ATTACHMENT C5:
ADDITIONAL COST ASSESSMENT RESULTS & REGIONALIZATION ANALYSIS

Attachment to the State Water Resources Control Board
2021 Drinking Water Needs Assessment
Cost Assessment Methodology Appendix C
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2021_needs_assessment.pdf

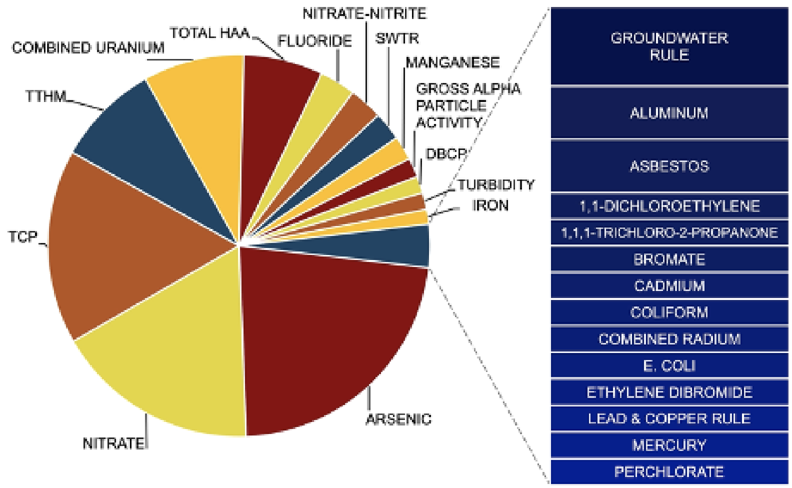
INTRODUCTION

This attachment provides supplementary information on the results of the cost assessment. No system specific costs are identified because the costs presented here are for broader planning purposes only and should not be used for making system specific decisions.

HR2W LIST INCLUDED IN THE COST ASSESSMENT

The long-term solution component of the 2021 Cost Assessment utilized a Human Right to Water (HR2W) list that was generated by the State Water Board on December 1, 2020. This list contained 305 public water systems (PWSs) that were out of compliance for either a primary or secondary MCL violation. Figure C5.1 summarizes the analytes causing violations among the HR2W list systems.

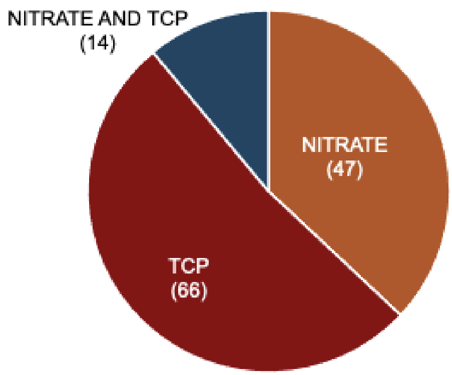
Figure C5.1: All HR2W List Systems' Violations by Analyte Occurrence



A closer look at the analyte violations in the HR2W list systems shows that arsenic, nitrate, and 1,2,3-TCP are the most frequently occurring violations, representing 56% of all exceedances. All 21 of the large HR2W list water systems were out of compliance for 1,2,3-TCP. The Maximum Contaminant Level (MCL) for 1,2,3-TCP was set in 2017 in California. It is likely that the large water systems that currently have a 1,2,3-TCP violation will be able to install treatment and come back into compliance, while many of the smaller systems many not have the technical, managerial, and financial capacity available to achieve compliance with existing regulations or to keep up with new regulations.

A substantial minority of HR2W list systems were also found to be out of compliance for multiple analytes. This is concerning because different treatments may be required for each analyte, resulting in higher solution costs. For example, if a system has a nitrate violation and a 1,2,3-TCP violation, treatment for these contaminants requires two different treatment technologies, which increases the expense of maintaining water quality compliance in the long-term. A summary of HR2W list systems with nitrate and 1,2,3-TCP violations alone and co-occurring, is shown in Figure C5.2.

Figure C5.2: Count of systems with a nitrate (excluding 1,2,3-TCP), 1,2,3-TCP (excluding nitrate), or nitrate and TCP co-occurring violation. Nitrate and 1,2,3-TCP sections may include other co-contaminants



In Figure C5.2, Nitrate and 1,2,3-TCP, two of the most common violation analytes, are co-occurring in 14 systems. These systems would require both GAC to treat the 1,2,3-TCP and strong-base anion exchange to remove nitrate.

AT-RISK STATE SMALL WATER SYSTEMS AND DOMESTIC WELLS MODELED WATER QUALITY RESULTS

The water quality of State Small Water Systems (SSWS) and domestic wells were modeled to estimate the number at risk of potential water quality issues, using the groundwater ambient monitoring and assessment (GAMA) methodology[1] outlined in Attachment C1. SSWS were classified as such if they had no PWSID, had a population less than 26, and had fewer than 15 connections. The water quality model was for a limited number of parameters: 1,2,3-TCP, arsenic, hexavalent chromium, nitrate, perchlorate, and uranium. Hexavalent chromium is not discussed further since there is no current regulation. A summary of the At-Risk SSWS and domestic wells is shown in Table C5.1.

Table C5.1: Total SSWS and Domestic Wells with Modeled Water Quality Issues

System Type	# of Systems	Modeled Not At-Risk Water Quality Issues	Modeled At-Risk of Water Quality Issues
SSWSs	1,848	1,393	455[2]
Domestic Wells	347,592	284,985	62,607

[1] The long-term Cost Assessment Model utilizes an older set of At-Risk PWSs, SSWSs, and domestic wells. The most notable difference is the number of At-Risk domestic wells 77,569 for interim modeled solutions vs. 62,607 for long-term modeled solutions.

[2] Using the GAMA model, there are 693 At-Risk SSWSs. In Monterey county, actual water quality data was used instead of the modeled water quality. This brought the At-Risk system count down to 455.

Of the SSWS, 24.6% had modeled water quality issues, while of the domestic wells, 18% had a modeled water quality issue. A more detailed breakdown of the modeled water quality issues is shown for SSWS in Table C5.2. Please note that the total reflected in the table is using the GAMA model methodology accessible at the time of this analysis. In the future it will be critical to sample these sources to determine the actual occurrence of these parameters. The GAMA model estimated 693 At-Risk SSWS. The total number of At-Risk SSWSs used in the cost model was 455, because actual water quality data was used in Monterey county, rather than modeled water quality.

