Draft White Paper Discussion On:

Long Term Solutions Cost Methodology for Public Water Systems and Domestic Wells

August 28, 2020

Table of Contents

Executive Summary

The State Water Resources Control Board (State Water Board) is developing a methodology for estimating long-term cost solutions for public water systems, tribal water systems,[1] state small water systems, and domestic wells that are in violation or determined to be At-Risk. The statewide cost estimate for systems in violation and At-Risk will help the State Water Board inform the annual funding needs for the Safe and Affordable Drinking Water Fund and the SAFER Program.

The primary focus of this white paper is to provide an overview of and solicit public feedback on the Long-Term Cost Assessment Model methodology that is under development. It is important to note that the sole purpose of the Cost Assessment Model (Model) is to assist the State Water Board in making budget decisions for the Safe and Affordable Drinking Water Fund and informing other policy matters. The Model will not be used to inform system or community-level decisions around solution implementation or funding allocations. The State Water Board recognizes that the ultimate solution in each case will involve more detailed investigation of each water system and should include the input of the community and other stakeholders.

The State Water Board, in partnership with the University of California, Los Angeles (UCLA) and Corona Environmental Consulting, is seeking to inform stakeholders about the development of the draft Cost Assessment Model and highlight a number of the identified possible solutions the Model will evaluate to estimate the long-term cost of addressing identified water system challenges. Some of the possible long-term solutions include:

- Physical consolidation
- Managerial consolidation
- Blending water sources
- Drilling new wells
- Additional treatment of groundwater or surface water to address contaminants that exceed water quality standards
- Providing point-of-use or point-of-entry treatment to individual customers in a water system, with less than 200 connections, to address contaminants that exceed water quality standards
- Installation of other needed infrastructure such as: storage tanks, back-up generators, booster pumps and/or supervisory control and data acquisition (SCADA) systems

The State Water Board will continue to host public webinar workshops to provide opportunities for stakeholders to learn about and contribute to the State Water Board's efforts to develop a more robust Cost Assessment Model for public water systems, state small water systems, tribal water systems, and domestic wells.

[1] The State Water Board will be outreaching to Indian Health Services to collect data on estimates of needs to support tribal communities in California. Cost estimates for meeting needs for Tribal water systems will be developed by the State Water Board if this data is received. If tribal needs data is not available, the State Water Board will develop an approach to approximate potential needs and costs for these systems.

Introduction

In 2016, the California State Water Resources Control Board (State Water Board) adopted a Human Right to Water Resolution making the Human Right to Water[2] (HR2W), as defined in assembly Bill 685[3], a primary consideration and priority across all of the state and regional boards' programs. The HR2W recognizes that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking and sanitary purposes."

In 2019, to advance the goals of the HR2W, California passed Senate Bill 200[4] (SB 200), which enabled the State Water Board to establish the Safe and Affordable Funding for Equity and Resilience (SAFER) Program5. SB 200 established a set of tools, funding sources, and regulatory authorities the State Water Board can harness through the SAFER Program to help struggling water systems sustainably and affordably provide safe drinking water to their customers.

Foremost among the tools created under SB 200 is the Safe and Affordable Drinking Water Fund[6]. The Fund provides up to $130 million per year through 2030 to enable the State Water Board to develop and implement sustainable solutions for underperforming drinking water systems. The annual Fund Expenditure Plan prioritizes projects for funding, documents past and planned expenditures, and is "based on data and analysis drawn from the drinking water **Needs Assessment**" (Health and Safety Code §116769).

SB 200 explicitly requires the annual Fund Expenditure Plan include "an estimate of the funding needed for the next fiscal year based on the amount available in the fund, **anticipated funding needs**, other existing funding sources, and other relevant data and information" (Health and Safety Code §116769).

FY 2020-21 Fund Expenditure Plan

The FY 2020-21 Fund Expenditure Plan does not include the Cost Assessment model or results from the efforts detailed in this white paper. The State Water Board intends to incorporate the results of this effort into the next iteration of the Fund Expenditure Plan for FY 2021-22 after the Needs Assessment methodologies have been more fully developed through a stakeholder-driven process.

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[2] Human Right to Water
https://www.waterboards.ca.gov/water_issues/programs/hr2w/
[3] Assembly Bill 685
https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120AB685
[4] Senate Bill 200
https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB200
[5] SAFER Program
https://www.waterboards.ca.gov/safer/
[6] Safe and Affordable Drinking Water Fund
https://www.waterboards.ca.gov/water_issues/programs/grants_loans/sustainable_water_solutions/safer.html

About the Needs Assessment

The State Water Board's Needs Assessment consists of three core components:

- **Risk Assessment**: Identifying public water systems,[7] tribal water systems,[8] state small water systems,[9] and regions where domestic wells[10] consistently fail or are at-risk of failing to provide adequate[11] safe drinking water.

- **Cost Assessment:** Determining the costs related to the implementation of interim and/or emergency measures and longer-term solutions for systems in violation and at-risk systems. Solutions may include, but are not limited to, water partnerships, physical and managerial consolidations, administrators, treatment facility additions or upgrades, distribution system repairs or replacement, and/or point of use/point of entry treatment. The cost assessment also includes the identification of available funding sources and the funding gaps that may exist to support interim and long-term solutions.

- **Affordability Assessment:** Identifying community water systems that serve disadvantaged communities[12] that charge their customers' fees that exceed the affordability threshold established by the State Water Board in order to provide adequate safe drinking water.

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[7] "Public Water System" means a system for the provision to the public of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. A PWS includes any collection, pretreatment, treatment, storage, and distribution facilities under control of the operator of the system that are used primarily in connection with the system; any collection or pretreatment storage facilities not under the control of the operator that are used primarily in connection with the system; and any water system that treats water on behalf of one or more public water systems for the purpose of rendering it safe for human consumption. (Health & Saf. Code, § 116275, subd. (h).)

[8] "Tribal water systems" means federally recognized California Native American Tribes, and non-federally recognized Native American Tribes on the contact list maintained by the Native American Heritage Commission for the purposes of Chapter 905 of the Statutes of 2004. (Health & Saf. Code, § 116766, subd. (c)(1).) Drinking water systems for federally recognized tribes fall under the regulatory jurisdiction of the United States Environmental Protection Agency (USEPA), while non-federally recognized tribes are currently under the jurisdiction of the State Water Board.

[9] "State small water system" means a system for the provision of piped water to the public for human consumption that serves at least five, but not more than 14, service connections and does not regularly serve drinking water to more than an average of 25 individuals daily for more than 60 days out of the year. (Health & Saf. Code, § 116275, subd. (n).)

[10] "Domestic well" means a groundwater well used to supply water for the domestic needs of an individual residence or a water system that is not a public water system and that has no more than four service connections. (Health & Saf. Code, § 116681, subd. (g).)

[11] "Adequate supply" means sufficient water to meet residents' health and safety needs at all times. (Health & Saf. Code, § 116681, subd. (a).)

[12] "Disadvantaged community" or "DAC" means the entire service area of a community water system, or a community therein, in which the median household income is less than 80 percent of the statewide annual median household income level. (Health & Saf. Code, § 116275, subd. (aa).) See separate definition of 'GGRF Disadvantaged Community'.

Figure 1. Needs Assessment Components

The State Water Board's Needs Analysis Unit in the Division of Drinking Water is leading the implementation of the Needs Assessment in coordination with the Division of Water Quality (DWQ) and Division of Financial Assistance (DFA). The University of California, Los Angeles (UCLA) was contracted (agreement term: 09.01.2019 through 03.31.2021) to support the initial development of Needs Assessment methodologies for the Risk Assessment and Cost Assessment. Although it is important to note, the contract with UCLA was written and scoped prior to passage of SB 200 and was originally designed to conduct a one-time Needs Assessment. Three State Water Board workshops hosted in early 2019 informed the original scope of the UCLA contract.[13] [14]

Overall, the Needs Assessment contract with UCLA consists of two core Elements:

- **Identification of Public Water Systems in Violation or At-Risk**: focuses primarily on developing and evaluating risk indicators for community water systems up to 3,300 connections and non-transient non-community water systems, due to the large number of historical violations associated with these smaller systems.

- **Cost Analysis for Interim and Long-Term Solutions**: developing a model to estimate the costs related to both necessary interim and/or emergency measures and longer-term solutions to bring systems into compliance and address the challenges faced by at-risk water systems. This Element also includes the identification of available funding sources and the funding gaps that may exist to support interim and long-term solutions.

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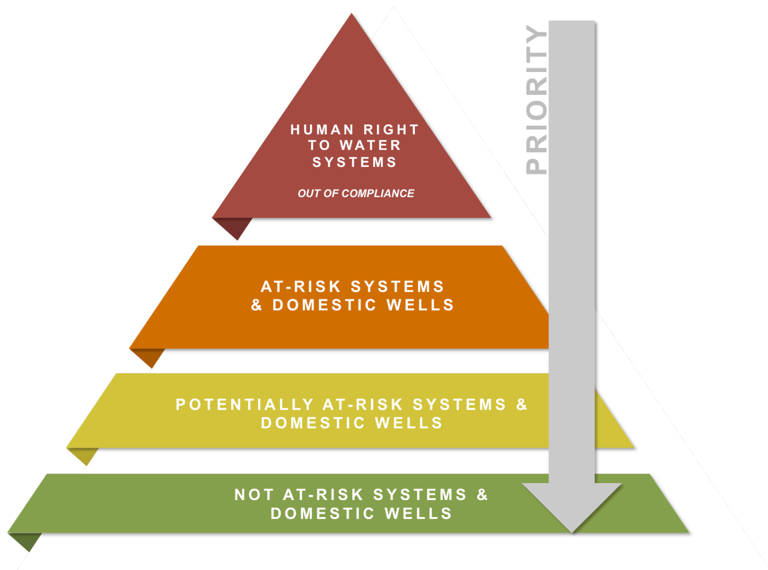
[13] Key Participants: Rural Community Assistance Corporation; CA Rural Water Association; UC Davis, UCLA; UC Berkeley; Pacific Institute; Office of Environmental Health Hazard Assessment; and many more

[14] Drinking Water Quality Needs Assessment
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/needs.html

These two UCLA Contract Elements of the Needs Assessment are providing the SAFER Program with foundational methodologies for evaluating drinking water risk for public water systems and domestic well users, and estimating the cost to ameliorate these challenges. Moving forward, the Needs Analysis Unit will be updating the Needs Assessment annually to support the implementation of the SAFER Program. The results of the Needs Assessment will be used to help prioritize public water systems, tribal water systems, state small water systems, and domestic wells for funding in the Safe and Affordable Drinking Water Fund Expenditure Plan; direct State Water Board technical assistance; and to develop strategies for implementing interim and long-term solutions.

