitigated, but to avoid economic hardships from immediate demand reduction, it takes time and other activities to bring aquifers and basins into sustainable groundwater management practices. Basins in depletion should at a minimum develop plans to address the water budget, inventories of wells and pumping volumes, monitoring of sustainability indicators (groundwater levels, groundwater quality, change in storage, land subsidence, seawater intrusion, and interconnected surface water), action thresholds for sustainability indicators, projects to increase supply, and approach to demand reductions over a reasonable period. Actions to take include:

- Incentivize and support state and local programs to mitigate effects on residential and small community supply wells addressing wells going dry and water quality degradation.
- Establish a national groundwater basin/aquifer status inventory, prioritization and needs assessment
 - Prepare a national inventory of the state of groundwater resources and contamination by groundwater basin or aquifer, with Federal and state agencies working with local groundwater managers.
 - Conduct a prioritization of groundwater basins/aquifers based upon defined criteria. Examples of state efforts are those by [California](#) and [Texas](#).
 - Provide federal support and incentives for state and local managers to mitigate ineffective processes and contaminated conditions.
- Reinvigorate federal programs to protect against contamination and depletion including reassessment of [source water protection](#) areas around wells and incentives for water efficient plumbing fixtures to replace old fixtures, and for enhanced water reuse.
- How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

RESPONSE: Developing targeted local and household information, educational materials and media that is actionable is key to community acceptance of revised public performance objectives and informed decisions. Actions to take are:

ATTACHMENT: NGWA Response Addressing “America’s Groundwater Challenges”

- Consider a Groundwater Academy modeled after EPA’s [Watershed Academy](#) to similarly include Learning Modules, Webcasts, Kid’s Corner, and Resources (management resources, publications, and state and federal training).
- Provide federal incentives and guidance for local outreach; also where federal government has presence (U.S. Army Corps of Engineers, Bureau of Reclamation), participate and support the local outreach.
- What strategies and incentives can help limit groundwater over-use?

RESPONSE: Groundwater depletion has occurred in every state at some scale. The federal government can provide technical and economic support to states. Actions to take include:

- Facilitate development of [groundwater sustainability plans](#) (or comparable means) to establish basin or aquifer level water budgets and sustainable management criteria for groundwater levels, groundwater storage change, groundwater quality degradation, groundwater extraction related land surface subsidence, saline (brackish, seawater) intrusion, and groundwater extraction related surface water depletion, including consideration of current and future climate trends. Plans to include projects and demand management actions to reach and maintain sustainability. Further federal support and funding for sustainability projects to include managed aquifer recharge using stormwater capture and recycled water, increased use of recycled water for irrigation and other beneficial uses, increased water use efficiency, recognition of water conservation as way of life, and demand reduction where necessary to achieve groundwater sustainability. Recognizing that the time for depletion took decades, the time frame for achieving sustainability while urgent, should be reasonable to minimize economic hardships in adjusting to reduced water demand through land use changes from water intensive use where necessary.
 - Strategies should include further development and application of best available science into best suggested practices to better understand the inherent complexities and improve management of the critically important resources of the nation’s groundwater systems.
 - Strategies should also include incentivizing **nature-based solutions** that integrate sustainable planning, design, environmental management and engineering practices that weave natural features or processes into the built environment to promote adaptation and resilience and use natural features and processes to address climate change while reducing flood risk.
 - Incentives should include grants and loans to assist state and local agencies to do the work and projects needed to achieve and maintain sustainable groundwater resources.
- Increase federal funding for USGS and other federal agencies to provide technical assistance for best applicable science including monitoring, modeling, and decision-making.

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 20: LH Thorleifson, University of Minnesota

Written: 7/1/2024

Subject: Groundwater

I am pleased to provide the attached letter as a response to the April 25th, 2024, PCAST request for suggestions regarding the national groundwater crisis. Sincerely,

LH Thorleifson Ph.D., P.Geo., D.Sc., Professor, Department of Earth and Environmental Sciences; College of Science and Engineering; University of Minnesota

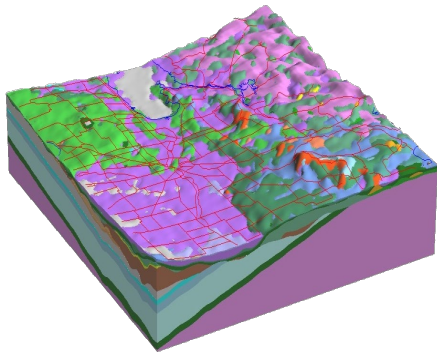
Attached: Letter to PCAST from LH Thorleifson re Groundwater

College of Science and Engineering
Earth & Environmental Sciences
Minneapolis MN 55455 USA
thorleif@umn.edu

July 1st, 2024

To: President's Council of Advisors on Science and Technology (PCAST)
The White House; pcast@ostp.eop.gov

Re: Groundwater



I am writing in response to the April 25th 2024 PCAST request for suggestions regarding the national groundwater crisis that is an escalating threat to the quality of life enjoyed by people of the USA.

I am a University of Minnesota Professor, and Chair of the international Commission for Geoscience Information. I was MN State Geologist for two decades, President of the State Geologists' association, and six-year member of the National Geospatial Advisory Committee. I was a Geological Survey of Canada research scientist for almost two decades, and President of the Canadian Federation for Earth Sciences. I hold a University of Colorado Ph.D.

The answer to your question is *all of the above*. We need **research**, which is conceptual, **mapping**, which is spatial, **monitoring**, which is temporal, and **modeling**, which assembles the foregoing, to support **management**, that will ensure sustainable pumping rates, and protection of groundwater quality.

We are doing all of this, but we forgot to do one piece – *mapping*. Oops. Groundwater modelers refer to mapping as the conceptual model and the grid. We have many magnificent 2D and 3D maps, as a patchwork for maybe a quarter of the nation. Great. That is like a jigsaw puzzle with one-quarter of the pieces. The conclusion of my letter is that we need to comprehensively map the geology of the USA.

Without a map, you are lost. No one thinks a pilot doesn't need a map. No one would drive across the state without a map. No one says that we don't need Google Maps, as we already have folded paper maps. But with groundwater, we are winging it. That is because groundwater is out of sight and out of mind. Geologists can't visualize the water, and hydrologists can't visualize the geology. That's a problem.

We need to treat groundwater as we do for weather, climate, surface water, and soil. We need a network of multi-county groundwater models for all of each state, statewide models, and national models. We need to fully add groundwater to the National Water Model. This is a digital twin – an indefinitely sustained forecasting system that receives data, and that supports interventions. The missing piece is mapping.

In the 90s, I was directed to invent procedures for mapping regional groundwater systems. Despite its age, that pilot – illustrated here – remains famous. I have been co-leading international workshops on these methods for over two decades, although uptake of the methods has been slow. "If it's not in the papers, it's not a problem." Now, regional groundwater sustainability is in the papers. It's time to do something.

Google Earth users understand that you start with the globe, and zoom in. Although the pieces are a mess, it's the same for geology - from global, to continental, to national, to regional, and then to local mapping done by property owners for their own use. Completeness is first achieved at low resolution. Global resolution is done by international agencies. Remaining resolution levels beyond the scope of property are done by the US Geological Survey, and state geological surveys. Consultants map private land.

Academics do research, teaching, and service. Survey geologists do research, mapping, and service. USGS Energy, Hazards, Minerals, and Water play roles in geological mapping – the Regional Aquifer-System Analysis (RASA) was a superb early attempt to do what I am outlining. Coordination is provided by the National Cooperative Geologic Mapping Program (NCGMP), to build the National Geologic Map Database (NGMDB), under the National Geologic Mapping Act (NGMA). Federal NCGMP roles include cross-border mapping, essential research, as well as specialized topics and technology. States play their role by contributing match under Statemap, and through major state-funded additional investments.

Past geological mapping was done as paper maps. Now, authored and peer-reviewed paper maps and their digital versions are more important than ever, as documentation. Meanwhile, a new form of geological mapping has emerged this century, as multi-resolution seamless 3D. At each level of resolution, as data allows, we need a 2D map for each major unconformity, vertically georeferenced by an elevation grid – earth surface below soil mapping and water in sediment-covered regions, top of mineral sediment, bedrock, pre-Mesozoic, Precambrian, and basement. Then we do 3D by subdividing between the surfaces.

At regional resolution, we are building jurisdiction-wide databases of observations and inferences. We are assembling non-superseded maps at scales more detailed than the state geologic map as regularly updated seamless databases for each unconformity, that undergo regular audit rather than peer review.

What gets measured gets managed. Status mapping as a composite index for multiple layers, based on local judgement regarding needs, shows consensus on and progress toward goals, helps identify priorities, stimulates funding, and causes us all to strive. Aquifers cross borders, and contradictory maps erode user confidence, so a major task is to reconcile mapping with international neighbors, starting with Canada.

We need quick wins, and we need to build for the long term by imaging and drilling undocumented deep geology. A dramatically exciting technology that will allow major progress is airborne EM.

In summary, we need to fully implement FY20 Congressional Language, that outlines fulfilment of the mapping and research that I have outlined here as NGMDB Phase Three, and I anticipate that Congress will want to fully fund the NCGMP at its authorized level in order to fulfil obligations to society.

I will be pleased to provide additional assistance in any way that may be required.

Sincerely,



L. H. Thorleifson Ph.D., P.Geo., D.Sc.,
Professor, University of Minnesota
Chair, Commission for Geoscience Information

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 21: Zippy Duvall, American Farm Bureau Federation

Written: 7/1/2024

Subject: Groundwater

Attached: Water.AFBF Ltr.PCAST Groundwater

July 1, 2024

President's Council of Advisors on Science and Technology
The White House
1600 Pennsylvania Avenue, NW
Washington, DC 20500

Dear Groundwater Working Group:

As the President's Council of Advisors on Science and Technology continues its work to improve its understanding of the critical resource of groundwater, the American Farm Bureau Federation would like to comment because of the issue's importance to our farming, ranching and forestry members. AFBF is the nation's largest general farm organization, with nearly 6 million member families in all 50 states and Puerto Rico, working together to build a sustainable future of safe and abundant food, fiber and renewable fuel for our nation and the world.

We appreciate efforts to better understand the key role that groundwater plays in our country. This is a vital resource for human health and safety, manufacturing, energy, and especially agriculture. Farmers and ranchers value access to water for our crops and animals as existential to our ability to do our business. We use this resource to responsibly grow food in a sustainable manner.

Farm Bureau strongly supports the current state-based regulation of groundwater. In addition, our members work collaboratively with irrigation districts in the West for the efficient delivery of surface water. Our members live and work on their farms, making clean water a priority for our homes, families and businesses. We actively participate in federal programs to support agriculture in times of drought and conservation programs that work to improve water quality. Water is vital in all farming operations, so our members understand the importance of protecting and conserving our precious water resources.

Farm Bureau respectfully suggests that the Council may find greater value in a conversation that starts with specific outreach to states, and if it sees further discussion as necessary, then engage in a non-regulatory Request for Information or other process through the Federal Register. Unfortunately, we have been made aware that many interested parties, including states, were unaware of this White House website-based request.

Farmers, ranchers and foresters play an integral role in managing our shared resources, and we will continue to play our part.

Sincerely,



Zippy Duvall
President

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 22: Jamie S. Heisig-Mitchell, HSRD

Written: 7/1/2024

Subject: Groundwater

Good afternoon,

Please find attached HRSD's response to the President's Council of Advisors on Science and Technology request for public input on America's Groundwater Challenges.

Respectfully,

Jamie Heisig-Mitchell (she/her)
HRSD Chief of Water Quality

Attached: Council_Groundwater_HRSDComm



July 1, 2024

President's Council of Advisors on Science and Technology
Email to: pcast@ostp.eop.gov

RE: Public Input on America's Groundwater Challenges

On behalf of HRSD, a water resource recovery utility in southeastern Virginia serving 1.9 million Virginians, I am pleased to offer the following responses to the Council's questions probing opportunities to further improve the protection of our nation's groundwater resources. While we believe that the state regulatory agencies and the United States Geological Survey (USGS) have technical expertise to address many of your questions, HRSD does have practical experience in groundwater supply augmentation through our [Sustainable Water Initiative for Tomorrow](#) (SWIFT). HRSD's SWIFT program is a managed aquifer recharge program and One Water solution designed to address multiple water challenges facing the communities of eastern Virginia. By adding advanced water treatment processes to several HRSD wastewater facilities, HRSD is producing SWIFT Water® that will be used to recharge the Potomac Aquifer, the primary source of drinking water in much of eastern Virginia. This will achieve several important benefits: SWIFT provides a sustainable source of groundwater, replenishing the depleted natural resource making groundwater abundant for generations to come; it helps the Chesapeake Bay by significantly reducing the amount of nutrients such as nitrogen and phosphorus that HRSD discharges to local waters; and it may reduce the rate at which land is sinking in Hampton Roads, which will enhance the ability of the environment and our communities to adapt to rising seas. By the end of this decade, HRSD will have completed the installation of two full-scale SWIFT facilities with the capacity to recharge 50 million gallons per day (MGD).

How can the nation enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resource?

Based on experience in Virginia, it seems likely that each state has a reasonable inventory on permitted withdrawals though it is also likely that each state has a different threshold of withdrawal that would trigger the need for a groundwater withdrawal permit. The United States Geological Survey (USGS) also has extensive data on groundwater supplies and use across the country. While coordination with state agencies and the USGS is expected to provide valuable information on permitted uses as well as managed aquifer recharge, a significant gap may still remain for groundwater users that fall below the threshold which requires a permit. While states can enact legislation similar to Virginia's which requires the registration of all private wells constructed in a groundwater management area ([Section § 62.1-258, Code of](#)

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[Virginia](#)), such legislation will not capture all private well uses which collectively can represent a significant portion of groundwater withdrawal.

HRSD and its groundwater management colleagues at the state and federal level have employed alternative approaches to understanding private use. Within our wastewater service area, we have compared the billing records from water purveyors to data on wastewater billing to identify well water users. Looking more broadly at areas that fall outside of sewer service boundaries, general assumptions can be made utilizing GIS applications or even remote sensing applications to identify structures that have a probable water supply and assume groundwater use if a public water supply is not provided. The volume of groundwater withdrawal can then be estimated from basic patterns of household use. This methodology is imperfect but provides some level of accounting for non-permitted uses.

We also expect as part of your information gathering that the Council will receive a variety of input on approaches that are being utilized to better capture this data. Sharing these best practices with the state regulatory agencies will provide opportunities for each program to improve its capabilities in estimating use. In fact, the collation and dissemination of groundwater management practices linked to the Council's key questions will be extremely valuable, allowing state programs to benefit from experiences across the country.

How can the nation effectively model and predict changes in the inventory, recharge and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

We suggest that this Council turn to the Subject Matter Experts in the groundwater resource programs within each state and with the USGS. Virginia's Department of Environmental Quality is advancing its groundwater monitoring program to inform model updates. There is also a considerable investment in developing and refining groundwater models in conjunction with HRSD's SWIFT program, to ensure a better understanding of aquifer response to SWIFT recharge. This work is being conducted with partners from the USGS and with the Potomac Aquifer Recharge Monitoring Laboratory, the technical experts which provide input to the Potomac Aquifer Recharge Oversight Committee, Virginia's legislatively enabled oversight committee for HRSD's SWIFT program.

How can the nation effectively scale groundwater recharge while mitigating risks?

The Interstate Technology and Regulatory Council (ITRC) recently published a [report](#) on managed aquifer recharge (MAR) that offers guidance on implementing managed aquifer recharge in addition to case studies on current MAR projects. This can be a useful resource in evaluating successful opportunities for MAR.

More specifically, HRSD's SWIFT program has implemented measures designed to ensure protection of the groundwater resource. Recognizing that treated wastewater is the source

water for the SWIFT Advanced Water Treatment facilities, multiple barriers of control are needed to protect the groundwater resource from contamination associated with organics, pathogens and other contaminants. Further details are available as part of HRSD's Underground Injection Control [permit](#) for the James River SWIFT facility.

Mitigation of risk begins with a source control program designed to limit introduction of contaminants into the waste stream. HRSD's Pretreatment and Pollution Prevention program manages this effort largely through its industrial discharge regulatory program. HRSD's Industrial Wastewater Discharge [Regulations](#) address protection of our beneficial reuses, including aquifer recharge, and allows HRSD to regulate Contaminants of Emerging Concern that are not addressed directly in other Clean Water Act programs. While HRSD can regulate the industries that discharge to our system, we do not have the ability to control the quality of the wastewater originating from residential sources. To address this, HRSD is exploring effective outreach strategies to educate consumers about their personal influence on water quality and what can and cannot be flushed down the drains. Years ago, we implemented a "[My Flush Counts](#)" program which can be leveraged for multiple outreach campaigns and was initially targeted toward education on proper pharmaceutical disposal.

Following source control, the next key barrier for treatment is advanced wastewater treatment. The source water for HRSD's SWIFT facilities is treated through an advanced wastewater treatment facility, designed for enhanced nutrient removal. The biological activity in these facilities is highly effective at biodegradation of organic compounds.

The SWIFT Advanced Water Treatment facility itself includes multiple barriers of control (Figure 1). The James River SWIFT facility, currently under construction, employs coagulation, flocculation and sedimentation; advanced oxidation with ozone and hydrogen peroxide; biofiltration; granular activated carbon (GAC) adsorption, and UV disinfection prior to recharge to the Potomac Aquifer, our receiving aquifer. The process produces SWIFT Water® which meets all Safe Drinking Water Act regulatory requirements and matches the geochemistry within the aquifer. The use of GAC provides treatment of per- and polyfluoroalkyl substances (PFAS) and ensures compliance with the recently released National Primary Drinking Water Regulation for PFAS. A similar treatment train has been operating at HRSD's SWIFT Research Center since 2018 and has demonstrated consistent and reliable performance in compliance with drinking water regulations and public health objectives. Thus far, this facility has treated and recharged more than 800 million gallons to the Potomac Aquifer.

Throughout the wastewater treatment process and the SWIFT Advanced Water Treatment process, critical control points (CCPs) have been identified, allowing real-time process control monitoring with the ability to redirect any water not meeting specifications away from the aquifer recharge wells to be managed instead by the wastewater facility in compliance with its receiving stream discharge permit (Virginia Pollutant Discharge Elimination System (VPDES)).

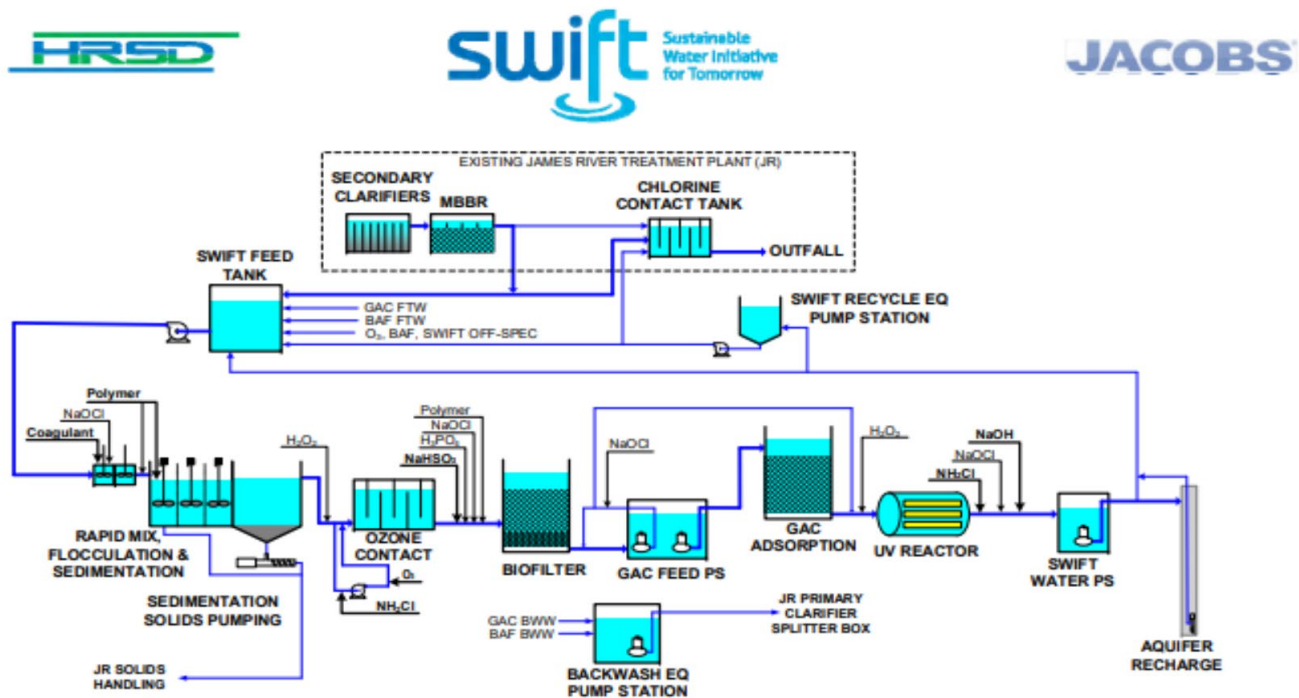


Figure 1: James River SWIFT Advanced Water Treatment Process Flow Diagram

What strategies and incentives can help limit groundwater overuse?

Management actions focused on incentives should include programs for groundwater banking and trading. Such programs can provide the financial driver for groundwater users to implement water conservation strategies and also implement MAR programs. MAR at the scale of HRSD's SWIFT program represents a significant capital investment in addition to the costs associated with on-going Operations and Maintenance (O&M) of the facilities. Groundwater trading creates an avenue for cost recovery for these types of projects, charging a fee to the beneficiaries of the increased availability in water supply. This strategy was contemplated by Virginia's Eastern Virginia Groundwater Management Advisory Committee in their 2017 [report](#) (see page 33 for start of Groundwater Trading and Banking section), and included a model for such a program in practice in Australia.

We hope you find value in this input and welcome the opportunity to share more about our efforts to ensure the sustainability of Virginia's groundwater resource.

Respectfully submitted,



Jamie S. Heisig-Mitchell
Chief of Water Quality

Linked Resources, in order of appearance:

HRSD. (n.d.) HRSD's Sustainable Water Initiative for Tomorrow. <https://www.hrsd.com/swift>

Code of Virginia. (2015). § 62.1-258. Use of ground water in ground water management area; registration of well construction required.

<https://law.lis.virginia.gov/vacode/title62.1/chapter25/section62.1-258/#:~:text=It%20is%20unlawful%20in%20a,C%20of%20%C2%A7%2062.1%2D261.>

Interstate Technology and Regulatory Council. (n.d.) Managed Aquifer Recharge Home Page. <https://mar-1.itrcweb.org/>

U.S. Environmental Protection Agency. 2023. Underground Injection Control Area Permit VAS5B170028617 Authorization to Operate Class V Injection Wells. Accessed July 1, 2024 from HRSD website.

https://www.hrsd.com/sites/default/files/assets/Documents/pdfs/SWIFT/VAS5B170028617_FINAL_PERMIT.pdf

HRSD. (2022). HRSD Industrial Wastewater Discharge Regulations.

https://www.hrsd.com/sites/default/files/assets/Documents/pdfs/iwd_regs/IndustrialWastewaterDischargeRegulations-Rev07012022.pdf

HRSD. (n.d.) My Flush Counts. <https://www.hrsd.com/my-flush-counts>

Virginia Department of Environmental Quality. (n.d.) Eastern Virginia Groundwater Management Advisory Committee, 2017 report.

<https://www.deq.virginia.gov/home/showpublisheddocument/6884/637514840103430000>

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 23: Michelle Bushman, Western States Water Council

Written: 7/1/2024

Subject: Groundwater Comments

Dear PCAST Groundwater Working Group Co-Leads and Members:

Thank you for the opportunity to comment on your interest in water security and conservation as it relates to groundwater.

The Western States Water Council, a multi-state government entity, has prepared the attached cover letter emphasizing the critical importance of state-federal collaboration on water issues in the west, noting the complexities of laws and hydrogeology, and the need for deference to state laws and management of water resources. Following the cover letter, we provide a broad overview of historical and recent programs, challenges, and opportunities identified by our states in response to your five questions.

We would be interested in supporting further engagement with our states for a more detailed exchange of information in the future, and are happy to answer any further questions you may have.

--

Michelle Bushman

Deputy Director and General Counsel

Western States Water Council

Attached: WSWC Letter to WH PCAST Groundwater Working Group



WESTERN STATES WATER COUNCIL

682 East Vine Street, Suite 7 / Murray, Utah 84107 / (801) 685-2555 / FAX (801) 685-2559

Web Page: www.westernstateswater.org

July 1, 2024

Sent via email: pcast@ostp.eop.gov

PCAST Groundwater Working Group
Inez Fung, Joe Kiani, Steve Pacala, Laura Greene, Catherine Woteki

Subject: State Groundwater Management and Protection

Dear PCAST Groundwater Working Group Co-Leads and Members:

The Western States Water Council (WSWC) is a bi-partisan government entity created by Western Governors in 1965, representing eighteen States. Our members are appointed by and serve at the pleasure of their respective Governors, advising them on water policy issues. Our mission is to ensure that the West has an adequate, secure, and sustainable supply of water of suitable quality to meet its diverse economic and environmental needs now and in the future. Two of our WSWC position statements related to groundwater are summarized below.¹

Water in the West is an increasingly scarce and precious resource. Groundwater is a critically important resource that is vital to the economy and environment of the arid West. Western States recognize the importance and role of comprehensive groundwater planning in overall water management. The conditions affecting groundwater supplies, demands, and quality vary considerably across our individual member States, and we anticipate that their comments will reflect these variations. States are in the best position to protect groundwater quality and quantity. Western States understand and have demonstrated effective and comprehensive groundwater management policies, programs, and projects. They have shown the ability and authority to protect, allocate, and administer groundwater resources through state laws and regulations tailored to their individual circumstances. Working cooperatively with their federal partners, States have also shown that they have the ability and authority to address federal needs regarding groundwater within existing legal frameworks, including but not limited to, memoranda of understanding, water rights compacts, stipulations, and other methods.

States have exclusive authority over the allocation and administration of rights to the use of the groundwater located within their borders and are primarily responsible for allocating, protecting, managing and otherwise controlling the resource. Federal agencies should work cooperatively with appropriate state agencies and officials to address federal needs involving groundwater through state laws and authorities. The WSWC opposes any and all efforts that would establish a federal ownership interest in groundwater not otherwise recognized or allowed under state law, or diminish the primary and exclusive authority of States over groundwater. Wisely, the United States' Congress and court system have long upheld States' exclusive authority over the allocation and administration of rights to the use of

¹ See https://westernstateswater.org/wp-content/uploads/2023/09/506_Groundwater-Quality-Resolution.pdf and <https://westernstateswater.org/wp-content/uploads/2024/03/515-State-Primacy-over-Groundwater-14March2024.pdf>

water within their borders.² Federal administrative actions have also followed a longstanding policy of deferring to the States to develop and implement groundwater management and protection programs. Any Administration effort to exert control over groundwater or otherwise infringe upon States' authority over groundwater are contrary to existing federal law and threaten effective groundwater management and protection.

Efforts to safeguard water security should be conducted with careful adherence to the principles of cooperative federalism and deference to States' respective laws, policies, and programs. No future administrative initiatives should attempt to usurp States' rights and prerogatives related to the management and protection of groundwater resources. Any federal groundwater strategies must recognize and respect States' primacy, reflect a true state-federal partnership, and provide adequate funding consistent with current federal statutory authorities and regulatory mandates.

Attached are responses to the specific working group questions, which are intended to serve as illustrations from a western regional perspective rather than exhaustive lists. On behalf of the WSWC, we look forward to further conversations with PCAST related to this effort.

Sincerely,

A handwritten signature in cursive script that reads "Tony Willardson".

Tony Willardson
Executive Director

² See, e.g., the Mining Acts of 1866 and 1870, the Desert Land Act of 1877, § 8 of the Reclamation Act of 1902, § 10 of the Federal Water Power Act of 1920, § 1 of the Flood Control Act of 1944, § 301(a) of the Water Supply Act of 1958, § 101(b) and (g) of the Clean Water Act of 1972, *Oregon Power Co. v. Beaver Portland Cement Co.*, 295 U.S. 142 (1935), *County of Maui v. Hawaii Wildlife Fund*, 140 S. Ct. 1462, 1471-72 (2020).

Groundwater Working Group Questions

1. How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

WSWC principles declare, “All levels of government must prioritize the collection, analysis and open sharing of reliable data regarding water availability, quality, and usage given its importance to research for sound science and data driven decision making.” Federal agencies should work cooperatively with appropriate state agencies and officials to address both federal and state data needs involving groundwater, and to disseminate data as appropriate in a findable, accessible, interoperable, and reusable way.

All Western States administer rights to the use of groundwater and have various sources of data related to water use. The WSWC's Water Data Exchange (WaDE) program has provided access to data and metadata for some 3 million western state water rights, including ownership, point of diversion and place of use, surface or groundwater sources, and allowed diversions measured by flow or volume. This water rights data is available via a user-friendly dashboard referred to as our Western States Water Data Access and Analysis Tool (WestDAAT). The WSWC is also working with the U.S. Bureau of Reclamation to incorporate water rights and open evapotranspiration (OpenET) data as a measure of consumptive use, including groundwater use. Similar support for state efforts is likely to be the most effective and efficient means of securing more comprehensive and timely data on groundwater.

Further, States require drilling logs for water wells that can provide data on water levels and changes over time. States also operate monitoring wells with data available in varying formats on both water quantity and quality. Some States require flow meters on groundwater wells and periodic reporting of use. Others use indirect measurements, such as monitoring power used for pumping groundwater. Remote sensing to measure evapotranspiration and consumptive use by agriculture and other outdoor uses continues to expand using both aerial surveys and satellite imagery.

The WSWC strongly supports existing federal programs critical to addressing groundwater challenges, such as the National Aeronautics and Space Administration's (NASA) and U.S. Geological Survey (USGS) land imaging programs. Past and present Landsat satellites (Landsat 7,8 & 9), and the Landsat Next mission, provide thermal infrared imagery that many Western States are using to measure and monitor water use, including groundwater use, to administer water rights, and to inform water resources planning and management. The NASA-ISRO SAR (INSAR) Mission enables Synthetic Aperture Radar Interferometry (InSAR) using radar satellites to observe and monitor the ground surface and map topography and detect surface changes. InSAR, can be used to measure land subsidence due to groundwater extraction. Light Detection and Ranging (LiDAR) is another useful tool for precision topographic measurements.

Based on NASA's capabilities, Open Evapotranspiration (OpenET) uses best available science to provide easily accessible satellite-based evapotranspiration (ET) data for improved water management across the western United States. Using the Data Explorer or Application Programming Interface (API), users can

access OpenET data at the field scale for millions of individual fields or at the original quarter-acre resolution of the satellite data.

The USGS Water Resources Mission area covers important programs related to groundwater data. USGS works in collaboration with federal, state and local data providers as partners to monitor groundwater levels using the framework of the National Groundwater Monitoring Network (NGWMN). USGS also provides federal support for a Climate Response Network (CRN) with continuous, real-time instrumentation designed to provide data on long-term groundwater levels. These data are vital to water-availability studies and assessments which seek to evaluate the balance between supply and demand and the relative influence of individual components in affecting that balance and achieving water security.

The SECURE Water Act (42 U.S.C. §10368) authorized a program that supports activities related to data collection and methods research and development at the State level. The USGS Water-Use Data and Research program (WUDR) provides financial assistance through cooperative agreements with water resource agencies in States to improve the availability, quality, compatibility, and delivery of water-use data that is collected or estimated by States, including groundwater use data. USGS support for state water data gathering plans and implementation is limited. Some States have taken full advantage of WUDR funding and exhausted available funding, while others have not, often due to the prohibitive administrative burden. Further support for States' efforts is needed.

The Bureau of Reclamation plays a significant role in certain western states with respect to developing, funding, and delivering water to local recharge or water banking initiatives. It is essential that the Bureau coordinate with and consult state agencies when conducting these activities to ensure state groundwater management strategies and water rights considerations are incorporated.

2. How can we effectively model and predict changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle and provide that information to stakeholders and decision-makers?

Effectively modeling changes in groundwater availability requires enhanced data collection, inventorying, and monitoring best accomplished through state-federal partnerships and collaborative data management. Funding for water modeling, water budgeting and water data sharing will allow state and local management agencies to make informed, timely, coordinated decisions within their respective legal frameworks.

