



# Google's Water Risk Framework

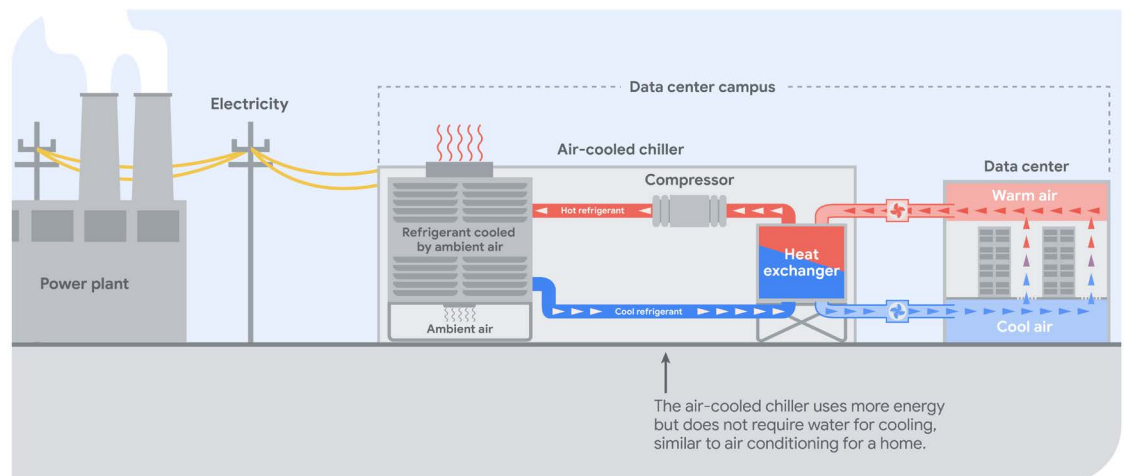
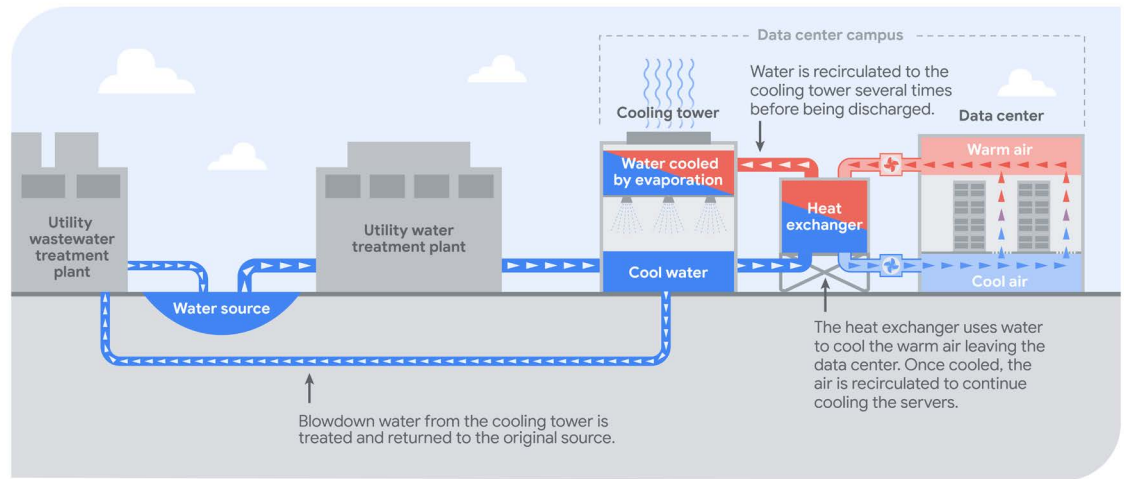
## Assessing watershed health in data center communities

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### Introduction

Data centers are the supercomputers that help power Google's latest innovations in artificial intelligence and the digital tools we use every day, like Search, Gmail, and Maps. Similar to personal computers, the servers in data centers generate heat and need to be cooled in order to operate safely and efficiently. Many of Google's data centers use water for evaporative cooling, which is often the most energy-efficient way to manage a data center's temperature. Other methods, such as air-cooled chillers, use little to no water, but, as a trade-off, consume more energy and typically have a higher carbon footprint.

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**Caption:** We use a climate-conscious approach to cool our data centers, evaluating the trade-off of using more energy-efficient evaporative cooling (top) vs. more energy-intensive air-cooled chillers (bottom).