Figure 2. SAFER Prioritization of Risk Assessment Results



Long-Term Cost Assessment

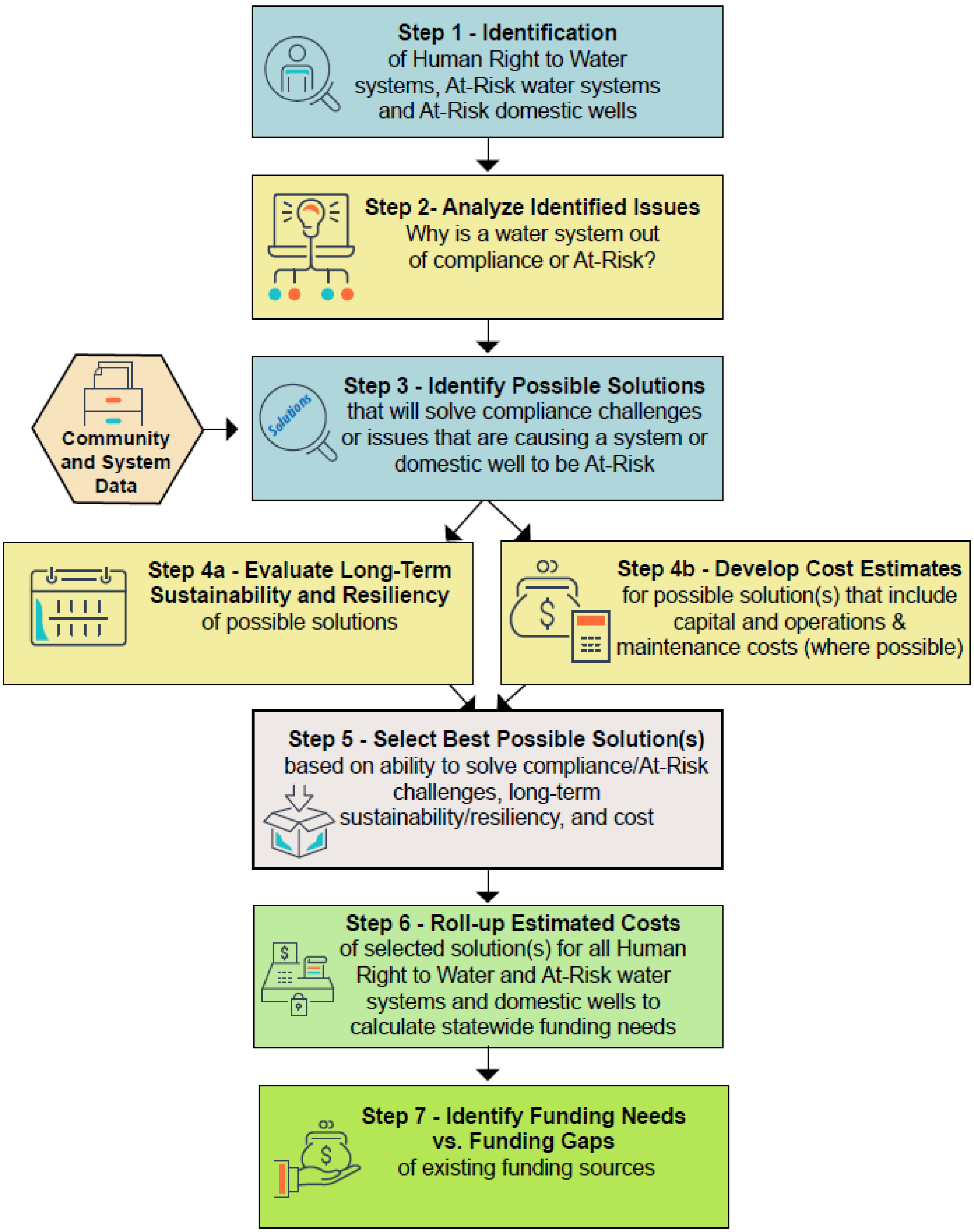
UCLA partnered with Corona Environmental Consulting, LLC (Corona) to develop the Long-Term Cost Assessment Model for the State Water Board. The goals of the Long-Term Cost Assessment are: 1) to estimate the potential cost of implementing solutions for systems in violation (HR2W Systems) and At-Risk water systems and domestic wells; and 2) inform future Fund Expenditure Plans by identifying potential funding gaps that may exist to support these long-term solutions.

The primary focus of this white paper is to provide an overview of the Long-Term Cost Assessment Model methodology that is being developed, highlighting the potential solutions being considered for incorporation into the model and the cost figures being developed for those possible solutions.

Process

The Cost Assessment Model under development utilizes the following process summarized in Figure 1 to identify potential solutions and estimate the long-term costs for implementing those solutions for systems in violation (HR2W Systems) and At-Risk. Figure 3 provides an overview of these core components of the model:

Figure 3. Cost Assessment Model Process



Step 1: Identification of Water Systems and Domestic Wells

The purpose of the Cost Assessment Model is to estimate the potential cost of implementing solutions for systems in violation (HR2W Systems) and At-Risk water systems and domestic wells. Therefore, the first critical dataset the model requires is the list of HR2W systems and At-Risk water systems and domestic wells.

- **HR2W Systems**: The identification of HR2W systems is conducted on a regular basis by the State Water Board utilizing enforcement and compliance data. The list of current HR2W systems is maintained on the State Water Board website: https://www.arcgis.com/apps/MapJournal/index.html?appid=143794cd74e344a29eb8b96190f4658b.

- **At-Risk Public Water Systems**: The State Water Board and UCLA are developing a methodology for determining at-risk public water systems. The Risk Assessment methodology will be finalized by January 2021 and the initial list of At-Risk public water systems will be identified and incorporated into the Cost Assessment Model. Learn more about the development of the Risk Assessment methodology in the draft white paper "Identification of Risk Assessment 2.0 Indicators for Public Water System": https://www.waterboards.ca.gov/drinking_water/programs/safer_drinking_water/docs/draft_white_paper_indicators_for_risk_assessment_07_15_2020_final.pdf.

- **At-Risk State Small Water Systems and Domestic Wells**: The State Water Board's DWQ's Groundwater Ambient Monitoring and Assessment Program (GAMA) Unit is leading the effort to develop the Risk Assessment methodology for state small water systems and domestic wells that is focused on groundwater quality. This effort will be accomplished through the mapping of aquifers that are used as a source of drinking water that are at high risk of containing contaminants that exceed primary drinking water standards. DWQ's GAMA Unit has published a Draft White Paper[15] for public feedback and Needs Assessment Domestic Well Water Quality Tool,[16] detailing the development of the Risk Assessment methodology for state small water systems and domestic wells.

- **At-Risk Tribal Water Systems**: The State Water Board's Needs Analysis Unit Office of Public Participation is working to collect data and develop a Risk Assessment methodology for State and Federal tribal water systems located in California.

The Cost Assessment Model also utilizes location data of public water systems, state small water systems, and domestic wells that are not on the HR2W list or deemed At-

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[15] Draft GAMA Needs Assessment White Paper 021420
https://gispublic.waterboards.ca.gov/portal/home/item.html?id=0e7fe8d490ef45fb826ab3ad86db5409
[16] Needs Assessment Domestic Well Water Quality Tool
https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=292dd4434c9c4c1ab8291b94a91cee85

Risk in order to identify possible physical consolidation and regional solutions. Detailed information on the datasets used to gather locational information on water systems and domestic wells, including water quality, is located in Appendix A.

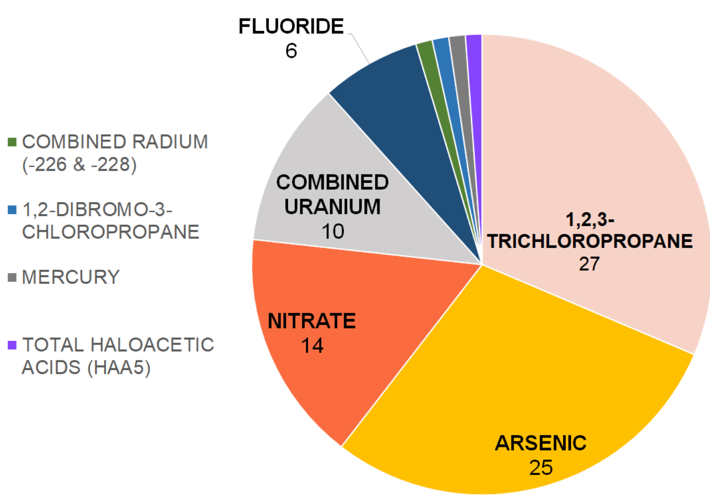
Step 2: Analyze Identified Issues

In order to estimate the cost of providing solutions to HR2W systems and At-Risk systems, the Model needs to incorporate and analyze the challenges and issues these systems are struggling with in order to provide sustained safe and accessible drinking water. Ultimately, the State Water Board's Risk Assessment will be utilized to identify these challenges or issues for the Model. The Risk Assessment will analyze a variety of risk indicators that fall into the following four categories. Water system performance for each of these risk indicator categories will provide the Model a baseline amount of data to begin analyzing possible modeled solutions.