While the WSWC is primarily a policy advisory body, our member states have spent several decades collecting information about and developing expertise to better manage their respective and sometimes overlapping aquifers. For example, in 1980, Arizona passed a Groundwater Code that established Active Management Areas (AMAs) to address the effects of large-scale groundwater withdrawals on groundwater resources. Additionally, all water wells in Arizona must be registered with the Arizona Department of Water Resources (ADWR). California's Department of Water Resources (DWR) has used groundwater models for at least 40 years to simulate interactions of river basins, groundwater basis, and water projects in the Central Valley. The California DWR provides extensive technical support for local agencies on groundwater modeling, including serving modeling code,³ has invested in a massive statewide mapping and analysis program to characterize areas suitable for recharge,⁴ and has pioneered a

³ https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/FAQ-and-Fact-Sheets/SGMA-Data-Tools-and-Reports-Fact-Sheet_2023.pdf

⁴ <https://data.cnra.ca.gov/dataset/aem>

FloodMAR program.⁵ Idaho has been a leader in the modeling of groundwater use and changes in groundwater levels and the impact of both surface and groundwater availability in the Snake Plain Aquifer. Kansas has developed several groundwater flow models for various basins. Nebraska has developed a number of models simulating the interaction between surface and groundwaters. Oregon has developed groundwater flow models in four basins and uses them to evaluate options for groundwater management. These models and their foundational studies were conducted in collaboration with the U.S. Geological Survey with support from its Cooperative Matching Funds (CMF) program. The CMF program supports such applied, collaborative science across the country, and limited availability of these funds constrains the nation's capacity for data-informed resource management. Expanding CMF funding for the USGS Water Availability and Use Science Program (WAUSP) budget area will directly and efficiently provide additional capacity to effectively model and predict changes in groundwater quantity and ensure that information is both peer-reviewed and readily available to stakeholders and decision-makers through USGS publications and data products. Texas has developed groundwater availability models (GAMs) that include comprehensive information on each aquifer: such as recharge; geology and how that conveys into the framework of the model; related rivers, lakes, and springs; water levels; aquifer properties; and pumping. Each model is calibrated to ensure that the models can reasonably reproduce past water levels and groundwater flows.

3. How can we efficiently scale groundwater recharge while mitigating risks? How can we ensure clean and safe groundwater, especially for the communities that are affected most by groundwater contamination and depletion?

Many Western States have decades of experience with groundwater recharge programs and projects, particularly in the Southwest. In the 1990's, the WSWC worked with the U.S. Bureau of Reclamation to evaluate legal and institutional issues related to a number of groundwater recharge demonstration projects.⁶ Some of the findings are summarized below.

Groundwater recharge projects are very site specific for hydrologic, geologic, economic, legal, and regulatory reasons. Projects are generally undertaken at a private or local government level to augment water supplies and ensure the reliability of existing water supplies. The highly variable and uncertain nature of natural precipitation and snowpack runoff in the West is often both a reason for and an obstacle to successful recharge projects. Not all aquifers are suitable candidates for groundwater recharge. Project sponsors must take into consideration the porosity or fractured nature of the underlying sediments or bedrock; the timing of the intended storage and recovery and whether the water will stay in the desired location or migrate; and the chemistry of the recharge water, the receiving water, and the surrounding aquifer geology. Project costs for upfront capital financing have generally been recovered through general tax revenues or water and sewer user fees. Unit costs of water are sensitive to such factors as project scale and production levels, and municipal projects have historically had a higher probability of success given the economies of scale and higher water values. In the West, water rights are similar to property rights, and state water laws regarding beneficial use and the administration and allocation of water can impose some constraints on the intended benefits of groundwater recharge projects. Local planning and zoning requirements can substantially increase the costs of municipal recharge projects. State and federal laws protecting the quality of existing groundwater resources, particularly where those resources are used for drinking water, can also constrain groundwater recharge projects. Federal environmental oversight and regulatory requirements under the Clean Water Act, Endangered Species,

⁵ See <https://floodmar.org/> and <https://water.ca.gov/programs/all-programs/flood-mar>

⁶ See [Ground Water Recharge Projects in the Western United States: Economic Efficiency, Financial Feasibility, and Legal/Institutional Issues \(Part I\) \(1990\)](#) and [\(Part II\) \(1998\)](#)

Act, National Environmental Policy Act, and Safe Drinking Water Act can substantially increase the cost of federally-supported projects, to the point of making them cost-prohibitive and outweighing the federal cost-share.

Successful agricultural recharge projects have used existing infrastructure and low-cost water, and often help maintain rural lifestyles. Small impoundments can significantly increase recharge. However, discharges to groundwater through infiltration are not clearly regulated, and non-point source pollution controls can have a significant impact on such recharge projects. Banking water through recharge activities offers water managers greater flexibility in meeting peak demands and providing protection from drought. However, finding water available for recharge is a primary constraint. Additionally, during drought when many water users turn to groundwater as an alternative resource, recharge facilities may be idle or operate at a fraction of their capacity due to the lack of an available surface water supply. Reclaimed water may be used for groundwater recharge if the water quality and water chemistry is suitable, however, there is still a public aversion to commingling water supplies. Public education and participation may help minimize conflicts and opposition.

Where there is a clear public interest or benefit in a groundwater recharge project, state or federal involvement may be both appropriate and necessary, including reimbursable public financing, cost sharing, and technical assistance, including investigative research and baseline data collection to facilitate decisionmaking, and monitoring water quality and quantity. State and federal surface water projects may be used as a resource where appropriate to encourage and integrate recharge opportunities.

For federal financial assistance, project purposes that may justify federal cost sharing include flood control, environmental and fish and wildlife enhancement, endangered species recovery, federal reserved water rights uses, international treaty obligations, public health, and water quality improvements. In evaluating the benefit/cost ratio, social costs and benefits should be included, such as environmental values and instream water uses. The development of accepted standards of measurement for such costs and benefits would facilitate public and private decisionmaking.

Two primary state concerns associated with groundwater recharge are: (a) the potential degradation of ambient groundwater quality and adverse effects on the current, or future use of an aquifer; and (b) the technical challenge of quantifying water available for recovery given the hydrogeologic uncertainty surrounding some proposed projects. States have an interest in ensuring that their water quality standards protect the beneficial uses of groundwater and that water is put to allowable beneficial uses. States have also been grappling in recent decades with how their legal and institutional systems govern recharge and recovery activities, seeking a balance between protecting existing resources and facilitating future resources. Some of the legal and institutional questions that arise with recharge activities include: (i) is groundwater recharge recognized as a beneficial use of surface water; (ii) is the right to withdraw groundwater protected, and is adequate information available to define the recoverable amount; (iii) are third parties with groundwater and surface water rights adequately protected; (iv) are public interest values adequately protected; (v) should groundwater protection be based on ambient quality, which may preclude the recharge of potable surface water and other waters, or preclude present and future beneficial uses?

Future construction and operation of successful recharge projects in the West will depend in large part on the ability of different public and private entities to cooperate, find common or compatible purposes, and work out collaborative working arrangements.

4. How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

Different sectors that rely on groundwater are best engaged through existing state and federal programs. Fully funding federal/state groundwater-related conservation programs, including Farm Bill programs would be an important step. Public education and stakeholder participation in programs that explain project costs, benefits, and legal and environmental constraints should be encouraged.

5. What strategies and incentives can help limit groundwater over-use?

Every Western State has addressed the problem of groundwater depletion and many have tied water supply planning, including groundwater management, to land use planning. State groundwater management plans, policies and programs should be the base for evaluating and implementing any federal strategies and incentives. For example, Arizona's Groundwater Management Act established specific management goals and requirements to address groundwater overdraft including a demonstration of a 100-year assured water supply in AMAs and adequate water supply outside of AMAs. More recently, in 2014, the State of California enacted the Sustainable Groundwater Management Act (SGMA) to better manage groundwater supplies. It requires local agencies to adopt groundwater sustainability plans for high- and medium-priority groundwater basins, aiming to balance the amount of water pumped out of and put back into a basin's aquifers. Idaho curtailments of junior groundwater users under prior appropriation laws have led to various agreements to share in the water shortages during dry years. The Nebraska, New Mexico, Kansas, and Nevada legislatures have funded programs for the voluntary retirement of groundwater rights. Oregon is collaborating with the Farm Service Agency (USDA) to launch the Harney Valley Groundwater Conservation Reserve Enhancement Program (HVG CREP), a voluntary program aimed at reducing consumptive water use by incentivizing landowners to voluntarily cancel groundwater rights and establish new conservation crops in exchange for payments.

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 24: J.T. Reager, California Institute of Technology

Written: 7/1/2024

Subject: Groundwater

Dear Groundwater working group,

Please find attached the letter on "Spaceborne remote sensing for the monitoring of global groundwater changes".

Thank you

J.T. Reager

Water and Ecosystems group

NASA Jet Propulsion Laboratory

California Institute of Technology

Attached: Spaceborne Remote Sensing for the Monitoring of Global Groundwater Changes

Spaceborne remote sensing for the monitoring of global groundwater changes

Under the dual pressures of a changing climate and increasing societal demands for freshwater, many regions of the world face looming water crises. Groundwater accounts for 96% of the unfrozen freshwater globally, is the major source of water for over 2 billion people, supplies roughly 45% of the water for irrigation globally, and supplies over half of the drinking water in the United States. Yet, there is little reliable infrastructure for consistent groundwater monitoring globally, and more information on groundwater supplies and changes to those supplies is desperately needed.

For these reasons, remote sensing approaches to monitoring groundwater or aquifer change can be advantageous. Satellite and airborne observations have revolutionized the understanding of hydrology and water availability at regional to global scales in ways that would not have occurred with relatively sparse in situ observations. Earth-observing satellites and airborne systems can provide both the “big picture” spatial coverage as well high-resolution proxies for groundwater storage change and aquifer structure over large regions. This Earth sensing data revolution has the potential to provide the regional to global understanding essential for improving predictive models and informing policy makers, resource managers, and the general public. In recent years, several space- and air-borne remote sensing methods have been applied to the study of groundwater, demonstrating that water storage, extraction, and recharge, as well as aquifer hydrostratigraphy, can be estimated under the right circumstances on regional to global scales. Yet, challenges remain in using these data sets, particularly in relating the raw observed data to hydrologic variables of interest, in downscaling coarse data sets, and in integrating diverse remotely sensed data sets into groundwater models. In this work, we review the principal groundwater (and groundwater/aquifer proxy) measurement techniques that have been developed, including gravitational techniques, InSAR, lidar, airborne electromagnetic (AEM) systems, and GNSS. We also discuss future needs and research directions both in measuring and modeling capabilities, noting that integrating multiple remotely sensed data sets into groundwater modeling frameworks is an area of significant opportunity.

Existing techniques

Several recent research studies have marked important milestones in the advent of remotely sensed groundwater observations (Adams et al., 2022). Remote sensing approaches such as gravitational measurements, Interferometric Synthetic Aperture Radar, Global Navigational Satellite System, lidar altimetry, and Airborne Electromagnetic Systems can yield indirect yet valuable information about groundwater.

Table 1: A summary of remotely sensed groundwater techniques (From ADAMS et al., 2002)

Technique	Capabilities	Advantages	Disadvantages
Gravimetric measurements	GRACE and GRACE-FO: Measures groundwater storage change using gravimetric measurements at a (300 km) ² , 30-day resolution.	Can obtain a global picture of groundwater storage anomalies.	Spatial scale makes it difficult for usage in smaller aquifers without additional modeling, and high frequency mass variations are not captured.
Surface deformation measurements	Tracks ground movement to estimate changes in groundwater storage. Deformation is driven by changes in pore pressure and effective stress as groundwater storage changes. InSAR: mm-scale changes can be recorded in meter-scale track resolutions. GNSS: Provides point-based measurements but stations exist globally. Radar altimetry: > 1 cm/yr vertical scales along 1-km track resolutions. Lidar: 3 cm vertical scales in 1-km grids (ICESat-2).	Can provide continuous records of surface deformation. High temporal and spatial resolution (or station density, in the case of GNSS) allows for robust applications at various scales.	A good constraint of geologic characteristics is needed to accurately relate nonlinear surface deformation responses to groundwater storage changes.
Airborne Electromagnetic Systems (AEM)	Electrical conductivity is measured to estimate water table. Shallow (1–3m) and deep (300–400m) aquifers can be surveyed.	Can rapidly survey large areas at a low cost.	Geologic properties of the aquifer system need to be well-constrained. Limited capacity in saline systems.
Proxy measurements	Soil moisture and evapotranspiration can be used as proxies to groundwater use in regions that have vegetation reliant on groundwater (e.g., arid regions, pumping/irrigation regions, and high-infiltration regions).	Optical remote sensing methods are often high in spatial resolution, allowing this technique to be applied at local scales.	Relies on an inferred relationship between vegetation and groundwater use (conjunctive use of surface water not considered).

Figure 1 presents the spatial and temporal scales of groundwater variability and the various observational approaches. While remote sensing methods are capable of capturing groundwater dynamics on much greater spatial scales than in situ or point-based methods, distinct spatial and temporal gaps between various observational approaches still exist. Advances in other methods such as radar altimetry, lidar, and soil moisture, while not discussed, would complement other data sets to generate a coherent picture of the aquifer in question. Further, numerical groundwater models or data assimilation platforms can further serve as a valuable tool in integrating the observations to the appropriate spatiotemporal scale according to the research question.

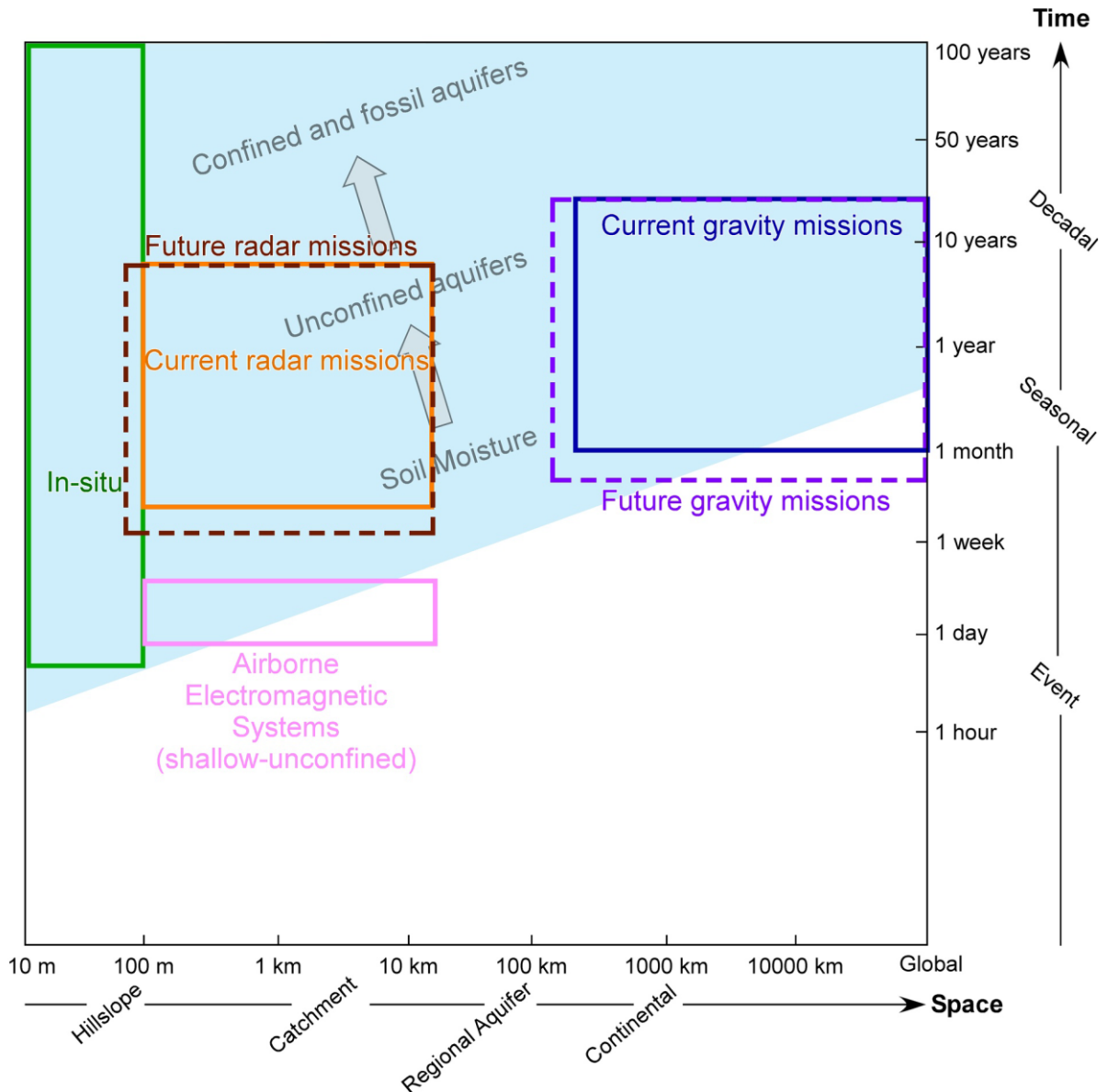


Figure 1: spatial and temporal scales of groundwater variability and sampling constraints of observational approaches

While well-managed in situ observation networks with dense spatiotemporal sampling are superior to the coarse-resolution measurements provided by remote sensing, such networks can be cost-prohibitive, labor intensive to maintain, and are increasingly difficult to find around the world. Within this context, recent advances in remote sensing provide a means to monitor groundwater and related geophysical changes at spatial scales otherwise unattainable with in situ methods. These advances also ease data distribution, inviting a range of users to utilize the data according to their needs. This is being augmented by open, community-based coding programs such as Python or Google Earth Engine that allow users to share codes to manipulate data sets.

Future advances and potential directions

Although groundwater storage change can be monitored with gravity- and deformation-based measurements, each have limitations. The primary limitation of gravity-based measurements is resolution, while the primary limitation of deformation-based measurements is the lower sensitivity in unconfined aquifers, though they are often the first source of extracted groundwater resources.

Future methods to address these limitations could greatly advance the ability of remote sensing to estimate groundwater storage change at a resolution that is applicable for water management in management districts, which often are smaller in area than the resolution of gravity-based measurements.

Individual methods have varying spatial, temporal, and technological limits, which make them appropriate for different regions and research goals. In this light, numerical models can serve as a valuable tool to integrate the various data sets and simulate groundwater processes, and the continued development of models that can integrate multiple remote sensing data sets is an area of great promise for improved groundwater resource evaluation. In certain cases, such as groundwater quality, where close contact with the porewater or aquifer medium is required, strategic deployment of in situ data may outweigh the benefits of remote sensing. In cases where continuity of data is critical, the gaps in remote sensing data due to mission termination or technological shifts may adversely impact outcomes. Nonetheless, remote sensing methods provide “big picture” assessments of groundwater globally, and lead the technological vanguard toward groundwater sustainability. Future advances in remote sensing, in addition to better data assimilation methods, will greatly enhance our ability to monitor and quantify global groundwater resources in the long-term.

References

1. Adams, K. H., Reager, J. T., Rosen, P., Wiese, D. N., Farr, T. G., Rao, S., et al. (2022). Remote sensing of groundwater: Current capabilities and future directions. *Water Resources Research*, 58, e2022WR032219. <https://doi.org/10.1029/2022WR032219>
2. Famiglietti, J. S., Cazenave, A., Eicker, A., Reager, J. T., Rodell, M., & Velicogna, I. (2015). Satellites provide the big picture. *Science*, 349(6249), 684–685. <https://doi.org/10.1126/science.aac9238>
3. Rodell, M., & Reager, J. T. (2023). Water cycle science enabled by the GRACE and GRACE-FO satellite missions. *Nature Water*, 1(1), 47-59.

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 25: Dan Keppen, Family Farm Alliance

Written: 7/1/2024

Subject: Groundwater

Dear Groundwater Working Group Members:

The Family Farm Alliance appreciates the opportunity to offer the attached comments in response to the April 25, 2024 announcement of the President's Council of Advisors on Science and Technology's creation of your Working Group.

The Family Farm Alliance (Alliance) is a grassroots organization of family farmers, ranchers, irrigation districts, and allied industries in 17 Western states. We support the preservation and protection of Western irrigated agriculture for our nation's year-round availability of fruits, vegetables, nuts, grains and beef.

Managing groundwater resources in the western United States is a major issue that has become more complex. However, the Alliance and its members firmly believe that this issue is best handled at the state and local level. States have unique expertise and have established working relationships with agriculture, irrigation, municipalities, and water users that are most affected by groundwater supply and have the highest interest in finding solutions. Moreover, Congress has long deferred groundwater management to the states.

We fear that tasking the Environmental Protection Agency, the Department of the Interior and other federal agencies to develop a "national strategy" on groundwater would inevitably result in yet another one-size-fits-all, top-down approach, adding a new layer of conflicting regulatory interference in existing state groundwater management and undermine water rights and the flexibility of local water users.

Further, we are concerned with the lack of meaningful public notice or engagement with affected local, state and agriculture stakeholders for this effort. Having virtual meetings with a few select academic and unelected federal officials and inviting public comment on such a broad topic raises concerns about the ultimate objective of the working group and what sort of new federal regulations will result.

These issues and concerns are dealt with further in the attached letter.

We would appreciate more information on the Working Group's goals and activities, especially with regard to any use of federal appropriations and regulations relating to groundwater.

Again, thank you for the opportunity to comment.

Sincerely,

Dan Keppen
Executive Director
Family Farm Alliance

Attached: FFA Groundwater Letter to WH



July 1, 2024

Groundwater Working Group
Office of the President's Council of Advisors
On Science & Technology
The White House
Washington, DC 20500

To Whom it May Concern:

The Family Farm Alliance appreciates the opportunity to offer comments in response to the April 25, 2024 announcement of the President's Council of Advisors on Science and Technology's creation of a Groundwater Working Group.

The Family Farm Alliance (Alliance) is a grassroots organization of family farmers, ranchers, irrigation districts, and allied industries in 17 Western states. We support the preservation and protection of Western irrigated agriculture for our nation's year-round availability of fruits, vegetables, nuts, grains and beef.

Managing groundwater resources in the western United States is a major issue that has become more complex. However, the Alliance and its members firmly believe that this issue is best handled at the state and local level. States have unique expertise and have established working relationships with agriculture, irrigation, municipalities, and water users that are most affected by groundwater supply and have the highest interest in finding solutions. Moreover, Congress has long deferred groundwater management to the states.

Aquifers that serve millions of square miles are also pivotal to rural economies. For example, the Eastern Snake River Plain Aquifer (ESPA) in Idaho yields approximately 21percent of all of the goods and services produced in Idaho—the equivalent of \$10 billion annually. Despite facing very complex and contentious challenges in the ESPA recently, state and local water users—without federal involvement--are working together to achieve local solutions.

The Central Arizona Project (CAP) as an example where nearly complete loss of surface water due to drought conditions has left CAP farmers with sole reliance on groundwater pumping to even maintain half of their normal crop production. While Arizona has been subject to one of the most comprehensive groundwater management laws since 1980, the State also recognized the need for certain pumping allowances in Pinal County in order to preserve agricultural production in that county for as long as possible. In a widespread federal groundwater law, such allowances in order

to preserve local and rural economies, would seem unlikely.

We fear that tasking the Environmental Protection Agency, the Department of the Interior and other federal agencies to develop a “national strategy” on groundwater would inevitably result in yet another one-size-fits-all, top-down approach, adding a new layer of conflicting regulatory interference in existing state groundwater management and undermine water rights and the flexibility of local water users. These and all other federal agencies have been mandated by the White House to develop and implement climate adaptation policies and regulations that often are at odds with and create obstacles to on the ground efforts to enhance Western water supplies.

Further, we are concerned with the lack of meaningful public notice or engagement with affected local, state and agriculture stakeholders for this effort. Having virtual meetings with a few select academic and unelected federal officials and inviting public comment on such a broad topic raises concerns about the ultimate objective of the working group and what sort of new federal regulations will result.

The discussion on the December 1, 2023 Zoom meeting found on the White House’s website references projects in California, Arizona, Colorado, and Idaho and refers to agriculture as “the elephant in the room” and “the culprit” of depleted aquifers. Our experience suggests that federal water management policies that redirect water once used for decades by agriculture towards environmental purposes may be a more realistic cause for concern.

In the absence of once reliable surface water supplies provided by the federal Central Valley Project (CVP), many of California’s farmers over the past 15 years have been forced to rely on pumping groundwater from underlying aquifers. Ironically, one of the original purposes of the CVP was to shift San Joaquin well users away from groundwater by importing stored surface water supplies. Now, 80 years later, farmers and ranchers are again looking below ground to replace once-reliable CVP surface water that has been reduced due to drought and redirection to environmental uses.

Similar impacts to groundwater have been experienced by farmers and other landowners in and around the federal Klamath Project in southern Oregon and Northern California. Groundwater levels have declined as once-reliable federal water supplies have been steadily redirected away from irrigation use and instead sent downstream to meet flow requirements associated with coho salmon, which are protected under the Endangered Species Act (ESA). In addition to increasing pumping costs, declining groundwater levels in the Klamath Basin has caused other significant costs. In the last several years, over 200 domestic wells in the basin have run dry, resulting in costs to procure emergency water as well as to drill deeper wells. In December of 2021, the State of Oregon allocated \$4 million to assist people in Klamath County with the expense of drilling new wells. The following year, Oregon allocated \$5 million to help Klamath County and residents of other counties with dry wells. This money pays for water tanks and delivery of emergency water to Klamath County residents with empty wells.

In both the Central Valley and Klamath cases, the water insecurity imposed by taking away surface water creates not just these types of financial costs but also emotional costs as people face uncertainty in meeting basic needs. The lack of surface water to such productive agricultural regions has

detrimentally impacted groundwater use, the economy of those communities as well as the state, and has the potential to increase food prices. Finally, replacing surface water irrigation with groundwater pumping in effect imposes a “double whammy” on the underlying water resource. Not only is groundwater replacing the lost surface water, the recharge provided by the surface water application is also lost.

Another speaker at the December 1, 2023 Zoom meeting suggested imposing federal regulation and costs on agriculture as a solution. The Alliance opposes this White House’s backdoor threat to regulate groundwater or impose new restrictions on agriculture as a means of advancing its climate adaptation policies. We also oppose any attempt by a federal regulatory agency to coerce or intimidate local and state governments into regulating groundwater use and management under the auspices of compliance with federal laws such as the Clean Water Act and the ESA without specific authority or cause.

We would appreciate more information on the Working Group’s goals and activities, especially with regard to any use of federal appropriations and regulations relating to groundwater.

Again, thank you for the opportunity to comment.

Sincerely,

A handwritten signature in black ink, appearing to read 'D. Keppen', with a stylized flourish at the end.

Dan Keppen, P.E.
Executive Director

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 26: Caitlin McHale, National Mining Association

Written: 7/1/2024

Subject: Groundwater

Dear OSTP and PCAST:

Attached are the National Mining Association's (NMA) comments on OSTP and PCAST's request for input on addressing America's groundwater challenges and opportunities. We appreciate the opportunity to provide comment and look forward to working with your teams on next steps.

Thank you so much, and please do not hesitate to reach out if you have any questions or need more information.

Caitlin

Caitlin McHale
Associate General Counsel
National Mining Association

Attached: Final NMA OSTP GW Comments



Submitted via email to pcast@ostp.eop.gov

July 1, 2024

The Honorable Arati Prabhakar, PhD.
Director, White House Office of Science and Technology Policy and Assistant
to the President for Science and Technology
1650 Pennsylvania Avenue, N.W.
Washington, D.C. 20502

**Re: National Mining Association Comments on OSTP and PCAST
Request for Public Input on America's Groundwater Challenges**

Dear Dr. Prabhakar:

The National Mining Association (NMA) appreciates the opportunity to file comments on the Office of Science and Technology Policy's (OSTP) and President's Council of Advisors on Science and Technology (PCAST or the Council) request for public input on America's groundwater challenges.¹ We understand the information collected during this initiative will form the basis of a report to "advance government-wide action on groundwater."²

We appreciate this administration's attention to better understanding America's groundwater challenges and welcome the opportunity to work with the Council on actionable ideas and recommendations to address groundwater-related issues. However, as explained below, we are concerned that the Council plans to advance nationwide, government-wide action without conducting sufficient stakeholder outreach with experts and entities critical to this discussion, including states, Tribes, other federal agencies, and the regulated community. We are also very concerned that the Council may be moving forward with an effort without properly recognizing the

¹ The White House, "PCAST Welcomes Public Input on America's Groundwater Challenges," (Apr. 25, 2024), available at <https://www.whitehouse.gov/pcast/briefing-room/2024/04/25/pcast-welcomes-public-input-on-americas-groundwater-challenges/> (last visited July 1, 2024).

² *Id.*

longstanding and primary role of states in managing groundwater. Groundwater supply, use, and regulation is already managed well at the state and local level. Unnecessary federal government involvement in groundwater management could upset longstanding and complex legal frameworks and management practices. If the Council decides to move forward with this effort, we encourage it to consider supporting several recommendations related to developing incentives and funding for groundwater management programs, technical development, and water conservation practices.

I. The NMA's Statement of Interest

The NMA is the official voice of the entire U.S. mining industry, representing all facets of the domestic mining industry and the hundreds of thousands of American workers it employs before Congress, federal agencies, the courts, and the public. The NMA advocates for public policies that will help America fully and responsibly utilize its vast natural resources. The NMA has a direct interest in this request for public input, as our member companies manage and reuse groundwater and other water resources at their sites under a comprehensive framework of federal, state, and local laws and regulations. NMA members also operate in diverse regions across the United States and have unique insight into groundwater management depending on the geography and hydrology of these regions.

II. OSTP and the Council Should Expand Their Stakeholder Outreach and Engagement

- A. OSTP should open a non-regulatory docket to collect information and recommendations transparently and comprehensively.

The NMA urges OSTP and the Council to open a non-regulatory docket where we and other interested stakeholders can provide more information that will be helpful in the development of this report. The Council seeks input from the public on six complex questions regarding a wide range of topics related to groundwater, including data on groundwater inventory, use, recharge and flow across the United States; modeling and predicting changes in the inventory, recharge and flow of groundwater in the context of the overall water cycle; efficiently scaling groundwater recharge while mitigating risks; ensuring clean and safe groundwater; engaging with communities to ensure a sustainable supply of groundwater; and limiting groundwater over-use. But comment submissions are limited to just five pages. It is difficult to provide actionable ideas and recommendations related to the complex legal, technical, and scientific issues related to groundwater in such limited space.

It would be impossible in five pages to respond to these questions based on even a few state programs. Opening a non-regulatory docket would allow stakeholders to submit more detailed information that could be useful to the Council, while also ensuring that this information is transparently accessible and available online for the general public.

B. OSTP and the Council should work proactively with states, Tribes, federal agencies, the regulated community, and other stakeholders with expertise in groundwater management.

As OSTP and the Council acknowledge in the request for input, groundwater is managed comprehensively at the state and local level. Many states have their own groundwater protection programs, state water boards, and state and regional water planning bodies, that engage in regulatory actions, the certification of water well drilling, flood and drought prevention and more.

Unfortunately, we understand that many states, including Western states that appear to be the focus of this initiative, were not informed about this effort when it was first announced, and some were therefore unable to comment. Early, proactive engagement with state experts who have long managed groundwater is critical to any future federal policy or action on groundwater. Additionally, we encourage OSTP and the Council to engage with the U.S. Geological Survey and other federal agencies that already conduct comprehensive research on groundwater issues. We also encourage the Council to acknowledge the numerous voluntary sustainability standards that address groundwater issues. The NMA tracks over 50 sets of voluntary sustainability standards, such as those led by the International Council on Mining and Metals, Toward Sustainable Mining, Copper Mark, the Global Reporting Initiative, and the Sustainability Accounting Standards Board, that support member companies' compliance and audit efforts. Any federal program, even data collection, should complement the existing work that states, other federal agencies, and other experts are already doing in this space and should not duplicate existing efforts.

We also urge the Council to ensure that our associations and member companies are included in the development of this report and in the development of any new federal policy or action on groundwater. Our members are committed to environmental stewardship and the efficient use and reuse of groundwater resources. They have deep expertise and on-the-ground experience in diverse regions across the country in how to efficiently use, reuse, and manage groundwater. To maximize public participation, the Council should ensure that any comment opportunities, public meetings, or

other opportunities to provide input on this effort are well-publicized and published in the *Federal Register*.

III. States, not the Federal Government, are the Primary Managers of Groundwater

States, not the federal government, generally have legal authority over groundwater management. States use a “variety of management systems for determining the legal rights and liabilities pertaining to groundwater,” including the absolute ownership doctrine, correlative rights doctrine, prior appropriation rights, and public trust management, or a combination of management systems.³ The “complicated nature of groundwater laws and practices” means that “any new executive branch action...that affects groundwater resources may perturb long-established state and local groundwater management regimes.”⁴ Disrupting this structure will have far reaching and potentially negative consequences. Given the longstanding state and local expertise on groundwater management, and the complex legal framework regarding groundwater, the Council must ensure that its actions do not infringe on the ability of states, Tribes, and local governments to manage groundwater resources.