In September 2021, Google announced our [water stewardship](#) strategy, which comprises three pillars: advancing responsible water use at Google, benefitting watersheds and communities where we operate, and supporting water security with technology. Core to this program is transparency, including the disclosure of data center water metrics in our Environmental Report. This complements our annual reporting on progress toward our 2030 goal to operate all data centers and office campuses on [24/7 carbon-free energy](#). Through these initiatives, Google aims to be a responsible steward of the natural resources that power its data centers while sharing the lessons we’re learning and the models we’re developing so that others can join us in building a sustainable future.



To select a locally appropriate cooling technology for new development, Google takes a [climate-conscious approach](#) — a multi-dimensional, data-driven strategy that considers local hydrology and water risk, geography, energy, and emissions factors. Based on these considerations and in consultation with local experts, we seek to identify a cooling solution for each site that is both responsible and resilient. Our cooling technology decisions look at the local environment — balancing the availability of carbon-free energy and responsibly sourced water — to minimize the net climate impact both today and in the future.

The “responsible use” of water differs from location to location. In watersheds with low scarcity risk, there is often ample water that can be used for cooling, enabling lower energy consumption, while in regions experiencing high scarcity risk, it may not be responsible to use significant volumes of freshwater for cooling.

In consultation with a team of water experts, Google has developed a peer-reviewed, context-based Water Risk Framework to define what responsible use means for its data center portfolio. For existing locations, we have utilized this framework to assess the level of water risk and identify opportunities for mitigation. For new locations, the framework will guide decision-making on whether to use a freshwater source such as a lake, river, or groundwater aquifer for cooling.<sup>1</sup> This structured approach evaluates conditions for responsible and resilient use of freshwater within a specific watershed, identifies different facets and levels of water risk to inform mitigation, and provides a mechanism to monitor risk throughout a data center life cycle.

Through this white paper, we aim to share what we’ve learned in the development of the Water Risk Framework and how we are applying it, as an example of how other industrial users might approach responsible water decisions for their own operations.

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<sup>1</sup> The framework does not apply to seawater.



## Developing a Water Risk Framework

When Google started assessing the water risk of its data center portfolio several years ago, we drew upon publicly available and commonly used tools such as the World Resources Institute's [Aqueduct Water Risk Atlas](#) and the World Wildlife Fund's [Water Risk Filter](#). We found that these global tools are valuable for high-level screening at the regional and basin levels; however, they are not intended to capture more granular detail about the availability of specific water sources or other relevant local context to support decisions like data center cooling design. For example, in some cases, the water supply for a site may be located in a different geographic basin than where the site is located. Or, the global tools might not reflect the water allocations of other users including communities and industries that also rely on the same shared water resources. We needed a framework that would allow us to evaluate water risk holistically, consider local issues, and determine how we can best operate our data centers within a community.

Google's Water Risk Framework defines key performance indicators (KPIs), including several related to climate trends drawn from global tools like Aqueduct and the Water Risk Filter. These KPIs evaluate each freshwater source for a specific data center site, with the goal of informing cooling technology selection and water risk mitigation using local information and insights.

The framework uses a two-tier approach – the first tier is a Responsible Use evaluation that captures the physical availability of water, today and in the future. For new data center capacity, this tier determines whether Google should consider using a freshwater source for evaporative cooling. If a source meets the Responsible Use threshold, it progresses to the second tier, a Composite Risk evaluation that covers a broad spectrum of five categories to identify areas for water risk mitigation. For each KPI in both tiers, a low, medium, or high risk score is assigned based on a calculated value or qualitative assessment. Based on the results of both tiers, each water source for a site is evaluated overall as low, medium, or high risk.