- Water Quality
- Accessibility
- Affordability
- Technical, Managerial, and Financial (TMF) Capacity

The Risk Assessment methodology is being developed in parallel to the Cost Assessment Model. Due to the timing of this project, Corona conducted a case study of the HR2W systems in Kern County to identify and refine the possible challenges the Cost Assessment Model may need to address. Kern County was selected for initial analysis because it has 61 of the state's 311 HR2W listed systems. Figure 4 summarizes the different water quality violations in Kern County.

Figure 4. Kern County HR2W Systems Water Quality Violations

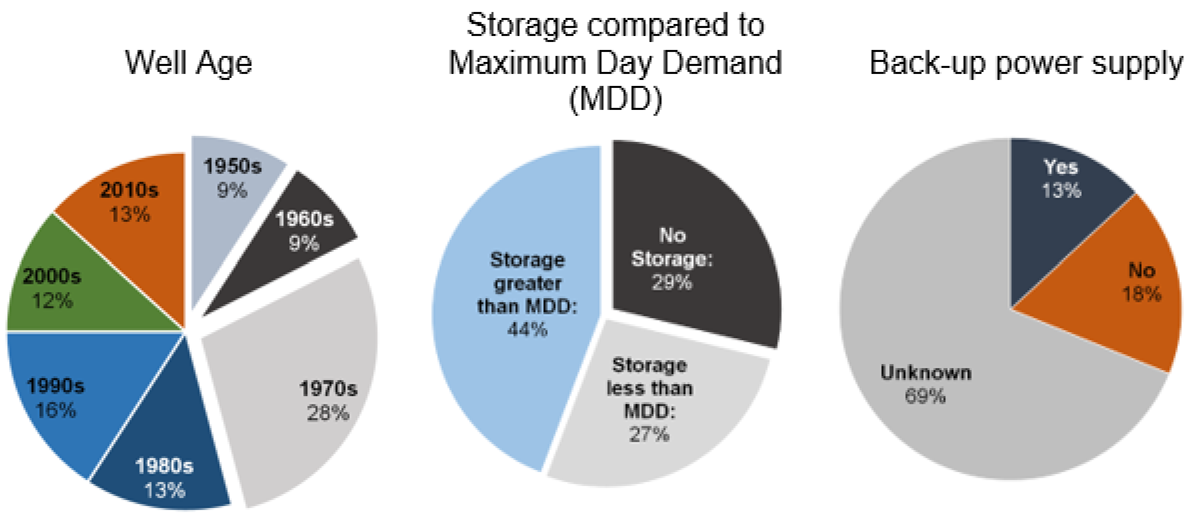


To examine these challenges in a more quantitative way, the sanitary surveys[17] for 60 of the HR2W systems in Kern County were analyzed to look at source age, source

[17] The most recent Sanitary Surveys for Kern County Human Right to Water systems were provided by the State Water Board in PDF format.

capacity, and storage capacity. Figure 5 summarizes the proportion of systems that may have additional infrastructure needs based on this review.

Figure 5. Additional Issues Identified



The Kern County case study identified several challenges that are anticipated to be applicable across the state and utilized this information to develop more nuanced assumptions in the Model. These findings are summarized below and further discussed in Appendix B.

- In Kern County, 75% of the water systems served fewer than 200 connections. Small water systems having fewer technical, managerial and financial resources to leverage may need additional technical assistance or managerial support to achieve interim and long-term compliance.

- Approximately half of the water systems reviewed in the Kern County case study had only one well and thus lacked the water supply redundancy to meet current standards. These water systems frequently also had inadequate storage and no backup power. Therefore, water systems that are not consolidated may need additional water infrastructure redundancy to remain out of the At-Risk or Potentially At-Risk category.

- Only 25% of the wells were constructed within the past twenty years, indicating that at least some of the water system infrastructure is likely beyond its useful life. Aging infrastructure effects many of the water systems in Kern County. This is expected to impact the cost of consolidation/regionalization projects if receiving entities are hesitant to combine with water systems having poor existing infrastructure and/or increase the need for funding for infrastructure replacement.

The study also identified a high prevalence of 1,2,3-Trichloropropane (1,2,3-TCP) violations. It is theorized that the high number of 1,2,3-TCP violations are in part a result of the relatively recent implementation of the maximum contaminant level, effective in December 2017. It is also observed that there is significant co-occurring contamination across Kern County with nitrate and that the presence of multiple contaminants will significantly increase treatment costs and complexity.

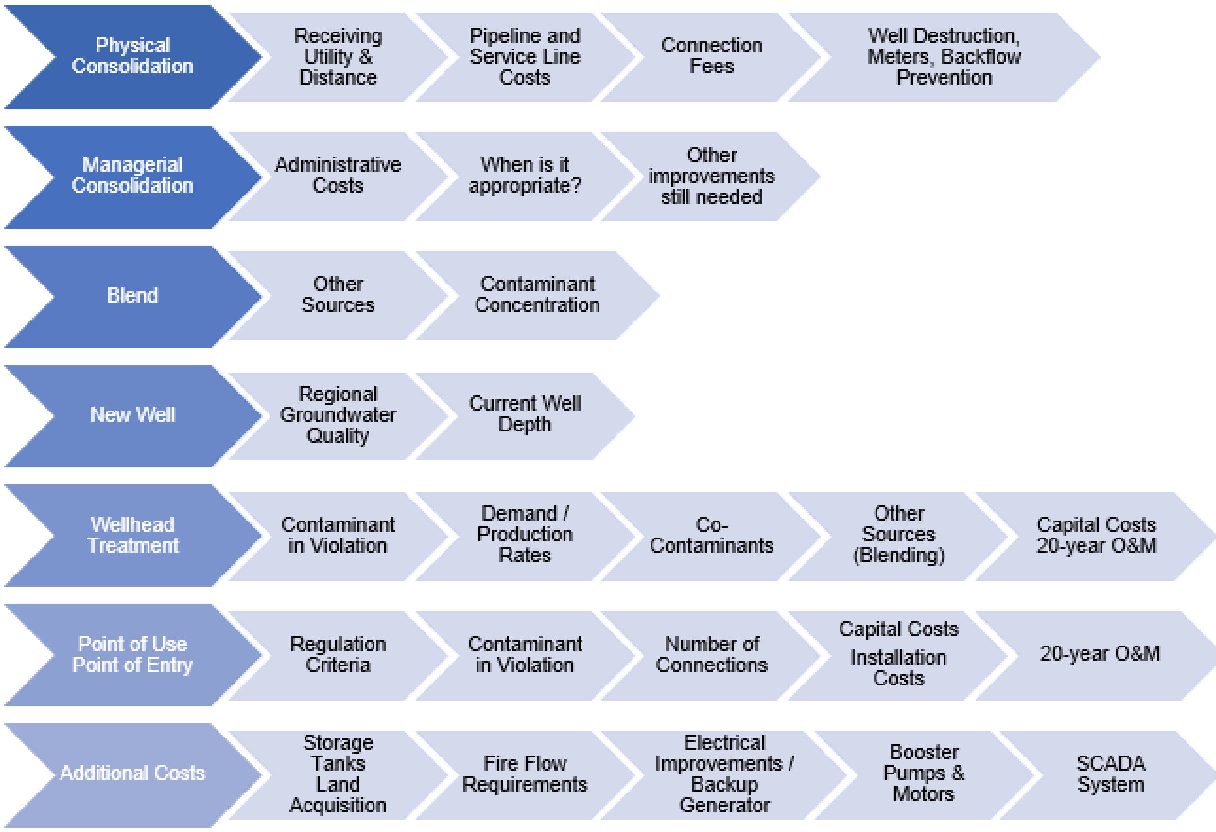
At this time, water quality information is lacking for State Small Water Systems and domestic wells. Future iterations of this analysis would benefit from more specific information about these water sources and associated infrastructure. Regional water quality maps for selected constituents have been developed statewide by the State Water Board's Groundwater Ambient Monitoring and Assessment (GAMA) program.[18] Any domestic wells in areas of the state that are expected to have the water quality issues mapped in the GAMA project are assumed to have a water quality issue.

Step 3: Identifying Possible Solutions

The methodology considers a range of regional and individual system-based solutions for water systems and domestic wells as illustrated in Figure 6 along with additional considerations that are important to each potential modeled solution. The following section describes the range of solutions in more detail. In some cases, multiple solutions may be viable to address a water system's challenges.

[18] State Water Resources Control Board. 2020. Needs Analysis Groundwater Ambient Monitoring and Assessment (GAMA) Tool, GAMA Program. https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=292dd4434c9c4c1ab8291b94a91cee85

Figure 6. Solutions and Considerations Considered



It is important to note that the possible solutions utilized in the Cost Assessment Model are only intended to provide a statewide cost estimate for implementing solutions for HR2W Systems and At-Risk systems. Solutions modeled for individual systems in the Cost Assessment Model will not be utilized by the State Water Board to make funding or technical assistance decisions. The State Water Boards recognize that HR2W Systems and At-Risk systems will require a site-specific detailed evaluation conducted by a qualified engineer or technical assistance provider, or other specialized firm, to identify implementable solutions for communities.

Regional Solutions

The challenges that individual water systems experience often reflect regional issues of degraded source water quality, inconsistent source water availability, and economic disadvantage. Once challenges are identified at a regional and individual water system level, potential long-term solutions can be considered to eliminate current water quality violations and ensure long-term water quantity and water quality sustainability.

This methodology includes a regional component to identify opportunities where water systems and communities can work together to solve common issues. Some of the solutions evaluated that are aimed at resolving regional issues include:

Physical consolidation of two or more water suppliers that are geographically close. Please refer to Appendix A for more information on the GIS methodology developed for this evaluation.

Physical consolidation is the joining of the actual infrastructure of two or more water systems. For example, a small mobile home park that operates its own water system may be near or within a city (i.e. receiving system) and decides it no longer wishes to be responsible for providing drinking water. The city can begin providing water to the mobile home park through a master meter or other type of connection.

Some of the benefits of physical consolidation include:

- The receiving water system may already have adequate treatment or the ability to construct water treatment that is designed to address the water quality challenges that impact area water supplies.