IV. If OSTP and the Council Move Forward with this Effort, they should Consider Developing Incentives and Funding for Certain Programs

Should OSTP and the Council move forward with this effort, we encourage the development of national programs that incentivize and fund various groundwater improvements and water conservation practices. For example, the Council could help develop incentives and funding for improved water metering (total use and sub-metering). The Council also could explore the development of incentives and funding for research and development efforts to identify technically viable methods to recycle mining, milling, and industrial waters and solutions. The Council could also examine the development of incentives/funding for capital projects associated with water recycling, and the development of technical tools, trainings, and resources to improve technical capability for industrial water conservation. For example,

³ See Overview of Groundwater Regulation, Sea Grant Law Center, *available at* <https://nsglc.olemiss.edu/projects/waterresources/files/overview-of-groundwater-regulation.pdf> (last visited July 1, 2024).

⁴ Cong. Research Serv., *The Federal Role in Groundwater Supply* (May 22, 2020), *available at* <https://crsreports.congress.gov/product/pdf/R/R45259#:~:text=Managing%20groundwater%20resources%20largely%20has,a%20lesser%20extent%2C%20federal%20law.>

the Council could review the Department of Energy's (DOE) Better Plants Program, in which DOE works with leading U.S. manufacturers and wastewater treatment agencies to set energy, water, waste, and carbon reduction goals. We welcome the opportunity to work with the Council on these and other ideas to promote efficient reuse and management of groundwater resources.

V. Conclusion

The NMA appreciates the opportunity to provide initial comments on the Council's effort to address America's groundwater challenges. We urge OSTP and the Council to conduct more extensive stakeholder engagement to ensure that the appropriate experts on this matter, including the regulated community, are involved in any discussions or reports that could inform a government-wide groundwater strategy. Any future policy changes or strategies must ensure that states, Tribes, and local governments remain in control of managing their groundwater resources. Should OSTP and the Council move forward with this effort, we encourage the development of national programs that incentivize and fund various groundwater improvements and water conservation practices. The NMA and our members stand ready to assist OSTP and the Council on next steps and look forward to working with you.

Please contact me at cmchale@nma.org or (202) 463-2646 if you have any questions or need more information.

Respectfully submitted,



Caitlin McHale
Associate General Counsel

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 27: Terry Camp, Utah Farm Bureau Federation

Written: 7/1/2024

Subject: Groundwater

Good Afternoon,

Please accept the attached comments from the Utah Farm Bureau Federation in response to your request for public comments on America's groundwater challenges.

Terry Camp

Attached: Utah Farm Bureau Groundwater Comments



UTAH FARM BUREAU FEDERATION

9865 South State Street • Sandy, Utah 84070-3205 • Phone: (801) 233-3040 • www.utahfarmbureau.org

"Inspire All Utah Families to Connect, Succeed, and Grow Through the Miracle of Agriculture."

July 1, 2024

President's Council of Advisors on Science and Technology (PCAST)

Submitted via pcast@ostp.eop.gov

RE: Utah Farm Bureau Federation comments on PCAST's groundwater management questions

Dear PCAST Working Group Members:

The Utah Farm Bureau Federation (UFBF) appreciates the opportunity to comment on [PCAST's questions related to America's groundwater challenges](#). We offer the following comments on behalf of our 35,000 member families throughout Utah. The UFBF believes that sustainable groundwater use must continue to be a national priority.

Agriculture in the West uses water to produce the food supplies essential to our national security and life itself. These comments are focused on groundwater management within the State of Utah and the proper role for the federal government in assuring water supplies needed for the essential food production provided by Utah farmers and ranchers along with our colleagues across the country.

Briefly stated, Utah employs a robust statutory framework of groundwater management, the objectives of which, as applied to any aquifer, are to:

- (i) limit groundwater withdrawals to safe yield;¹
- (ii) protect the physical integrity of the aquifer; and
- (iii) protect water quality.

[\(Utah Code, Section 73-5-15\)](#)

This comprehensive and effectively state-run system, as further explained below, obviates the need for federal engagement in regulatory functions. If the federal government has a role in furthering groundwater management and protection in Utah, it is most likely through data collection and analysis and in continued incentives for optimal use of water resources and water supply resilience.

¹ "Safe yield" is defined in the same section of code as "the amount of groundwater that can be withdrawn from a groundwater basin over a period of time without exceeding the long-term recharge of the basin or unreasonably affecting the basin's physical and chemical integrity."

Discussion

Utah has as long a history in groundwater management as any other jurisdiction, state or federal. Utah began regulation of groundwater withdrawals in 1935, recognizing the continuity of water resources above and below the land surface and the need for conjunctive management. Indeed, if actions of individual states provide experimental experience in the laboratory of democracy, Utah can stand as a beneficial model of groundwater management.

The first section of the Utah statutes governing water use states:

All waters in this state, *whether above or below the ground*, are declared to be the property of the public, subject to all existing rights to the use thereof. ([Utah Code, Section 73-1-1](#), emphasis added.)

The State of Utah oversees groundwater withdrawals through Utah Division of Water Rights, a division of the Utah Department of Natural Resources, known colloquially as the office of the Utah state engineer. Utah statutory law charges this office with maintaining aquifers at sustainable levels under the criteria noted above. Where groundwater mining is occurring, or for other management reasons, the state engineer develops groundwater management plans with water user involvement to reduce withdrawals to safe yield levels. These processes are very involved and take time, yet are proving to be effective.

Utah's basin and range geography limit the geographic reach of most Utah aquifers. Only a few reach across state lines, and those are relatively small – especially when compared to the reach of the Ogallala Aquifer, the Flint River Basin, the Rio Grande River and other such areas across the nation. Even the Utah portion of the Colorado River is more heavily influenced by surface water than by groundwater contribution. Even so, the Division of Water Rights exclusively applies conjunctive management of surface and groundwater to water regulation and accounting, such that groundwater is managed as a separate and distinct resource in only a few areas of the state and groundwater management planning processes are already underway in those areas.

In this setting, working relationships have matured between water users and the State of Utah such that any regulatory action by the federal government would be counterproductive. We urge the federal government to continue its long-observed deference. The comments of Prof. Upmanu Lall in the [December 1, 2023, meeting of PCAST](#) as reported in the meeting minutes apply here:

In framing possible federal roles in potential solutions to groundwater depletion, Lall said there is resistance to bringing regulatory pressure and ideas from outside, i.e., from the federal government.

The role of the United States' agencies in groundwater management in Utah should be limited to data collection and, in cooperation with state agencies, analysis of that data. Beneficial relationships in this respect already exist and should continue to be encouraged. Also, revenue sharing with the State of Utah and allocation of those funds to Utah food producers through state programs have been used to improve resiliency of water supplies.

In conclusion, the UFBF strongly urges the federal government to recognize and respect Utah's established and effective groundwater management system. The state's historical and ongoing efforts in

sustainable groundwater management have proven to be successful without the need for federal regulatory involvement. Collaboration, rather than regulation, will best serve the interests of Utah's farmers, ranchers, and the broader agricultural community, ensuring the sustainability of our vital water resources for future generations. Thank you for your consideration of our comments.

Sincerely,

A handwritten signature in black ink, appearing to read "ValJay Rigby". The signature is written in a cursive, flowing style.

ValJay Rigby
President
Utah Farm Bureau Federation

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 28: Ana Kennedy Otto, Arizona Farm Bureau Federation

Written: 7/1/2024

Subject: Groundwater

To Whom It May Concern:

Attached are comments from the Arizona Farm Bureau Federation addressing PCAST's request for information on groundwater.

Kind regards,

Ana M. Kennedy Otto
Government Relations Manager
Arizona Farm Bureau Federation

Attached: AZFB Comments_2024 WH Groundwater Public Engagement



Arizona Farm Bureau Federation

325 S. Higley Rd, Suite 210
Gilbert, AZ 85296

July 1, 2024

Submitted electronically via to pcast@ostp.eop.gov

RE: PCAST Public Input on America's Groundwater Challenges

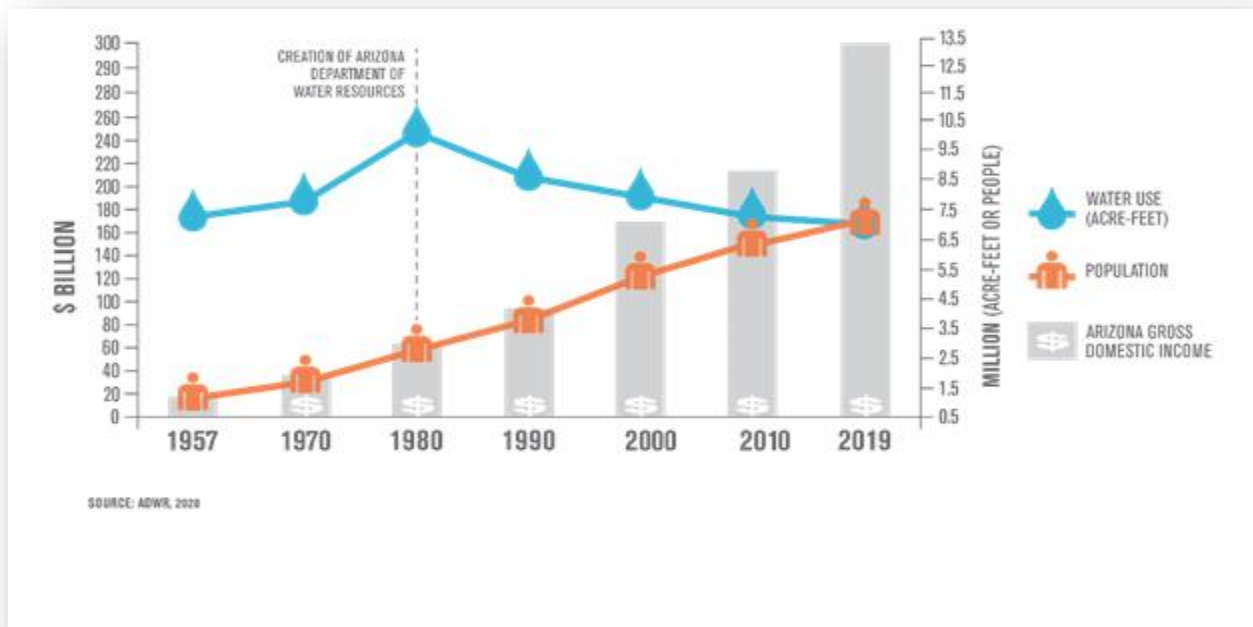
To Whom It May Concern:

The Arizona Farm Bureau Federation represents farmers and ranchers from across Arizona. Our members produce an array of crops and livestock that contribute over \$23.3 billion of economic impact to the state. Our comments below address the President's Council of Advisors on Science and Technology's (PCAST) request for public input on America's Groundwater Challenges.

It is notable that the White House and PCAST seeks to better understand a number of factors related to groundwater use in our nation, however both entities should not lose site of the fact that groundwater allocation is by and large regulated by state governments. There are complex state laws in place that have been developed and continue to evolve to meet the challenges and needs of each state, its communities, and its citizens.

State governments have purview over ground water regulations and its allocation. Arizona, an arid state, developed groundwater regulations in the 1980's to protect certain groundwater basins through the development of Active Management Areas (AMAs) and Irrigation Non-expansion Areas (INAs). Developing these regulations was not an easy task and it took years of meetings and discussions by stakeholders within the state to develop what would become the 1980 Groundwater Management Act. In light of a long-term drought and continued population growth in Arizona, stakeholders have been meeting once again to evaluate how best to regulate groundwater in areas outside of the current AMAs and INAs.

There is no doubt that a significant amount of groundwater is used by agriculture. The notable results of agriculture's water use are the food and fiber that sustains our nation and many rural communities. Because water is such a precious resource, farmers and ranchers have developed and adopted a variety of practices to help conserve water. In Yuma, Arizona, where nearly 90 percent of the nation's leafy greens are produced during the winter season, they have coined the phrase "more crop per drop." In fact, state-wide, Arizona uses the same amount of water today as it did in 1957, and agricultural conservation efforts have played a key role in that reduction. See graph below.



Researchers as well as faculty at our state’s land grant university, the University of Arizona (UA) have worked extensively in various areas of water including groundwater and water conservation. UA is home to the Water Resources Research Center (WRRC). One of the current projects of the WRRC is developing county level water factsheets which provides comprehensive water information for Arizona’s 15 counties.¹ These fact sheets highlight how unique water issues are across the state and further emphasize that addressing these challenges is best handled by the state in conjunction with local stakeholders.

The federal government and its agencies must recognize the current state laws and regulations in place that address groundwater. As groundwater issues arise in states across the nation, state leaders and state agencies can learn from each other regarding state groundwater regulations and research through their participation in organizations like the National Governors Association and regional associations such as the Western Governors’ Association and the Western States Water Council. Furthermore, states have the opportunity to learn from each other through multiple and diverse examples of groundwater management frameworks, as well as from the research that state agencies and universities in those states provide. It is wholly inappropriate for the federal government to spend any time or federal resources on the subject matter of groundwater.

Thank you for your consideration.

Sincerely,

Stefanie A. Smallhouse

Stefanie Smallhouse, President
Arizona Farm Bureau Federation

¹ University of Arizona Water Resources Research Center Arizona Water Fact Sheets can be found at <https://wrrc.arizona.edu/resources/arizona-water-factsheets>

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 29: Rachel O'Connor, Environmental Defense Fund

Written: 7/1/2024

Subject: Groundwater

Hello,

Please see the attached for Environmental Defense Fund's input on America's groundwater challenges.

Thank you,

Rachel

Rachel O'Connor (she/her)

Senior Manager, Climate Resilient Water Systems

Environmental Defense Fund

Attached: EDF Input on America's Groundwater Challenges

Improving data, community engagement, and strategic initiatives to address America's groundwater challenges

Proposals from the Environmental Defense Fund

Contact: Rachel O'Connor, roconnor@edf.org

Over-extraction of groundwater is a significant threat to U.S. aquifers and rivers, impacting the communities and economies that depend on them. Declining groundwater levels jeopardize water accessibility and reliability for agricultural production, drinking water and food security. Reports from state agencies and peer-reviewed literature have documented chronic well level declines across key areas of food production in the United States. Overuse of groundwater not only affects direct users but also impacts hydrologically connected surface waters, which can adversely impact surface water users and degrade ecosystems.

Groundwater's lack of visibility, local control, and shared ownership forms persistent and formidable barriers to sustainable management.

The Environmental Defense Fund has over a decade of experience in advancing landmark groundwater initiatives in the western U.S. By working with communities and leveraging scientific expertise, EDF aims to drive sustainable practices and policies that protect this vital resource. EDF commends PCAST for recognizing the importance of building groundwater resilience and soliciting public input on how to address America's groundwater challenges. Our expertise lends itself to addressing three of the questions posed by PCAST:

- I. How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?
- II. How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?
- III. What strategies and incentives can help limit groundwater over-use?

I. How can we enhance the timely collection of data on groundwater inventory, use, recharge, and flow across the United States to gain a whole-of-country picture of the nation's groundwater resources?

Increase funding to federal and state groundwater monitoring networks to enhance the spatial and temporal resolution of groundwater levels and water quality monitoring. Prioritize funding to expand monitoring coverage in groundwater-reliant communities to ensure safe drinking water access and enable timely response during extreme climate events, such as droughts. Additionally, given the depletion of groundwater in many regions, expansion of monitoring efforts should focus on vulnerable areas prone to salinity intrusion, subsidence, pollution, domestic well failures,

depletion of interconnected surface water (rivers and streams) and impacted groundwater dependent ecosystems.

Improve cross-agency data management infrastructure and data governance to support decision-making. This involves funding existing and new data governance structures that can ensure that local, state and federal collected data are high-quality, interoperable, reliable and useful for decision makers. Funding should aim to increase the capacity of existing expertise and resources coordinating data efforts and initiatives under a common data governance framework. This requires identifying, defining and funding roles required to manage, develop, coordinate and implement protocols for data collection, documentation, quality control, verification, and data publication.

Advance technology that supports state and federal water data collection, management, and sharing to enable coordinated data processes across agencies and departments. Funding data repositories and platforms—including data on aquifer table elevation, water availability, water quality, and evapotranspiration—that are user-friendly and accessible is crucial for quick access and analysis, leading to informed and timely decisions. Coordinated data processes include development of common metadata and data standards, improving interoperability and documentation, data taxonomies, and more.

II. How can we engage with communities to successfully ensure a sustainable supply of groundwater, including for agriculture, industry, energy, human consumption, and healthy ecosystems and biodiversity?

Build more inclusive planning and decision-making processes. Non-profits and other organizations play a crucial role in facilitating engagement among diverse stakeholders, including state and federal agencies and community-based organizations. They provide science-based solutions and can bridge the gap between funding sources and those implementing sustainable strategies.

Support local governance or regional coordination structures to foster collaborative and sustainable groundwater management. With support from state or federal government, these bottom-up structures can ensure long-term sustainability and equitable access to groundwater. These can be key for coordinating diverse actions that aid in the planning and implementation of groundwater management strategies. These structures also create spaces for communication and engagement, balance power dynamics in decision making and aim for an equitable distribution of benefits from groundwater management. By enabling these collaborative spaces, groundwater management can be implemented more effectively, finding strategies that create consensus, are multi-benefit and win-win solutions and can reduce social conflict. In some regions this may require an examination and restructuring of governance systems and procedures to invite meaningful public participation and authentically incorporate situated knowledge. For example, it may require consideration of venues, languages, and time frames in which discussions occur.

Fund pilots and research that demonstrate practices to reduce water consumption, protect groundwater resources and prove their feasibility. These projects along with research and monitoring can be key to conveying practices and innovative approaches with decision makers, water users, non-profits, conservation groups, etc. that aim to ensure groundwater sustainability under local conditions.

Outreach and technical assistance are key to conveying best practices and strategies that users such as farmers and industry can adopt. Outreach via locally trusted messengers is crucial to conveying the essential role of groundwater and the impact of depletion. Effective outreach efforts foster collaboration among actors, local leadership and support bringing perspectives and concerns of all sectors (communities, farmers and ranchers, conservation groups, etc.) to decision making spaces. Additionally, these actions foster collaboration of state and federal decision makers with local organizations such as universities, extension specialists, community and farmer organizations, etc. Technical assistance is critical to increase the adoption of different sustainable groundwater use strategies and ensure they are well designed and economically feasible for interested users and different local contexts.

Support tribes in resolving tribal water issues. Several sovereign tribes are still without a resolution and full state and federal recognition of their water rights. For some tribes, this prevents access to water to meet basic needs. Federal infrastructure dollars should be directed towards improving access to clean and reliable drinking water on tribal lands, as well as other investments that advance livelihood security consistent with tribal self-determination in the use and conservation of their water. State and federal governments must work with tribes to complete equitable water rights settlements for those tribes who seek it or help find other resolutions to fully recognize and fulfill tribes' unique water rights.

III. What strategies and incentives can help limit groundwater over-use?

Consumptive use and demand reduction programs are crucial efforts in promoting the transition of groundwater overuse to sustainable water and land management. These programs aim to reduce water demand by repurposing previously irrigated agricultural lands to new uses that require less water and create new public benefits. These programs encourage voluntary water conservation, enhance groundwater recharge, create community recreational spaces and restore natural habitats. By integrating financial incentives, technical support, and collaborative efforts, these initiatives help ensure long-term water sustainability, support agricultural communities, and protect environmental health across various regions.

Water accounting is the foundation of smart water management. Through accounting of groundwater, water managers and water users can track water availability and water use. This enables the ability to identify imbalances and instances of overextraction, highlighting areas at risk of depletion. Water accounting provides data that can be used by policymakers and water managers to make informed decisions about water allocations, restrictions, and conservation measures. Where relevant, water accounting can integrate groundwater data with surface water and other hydrological data, supporting a holistic approach to water management that considers the interconnectedness of different water resources. Continuous water accounting allows for adaptive management, where strategies and policies can be adjusted based on the latest data and trends in groundwater use and availability.

Agricultural irrigation efficiency can help to optimize water use, conserve water resources, and lead to significant water savings. However, it is not a sufficient or effective strategy on its own and must be coupled with policies and practices that ensure the saved water is not simply redirected to uses that increase consumption. Other policies and practices must be in place to effectively limit groundwater overuse, such as setting caps on total water extraction, and incentivizing the reduction of overall water use rather than just improving efficiency.

Development of alternative water sources can reduce pressure on groundwater resources. For example, increased investments are needed to accelerate municipal and industrial wastewater reuse, direct potable reuse projects, aquifer storage and recovery, managed aquifer recharge projects, and net zero water solutions in urban areas, such as onsite water reuse and rainwater capture.

New eligibility criteria for relevant grant programs can better protect groundwater that is conserved through such programs. In basins experiencing groundwater over-use, water conservation efforts are only likely to address that over-use if those basins are closed to new uses, otherwise conserved water can be taken up by a new user, further exacerbating the issue. Federal funding programs that seek to address groundwater over-use should prioritize regions that are closed to appropriation or meet certain sustainability-focused management standards.

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 30: Courtney Briggs, American Farm Bureau Federation

Written: 7/1/2024

Subject: Groundwater

Good evening,

Please find the attached comments on behalf of many members of the Waters Advocacy Coalition. Please do not hesitate to contact me with any questions.

Best,

Courtney Briggs

Senior Director, Government Affairs

American Farm Bureau Federation

Attached: Final WAC Groundwater OSTP Comments w Sign-ons

July 1, 2024

Re: Input on America's Groundwater Challenges

Submitted at pcast@ostp.eop.gov

To the President's Council of Advisors on Science and Technology:

We, the undersigned trade associations, represent a large cross section of the nation's construction, transportation, real estate, mining, manufacturing, forestry, agriculture, energy, wildlife conservation, and public health and safety sectors – all of which are vital to a thriving national economy and provide important resources and good paying jobs in local communities across the United States. We hope that the administration will continue to work with our sectors as partners in protecting and enhancing the environment.

States have historically had purview for managing groundwater, with the federal government providing resources for monitoring and reporting through the U.S. Geologic Survey (USGS). We urge the Council to ensure that any efforts relating to groundwater start with discussions with the states. Below are actionable ideas for the Council to consider.

Groundwater is Effectively Managed by the States and Tribes and this Should Continue

States and Tribes have been effectively managing groundwater and water supply “over many decades, and with federal encouragement,” and in many cases, states and tribes have done so for more than 100 years.¹ These include (but are not limited to) state and regional water plans, regulation, and certification of water well drilling, flood and drought prevention. Unfortunately, we understand that many states were not made aware of the Council's effort early in the process and as a result some are unable to comment. The Council should ensure that it works collaboratively with States and Tribes with expertise in groundwater management on this initiative. It should also avoid developing policies or directives that risk “undermining the states' longstanding regulatory authority over land and groundwater.”²

State and local governments are experts on groundwater which is why they generally have legal authority over groundwater. They use a “variety of management systems for determining the legal rights and liabilities pertaining to groundwater,” including the absolute ownership doctrine, correlative rights doctrine, prior appropriation rights, and public trust management, or a combination of management systems.³ States and tribes are particularly suited to protect and regulate groundwater given that groundwater and land use are inextricably intertwined and thus, the extent and manner of regulation vary widely depending on local geology and

¹ See *County of Maui v. Hawaii Wildlife Fund*, 140 S. Ct. 1462, 1471 (2020).

² *Id.* at 1476.

³ See Overview of Groundwater Regulation, Sea Grant Law Center, available at <https://nsglc.olemiss.edu/projects/waterresources/files/overview-of-groundwater-regulation.pdf> (last visited July 1, 2024).

groundwater use.⁴ This regulation is not theoretical: a nationwide survey on groundwater regulation revealed that all 49 states that responded (and the District of Columbia) do, in fact, regulate groundwater.⁵

The “complicated nature of groundwater laws and practices” means that “any new executive branch action...that affects groundwater resources may perturb long-established state and local groundwater management regimes.”⁶ Disrupting this structure could have far reaching and potentially negative consequences. Given the longstanding state and local expertise on groundwater management, and the complex legal framework regarding groundwater, the Council must ensure that its actions do not infringe on the ability of States, Tribes, and local governments to manage groundwater resources.

The U.S. Geologic Survey Already Works with State Partners on Groundwater Issues, and this Should Continue

Federal funding for research on groundwater issues flows through USGS and goes to state partners such as geologic surveys and other state agencies to continue to collect and analyze scientific data on groundwater inventory, use, recharge, and flow for a better understanding of nationwide groundwater issues as well as modeling and anticipation of changes in the inventory, recharge, and flow of groundwater in the context of the overall water cycle.

USGS and state agencies should also work to involve and educate communities across the country on the importance of groundwater and its protection. The USGS has technical expertise on this issue and should continue to collaborate with states on groundwater efforts.

Industry Needs to be Involved in Groundwater Policy and Incentives Considered

Our industry sectors rely on clean and reliable groundwater to provide the products needed by Americans every day. We urge the Council to ensure that our associations and member companies are included in the development of this report. Our members are committed to environmental stewardship and the efficient use and reuse of groundwater resources. They have a deep understanding and on-the-ground experience in diverse regions across the country in how to efficiently use, reuse, and manage groundwater. To maximize public participation, the Council should ensure that any comment opportunities, public meetings, or other opportunities to provide input on this effort are well-publicized and published in the *Federal Register*.

We also encourage the Council to consider incentives and funding for research and development efforts to identify technically viable methods to increase recycling of industrial

⁴ 2 Waters and Water Rights § 19.04 (2019).

⁵ Sharon B. Megdal et al., Groundwater Governance in the United States: Common Priorities and Challenges, 53 Groundwater 677, 678 (Sept.-Oct. 2015).

⁶ Cong. Research Serv., The Federal Role in Groundwater Supply (May 22, 2020), available at <https://crsreports.congress.gov/product/pdf/R/R45259#:~:text=Managing%20groundwater%20resources%20largely%20has,a%20lesser%20extent%2C%20federal%20law.>

wastewater and grants for capital projects associated with water recycling. We support incentives to facilitate the early adoption of water saving products and practices that can lead to a reduction in fees and improve tax credit programs. Any forthcoming proposal should be voluntary, not cost-prohibitive, sufficiently flexible and include options for industry to improve the efficient use and reuse of groundwater resources.

Thank you for your consideration of these comments. We look forward to working with the Council on this issue and to enhance groundwater management in the U.S.

Sincerely,

American Exploration & Mining Association
American Farm Bureau Federation
American Fuel & Petrochemical Manufacturers
Associated General Contractors of America
National Asphalt Pavement Association
National Association of Home Builders
National Association of REALTORS®
National Association of States Departments of Agriculture
National Mining Association
National Stone, Sand and Gravel Association
RISE (Responsible Industry for a Sound Environment)
Southeastern Lumber Manufacturers Association
U.S. Chamber of Commerce

WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 31: Marco Menezes

Written: 7/3/2024

Subject: Groundwater Issues

I know this is a few days late, but thought it might be of interest.

Marco Menezes

Attached: Critical Issues

TALKING POINTS FOR JULY 11, 2024 EPA HEARING

- I. **MICHIGAN WATER POLICY** – While Michigan has been blessed with historically abundant groundwater, current State policy encourages unsustainable over-use and destruction of potable water resources and encourages “gaming” of the regulatory process.
- **Gaming the regulatory process** - EGLE’s online water withdrawal application “tool” provides a **loophole for large groundwater withdrawal applicants to avoid scrutiny** and site-specific review of applications. If the applicant “limits” proposed withdrawals to below 1,200 gallons per minute, (a stupendously high volume of over **630 million gallons per year**, enough to annually refill over 20,000 average sized backyard pools, **5 times Nestle/ Blue Triton’s annual rate and 2.5 times the rate projected by Gotion for its proposed battery plant**) it receives only cursory, office review and is typically approved.
 - **Inadequate site-specific review** - **Michigan Potash and Salt (MP&S) received a permit from EGLE to consume this huge volume of fresh water with no site-specific evaluation** of whether the local aquifer could tolerate such depletion into perpetuity, or what effect it would have on local water wells or nearby surface waters. Wells are the sole source of potable water for homes and farms within the project’s area of influence.
 - **Water giveaway** - Since receiving the permit to withdraw 1,200 gpm, MP&S has increased its proposed annual production rate at full build-out by two thirds, from 600,000 tons of potash per year to 1,000,000 tons with no commensurate increase in its permitted water consumption. A 2/3 increase in water use would increase the rate of consumption to **over 1 billion gallons per year, given away for the cost of a \$25 permit.**
 - **Fresh water destruction** - While some of this captured water might be recycled and reused in the production process, most of it would be “waste,” contaminated with salt brine and injected deep underground in one of the Class I disposal wells that are the subject of this EPA hearing. This water is essentially destroyed, polluted and removed from the hydrologic cycle **forever.**
 - **Inaccurate assumptions, unacceptable risk.** - Scientists have known for 20 years that historical projections of rainfall can no longer be accurately relied upon to forecast groundwater availability over the long term. As effects of climate change become ever more apparent, unprecedented and increasingly unpredictable deluges and droughts have made the State’s large water withdrawal permitting process a dangerous gamble for industries requiring massive, 24/7 inputs of fresh water. Even more importantly, this is a massive risk for their host communities, whose needs would likely become subordinate to those of industry.

II. **MICHIGAN’S ECONOMIC DEVELOPMENT POLICY** – Under its present structure, Michigan’s economic development apparatus [the Michigan Economic Development Commission (MEDC) and Strategic Fund (MSF)] is singularly focused on money and jobs. It routinely pumps millions of taxpayer dollars into such projects, heedless of their effects on quality of life in the “host” communities, which could more accurately be described as “sacrifice zones.”

- **Market reluctance and corporate welfare, past and present** – While private capital markets appear reluctant to invest, the Michigan Potash project has already been awarded a \$50 million “one time grant” by the Michigan State legislature.
- **Inexperience? Who cares?** - We can’t overlook the fact that massive taxpayer subsidies are going to a company that has never mined an ounce of potash or anything else. There are no proofs of concept here, just **huge taxpayer-funded giveaways**.
- **And yet more corporate welfare in the works** - The MEDC and MSF are considering awarding MP&S a “package” of additional incentives totaling hundreds of millions more, including issuing “private activity” revenue bonds for upwards of \$200 million for “solid waste disposal.” What is that solid waste? It’s mostly sodium salt or table salt (NaCl), necessarily produced along with potash. Because the salt market is already flooded, this Co-product is waste. It must be redissolved in fresh water and injected as brine deep underground. **In effect, the State would be applying hundreds of millions of taxpayer dollars to subsidize the pollution and destruction of our shared freshwater, one of Michigan’s most prized and valuable resources.**
- **Jobs? Maybe a handful.** - For all the corporate welfare, MP&S projects that **it will create 129 permanent local jobs. Is this worth huge taxpayer subsidies and quality of life sacrifices from everyone who won’t be offered one of these few positions?**

III. **LACK OF TRANSPARENCY** – MP&S touts their project as “transformative” for the host community (sacrifice zone) but refuses to reveal the specifics of this planned transformation. **What are they hiding?**

- **The sacrifice zone for this project comprises over 15,000 acres** of land, spanning several townships in southern Osceola and Northern Mecosta Counties. Because many of the mining and disposal wells would necessarily be located miles from the refinery/ processing plant, they must be connected to the plant by a network of pipes and pumps, moving massive volumes of corrosive salt brines at high pressure over great distances, for generations.
- **“Stonewalling” MP&S won’t say what our “transformation” will look like.** While the Company has published attractive conceptual drawings of its plant, it does not respond to questions about the vast plumbing network that goes hand in

hand with the plant itself. How and where will they safely and legally cross public roadways, local streams and wetlands? How will they safely accommodate the huge increase in semi-truck traffic (upwards of 6 trucks per hour) along rural roads? These are among the **questions repeatedly asked by the Osceola County Planning Commission, which the Company has refused to answer.**

- **MP&S wants more room for its waste.** The company is now requesting (in addition to a 1,000 foot upward expansion of the injection zone for its three currently permitted Class 1 disposal wells) **new permits for 3 more disposal wells.** Why are these additional wells necessary when there may be nothing to dispose of for years? Are the 3 currently permitted wells inadequate to accept the volume of water which EGLE has permitted to be withdrawn? At a minimum, MP&S should be required to submit a significant amount of additional detail about their plans to justify this new permit request.