Table C5.2: SSWSs with Modeled Analytes and Analyte Combinations Out of Compliance using GAMA Data

Modeled Water Quality Issue(s)	Count of SSWS
Arsenic only	165
Arsenic and 1,2,3-TCP	7
Arsenic, 1,2,3-TCP, and Uranium	1
Arsenic and Uranium	8
Nitrate only	270
Nitrate and Arsenic	130
Nitrate, Arsenic, and 1,2,3-TCP	1
Nitrate, Arsenic, and Uranium	1
Nitrate and Perchlorate	1
Nitrate, Perchlorate, and 1,2,3-TCP	7
Nitrate and 1,2,3-TCP	21
Nitrate and Uranium	2
Perchlorate only	3
1,2,3-TCP only	61
1,2,3-TCP and Uranium	3
Uranium only	12
TOTAL:	**693**

Similar to the HR2W list systems, arsenic, nitrate, and 1,2,3-TCP were the most commonly modeled analytes of concern in At-Risk SSWS. The most common water quality issue was nitrate only, which accounted for 39% of wells estimated to have water quality issues (Table C5.3). Of the SSWS,182 had modeled water quality issues for multiple analytes. The most frequently co-occurring analytes in SSWS were nitrate and arsenic.

As mentioned above, co-contaminants are important to consider because they can require different treatment technologies. For the co-occurrence of 1,2,3-TCP with any of the other analytes, both POE and POU treatment would be needed. However, in the case of co-occurring arsenic, nitrate, perchlorate, and or uranium, all of these can be removed using the same POU RO technology.

A more detailed breakdown of the modeled water quality issues and their combinations is shown for domestic wells in Table C5.3.

Table C5.3: Domestic Wells' Modeled Analytes and Analyte Combinations Out of Compliance using GAMA Data

Modeled Water Quality Issue(s)	Count of SSWS
Arsenic only	19,810
Arsenic and Perchlorate	22
Arsenic, Perchlorate, and 1,2,3-TCP	2
Arsenic and 1,2,3-TCP	1,270
Arsenic, 1,2,3-TCP, and Uranium	430
Arsenic and Uranium	1,579
Nitrate only	10,800
Nitrate and Arsenic	1,066
Nitrate, Arsenic, and Perchlorate	2
Nitrate, Arsenic, and 1,2,3-TCP	109
Nitrate, Arsenic, and Uranium	145
Nitrate and Perchlorate	293
Nitrate, Perchlorate, and 1,2,3-TCP	42
Nitrate, Perchlorate, and Uranium	20
Nitrate and 1,2,3-TCP	1,815
Nitrate, 1,2,3-TCP, and Uranium	343
Nitrate and Uranium	1,098
Perchlorate only	260
Perchlorate and 1,2,3-TCP	9
1,2,3-TCP only	19,074
1,2,3-TCP and Uranium	408
Uranium only	4,096
Total	**62,693**[3]

[3] In the Cost Analysis 62,607 domestic wells are reported as At-Risk. Initially 62,693 domestic wells were identified; the difference is between the count for MTRS features vs PLSS sections.

Arsenic only was the most commonly modeled water quality issue in the At-Risk domestic wells, accounting for 31% of wells with a water quality issue. Wells with 1,2,3-TCP alone was modeled in 30% of At-Risk domestic wells. The co-occurring contaminant combination of nitrate and 1,2,3-TCP was the most common. In this case, these contaminants have two completely different treatment technologies (POE GAC for 1,2,3-TCP and POU RO for nitrate), thus making it more expensive and complicated to treat these wells.

MODELED PHYSICAL CONSOLIDATION RESULTS

Physical consolidation options have been considered as potential solutions for HR2W list systems as well as those identified as At-Risk PWSs, SSWSs, and domestic wells. To assess the potential for broader application and regional solutions, physical consolidation was also modeled for all small public water systems in California; this included any small system (population < 3,300). Lastly, inclusion of all domestic wells and state and local small water systems (SSWS and LSWS) in potential physical consolidation solutions was examined; domestic wells were considered to the extent that they could be picked up along a pipeline route connecting a small public water system to a compliant larger public water system.

Physical consolidations of SSWS and LSWS with larger compliant systems were considered similarly to domestic wells as potential pickups; as individual pipeline connections depending on proximity; and as part of regional solutions (e.g., clusters of systems). Details of the methodology's assumptions and limitations are included in Attachment C1: Geographic Information System and Database Methodologies.

The results of the physical consolidation assessment are included below. The potential physical consolidations identified are subject to change, based on changes in the underlying datasets and assumptions. Further consideration and implementation of the physical consolidations described herein would be determined by factors beyond the scope of this analysis (e.g., agreements between participating water systems, participation of private well owners, permitting and environmental considerations, etc.). There may be local and regional limitations that will impact the scope of potential physical consolidations. This analysis is thus intended as a one-time snapshot of potential for physical consolidation using different integration possibilities throughout the state (e.g., individual pipelines between joining and receiving systems, picking up domestic wells along a pipeline connecting water systems, connecting clusters of systems to a nearby larger compliant water system). Table C5.4 provides a summary of the number of systems and wells with potential physical consolidation solutions.

Table C5.4: Total system and domestic well counts, count of systems and domestic wells evaluated for physical consolidation, and count of systems and domestic wells with potential physical consolidation solutions

Water System Type	# of Systems	# Evaluated for Physical Consolidation[4]	# w/ Potential Physical Consolidation Solutions
HR2W	305	272	107
At-Risk PWS	630	604	234
All SWS	7,190	7,070	3,201
All SSWS	1,848	1,848	1,006
At-Risk SSWS[5]	455	455	262
All Domestic Wells	347,293	347,293[6]	133,265
At-Risk Domestic Wells[7]	62,607	62,607[8]	25,696

HUMAN RIGHT TO WATER SYSTEMS IN VIOLATION (HR2W)

305 HR2W list systems were identified as having violations of primary MCLs. Only systems having a population of 3,300 or less were evaluated for physical consolidation; of the 305 systems, 33 systems serve a population above that limit, leaving 272 possible HR2W list systems for evaluation in physical consolidation. Options identified are for the individual systems where a potential physical consolidation is either (1) an intersect - when a joining system is already located within a receiving system boundary or (2) a route - when any route between a joining system and a receiving system is less than 3 miles. Physical consolidation potential was identified for 107 HR2W list systems, or 35% of the total (Figure C5.3); the remaining 165 HR2W list systems are too far from potential receiving system boundaries to be reasonably considered for physical consolidation.

[4] Systems without location information were excluded from the analysis.