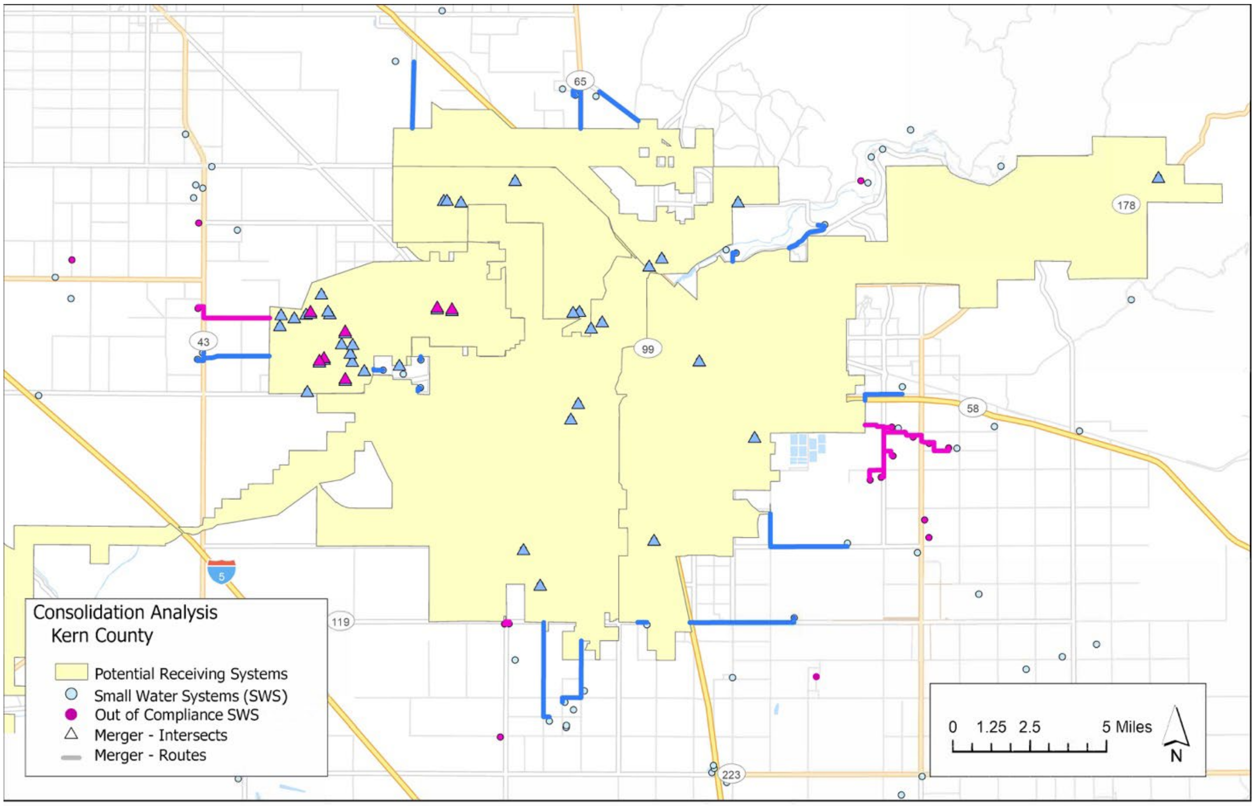
- The receiving water system may have offer a diversified water supply portfolio affording optimization of available area water supplies to ensure that its population will not be faced with shortages. This alleviates small systems' issues due to a lack of storage, inadequate pumping capacity, or inadequate individual well productivity.

- Consolidation of treatment and operations can improve water rate affordability by spreading costs over a larger customer base, decreasing redundant efforts and decreasing treatment costs through larger bulk purchases.

- Some physical consolidation projects may be in proximity to and allow connections with state small water systems, households served by domestic wells, and other At-Risk water systems, in addition to the targeted joining system. The physical consolidation analyses conducted as part of this methodology have determined the expected cost range of a given project.

Figure 7 shows an example of a physical consolidation analysis map. This methodology identifies potential physical consolidation projects and even larger scale regional projects. While engineering and cost-modeling play a large role in consolidation and regionalization, the actual solution that will be implemented may be highly variable depending on other factors such as political boundaries, water rights boundaries, etc.

Figure 7. Example Physical Consolidation Analysis Map



Managerial consolidation. Managerial consolidation can refer to a water system having an outside administrator appointed, having shared services contracts with other utilities, or when a small water system becomes part of a larger water system for all managerial purposes but continues to use their original water supply and distribution system without physically connecting. For example, a small community may once have had an all-volunteer staff. The volunteer staff may be aging and no longer want to be responsible for the water system. The water system may be too far from a larger, potentially receiving water system to make it cost-effective to physically consolidate. The larger water system can legally take over the water system functions such as regulatory reporting, billing, operations, etc., but uses the existing infrastructure. The smaller water system governance structure dissolves and is no longer legally responsible for water service.

Non-Consolidation Solutions

As consolidation and regionalization solutions are not always possible or practical for the challenges faced by individual water systems, solutions that are aimed at resolving challenges on a case-by-case basis are also evaluated. Some examples of solutions evaluated to solve individual water system challenges include:

Blending water sources: Blending is a possibility when water systems have multiple sources. When a source with a low concentration of the target contaminant is available, it can be cost effective to blend it with the source in violation of a water quality standard.

This methodology has identified some water systems that should further investigate blending as a potential solution. In the case of 1,2,3-TCP violations, blending is not considered as an option because the drinking water standard is often much lower than the occurrence concentrations, therefore blending is not generally a viable solution. While blending can be cost effective, it also limits operational flexibility and can create significant vulnerabilities if a utility does not have a robust water supply portfolio, a common challenge faced by smaller systems.

Drilling new wells: In some locations, drilling a new well that is constructed differently than the existing well may allow a water system to avoid treatment. Drilling a new well does not guarantee that water quality issues can be avoided. In circumstances where the well in violation of a water quality standard is also at the end of the expected useful life, then this option certainly warrants further investigation.

Treatment of groundwater or surface water to address contaminants that exceed water quality standards: Many of the water systems that are under evaluation, in particular those that have been added to the HR2W list for recurring water quality violations, may require new or additional treatment. Some of the contaminants that have resulted in water quality violations in the systems under evaluation include:

- Arsenic
- Nitrate
- 1,2,3-TCP
- Disinfection byproducts [trihalomethanes (THM) and haloacetic acids (HAA)]
- Perchlorate
- Uranium

In some cases, there are multiple treatment options that may effectively remove a contaminant. In other cases, there may only be a single treatment option that is currently available to treat a contaminant. And in yet other cases, there may be multiple contaminants that a water system needs treatment for that may ultimately impact the type of treatment required. An example of wellhead treatment is shown in Figure 8.

Figure 8. Example of Wellhead Treatment

Point-of-use (POU) or point-of-entry (POE) treatment: Providing POU/POE to customers served by affected water systems with less than 200 connections or domestic wells may be a viable option to address contaminants that exceed water quality standards. POU treatment is considered for most commonly occurring inorganic contaminants (for example nitrate or arsenic). An example POU treatment device is shown in Figure 9.

Figure 9. Example Point of Use Treatment Device[19]

POE treatment must be considered in the case of 1,2,3-TCP, or other volatile organic compounds, to address health impacts of inhaling the compounds during exposure in the shower for example. POU treatment is not acceptable for these types of contaminants.

Installation of other needed infrastructure: In addition to water quality challenges, many identified systems have additional infrastructure needs to address reliability and basic system operation. Examples of these items include storage tanks and booster pumps, replacement well(s), back-up generators, main replacement, and/or supervisory control and data acquisition (SCADA) systems.

Solution Options for At-Risk Systems

The potential solutions for At-Risk systems are still under development. The discussion around potential solutions will continue as the final risk indicators are selected for the Risk Assessment.

Solution Options for Domestic Wells

Physical consolidation and POU or POE treatment are considered a potential solution for domestic wells. No detailed information about the water quality of individual domestic wells is available. Locations of domestic wells are available as a count of wells in a square mile area. The status of the wells is unknown. Given the limitations of the existing data, this methodology will assume that all of the domestic wells along a physical consolidation route could be connected to a public water system. Regional water quality maps for selected constituents have been developed statewide by the State Water Board's Groundwater Ambient Monitoring and Assessment (GAMA)

[19] Photo courtesy of Arvin and RCAC

program.[20] As appropriate, POU or POE treatment will be budgeted for any domestic wells in areas of the state that are expected to have the water quality issues mapped in the GAMA project.

Step 4.a: Sustainability and Resiliency Assessment

The State Water Board recognizes that the lowest-cost model solution may not be the best long-term solution of a system or community. It is important that the Cost Assessment Model incorporate a sustainability and resiliency assessment of modeled possible solutions to better refine the results of the Model. The sustainability and resiliency assessment will examine the economic viability, technical performance, social acceptability, and environmental sustainability of potential modeled solutions. The criteria that will be used in the resiliency assessment will be discussed, and public feedback solicited, in a separate public webinar in September 2020. Once public input has been considered, the final sustainability and resiliency criteria will be incorporated into the Cost Assessment Model.

Step 4.b: Develop High-Level Costs Estimates for Potential Solutions

The Model methodology develops high-level cost estimates for the solutions that are identified as viable options to address water system challenges. The generalized costs developed do not contain site-specific details that will significantly impact total project costs and should be considered as planning numbers on a statewide level rather than a decision-making tool for a specific system. The following sections provides a summary of the potential modeled solutions considered and how the solution costs are being developed.

Physical Consolidation Costs

The cost methodology for physical consolidation builds upon previous work[21] completed by Corona for the Water Foundation with cost details updated.[22] Some of the costs accounted for in the physical consolidation of systems includes:

- The capital costs of pipeline needed to connect systems.
- Upgrades, such as back flow prevention, tanks, and metering required by receiving water system, as well as water quality needs to address or inform corrosion control.