IV. LIFE IN THE SACRIFICE ZONE – The area immediately surrounding the proposed refinery is a quiet, rural community with homes and small, family farming operations. These families and farms are completely reliant on the clean, plentiful groundwater drawn from local aquifers. Springs, seeps and small streams are abundant in the area. Immediately west and steeply downhill from the initial proposed “cluster” of eight solution mining wells and refinery, lie the headwaters of Bullkill Creek, which flow north into a marshland several hundred acres in size and ultimately, into the Muskegon River and Lake Michigan. Bullkill Marsh is among the largest wetlands in Osceola County and home to Trumpeter Swans, Canada Geese, Sandhill Cranes, multiple species of ducks, Blanding’s Turtles, beaver, otters, Great Blue Herons and many other species of wildlife. Trumpeter Swans and Blanding’s Turtles are already “species of special concern” due to the effects of habitat loss on their populations. **You could not find a worse location for a solution mining and refining operation.**

- **Solution mining infrastructure and operations will dominate and destroy the local environment** – The initial mining well cluster will feature holding ponds, pipes and pumps carrying hot, concentrated brines under high pressure to and from the refinery. This is all about ¼ mile uphill from Bullkill Marsh. A failure of this system and resulting brine spill would flood these hot concentrated brines directly into the Marsh and downstream to the Muskegon River, causing serious damage to water quality and wildlife.
- **The risk from improperly plugged oil & gas wells is substantial and underestimated** - Those who live in this sacrifice zone have historically been subjected to extensive oil and gas development, evidenced by numerous (purportedly) plugged and abandoned well bores within the EPA’s “area of review.” Some of these old wells penetrate the “confining layer,” a non-porous, underground geological formation. In theory, this layer prevents high pressure injected fluids from migrating upwards into drinking water aquifers. This detail is critical because an improperly plugged well bore provides a direct conduit for contaminants to migrate upward into fresh water aquifers.

- **Reliance on historical records to determine well integrity is dangerously misplaced.** Both the EPA and EGLE have assumed from archived well logs that the confining layer is intact, that the old well bores penetrating it were properly plugged, and will withstand the migration of contaminants under pressure. But, since none of these well bores were actually tested for structural integrity, the assumption amounts to blind faith reliance on the veracity of unaccountable wildcat oil drillers who are driven solely by profit.
- **There is no such thing as “safe” deep well injection** - The entire premise that toxic fluids can be injected underground, reliably contained and segregated from potable water supplies forever is scientifically uncertain and belied by experience. A 2012 article by Pro-Publica presented an in-depth analysis of the science behind this disposal method and how it has often failed in practice. According to Stefan Finsterle, a hydrogeologist at Lawrence Berkeley National Laboratory, “There is no certainty in any of this, and whoever tells you the opposite is not telling you the truth.” Inspectors examining well records and government summaries of over 220,000 wells nationwide found “routine” structural failures, integrity violations in one of every six wells examined and 7,000 wells showing signs of leakage. Documentation also revealed that “wells are frequently operated in violations of safety regulations and under conditions that greatly increase the risk of fluid leakage and the threat of water contamination.” If current practices continue, according to Mario Salazar, an engineer who for 25 years served as a technical expert with the EPA’s Underground Injection Control (UIC) program, “In 10 to 100 years we are going to find that most of our groundwater is polluted.”
- **Does “Pure Michigan” promise a future of rural industrialization?** – At full buildout, the “transformative” vision contemplated by MP&S and its proponents will require the wholesale reconfiguration of at least 15,000 acres in southern Osceola and northern Mecosta Counties. Those of us who are blessed to live in this place do so because of the quiet, peaceful, rolling hills, fields, streams and wetlands that exist today. But the MP&S project would totally alter this beautiful and wholesome landscape. It’s a transformation, alright, but not one we want, need or would benefit from. MP&S would make us into another sacrifice zone, transforming this beautiful place into an industrial hellscape of pumps, pipes, truck traffic, noise, air and water pollution for the next 150 years. Some landowners may benefit from mineral royalties and local governments *might* benefit from tax revenue, although MP&S has already announced its intent to seek property tax abatement. The remainder of us will be expected to simply sacrifice our water, our quality of life, and the land we love, in the name of “economic development.” Is this the “Pure Michigan” loudly and proudly advertised by our State government?

Prepared by Michigan Potash Watch 7/1/2024



CYBER PHYSICAL RESILIENCE PUBLIC COMMENTS



WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Section 1: Fabian E. Bustamante

Written: 6/17/2024

Subject: Cyber-Physical Resilience: NSF Workshop on Internet Survivability and Resilience

Dear members of the working group,

My colleague Dr. Walter Willinger and I have been working on the topic of the Internet as a critical infrastructure and its resilience, a topic of significant importance in our modern society.

In November of last year, with the support of the National Science Foundations, we organized a workshop as a first step in drafting a research agenda on what we think is a difficult and important challenge facing society at large. The report of this workshop is attached.

We hope you find this of value to your group; we would be happy to continue the conversation

