SMALL RURAL DRINKING WATER SYSTEM CONSOLIDATION AND INFRASTRUCTURE DEVELOPMENT: LESSONS LEARNED FROM CALIFORNIA

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ABSTRACT (500 WORDS MAXIMUM)

Throughout California, USA, many small drinking water systems struggle to provide reliable, high-quality water for their communities, facing inadequate infrastructure and water quality standard violations, but without the resources to resolve these challenges. The state's Human Right to Water List, which tracks systems experiencing severe water quality violations, shows 306 of 352 such systems are considered either small (population between 500 and 3000) or very small (population under 500). In response, the State of California, as the primary governing agency, has begun a major effort to address these issues through expanded Technical Assistance programs, allocation of additional funds for grants and loans, and a focus on solutions for small, rural, and economically disadvantaged communities.

Many of the small systems served by these programs face unique challenges to updating infrastructure and achieving compliance with drinking water standards, stemming from remote locations, workforce limitations, ageing system infrastructure, and small populations, in addition to challenges like drought, atypical precipitation patterns, and wildfires. The broad mandate of the State effort provides an opportunity for projects that address multiple issues for a given system – through mandated or voluntary physical and managerial consolidation, regional agreements, or traditional infrastructure improvements. Such multi-solution projects, however, require additional planning and a nuanced approach to gain community support.

This paper addresses the following:

- The nature of water system issues in small communities
- An overview of the recent California state response and program structures
- Common challenges for small water systems project implementation
- Solutions and creative approaches to these challenges, including state-supported financing and consolidation support techniques
- Case studies from recent small water system projects
- The implications for small systems and assistance programs broadly
- Observations relevant to New Zealand under the Water Services Reform Programme

This paper will provide a window into the challenges faced, important considerations unique to small systems, and approaches leading to successful improvement projects in California. This is of immediate relevance to water system improvements and consolidation efforts related to Water Reform in New Zealand. New Zealand is in a unique position to take advantage of economies of scale through entity-wide or national standardisation of drinking water source, treatment, and provision systems; data collection, reporting, and asset management; and design and documentation. This paper will summarise experience within the strict regulatory framework of California and propose opportunities and outcomes appropriate to New Zealand's new regulatory and organisational framework.

KEYWORDS

Small Drinking Water Systems, Consolidation, Regionalisation, Regulatory Compliance, Technical Assistance, Community Engagement, Infrastructure Renewal, Rural Systems

PRESENTER PROFILE

Susan Willis holds a doctorate in Civil and Environmental Engineering from the University of California, Berkeley and has thirteen years of experience working across three waters disciplines. She spent the past five years supporting small drinking water consolidation projects prior to transferring to New Zealand with GHD.

INTRODUCTION

Throughout California, USA, many small water systems struggle to provide reliable, high-quality water for their communities, and are facing inadequate infrastructure and water quality violations, but lack the resources to resolve these challenges. The state's Human Right to Water List, which currently lists 352 systems experiencing water quality violations, shows 306 of them are considered either small (population between 500 and 3000) or very small (population lower than 500). In response, the State of California has begun a major effort to address these issues through expanded Technical Assistance programs, allocation of additional funds for grants and loans, and a focus on solutions for small, rural, underserved and economically disadvantaged communities.

DISCUSSION

RECENT ACTIONS ON WATER SYSTEM ASSISTANCE IN CALIFORNIA

REGULATORY FRAMEWORK

Small drinking water systems ("water systems") in California are regulated by local government agencies rather than the California State Water Resources Control Board (SWRCB), the administrator of the US's Safe Drinking Water Act (primary set of drinking water regulations) in the state. While information about larger systems, including service area boundaries, water quality sampling results, sanitary surveys, and managerial resources have been available to SWRCB staff for years, the same information was not available for small systems due to a lack of investment in data collection and management.

In 2019, CA Senate Bill 200 established the Safe and Affordable Drinking Water Fund and mandated the SWRCB to further investigate the conditions and needs of small and disadvantaged communities throughout the state. The program which arose from SB 200, known as the Safe and Affordable Funding for Equity and Resilience (SAFER) Program, established, among other things, the SAFER Engagement Unit, a new group within the SWRCB Division of Drinking Water (DDW) focused on identifying communities in need, developing relationships with small and disadvantaged systems, and assisting with interim solutions. In April 2021, the SWRCB published its state-wide Drinking Water Needs Assessment, which included expansion of the aforementioned Human Right to Water List, a Risk Assessment for vulnerable communities (including tribal communities), a Cost Assessment for estimating the required investment to implement solutions for these communities, and an Affordability Assessment of safe water service for all Californians. Similar efforts have been undertaken in New Zealand as part of the Water Reform and National Transition Unit efforts.