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[20] State Water Resources Control Board. 2020. Needs Analysis Groundwater Ambient Monitoring and Assessment (GAMA) Tool, GAMA Program.
https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=292dd4434c9c4c1ab8291b94a91cee85

[21]Henrie, Tarrah and Chad Seidel, 2019. *Cost Analysis of California Drinking Water System Mergers*. Water Foundation.
https://waterfdn.org/wp-content/uploads/2019/08/COSTAN1.pdf

[22] Costs for the major capital improvements on this list will be updated based on information provided by QK, Incorporated, which is an engineering design firm in the Central Valley.

- Connection fees[23] charged by the receiving water system.
- Legal and administrative costs[24] to develop necessary agreements between connecting systems.

The cost of physically consolidating systems can vary widely depending on a number of factors. High-level cost estimates have been developed in the context of this methodology leveraging existing case studies from systems that have accomplished physical consolidation.

Managerial Consolidation Costs

Managerial consolidation encompasses a spectrum of options, ranging from independent ownership and management with shared contracts for goods and services to common ownership and services for systems that are physically not connected. In many cases managerial consolidation will not eliminate the need for other capital improvements, but it should increase the technical, managerial, and financial capacity of systems to address issues in each system.

Available data on the costs associated with managerial consolidation are sparse. Limited case studies,[25] summarized in Table 1, have been gathered to inform managerial consolidation costs. In the case of a system needing an Administrator, service is assumed to be needed for 5 years. As more systems implement managerial consolidation, more case studies will become available and the cost model will become more informed.

Table 1. Managerial Consolidation Costs

Annual Cost for Administration in a Lower Need System	Annual Cost for Administration in a Higher Need System	Average one time Legal and Administrative Costs for System Acquisition
$12,000 ($60,000 for 5 years)	$60,000 ($300,000 for 5 years)	$200,000

Blending Costs

Based on an analysis of Kern County HR2W systems, blending will not be a feasible modeled solution for a majority of HR2W and At-Risk systems. Forty-eight percent of the Kern County HR2W systems only have one source. Some systems also have contaminant concentrations that make blending infeasible. Out of the 61 systems examined in Kern County, only 12 could consider blending as a potential solution. With

[23] Based on the connection fees of 42 water systems reviewed.
[24] The legal and administrative cost assumption is based on information from an Investor Owned Utility for recent acquisitions in California. No other data or case studies are available.
[25] Two case studies of receivership costs have been provided by the State Water Board. An Investor Owned Utility has provided an average cost for the legal and administrative fees associated with system acquisition in California.

this in mind, meaningful costs for blending cannot be developed as part of this methodology due to the following information gaps:

- For water systems with multiple wells, individual well production information is not available in a digitized format for all systems, so the blend ratio cannot be calculated.
- Well locations and the plumbing arrangements in distribution systems is not known, so pipeline distances cannot be calculated.
- Information about emergency interties, that could be considered as a blending source, is also unknown.

Although costs cannot be developed, blending can be a cost-effective solution for some utilities, and it should be considered in future iterations of the model as Statewide data becomes available.

New Well Costs

In some cases, a new well can successfully be installed to avoid the local contaminant of concern and the corresponding cost of treatment. However, newly drilled wells often face the same water quality issue or a different water quality issue requiring treatment. A new well, for the purpose of this methodology, is not assumed to alleviate the need for treatment.

Aside from treatment avoidance, many systems need a new well to replace aging infrastructure or provide supply reliability. For the HR2W systems, the Model methodology includes costs for an additional well for systems that only have one source. New wells will be sized to meet Maximum Day Demand in systems with only one existing source in accordance with regulatory requirements for new water systems.[26] Wells constructed prior to 1980 are assumed to require replacement, as forty years is expected to be near the useful life expectancy of the well. Costs for a range of new well sizes and flow rates will be developed by QK, Incorporated, a design-engineering firm located in the Central Valley. Cost for land purchase of a 100-foot by 100-foot lot will be included.

Well Head Treatment Costs

Treatment costs rely on three components: (1) estimating water demand, design and average flow rates, (2) determining the appropriate treatment solution, and (3) developing capital and operational cost details. The following sub-sections describe the methodology for each.

Estimating Water Demand, Design, and Average Flow Rates

Design and average flow rates are the foundation of estimating capital costs and ongoing operations and maintenance costs. System-specific information for water demand, design and average flow rates are not readily available for the systems

[26] Title 22 Code of Regulations, 2019. Section 64554 (c)
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dw_regulations_2019_04_16.pdf

included on the HR2W and at-risk lists, so surrogate water demand data must be developed from existing information.

Past regulatory development efforts (e.g. *1,2,3-Trichloropropane Maximum Contaminant Level Regulations Initial Statement of Reasons*[27]*)* have estimated design and average flow rates in particular cases based upon a single statewide assumed 150 gallons/person/day demand. This approach is presumed to both over and underestimate design and average flow rates given differences across California. In an effort to improve upon that limitation, this methodology uses the June 2014-October 2019 *Urban Water Supplier Monthly Reports Raw Dataset* produced by the California Water Boards (California Water Boards, 2019) that provides per-capital residential water consumption data for larger systems. Systems with available data located in close geographical proximity to the systems of interest are used as surrogates to estimate system water demand along with system population.

Review of limited design and average flow rate information contained in Kern County paper-based sanitary surveys revealed actual values can vary considerably from these estimated values. Future efforts to refine this methodology should obtain and utilize system- and source-specific design and average flow rates.

System water demand data are used to calculate maximum day demand (MDD) and peak hourly demand (PHD) as described in the California Code of Regulations Title 22, Sections 64554(a) and (a)(2). Under these regulations, a public water system must have the capacity to meet the system's MDD at all times. Additionally, systems with 1,000 or more services connections must be able to meet four hours of PHD with a combination of source capacity, storage capacity and/or emergency source connections. These calculated MDD and PHD requirements influence treatment flow rates, sizing and ongoing treatment and operations costs.

As stated, system MDD and PHD values will be calculated in accordance with the California Code of Regulations, Title 22, Section 64554: New and Existing Source Capacity. The method in which MDD and PHD are computed is dictated by the type of data available and follows the hierarchy of daily water use, annual water use and no data available. The method in which MDD and PHD are calculated based on no available data is summarized in the table below (Table 2). It should be noted that the "Residential Gallons-per-Capita-Day" in the *Urban Water Supplier Monthly Reports Raw Dataset* is a monthly estimate reported by suppliers and is calculated using the equation described in the *Instructions for Estimating Residential Gallons Per Capita Day (R-GPCD) in Completing Monthly Urban Water Supplier Report* (California Water Boards, 2014).

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[27] California Water Boards. (2017). Initial Statement of Reasons 1,2,3-Trichloropropane Maximum Contaminant Level Regulations. Title 22, California Code of Regulations: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/123-tcp/sbddw17_001/isor.pdf

Table 2. Maximum day demand and peak hour estimation approaches

Max Day Demand Estimation Approach	Peak Hour Demand Estimation Approach
• Use the *Urban Water Supplier Monthly Reports Raw Dataset*[28] produced by the California Water Boards to obtain production records for a geographically close system of similar elevation and climate to use as a surrogate • Calculate the average day demand of the surrogate system from the Reported Residential gallons-per-capital-day (R-GPCD) data column • Calculate the average daily demand in gallons per day by multiplying the average R-GPCD by the latest available system population[29] • Calculate MDD by multiplying the average daily demand in gallons per day by a peaking factor of 2.25	• Calculate the average hourly flow during MDD • Multiply by a peaking factor of 1.5

Identifying Appropriate Treatment Solutions

Violation types are determined from the HR2W database. Once a violation is determined, only approaches listed as Best Available Technologies (BAT) in Title 22[30] are considered for treatment. The BATs for many of the violation types found in the HR2W data are summarized in Table 3. Although adsorption is not listed as a BAT for

[28] California Water Boards. (2019, 10). Water Conservation and Production Reports. Retrieved from California State Water Resources Control Board: https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.html

[29] California Water Boards. (2014). Instructions for Estimating Residential Gallons Per Capita Day (R-GPCD) in Completing Monthly Urban Water Supplier Report: https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/ws_tools/guidance_estimate_res_gpcd.pdf

[30] California Drinking Water-Related Laws https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Lawbook.html

arsenic removal, it will be considered for small systems because of demonstrated experience and ease of operation. Additionally, anion exchange for arsenic removal may be considered for some systems if nitrate is found to be co-occurring.

Table 3. Summary of Drinking Water Best Available Technologies (BATs) for common groundwater violations

Violation Type	Regulatory Limit	Chemical Class	Best Available Technology
Arsenic[1]	10 µg/L	Inorganic	Activated Alumina, **Coagulation/Filtration[2]**, Lime Softening[2], Reverse Osmosis, Electrodialysis, Oxidation Filtration
1,2,3-TCP	5 ng/L	Organic	**GAC**
Nitrate	10 mg/L as NO_3	Inorganic	**Ion Exchange**, Reverse Osmosis, Electrodialysis
Uranium (Combined)	20 pCi/L	Radionuclides	**Ion Exchange**, Reverse Osmosis, Lime Softening[2], Coagulation/Filtration
Fluoride	2 mg/L	Inorganic	**Activated Alumina**

[1]Adsorption technology, although not listed as a BAT, will be considered for arsenic treatment in small systems because of demonstrated experience and ease of operation
[2]Not considered BAT for systems <500 service connections

With the exception of 1,2,3-TCP and fluoride, each of the violation types shown in Table 3 have multiple BATs. For this methodology, treatment approaches were limited based on the assumption that liquid stream residuals disposal is not available on-site at impacted systems. This assumption eliminates processes like reverse osmosis and electrodialysis because the residuals volume requiring disposal would be physically and cost prohibitive. Further, while processes like lime softening may be effective for some contaminants, they are rarely implemented for impacted systems. Capital and operational costs are developed for the technologies in bold in Table 3, with the exception of arsenic where adsorption was assumed for systems of with less than 500 service connections due the relatively simple operations when compared to coagulation/filtration.

Estimating Water Treatment System Capital Costs

Water treatment solutions vary considerably based upon site-specific considerations. In some cases, water systems that have multiple wells install water treatment systems on only the wells that are impacted by contaminants that pose a threat to human health. In other cases, if multiple wells in a water system are impacted by the same contaminant(s), pumping the impacted groundwater to a centralized treatment facility may be more cost effective. Due to the lack of individual well location data, this methodology cannot develop costs associated with centralized treatment.

