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## Standardized Siting and Risk Analysis Decision Support Mechanisms for Water-Intensive Industries

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**Focal Area(s):** This paper focuses on water for cooling industrial energy generation loads and energy and water for cooling large process loads.

**Existing Challenge:** Water resources across the United States are distributed heterogeneously in terms of location, amount, quality, type, and governing rights. In addition, facilities with substantial water demands (e.g., data centers, manufacturing, mining, nuclear power plants) may be sited such that they negatively affect the surrounding watershed to the point of impairing water availability or quality for the facility itself and other stakeholders [1], [2]. Siting any large facility with substantial water demands without understanding the baseline conditions and assessing potential multi-sector impacts on local water resources and systems may pose adverse long-term operational, economic, reputational, environmental quality, and societal risks [3].

For any water-intensive industrial facility, it is important to evaluate water source (*e.g.*, surface water, groundwater, municipal supply) availability and variability under changing conditions such as drought and regional growth. Water quality parameters (*e.g.*, temperature, salinity) should be evaluated for both the suitability of the source for operations and potential risks from facility discharge. It is also important to map the demand portfolio within a watershed to understand who uses water, how much they use, when they use it, and for what purposes. This includes characterizing municipal, agricultural, industrial, and environmental demands, as well as emerging uses.

Data centers are one prominent example of the need to assess water risks in siting facilities. Quantifying the specific water demand profile of a several hundred-megawatt (MW) data center is critical to sound siting decisions, as these facilities often consume substantial amounts of potable water and create direct competition with municipal needs, leading to legal, regulatory, and reputational risks [4].

**Near-Term Opportunity:** This white paper presents the need to develop standardized risk analysis mechanisms, including a tool to inform siting for facilities with high water demand. The tool should be based on an appropriately granular geographic unit of analysis for water issues (e.g., the Hydrologic Unit Code [HUC]) and integrate geospatial layers to highlight relevant metrics from watershed dynamics plus factors like municipal and agricultural water demand. A data-driven decision-making tool could provide location-specific information on decision-relevant water parameters for new large industrial or commercial sites. Inputs may include specific physical water parameters that indicate availability (both from self-supplied

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surface or groundwater sources and for a nearby municipal water/wastewater system), quality (*e.g.*, total dissolved solids, seasonal water temperature), meteorological variables [3], water stress [5], capacity and energy intensity of water resource recovery facilities [6], other nearby facilities and cross-sector competition, and the governing water rights regime—all integral to facility operations with substantial water demands. The use of artificial intelligence (AI) to fuse different data sources, run models in real-time, and optimize operations given water supply conditions and projected demand scenarios could provide a powerful capability to readily update the tool. This resource could create a sophisticated, scalable methodology to enable informed decisions on relevant water parameters. It would allow for the comparison of risks and opportunities across different potential locations using consistent metrics integrated with existing techno-economic optimization tool outputs (e.g., WaterTAP). Utilities and municipalities could thus better plan for future supply and demand, while operators could better understand the impact of facilities' water use plus the need for and benefits of conservation [7]. It has the potential to transform disparate, difficult-to-apply data sources into an actionable, evidence-based system—critical for strategic long-term investment and planning.

***Facilitates Deployment of Solutions:*** The decision support tool would be a practical resource that can be deployed by planners, investors, corporations, and others to make data-driven siting decisions around water from the outset. It may employ publicly available data from federal agencies (*e.g.*, aquifer data from the U.S. Geological Survey [USGS]), state water boards, and local water utilities to create a comprehensive water stress resource map. Advantages could include:

- Acting as a critical first-pass screening tool for companies, helping them deploy solutions and site facilities in more resilient locations, thus avoiding future water shortages and associated problems.
- Incorporating the "red flags" concept—identifying areas where development requires caution or should be avoided altogether (e.g., coupling data on over-tapped or near-depleted aquifers and/or surface water with information on water systems that may fail to meet the projected demand of a new site). The decision support tool would create a foundational map of water resource vulnerability.
- Connecting to datasets and analytical frameworks developed by DOE around the location and cost of accessing alternative water supplies in regions with high water stress to highlight alternative solutions.
- Highlighting specific water parameters (*e.g.*, high seasonal water temperature) that may be more important in certain regions [3]; this tool could help direct research and development and technical assistance efforts toward technologies solving those specific problems (*e.g.*, cooling systems that are efficient in warm climates).
- Demystifying state and local governance frameworks and datasets for water access, specifically the water rights in the region where a new site is being proposed. Employing large-language models (LLMs) to scrape water rights data would open up a universe of previously difficult-to-access information. The physical availability of water is irrelevant if a legal right to use it cannot be secured, a critical but often overlooked gating factor. In many regions, particularly the western U.S., water law is complex and predates modern industrial needs. A project can be technically and financially viable but fail due to legal or regulatory barriers.

This research would inherently require bringing together engineers, scientists, lawyers, policymakers, and community stakeholders, sparking conversations about how to modernize water management to accommodate new economic needs without compromising the environment or existing user rights. Other federal entities relevant to water use (e.g., EPA, USGS) should be consulted to ensure all relevant data are included and are represented accurately. These conversations could highlight areas where policy innovation is needed.

As another layer of the envisioned tool, additional capabilities supporting the management and operation of water-intensive facilities in accordance with regional water availability and demand are needed. Once industrial facilities have been sited, operational water management considering watershed conditions would minimize negative risks and impacts during operation. Elements of this additionality could include:

- Development of water use metrics: Without reporting of data and models of use and consumption, it is impossible to assess a particular facility's impact on a local water system or watershed.
- Demand projection: Accurate demand models would highlight the significant costs and risks associated with water use, creating a strong business case for investing in innovative cooling technologies that use non-potable or recycled water, or even no water at all, in areas with limited or unsuitable water supply options but other attractive siting factors.
- Energy-water tradeoff: The ability to estimate the energy requirements for accessing and treating alternate water supplies or operating without water will allow facilities to make more informed decisions about their water use. The use of potable water for certain applications elevates the issue from a simple resource allocation problem to an issue of public health, making it a high-priority political and planning challenge. Further, the use of potable water may not be needed, offering energy cost reduction opportunities.

This research would benefit from synergistic research efforts, including existing DOE activities [8-10], as well as more comprehensive water demand and treatment data consolidation and collection (the "Integrated Energy-Water Data for Cross-Sector Resilience" white paper). The data compiled and lessons learned could feed into more extensive multi-sector dynamics models to inform and/or optimize basin-wide water allocations (the "Building Resilient Energy–Water Systems: Near-Term Decision Support, Collaboration, and Deployment Pathways" white paper).

<u>Success Measures:</u>

- Demonstrate a decision support tool that can assess the capacity of selected U.S. regions to support water-intensive facilities, with an evaluation of their potential impacts on local water resources and nearby water users.
- Successful engagement with water-intensive industry decision makers about what information and decision support would be most useful, as well as help improve their siting decisions and convince them that better water data transparency would improve system resilience.
- Website use metrics, data downloads, application programming interface (API) queries.
- Possible data center siting studies around cooling cost optimization (or sensitivity analyses) based on location and cooling technologies.

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