Fabian E. Bustamante

Walter Wilinger

~~~~~

Fabian E. Bustamante, Professor

Department of Computer Science | Northwestern U.

Director of Research @ PhenixRTS

*Attached: NSF Workshop Report 2023*

# Towards Re-architecting Today's Internet for Survivability

NSF Workshop Report

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This article is an editorial note submitted to CCR. It has NOT been peer reviewed.  
The authors take full responsibility for this article's technical content. Comments can be posted through CCR Online.

## ABSTRACT

On November 28-29, 2023, Northwestern University hosted a workshop titled "Towards Re-architecting Today's Internet for Survivability" in Evanston, Illinois, US. The goal of the workshop was to bring together a group of national and international experts to sketch and start implementing a transformative research agenda for solving one of our community's most challenging yet important tasks: the re-architecting of tomorrow's Internet for "survivability", ensuring that the network is able to fulfill its mission even in the presence of large-scale catastrophic events. This report provides a necessarily brief overview of two full days of active discussions.

## CCS CONCEPTS

• **Networks** → **Public Internet; Network properties; Network architectures;**

## KEYWORDS

Internet, Survivability, Resilience

## 1 INTRODUCTION

Over the past decades, the Internet has undergone a major change from being primarily a research-oriented network for academics to becoming a cyber-physical infrastructure critical for modern society in general and the global economy in particular. This transformation has occurred mainly by happenstance rather than by design and under the assumption that the current architecture that has ensured its robustness in the past would be sufficient to provide the robustness now expected from it.

We believe that this organically-grown architecture of today's Internet cannot live up to this new role humanity has assigned it or withstand the types of threats that it now faces.

Re-architecting today's Internet as critical infrastructure requires a new understanding of the architectural principles on which it should be based. It demands a reassessment of the possible scenarios that can challenge the network's basic functioning and the

threats that can arise due to the network's constant evolution. At the same time, it must explore paths for incremental deployment that embed the necessary incentives for adoption. Given the expected tight coupling of tomorrow's Internet with the emerging smart grid, the analysis of potential threats and any re-design to enhance survivability must consider both systems in parallel and inform each other's progress.

The success of such an ambitious effort depends on close collaborations among a broad and interdisciplinary team of scientists, including networking researchers, power/smart grid experts, economists, resilience engineers, and control systems researchers.

With the generous support of NSF, a group of us organized a workshop on November 28-29, 2023. The workshop, entitled "Towards Re-architecting Today's Internet for Survivability," aimed to bring together an initial group of national and international experts in a range of these areas to sketch and start implementing a transformative research agenda for solving one of our community's most challenging yet important tasks: the re-architecting tomorrow's Internet for "survivability," ensuring that the network is able to fulfill its mission even in the presence of large-scale catastrophic events [5].

The workshop run for two days. Given the variety of topics, the first day focused on creating a shared understanding of the space with overview talks by leaders in the different areas we have identified: *Power Grid and the Internet*, *Control Systems*, *Threats to Internet Survivability*, *Resilience Engineering*, and *Perspective from the Public and Private Sectors*. Building on this, the second day was dedicated to short talks in each area, following more or less the same structure, and brainstorming sessions to derive a common research agenda.

This report follows the structure of the workshop as described in Table 1 that lists the presentations, speakers, and discussants that took part in the workshop agenda. Section 2 introduces a set of overview talks meant to build a common ground for in-depth discussions. Section 3 covers a number of discussion sessions lead by some of the participants. We close in Section 4 with some general

| <i>Overview Talks</i>               |                                                                                                                                                                                      |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reconsidering Internet Architecture | Presenter: John Doyle (Caltech)<br>Discussants: Ramesh Govindan (U. of Southern California), Fernando Paganini (U. ORT Uruguay), Lixia Zhang (UCLA)                                  |
| Threats to Internet Survivability   | Stefan Savage (UCSD)                                                                                                                                                                 |
| Powergrid and Internet              | Dominic Gross (U. of Wisconsin-Madison), Steven Low (Caltech), Lang Tong (Cornell U.)                                                                                                |
| Control and Learning                | James Anderson (Columbia U.)                                                                                                                                                         |
| Resilience Engineering              | David Alderson (Naval Postgraduate School), John Allspaw (Adaptive Capacity Labs), and David Woods (Ohio State U.)                                                                   |
| Public & Private Sector Perspective | Henning Schulzrinne (Columbia U.) and Marwan Fayed (Cloudflare)                                                                                                                      |
| <i>In-depth Discussions</i>         |                                                                                                                                                                                      |
| Threats to Internet Survivability   | Zakir Durumeric (Stanford U.), Stefan Savage (UCSD), Aaron Schulman (UCSD)                                                                                                           |
| Control and Learning                | Nik Matni (U. of Pennsylvania)                                                                                                                                                       |
| Resilience Engineering              | David Alderson (Naval Postgraduate School), John Allspaw (Adaptive Capacity Labs), Lorin Hochstein (Coupang), Zoran Perkov (Super Stealth Startup Inc.), David Woods (Ohio State U.) |
| Powergrid and Internet              | Dominic Gross (U. of Wisconsin-Madison), Steven Low (Cal Tech), Fernando Paganini (U. ORT Uruguay), Joshua Taylor (U. of Toronto), Lang Tong (Cornell U.), Le Xie (Texas A&M U.)     |
| Public & Private Sector Perspective | Henning Schulzrinne (Columbia U.), Marwan Fayed (Cloudflare), Doug Montgomery (NIST), Yih-Chun Hu (UIUC)                                                                             |

**Table 1: Overview of workshop topics and participants.**

observations and future directions. We aim to provide a faithful summary of the workshop presentations and discussions and reflect the participants’ diverse views.

## 2 OVERVIEW TALKS

The set of overview talks began with a presentation of recent advances on a theory of architecture by John C. Doyle, followed by presentations from Ramesh Govindan, Fernando Paganini, and Lixia Zhang, linking some of the concepts discussed in the context of today’s Internet architecture.

The remaining talks included a general introduction to threats to Internet survivability, by Stefan Savage, the architecture and challenges of the current power grid, led by Dominic Gross, Steven Low, and Lang Tong, and introductions to control and learning, by James Anderson, and resilience engineering, by David Alderson, John Allspaw, and David Woods. Henning Schulzrinne and Marwan Fayed closed these overviews with discussions on the role of the public and private sectors.

The following paragraphs present brief summaries of these talks with references to the relevant material.

### 2.1 Reconsidering Internet Architecture

The starting point of John Doyle’s presentation was that in the last decade, there have been significant advances in our understanding of how complex systems such as the human brain or the Internet work, both in terms of theory and its applications. In particular, this understanding has shed new light on complex system architectures in general, is particularly relevant for re-architecting the future Internet and power grid, and promises to be even more important in the context of envisioned cyber-physical systems (CPS) that use the Internet as “brain” for control of their physical networks (e.g., transportation network, public water systems).

To illustrate what new theory there is now and that might be relevant for the Internet or power grid, John Doyle focused on the (human) brain and especially on how it does sensorimotor control of the (human) body and used it as a canonical case study. In discussing his recent efforts on this topic (as described in [22]), among the key points he highlighted were (1) the need to understand how speed-accuracy tradeoffs at the level of individual components (i.e., nerves comprised of bundles of axons) connect to and characterize the speed-accuracy tradeoffs of the system that is comprised of these components (i.e., subsystems involved in sensorimotor control), (2) the ubiquity of diversity in living and engineered systems and the underlying mechanisms through which diversity in the delays and rates of sensing and signaling between layers improves the performance of (layered) control systems, and (3) the universal principle behind “diversity-enabled sweet spots (DESSs)” and the importance of examining what role this principle plays (or doesn’t play, and why not) in the exploration of layered architectures encountered in such diverse systems such as the bacterial cells, cell phones, and the Internet.

He argued that this is the richest existing case study demonstrating how sophisticated cyber systems (e.g., brains) control complex physical networks (e.g., human bodies) and how systems such as (human) brains have a richly layered architecture that has a far more sophisticated cyber control (e.g., Internet) of physical systems (e.g., CPSs) than anything that we have engineered/built yet. John Doyle concluded his talk with the ominous observation that while these richly layered architectures exhibit enormous robustness and evolvability, they are also prone to severe fragilities. In particular, he mentioned that ongoing efforts towards massive virtualization of much of modern technology make catastrophic failure events almost inevitable, just as our biological architectures make cancer, auto-immune disorders, and other life-threatening diseases largely unavoidable. On a more positive note, he expressed his hope that

once there will be enough “useful” case studies (such as the one that shows how the human brain does sensorimotor control) that demonstrate “the good, bad and the ugly” that our current architectures promote (and also show why), it will be possible to start leveraging the new theory and make attempts at re-architecting that tip the scale from new architectures that promote “the bad and the ugly” towards those that ensure “the good” . . . .

Ramesh Govindan, Fernando Paganini, and Lixia Zhang followed John Doyle with presentations that explored some of the design principles discussed in John’s talk in the context of two highly-engineered systems – the Internet and the power grid.

Ramesh Govindan’s presentation touched on the challenges of ensuring the availability of the global-scale infrastructures of hyper-scalers and the services they support. He presented findings of a “root-cause” analysis of large-scale failures in Google’s world-wide backbone network. The presented analysis could be considered as a motivation for the need for a broader and more in-depth understanding of identified root causes that goes beyond purely technical or engineering issues and explores how human decision-making (at layer 8 - the “social layer”), management decisions (at layer 9 - the “economic layer”), or regulatory policies (at layer 10 - the “political layer”) may turn out to be the ultimate culprits (individually or in combination).

Fernando Paganini’s presentation focused on decentralization of control architectures, drawing comparisons between the Internet and the power grid. For the Internet, a decentralized, layered architecture has operated well when there is abundance of bandwidth, together with buffering to manage transient traffic imbalances. In the power grid, various factors require the control of a centralized “system operator” entity. These factors include the peculiarities of AC power flow constraints, scarce transmission capacity, and the global dynamic effects of imbalance. However, both the Internet and the power grid are undergoing changes. While more centralized forms of control appear in the Internet (e.g. in cloud computing infrastructures), in the power grid, the massive deployment of distributed energy resources calls for increasingly more decentralized operations. For each of the two domains, the correct mix remains an open question, but will have to be recognizant of their mutual interdependence which, in turn, will be impacting their survivability under large-scale failure scenarios.

In the last presentation, Lixia Zhang challenged us to carefully consider what we mean by the current Internet architecture and how we envision any attempts at re-architecting it, especially when considering the ongoing changes to its layered organization, the evolving hourglass [27], and the seemingly endless layers of virtualization (e.g., RFC 9484 describing the tunneling IP through an HTTP server acting as an IP-specific proxy over HTTP [23]). Her talk was a reminder that there are really two alternatives to “re-architecting” the Internet – should we take a more *evolutionary* approach that is exemplified by the IP-over-HTTP example or is there a need to contemplate a more *revolutionary* approach such as the one articulated in [21])?

## 2.2 Threats to Internet Survivability

Stefan Savage gave an overview talk in which he discussed some of the different facets of threats to Internet security/survivability.

Starting with a historical perspective, he argued that while some of the core distributed Internet protocols and services were designed in a cooperative environment and were implemented in a similarly trusted world, subsequent effort to secure them against malicious intents by third parties (e.g., misusing DNS, hijacking BGP) have been largely unsuccessful.

As for the main reasons, Stefan pointed towards important trade-offs between distributed or decentralized and centralized designs. On the one hand, centralized designs are in general simple, cheap and practical but typically hamstringing innovation, limit expansion and scalability, and magnify the impact of problems or failures. On the other hand, while decentralized designs of protocols and services support innovation and expansion, they tend to cause complications (e.g. complex and unknown dependencies), create transitive trust relations that are both easier to attack and more difficult to scale, and result in limited visibility (i.e., difficult to audit). Importantly, as a community, we lack a good theory about where and when to use centralized vs decentralized designs.

In discussing the different aspects of this trade-off, Stefan first pointed out that economic forces favor centralized designs and described recent trends towards centralization in almost every aspect of the Internet ecosystem, from physical network infrastructure and access provisioning to service infrastructure and applications and services. For example, according to the 2019 Global Internet Report [1], at the service level, six companies deliver the majority of web resources, and the top three DNS, CA and CDNs cover between 50-70% of the top 100k sites. At the same time, a handful of operators run all gTLD registries, a few public resolvers are centralizing DNS resolution, and Microsoft and Google handle email for 30-40% of all domains [10, 16–18]. From a security/survivability perspective, this type of centralization clearly amplifies the impact of problems such as failures and attacks, as several recent events have shown us (e.g., Nashville bombing of 2020[25], Facebook incident of 2021 [13], Rogers’ 2022 outage [30]).

He then elaborated on the fact that the systems that comprise today’s Internet have become increasingly inter-dependent, creating complex and often unknown dependencies, with no straightforward ways to produce dependency graphs (e.g., do two ISPs share physical infrastructure and where?). He commented on a lack of a real composition architecture for cloud services and emphasized the fact that the lack of resilience in such increasingly inter-dependent systems is largely invisible - until some failure event occurs. He concluded his presentation by pointing towards three main culprits for the current state of affairs in today’s Internet: (i) The current architectures of the Internet as a whole and of the various systems that comprise the Internet are not designed for audibility (so integrity failures can be invisible); (ii) the key protocol deployments are not well-tested against threats that compromise their correct use and operation (e.g., DDoS will always be with us), and (iii) the design for resilience and the detection/mitigation of problems are severely hamstrung by limited visibility and a lack of good theory.

## 2.3 Powergrid and Internet

Steven Low organized an overview presentation where he, Dominic Gross, and Lang Tang discussed basic aspects of the power grid and key differences between the power grid and the Internet and

described issues that arise in the context of the ongoing transformation of today's power grid into tomorrow's smart grid.

In his presentation, Steven Low articulated the key differences between today's Internet and today's power grid by asking (and answering) three key questions: (Q1) What is the function of the Internet (power grid); that is, what does the Internet (the power grid) provide for applications? (Q2) What are the challenges that the Internet (power grid) faces and must overcome to support its function? and (Q3) What type of control system does the Internet (power grid) use to overcome these challenges? In short, for the Internet the answers are (I1) its function is to transfer byte-streams reliably end-to-end from senders to receivers, (I2) the challenges include lost or out-of-order packets and bit errors during transmission, and (I3) it utilizes a control system that has a layered architecture and is fully decentralized. In contrast, for today's power grid, the answers are (P1) its function is to transfer power at nominal voltage and frequency from generators to loads according to Kirchhoff's laws, (P2) its challenges concern generation-demand imbalances that can result in safety and power quality issues, including violations of frequency limits, voltage limits, or line capacity limits; and (P3) it uses a control system for balancing generation and demand everywhere that exhibits a time-scale based hierarchy and is largely centralized. Table 1 provides a further differentiation between today's Internet and power grid and is reproduced here from Steven Low's presentation.

Steven Low then discussed aspects that are of critical importance for ongoing efforts to design, deploy and operate tomorrow's smart grid infrastructure. On the generation side, these aspects include the use of uncertain, not dispatchable and typically highly intermittent sources of energy (e.g., solar and wind power) and the rapid expansion of distributed energy resources (DERs) and inverter-based resources (IBRs) that have low or zero inertia and give rise to new dynamic patterns that are absent in today's power grid with its generator-based control with large inertia. Another critical aspect for the future grid is the potential for significant energy storage. Table 2 (also reproduced here from Steven Low's presentation) succinctly summarizes these key aspects that differentiate today's power grid from tomorrow's smart grid and will require a major overhaul of the current grid control paradigm.

In his short talk as part of this session, Dominic Gross focused on the interoperability of the Internet and the power grid and addressed three future grid-specific topics. In particular, he discussed (i) the resilience of emerging power systems where converter-interfaced generation, storage and transmission are expected to dominate and produce fast time-scale dynamics that remain poorly understood; (ii) the need for grid-supporting Internet infrastructure, including grid-forming data-center concepts that can provide grid support on fast time scales, scalable and secure communication networks, and communication functions and infrastructure tailored to power system control and coordination; and (iii) the need for Internet-supporting power systems functions and infrastructure such as energy storage and power flow control to prioritize the power supply for critical information and communication infrastructure and technology-specific equipment/traffic and power flow control and medium voltage direct current (MVDC) to inter-link data-centers, power generation, and storage efficiently and reliably.

Lang Tong gave the last short talk in this overview session and discussed the requirements for next-generation monitoring and control for grid resiliency. In particular, he addressed implications of the increasing use of uncertain, not dispatchable and typically highly intermittent sources of energy and the rapid proliferation of DERs on future grid monitoring and control architectures and commented on the impact that these developments have on the requirements for the Internet as far as its use for effective monitoring and grid control is concerned.

## 2.4 Control and Learning

In his presentation, James Anderson introduced the System Level Synthesis (SLS) framework, a novel perspective on constrained robust and optimal controller synthesis for linear systems [3]. This framework featured implicitly in John Doyle's presentation where he used the canonical example of how the (human) brain does sensorimotor control of the (human) body. James highlighted how by working directly with system responses, SLS provides transparency in how system constraints, structure, and uncertainty affect controller synthesis, implementation, and performance. He showed that it is this transparency that can be exploited to improve upon the state-of-the-art so as to be able to apply controller synthesis at Internet scales.

For illustrative purposes, James focused on two particular applications of SLS, namely large-scale distributed optimal control and robust control. In the case of distributed control, he showed how SLS allows for localized controllers to be computed, extending robust and optimal control methods to large-scale systems under practical and realistic assumptions. In the case of robust control, he described how SLS allows for novel design methodologies that, for the first time, quantify the degradation in performance of a robust controller due to model uncertainty and emphasized that transparency is key in allowing robust control methods to interact, in a principled way, with modern techniques from machine learning. In explaining these applications, he focused on practical and efficient computational solutions and demonstrated the methods on easy to understand case studies.

James concluded his introduction to SLS with a brief discussion of promising ongoing research efforts in this area, including integrating SLS into model predictive control algorithms, combining optimal control and machine learning (ML), further understanding the algebraic structure underlying localized controllers and their state-space realizations, and applying the resulting new tools to application areas spanning power-systems, the Internet, and other cyber-physical systems of societal or economic importance.

## 2.5 Resilience Engineering

David Alderson, John Allspaw, and David Woods introduced "Resilience Engineering (RE)" and provided an RE perspective on the goal of the workshop, namely re-architecting today's internet for survivability. Alderson began with the simple point that Internet function is much more than routing, to include all the value-added layers above routing that now work together to provide an ecosystem of Critical Digital Services. That is, one can identify a number of failure scenarios where Internet routing works perfectly fine, but the broader ecosystem of services is severely disrupted. As a

| <b>Internet</b>                                                                                | <b>Power grid</b>                                                                                               |
|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Layerd architecture                                                                            | Time-based hierarchical control                                                                                 |
| Decentralized control                                                                          | Centralized control                                                                                             |
| Storage everywhere                                                                             | No significant storage                                                                                          |
| Dynamics & control:<br>fast and narrow timescale<br>(congestion control ~100ms, routing ~mins) | Dynamics & control:<br>slower and wider timescale<br>(power electronics ~ms, AGC ~sec-mins, market ~hours-days) |
| Packets follow routing algorithms                                                              | Power flows according to Kirchhoff's laws                                                                       |
| Control & economics are decoupled                                                              | Markets are integral part of control                                                                            |

**Table 2: Comparison: Today's Internet vs today's power grid.**

| <b>Today's grid</b>                                                   | <b>Future grid</b>                                                               |
|-----------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Generator-based control<br>with large inertia                         | IBRs and DERs<br>with zero to low inertia                                        |
| Few large control points                                              | Many small control points                                                        |
| Slow dynamics and control (~sec-mins)                                 | IBR enables fast control                                                         |
| Frequency deviation is global control signal                          | Greater reliance on the Internet for denser communication                        |
| No significant storage<br>(at timescales above ~30sec)                | Potential for significant storage<br>(e.g., EV, H2, flexible loads)              |
| Market conditions:<br>dispatchable generation and high marginal costs | Market conditions:<br>uncertain/intermittent generation and ~zero marginal costs |

**Table 3: Comparison: Today's grid vs future grid.**

result, the stated goal of "Internet survivability" in the presence of incidents needs to be much more than continued routing.

Responding to the argument in the workshop prospectus that "[the] transformation of the Internet into a critical infrastructure has occurred largely by happenstance, rather than by design," Alderson argued that this transformation has not actually been happenstance, but representative of broader patterns in adaptive behavior found in biology, cognitive systems, economics, engineering, social systems, etc. This "slide-to-criticality" for technologies—from nice-to-have, to front-line, to mission-critical, to essential—is ubiquitous in human and human-technology systems. For example, the recent discovery of the liblzma backdoor [11]—from evolution, vulnerability, hijacking to recognition—demonstrates a general pattern of adaptation for advantage that also produces mal-adaptive patterns that cross many layers well beyond the usual representations of the Internet, software, or technology stacks. Moreover, the real world provides continuing streams of incidents that invite study into these patterns, specifically as: (1) an empirical opportunity for learning about dealing with complexity, (2) context for developing theory to understand how resilient systems survive, and (3) a platform for engineering new architectures with adaptive capacity.

The concern in the workshop prospectus that "[the] evolved architecture of today's Internet cannot live up to this new role humanity has assigned it or withstand the types of threats that it now faces" is consistent with the challenges faced by other systems whose growth has led to increased complexification. That is, such systems must face growing system complexity (stimulated by new technologies and opportunities), new conflicts and threats

(as others 'hijack' capabilities for their own purposes), a changing environment with external events at scale (e.g., climate-driven extremes), and changing tempos of activity and larger shifts in tempo (as the world pushes to do things 'faster, better, and cheaper'). A major challenge in today's ecosystem of Critical Digital Services is whether we can learn how to offset changing risks before failures occur as growth continues. Or more specifically: Can we build capabilities to be poised to adapt to keep pace with and stay ahead of the trajectory of growing complexity and the penalties that arise as a result [38]?

Woods provided a brief introduction to Resilience Engineering, which has evolved over the last twenty years as a field [14, 15] and a community [24] devoted to understanding how adaptive systems, at all scales, possess the capacity to stretch or extend performance and avoid brittle collapse when events challenge their normal competence for handling situations. In particular, the Theory of Graceful Extensibility (TGE) [37] derives three subsets of principles (Subset A: risk of saturation, Subset B: networks of adaptive units, Subset C: constraints on maneuver) faced by all entities in the adaptive universe. These principles follow from three fundamental and inescapable constraints: (1) resources are finite (and therefore, conflict is ubiquitous); (2) change is continuous (therefore, models become stale and surprise recurs); (3) other units at other layers are adapting for advantage from their perspective. Collectively, TGE lays out a foundation for architecting systems that can adapt to challenges ahead, even when the exact challenge to be handled cannot be completely specified in advance. The pursuit of such a system architecture remains an important research challenge, and it is

particularly critical for the ongoing design and management of infrastructure systems [38]. To date, the adoption of RE design principles in critical infrastructure is nascent and remains a significant line of effort [2].

Despite the attention and progress, *resilience* as a concept remains noisy in the literature, largely due to its recent popularity across disparate communities as an organizing principle for managing stress and/or change. As described by Woods [36], there are four distinct notions commonly associated with resilience—rebound, robustness, extensibility, and sustained adaptability—with implications for how to engineer these features into complex systems [8]. For a review of these concepts as they have been studied in the context of network optimization, see also [26].

Resilience Engineering for the Internet has focused primarily on software, with past successes the result of a consortia of academia and industry studying how Critical Digital Services cope with complexity over cycles of growth, adaptation, challenge and surprise. For example, the STELLA Report [34] was the first result of a multi-year project called “Coping With Complexity” in which Ohio State’s Cognitive Systems Engineering Lab partnered with IBM, IEX, Etsy, and other organizations critically dependent on software infrastructure up and down the stack.

Allspaw provided a brief history of the DevOps movement and how it has led to a key acknowledgment: *how software behaves in the real world cannot be predicted or anticipated comprehensively*. That is, practitioners now believe that software cannot be built “correctly,” rather it must be operated. In turn, this means that there is no crisp boundary between ‘application developer’ and ‘systems engineer’ roles. Moreover, the rise of continuous deployment in Critical Digital Services has necessitated the use of various hedging strategies for managing the risk of brittle failure, as well as novel techniques for understanding disruptive events.

A starting point for re-architecting today’s Internet is a true understanding of the factors contributing to the incidents that cause Internet service disruption. Here, classic results in cognitive systems engineering distinguish between *Work as Imagined (WAI)* versus *Work as Done (WAD)*; see [41], with quotes from [35].

| <u>Work as Imagined (WAI)</u>                                                                                                                                                                                                                                       | <u>Work as Done (WAD)</u>                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• System is built and operated as designed</li> <li>• Components of the system (humans, algorithms, devices) behave as specified</li> <li>• Exceptions/Anomalies are relatively few and usually well anticipated.</li> </ul> | <ul style="list-style-type: none"> <li>• “Adaptations tailored to contingencies and context are always going on”</li> <li>• “The adaptations that make the system function also hide the systems weaknesses.”</li> <li>• “Management often can’t see the gaps so it seems that the system is functioning as designed.”</li> <li>• Anomalies and surprises are continuous.</li> </ul> |

This important distinction has revealed itself empirically in the handling of real Internet outages, with a large and evolving community of effort organized under the heading of “Learning From Incidents (LFI),” see [19]. At the core of this approach is a focus on incident analysis with “blameless” postmortems, using near misses to understand success, and moving beyond “human error” as a scapegoat

that precludes learning about system fragilities [41]. Collectively, the insights from the LFI community about how to manage Critical Digital Services have grown out of a disconnect between the way that Internet services are imagined versus the way that they actually are provisioned and operated.

| <u>How we imagine incidents</u>                                                                                                                                                                                                                    | <u>How incidents actually happen</u>                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Need to find the root cause</li> <li>• Can be categorized in a taxonomy, measured, and usefully described with statistics</li> <li>• Humans are seen as the problem because they make mistakes</li> </ul> | <ul style="list-style-type: none"> <li>• Things are always messy</li> <li>• Root cause analysis is a fallacy that hides the real problems lurking in system complexity</li> <li>• Taxonomies often hide rather than reveal; statistics like availability and mean time to failure (MTTF) are not useful</li> <li>• Humans are seen as a resource necessary for system flexibility and resilience</li> </ul> |

Of note and like many other artifacts that have resulted from the ongoing development of the Internet, the best practices being discovered and practiced by the LFI Community fall outside of any formal architecture for the current Internet.

People who operate Critical Digital Services confront forms of complexity and uncertainty under pressure. Here at the sharp end, there is a regular flow of incidents that threaten loss of valued services to stakeholders, and usually operations handle these threats successfully. The critical information about risks, threats, change, adaptation, growth—and therefore about architecture now and in the future—arises in studying how this sharp end adapts to cope with complexity [34]. The last two speakers in this overview session were practitioners from industry, who (a) tangibly experience the pressures, (b) develop means to better cope with the complexities for their organizations and industry segments, and (c) are thought leaders among the practitioner communities. They used incident vignettes to illustrate the evolution of tactics and strategies to cope with the complexities.

Lorin Hochstein used a particularly difficult case drawn from his experiences and reflections on incidents while at Netflix. The anomaly in this incident highlighted many findings about the cognitive and collaborative demands these situations present and the sources for resilient performance [7, 39].

Zoran Perkovic who has developed and managed the infrastructures enabling modern financial exchanges including IEX and NASDAQ, highlighted the web of complex interdependencies that spread from the base of the technology stack up to regulatory policies with financial and criminal penalties in a fiercely competitive, high stakes, massively autonomous, distributed environment. Interestingly, every change, every regulation, every competitive move, every new technique ends up being expressed and deployed as software with some autonomous capability providing the potential for many ‘strange’ interdependencies to emerge and combine across layers of the technology stack and engaging other layers of human goals, roles, and organizations. He recounted an incident episode which demonstrates the critical role of human expertise when the network of automated systems misbehaved — unfortunately — by behaving exactly as they were designed.



The talks and discussion in this session provided a real world sample of what it means to cope with complexities and the bottom-up adaptive innovations in knowledge, collaborations, policies, tactics and tools. This reality check grounds explorations of fundamental top-down theories for architecting the internet for the future.

## 2.6 Public & Private Sector Perspective

In this overview session, Henning Schulzrinne and Marwan Fayed presented a public and private sector perspective of the challenge of Internet survivability.

Henning Schulzrinne, who served as chief technology officer (CTO) for the United States Federal Communications Commission from 2011 to 2014, discussed the importance of the reliability and survivability of the Internet as a core civil infrastructure. His presentation highlighted the interdependencies of communication networks with other critical infrastructures like energy, transportation, and emergency services. He addressed the value of regulatory tools and policies to enhance network reliability and explored economic concepts such as asymmetric information and moral hazard, which affect market dynamics and infrastructure resilience. As part of his talk, Henning also commented on the need for regulatory intervention to mitigate market failures and ensure robust network performance during disasters.

Marwan Fayed, who is (acting) head of research at Cloudflare, a large network and content services operator as well as a faculty researcher, began by referring to a recent ACM co-sponsored research panel [28] to set context. Following that panel he reiterated that (i) packets are required for routing, but value is drawn from connections; (ii) exposing IP addresses to applications was a mistake of the socket interfaces [9]; and (iii) key management for routing and connection security remains a hard problem. Fortunately these have been and continue to be active areas of research.

Looking ahead, Marwan suggested three imminent Internet-wide challenges. First among them is that the Internet is relatively opaque. Unlike power grids and other critical infrastructures focused on improving instrumentation and visibility, the Internet anecdotally seems harder to understand and comes with less visibility – crucial elements for trust and ecosystem health. He also discussed the regionalization or sovereignty challenges emerging around the globe. Existing solutions strive for logical isolation via DNS and unicast and regional anycast, or physical isolation achieved with in-region datacenters and cabling. The former is known to affect resilience and performance [43], while the latter requires billions in capital and changing the Earth. A suggested design principle for future should be to devise mechanisms that enable data to flow where it chooses, with safeguards that can be trusted or verified.

Lastly, Marwan proposed a revised “narrow waist” model of the Internet in which edge networks and services have an opportunity to establish a unified interoperability layer for Internet infrastructure services, e.g. caching, DDoS, hosted firewalls, zero-trust, and others [29]. Prior narrow waists consist of the Internet Protocol between end-to-end and point-to-point protocols, as well as HTTP between client-server pairs and the networks that connect them. In the proposed model the edge services layer protects and improves performance of private infrastructure, from and with managed and