TECHNICAL ASSISTANCE PROGRAMMES

The state has been operating a Technical Assistance Program (TAP) to assist disadvantaged communities out of compliance with drinking water standards for a number of years. The TAP has been expanded to accommodate the additional funds made available through the SAFER program, totalling $130 million per year over a period of ten years.

Communities failing to meet minimum drinking water standards or experiencing other hardship related to operating, maintaining, or upgrading their drinking water system can apply for assistance through the TAP using an online form. These Technical Assistance (TA) Requests are reviewed by the grants team and consider a number of factors, including community household income, historical compliance with drinking water regulations, and type of assistance requested.

One or more members of a pool of pre-qualified vendors, not-for-profit agencies, and technical consultants known as TA Providers are assigned to assist with each TA Request. The TA Provider reviews the request with system representatives and develops a Work Plan describing a path forward. Work Plans include some combination of technical studies, planning assistance, infrastructure design, and documentation, and are typically paid for with a SAFER grant. A TAP team is then assigned to follow the TA project through to completion, including community and water system stakeholders, TA Providers, technical staff, local and regional regulators, members of the SAFER Engagement Unit, and grant administrators. This group represents meets regularly to check that planning efforts align with community needs and desires while fulfilling regulatory, funding, and project requirements.

Due to the wide variety of needs, grants and loans are available for qualifying communities to cover all aspects of administration, operations, infrastructure, and water service delivery. Support is available for both short-term and long-term solutions, including interim water supplies (a major issue in the drought-stricken state) and short-term operational support for systems lacking financial resources. Provision of funding for these interim solutions is typically followed by a thorough system evaluation for technical, managerial, and financial capabilities, often leading to an infrastructure project. Funding for major projects is administered through the same entity to ensure equitable access to available funds.

CONSOLIDATION CONSIDERATIONS

As part of every project, water systems are required to investigate the possibility of consolidation with one or more nearby water systems within a 5-mile radius. This allows the funding agency to assess the most cost-effective use of available funds, as economies of scale are acknowledged as a primary tool for maintaining affordable, long-term water services. The regulatory agency has the ability to force consolidation, particularly where a system is failing to meet water quality guidelines or other requirements, but this is rarely enforced as most systems willingly consolidate when community members come to understand the implications for costs, quality of water service, and longevity of projects.

In California, water system consolidations typically take one of three forms.

OPERATIONAL CONSOLIDATIONS

Operational consolidations maintain autonomous control of finances, administration, billing, and investment decisions between two or more consolidating water systems, but day-to-day operations are managed by a common entity. For example, a set of three small villages combine resources to hire two full-time specialist operators who travel between the three water systems to check on treatment systems and reticulation networks and provide on-call support. This allows the consolidated systems to employ a single set of skilled treatment and reticulation system operators to care for and oversee multiple treatment plants, intakes, bores, and pipe networks within a given area. Operational efficiencies are realised by employing fewer overall and/or more specialised staff and creating full-time employment for operators who otherwise would be only partially employed (or, in many cases, unskilled volunteers).

MANAGERIAL CONSOLIDATIONS

Managerial consolidations maintain separate physical water supply schemes while combining resources for management and/or operations of consolidating water systems. For example, a group of nearby towns integrate management and operational staff, billing systems, financial resources, and purchasing power to realise economies of scale for staffing, treatment systems, treatment chemicals, repair and installation of reticulation networks, and meter reading, among others. The water supplies and reticulation networks are maintained using the same processes and materials where possible, but the systems themselves are not connected to the same supply. This can be beneficial where each town has its own supply with sufficient quantity and quality but are too distant for a physical pipeline connection to be practical. This is the type of consolidation most aligned with the majority of systems to be consolidated under 3 Waters Reform entities.