The methodology cost models consider the fact that treatment costs are generally non-linear as a function of source capacity where the unit cost of water produced tends to increase as production capacity decreases.

Some of the factors that may influence the capital cost associated with installing new treatment systems include:

- Land that may need to be purchased to accommodate treatment system facilities
- The availability of pre-constructed treatment systems vs. the need to construct customized treatment
- Treatment system capacity requirements
- Complexity of system, if treating multiple contaminants
- Electrical improvements for system operation
- Wellhead improvements to overcome additional head loss

This methodology develops Class 5 cost estimates (+100%/-50%) as defined by the Association for the Advancement of Cost Engineering (AACE) International as costs that can be estimated at concept screening where there is little project definition. Developing more detailed cost estimates based on factors such as those listed above is addressed outside of the scope of this methodology and expected to be completed when individual systems undergo a more rigorous individual analysis. For the methodology, treatment system capital costs were derived from a variety of sources including costs models, peer reviewed article and manufacturer supplied information. An example of sources used is provided in Table 4 by example contaminant type.

Table 4. Data sources used for the development of capital cost estimates.

	1,2,3-TCP	Nitrate	Arsenic
Data Source	Vendor Supplied Quotes[31]	EPA Work Breakdown Structure[32]; calibrated to recent bid costs	Peer reviewed literature[33]
Notes	Outputs developed over a range of system sizes, based on commercially available equipment	Calibrated to recent bid costs for small-scale treatment systems	Regressions for costs of coagulation filtration and adsorption systems

[31] Drinking Water Treatment Technology Unit Cost Models
https://www.epa.gov/sdwa/drinking-water-treatment-technology-unit-cost-models
[32] Drinking Water Treatment Technology Unit Cost Models
https://www.epa.gov/sdwa/drinking-water-treatment-technology-unit-cost-models
[33] Hilkert Colby, Elizabeth J., Thomas M. Young, Peter G. Green, and Jeannie L. Darby, 2010. Costs of Arsenic Treatment for Potable Water in California and Comparison to U.S. Environmental Protection Agency Affordability Metrics. Journal of the American Water Resources Association (JAWRA) 46(6):1238–1254. DOI: 10.1111/j.1752-1688.2010.00488.x

Example Capital Cost Methodology for 1,2,3-TCP: Capital costs for 1,2,3-TCP were derived using recently received vendor quotes for water treatment pressure vessel pairs updated to 2020 dollars using Construction Cost Indices published by Engineering News Record. The EPA Work Breakdown Structure for Granular Activated Carbon cost model was considered for this purpose, however the resulting cost estimates were consistently well below both vendor supplied numbers and recently bid projects in California. The vendor-supplied estimates were averaged by vessel size and translated to an installed cost using an engineering multiplier of approximately 2.4x equipment cost. The multiplier accounts for items such as installation, electrical and instrumentation and controls, general civil, planning, engineering, legal and permitting, construction administration services, and project contingency.

Treatment equipment was sized assuming lead-lag configuration with a minimum combined empty bed contact time (EBCT) of 10-minutes. Lead-lag vessel pairs were assumed to have diameters of either 6, 8, 10, or 12 feet which are readily commercially available. GAC bed depths were fixed based on the standard weight of carbon for a given vessel size assuming GAC with a specific gravity of 0.54. Note that the mass and therefore volume of carbon in the 10-ft and 12-ft vessels is the same. The benefit of 12-ft vessels is realized through lower headloss and therefore lower operational cost and were selected for this reason. Table 5 shows the vessel diameter, accommodated flow ranges, and corresponding mass of GAC in each vessel. In the cases where the flow rate is greater than can be accommodated by a single pair of 12-ft vessels (e.g. > 875 gpm) a configuration with multiple vessel pairs is considered for the capital cost estimate.

Table 5. GAC vessel diameter, mass of carbon and flow range

Vessel Diameter (ft)	Mass of GAC (lb/vessel)	Flow Range (gpm)	Equipment Cost ($)
6	6,000	0 – 250	$421,000
8	10,000	251 – 425	$517,000
12	20,000	426 – 875	$720,000
Two Pair - 12	20,000	876 – 1,750	$1,440,000

Estimating Water Treatment System Operation and Maintenance Costs

While capital costs are an important factor to consider in the evaluation of water treatment solutions, it is just as important to have an understanding of the expected annual costs to operate and maintain a water treatment system. Operational costs for consumables are typically driven by the volume of water that requires treatment annually and the expense of having a certified operator oversee the treatment process. Examples of costs to be considered will include the following:

- Consumables
    - Chemicals such as ferric chloride, sulfuric acid, caustic soda, etc.

    - Media replacement: Granular activated carbon (GAC), ion exchange resin, green sand, activated alumina, other adsorbents, etc.
    - Pre-filter replacement
- Disposal of water treatment residuals:
    - Ion exchange brine, coagulation filtration dewatered solids, spent media
- Electricity
- Labor

Operational costs have been estimated soliciting costs for consumables including chemicals and media. Electrical costs were estimated based on the median cost of electricity in California and assuming a 10 PSI pressure loss across the system. Labor costs are included in the estimate based on the average salaries for operators with appropriate certification levels in California. The cost of water treatment residuals disposal can be more variable. Options available for disposal may vary depending on the volume of residuals that are estimated annually and whether the residuals will be able to be sent to a sewer or if they will require land disposal. A 20-year operations and maintenance cost will be used to develop a lifecycle cost comparison.

Example Operational Cost Methodology for 1,2,3-TCP: The primary driver for 1,2,3-TCP operational costs is the periodic replacement and disposal of the spent GAC media. In this case, the throughput performance estimate of 38,200 bed volumes cited in the EPA Work Breakdown Structure (WBS) model was found to be sufficiently adequate for this purpose of this analysis. The WBS also cites costs for virgin carbon ($1.89/lb-GAC), transportation ($0.27/lb-GAC), and disposal ($0.004/lb-GAC). These costs were normalized to a standard production cost equivalent to $0.22/1,000 gallons of water produced. Additional costs were then applied for operational support, analytical costs, and increased electrical costs required to pump the water through the treatment system.

Point of Use/Point of Entry Treatment Costs

Point of Use or Point of Entry treatment is considered an option for water systems with less than 200 connections and for domestic wells due to the complexity of monitoring and addressing units with individual residences in order to meet regulatory standards. As previously discussed, Point of Entry Granular Activated Carbon (GAC) treatment is considered in the case of 1,2,3-TCP, or other volatile organic compounds to address health impacts of breathing the compounds during exposure in the shower. Point of Use treatment is considered for most commonly occurring inorganic contaminants (for example nitrate or arsenic). Limited installations of this type of treatment have been completed in California, and the costs are not always clearly documented. The costs of POU and POE treatment have been developed based on projected costs detailed in Table 6 and Table 7. The methodology assumes full replacement of the POU or POE treatment unit at 10 years.

Table 6. Estimated Capital Cost (per connection) for POE and POU Treatment

POE GAC Treatment		POU Reverse Osmosis Treatment	
Estimated Cost per Unit[34]	**Installation Labor Cost per Unit ($100 / hr)**	**Estimated Cost per Unit[35]**	**Installation Labor Cost per Unit ($100 / hr)**
$3,000	$2,400	$1,500	$800

Table 7. Estimated Annual Operations and Maintenance (O&M) for POE and POU Treatment

POE GAC Annual O&M per Connection				POU RO Annual O&M per Connection			
GAC replacement (2x/year)[36]	Labor ($100/ hr)	Analytical ($125 2x/year)[37]	Total	Membrane Replacement (2x/year)[38]	Labor ($100/ hr)	Analytical ($20 2x/yr)	Annual Total
$410	$200	$250	$860	$100	$200	$40	$320

Considerations Beyond Construction of Water Treatment Facilities

Some water system challenges may not be resolved with additional constructed treatment. For instance, inconsistent water pressures may be of concern for some systems, and therefore may require booster pumps. In other cases, a system may rely a well that is incapable of producing enough water to satisfy peak demand, thereby requiring a storage tank to alleviate the problem. With this in mind, the following are some examples of needs for which high-level cost[39] estimates have been or are being developed:

- Water storage installation
- Booster pump installation
- Electricity generator installation
- Pipe replacement
- Meter installation

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[34] Based on costs of available POE treatment units in California.
[35] Porse, Erik, 2019. Sacramento State Office of Water Programs. Unpublished. Also used in the interim solutions cost part of the Needs Assessment project completed by Gregory Pierce at UCLA. Corona added operator labor costs and analytical costs on an annual basis.
[36] Based on vendor recommendations and pricing.
[37] Pricing quotes provided by BSK Analytical, in Fresno, California.
[38] Based on vendor recommendations and pricing.
[39] Costs for the major capital improvements on this list will be provided by QK, Incorporated, which is an engineering design firm in the Central Valley.

- SCADA installation
- Well installation
- Well destruction
- Backflow prevention assembly installation[40]

The information gathered during the review of limited data in the sanitary surveys for HR2W systems in Kern County will be used to identify additional costs that should be expected for certain challenges HR2W and At-Risk systems may be experiencing.

Cost Estimation Level of Accuracy

The methodology described above corresponds with a Class 5 cost estimate as defined by AACE International. Class 5 cost estimates are considered appropriate for screening level efforts and have a level of accuracy ranging from -20% to -50% on the low end and +30% to +100% for an encompassing range of -50% to +100%. For the developed costs, the central tendency of the cost estimates will be shown; however, it is important the reader view each value with the accuracy in mind. For example, if a cost of $100 is presented the corresponding range of anticipated costs is $50 to $200.

Step 5: Select Solution for Fund Expenditure Plan Purposes

Once the Cost Assessment Model evaluates the long-term sustainability and reliability of the potential modeled solutions in conjunction with costs, a final modeled solution will be selected for the system or domestic well. This selected modeled solution is only for the purpose of developing an overall projected budget need for the State, does not dictate the solution that a system will select to achieve compliance and long-term resiliency. The ultimate solution that will be implemented should involve more detailed investigation of each water system and should include the input of the community and other stakeholders.