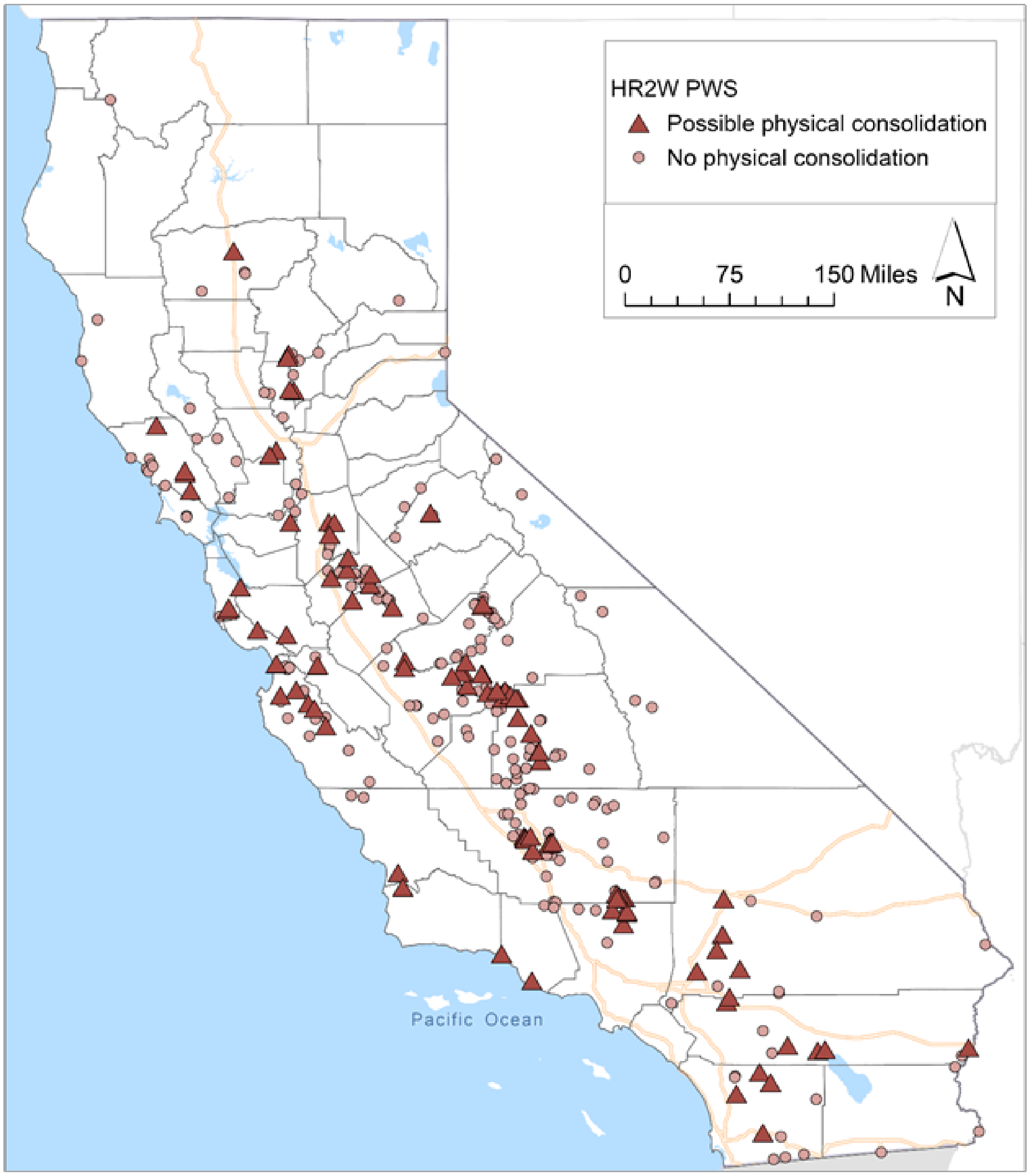
[5] Using the GAMA water quality data, SSWSs were classified as At-Risk with a grade of 4 or more for nitrate, arsenic, perchlorate, 1,2,3-TCP, or uranium. 693 At-Risk SSWS were identified based on the GAMA model only. 455 At-Risk SSWS were identified based on GAMA model data and actual Monterey County water quality data, where available.

[6] Pickups only.

[7] Using the GAMA water quality data, domestic wells were classified as At-Risk with a grade of 4 or more for nitrate, arsenic, perchlorate, 1,2,3-TCP, or uranium.

[8] Pickups only.

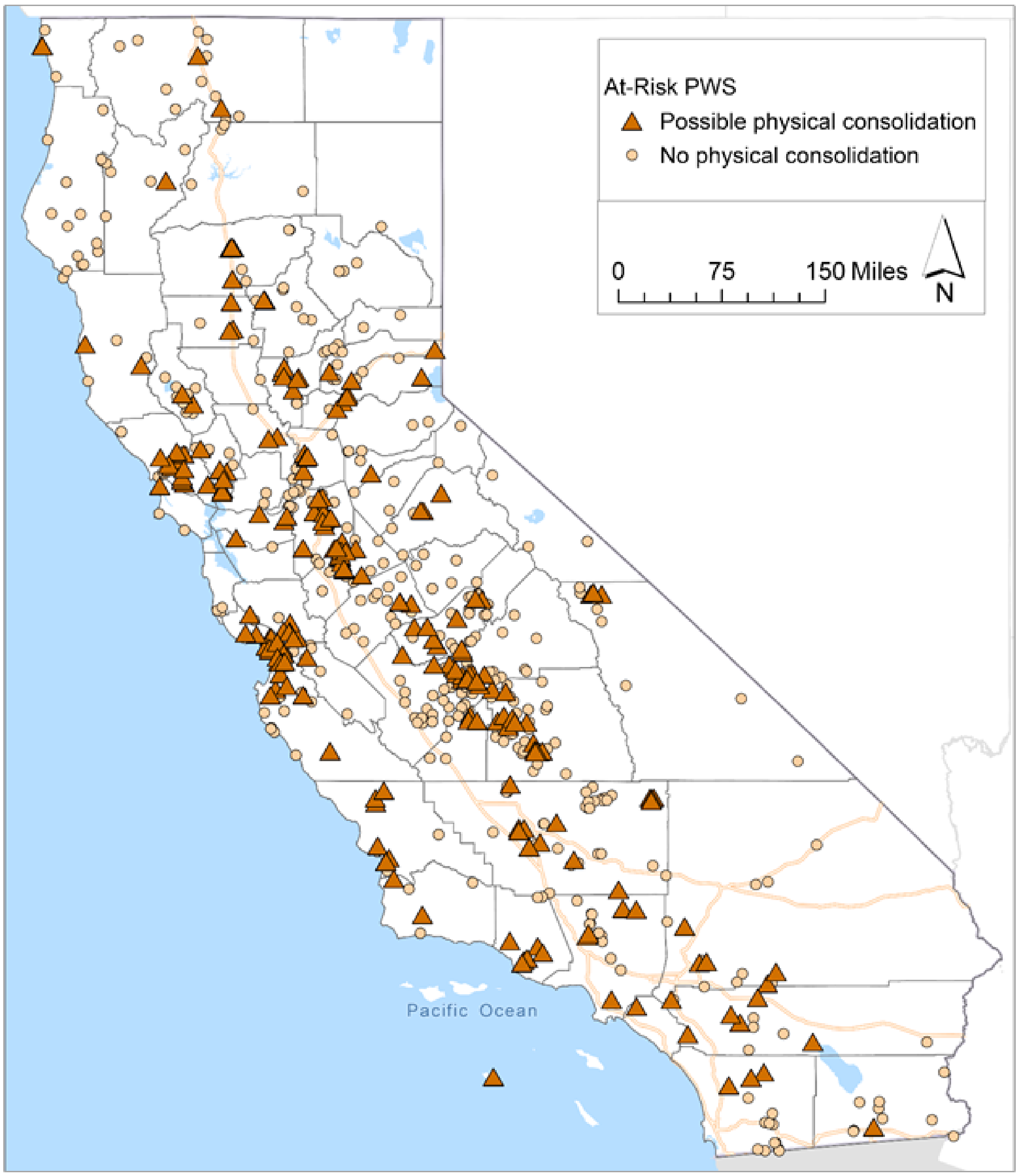
Figure C5.3: HR2W List Systems and the potential for Physical Consolidation



AT-RISK WATER SYSTEMS

As illustrated in Figure C5.4, of the 630[9] At-Risk PWSs identified, 26 either serve more than 3,300 people or did not have usable location information; the remaining 604 were evaluated for physical consolidation potential as intersects or routes, as described above. For At-Risk PWSs, a potential physical consolidation solution was identified for 234 systems, or 37% of the total.