unmanaged devices on the public Internet. This presents opportunities to establish common edge service interfaces so that providers can differentiate on value, and that facilitate new entrants into the ecosystem.

## 3 IN-DEPTH DISCUSSIONS

The second day was organized around a series of in-depth discussions led by the workshop’s co-organizers. The following paragraphs attempt to summarize the key observations and arguments that were made in the course of these discussions.

### 3.1 Threats to Internet Survivability

The session started with a presentation by Zakir Durumeric who revisited the trust and visibility issues alluded to in Stefan Savage’s overview presentation and focused on the problem of trust and transparency. Using WebPKI to illustrate the current foundation for trust on the Web, he reminded the audience that authentication on the Web is based on validating X.509 certificates signed by Certificate Authorities (CAs) and described the Internet’s CA ecosystem, some 1,300 organizations that are trusted to validate the ownership or control of a domain. He then shared a number of critical observations: (i) Prior to 2012, the community had zero visibility into this ecosystem, (ii) only through relatively recent Internet scanning efforts did the community discover most CA certificates, (iii) these efforts revealed that pretty much everyone had the ability to sign certificates for any website and that CAs had been selling CA certificates to anyone who would pay for one. While the bad news is that without some sort of certificate transparency, CA certificates can’t be assumed to be trustworthy, the good news is that since 2017, Google Chrome requires all certificates to be logged in public Certificate Transparency (CT) logs, which in turn has dramatically improved the CA ecosystem. Zakir concluded by pointing out that transparency is a strong security primitive, requires that distributed trust can be appropriately monitored and verified, and may be a promising approach in other contexts as well (e.g., DNS, Internet routing).

In the second presentation in this session, Aaron Schulman returned to the problem of centralization in the physical network infrastructure and the risks that the resulting physical concentration poses for Internet access networks. Using the example of the outage that was caused by the 2020 Nashville bombing and damaged an AT&T network facility, he argued that while many of these edge facilities are repurposed houses or commercial buildings, they have been transformed over time into small data centers capable of supporting an increasing number of services. However, designed to withstand at best independent failures, these access facilities typically lack the means to survive targeted attacks intended to cause physical damage (e.g., fire or other intentional physical attacks). At the same time, because they are critical for supporting ever more services, they have also become more tempting targets for nefarious actors. One possible solution to make Internet access more robust to physical attacks on access facilities is for enterprises to utilize multiple independent access networks (including cellular providers) and for regulators or the market to incentivize multi-carrier access interconnections.

In her presentation, Morley Mao discussed the fragility of the Internet’s control plane (e.g., BGP, DNS) and argued that Internet survivability ought to mean more than just network connectivity but should also include the continued provision of basic and especially critical services. She then outlined some initial ideas about how the use of AI/ML might help make the Internet’s control plane more secure. To this end, she described a case study where connected and autonomous vehicles (CAVs) share sensor data to enhance perception capabilities (i.e., collaborative sensing), where the threat model considers a malicious participant that sends falsified data to the other participants, and where AI/ML-based approaches for detecting and mitigating such attacks on collaborative sensing have been considered. Morley suggested that similar approaches where CAVs are viewed as routing peers may be suitable for developing a more secure Internet control plane but may have to be considered in conjunction with the use of digital twins of the Internet cyber-physical system of interest to increase the robustness of the decision making( e.g., route selection).

In the last talk in this session, Alberto Dainotti came back to the visibility issue highlighted in Stefan Savage’s talk and described his groups’ recent work on observing Internet infrastructure failures (that sometimes coincide with power grid failures) and doing so at scale. In particular, he argued that understanding when, where and how Internet connectivity fails is challenging, mainly because network operators are reluctant to share failure data (may not even be aware of certain failures) and the core Internet protocols have not been designed with monitoring or auditing failure events in mind. Alberto described the design of IODA, a real-time system for monitoring Internet connectivity at the global scale, at the scale of individual countries and regions, and at the level of individual ASes. For each observed event, IDOA provides detailed information about the cause of the event, the operators/networks affected, how the communication stack was disrupted, and a timeline (including onset of event and restoration efforts). He finished his presentation with some illustrative examples, including a large CenturyLink outage in late 2018, the Venezuela blackout in 2019, the damage caused by the Russian war on Ukraine on network infrastructure and the power grid in Ukraine, and a timeline of measured Internet connectivity in Gaza since October 8, 2024.

### 3.2 Control and Learning

This session was intended to be less of a discussion-style session and provide instead a second overview talk on the topic of "Control and Learning". This second overview presentation was given by Nik Matni and was titled "System level synthesis and learning-based control". Building on the recent advances in the area of constrained robust and optimal controller synthesis for linear systems (collectively referred to as System Level Synthesis, or SLS) that were discussed by James Anderson in his overview talk on Day 1 of the workshop, Nik presented some of his recent work that combines robust control and machine learning (ML). On the one hand, robust control is needed because using feedback is one way to mitigate the effects of dynamic uncertainty (and provide worst-case and deterministic guarantees), especially when uncertainty is ubiquitous, not just in the environment but also in the utilized sensing methods/components and the considered models. On the other hand,

when faced with increasingly challenging environments, ever more difficult sensing tasks, and growing model complexity, using ML is a promising way to use past data to learn about and/or act upon the world, but deploying ML in the real world requires being able to provide stability, performance, robustness, and safety guarantees.

Nik showed how ML can be combined with robust control so as to reduce uncertainty by means of using more data to achieve better models/predictions) and at the same time mitigate uncertainty by improving performance thanks to better models/predictions. In particular, he argued that uncertainty is inherent in the output of any ML model, elaborated on what kind of uncertainty quantification is useful for control, and described how to explicitly account for this uncertainty when designing control policies. He then presented a case study that concerned the optimal control of an unknown system (I.e., instances with full information but unknown dynamics), mentioned a second case study involving perception-based control of a known system (i.e., instances with partial information obtained via complex sensing but known dynamics), and concluded his presentation with an illustration of a third case study that featured the problem of distributed optimal control of an unknown system (I.e., instances with asymmetric information and unknown dynamics).

In particular, he used this last case study to (i) highlight the difference between centralized dense control, sparse and distributed and localized control with delayed communications, and scalable learning-based distributed control; (ii) consider as a concrete instance the in-network congestion management problem, wherein a software-defined network is used to implement a distributed optimal controller designed to mitigate the effects of in-network congestion caused by rapid variations in traffic demand, and (iii) show that the design of such dynamic link-service rate policies can be cast as a learning-based distributed optimal control problem. Among the key lessons learned from these case studies were the observation that quantifying uncertainty in learned dynamics and sensing allows for leveraging tools from robust control and the insight that SLS makes transparent the effects of structure and uncertainty on controller implementation, complexity, sensing, performance, and safety.

### 3.3 Resilience Engineering

David Woods began his presentation with a review of past work on survivability and complex systems, specifically how complex systems fail. A key finding across engineering disciplines is that failure is due to brittle systems, not limited components, subsystems, or human beings. One such example is the signature of "Robust Yet Fragile (RYF)"—i.e., surprising sudden collapse against backdrop of continuous improvement and/or new capabilities—because systems "are robust to perturbations they were designed to handle, yet fragile to unexpected perturbations and design flaws" [6, p. 2529]. Such brittle failure can often be explained by one of several patterns of adaptive breakdown [40]:

- *Getting stuck in outdated models*: the world changes but the system remains stuck in what were previously adaptive strategies.
- *Working at cross-purposes*: behavior that is locally adaptive, but globally maladaptive. This results from an inability to coordinate across roles, units, and echelons as goals conflict.

- *Decompensation*: exhausting capacity to adapt as disturbances and/or challenges cascade. Breakdown occurs when challenges grow and propagate faster than responses can be decided on and deployed to effect.

Collectively, TGE (Woods) and DESS (Doyle) provide the start of architectural principles to overcome risks from the brittleness that arises naturally from having to operate in a high-dimensional tradeoff space. Some architectural principles have demonstrations in real but bounded settings where responsible human roles supervise highly autonomous operations. The principles provide general policies for how to behave when approaching saturation and when neighbors are approaching saturation. In some cases these policies can take mathematical form [26]. In others they take the form of new software protocols that modify late and counter productive behavior when approaching saturation [8]. Practically, progress in Resilience Engineering has provided concepts and/or techniques to design or modify operational practices to be more continuously adaptive as they provide valued services. Both the more formal and more immediately pragmatic steps fall outside the usual frameworks for Internet dependent architectures.

The results from studying how people adapt to cope with complexity appear to be couched in the language of cognitive, social and organizational perspectives — new layers added to the technology stack. But this is not really the case. These studies reveal fundamental patterns and laws about adaptive behavior in general across the biological, technological and human spheres. These regularities apply everywhere across the technology stack regardless of which layer is chosen as a point of departure. The regularities are about more than people as they capture issues about architectures, growth, interdependencies, complexification, and trade-offs that influence adaptive capacities in the face of uncertainty and change. Technology advances stimulate these processes to transform human worlds of activity, purposes, risks, conflicts and cooperation, and the consequences that follow.

John Allspaw continued the discussion by talking about the Internet as a critical infrastructure as capabilities are developed, modified, deployed and operated over time to provide valued services to stakeholders. Ironically many of the services support other service providers and expand and hide interdependencies from stakeholders. Critical Digital Services have adapted over time to produce growth and handle new challenges demonstrating many principles of adaptive systems. One of the adaptations to handle complexities was to switch from separate silos for development, deployment and operations of critical software services. This structural partition had too little adaptive capacity to handle the pace of change and pressure to deploy advantageous services. Instead, he argued for (and pioneered) continuous development and deployment linking feedback, risk, gain, change into a fluent process both stimulating growth but also handling the complexities that accompany growth.

Operations and design need to be tightly connected in future architectures. The adaptive path of Critical Digital Services highlights several underlying principles that are surprising. Complete knowledge and testing of the system (components, software, users) is not possible without contact with the full complexities of production traffic. Inevitably, events will challenge its operation. The system is always adapting locally under pressures to be better, faster, and

cheaper. Ultimately, we can learn about the boundaries of a design’s competencies only by operating it. The key question is whether we can learn fast enough to keep pace with change and growth.

David Alderson summarized the current strategy for mitigating risks in infrastructure systems—through the use of modeling and simulation to find vulnerability gaps and then plug them—and led a discussion about why this will not work for the Internet. Because there is no staging environment that is representative of real production systems, digital twins will not suffice to uncover the edge cases that potentially lead to large scale failure. Despite recent emphasis on stress testing for financial systems by the US Federal Reserve and others, the RE perspective suggests there is perhaps little that can be learned from stress tests. Moreover, what is “critical” in the system is going to be dynamic, further complicating this challenge.

The RE lens re-conceptualizes “Internet survivability” as how to sustain long-term viability of Internet dependent critical services as growth produces new types and scales of challenges. One might see the descriptive language that results from studies of coping with complexity as characteristic of cognitive, human, and organizational layers. But this occurs because the patterns of adaptation—experienced by the networking research community as the “happence” evolution of the Internet—are derived from regularities of people in systems exemplifying these patterns. The patterns of adaptation are about much more than people as they capture issues about architecture, layering, interdependencies, trade-offs, saturation, tempo, synchronization, reframing, and more in a dynamic, limited resource world. Among the drivers of challenge and adaptation, deploying new technologies flows through and transforms human worlds of activity, purpose and consequences.

Moreover, the Resilience Engineering perspective, as practiced in the LFI Community for Critical Digital Services and elsewhere, serves also as the basis for empirical study of how engineers must confront the complexity that arises when Internet architecture comes into contact with real-world pressures for performance. Such an empirical grounding is an essential ingredient for any future re-architecting and is not currently being addressed elsewhere.

### 3.4 Powergrid and Internet

The session started with a presentation by Le Xie who used the cryptocurrency mining operations in Texas as an illuminating case study for illustrating the interaction between large flexible computing loads and the power grid. He presented data showing the impact of energy consumption of cryptocurrency mining data centers on the peak electric demand in Texas in the summer of 2022 and argued that the rapid growth of large flexible computing loads could bring both operational challenges and market design opportunities for power systems. Open research questions he posed included how to design the market signals so that flexible large computing loads could contribute maximally as demand response resources, especially during stressed grid operating conditions; and how to design proper incentive mechanisms in electricity markets to maximize the value and participation of cryptocurrency mining data center loads in provision of demand flexibility.

In the second presentation in this session, Josh Taylor talked about how the grid is used to transmit both energy and information. Sending information leverages the physics of the grid and can help with several different tasks such as fault protection and decentralized control. He argued that as more converter-interfaced resources are added to the system, this use of the grid is becoming more relevant because (i) it is easier for a converter to add small perturbations (e.g., by adding them to its controller setpoints), and (ii) at present, converters do not behave as predictably as synchronous machines. He illustrated this use with two examples: (i) fault detection, in which converters inject negative sequence current to make it easier for relays to distinguish between normal and faulty operation; and (ii) islanding detection, in which converters inject negative sequence current to detect when a portion of the grid has unintentionally disconnected and formed a self-powered island. Some of the open research questions he mentioned are how to optimize such perturbations so they are minimally disruptive, and for which tasks this use of the grid can and should be considered.

In the last talk in this session, Dominic Gross discussed in more detail aspects that concern the integration of power systems and the Internet infrastructure. In particular, he addressed a core question that arises in this context, namely whether or not the fact that the two systems become more dependent on each other necessitates a closer integration at the operational level and, if so, what entity or entities should drive such closer operational integration efforts. He suggested two plausible pathways to closer integration of power systems and Internet infrastructure: (i) closer collaboration of hyperscalers (i.e., large cloud service providers) and power system operators, and (ii) dedicated power infrastructure for hyperscalers. In particular, he commented on the facts that hyperscalers have already made significant Internet infrastructure investments (e.g., data-centers and subsea cables) and that a lack of recognition of the need for reliable power supply by power system operators and utilities may prompt them to invest into dedicated power infrastructure such as microgrids, renewable power generation and energy storage, and even dedicated power distribution infrastructure.

### 3.5 Public & Private Sector Perspective

As part of this session, organized by Marwan Fayed and Henning Schulzrinne, Yih-Chun Hu provided an introduction to SCION [42], a clean-slate secure Internet architecture designed to provide high availability in the presence of adversaries, trust and path transparency, and inter-domain multipath routing. It offers security, path-aware networking, and multipath communication, and has already adopted by operators like Swisscom and financial institutions such as the Swiss National Bank. SCION organizes ASes into isolation domains (ISDs), managed by a core set of ASes that establish trust roots and issue certificates. This path-based architecture allows end-hosts to select from multiple end-to-end paths, enabling rapid failover, dynamic traffic optimization, and robust DDoS defenses.

Doug Montgomery's presentation explored the current Internet architecture, primarily defined by protocols like TCP/IP, DNS, and BGP. He highlighted gaps in standardization, particularly with middleboxes, security functions, and network virtualization, and emphasized the need for more cohesive standards. Doug also discussed

security, contrasting protocol-specific measures with comprehensive network security, and advocated for a Zero Trust Architecture, where the default stance is to deny access unless explicitly authorized. He closed his presentation by questioning the current process of how the Internet's architecture is defined and standardized, and asking us to consider re-evaluating it if we are to ensure the network's long-term survivability.

Part of the discussion focused on open roaming in wireless networks during disasters. Open roaming in the US, especially in the event of natural disasters, has evolved significantly, transitioning from a largely voluntary practice (e.g., the arrangement between AT&T and T-Mobile USA during Hurricane Sandy [33]) to a mandatory requirement to improve the resiliency and reliability of mobile wireless networks before, during, and after emergencies (e.g., FCC-22-50 [31]). On June 4, 2024, the US Homeland Security Bureau announced procedures for states requests to activate the FCC Mandatory Disaster Response Initiative [32].

## 4 CLOSING THOUGHTS AND FUTURE DIRECTIONS

As organizers, we approached the workshop planning with the understanding that tackling a problem of the scale and complexity of "Internet survivability" mandates a cross-disciplinary effort that includes, among others, networking researchers and control theory experts, power/smart grid researchers and economists, political and social scientists, and public policy experts associated with either various government agencies or relevant private organization. The workshop discussions reinforced this understanding: any community-driven research agenda aimed at meaningfully addressing the workshop's stated challenge must be cross-disciplinary at its core. At the same time, we realized that no single meeting dedicated to this workshop's topic could cast a wide enough net to craft a detailed research agenda. Nevertheless, we believe that this initial workshop succeeded in identifying some key directions that should be part of any such agenda. The following is a selected list of lessons learned from these two intense days of discussions and possible future directions.

For networking researchers, an important item on their future research agenda is distilling the essence of ongoing foundational approaches to re-architecting today's Internet. These approaches include the consideration of a new economic architecture of the Internet that entails the creation of a "public option" for the Internet's core backbone [12] and the proposal for enabling a permanent revolution in Internet architecture via Trotsky [21], a novel architectural framework that provides a backwards-compatible path (i.e., ensuring the continued functioning of legacy applications or hosts) to an extensible Internet where both new architectures can be deployed in a backwards-compatible manner and multiple architectures can exist side-by-side – something that cannot be achieved with our current notion of IP as the Internet's narrow waist.

Viewed through a cross-disciplinary lens, these and similar approaches give rise to new questions of fundamental importance. For example, since effectively and efficiently operating and managing tomorrow's massively distributed power/smart grid relies increasingly on a well-functioning Internet that can provide provably secure communication for controlling the power/smart grid,

can we expect the economic incentives to be aligned with the technologies capabilities so as to support an architectural framework where one of the different co-existing architectures is secure by design and therefore satisfies the requirements that are necessitated by the growing mutual reliance between the future power/smart grid and tomorrow's Internet? Similarly, does the emerging theory of graceful extensibility advocated by Resilience Engineering [37], which lays out a foundation for architecting systems that can adapt to partially unspecified challenges ahead, inform us in meaningful and effective ways about ongoing efforts to design and manage critical infrastructure systems [38]? The adoption of Resilience Engineering-based design principles in critical infrastructure remains a significant line of effort [2].

For control theory experts, complex engineered and control systems, such as those used in the power/smart grid or the Internet, are characterized by needing to operate robustly and reliably across many spatio-temporal scales, despite being implemented using highly constrained hardware components and software. Moreover, control methods are, in general, only used to design algorithms in these components, typically with minimal or no theory, and the larger system that is comprised of these components is often designed by others. Despite these challenges, recent advances in control theory have identified a universal design pattern that centers around the notion of layered control architectures (LCAs) and has the potential for natural but large extensions of robust performance from control to the full decision and control stack [20]. Building on the "model LCA" described in [20] to initiate a quantitative study of LCAs, another critical item on a proposed future research agenda will be to identify the occurrences of different LCAs in the Internet and the power/smart grid (as well as other cyber-physical infrastructures), understand the underlying universal mechanisms and design patterns, and leverage this knowledge to outline tentative paths towards a useful design theory. The insights from such a theory will enable us to understand the many tradeoffs of complex engineered systems such as the Internet and the power/smart grid (see also [4]).

Last but not least, from a public policy perspective, as the importance of the Internet as a cyber-physical infrastructure critical for modern society and the global economy at large is increasingly recognized by the various stakeholders in both the public and private sectors, it seems fitting for local and federal governments to take on a more visible role in ensuring, monitoring, and incentivizing all aspects concerned with "Internet survivability". In particular, the increasingly mission-critical role that today's Internet is playing for an ever-growing number of stakeholders argues for the creation of dedicated agencies or public and/or private organizations whose sole focus is ensuring its long-term survivability. The US Cybersecurity and Infrastructure Security Agency (CISA), part of the Department of Homeland Security, is one such example, but complementary efforts that are concerned with visionary architectural frameworks and their possible realization or with more economics-driven architectural designs are needed.

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# WILDFIRE PUBLIC COMMENTS

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**WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST**

Section 1: Brien Seeley

**Written: 5/15/2024 5:09 PM**

Subject: Written supplements to last month's public appearance speech

Dear Dr. Campbell:

Please accept and widely share this important supplement that better articulates my public presentation at the April PCAST meeting. I believe it highly relevant to the upcoming May 22 meeting.

Thank you.

Brien

Brien Seeley M.D., President  
Sustainable Aviation Foundation, Inc. 501c3

*Attached: Climate Crisis Shocker: What Nobody Knew, Global Wildfires Cause More CO2 than Fossil Fuels*



# **Climate Crisis Shocker: What Nobody Knew**

## **Global Wildfires Cause More CO2 than Fossil Fuels**

- 1) **This astonishing new finding now makes ending wildfires the single fastest, most effective and affordable way to curb the Climate Crisis!**
- 2) **The Good News: Sustainable Aviation offers a feasible, affordable way to do it.**
- 3) **How? The details are presented in the Q&A below.**

The following Q&A addresses questions from industry leaders, media and policymakers and offers in-depth details for building [Autonomous Aerial Firefighting \(AAF\)](#)

## **Key Questions**

1. [What will be the benefits of ending wildfires with AAF?](#)
2. [How do wildfires cause CO2 emissions and affect the climate crisis?](#)
3. [Why have Climate Summits not prioritized ending wildfires?](#)
4. [If we end wildfires globally, how much will it help curb the climate crisis?](#)
5. [What challenges currently limit our capability to end wildfires?](#)
6. [Apart from Autonomous Aerial Fire-fighting \(AAF\), what are the alternative programs to end wildfires?](#)
7. [How will AAF provide for safe air traffic control?](#)
8. [Why are eVTOLs not suited for AAF?](#)
9. [What are the cost estimates to launch AAF statewide in California?](#)
10. [How can we get AAF launched?](#)

## **1) What will be the benefits of ending wildfires with AAF?**

### **Benefits of Autonomous Aerial Fire-fighting (AAF) for ending wildfires**

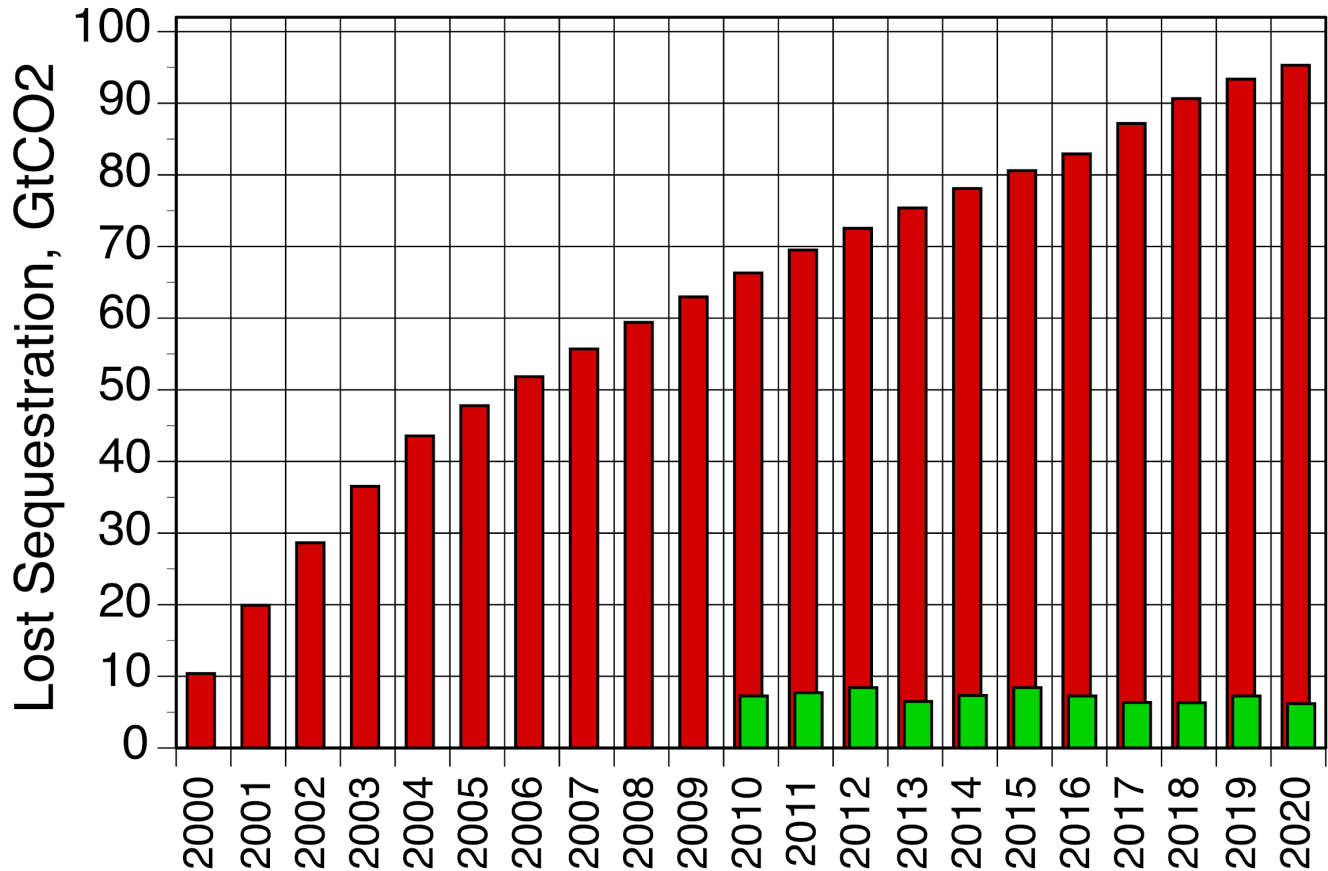
1. Effectively and rapidly reduce global CO2 emissions, potentially by tens of Gigatonnes annually
2. A safe and nearly-continuous aerial attack that can drop 20X more fire-suppressing liquid
3. Prompt detection, geo-location, dispatch & on-scene 3-4X faster than present air attack system
4. 20X lower vehicle costs with multi-purpose aircraft replacing \$24M aging fossil-fueled air tankers
5. Uncrewed aircraft means no shortage of pilots
6. A ubiquitous network of AAF air parks puts fire suppression much closer to fires
7. Autonomous air tankers can perform drops 24/7, even in heavy smoke or at night
8. Greater use of prescribed fires and back-fires with confidence in their containment and control
9. Aerial attack by emission-free, electric aircraft without flammable fuel on-board
10. Capability to make precise, low-level drops of retardant with minimal wind scatter

11. Self-spotting of fires by aircraft's on-board thermographic cameras and auto-guidance systems
12. End all nascent fires within one hour of their outbreak
13. Eliminate enormous smoke clouds that force mass regional evacuations and damage lungs
14. Use water instead of retardant to avoid contaminating ecosystems and waterways
15. Restore affordable home insurance by enormous reductions in risk of loss and damages
16. An exportable American-born AAF system and aircraft to rapidly proliferate to other nations
17. A strong stimulus for progress in EVs, battery and charging standards, renewable energy, job growth and advances in aerospace and tech industries

## 2) How do wildfires cause CO2 emissions and affect the climate crisis?

Wildfires not only emit CO2 in smoke, but also devastate the natural photosynthetic sequestration of CO2 by the forests and grasslands that have been burned. This lost sequestration increases every year as wildfires burn new areas. Burned forests take more than 20 years to regrow to 50% of their pre-fire photosynthetic capacity. Burned grasslands take 4 years to do so. If those losses of CO2 sequestration are cumulated globally for the 20 years ending in 2020, they sum to over 95 Gigatonnes of CO2. When combined with the 6 Gigatonnes of CO2 from fire smoke in 2020, they comprise an annual CO2 increase of 101 Gigatonnes, which is more than 2.5 times the 40 Gigatonnes of CO2 annually emitted by global use of fossil fuels. See graphs below.

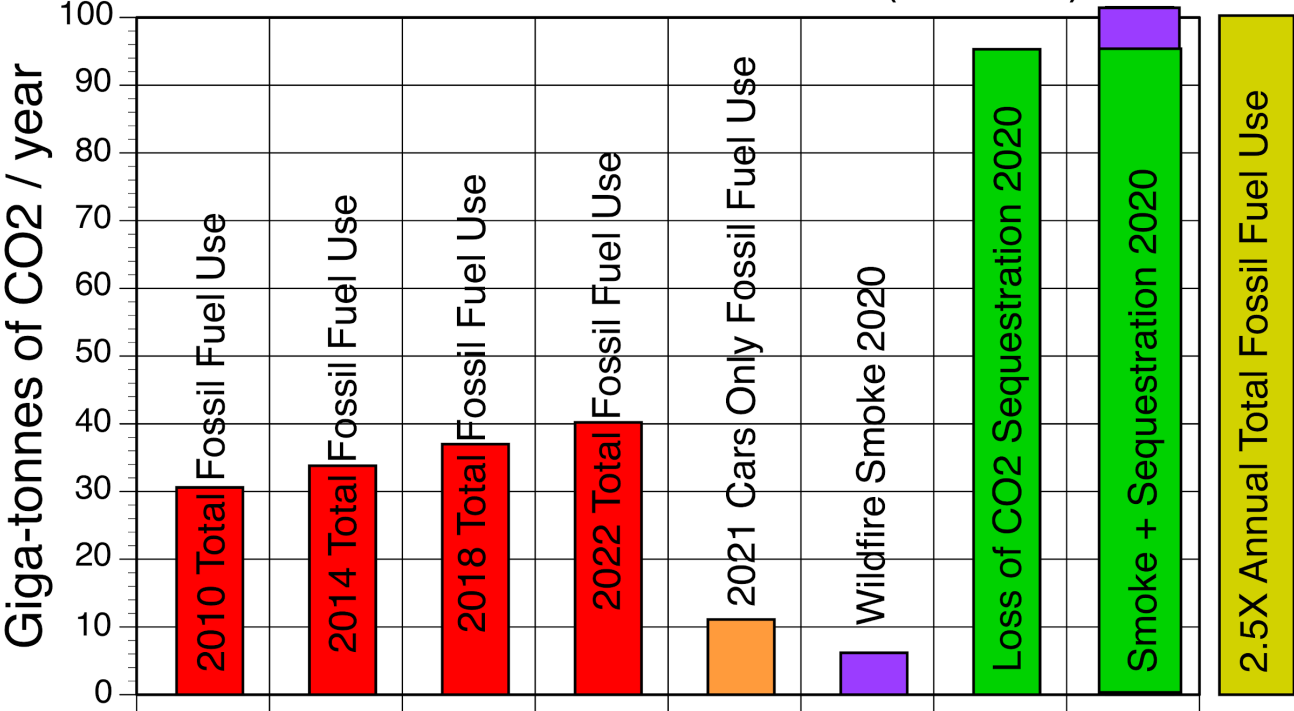
## Cumulative Global Annual CO2 Sequestration Loss



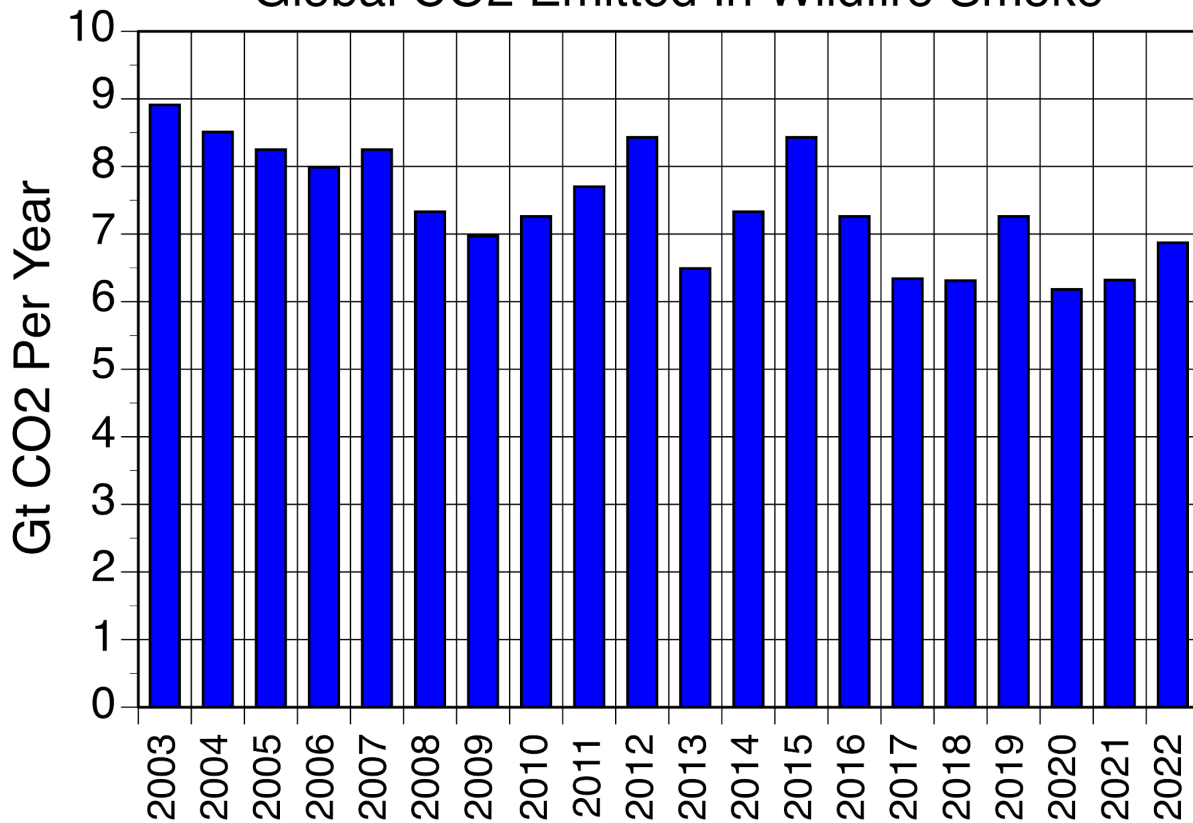
Cumulative global annual CO2 sequestration lost, in gigatonnes, due to fire damage. Includes linear regrowth to 50% of original photosynthetic capacity. Green bars are smoke CO2.

Sources: IPCC data with consensus to NASA, FAO, GCW, and GFED. Filename: FIRE2.Chen.Burn.Areas.xlsx

# Global Annual CO2 Emissions (Gt CO2)



## Global CO2 Emitted In Wildfire Smoke



Per Copernicus Atmosphere Monitoring Service (CAMS)

Dec 13, 2022 filename:FIRE.wildfire.damage.cumulation.2024.xlsx  
and filename: FIRE.Wildfire.data for years 2020-2022 (NASA data)

The data for the graph above is found at: [\[HERE\]](#)

To calculate these sequestration losses we applied the latest, most accurate data from the major paper by Chen et al on mean global wildfire burn areas over the 20-year period from 2000 to 2020 to the most recent compilation by Zhuravlev et al of the respective net ecosystem exchange values (NEE) for the main land-cover types of those burn areas (forest, grasslands, savannah, etc.) to obtain a first-order calculation of annual global atmospheric CO2 attributable to wildfires.

Our calculation included both the CO2 in smoke and that lost due to loss of sequestration. **The astonishing result found that wildfires could be blamed for increasing atmospheric CO2 by 101 gigatonnes in the year 2020 alone.** This value is shocking, and yet conservative for at least three reasons — It only includes the most recent 20 year period during which we have accurate data for burn areas and NEE, —it only accumulates sequestration losses for the first 50% of the burned area's regrowth period and —it is modeled on a linear rate of regrowth rather than an exponential one.

The huge CO2 emissions caused by wildfire smoke and its damage to vegetation drive a feedback loop that further warms the planet and causes ever more extreme weather that increases the incidence of future megafires. This vicious cycle worsens CO2 emissions even further because the annual amount of forfeiture of

CO2 sequestration is cumulative. Adding to that forfeiture is the uncertain amount of lost photosynthetic capacity in the incalculably larger areas of forest and grass vegetation that, though not directly burned by wildfire, are injured by smoke and being covered with ash. Smoky skies themselves further impede the amount of solar energy reaching the vegetation for the process of photosynthetic capture of CO2. [Some estimate that we will see more than a doubling of global wildfires in the next 30 years.](#)

This positive feedback loop described above and driven by wildfires is already causing the number and severity of extreme weather events to increase faster than generally predicted. This is likely related to under-accounting for the escalating impacts of wildfire. Some examples include Carolyn Kormann in the New Yorker of September 6, 2023 who states “Phoenix is the fifth-largest city in the U.S., and the hottest large city, with an average summer temperature of 93.7 degrees—an average that has increased by 3.8 degrees since 1970. Nighttime summer temperatures, largely owing to urbanization, now average a low of eighty-three degrees, an increase of 5.4 degrees since 1970. . . . there was a stretch of sixteen days [in July 2023] when the nighttime low was ninety degrees or above, including one night when the low was ninety-seven degrees.” The hottest temperature ever recorded in Sonoma County, California is 115 degrees Fahrenheit. This temperature was recorded at Santa Rosa on September 6, 2020. Additionally, Atlantic Ocean temperature recorded at a buoy in Manatee Bay near Miami reached 101°F on July 25, 2023, a likely new world record.

The Paris Climate Agreement set a goal to limit global temperature rise to 1.5°C, but recent emissions control efforts appear insufficient to achieve that goal. The extreme weather events that can occur from even a 1.5° to 2.0° C rise in global temperature can be horrible and can kill millions. These events include heatwaves, floods, hurricanes, tornadoes and wildfires that could wipe-out vital infrastructure. The importance of ending wildfires with AAF is emphasized by the following cascade of events that can happen from extreme weather events: widespread power blackouts, temperatures that soar with no air conditioning. Highways gridlocked with evacuating hoards. Gas pumps that don't work, leaving people stranded in vehicles with empty tanks. Water pumps that fail. Hospitals that overflow with emergencies. Internet and cellular phone service go dead. Megafires can cause such failures and their smoke can choke millions. Hurricane flooding can block escape routes and ruin drinking water. Tornadoes can level community shelters and fire stations. Mayhem and looting can ensue. Hundreds of millions of climate refugees, with mass deaths from famines, dehydration and vector-borne pandemics can occur.

Recent assessments by a team of experts in the U.K. from the Institute and Faculty of Actuaries and University of Exeter have revealed further indications that the climate crisis is already worse than we've been told: [\[HERE\]](#)

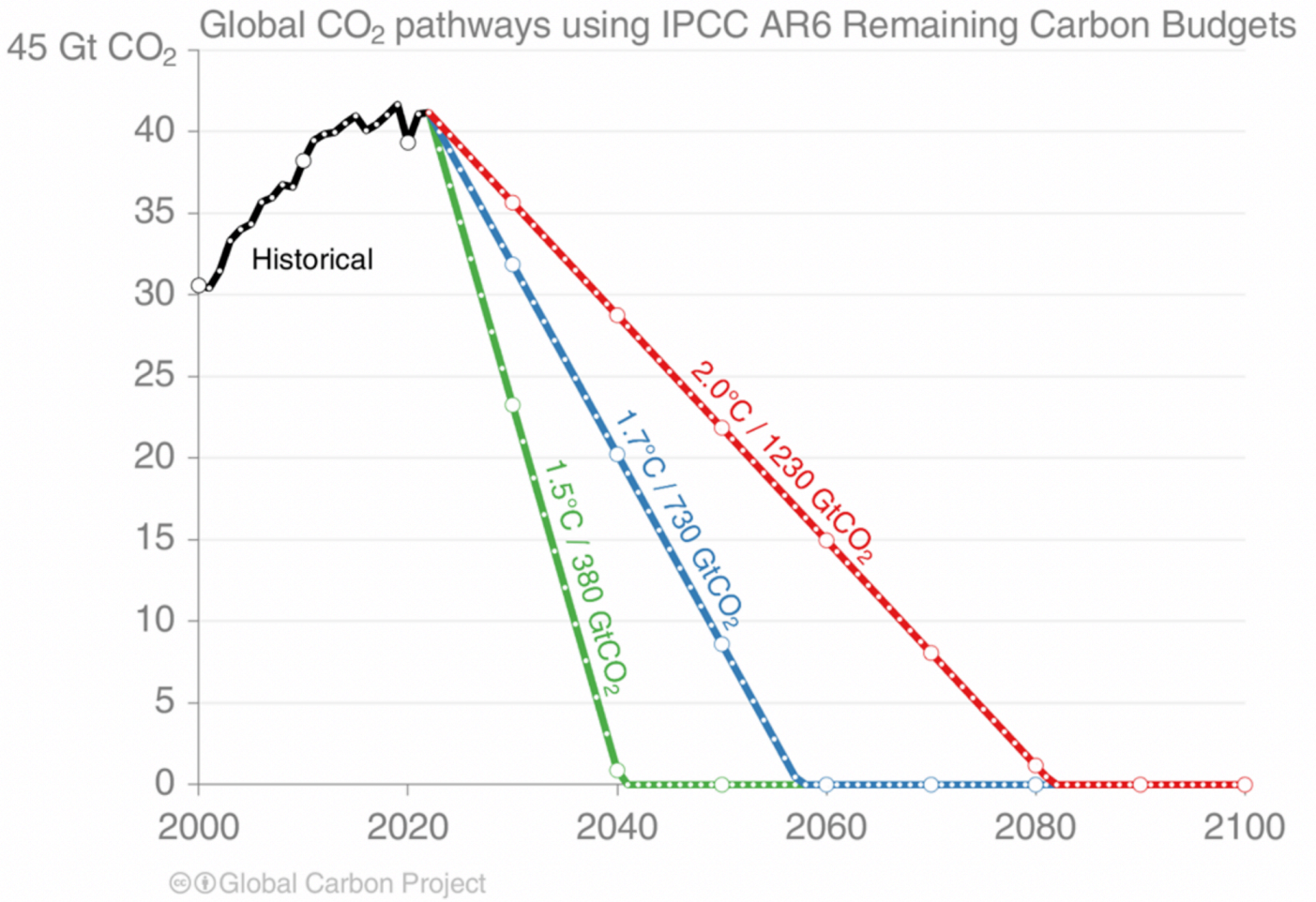
The US EPA now estimates that each Gigatonne of CO2 emitted into the atmosphere costs our planet \$190 billion dollars. By that metric, the 101 Gigatonnes of CO2 attributable in 2020 to wildfires **cost our planet over \$19 trillion dollars in one year!** The enormity of the global CO2 emissions caused by wildfires and their cost in loss and damages is now an existential threat to our world. Its substantial worsening effect on the climate crisis makes it extremely urgent to start now to build an affordable, feasible system that can end wildfires. Fortunately, research shows that such a system can be built and would be highly effective in curbing the climate crisis and thereby averting the horrific events described above. **But that remedy only occurs if we seize the opportunity to do so.**

### 3) Why have Climate Summits not prioritized ending wildfires?

Climate Summits have generally agreed to dismiss wildfires as untouchable nature, a part of the planet's ecosystem whose adverse effects on atmospheric CO<sub>2</sub> had to be accepted as 'baked-in' and unalterable. Estimates made by [Copernicus at section 2.7](#) admit that *"the loss of additional sink capacity from reduced forest cover is missing in the combination of approaches used here to estimate both land fluxes (Emissions and Sequestration)"*. This omission is a policy that reflects the untenable cost and difficulty of ending all wildfires globally using present-day equipment and systems. Up to now, Climate Summits have shared the assumption that reducing CO<sub>2</sub> emissions by curbing fossil fuel is the most effective way of curbing the climate crisis. **In light of this new discovery of the enormous annual atmospheric CO<sub>2</sub> attributable to wildfires, Climate Summits need to recognize that ending wildfires is the fastest and most effective way to reduce atmospheric CO<sub>2</sub>.**

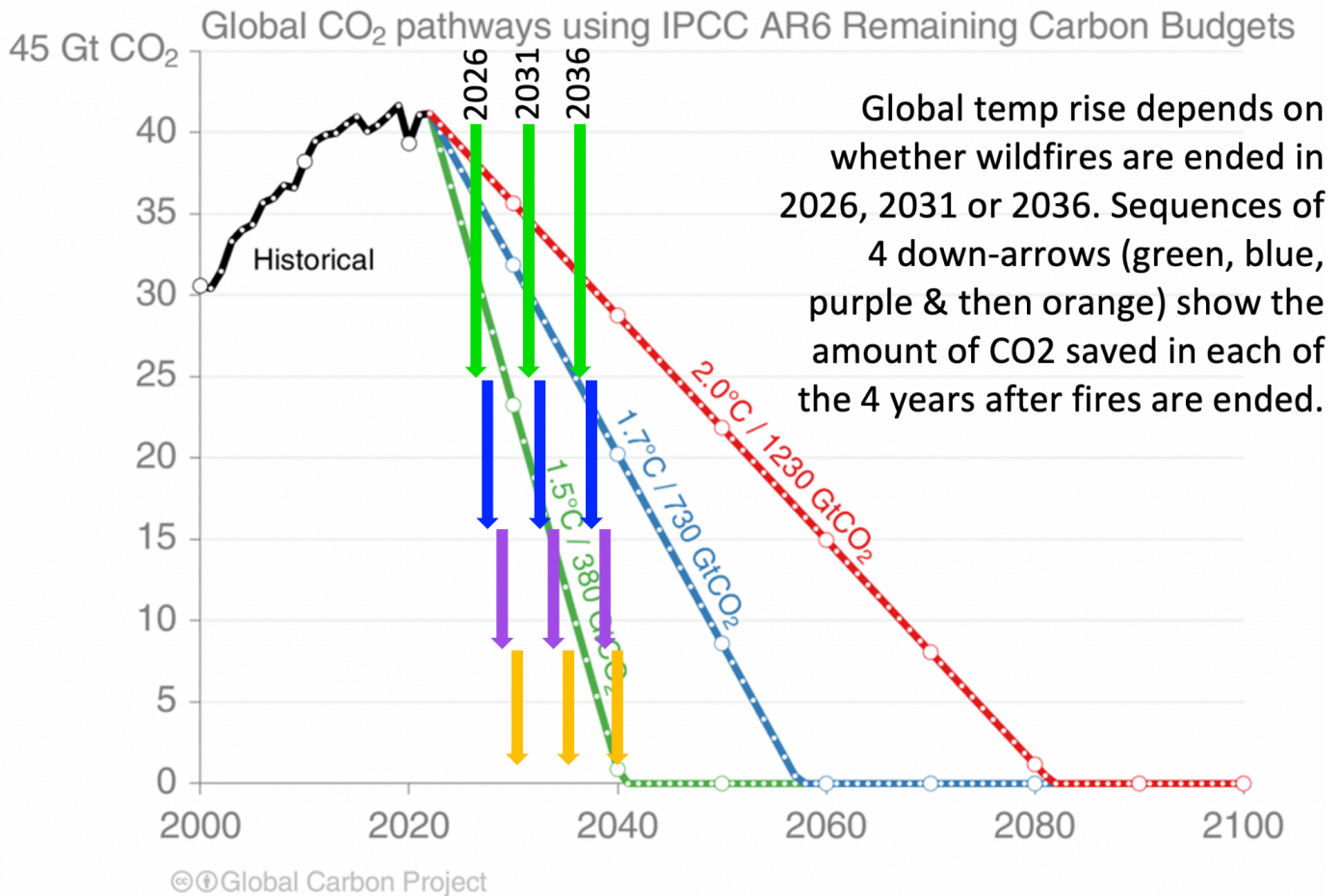
### 4) If we end wildfires globally, how much will it help curb the climate crisis?

Our calculations in the figures below attempt to answer this question. The first graph shows the diagonally sloping downward dotted lines that depict the steep pathways we must follow for reducing future atmospheric CO<sub>2</sub> if we are to limit global temperature rise to 1.5, 1.7 and 2.0°C, respectively. The second graph is a duplicate of that information but with an overlay of three sets of solid vertical downward arrows (green, then blue, then purple, then orange) that depict the size and the sequence of annual reductions in atmospheric CO<sub>2</sub> that could occur over a 4-year period after we end wildfires. For purposes of illustrating how fast ending wildfires could curb the climate crisis, each of these three 4-year sequences (as shown by its solid green vertical arrow) is depicted to begin in a different year (2026, 2031 and 2036), as the year in which we hypothetically first achieve an end to wildfires. The smaller downward solid arrows below the green arrows (blue then purple then orange) are scaled to show the relative amounts of CO<sub>2</sub> reductions that could occur in each of the subsequent 3 years. The graph's main messages are 1) that the sooner that wildfires are ended, the greater the chance of limiting global temperature rise to 1.5°C, and 2) that the CO<sub>2</sub> reductions from ending wildfires are much larger and more rapid than those expected from efforts to reduce global fossil fuel use. The two graphs below make it evident that **ending wildfires with Autonomous Aerial Fire-fighting (AAF) can be the single fastest, most effective, feasible and affordable way to reduce global CO<sub>2</sub> emissions. The urgent need to rapidly curb the climate crisis and the enormous costs of failing to do so compel us to enact a bold and mass-scale program to achieve that goal AS SOON AS POSSIBLE.**



Source: [Friedlingstein et al 2022](#); [Global Carbon Project 2022](#)





Source: [Friedlingstein et al 2022](#); [Global Carbon Project 2022](#)

## 5) What challenges currently limit our capability to end wildfires?

A meeting in 2020 on this topic with the Directors of Cal Fire Aviation elucidated these challenges:

- Difficulty in timely reaching remote wildfires with ground crews, fire engines and bulldozers
- A shortage of trained air-tanker pilots
- A shortage of very large air tankers (VLAT) and air attack bases
- Inability of air tankers to fly at night or in heavy smoke
- Remoteness of large air attack bases from wildfire outbreaks (long times to arrive on-scene)
- High cost of VLATs (\$24M each, on average)
- A need for a global early detection network that can issue prompt dispatch of aerial assets
- A need for aerial attack that can make precise, low-level drops of fire suppressing liquid with minimal wind scatter (VLATs drop retardant from too high up, with wind scatter)
- A need to avoid contamination of waterways with eco-toxic fire retardants
- The danger of aircraft with flammable fuel onboard making low passes above fires
- 53% of Wildfires of > 10,000 acres happen outside the 10AM-6PM pilot's flying window.

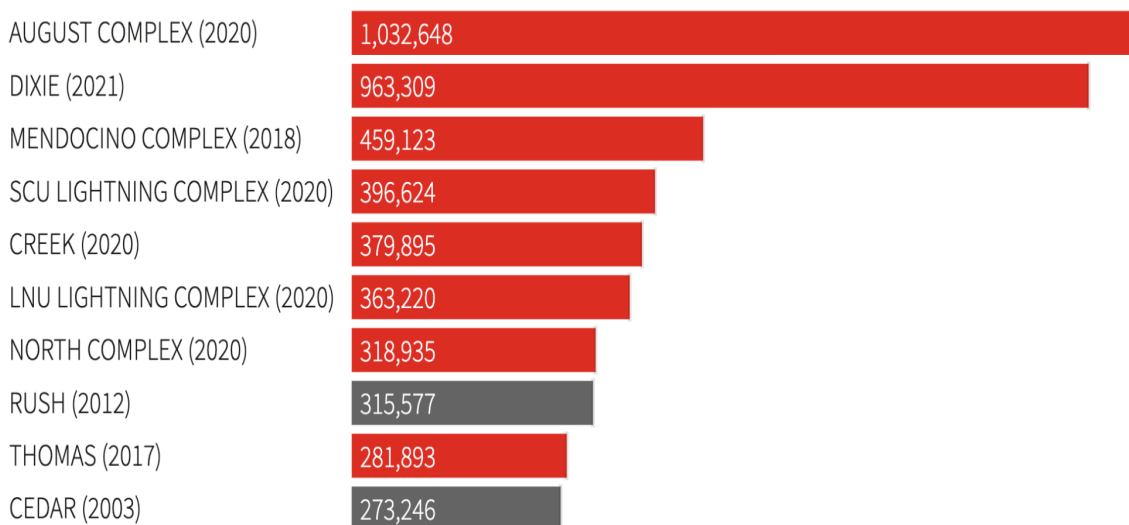