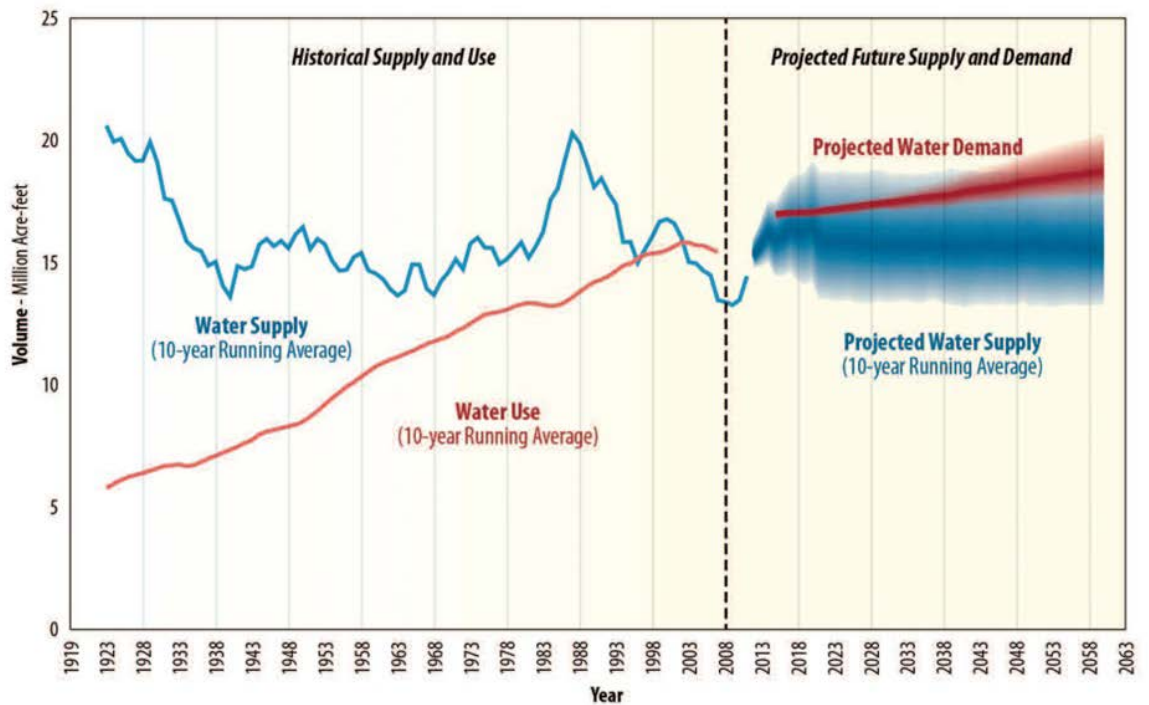
**Caption:** Google's Water Risk Framework uses a two-tier approach comprised of a Responsible Use evaluation and a Composite Risk evaluation.

## Responsible Use Evaluation

The Responsible Use evaluation is intended to mitigate the water risk of Google's data center portfolio by identifying water sources at high risk and avoiding the use of such sources for new buildings that have not already been designed. This evaluation comprises five KPIs across two risk categories: Water Scarcity and Water Depletion. If any of the five KPIs – current and future water scarcity, chronic and acute depletion, and curtailment – is high risk, then the water source overall would be considered at high risk, and Google would not utilize that freshwater source for evaporative-based cooling of new capacity. Instead, we would implement either alternative cooling technologies, such as air-cooling, or utilize available alternative water sources, such as reclaimed water.<sup>2</sup>




The Water Scarcity KPIs calculate the ratio of the total system demand for water – from the local community and Google's data center – to the available sustainable supply, measuring the current and future expected allocation of a water source. We use data sourced from utility and water district management plans, prioritizing sources that consider climate impacts. The future state is typically evaluated twenty to thirty years out.

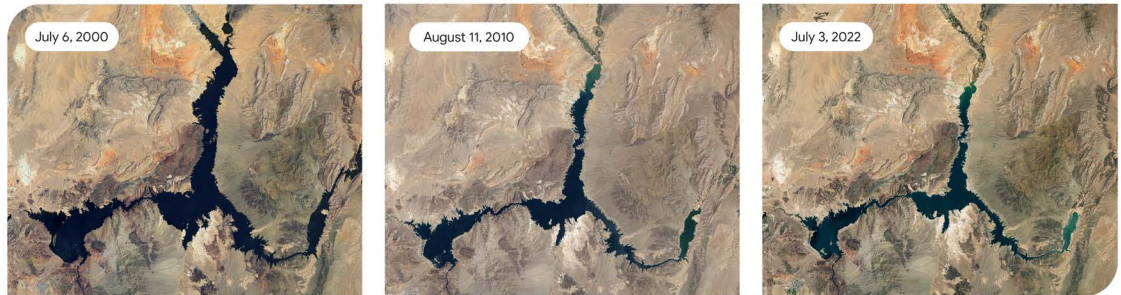
<sup>2</sup> Reclaimed water is wastewater effluent that has been treated to a standard sufficient for reuse.



**Caption:** An example of historical water supply and use and projected water supply and demand for the Colorado River Basin (Source: U.S. Bureau of Reclamation, [Colorado River Basin Water Supply and Demand Study Executive Summary](#))

While the ratio of demand to supply is a commonly used metric to assess water risk, Google’s Water Risk Framework includes new KPIs that reflect the current state of water-level decline within a source water body due to continued diversion or withdrawal. Using data sourced from public entities such as the U.S. Geological Survey and groundwater management agencies, our framework calculates three KPIs to indicate Water Depletion of each source: chronic depletion, acute depletion, and curtailment.