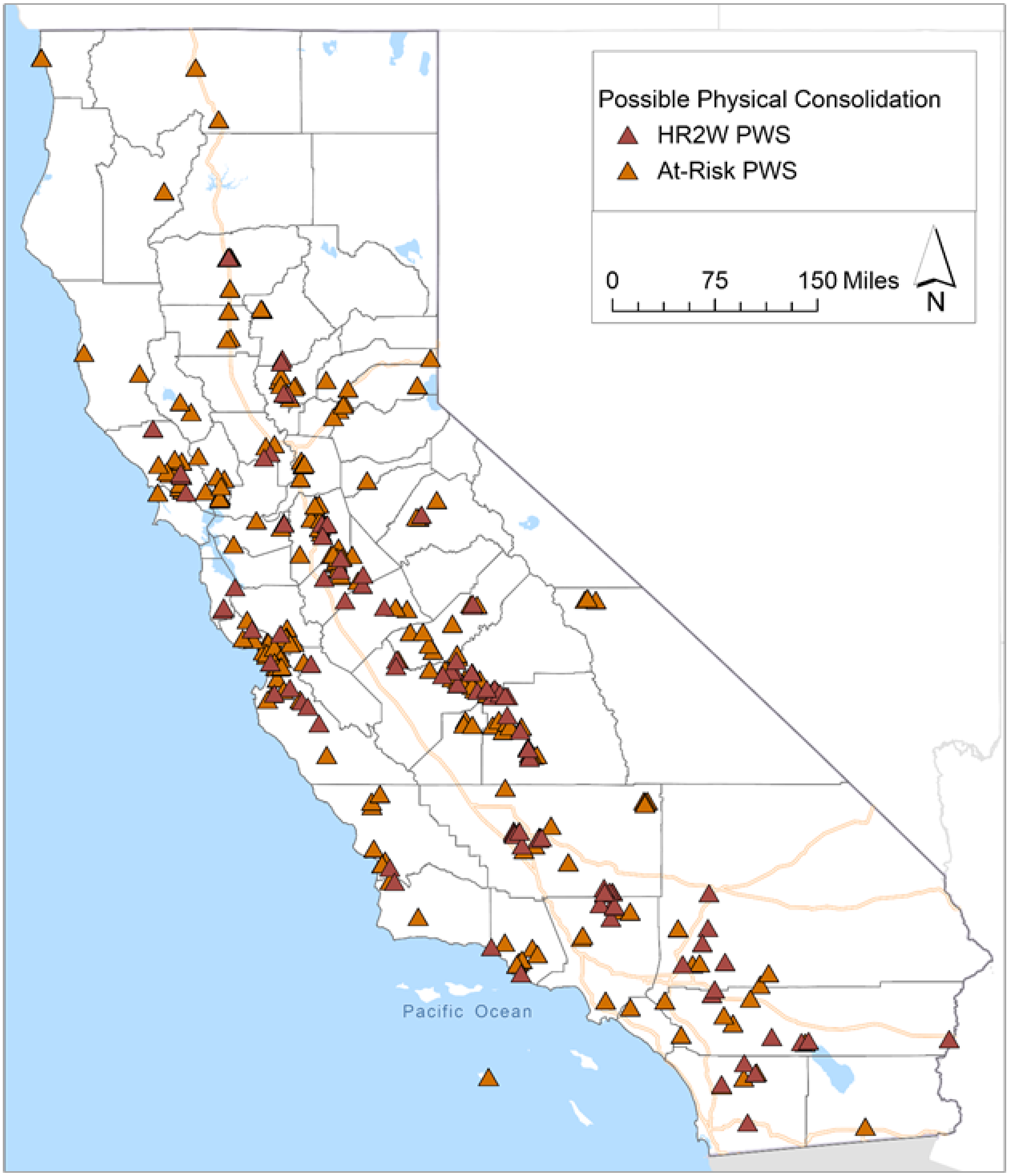
Figure C5.4: At-Risk Systems and the Potential for Physical Consolidation



[9] For the Cost Assessment, 617 At-Risk PWSs and 13 systems from the expanded HR2W list were included, for a total of 630 At-Risk PWS.

Figure C5.5 illustrates the HR2W list systems and the At-Risk PWSs for which a potential physical consolidation solution was identified.

Figure C5.5: Overlay of HR2W and At-Risk systems where physical consolidation was identified as a possible solution



ALL SMALL WATER SYSTEMS (SWS)

Of the 7,190 small public water systems (excludes SSWS but includes HR2W list and At-Risk PWSs), the potential for physical consolidation was also evaluated for all systems with location information, totaling 7,070 systems. A potential physical consolidation solution was identified for 3,201 systems, or 45% of the total.

The potential for physical consolidation in each county is summarized in Table C5.5. Figure C5.6 illustrates potential physical consolidations in a region of Kern County. County-wide, a total of 115 SWS were found that could consolidate with larger receiving systems in Kern County; of the 115 total systems 21 are HR2W list systems and 15 are At-Risk PWSs. Figure C5.7 illustrates potential mergers in a region of Monterey County. County-wide, a total of 173 SWS were found that could consolidate with larger receiving systems in Monterey County. Of the 173 SWS, 7 are HR2W list systems and 14 are At-Risk PWSs.