Other challenges: The annual Cal Fire budget is now more than \$1B. With more than \$44B in property loss and damage in California from megafires in just 4 years (2017-2021), this means that, on average, wildfire loss and damages are directly costing \$11B per year in California, not to mention their incalculable damages to climate, evacuation costs, lung damage, death, etc. The costs of those fire losses are now being passed on to California voters as either cancellation of their homeowners insurance coverage or quadrupling of their annual insurance premiums.

Business as usual is not an option for addressing these challenges: For example, a ten-fold or even one hundred-fold increase in the present-day, piloted, daytime-only fossil-fueled aerial methodologies employed by Cal Fire Aviation would not only prove to be insufficient but would be cost prohibitive while generating no revenue and having major adverse environmental and health impacts, which include contaminating our waterways with retardant chemicals and exposing employees to flight risks and cancer causing chemicals. The present day strategy of using fire retardant drops by VLATs at the perimeter of large wildfires to slow their spread enough to allow ground crews to arrive and fight them, while helpful and even heroic in its efforts, has proven to be starkly inadequate for stopping the many megafires that keep happening across California as shown in the chart below:

## Largest California wildfires

Eight of the 10 largest wildfires in California history have occurred in the last five years.

Red bars show fires from the last five years



Note: The Rush fire burned 271,911 acres in CA, and 43,666 in NV.

Source: Cal Fire

The graph above is sourced at: <https://www.reuters.com/graphics/CALIFORNIA-WILDFIRES/gdpzyjxmoww/>

## 6) Apart from Autonomous Aerial Fire-fighting (AAF), what are the alternative programs to meet the challenges to end wildfires?

Simply put, none.

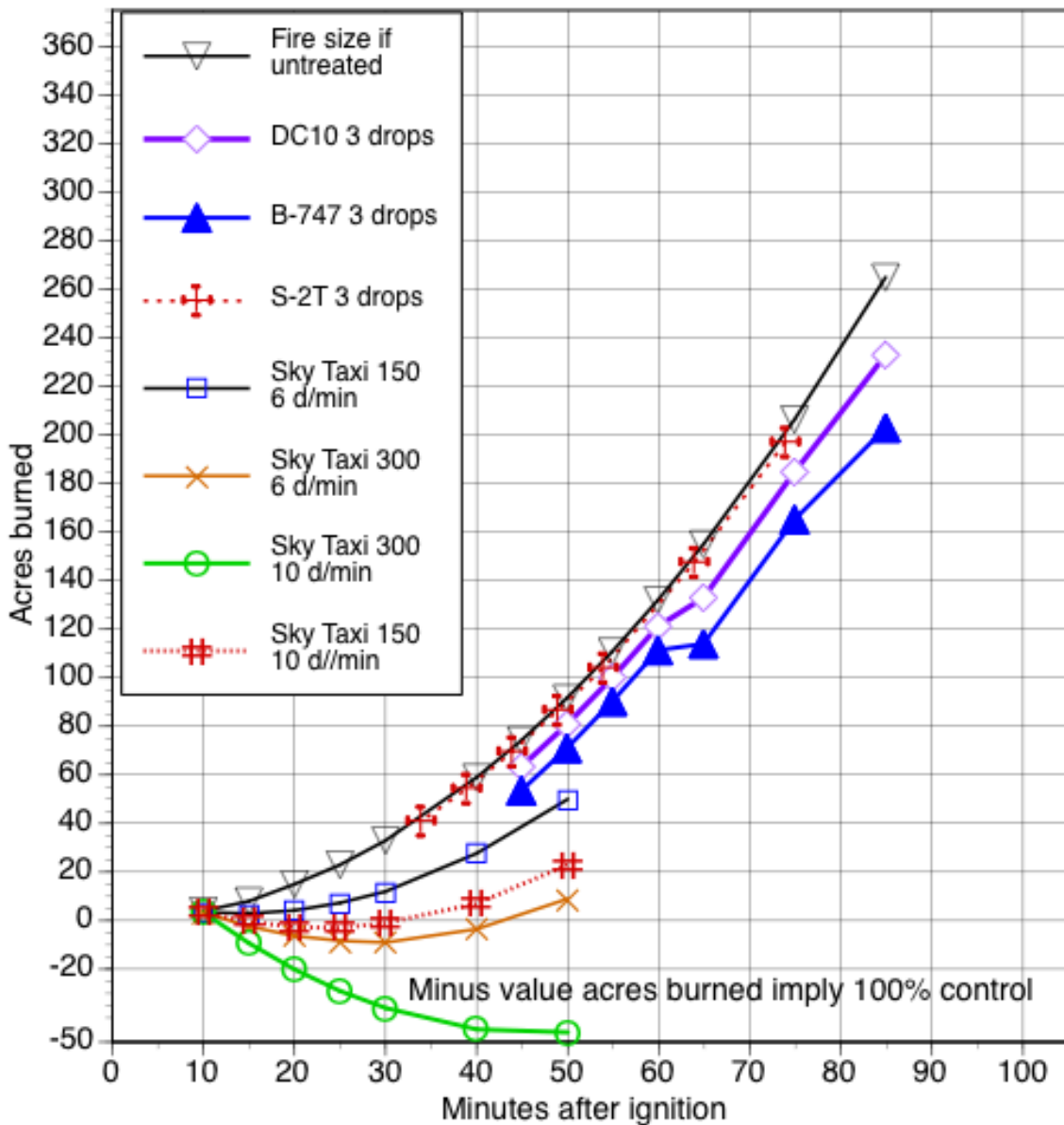
Instead, incremental efforts to expand present methods to control (not end) wildfires are being made by numerous agencies and with NASA getting involved as a coordinator of those agencies. However, in light of the newly discovered annual atmospheric CO2 attributable to wildfire damage, these incremental efforts will be too little, too late. None of the current agency initiatives aim to do what the AAF system is proposed to do: i.e., comprehensively end wildfires. The partial solutions that are being considered appear to be either prohibitively expensive, environmentally unsound or incapable of reaching all fires. Wildfires are proving to be too numerous, remote and fast-spreading to be consistently extinguished within the first hour after outbreak by the positioning of ground crew, bulldozers and firetruck assets alone, even with massive spending. This is particularly true when the fire ignites at night in a remote and inaccessible forest. Such fires can only be safely and promptly attacked by air using autonomous aircraft.

With AAF aircraft, we can create our own very localized type of rain. The amount of water needed depends upon the size of the fire which in turn depends upon how long the fire has been burning since it ignited. Clearly, the only way to effectively end wildfires and megafires is to extinguish them wherever they begin and before they can grow. We must extinguish them at night and in smoke in remote areas, before they can spread. This can only be accomplished by the very prompt dispatch of a large, nearby squadron of autonomous aerial fire-fighting aircraft that can provide a bucket brigade process that delivers a near-continuous spray of fire-dousing water. That squadron must be available 24/7 from a widely distributed network of airparks that blanket the nation with adequate proximity to any fire's location. As such, AAF would comprise an aerial water delivery system that would be able to extinguish any fire within the first hour after its outbreak.

AAF would consist of effective flame-hunting air tankers that could be mustered by a network of remote sensors to a fire's geo-location at which they would arrive on-scene 4X faster than the present fleet of VLATs and drop 20X more liquid per hour. Being uncrewed, there would be no shortage of fire-bomber pilots and this fleet of electric air tankers could fight fires 24/7 at night and in heavy smoke, effectively comprising an unrelenting aerial 'spray can'. Their nose-mounted thermographic camera would guide them to the active flames where, carrying no flammable fuel, they could make precision drops from a low height with minimal wind scatter, using water as the suppressant instead of eco-toxic retardants.

The graph below shows how effectively AAF would end wildfires relative to data for the conventional aerial attack system that was employed on the LNU Complex Fire in California:

Frequency of drops matters: Coverage level 2. Initial attack: Cal Fire LNU complex fire data: <https://graphics.reuters.com/CALIFORNIA-WILDFIRE/AIRCRAFT/bdwpkzmyyvm/> Fire detection is 4.5 minutes after ignition. Presumes 500 airparks for Sky Taxis.



Wind 10 fps, flame spread at 10% of wind speed with 24° spread angle on each flank. Sky Taxis with either 6 drops/minute (d/min) or 10 d/min. Minutes from take-off to 1st drop: 35.4, 26.4, 4.5 for VLATs, S-2T and Sky Taxis, respectively. VLATs are DC-10 and B-747. Drop intervals after 1st drop are: 20, 20, 18 for DC-10, B-747 and S-2T, respectively. B-747 data is hypothetical for 17,964 gallons per drop. **NOTE: Does not account for slowing of flame spread by drops.**

File source: Cal Fire.Swaths.calcs.7.xlsx

## 7) How will AAF provide for safe air traffic control?

Simulations of high density air traffic have shown it to be a manageable challenge when optimized technology is implemented. Optimized technology is comprised of "sovereign, sentient and polite" air vehicles that each

are equipped with a complete suite of onboard avionics, sensors, radios, GPS and Inertial Navigation Systems (INS) and cameras that are sensor-fused so as to offer negligible control latency and extreme aerial agility. A 2019 study by the MIT Technology Review found that the use of drones [i.e. driverless aircraft] could potentially increase the number of small aircraft safely operating in low-altitude airspace by up to 100 times [i.e., up from 1000 to 100,000 aircraft]. However, the study also found that this would require significant changes to the airspace, including new separation standards, the creation of new air corridors and the implementation of new safety procedures.

Before taking off, each AAF vehicle will be provided an integrated precision de-conflicted 4D flight path from airpark to airpark. "4D" refers to a three dimensional (3D) flight path that also includes an exact time for arriving at each point along that path. That flight path would effectively be a unique pathway in the sky, automatically de-conflicted with all other air traffic. Any intrusion into such assigned airspace by a rogue piloted or unpiloted aircraft would be automatically detected, interrogated, tracked and announced to all other relevant traffic. The relevant traffic would all use their on-board sentient sense and avoid guidance systems to avoid any conflicts and proceed on appropriately revised 4D flight paths. As is commonly done in today's controlled airspace, private aviation and airline traffic could use dedicated high volume flight corridors to keep their aircraft away from geo-fenced AAF operations.

## 8) Why are eVTOLs not suited for AAF?

The limited energy density of batteries is the main reason that essentially disqualifies eVTOLs from offering competitive range and payload capabilities in aerial fire-fighting. With a given battery pack, the aircraft that optimize lift and minimize drag and weight (in order to reduce the power required and noise) will thereby optimize the aircraft's range and payload. This is conventionally accomplished by having a low span loading and long, slender wings of high aspect ratio, such as are seen on the Boeing 777, B29 and modern sailplanes. These design features provide a high lift-to-drag ratio (L/D), the key metric for efficient, long-range flight according to the Hepperle modification of the Breguet Range Equation.

A fixed-wing aircraft with a cruise L/D ratio of 20:1 not only enjoys longer range but also lower power required that gives ultra-low noise emissions and lowers its cost of operation. Long experience with vertical take-off and landing aircraft, by contrast, shows them to typically have a poor L/D of about 5:1. Such a low L/D translates to requiring at least 3.3 times more power than the fixed-wing Sky Taxi in order to lift the same payload weight on take-off and landing. That excessive amount of power required worsens both the noise and the range of the eVTOL aircraft. The excessive power required for eVTOLs ruins their suitability for carrying a heavy load of fire retardant and reaching and fighting distant wildfires.

Another important reason that eVTOLs are not workable for AAF is that the noise emissions from their rotors cannot be made quiet enough to fulfill the FAA and W.H.O. requirements when operating in the quiet ambiance at the small air-attack airparks that will need to be located in close proximity to residential areas. This is evidenced by the quietest of today's eVTOLs having take-off noise emissions being **25 dBA too loud** for those requirements. Future noise requirements for effective AAF must respect not only the 2021 FAA National

Curve of Noise Tolerance, but also the even more stringent limits on continuous noise events as the guiding metric, because in effective AAF, the take-offs occur almost continuously (every 10 seconds).

The noisiness of eVTOLs alone disqualifies them for use in AAF and stems mainly from their inherent demand for higher power compared to fixed-wing aircraft. The table below summarizes the published noise levels of the current market leading eVTOLs relative to AAF's much quieter fixed-wing ESTOL design. The quietest eVTOL (Joby) is inadequate, being 25 dBA louder than the eVTOL requirement to comply with the FAA's National Curve of noise tolerance. Published noise data about the leading eVTOLs indicate that taming their excessive noise at the perimeter of a vertiport would require those vertiports to vastly expand in both cost and area to occupy hundreds or thousands of acres, forcing them to be sited well outside of towns and many miles from residential areas, thereby disqualifying them from practicality in serving effective AAF.

| Aircraft                      | dBA, Leq published | @ distance, m | dBA @ 40m, Leq | 37.6 dBA Leq @ distance, m | airpark size, hectares |
|-------------------------------|--------------------|---------------|----------------|----------------------------|------------------------|
| Joby eVTOL                    | <b>55</b>          | <b>100</b>    | 62.96          | 741                        | <b>220</b>             |
| Lilium eVTOL                  | 60                 | 100           | 67.96          | 1318                       | 695                    |
| Heavyside eVTOL               | 65                 | 305           | 82.64          | 7150                       | 20448                  |
| Volocopter eVTOL              | 65                 | 75            | 70.46          | 1758                       | 1236                   |
| <b>FAA/W.H.O. Requirement</b> | <b>30</b>          | <b>100</b>    | <b>37.96</b>   | 42                         | <b>0.7</b>             |
| <b>Quiet ESTOL fixed-wing</b> | <b>29</b>          | <b>40</b>     | <b>29.00</b>   | <b>15</b>                  | <b>0.09</b>            |

All eVTOL designs inherently share the same requirement to surround their cabin payload with several lift rotors in order to position their thrust axes to balance and control the aircraft's attitude and keep it right-side-up. Together, those several rotors can impede access for the loading and unloading of firefighting payloads. And eVTOL aircraft suffer increased airframe interference drag due to their need for multiple large rotors (whether shrouded or open-rotored), each of which must be mounted on a strut or structural support with an intersection that joins it to either the fuselage or wing of the aircraft. These multiple intersections on the airframe produce numerous interactive turbulent wakes with separated airflow and increased noise, as shown in this video of VTOL turbulence revealed by computational fluid dynamics:

<https://www.youtube.com/watch?v=hywBEaGiO4k&t=2s>

These rotor geometry drawbacks further penalize the performance and capacity of eVTOLs compared to those of fixed-wing ESTOL AAF vehicles. In addition, it is generally conceded that eVTOLs will cost more and take longer for the FAA to certificate than more conventional and simpler fixed-wing AAF aircraft.

## 9) What are the cost estimates to launch AAF statewide in California?

California is chosen as the ideal birthplace of AAF due to its resources, weather, fire history and aerospace industries. These following cost figures depend very much upon the resolve and urgency applied to the project, including competitive bidding, streamlined permitting, concurrent development, prioritized inter-agency cooperation and leadership. They also depend upon developing public-private partnerships after the initial proof of concept prototyping. The most current 2024 cost and timeline estimates for a rapidly deployed moonshot program for a fully built AAF system statewide in California are:

- \$4M for design to demonstrate the key enabling technology of ultra-quiet propulsion. Year 1
- \$60M for a single fixed-wing ESTOL AAF prototype flight demo. Year 1
- \$10M AAF air tanker demo of autonomous fire suppression Year 2
- \$1500M Concurrent AAF FAA Certification. Year 3
- \$12B Concurrent build of 1200 three-acre air attack airparks at \$10M each. Years 3-5
- \$8.25B Concurrent build 33,000 AAF vehicles at \$250K each. Years 3-5
- Total: estimated at about \$22B cost spread over 5 years = **\$4.4B per year**

That amounts to \$1.47B per year when amortized over 15 years of service life for aircraft and airparks. We should remember that that \$1.47B per year is **a very small amount relative to the \$19 trillion dollars per year in losses attributable to wildfires**. **These estimated costs could be substantially reduced if the AAF fleet of aircraft were comprised of multi-purpose aircraft that could earn revenue in serving other markets.**

## 10) How can we get AAF launched?

We believe that the mission urgency and system scale entailed in the data above require that AAF be initiated by the state and/or federal government as a moonshot type of program, since it directly and effectively fulfills the government's duty to manage wildfires and mitigate climate change.

The amount of funding needed to launch AAF surpasses that of typical government agency block grants. Piecemeal funding by Senate and Assembly Bills will take too long. A bond measure to directly put the AAF program proposal to voters could provide seedling funding, but would lack the urgency needed to meet the challenge at scale.

Success requires going all-in now to build, demonstrate and implement a concerted system that will be expandable and exportable. We believe a dedicated moonshot-style program is necessary.

Achieving such commitment requires spreading the word about the need and benefits for AAF.. Politicians respond to groundswells of support. Your email messages and letters of support can definitely make this move forward. Please encourage government leaders to personally attend a one-hour hearing for the AAF program proposal. This is exactly how acting locally can lead to global breakthroughs.

Please share this article widely with your friends and colleagues.

Please contact our leaders by emailing your suggestions to:

<https://www.gov.ca.gov/contact/> and/or to:

<https://www.whitehouse.gov/contact/>

OR, Please send your letters of support to:

BY US MAIL:

Governor Gavin Newsom

1021 O Street, Suite 9000

Sacramento, CA 95814

Phone: (916) 445-2841

Or, to:

BY US MAIL:

President Joseph Biden

The White House

1600 Pennsylvania Avenue, N.W.

Washington, DC 20500

As the contact person who is prepared to attend and testify at the one-hour hearing, you can suggest the following:

Dr. Brien Seeley, President, Sustainable Aviation Foundation

[brienseeley@gmail.com](mailto:brienseeley@gmail.com)

phone: 707-544-2720

Supporting AAF is a legitimate and prudent investment toward a feasible, affordable, green solution to urgent global problems.





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MISCELLANEOUS  
PUBLIC COMMENTS

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**WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST**

Section 1: Jester Jersey

**Written: 5/22/2024**

Subject: Re: Registration; Request to provide public comment at PCAST meeting

Hello,

Thank you for facilitating my public comment. Enclosed is a written comment regarding some of PCAST's recent discussions, including today's on research, that may be useful for discussions at future PCAST meetings.

Kinds regards,

Jester Jersey

## WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

### **Written Comment to the President's Council of Advisors on Science and Technology: Building Trust in the Science to Combat Malnourishment, Pandemics & Mistrust From the Perspective of A National Community Health Worker**

Dear President's Council of Advisors on Science & Technology (PCAST),

Greetings, my name is Jester Jersey and I am a vaccine and health advocate. I will be speaking at the May meeting of PCAST, or will have already spoken, but my written comment is applicable to the recent substantive work of PCAST as well as its future endeavors. Thank you for giving me the opportunity to write this to you. It is my sincerest wishes that the expertise I am sharing in this public comment will be of beneficial use to the Council's work. Although my voice and writings may be only one of many that you may have heard over the years, it is my hope that the Council of Advisors will take a moment to read some, if not all, that I am sharing here today.

Science is a complicated concept. Like many things, it can be used for good or for bad purposes. When used for good, it can help and heal. When used for wrong, it can also harm and hurt. No example can best be seen in the recent fentanyl and opioid crisis, which has claimed many lives in recent years. It is through science that we have seen how these drugs were made- created to destroy lives when used for intentions outside of prescribed medicinal use, something that some have used to their advantage for financial gain. However, it is also through science that we have also seen the emergence of tools to save lives, such as the tool known as NARCAN(naloxone hydrochloride nasal spray), for resuscitating those who have experienced an opioid overdose. The intentions behind who either administers or uses these tools of science has the power to either give science a bad reputation or a good one. This power afforded to the individual lies in one key quality: trust.

For the last several years, around the start of the pandemic up to even today as I write, I have worked as a trusted messenger to serve the people, to protect communities across the country and to save lives-through trust. Some might call me an advocate, while others might call me a trusted messenger. Most might refer to me as a Community Health Worker, or a CHW, as many of those I work with are often called. Whatever I'm labeled as, it is not the facts that I can recite from the latest studies, the reputations of the vaccine manufacturers I prop up through advocacy, the effectiveness of the vaccines I support or even my eloquence of speech that helps me be the successful advocate that I am today. It is the factor of trust.

PCAST has discussed many topics in the last few months that deals with technology, including this month's meeting: from the impact of nutrition on local communities and addressing global climate concerns to artificial intelligence and the importance of research. Of the later two, since I will go in depth on the former during the public comment at the meeting, I will focus on implementation with respect to the other three. Science is an overarching theme in those, as it is science that gives us the tools to put together the knowledge gleaned from research to make it applicable to the first two: nutrition and climate. Obviously, science is important in many other aspects, but as this commentary is supposed to be a substantive look at PCAST's work, I shall stay within those guidelines. I want to focus on how trust can help with implementation, particularly with diets(nutrition), diseases(pandemics) and devices(technology).

In the first half of March's PCAST meeting, the Nutrition Working Group, we saw the high costs of health disparities, often shouldered by the most vulnerable in our communities. Although there are many government agencies to address these health issues, there is a high level of fragmentation among these

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agencies, which makes making any coordinated effort to implement research findings into significant action.

Additionally, Dr. Frances Colón mentioned a broad list of consultation sources for the work group. However, there is no mention of more local community-based organizations, such as groups that those with low socio-economic status may see as trusted sources in the local community. These include sources where residents may derive some of their dietary needs, such as local food banks or national groups like Meals on Wheels. While the list was broad, the lack of more local sources that are familiar with the nutritional needs of communities as opposed to the health issues that residents faced after periods of time after consuming foods, often years, makes the information seem less personable and difficult to implement action on.

For example, one may look at the findings and conclude that because a large number of contributors are from the education and insurance sector, one may not be able to generalize the findings to the general population. It was noted that three-fourths of Americans with chronic conditions also deal with obesity. However, what isn't mentioned is where those with these chronic conditions derive their food sources from, such as through SNAP/EBT, through senior meal delivery groups, or if it self-bought. These may have been covered on paper, but not apparent on the presentation slides.

When one factors in that insurance groups are one of those consulted for data, one might also have to consider that sometimes the healthiest people in the population don't always subscribe to health insurance and sometimes go without it, skewing the data more to those who are most likely to seek insurance because of one being aware that it will be needed due to address their health status and concerns.

More outreach efforts are needed to assess those who don't always fall into these categories because data from those healthier groups may even be just as important as looking at populations with comorbidities. In later recommendations, the Nutrition Working Group mentions that these gaps in science necessarily limits the scope and level of opportunities available to make implementary changes on a societal level.

Dr. Catherine Woteki expounds on the previously mentioned federal agency programs, and makes some startling findings. The most significant being that there's an insufficient focus on chronic disease prevention. Considering that diet is the most modifiable on the list of risk factors, there is little investment in it. I concur with Dr. Woteki that more investment needs to be made on that front. Some solutions I can provide would be to work with local food providers to change the "culture of diet", i.e. to change the mindset that people are what they eat. When they eat healthier, they will be healthier. This could be through a national ad campaign, collaborating with advocates, investing in local dietary programs to provide incentives to switch to healthy foods that's more accessible to the community.

There also needs to be the use of more proactive approaches, as recommended by Dr. Woteki. Community-based participatory efforts are crucial to ensuring a healthier population to prevent health risks and costs, as well as to build trust in federal collaborative efforts at the local level. Expanding on data sets to include more specific groups such ethnographic studies and studies across the life spectrum (pregnancy, retirement) can help mete out differences and find out where best to implement these interventions, if any, to modify consumer dietary habits.

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Overall, I think the Nutrition Working Group's recommendation to advance nutrition goals and the science behind is both admirable and actionable, but these do not happen overnight nor automatically, so there is a need to engage in actionable efforts recommended by the group to change the dialogue around diet and health.

The first is better interagency collaboration on the large data sets accumulated to make sense of what to implement and where to implement interventions. This is one area where A.I. could help within the scientific field, such as generating narratives around the vast information acquired, or forming a plan for implementation.

The second would be to focus on prevention rather than cure, as health expenditures are exponentially higher than preventative measures. This makes needing to commit already strained resources into more focused pockets of intervention rather than a one-size-fits approach that wastes resources, making the system more efficient at implementation. In other words, you know what to prevent and how to prevent it.

The last thing would be to collaborate at the community level. Just as science is complex, so are communities that will benefit from it. What works in one community may not always work in the next. This means working with local contributors. Getting information from national sources that looks at the bigger picture is one thing, but getting a micro-level picture where you know what would be the most effective for a given location rather than what works on average everywhere else would be ideal. As mentioned, this works best through a community-based approach- find out the key players of an area/region, and reach out to them about collaboration. Share information that you've found, formulate a plan that can be carried out jointly with local community organizations, and use appropriate metrics to gauge levels of effectiveness. These can then be modified using a funding sliding-scale, where in areas where less resources are needed to effect change, the then excess funds can be transitioned to somewhere else where more resources might be needed.

In turn, the effectiveness of these programs can then translate as trust in the system, as now information can be easier to access when beneficiaries of these programs can see that the more information they provide equals more effectiveness of programs. Information at the local level can be gleaned from self-provided responses through surveys and communications with organizations and/or advocates. Offer incentives if necessary/when the budget allows. Local voices can then serve as trusted messengers.

As a short side note, I want to echo the sentiments in the public comment offered up by Rehman Hassan, who mentioned that there needs to be proactive engagement with civil societies to ensure equitable participation when dealing with public policies. Local groups know what strategies to best implement in their local communities.

This concludes my assessment of dietary and nutrition concerns from PCAST's meeting in March. The following section will look at diseases from my perspective as a health advocate during the COVID pandemic from 2020 up to today.

In the second half of the PCAST meeting from March, Dr. Steve Pacala mentions that that portion of the meeting was convened to address three things: climate change concerns, emerging pandemics and emerging antibiotic resistance. As a vaccine and health advocate, I will deal with and discuss the latter two in this section.

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During COVID, and even today, I work as a trusted messenger. I've met with numerous organizations across the country devoted to fighting vaccine-preventable diseases through advocacy. From 2021 to 2022, I worked as an independent CHW with a group called Made to Save, a national effort to get the first COVID-19 vaccines out to the public. When those efforts sunsetted in the summer of 2022, I later joined the Vaccination Collaborative (VC), a group of organizations who met through the Made to Save efforts. We continued vaccine advocacy from where Made to Save left off. Today, I continue those advocacy efforts with the VC.

As vaccine-preventable diseases are on the rise after the end of the Pandemic Health Emergency (PHE), it is crucial that the advocacy efforts continue to fight disease. This is where my personal contributions to PCAST comes in.

The first presenter, Dr. Derek Cummings, talked about mosquito-borne illnesses, giving rise to future pathogen concerns that might give rise to the next pandemic. Future pandemics may be further complicated due to climate change, causing drastic climate variability. He had noted that this is currently being seen in the rise in dengue cases in Brazil in the past week. Much of this can be attributed to changes in climate.

A concern I would like to share with the Council is the co-occurring incidences of multiple health events, such as what we recently saw during the COVID-19 pandemic. Those who represent the LGBTQI+ community dealt with the additional mini-pandemic of MPOX. While fighting the COVID pandemic was already chaotic for the country as guidelines shifted the more science knew when we knew it, the added burden of MPOX on the LGBTQI+ community provided a double whammy, as some in the community also had to deal with past stigmas resurfacing due to concerns about HIV/AIDS (As a sidenote, I recently spoke to PACHA (Presidential Advisory Committee on HIV/AIDS) in March, so please check with that group about the specific concerns I raised about getting equitable pandemic care).

In a nutshell, while the MPOX guidelines proved confusing, and the issue did not prove as devastating on a national level as COVID did, it did resurrect fears about treatment as second-class citizens not deserving of treatment. When vaccine supplies were in early production and not yet widely available, there were cases where vaccines were withheld from some who were not involved in a PrEP (Pre-exposure prophylaxis) regimen, despite COVID being contagious regardless of your HIV status. This discrepancy potentially gives rise to mistrust, which in turn could hamper a future pandemic response. Fellow Americans should never experience this treatment.

On one hand, should another pandemic event happen in the near future, it may not be mistrust of the actual science behind the vaccine that might drive hesitancy, but remembering how one was treated when they tried to access care. Depending on one's lifestyles, they may fear being shunned for treatment once more because they may reason that if they were treated one way in a previous pandemic, they may not be prioritized for care at another pandemic. This is in stark contrast to vaccine uptake on the other side of the coin- those who are hesitant because they don't trust the science. In both situations, an increased level of trust, either to give a vaccine, or to build confidence in the vaccine so they can decide to get vaccinated, is important.

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On the preparation side, Dr. Cummings talked about the importance of using the information we learned from the pandemic to prepare for addressing future pathogens. However, he also emphasized that building trust, from the perspective of those on the response side, is key to efficiently facilitating the response to the pandemic, echoing the public comment from the previous section to work with advocates in the civil sector. It is the same strategy that I wish to offer up to the Council in this commentary, not just based on my own personal advocacy, but also the experiences I've learned from other advocates in the field, and what others have said such as through live public commentary to other health leaders around the world.

Dr. Judith Green argued for the better utilization of science information, something that could have been better done during the COVID pandemic. Dr. Green talked about mobilizing the right information at the right place at the right time to deal with pandemics. Obviously, timely information is important in any pandemic situation.

More importantly, Dr. Green also mentioned that in dealing with pandemics, not only is knowing what tools to use and how to respond to a pathogen is important, but also knowledge from the public itself as well knowledge of the "publics" you're responding to. On the response side (agencies, health leaders, etc.), we know the science works. On the layman side, the public, not everyone has an advanced degree in microbiology, so it's understandable why there's a lack of trust.

The discrepancy between the gaps in the low vaccine rates we see today and the vaccine rates we hope to be seeing are a direct result of this disconnect. There's no middleman to serve as a trusted agent or trusted messenger between the response side and the receiving side. This doesn't just apply to the COVID boosters, but virtually all vaccines- the flu, RSV, measles and so many others, too long to list here.

To say that public trust has eroded in our national health system is an understatement. But what is our response to our dismal pandemic response? Will we continue that downward spiral, or will we change course, do a one-eighty and build a better foundation to address the next pandemic? I am hoping the latter, so that is why I'm putting forth this much effort to help advise this administration, and subsequent presidential administrations, to be better prepared for handling the next pandemic.

Next, Dr. Sarah Kapnick talked about compound risks with regards to climate. Before I elaborate on my commentary, I would just like to note that we literally saw the hottest year on record last year, 2023. Despite Dr. Kapnick's presentation dealing more with climate, there's some applicable wisdom we can gain from it.

For example, Dr. Kapnick echoed the ideas mentioned earlier by Dr. Cummings about the effects of climate on national health when she presented how drier weather means an increase in cases of Valley Fever. If something remotely related to national health can affect national health, imagine what multiple health concerns can do.

While climate isn't the focus of my commentary, it is a prior point to this example that Dr. Kapnick mentioned that is relevant to my experiences as an advocate- the need for constant monitoring- because small changes matter too. This is applicable to our current "vaccine climate", as the uptake is low while the spread of disease is high. We want to swing the pendulum in a way that fixes our vaccine climate by getting vaccine rates up while mitigating disease spread.

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What is the best course of action? It is to build up trust. There's a correlation between vaccine levels and trust levels. The more investment in trusted messaging, the higher the vaccine rate will likely be. Right now, there's hardly any investment at all. I believe trusted messaging can be seen as a form of chronic disease prevention, as mentioned by Dr. Woteki in the first section of March's PCAST. Just as there are few programs that focus on disease prevention, there's also less focus on investing in trusted messenger efforts today. It is no accident that vaccine rates remain low.

Just like there's interconnectedness between climate and health risks, so too is there interconnectedness between the public's trust in vaccines with how much we invest in health advocates today. When we invest in trusted messengers, we can prevent the most disease. Adaptation is the equivalent to trusted messaging in this regard.

Dr. Kapnick's last point showed how the funding to address climate concerns is broken down, including in increase in adaptation to a changing climate. This is what we should be doing with regards to the current vaccine problem- shift some finances into investing in trusted messaging. What funding adaptation efforts does for climate change should be what trusted messaging does for vaccine rates- it will produce a positive change. By managing adaptation well to address disease, you can use timely information, work with local communities and address inequities in our health system.

Finally, Dr. Nick Pidgeon talks about the various factors that come into play when addressing issues of national importance, including complexities brought about by the human element, our perceptions of the situation, how much control we see in addressing the situation, and finally what we learn from the ordeal.

What I wanted to convey to the Council is that there is always room for improvement, but improvement isn't always an open window of time where we can do it at any time. For immediate situations needing an immediate response, such as we saw in the COVID pandemic, timely moves to improve should be done as quickly as possible- in days to weeks. Rather than go through each point mentioned by Dr. Pidgeon separately, I will show how each worked during the pandemic.

When we saw that the pandemic was quickly becoming more complex, we knew we needed a solution quickly- vaccines became available to those 16 years of age or older (complexity of COVID). However, we knew that children were also deserving of vaccine protection, so we recognized that the situation would only improve if we got as many people vaccinated across the population, regardless of age (perception of the situation). We then pivoted to gradually include more and more people as vaccines started getting approved for younger age groups, thinking that now, the pandemic would subside soon since we had tools to vaccinate with (appearance of control).

However, we learned that the pandemic wasn't a sprint but a marathon, which meant that any gains to fight COVID needed to be sustained, as a booster is needed to be taken after some time due to waning protection from earlier vaccinations and the constantly changing nature of COVID variants (learning from hindsight).

Where we're in in that multi-level framework of considerations depends on your view point. For some, who never acknowledged the pandemic to begin with, they either never entered anywhere into the cycle or jumped straight to perception- i.e. there's either no pandemic or this is just a mild illness and not that severe. Depending on what happened further, if they were sick longer, they immediately saw that they didn't have control of the situation and hopefully learned the error of their ways and sought to get



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vaccinated. In this case, where a person was saved because they chose to get vaccinated, is what we should strive to aim for in preparation for the next pandemic.

Dr. Pidgeon also brings up several points that fit in throughout the process, where shifting course becomes an option, and also offered several important points within his point of perception. He also points to Dr. Green assessment from earlier about there being multiple publics, supporting his idea that the idea of a global public is a complex concept, each in need of the relevant response to address the relevant issue at hand. This goes to Dr. Pidgeon's next point about building trust so that confidence (in the science and vaccines) is not undermined. In his closing point within the page, Dr. Pidgeon also mentions the need to remain flexible, as complex challenges can sometimes need variable response, or a changing response if previous responses don't work well. This could be seen in the response to the pandemic.

As we recognized that COVID was the pandemic that we later learned that it was, we were flexible in addressing the contagious pathogen, knowing that we would be expanding coverage to cover as many of the people as possible. We were managing the pandemic, and when we saw what wasn't working, there were times when strategy change was necessary. This included working to some extent with trusted messaging efforts and opening more lines from to public during government leader meetings. Finally, we corrected where we could, based on the information we had on hand. This follows the concept of resiliency to adaptability that Dr. Pidgeon mentioned.

To apply this now to a post-PHE world, how resilient we are to adaptability today will depend on how you see the response to be. Rather than present what I heavily lean to, I want to provide both examples because lessons can be learned from both views.

On one hand, resiliency to adaptability seems strong- we haven't reactivated the PHE or called for something similar. COVID guidelines have been relaxed and you hardly see COVID mentioned today. One look from someone who was never familiar with the pandemic to begin with may see this as, "Yes, we are resilient to adaptability, as our course of actions had resulted in us being a better place than in early 2020."

However, on the other hand, one could also argue that we aren't as resilient. Although we are no longer in a pandemic situation, one can say that we didn't learn- the pandemic went away on its own, but rather than dealing with a severe COVID pathogen, it was simply replaced by pre-existing diseases we already have vaccines to, i.e. polio, the flu, RSV, measles, etc. One could also say it's been replaced by diseases we don't have vaccines for in the United States, such as tuberculosis (TB). In this manner, we have not been resilient. As a result, we haven't learned anything during COVID, and are instead, living in a less severe form of pandemic known as an era of "low vaccine rates", with vaccine being defined as any vaccine tool we have that prevents any vaccine-preventable disease. Low rates are defined as our current status.