PHYSICAL CONSOLIDATIONS

Physical consolidations (or “full” consolidations) involve physically connecting the reticulation systems of two or more water systems to allow for integration of water service. In this case, multiple water systems become a single interconnected entity. This can be accomplished through a number of water provision agreements, such as:

- Serving two or more reticulation networks with a single water source (in the case one system's source is of poor quality or unable to meet demand)
- Combining two or more reticulation networks and maintaining multiple water sources (sharing of water resources to keep both systems operational)
- Providing an emergency interconnection for one or more water systems (one-way valving used only in case of system depressurisation or failure of a source)

Physical consolidation effectively extends the service area of a combined water system. In this case, the entities combine all resources, debts, staff, operations, and system planning. Typically,

- One system ceases to exist and is incorporated into the other system, or
- Both systems cease to exist, and a new entity is formed, managed by representatives of both systems (this is particularly common for consolidation of mutual water companies)

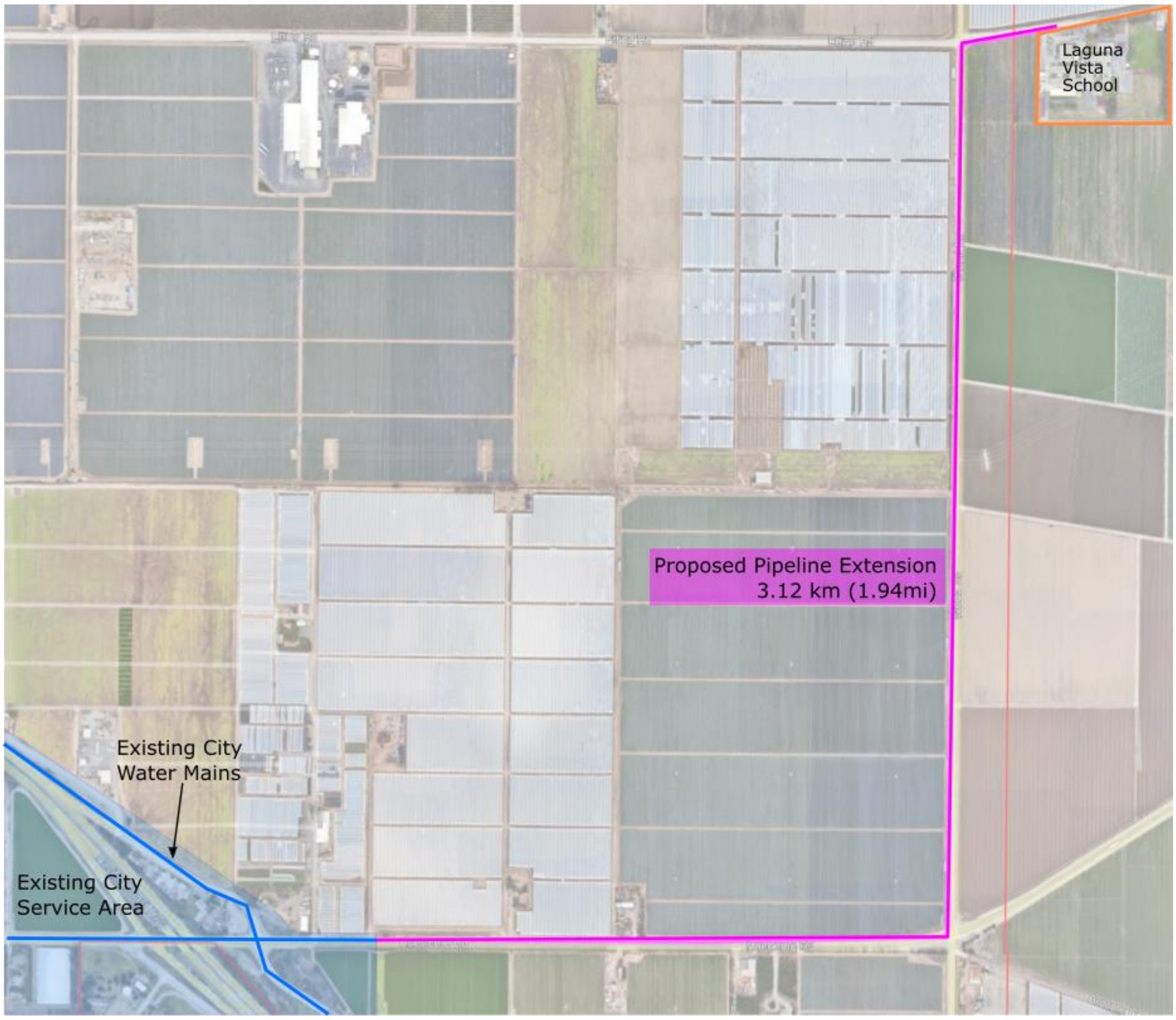
In the case where one system is very small, serving only a few connections (such as a school or small neighbourhood), often these users simply become customers of the larger system, with new meters and service connections to the larger system.