Table C5.5: Count by County of Small Systems (serving ≤ 3,300 people) with Potential Physical Consolidation Solutions

County	SWS	HR2W	At-Risk
ALAMEDA	17	-	-
ALPINE	1	-	-
AMADOR	26	-	1
BUTTE	44	2	2
CALAVERAS	16	-	-
COLUSA	6	-	-
CONTRA COSTA	87	1	4
DEL NORTE	10	-	2
EL DORADO	70	-	-
FRESNO	116	13	14
GLENN	18	-	3
HUMBOLDT	12	-	-
IMPERIAL	19	-	1
INYO	26	-	3
KERN	115	21	15
KINGS	13	-	4
LAKE	19	-	2
LASSEN	6	-	-
LOS ANGELES	95	5	5
MADERA	80	3	10

County	SWS	HR2W	At-Risk
MARIN	35	-	1
MENDOCINO	30	-	2
MERCED	40	1	3
MONO	9	-	1
MONTEREY	173	7	14
NAPA	149	-	7
NEVADA	27	-	2
ORANGE	18	-	1
PLACER	72	-	6
PLUMAS	4	-	-
RIVERSIDE	134	5	6
SACRAMENTO	92	-	4
SAN BENITO	13	1	1
SAN BERNARDINO	132	6	5
SAN DIEGO	51	4	3
SAN FRANCISCO	6	-	-
SAN JOAQUIN	206	4	20
SAN LUIS OBISPO	107	1	7
SAN MATEO	20	3	-
SANTA BARBARA	65	1	2
SANTA CLARA	83	1	7
SANTA CRUZ	86	1	10
SHASTA	55	-	-
SISKIYOU	16	-	2
SOLANO	39	-	-
SONOMA	272	4	11
STANISLAUS	129	6	10
SUTTER	21	1	3
TEHAMA	53	1	6
TRINITY	1	-	1

County	SWS	HR2W	At-Risk
TULARE	96	9	17
TUOLUMNE	53	1	3
VENTURA	63	2	8
YOLO	36	2	2
YUBA	19	1	3

Figure C5.6: Consolidation Results for a Region in Kern County

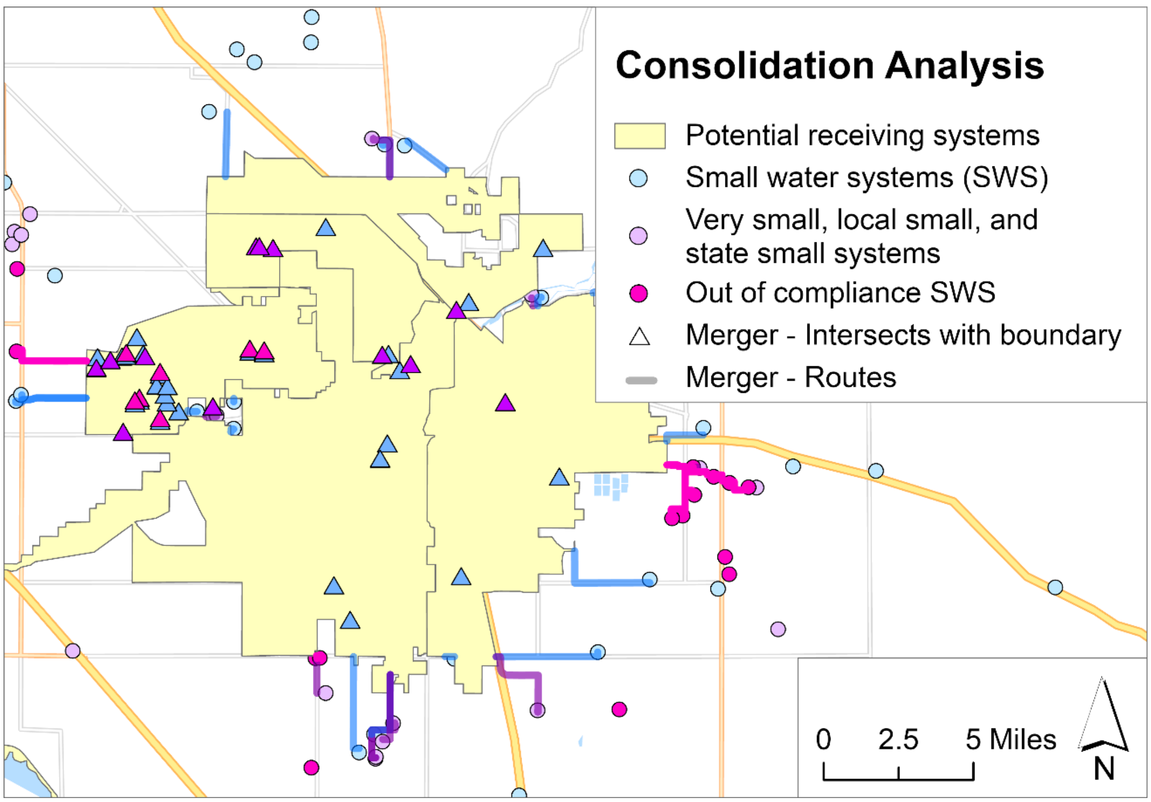
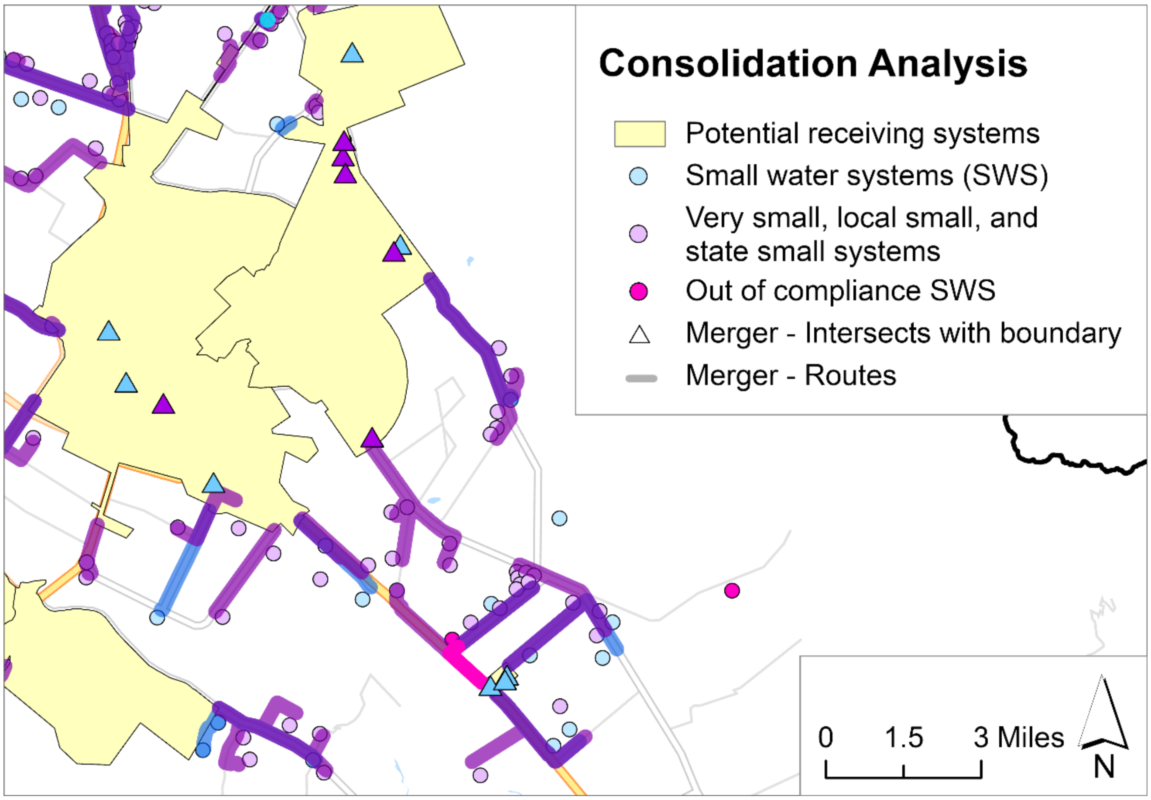