-  Chronic depletion measures the deviation of current water levels from historic levels within a water source – how depleted is the water source relative to an established baseline?
-  Acute depletion measures the amount of time within the last five years that the current water level has decreased below a minimum level for normal operations, such as the water elevation required to operate critical infrastructure such as an intake pipe or hydroelectric turbines.
-  The curtailment KPI counts the number of times that a water agency has restricted water use due to scarcity conditions.



**Caption:** The three images above show the waterline of Lake Mead receding over two decades. Courtesy of the U.S. Geological Survey, captured by Landsat 7, Landsat 5, and Landsat 8.

## Composite Risk Evaluation

If a water body meets the Responsible Use threshold, we assess Composite Risk – a set of water-related risks that can typically be mitigated through investment and monitoring. These KPIs pertain to Source Water Quantity; Water Discharge; Water Access, Sanitation, and Hygiene (WASH); Local Sentiment; and Regulatory Risk.

The Source Water Quantity KPIs assess both a local utility’s ability to provide water to its users and expected climate trends that could affect water supply. For example, we evaluate a utility’s water planning process and the available infrastructure to treat and convey water to our site based on its water management plans. The framework also flags concerns related to [precipitation and drought trends](#) to reflect the potential impact of climate change on the watershed.

The Water Discharge KPIs evaluate risks associated with discharging process water from the data center, either directly to a receiving body of water or to a wastewater treatment plant. These KPIs address the potential impacts of a site’s discharge on water quality or on a utility’s treatment process and capacity, drawing information from its wastewater management plans.

The WASH KPI is a qualitative assessment of safe water access, sanitation, and hygiene issues affecting the local community or the source water body based on reports from the World Health Organization, United Nations Children’s Fund (UNICEF), and non-governmental organizations such as Water.org and WaterAid.

The Local Sentiment KPI evaluates public perception surrounding industrial water use, drawing from sources such as local newspapers and public meetings.





The Regulatory Risk KPI describes current and potential regulations and governance that may impact industrial water use, referencing sources such as local and federal management plans, draft regulations, and public meetings.

## Applying the Framework

The two tiers of the framework provide a holistic view of the operational capacity of a freshwater source as well as the potential risks associated with our operations. This allows us to determine where we can sustainably use water and to identify opportunities where we can support the community with critical infrastructure or best water management practices. For sources with an overall medium- or high-risk, we develop a site mitigation plan, which may include off-site infrastructure improvements, investment to reduce water consumption or improve water quality, and local stakeholder engagement. Due to the changing nature of water resources, we will refresh the water risk assessments every three to five years, such that Google can develop future capacity in consideration of evolving water risks across our portfolio.

The Water Risk Framework will be applied by regional water experts to new data center sites prior to acquisition, as well as future development on existing sites, to determine whether or not the watershed can sustainably support our operations. We have already started to incorporate the results of the Responsible Use evaluation in cooling technology selection for planned and potential development at a number of locations. For example, our campus under development in Mesa, Arizona, will utilize air-cooled technology because the available water source – the Colorado River – does not meet the Responsible Use threshold.

## Challenges and Future Enhancements

In applying the Water Risk Framework to Google's data center portfolio, we identified a number of challenges, particularly with the Water Scarcity KPIs – the ratio of demand to sustainable supply. The concept of sustainable supply takes into account the impact of climate change as well as environmental flow requirements (EFR) to support native ecosystems and biodiversity. We prioritize data sources that consider both of these aspects, and the majority of our assessments to date have drawn from such sources.

If the available data set for a water source does not account for EFR, our methodology sets aside [20 percent](#) of the available supply to support EFR. We recognize that this approach does not reflect the unique needs of each ecosystem – a 20 percent reservation of water may be insufficient in some environments and excessive in others.





As a tool to inform site selection and cooling technology decisions, the Water Risk Framework is designed to be completed within two months. To date, we have not commissioned watershed-specific studies to quantify EFR or climate change impacts, which typically require six to twelve months to complete. For existing sites with a medium or high overall risk rating, we may commission additional studies to supplement publicly available data. We also anticipate that incorporating the effects of climate change on future supplies will become standard practice across water agencies.