CASE STUDY: LAGUNA VISTA ELEMENTARY SCHOOL

Laguna Vista School is located outside the city of Oxnard, California. Historically, it has served an economically disadvantaged population and operated a single aging supply well. Due to its rural situation, building age, and lack of nearby water resources, it is required by local law to keep a significant volume of water onsite for firefighting purposes. As the school is single-plumbed, fire hydrants pull from the potable supply, so all water must meet drinking water regulations. This leads to significant water age in the tank, leading to breakdown of residual disinfectant, growth of biofilm and bacteria, and buildup of disinfection by-products. Currently, the school must dump water every few weeks to maintain water quality- a significant issue in a drought-stricken area. The school also lacks the required expertise and resources to operate its water system in-house, expending significant sums each year to keep a qualified operator on retainer and maintain its drinking water permit.

Through the TA Program, Laguna Vista is working on a physical consolidation with the City of Oxnard. A 3-km pipeline will extend from the furthest point in the City's reticulation system to the school, providing both potable water and fire service. The pipeline is sized to meet minimum requirements set forth in the City standards (6-inch nominal diameter); while this will allow for fire-protective flows and later expansion of water service to undeveloped properties in the area, the school uses a small fraction of the pipeline volume each day. High water age is anticipated along with accompanying water quality issues, though with less impact than the existing system. For the time being, water will be periodically flushed from the new pipeline into the existing tank, which will be repurposed for irrigation use.

Figure 1: A 3-km pipeline extension will provide potable and firefighting water service to Laguna Vista School from the City of Oxnard, decreasing operational and maintenance burdens at the school.



While far from ideal, this provides the school with a long-term solution to management and operation of their water system. The City already employs a number of qualified operators who can test and track water quality and operate flushing valves to clean the pipeline. The school no longer needs to sample water, maintain a well, file permit documents and reports, or operate a treatment system. As the area is developed into additional housing and services, the additional demand will decrease water age in the pipeline and flushing will no longer be required.

COMMON CHALLENGES FACING SMALL WATER SYSTEMS

While each small system faces its own unique challenges, some common trends can be observed across systems receiving Technical Assistance in California, with direct analogues across New Zealand.

AGEING INFRASTRUCTURE

With the population boom of the 1940s-1960s and subsequent water system funding programs of the 1970s and early 1980s in California, many water systems are operating infrastructure built over fifty years ago. This infrastructure is deteriorating beyond its useful life and often requires costly capital investment to renew or replace. Typical items include undersized and disintegrating asbestos-concrete (AC) pipelines, failing redwood and rusting steel tanks, outdated and broken chlorinators and pH adjustment systems, underperforming groundwater wells, and lack of customer meters, emergency backup generators, and control systems.

Photograph 1: "Well, treatment, storage, and pressure tanks installed in the 1960s have passed the end of their useful life at one small system in Northern California." Photo Credit: Susan Willis/ GHD

WATER QUALITY

The majority of small systems in California use groundwater wells (bores) as their primary source, typically with no treatment besides chlorination. However, many were constructed before current well construction standards were in place, which require a minimum 15.25-m (50-ft) sanitary seal, well head protection, and pumping capacity meeting or exceeding the system's maximum day demand (MDD). One recent well inspection found a sanitary seal extending only a few meters rather than the presumed ten, with the first set of perforations starting at

3 meters below ground surface; this system suffers from both bacterial and nitrate contamination.

Small systems which treat and serve surface water are no better off. Increasing temperatures, declining surface water levels due to drought, and dissolved nutrient concentrations in lakes and ponds have all contributed to a rise in algal growth, inundating small sand filtration and membrane filter plants with organics concentrations far exceeding their intended treatment capacities. One small surface system using local lake water was required to increase dosage and frequency of chemical tank replenishment from fortnightly to every two days, requiring significant additional commitments of time and physical effort from its overburdened and ageing volunteers.