Figure C5.7: Consolidation Results for a Region in Monterey County



PHYSICAL CONSOLIDATION SOLUTIONS FOR STATE AND LOCAL SMALL SYSTEMS

Of the 1,848 SSWS and LSWS with location information, a potential physical consolidation solution was identified for 1,006 systems. Statewide counts of systems for which a physical consolidation solution was identified are listed in Table C5.6 for all SSWS and LSWS systems and for At-Risk SSWS and LSWS; the corresponding counts of systems are included for Kern County and Monterey County for reference. At-Risk systems in this category were identified based on an earlier version of the GAMA Needs Analysis Tool[10] and the associated water quality estimates. SSWS and LSWS are included above in Figure C5.6 for a region in Kern County and Figure C5.7 for a region in Monterey County.

[10] Needs Analysis GAMA Tool
https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=292dd4434c9c4c1ab8291b94a91cee85

Table C5.6: Count of State and Local Small Water Systems (SSWS and LSWS) with Potential Physical Consolidation Solutions by Type of Connection

	Statewide	Kern County	Monterey County
Any SSWS or LSWS			
Direct Routes	1,006	40	540
Pickup[11] with HR2W Route	24	3	14
Pickup with Any Route	362	6	259
Intersect	275	19	81
At-Risk SSWS[12] or LSWS			
Direct Routes	358	18	262
Pickup with HR2W Route	18	3	12
Pickup with Any Route	141	3	110
Intersect	75	12	41

PHYSICAL CONSOLIDATION SOLUTIONS FOR DOMESTIC WELLS

As above for SSWS and LSWS, At-Risk domestic wells were identified based on the GAMA Needs Analysis Tool[13] and the associated water quality estimates. The dataset includes the domestic well count in one square mile sections by Public Land Survey System (PLSS) sections from Department of Water Resources Online System of Well Completion Reports. Of the 347,293 domestic wells included in the dataset statewide, 133,265 have the potential to be picked up by a physical consolidation route or are located within a receiving system boundary. Statewide counts of domestic wells for which a physical consolidation solution was identified are listed in Table C5.7 for all wells and for At-Risk wells; the corresponding well counts are included for Kern County and Monterey County for reference. Figure C5.8 illustrates an example of domestic well pickups. Receiving system boundaries and potential physical consolidation routes overlay the one square mile sections, with domestic well count shown per section.

[11] Pickups refer to state and local small water systems that are located within 0.38 mi of a consolidation route between a small water system and a potential receiving system or are located within a receiving system boundary.

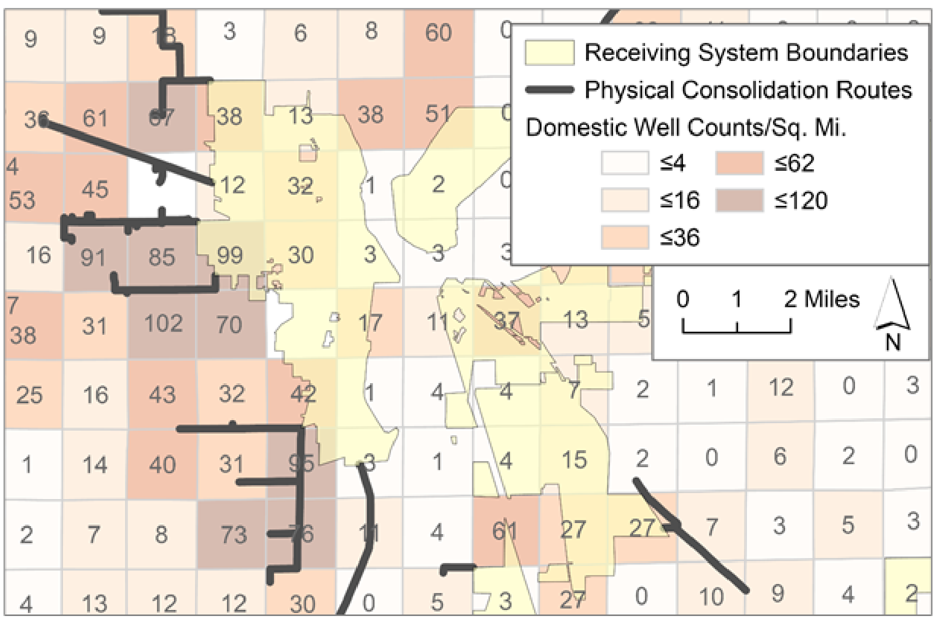
[12] Using the GAMA model water quality data, a SSWS was classified as At-Risk with a grade of 4 or more for nitrate, arsenic, perchlorate, 1,2,3-TCP, or uranium. 693 At-Risk SSWS were identified based on the GAMA model only; the above totals are based on this set of systems. 455 At-Risk SSWS were identified based on GAMA model data and actual Monterey County water quality data, where available.

[13] Needs Analysis GAMA Tool https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=292dd4434c9c4c1ab8291b94a91cee85

Table C5.7: Count of Domestic Well Pickups

	Statewide	Kern County	Monterey County
Any Domestic Well			
Pickup[14] with Any Route	56,566	997	1,841
Intersect	76,699	1,929	633
At-Risk Domestic Well[15]			
Pickup with Any Route	13,169	333	847
Intersect	12,527	940	144

Figure C5.8: Map Illustrating the Potential for Domestic Well Pickups (count of domestic wells is shown for each square mile section)



REGIONAL PHYSICAL CONSOLIDATION SOLUTIONS

Regional physical consolidation solutions can decrease the cost per connection by joining more systems, wells, and connections along a given route or within a physical consolidation

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[14] Pickups refer to state and local small water systems that are located within 0.38 mi of a consolidation route between a small water system and a potential receiving system or are located within a receiving system boundary.

[15] Using the GAMA model water quality data, a SSWS was classified as At-Risk with a grade of 4 or more for nitrate, arsenic, perchlorate, 1,2,3-TCP, or uranium. 693 At-Risk SSWS were identified based on the GAMA model only; the above totals are based on this set of systems. 455 At-Risk SSWS were identified based on GAMA model data and actual Monterey County water quality data, where available.

project. Regional solutions were examined by grouping all routes and intersects by receiving system. All of the individual routes from small systems to the receiving system were merged into a collective route; this is illustrated in Figure C5.9. Table C5.8 provides a comparison of the distance and cost of individual routes versus collective routes for the receiving systems with the 10 highest number of potential joining systems.