Step 6: Aggregation of Estimated Costs

The estimated costs of the selected solutions for HR2W systems, At-Risk public water systems, tribal water systems, state small water systems, and domestic wells will be aggregated into a statewide cost estimate. This cumulative statewide cost estimate is meant to provide a broad overview of the potential projected demand for the Safe and Affordable Drinking Water Fund. The aggregated cost estimate will be conducted annually and will be included in the Fund Expenditure Plan.

Step 7: Identify Funding Needs and Funding Gap

Although the SAFER Program has been allocated up to $130 million and year for ten years, it is anticipated that it will not be sufficient to address all of the issues identified by the Need Assessment. Therefore, Pacific Institute, a subcontractor to the UCLA contract is developing an approach to (1) evaluate the funding alternatives available for both interim and long-term solutions identified by the Cost Assessment Model and (2) estimate the gap between the funding potentially available and the amount needed over

[40] Costs provided by Backflow Prevention Specialists in Sunnyvale, CA

time. These tasks will help the State Water Board inform future Fund Expenditure Plans and be used to communicate the SAFER Program's funding needs to decision makers and stakeholders.

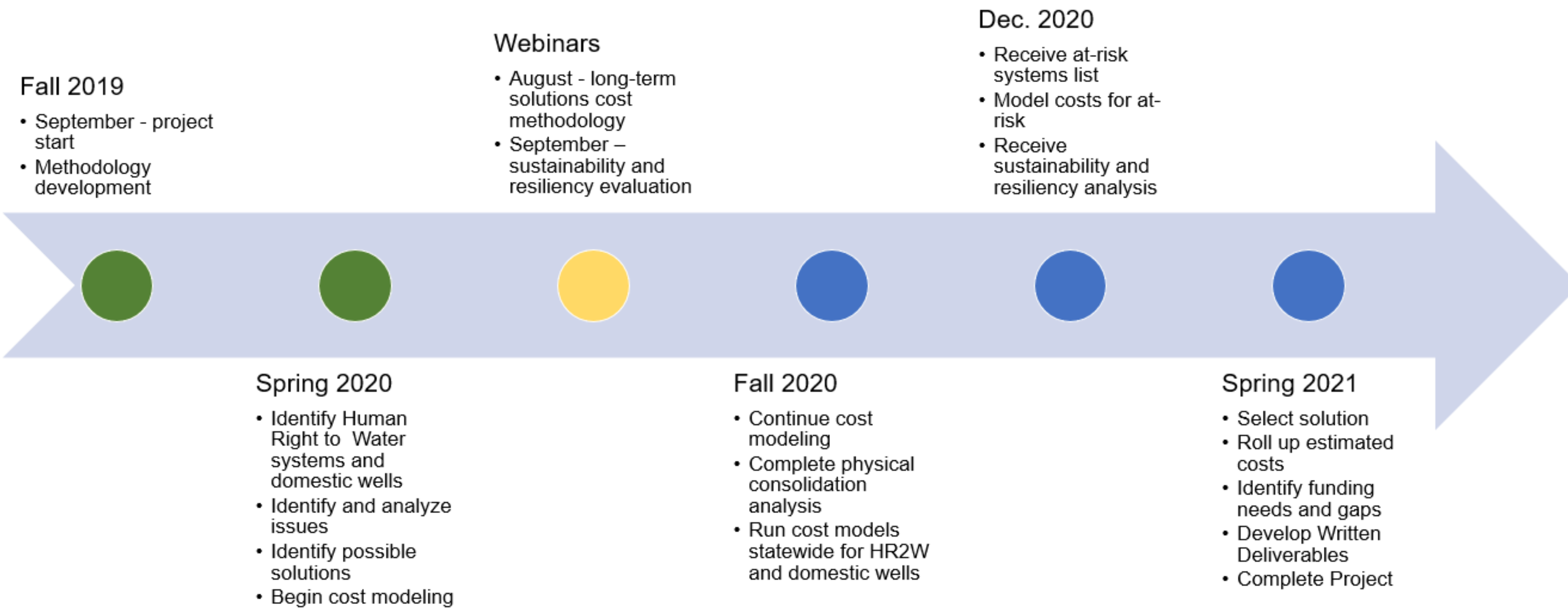
To accomplish these tasks, the Pacific Institute is, first, compiling a list of state, federal, and private funding options potentially available to support the modeled solutions for HR2W systems and At-Risk systems. Second, the Pacific Institute is designing a process to efficiently match identified solutions with potential funding sources and to prioritize matches to ensure that the available funds address the greatest need. Third, the amount of potential funding needed will be compared to the amount of funding available, over time.

Current Status and Next Steps

The Cost Assessment Model will be completed by the first quarter of 2021. Figure 10 provides a summary of the development timeline. The treatment cost models are currently undergoing quality assurance and quality control review. Estimated costs for non-treatment items are anticipated to be developed and reviewed in September 2020; they will then be incorporated into the existing cost models. In the last quarter of 2020, work will continue on the physical consolidation analysis, and the cost models will be applied statewide for the most up-to-date list of HR2W systems and domestic wells. In December 2020, the list of water systems that are considered At-Risk is anticipated from UCLA and the sustainability and resilience assessment from Sacramento State. After the list of At-Risk systems is received, the solutions cost estimates will be completed for those systems.

At the conclusion of this project, the methodology and data developed will be used by the State Water Board's Needs Analysis Unit to update the 2021-22 Fund Expenditure Plan. Moving forward, the State Water Board will continue to refine the Cost Assessment Model through a stakeholder-driven process.

Figure 10. Long-Term Costs Assessment Model Development Timeline



Appendix A – Geographic Information System and Database Methodologies

GIS Methodology

Table A1 and Table A2 provides a list of data sources for water system locations, boundaries, compliance status and economic status estimation that have been identified for use in the GIS effort. At this time, we have identified and gathered data for 9,802 water systems.

Table A1. Data Sources for GIS Analysis

Dataset	Source Agency	Original Feature Count	Notes
Human Right to Water[41]	State Water Board	3,279	Compliance status, analyte data
Monterey County SWS Out-of-Compliance 2019 03	Environmental Justice Coalition for Water (EJCW)	233	Merged with Human-Right-to-Water compliance data
California Census Block Groups[42]	U.S. Census Bureau Tiger/Line Shapefiles	23,212	GIS polygon data
Median Household Income 2013-2017 California Block Group[43]	U.S. Census Bureau American Fact Finder	23,213	Joined to block groups to provide DAC statuses. Includes average MHI data for 2013-2017.

[41] Exceedance and Compliance Status of Public Water Systems
https://www.arcgis.com/apps/MapJournal/index.html?appid=143794cd74e344a29eb8b96190f4658b
[42] Data.Gov-California Census Block Groups
https://catalog.data.gov/dataset/tiger-line-shapefile-2016-state-california-current-block-group-state-based
[43] United States Census Bureau-Median Household Income 2013-2017 California Block Group
https://data.census.gov/cedsci/table?q=B19013&tid=ACSDT1Y2018.B19013&hidePreview=false

Table A2. Water System or Domestic Well Locational Data

Dataset	Source Agency	Original Feature Count	Notes
California Water System Service Areas[44]	Tracking California	4,696	Public water system boundaries
RCAC Small Water Systems[45]	Rural Community Assistance Corporation (RCAC)	1,132	Merged with California Water System Service Areas
Monterey County Revised Water System Boundaries[46]	State Water Board staff	6,676	Multiple parcel features per system. These corrected boundaries were used in the physical consolidation analysis.
Monterey County Small Water Systems[47]	Environmental Justice Coalition for Water (EJCW)	2,935	Merged with California Water System Service Areas
Water System Well Locations[48]	State Water Board's GAMA Program	22,672	Used to better locate Human Right to Water Systems without accurate boundaries
Domestic Well Locations and Modeled Water Quality[49]	State Water Board's GAMA Program	347,592	Domestic wells drilled

44 Tracking California Water Boundary Tool used for Water System Service Areas was retried on July 1, 2020. https://trackingcalifornia.org/water/map-viewer
45 RCAC Small Water System dataset contains information from the following counties; Colusa, Contra, El Dorado, Fresno, Glen, Humboldt, Kern, Kings, Lake, Mariposa, Merced, Mono, Nevada, Plumas, Riverside, San Bernardino, San Diego, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Shasta, Solano, Sutter, Tulare, Ventura and Yolo counties. Unpublished.
46 Provided by William Allen with the Board. Unpublished.
47 A pdf version of the map can be viewed at "The GIS data was provided by EJCW" Unpublished. https://www.co.monterey.ca.us/home/showdocument?id=67378
48 GAMA Groundwater information System https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp
49 Needs Analysis GAMA Tool https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=292dd4434c9c4c1ab8291b94a91cee85

Dataset	Source Agency	Original Feature Count	Notes
Building Footprint Method Water System Boundaries [50]	Pacific Institute	56	Revised boundaries based on where buildings are within a system. Used in selected situations for the physical consolidation analysis.

Water System Locations and Boundaries

To support cost estimates based on potential pipeline lengths and other factors, the accuracy of water system locations and service area boundaries is important. Where available, more detailed estimates of water system locations, especially for small systems, and boundaries have been integrated into the water systems dataset.

Water system boundaries from the public water systems serve as the starting point for this dataset. However, this dataset does not include locations or boundaries for most small systems. To incorporate small systems, multiple small system datasets have been mined, merged and joined with the California Water System Service Area dataset. As needed, the small systems have been located in GIS using the Groundwater Ambient Monitoring and Assessment (GAMA) Program Groundwater Information System's Groundwater Well Locations dataset based on water system identification, or reverse geocoded to addresses provided from the raw sources. State small water system locational data from a recent RCAC project was incorporated. Data was not available for all counties, and the data was provided in a variety of formats. Domestic well locational data is only available as a count per square mile. Each dataset has limitations and inaccuracies and pending improvements to the locations of water systems and boundaries will increase the accuracy of future analyses. These data, summarized in Table, have been integrated into the final water systems data layer.