To sum up all that has been said by the presenters at March's meeting, one key commonality that all had mentioned was the factor of trust, as mentioned by Dr. Pacala. Whether presenters spoke about pandemics, publics, precipitation or perception of the world around them, the common factor around it all was trust. How one addresses their health needs (and/or that of those close to them), how they interact with those outside their private network(public), how they react to the science telling them about climate(precipitation) and how they perceive reality around them (their perception), is based on who they trust (the messenger they believe). If they trust the messenger, the messenger's message, and therefore the one who sent the messenger, will be able to convince the message receiver to adapt to the new information (COVID guidelines). If not, then the effort will fail. This all has to do with building a foundation

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of trust at the local level, nationwide, on a continuous basis. How we address future pandemics depends largely on what we're doing today (investment).

In the closing statements by the Council for Science and Technology's Dr. John Browne mentioned the importance of collaborative efforts on a global scale, as we've often heavily relied on our partners from the United Kingdom when we were planning strategies around COVID mitigation, as their cold season months often reflected or paralleled similar experiences to our own at the height of the pandemic. Dr. Browne again echoed the importance of adaptability on global concerns, as mentioned by Dr. Kapnick earlier. Dr. Browne goes further by stating that that will likely occur through finance, implying that the success of adaptability will depend on how much we invest in trusted messaging to facilitate adaptation to changing situations (see above).

Second, regardless of where there is a situation in need of a response, the large-scale responses will have consequences for both global and local levels, but especially so for the latter. I believe that in order for large scale changes like increasing vaccination rates at the national level to occur, we have to start at the locally, work with trusted entities on the ground and build our way up, rather than operate from the top down.

Dr. Browne's third observation was better communication of risks. This was something that saw mixed messages during the pandemic, and seems to continue even today, as now, vaccines seem to be more of an optional thing rather than something that protects individuals, communities and the global society, on a full-time basis.

Finally, learning needs to occur. Too often we forget lessons of the past, only to repeat them again in the future. This is unacceptable when so much is at stake.

I want to emphasize again that all the presenters mentioned that trust is important. I also want to reiterate many presenters also mentioned the importance of better interagency collaboration. I agree there needs to be more joint agency efforts, particularly where health is concerned. By the same token, there has to be better intercommunication efforts between the responders and those being responded to. Sometimes, a middleman is necessary to facilitate dialogue by making those being responded to receptive of a message from responders through someone they trust.

This concludes my assessment of disease and climate concerns from PCAST's meeting in March. The following section will look at the importance of research in the work PCAST is doing, and continued importance that research from reputable sources brings with regard to addressing modern health issues.

Research is an important facet of any campaign, whether that be decisions on the local scale to best decide how to construct a roadway that connects the town to other nearby cities to finding the best medical strategy to distribute vaccines to address the next pandemic threat. Knowing how to respond is as important as knowing what problem is being responded to, and later, how you reach out to those being affected.

Prior to graduating college, I participated in a summer research study that looked at the effects of low socioeconomic status when it came to addressing the needs of migrant populations, so I can understand and appreciate the importance of research when discussing any topic of significance. Advocacy is almost no different, except the information I share could have life-altering consequences for those willing to listen.

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Because I will already be looking at A.I. during the public comment, I will focus on the ethics from the human perspective instead, so much of this commentary covers last month's PCAST meeting.

When I started this written comment, I mentioned the potentials of science, how it can be used for bad and good purposes. In the same way, the tools of science can be misused if there are opportunities for doing so. Errors in research can be as neglectful as not checking the parameters of the measurements being made (the right container, the right laboratory conditions, the right materials, etc.) to the more nefarious, such as substituting flawed or incorrect data with fake information to achieve a desired narrative, such as additional funding for additional studies or improve one's prestige in the field. Obviously, there's limitations in technology to counter such fraud. In this case, the human element will still be needed to determine the veracity of findings.

In a similar manner, trust is important in the devices we use because of the consequences they have for people today. For example, during the pandemic, social media was an unchecked platform that was free of medical authority scrutiny. Very little efforts by the platforms were done to self-police the soundness of posts. This made the proliferation of misinformation and disinformation rampant on the world wide web, leading some to not always choose the best decisions for their health.

Before I go further, I want to make a distinction between misinformation and disinformation. Misinformation is putting information out there that one thinks may help others because they falsely believe, through their lack of knowledge, that it helps. Disinformation, however, according to the World Health organization, is far worse and often done intentionally, as it is a disservice to true information and the public.

With the advancements in technology, particularly that of A.I., the threat of distributing false information becomes even more of a danger, and a threat to their network the more believable the poster is. During the pandemic, much of my vaccine allies looked at the many kinds of disinformation we have on social media. These weren't by people who simply didn't know any better. They wanted to cater to a certain type of audience, so it was crucial to distinguish between fake information and relevant information that helps our advocacy. We did this by working closely with our research partners who have years of experience in the scientific community.

With the arrival of A.I., this now becomes complicated because even the average person can easily create data, make the data seem real and reputable, then share that fake data as disinformation. Unsuspecting people who then may know the person but not know that the material is not correct may then share it from the latter's perspective, as misinformation, not knowing that it does nothing to help. This is one concern to address when incorporating next technology to aid groups working with the federal government. In a world of rampantly evolving technology, this is an all-too real scenario. Often, the safeguards for this would be manual review by experts.

Near the conclusion of the meeting, A.I. is counterbalanced by checks and balances, with the first being by Dr. Terence Tao, who argued that it needs to be paired with verification tools. In a similar note, Dr. Laura Greene notes that humans need to be involved every step of the way. I concur with these recommendations.

Outside of research endeavors, technology obviously has its uses. In the public comment by Dr. Brien Seely, drones, for example, can do a much more efficient, effective job severalfold times better than

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human efforts to combat climate disasters, such as the example fire scenario. However, even before such measures can be taken, humans will still have to set this up, as drones are only able to be used for the purposes they are made for if they are programmed by human handlers.

The obvious concern with working with technology now is who is behind those technologies. Your tech, and therefore any data from it, is only as reputable as the people behind those efforts. If there's any dishonesty or negligence in any step between the concept and the final product, it will mess up the entire process, and the desired ends will likely not be reached. Any new technology, whether completely automated or partially, will always require human hands to operate efficiently.

This concludes my comment on research and technology concerns from PCAST's meeting from last month. The rest of my commentary will be concluding remarks on the recent discussions from PCAST's previous meetings.

People are living in a very uncertain world these days. Communities are getting less healthier, with few government programs that focus on disease prevention. Pandemics can occur with other health concerns, such as when MPOX occurred during COVID, or health concerns can occur and be exacerbated by climate change, such as Valley Fever, in a continually warming world. These uncertainties are compounded by newer technology, which at best is subject to negligence or at worst handled by untrustworthy individuals. Trust is at an all-time low while anxiety is at an all-time high. We need to invest more in trust, and I literally want to help with this effort.

Solutions can only happen through dialogue, and later, action. But dialogue can only happen if one side willing to communicate with the other. I have been working as a speaker, vaccine advocate and trusted messenger since the beginning of the global COVID pandemic, working with a vast network of other health advocates. It is not too late to change course and build back trust. The Council and the Administration has my email, and my lines of communication are always open. Thank you.

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### Section 2: Gregory Spaulding

Written: 6/16/2024

Subject: The international electromagnetics community accepts MEAMOMU, but not one US Government "Scientist" understands MEAMOMU

Dr. Prabhakar; Dr. Arvisu; Dr. Greene:

MEAMOMU renewable power source is being suppressed by the US government by being ignored (not acknowledged or promoted) and by not being funded, only solar, hydrogen, lithium battery alternative, and fusion are getting funding.

<https://duckduckgo.com/?q=%2BMEAMOMU&va=e&t=hq&ia=web>  
<https://www.perplexity.ai/search/MEAMOMU-iHUFio1vSkOJHBVAVoxWng>

Magnetic Energy Automaton Mechanical Oscillator for Multiple Uses

Gregory Spaulding

Magnetic Voltage Source  
greg.spau@protonmail.com

#### EXECUTIVE SUMMARY

Prof. Laithwaite proved steel can coupler two same polarity linear magnets.  
Prof. Laithwaite proved if you divert at least one of the four coupled flux polarities both magnets are uncoupled and repel.  
General Electric Excursions in Science #2 proved magnets with equal flux attractive pull strength can push or pull an object into either ones flux path including Pyrolytic Carbon.  
UCLA lectures proved Pyrolytic Carbon and Bismuth repels both magnetic flux polarities.

Sincerely,

Greg  
Sent with Proton Mail secure email.

*Attached Magnetic Voltage Source\_CP Notification Letter*

June 11, 2024

Gregory Spaulding  
Magnetic Voltage Source  
greg.spau@protonmail.com

**SUBJECT:** Funding Opportunity Announcement Number DE-FOA-0003214, “Bipartisan Infrastructure Law (BIL) – Joint Office of Energy and Transportation: Communities Taking Charge Accelerator, Fiscal Year 2024 Funding Opportunity Announcement”

Project Title: Magnetic Energy Automaton Mechanical Oscillator for Multiple Uses

Control Number: 3214-1511

Dear Gregory Spaulding:

Thank you for your concept paper submitted in response to the subject Funding Opportunity Announcement (FOA). The Department of Energy (DOE) recognizes the significant effort your organization expended to prepare an initial response to this announcement. Your concept paper was carefully reviewed in accordance with the concept paper evaluation criteria in the FOA. The results of your concept paper review are as follows:

     **Encouraged to Submit a Full Application**

Receiving a letter of encouragement is not a guarantee that an application will be selected for negotiations leading to award.

  **X**   **Discouraged from Submitting a Full Application**

     The Concept Paper did not adequately describe the proposed technology, project, or goal.

     The Concept Paper did not adequately establish how the proposed technology or project is unique and innovative.

  **X**   The Concept Paper did not adequately describe how the proposed technology will overcome shortcomings in the current state of the art.

     The Concept Paper did not sufficiently outline the risks and challenges or possible mitigation strategies.

     The Concept Paper did not adequately demonstrate that EERE funding would have meaningful impact on the proposed project, that the proposed project would have a meaningful impact on the relevant field and application or that the proposed project would have a meaningful impact on the problem described in the FOA topic.

- It is not clear from the Concept Paper that the team has sufficient qualifications, experience, or capabilities to successfully execute the proposed project.
- The Concept Paper did not adequately demonstrate that the Applicant has adequate access or adequate plan to obtain access to equipment and facilities necessary to complete the proposed project.
- The proposed concept/technology appears to be outside the scope of the FOA.
- The Concept Paper appears to be submitted to the wrong FOA or FOA topic.
- The proposed concept or project approach appears identical to or similar to those already being investigated through current or recent DOE projects.
- The Concept Paper did not adequately describe how the project will accomplish its goal.
- The proposed approach does not appear to be technically or logistically feasible.
- The proposed project did not meet the requirements of the FOA topic.
- There are concerns with:

Receipt of a discouragement notification regarding your concept paper does not prohibit your organization from submitting a full application in accordance with the instructions and requirements contained within the FOA.

Applicants who choose to move forward with a full application may want to visit <https://driveelectric.gov/communities-taking-charge> for first-time applicant resources as well as additional information.

This letter comprises the sole debriefing the DOE will provide with regards to your Concept Paper.

Full Applications must be received in the EERE EXCHANGE system no later than the date and time specified in the FOA. Please refer to the FOA at <https://eere-exchange.energy.gov/> for further information regarding submission of a full application.

On behalf of the DOE, I would like to express our appreciation for your interest in the Joint Office of Energy and Transportation and our FOA. We look forward to your continued interest and participation in future programs sponsored by the Office of Energy Efficiency and Renewable Energy (EERE).



**NATIONAL ENERGY TECHNOLOGY LABORATORY**

Albany, OR | Morgantown, WV | Pittsburgh, PA



Sincerely,

*Amy Falcon*

Amy Falcon  
Merit Review Committee Executive Co-Chairperson



**WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST**

Section 3: Scott Kilroy

Written: 5/23/2024

Date: 05/23/2024 1:12 AM PDT

- > Subject: notes from AMS phone call .....also adding U.S. Congress and much additional CC's in e-mail
- > SECURITY WARNING: (UPDATE: 8/16/2023 security markings)
- > SECURITY WARNING: Please secure all our communications.
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- > SECURITY WARNING: If you are not sure if you have security technology on you, request in writing, and go in person to request, with ALL FOUR: ALL U.S. House & Senate Intelligence Committee Members, the NSA, (ODNI)Office of the Director of National Intelligence, and FBI. Request security procedures to verify. Secondly, NAFTA, NATO, and the United Nations might be able to verify. International information exchange does likely occur dealing with these additional organizations. I recommend requesting in writing, and going in person to request, with ALL FOUR plus ALL ADDITIONAL INTELLIGENCE AGENCIES(ALL U.S. House & Senate Intelligence Committee Members, the NSA, (ODNI)Office of the Director of National Intelligence, and FBI, + [see [www.dni.gov](http://www.dni.gov) for updates] Air Force Intelligence, Department of the Treasury, Army Intelligence, Drug Enforcement Administration, Central Intelligence Agency, Federal Bureau of Investigation, Coast Guard Intelligence, Marine Corps Intelligence, Defense Intelligence Agency, National Geospatial-Intelligence Agency, Department of Energy, National Reconnaissance Office, Department of Homeland Security, National Security Agency, Department of State, Navy Intelligence
- > ) before International information exchange does occur.
- > SECURITY WARNING: Please check for conflict in authority with BOTH the NSA and the Director of National Intelligence. They control the networks this information goes over.
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- > SECURITY WARNING: I have complaints about the NSA. If you are controlled or influenced by NSA security technology this is a conflict while reviewing NSA procedures. Please make arrangements to validate otherwise, during the whole time period, of any National Security abuse complaint review.
- > \*\*\*\*\*INCLUDING\*\*\*\*\*
- >
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- >
- > Lauren,
- > [Staff of Aux. Bishop Coffee]
- > Aux. Bishop Coffee,
- > All needed priests and staff at the Archdiocese for the U.S. Military Services, USA;
- >
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- >

**WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST**

> (quickly typed.....)

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>  
>

> EMAIL & MORE SECURE PAPER COPY DELIVERY

> =====

> I enjoyed our phone call. Yes, please confirm my e-mails, from my various e-mail addresses, are getting through to Archbishop Broglio[absecretary@milarch.org], the AMS Vicar General[vicargeneral@milarch.org], and AMS Aux. Bishop Coffee[joseph.coffee@usmc.mil].

"skilroy@notabortive.com" ; "scott8926@aol.com" ; "skilroy@outlook.com" ;

"s@stpeterssoftware.com" ; "skilroy@gmail.com". Networks are generally insecure, and individual-via-individual paper copy(non-digital) delivery at a regular interval is better security. Any Roman Catholic Chaplains I could give paper letters to in Southern California to delivery to Archbishop Broglio and appropriate AMS offices?

>  
>  
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>

> BIG E-MAILS & PHONE CALLS

> =====

> Please note I e-mail the U.S. House and Senate Intelligence Committee's on almost all of my communications. Also, I have a long security mark to add at the top of my e-mail. Since there is concern about communications going through, we likely should coordinate via phone also[714 486 1282 office; 714 936 5379 wireless]. I also already e-mailed about this concern to the U.S. House and Senate intelligence Committee's and additional.

>  
>  
>  
>

> PHONE CALL NOTES[5/22/2024 today]

> =====

> Major topics mentioned in our earlier conversation today[5/22/2024 at approximately 3:45pm Eastern time]. Much more technology released to be commercialized than I am mentioning in this e-mail. Example: newer (AI)artificial intelligence, and wireless biomedical technology. Example: the entire area of applied physics field theory is allowed to be rather broadly applied in application.

>  
>

> + Pope Francis hopefully will approve the creation of a public formal engineering design of AI software[AI software; AI hardware; AI dataset]. Roman Catholic priests should control this at the Vatican to give better security. I'm told the Pope possibly should license these standards to keep control on this technology[AI software; AI hardware; AI dataset]. I'm told people could at least possibly be sued if they don't comply, and we attempt to avoid "bad Bible copies, in AI device equivalent". Roman Catholic priests delivering paper copy of AI transcripts upon request is recommended by the U.S. Military. Additionally on top of Vatican work, I am offering to put a company together to make an additional AI talking device[Pope AI Wireless Talking AI Keychain device]. Pope Francis might want to control the quality & security & additional, and make some, none, or all of these equivalent devices at the Vatican. Security is particularly important with AI devices and an obvious target historically. Public networks are

## WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

particularly insecure. READ-ONLY handheld devices is recommended by the U.S Military. Labeling clearly "less secure", any wireless network use, audibly and visually during use is recommended. A physical switch to turn off and on wireless use is recommended also.

>

>

> NotAbortive Catholic Solutions is the future company name I have been speculatively using.

>

>

> +Cardinal tours are being offered of the advanced physics "step across transport" system in historical release to be commercialized. Particle interaction being adjusted is shocking to most people visually. People will possibly have religious questions after seeing these devices work. I'm told advancing travel time rates strongly pushes pro-life in U.S. Military numbers, and likely globally. "Space bending" is what this looks like visually, or bringing objects closer. Hopefully the Pope approves soon.

>

>

> +Newer lower cost medical sensor booths based on neuroscience[neurotransmitters visualized; also with blood flow visual mapping; muscle position visualization; additional ] are in release. Archbishop Broglio will likely want them at various convenient locations is my guess. Hopefully the Pope approves soon. I'm told various Catholic social teachings are made much easier to explain.

>

>

> Example: "Nobody is born homosexual" can be visually demonstrated. Heterosexual arousal can be visually demonstrated on a digital screen with everyone except those with medical problem exceptions. [ Dopamine from eyes emitted upon appropriate visual symmetrical lines -> increased blood flow if no countering(epinephrine; other vasoconstrictor; other...these all could be visually shown on screen) -> visual showing this in real-time on a screen

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> Example: homeless pastoral care giving a priest quick medical answers

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> Example: Catholic marriage classes using to explain (NFP)natural family planning

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> God bless,

> Scott

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**WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST**

- >
- >
- >
- > ---
- > ---
- > Scott Kilroy
- > CEO & President
- > NotAbortive Catholic Solutions (looking to incorporate): Biomedical technology & more
- > phone(temp): (714) 486 1282
- > office: Looking in Santa Ana, CA.
- > <http://www.notabortive.com> (><http://www.notabortive.com/><) (in construction)
- > "How to justify God."
- > -----
- > First Mover Argument: The first way is by considering motion in
- > the world. Where there is motion, there is a mover and ultimately a
- > first mover, itself unmoved. This is God."
- > ----"A Tour of the Summa"

## WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

### Section 4: Scott Kilroy

Written: 5/15/2024

Date: 05/15/2024 5:24 AM PDT

Subject: FW: [ADDITIONAL EMAILED]Re: AI meeting notes ..... the Vatican needs AI with weigh through

SECURITY WARNING: (UPDATE: 8/16/2023 security markings)

> SECURITY WARNING: Please secure all our communications.

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> ) before International information exchange does occur.

> SECURITY WARNING: Please check for conflict in authority with BOTH the NSA and the Director of National Intelligence. They control the networks this information goes over.

> SECURITY WARNING: Please check for conflict in authority with BOTH the NSA and the Director of National Intelligence. If you are controlled or influenced by security technology this is a conflict while reviewing security procedures. Please make arrangements to validate otherwise, during the whole time period, of any National Security abuse complaint review.

> SECURITY WARNING: I have complaints about the NSA. If you are controlled or influenced by NSA security technology this is a conflict while reviewing NSA procedures. Please make arrangements to validate otherwise, during the whole time period, of any National Security abuse complaint review.

> \*\*\*\*\*INCLUDING\*\*\*\*\*

>

> \*\*\*ADDITIONAL OF LISTED E-MAILED WHEN A.I. ALLOWS\*\*\*

>

> NOTE: \*\*\*\*Roman Catholic Vatican Pontifical Academy of Sciences

> NOTE: \*\*\*\*U.S. House & Senate Intelligence Committee Members( Feinstein[Staff R.W, Scheduling,Peter], Sen. Burr[Staff Janet, Garth ], Ranking Member Rep. Turner[Howard,M.C.], Rep. Garcia[Turner,Navarro,Brown,G.H.] Sen. King[Scheduler],Sen.Collins[Scheduling], , Sen. Cotton[Schedule\_Request], Vice Chairman Sen. Rubio[casework,scheduling]), Chairman Sen. Warner[R.C],Sen. Risch[Renee R.] .....OLD MEMBERS: , Sen. Lankford[Office], Previous Chairman Rep. Schiff[Staff Peifer,Oinuma,Elizabeth], (Retired Ranking Member Rep. Nunes[Langer]),

>

> NOTE: \*\*\*\*\* (additional Representatives) Rep. Calvert[Staff Murphy, Lansing], Rep. Issa[veronica,lenna,walker,jonathan,tyler], Rep. Jeffries[Tasia,Lenderman], Rep. Obernolte[ Lorissa, Seth, Hayden ]..... OLD MEMBERS & PREVIOUS STAFF: Rep. Hunter[Staff Hough,Michael H.],

## WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

Rep.Calvert[Jose], Rep. Campbell[Staff Palmer(Rep. is retired and not cc'd)], Rep. Cook[Staff Wessell,Higgins], Rep. Lowenthal[Staff Hysom], Ryan[Steil,Clark,Katie,T.W.],

- > NOTE: \*\*\*\*Office of the Director of National Intelligence
- > NOTE: \*\*\*\*White House --Vice President
- > NOTE: \*\*\*\*White House -- President
- > NOTE: \*\*\*\* U.S. Senate Armed Services Committee Member( Sen. Cruz, Sen. Hirono, Sen. Cotton)....

OLD MEMBERS: Sen. McCain[Julie,casework],

- > NOTE: \*\*\*\* U.S. House Armed Services Committee Member(, Rep. Cook[Dakota, merlene]) ..... OLD MEMBERS: Rep. Hunter[holly,Michael h,wes]
- > NOTE: \*\*\*\*\* ALL U.S. Senate Members\*\*\*\*\*
- > NOTE: \*\*\*\*\*ALL U.S. House of Representative Members\*\*\*\*\*
- > NOTE: \*\*\*\*\*ALL U.S. Supreme Court Members \*\*\*\*\*
- > NOTE: \*\*\*\*\*STATE COURTS – CALIFORNIA: CA Supreme Court(Invitations, C.C., laura.speed),Orange County(( Presiding Judge Kirk H. Nakamura via.
- > Executive Assistant Leslie Hernandez (previously Catalina Rogers) ; Presiding Judge Magines via Executive Assistant Leslie Hernandez (previously Catalina Rogers) ; HR Staffing), ....OLDER JUDGES: Presiding Judge Borris(Staff G. Sukumar);
- > Los Angeles(Law Clerk Office; Temporary Judges Program)
- >
- > NOTE: \*\*\*\*\*CA STATE ASSEMBLY: Asm. Rendon(Lawrence), .....OLD MEMBERS: Asm. Allen(Patrascu)
- > NOTE: \*\*\*\*\*CA STATE SENATE: Sen. Wilk, Sen. Grove ....OLD MEMBERS: Sen. Huff
- > NOTE: \*\*\*\*\*Department of Homeland Security Secretary Office;NOTE: \*\*\*\*\* Department of Homeland Security Secretary Alejandro Mayorkas
- > NOTE: \*\*\*\*\*National Security Administration/Central Security Service IST Office
- >
- > NOTE \*\*\*\*\*Commander, U.S. Cyber Command Director, National Security Agency Chief, Central Security Service Nakasone
- >
- > NOTE: \*\*\*\*\*Commander, U.S. Cyber Command Director, National Security Agency Chief, Central Security Service (Retired) Rogers
- > NOTE: \*\*\*\*\*Commander, U.S. Cyber Command Director, National Security Agency Chief, Central Security Service (Retired)Alexander
- > NOTE: \*\*\*\*\*Defense Advanced Research Project Agency: Public Release Center
- > NOTE: \*\*\*\*\* University of Notre Dame -- President Rev. Jenkins
- > NOTE: \*\*\*\*\*Boeing [K. Barry,supplierperformance]
- > NOTE: \*\*\*\*\*AT&T [J. Heffernan]
- > NOTE: \*\*\*\*\*Military Health System
- > NOTE: \*\*\*\*\*DISA -- Defense Information System Agency
- > NOTE: \*\*\*\*\*NIH -- National Institute of Health
- > NOTE: \*\*\*\*\*FDA -- CDRH -- Center for Devices and Radiological HealthNOTE: \*\*\*\*\*Health and Human Services Secretary Xavier Becerra,
- > NOTE: \*\*\*\*\*CIA
- > NOTE: \*\*\*\*\*FBI

[Baltimore,Birmingham,Charlotte.public,chicago,fbi.dallas,lasvegas,miami,newyork,ny1,phoenix,san.diego,tampa.division,texas,washington.field,Brenda.Robinson,LauraEimiler]

- > NOTE: \*\*\*\*\*St. Joseph Health System
- > NOTE: \*\*\*\*\*STRATCOM
- > NOTE: \*\*\*\*\*Roman Catholic Archdiocese of the U.S. Military, Archbishop Broglio

## WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

- > NOTE: \*\*\*\*\*Navy Base San Diego, Chaplains Office, CA
- > NOTE: \*\*\*\*\*Navy Base, Seal Beach, CA
- > NOTE: \*\*\*\*\*Navy Base, Seal Beach/ detachment Norco, CA
- > NOTE: \*\*\*\*\*Air Force Base, Los Angeles, CA
- > NOTE: \*\*\*\*\*Air Force Base, Vandenberg, CA
- > NOTE: \*\*\*\*\*Air Force Base, Edwards, CA
- > NOTE: \*\*\*\*\*Air Force Base, Nellis, CA
- > NOTE: \*\*\*\*\*Marine Base, Pendleton, CA
- > NOTE: \*\*\*\*\*Air Force Base, Creech, NV
- > NOTE: \*\*\*\*\*Air Force Base, Beale, CA
- > NOTE: \*\*\*\*\*Marine Base, 29 Palms, CA
- > NOTE: \*\*\*\*\*U.S. Secret Service
- > NOTE: \*\*\*\*\*STATE COURTS – TEXAS: 'martha.newton@txcourts.gov'; HechtApps@txcourts.gov; JohnsonApps@txcourts.gov
- > NOTE: \*\*\*\*\*VARIOUS FEDERAL CIRCUIT COURT CONTACT E-MAIL ADDRESSES(Sue\_creech@ca5.uscourts.gov; Susan\_Goldberg@ca1.uscourts.gov; circuit\_library\_position@ca3.uscourts.gov; sao\_applications@ca2.uscourts.gov; Personnel@LB9.uscourts.gov; CA06-Library@ca6.uscourts.gov; CA06-Mediation@ca6.uscourts.gov; Dan\_Crafton@ca8.uscourts.gov)
- > NOTE: The Federal Judicial Center Foundation[M. Gross(Foundation Secretary), Personnel]
- > NOTE: \*\*\*\*\*RTX (previously Raytheon(Products,abilities))
- > NOTE: \*\*\*\*\*Northrop Grumman(issector.ebp, Peter)
- > NOTE: \*\*\*\*\*Honeywell(AeroTechSupport, HIPI, HRDirectSupport, Lois)
- > NOTE: \*\*\*\*\*Rockwell Collins(ClientSupport, CustomerService, Learnmore, Dennis)
- > NOTE: \*\*\*\*\*Lockheed Martin(Eric Ouellette, Bruce N.S.)
- > NOTE: \*\*\*\*\* (additional Representatives) Sen. Cruz[press,schuduling], Former Sen. Santorum[Info]
- > NOTE: \*\*\*\*\*Senate Minority Leader Sen. Schumer[DC\_Scheduling, Schumer\_Scheduling]
- > NOTE: \*\*\*\*\*Senate Majority Leader Sen. McConnell(Staff Member P.M.; Patrick F.)
- > NOTE: \*\*\*\*\*House Minority Leader Pelosi[americavoices,pelosi]
- > NOTE: \*\*\*\*\*U.S. House Speaker Rep. McCarthy[Kyle, Trevor]NOTE: \*\*\*\*\*CA Catholic Conference
- > NOTE: \*\*\*\*\*Sandia National Laboratory
- > NOTE: \*\*\*\*\*Office of Commercial Space Transportation [ hotline, ecf@nara.gov,Laura.Bachurski]
- > NOTE: \*\*\*\*\*U.S. Customs and Border Patrol [decals,gmb.cbpwcomailbox,lei.shen,procurement-ipop]
- >
- > NOTE: \*\*\*\*\*Secretary of Defense Lloyd Austin
- > NOTE: \*\*\*\*\*Secretary of Defense staffNOTE: \*\*\* \*\*Under Secretary of Defense for Acquisition and Sustainment, E. M. Lord,
- > NOTE: \*\*\*\*\*Frank Kendall, Former Under Secretary of Defense for Acquisition, Technology and Logistics
- > NOTE: \*\*\*\*\* Under Secretary of Defense for Research and Engineering, Dr. Michael Griffin
- >
- > NOTE: \*\*\*\*\*United States Joint Chiefs of Staff Chairman Milley
- > NOTE: \*\*\*\*\*ALL United States Joint Chiefs of Staff
- >
- >
- >
- >
- > NOTE: \*\*\*\*\*Order of Malta
- >

## WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

- >
- >
- > NOTE: \*\*\*\*\*United Nations
- > NOTE: \*\*\*\*\*NATO
- > NOTE: \*\*\*\*\*USMCA [previously NAFTA]
- > NOTE: \*\*\*\*\*NASA
- > NOTE: \*\*\*\*\*ESA European Space Agency
- >
- >
- > [PRESIDENT BIDEN AND VICE PRESIDENT HARRIS EMAILED VIA WHITE HOUSE (OSTP)OFFICE OF SCIENCE AND TECHNOLOGY POLICY]
- >
- > ---
- > ---
- > A.I. in control.....typically over insecure network channel.
- > ---
- > (Give to appropriate staff)
- >
- >
- > Pope Francis;
- > Vatican Pontifical Academy of Sciences;
- > Vatican Pontifical Academy of Social Sciences;
  
- > These are my notes from what Intelligence technology had me state at a University of Notre Dame (AI)artificial intelligence talk tonight by an ND professor:
- >
- >
- > Whose ethics should be used in AI?
- > =====
- > + Let's see what Pope Francis & Vatican Pontifical Academy of Sciences do with AI datasets. [SINGLE ENGINEERING DESIGN NEEDED AI HARDWARE/SOFTWARE/DATASET]
- > ++Weigh through in AI. The answer.
- > ++Value math in AI.
- > ++Value based datasets.
- > ++Empirical method based datasets.
- > ++Value based datasets through time period increments.
- >
- >
- > ++The eventual product of "Pope Wireless AI Talking Device" could use similar weigh through talk like the Catholic Church does. We can say what is sin and what kind.
- >
- >
- >
- > Additional (non-meeting extra comments)
- > =====
- > +Assumptions and definitions could be discussed with answers weighed through.
- > +AI that does research for you is what is intended with the eventual product "Pope Wireless AI Talking Device".



**WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST**

- >
- > God bless,
- > Scott
- 
- > ---
- > Scott Kilroy
- > CEO & President
- > NotAbortive Catholic Solutions (looking to incorporate): Biomedical technology & more
- > phone(temp): (714) 486 1282
- > office: Looking in Santa Ana, CA.
- > ><http://www.notabortive.com>< (in construction)
- > "How to justify God."
- > -----
- > First Mover Argument: The first way is by considering motion in
- > the world. Where there is motion, there is a mover and ultimately a
- > first mover, itself unmoved. This is God."
- > ----"A Tour of the Summa"

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\*\*\*\*\*INCLUDING\*\*\*\*\*

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**WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST**

NOTE: \*\*\*\*Roman Catholic Vatican Pontifical Academy of Sciences

NOTE: \*\*\*\*U.S. House & Senate Intelligence Committee Members( Feinstein[Staff R.W, Scheduling,Peter], Sen. Burr[Staff Janet, Garth ], Ranking Member Rep. Turner[Howard,M.C.], Rep. Garcia[Turner,Navarro,Brown,G.H.] Sen. King[Scheduler],Sen.Collins[Scheduling], , Sen. Cotton[Schedule\_Request], Vice Chairman Sen. Rubio[casework,scheduling]), Chairman Sen. Warner[R.C],Sen. Risch[Renee R.] .....OLD MEMBERS: , Sen. Lankford[Office], Previous Chairman Rep. Schiff[Staff Peifer,Oinuma,Elizabeth], (Retired Ranking Member Rep. Nunes[Langer]),

NOTE: \*\*\*\*\* (additional Representatives) Rep. Calvert[Staff Murphy, Lansing], Rep. Issa[veronica,lenna,walker,jonathan,tyler], Rep. Jeffries[Tasia,Lenderman], Rep. Obernolte[ Lorissa, Seth, Hayden ]..... OLD MEMBERS & PREVIOUS STAFF: Rep. Hunter[Staff Hough,Michael H.], Rep.Calvert[Jose], Rep. Campbell[Staff Palmer(Rep. is retired and not cc'd)], Rep. Cook[Staff Wessell,Higgins], Rep. Lowenthal[Staff Hysom], Ryan[Steil,Clark,Katie,T.W.],

NOTE: \*\*\*\*Office of the Director of National Intelligence

NOTE: \*\*\*\*White House --Vice President

NOTE: \*\*\*\*White House -- President

NOTE: \*\*\*\* U.S. Senate Armed Services Committee Member( Sen. Cruz, Sen. Hirono, Sen. Cotton).... OLD MEMBERS: Sen. McCain[Julie,casework],

NOTE: \*\*\*\* U.S. House Armed Services Committee Member(, Rep. Cook[Dakota, merlene]) ..... OLD MEMBERS: Rep. Hunter[holly,Michael h,wes]

NOTE: \*\*\*\*\* ALL U.S. Senate Members\*\*\*\*\*

NOTE: \*\*\*\*\*ALL U.S. House of Representative Members\*\*\*\*\*

NOTE: \*\*\*\*\*ALL U.S. Supreme Court Members \*\*\*\*\*

NOTE: \*\*\*\*\*STATE COURTS – CALIFORNIA: CA Supreme Court(Invitations, C.C., laura.speed),Orange County(( Presiding Judge Kirk H. Nakamura via.

Executive Assistant Leslie Hernandez (previously Catalina Rogers) ; Presiding Judge Magines via Executive Assistant Leslie Hernandez (previously Catalina Rogers) ; HR Staffing), ....OLDER JUDGES: Presiding Judge Borris(Staff G. Sukumar); Los Angeles(Law Clerk Office; Temporary Judges Program)

NOTE: \*\*\*\*\*CA STATE ASSEMBLY: Asm. Rendon(Lawrence), .....OLD MEMBERS: Asm. Allen(Patrascu)

NOTE: \*\*\*\*\*CA STATE SENATE: Sen. Wilk, Sen. Grove ....OLD MEMBERS: Sen. Huff

NOTE: \*\*\*\*\*Department of Homeland Security Secretary Office;NOTE: \*\*\*\*\* Department of Homeland Security Secretary Alejandro Mayorkas

NOTE: \*\*\*\*\*National Security Administration/Central Security Service IST Office

NOTE \*\*\*\*\*Commander, U.S. Cyber Command Director, National Security Agency Chief, Central Security Service Nakasone

NOTE: \*\*\*\*\*Commander, U.S. Cyber Command Director, National Security Agency Chief, Central Security Service (Retired) Rogers

NOTE: \*\*\*\*\*Commander, U.S. Cyber Command Director, National Security Agency Chief, Central Security Service (Retired)Alexander

NOTE: \*\*\*\*\*Defense Advanced Research Project Agency: Public Release Center

NOTE: \*\*\*\*\* University of Notre Dame -- President Rev. Jenkins

NOTE: \*\*\*\*\*Boeing [K. Barry,supplierperformance]

NOTE: \*\*\*\*\*AT&T [J. Heffernan]

## WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST

NOTE: \*\*\*\*\*Military Health System

NOTE: \*\*\*\*\*DISA -- Defense Information System Agency

NOTE: \*\*\*\*\*NIH -- National Institute of Health

NOTE: \*\*\*\*\*FDA -- CDRH -- Center for Devices and Radiological Health  
NOTE: \*\*\*\*\*Health and Human Services Secretary Xavier Becerra,

NOTE: \*\*\*\*\*CIA

NOTE: \*\*\*\*\*FBI

[Baltimore,Birmingham,Charlotte.public,chicago,fbi.dallas,lasvegas,miami,newyork,ny1,phoenix,san.diego,tampa.division,texas,washington.field,Brenda.Robinson,LauraEimiler]

NOTE: \*\*\*\*\*St. Joseph Health System

NOTE: \*\*\*\*\*STRATCOM

NOTE: \*\*\*\*\*Roman Catholic Archdiocese of the U.S. Military, Archbishop Broglio

NOTE: \*\*\*\*\*Navy Base San Diego, Chaplains Office, CA

NOTE: \*\*\*\*\*Navy Base, Seal Beach, CA

NOTE: \*\*\*\*\*Navy Base, Seal Beach/ detachment Norco, CA

NOTE: \*\*\*\*\*Air Force Base, Los Angeles, CA

NOTE: \*\*\*\*\*Air Force Base, Vandenberg, CA

NOTE: \*\*\*\*\*Air Force Base, Edwards, CA

NOTE: \*\*\*\*\*Air Force Base, Nellis, CA

NOTE: \*\*\*\*\*Marine Base, Pendleton, CA

NOTE: \*\*\*\*\*Air Force Base, Creech, NV

NOTE: \*\*\*\*\*Air Force Base, Beale, CA

NOTE: \*\*\*\*\*Marine Base, 29 Palms, CA

NOTE: \*\*\*\*\*U.S. Secret Service

NOTE: \*\*\*\*\*STATE COURTS – TEXAS: 'martha.newton@txcourts.gov'; HechtApps@txcourts.gov;  
JohnsonApps@txcourts.gov

NOTE: \*\*\*\*\*VARIOUS FEDERAL CIRCUIT COURT CONTACT E-MAIL

ADDRESSES(Sue\_creech@ca5.uscourts.gov; Susan\_Goldberg@ca1.uscourts.gov;  
circuit\_library\_position@ca3.uscourts.gov; sao\_applications@ca2.uscourts.gov;  
Personnel@LB9.uscourts.gov; CA06-Library@ca6.uscourts.gov; CA06-Mediation@ca6.uscourts.gov;  
Dan\_Crafton@ca8.uscourts.gov)

NOTE: The Federal Judicial Center Foundation[M. Gross(Foundation Secretary), Personnel]

NOTE: \*\*\*\*\*RTX (previously Raytheon(Products,abilities))

NOTE: \*\*\*\*\*Northrop Grumman(issector.ebp, Peter)

NOTE: \*\*\*\*\*Honeywell(AeroTechSupport, HIPI, HRDirectSupport, Lois)

NOTE: \*\*\*\*\*Rockwell Collins(ClientSupport, CustomerService, Learnmore, Dennis)

NOTE: \*\*\*\*\*Lockheed Martin(Eric Ouellette, Bruce N.S.)

NOTE: \*\*\*\*\* (additional Representatives) Sen. Cruz[press,schuduling], Former Sen. Santorum[Info]

NOTE: \*\*\*\*\*Senate Minority Leader Sen. Schumer[DC\_Scheduling, Schumer\_Scheduling]

NOTE: \*\*\*\*\*Senate Majority Leader Sen. McConnell(Staff Member P.M.; Patrick F.)

NOTE: \*\*\*\*\*House Minority Leader Pelosi[americavoices,pelosi]

NOTE: \*\*\*\*\*U.S. House Speaker Rep. McCarthy[Kyle, Trevor]NOTE: \*\*\*\*\*CA Catholic Conference

NOTE: \*\*\*\*\*Sandia National Laboratory

NOTE: \*\*\*\*\*Office of Commercial Space Transportation [ hotline, ecf@nara.gov,Laura.Bachurski]

NOTE: \*\*\*\*\*U.S. Customs and Border Patrol [decals,gmb.cbpcwcomailbox,lei.shen,procurement-ipop]

NOTE: \*\*\*\*\*Secretary of Defense Lloyd Austin

**WRITTEN PUBLIC COMMENTS SUBMITTED TO PCAST**

NOTE: \*\*\*\*\*Secretary of Defense staffNOTE: \*\*\* \*\*Under Secretary of Defense for Acquisition and Sustainment, E. M. Lord,

NOTE: \*\*\*\*\*Frank Kendall, Former Under Secretary of Defense for Acquisition, Technology and Logistics

NOTE: \*\*\*\*\* Under Secretary of Defense for Research and Engineering, Dr. Michael Griffin

NOTE: \*\*\*\*\*United States Joint Chiefs of Staff Chairman Milley

NOTE: \*\*\*\*\*ALL United States Joint Chiefs of Staff

NOTE: \*\*\*\*\*Order of Malta

NOTE: \*\*\*\*\*United Nations

NOTE: \*\*\*\*\*NATO

NOTE: \*\*\*\*\*USMCA [previously NAFTA]

NOTE: \*\*\*\*\*NASA

NOTE: \*\*\*\*\*ESA European Space Agency

[PRESIDENT BIDEN AND VICE PRESIDENT HARRIS EMAILED VIA WHITE HOUSE (OSTP)OFFICE OF SCIENCE AND TECHNOLOGY POLICY]

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A.I. in control.....typically over insecure network channel.

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(Give to appropriate staff)

[ADDITIONAL EMAILED]

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Scott Kilroy

CEO & President

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phone(temp): (714) 486 1282

office: Looking in Santa Ana, CA.

><http://www.notabortive.com>< (in construction)

"How to justify God."

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First Mover Argument: The first way is by considering motion in the world. Where there is motion, there is a mover and ultimately a first mover, itself unmoved. This is God."

----"A Tour of the Summa"