Each of the 107 HR2W list system mergers can be viewed individually – as a single pair of systems for a one-to-one merger. Alternatively, each of the HR2W list systems in violation could also be a part of a regional solution including other small systems, domestic wells, and/or state and local small water systems. If regional solutions were implemented to incorporate all of the 107 identified mergers associated with HR2W list systems, as many as 1,101 small, state small, and local small systems could be included in collective routes to the associated 60 receiving systems.

Figure C5.9: Regional solutions - Example of collective routes for an area in Monterey County

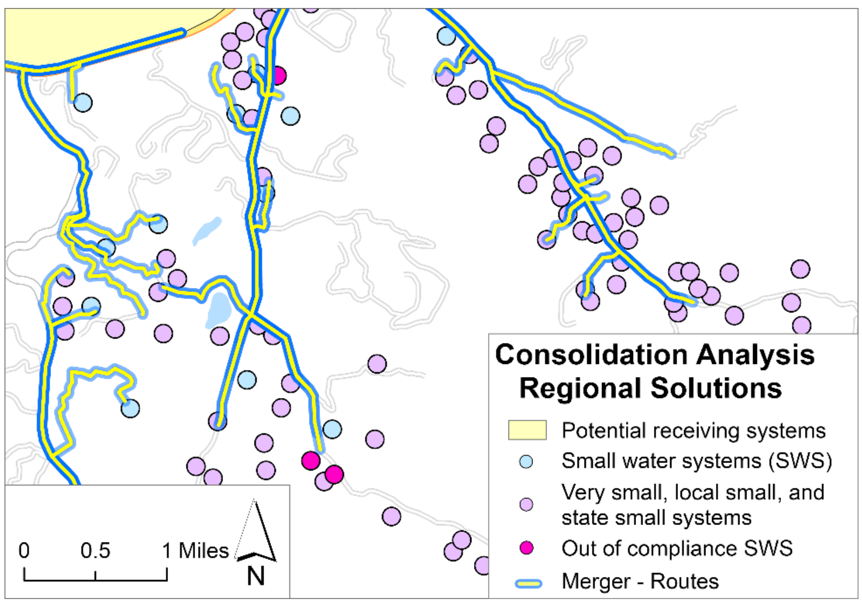

Table C5.8: Regional Modeled Physical Consolidation Costs for the Top 10 Highest Number of Potential Joining Systems

Nearby City (County)	# Potential Joining Systems	Total Distance of Individual Routes (Mi)	Total Distance of Consol. Routes (Mi)	Individual Routes, Pipeline $/Connection	Regional Route, Pipeline $/Connection
Prunedale (Monterey)	177	321.4	32.3	$153,000	$15,000
West Salinas (Monterey)	100	173.3	36.8	$98,000	$21,000

Nearby City (County)	# Potential Joining Systems	Total Distance of Individual Routes (Mi)	Total Distance of Consol. Routes (Mi)	Individual Routes, Pipeline $/Connection	Regional Route, Pipeline $/Connection
Marina (Monterey)	85	138.3	25.4	$39,000	$7,000
Los Lomas (Monterey)	55	93.8	13.6	$169,000	$24,000
Pajaro (Monterey)	55	93.5	22.0	$90,000	$21,000
Fresno[16] (Fresno)	51	78.9	44.6	$38,000	$22,000
East Salinas (Monterey)	38	70.2	19.9	$217,000	$61,000
Sebastopol (Sonoma)	44	64.7	20.7	$118,000	$38,000
Modesto (Stanislaus)	55	60.8	34.6	$43,000	$25,000
Santa Rosa[17] (Sonoma)	44	55.7	30.4	$34,000	$18,000

OTHER ESSENTIAL INFRASTRUCTURE NEEDS COSTS

In addition to the potential solutions discussed above, other infrastructure needs need to be considered because systems on the HR2W list and At-Risk water systems often need other infrastructure upgrades to address system maintenance and reliability. For a full explanation of these costs, please see Appendix C and Attachment C2, *Long Term Solutions Cost Methodology for Public Water Systems and Domestic Wells*. Table C5.9 breaks down the additional required infrastructure needs and the costs for HR2W list and At-Risk PWSs.

[16] The State Water Board is currently collaborating on initial consolidation outreach in this area.

[17] The State Water Board is currently working with the City of Santa Rosa on a regional consolidation of eight water systems. The City had previously completed a regional consolidation of four water systems.

Table C5.9: Summary of Other Infrastructure Needs Costs, by Category, in Millions of Dollars

OEI Category	HR2W Systems (<10K population)	HR2W Systems (≥10K Population)	At-Risk PWS (<10K Population)	At-Risk PWS (≥10K Population)	Total
Add a Second Well	$139	$0	$339	$2	**$480**
Replace Well Due to Age	$90	$8	$182	$3	**$283**
Replace Well Pump and Motor	$4	$3	$7	$0.4	**$14**
Upgrade Electrical	$12	$1	$24	$0.3	**$37**
Additional Storage	$77	$23	$157	$2	**$259**
Add Backup Power	$9	$26	$17	$3	**$55**
Replace Distribution System	$125	$448	$235	$44	**$852**
Add Meters	$15	$51	$27	$5	**$98**
Managerial Oversight	$11	$1	$23	$0.3	**$35**
Land Acquisition for Additional Storage	$4	$0.3	$7	$0.1	**$11**
Land Acquisition for Adding a Second Well	$1	$0	$2	$0.1	**$3**
TOTAL:	**$486**	**$562**	**$1021**	**$61**	**$2130**

ADDITIONAL COST ASSESSMENT LIMITATIONS

Future iterations of the Cost Assessment should strive to improve upon the limitations of this first version. In particular, improved data collection for HR2W list systems and At-Risk systems will increase the accuracy Cost Assessment Model. This section summarizes the limitations of the Cost Assessment methodology.

OVERALL LIMITATIONS

1. The Cost Methodology corresponds with a Class 5 cost estimate as defined by AACE International.[18] 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 point estimate of the cost estimates is 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.
2. Solutions have been developed and applied generally. Actual costs will vary from system to system and will depend on site-specific details. These estimates will not be used to direct site-specific decisions.