Database Methodology

The database developed by Corona Environmental houses all relevant data for the project, including information required for and generated by the GIS and cost evaluation efforts. The database is a PostgreSQL (Postgres) database managed using pgAdmin, an open source administration and development platform for Postgres. The open source software R for statistical computing is used as needed for data analysis and formatting data tables ahead of uploading to the PostgreSQL database. The following sources have been incorporated into the database:

- Safe Drinking Water Information System (SDWIS) federal reports data[51]

[50] Shimabuku, Morgan, 2019. Pacific Institute. *Boundary Refinement Methods and Notes*. Unpublished.
[51] USEPA. SDWIS Federal Reporting Services System.
https://ofmpub.epa.gov/apex/sfdw/f?p=108:200:::NO::: Accessed December 5, 2019.

- State Water Board's Division of Drinking Water water quality data[52]
- Water system economic status from the GIS analysis
- HR2W data[53]
- Selected information from the electronic annual reports[54] and information from a few select sanitary surveys[55]

The data developed by Corona Environmental will be delivered to the State Water Board in March 2021 and maintained by the Division of Drinking Water's Needs Analysis Unit.

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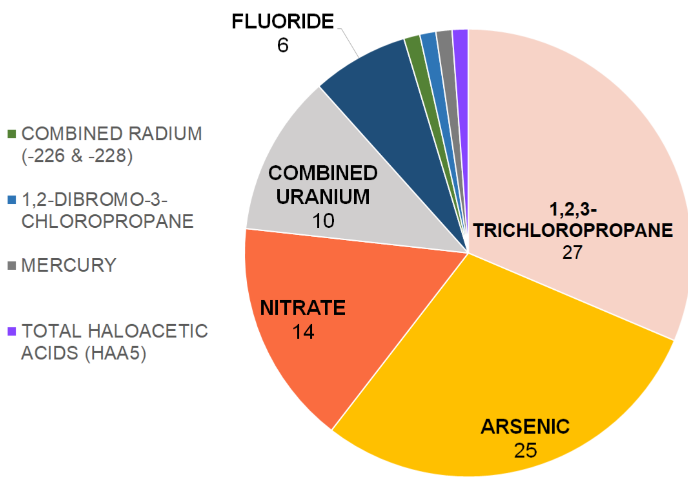
[52] California SWRCB. EDT Library and Water Quality Analyses Data and Download Page. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/EDTlibrary.html Accessed March 17, 2020.
[53] California SWRCB. Human Right to Water Portal: Water System Drinking Water Data. https://www.waterboards.ca.gov/water_issues/programs/hr2w/ Accessed October 28, 2019.
[54] Provided by the State Water Board
[55] Provided by the State Water Board

Appendix B – Kern County Case Study

In order to estimate the cost of providing solutions to HR2W systems and At-Risk systems, the Cost Assessment Model (Model) needs to identify the challenges and issues, beyond water quality, that these systems are struggling with in order to provide sustained safe and accessible drinking water. Due to the timing of this project, the Risk Assessment risk indicators are still under development and could not be utilized to determine possible challenges. Therefore, Corona conducted a case study of the HR2W systems in Kern County to identify and refine the possible challenges the Model may need to address. Kern County was selected for initial analysis because it has 61 of the state's 311 HR2W listed systems. Figure B1 summarizes the different water quality violations in Kern County.

Figure B1. Kern County HR2W Systems Water Quality Violations

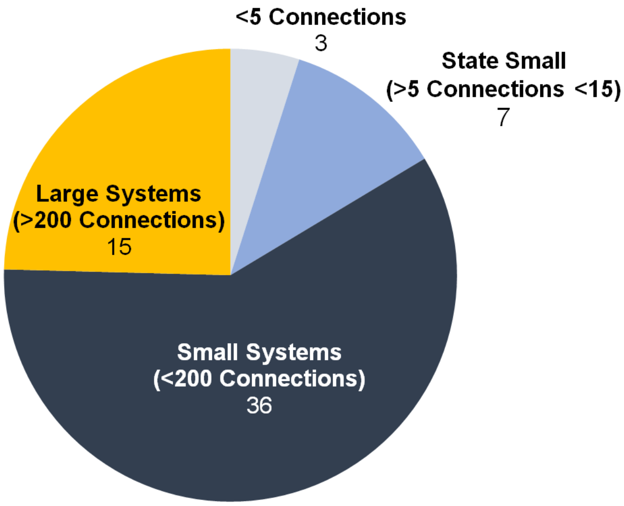


1,2,3-Trichloropropane (TCP) violations are the most numerous in Kern County. This is a fairly new regulation, which became effective in December of 2017[56], and the Central Valley is heavily impacted by TCP groundwater contamination. Although the federal arsenic MCL was announce in 2001[57] and became effective in 2006, there are still 25 systems in Kern County that have not been able to come into compliance.

One of the common factors shared by HR2W systems is small system size. Smaller systems often have fewer technical, managerial, and financial resources to leverage. The size distribution of the Kern County HR2W systems is shown in Figure B2 with 75% of systems serving fewer than 200 connections.

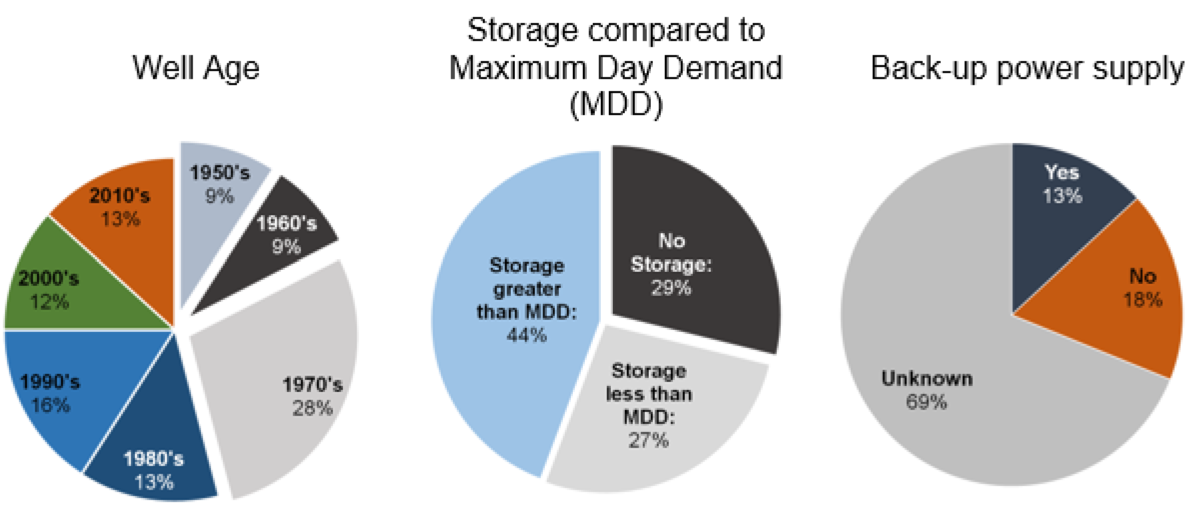
[56] State Water Board, 2017. *Information Pertaining to this Regulatory Proposal*. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/SBDDW-17-001_123TCP_MCL.html
[57] US EPA, 2001. *Technical Fact Sheet: Final Rule for Arsenic in Drinking Water*. https://nepis.epa.gov/Exe/ZyPdf.cgi?Dockey=20001XXE.txt

Figure B2. Kern County HR2W Systems by Number of Service Connections



In addition to the water quality challenges, these systems also often face other infrastructure issues. To examine these challenges in a more quantitative way, the sanitary surveys[58] for 60 of the HR2W systems in Kern County were analyzed to look at source age, source capacity, and storage capacity. Figure B3 summarizes the proportion of systems that may have additional infrastructure needs. Nearly half (48%) of these systems only have one water source, which would not be allowed in a newly constructed water system.[59]

Figure B3. Additional Issues Identified



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[58] The most recent Sanitary Surveys for Kern County Human Right to Water systems were provided by the State Water Board in PDF format.

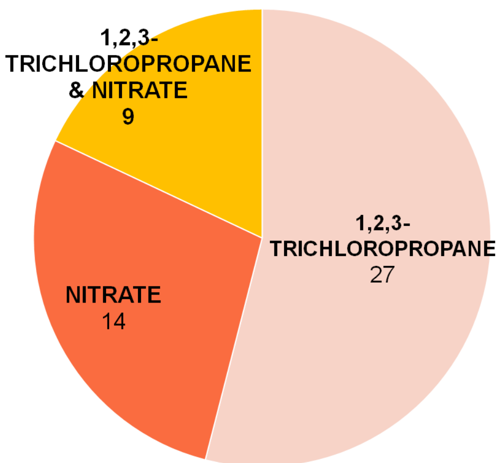
[59] Title 22 Code of Regulations, 2019. Section 64554, (c) https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dw_regulations_2019_04_16.pdf

A more system specific analysis would be required to understand how many of these systems meet the storage requirements outlined in the regulations,[60] however it is worth noting that only 44% of the systems clearly have enough storage to meet Maximum Day Demand (MDD).

This detailed analysis will not be performed for systems in other counties, but this data will be used to inform the overall cost analysis statewide.

When a water source has co-occurring contaminants (e.g. more than a single contaminant) that require treatment, the cost to treat the water can increase dramatically. In Kern County, the most common example of co-occurring contaminants requiring treatment includes both nitrate and TCP at levels over the MCL, as shown in Figure B4. Another group of systems to consider are those with co-occurring contaminants that are not yet over the MCL, but impact treatment decisions.

Figure B4. Co-occurring Contamination of Wells with Nitrate and TCP in Kern County HR2W Systems



At this time, water quality information is lacking for State Small Water Systems and domestic wells in Kern County.

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60 [Title 22 Code of Regulations, 2019. Section 64554, (a)(2)](https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dw_regulations_2019_04_16.pdf)
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dw_regulations_2019_04_16.pdf