Beyond data quality, the Water Scarcity evaluation does not currently take into account seasonal variation – both supply and demand are assessed on an average annual basis. However, data center cooling systems use less water in colder weather and more water during hotter months, which typically coincide with drier periods and higher water demand from other users. The average annual KPIs may not capture short-term water scarcity that occurs at the intersection of peak demand and lower supply. Future iterations of the methodology will address the issue of seasonality.

Google's Water Risk Framework is still in its early stages of application, and it will continue to evolve as we identify additional areas for enhancement.

## Responsible Water Use in Action

Google's Water Risk Framework helps determine whether use of a specific freshwater source for evaporative-based cooling can be considered responsible and resilient. Google's commitment to responsible water use is not limited to implementation of the Water Risk Framework; it is complemented by our track record of using alternative water sources, the drive for operational efficiency, and our investments in watershed health.

Google utilizes air cooling or non-potable water sources at 30% of the operational sites in our portfolio. Most recently, we partnered with the utility provider, North Water (a joint venture of Evides Industriewater and Waterbedrijf Groningen), in the Netherlands to develop a process water solution that [treats water from a canal](#), reducing reliance on groundwater, a critical resource for municipal potable water use at risk of saline intrusion.

This is not the first time we have worked with a local utility to develop an alternative water source – one of the earliest data centers in our fleet in Douglas County, Georgia, uses reclaimed effluent from the nearby wastewater treatment plant for cooling. We then treat any water that doesn't evaporate before returning it to the Chattahoochee River. The use of reclaimed water as the primary source for cooling water reduces demand for the freshwater resource.



**Caption:** Intake structure from the Eems Canal (left) to the water treatment system (right) in Eemshaven, Netherlands, treating process water conveyed to Google’s data center.

Whatever the source, we seek to use water as efficiently as possible. We optimize the water chemistry at our sites to recycle cooling water as many times as possible before it must be discharged to prevent equipment corrosion or fouling from increased mineral concentration. We actively and regularly monitor key water metrics within each data center, enabling us to detect inefficiencies and then diagnose and address them for stable cooling system operation. We also continue to develop new cooling products, incorporating adiabatic solutions that will reduce the amount of water needed to cool a data center.

Outside the data center campus, we seek to benefit the watersheds and communities where we operate – the second pillar of Google’s water stewardship strategy. We are investing in projects that will replenish 120 percent of the water we consume, on average, across our data centers and offices and improve the health of our local watersheds by 2030. While the volume of replenishment will vary by location, within the data center portfolio, we will focus on sources with a medium or high overall risk rating under the Water Risk Framework.

To date, we have funded water stewardship projects through groups like The Nature Conservancy and the Bonneville Environmental Foundation, ranging from reforestation and wetlands restoration to agricultural best management practices and infrastructure improvements. One such example is the [precision irrigation project](#) in Chile’s Maipo basin implemented by Kilimo, an agricultural technology start-up.

The project uses soil data, satellite data, and AI tools to help inform participating farmers whether to irrigate their fields, conserving water while increasing agricultural productivity. In a region where agricultural irrigation consumes nearly three-quarters of the regional water supply, these efforts have the potential to achieve large-scale impact on critical surface water resources.



**Caption:** Using data and AI tools, farmers know when and how much to irrigate their fields, conserving water while increasing agricultural productivity in the Maipo River Basin in Chile. (Photos courtesy of Kilimo)

In the coming years, Google will continue to invest in water stewardship through new and existing partnerships that help address locally pertinent water challenges faced by the communities where we operate.

## Conclusion

As the digital economy continues to expand, driven by advances such as machine learning and artificial intelligence, the demand for data center capacity – and for the natural resources that enable them to operate efficiently – will grow alongside it. Google is committed to advancing the responsible use of water at our data centers, using the Water Risk Framework as the foundation for our cooling technology selection and risk mitigation.

In abundant watersheds, we expect our data centers to use water efficiently for cooling in order to reduce our energy consumption and carbon footprint. In locations with a high risk of freshwater scarcity or depletion, we will prioritize alternative water sources or cooling technologies to minimize impacts on freshwater resources. Additionally, we remain committed to investing in and developing cooling solutions across our portfolio that will reduce a data center’s water consumption compared to traditional evaporative-based cooling.

Google aspires to lead thoughtful engagement on how to practice responsible water stewardship, and we are eager to join with others in protecting our shared water resources. The water use of our data centers is inextricably tied to energy consumption and carbon emissions, and we recognize that others may have different trade-offs to consider. Our hope is that other companies, from data center developers to other industrial users, will find the Water Risk Framework and methodology a helpful reference as they navigate their own journeys.



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