HR2W SYSTEM DATA AND TREATMENT COST

1. Violations are assigned to a system and not assigned to a water source. Water quality data was used to determine which sources have been over a given regulatory limit, but this does not always accurately reflect the water source that needs treatment. This may result in an over-estimation of the number of sources being budgeted for treatment. In the future, estimated treatment costs could be improved by documenting the exact source(s) associated with the violation.
2. The HR2W list is constantly changing. It doesn't capture systems that are on the verge of implementing solutions, so some systems that have been included in the cost calculation do not need additional funding. In the future it would be beneficial to capture the project status.
3. Raw and treated water locations are not tied together in the DDW water quality analyses database, so existing blending, and treatment is not accounted for in this analysis. This may result in an over-estimation of the number of sources being budgeted for treatment.
4. Treatment costs are based on water production. Maximum Day Demand is important in determining the design flow of treatment units and Average Day Demand is used for

[18] AACE International Recommended Practice No. 17R-97 Cost Estimate Classification System, TCM Framework: 7.3 - Cost Estimating and Budgeting, Rev. August 7, 2020.

calculating the operations and maintenance expense. For this project, production data was estimated because there is not accurate production data available for many of the HR2W systems. In the future costs would be more accurate if actual production and demand data was collected in the Electronic Annual Report (EAR) for HR2W systems.

5. Treatment system costs are based upon full-flow treatment at a given source and do not account for opportunities for potentially lower cost partial-stream treatment.
6. Total Trihalomethanes (TTHM) and Haloacetic Acids (HAA5) violations are not source specific because the samples are collected in the distribution system. Treatment was budgeted for all of the active sources. In some systems this is not accurate.
7. The treatment system costs presume a minimum treatment system size, but the actual needed treatment size may be substantially smaller leading to an overestimate of the capital cost.
8. The current methodology for treatment selection only accounts for water quality of the contaminants causing violations. It does not account for other site-specific water quality conditions that can influence treatment selection. Further consideration of co-contaminants and water quality are needed in the future.
9. Surface water treatment and turbidity solution options do not include potentially necessary additional operational costs (other than operator labor).

PHYSICAL CONSOLIDATION ANALYSIS AND COST ESTIMATION

1. It is assumed that potential receiving systems have sufficient quantity and quality of water to supply the joining system. There is no accounting for how many sources of supply are not able to be used.
2. Location information is not available for all systems. Systems without location information were not included in the physical consolidation analysis.
3. Data about water system service boundaries are constantly improving. Some water system service area boundaries used in this analysis may not be wholly accurate or may include jurisdictional boundaries; this would affect the feasibility and cost of potential physical consolidations.
4. If the system was geolocated by address, it may be incorrect in cases where an administrative address is provided in a location different from the physical system.
5. Population and connection information was not available for all systems, generally this applies to some State Small Water Systems (SSWS)/Local Small Water Systems (LSWS). For systems lacking population and connection information it is not possible to classify the system as a small, state small, or local small system. When population and connection information was not available, the population was set to zero and a connection count of 8

was used for costing. Systems without a PWSID were classified as SSWS/LSWS if population < 26, connections < 15.

6. Some population and connection information should be corrected in the DDW database. There were instances where it appeared that population and connections were reversed.

7. The possible pipeline path along roadways was determined through network analysis using Street Map Premium and ArcGIS Pro. The actual feasibility of the pathways would need to be investigated on a site-by-site basis and associated distances for a necessary pipeline would change accordingly.

8. The distance between system and from roadway to the actual system connection is approximated and will need to be reviewed on a case-by-case basis.

9. The maximum allowable distance set for the consolidation analysis was 3 miles; associated costs for some systems will make physical consolidation infeasible. For other systems, with regional solutions, total pipeline distance beyond 3 miles could become feasible with consolidation of a greater number of systems.

10. Any systems that mapped outside the state were removed from the analysis.

11. Only active systems were included in the analysis.

12. The compilation of water system location information required merging of multiple layers from different sources. Whenever possible all useful attributes were merged from relevant sources by matching PWSID and/or system names. Data were reviewed and multiple data quality issues were identified and corrected where possible. For example, there were some systems provided with and without PWSIDs from multiple sources, some other systems had notes or stray keystrokes included with the system name resulting in an inability to match on system name.

13. Some well locations from the GAMA Groundwater Information System indicate a system location in a county different from the county code of the PWSID. In this case the mapped location was used.

14. Detailed information was provided by Monterey County with respect to state and local small water systems, and thus the potential for regional solutions in Monterey County was highlighted. This does not imply that similar opportunities for other counties are not available, just that the data for Monterey County is a higher resolution.

DOMESTIC WELL LOCATIONS AND USE OF THE GAMA WATER QUALITY MODEL TO DETERMINE AT-RISK DOMESTIC WELLS AND SSWS

1. Domestic well locations are assigned within one square mile sections; actual domestic well locations within one square mile sections are unknown.

2. The count of domestic wells in a one square mile section was used to estimate domestic well pickups for regions with water quality concerns modeled by the GAMA Needs Analysis

Tool. The actual distance between a consolidation route and domestic wells in a section is unknown.

3. For domestic wells and many SSWSs, actual water quality is unknown and could be different from the modeled water quality data from the GAMA Needs Analysis Tool.
4. See the following for additional information and limitations. DWQ's GAMA Unit has published a Draft White Paper[19] and Needs Assessment Domestic Well Water Quality Tool,[20] detailing the development of the Risk Assessment methodology for state small water systems and domestic wells.

POINT OF USE/POINT OF ENTRY (POU/POE) TREATMENT

1. The POU/POE treatment analysis assumes treatment for the contaminant in violation. In some cases, other water quality or co-occurring contaminant conditions may limit the effectiveness of POU/POE to meet the regulatory standards. For example, high concentrations of nitrate cannot be effectively removed to regulatory standards by POU devices. Bacteriological growth, hard water, or the presence of iron or manganese may also cause issues with membrane fouling.
2. Bacteriological growth in POE treatment devices can create unacceptable levels of bacteria in the treated water.
3. POE GAC can experience nitrate sloughing, which is a temporary spike in nitrate concentrations upon start-up. Even in wells with nitrate below the MCL, the nitrate in the treated water can be above the MCL. This may limit the implementation of POE treatment.
4. POU/POE treatment costs have been estimated for systems with up to 200 service connections; however, achieving 100% adoption becomes more difficult as system size increases. In cases that 100% adoption is not possible, then a system is not considered to be in compliance.

OTHER INFRASTRUCTURE COSTS

1. Kern County sanitary survey information for HR2W systems was used to develop the other infrastructure needs assumptions. The extent to which the Kern County information is relevant to other Counties or At-Risk PWS is unknown.

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[19] Draft GAMA Needs Assessment White Paper
https://gispublic.waterboards.ca.gov/portal/home/item.html?id=0e7fe8d490ef45fb826ab3ad86db5409

[20] Needs Assessment Domestic Well Water Quality Tool
https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=292dd4434c9c4c1ab8291b94a91cee8

2. Actual infrastructure age and condition, in addition to well production and capacity data, should be captured in a database format from the sanitary survey in the future for HR2W and At-Risk systems.

3. Other infrastructure costs were supplied by a Central Valley engineering firm, QK, Incorporated, with a focus on Central Valley cost levels. A regional multiplier was thus applied for statewide estimation purposes.

4. Several cost items, such as electrical upgrades and California Environmental Quality Act (CEQA) documentation, were not able to be scaled by system size.