Photograph 2: "Two manually-operated storage tanks in poor repair (left) share a backyard with another partially-collapsed steel tank (right) next to this California system's treatment enclosure." Photo Credit: Susan Willis/ GHD

STAFFING CHALLENGES

Rural communities through California are experiencing declining and ageing populations. For small water systems, the pool of candidates for positions on the governing board and day-to-day system management is similarly declining. Typically, these positions are staffed by volunteers who are at most compensated with a negligible amount, usually in the form of water rate reduction or forgiveness.

In economically disadvantaged communities, able adults often work multiple jobs and lack the resources to contribute to volunteer operations or management in a meaningful way. The governing boards of privately-owned mutual water companies (MWCs) tend to be staffed by older generations, with retirees the only available volunteers to check on the myriad of required daily measurements (pH, chlorine concentrations, pump status, etc.), prepare reports, and maintain finances.

COMMUNITY STAKEHOLDERS

The importance of community relationships in consolidation projects cannot be underestimated. A plan for consolidating up to ten small water systems (two MWCs and several commercial systems) within one small town was impeded by one MWC's dislike of residents in the other MWC, despite grant funding available for the entire project, which would upgrade water service, fire storage, and groundwater availability for every resident.

Community members' distrust towards regulators and technical experts (engineers) has also been observed across California. Regulators are rarely seen as partners, but rather demanding and unreasonable overlords. Engineers tend to be viewed as unrealistic wielders of power, with little to no understanding of what running a water system is like on a day-to-day basis. One community was wary of working with Technical Assistance providers following a previous experience in which an engineer took advantage of their inexperience to design and install an expensive, complicated, and inappropriate treatment system on their behalf. Another community was convinced that the only reliable way to adjust pH was through a soda ash system maintained weekly by their certified operator, though a neighbouring system was able to successfully treat the same water source with ion exchange requiring only annual adjustment.

Photograph 3: "This steel storage tank has not been inspected or re-lined since its installation in the 1980s." Photo Credit: Susan Willis/ GHD

GUIDANCE FOR WORKING WITH SMALL SYSTEMS: LESSONS FROM CALIFORNIA

Setting up a small water system for long-term sustainability and success requires careful planning, collaboration with community members, and funding for both infrastructure and management. When working with a small community, consider the following:

Work with staff, volunteers, and operators to identify solutions (technical, managerial, financial, infrastructure, social) which meet their level of expertise, availability, and interest. No technology is truly a solution if the recipients are unable or unwilling to employ it as intended.

Water source, treatment systems, and operations should be simple and straightforward. Where options exist, choose solutions which both limit the number of breakable moving parts and require the least amount of specialised expertise possible. Provide robust technologies to prevent costly and unexpected repairs after the project or assistance program ends.

Consider current and future regulations which may pose challenges for the system. Where possible, sample for emerging contaminants in the primary water source(s) to identify potential issues. Assist with planning for system response to future regulatory requirements and facilitate a positive relationship between regulators and community members.

Replace ageing components near the end of their useful life, not only those which have already failed, if possible. The relative cost of investing in new infrastructure rather than waiting for catastrophic failure is widely understood, especially when considering the time, effort, and expense used to identify and engage the system in need. Doing so will also help the community feel valued and ready for the future.

Organise infrastructure and controls to allow for later expansion or reconfiguration. Examples include laying out valves and pipelines to allow for replacement or upsizing; using "future-proof" technologies, such as digital record-keeping; and expanding treatment building footprints slightly to accommodate larger components or a new treatment train.

Install simple controls to turn over water regularly and limit water age in tanks. This is particularly important as ambient temperatures rise, per-capita water use declines with drought conditions, and, in some areas, wildfires become more common, requiring additional water storage. Alternately, install an active mixing system to prevent stratification, "dead zones", and biofilm growth. Recent advances have made active systems available for tanks as small as 18kL, running on solar panels or standard power.

Consider available options for remote operation and maintenance of the system. While full SCADA-controlled operations may not be appropriate for small systems, vital measurements such as well pump or treatment system status and storage tank level can be shared over a low-speed internet connection. A number of cloud-based systems have been developed in recent years which require only a small transmitter and radioed, wireless, or wired internet connection. This type of remote observation can assist certified operators overseeing a number of small systems simultaneously, allowing them to respond quickly to issues rather than waiting for their next site visit or call from a frantic community member.

OBSERVATIONS FOR NEW ZEALAND

A lack of effective communication may be a primary barrier to community acceptance of the important changes associated with the 3 Waters Reform Programme. The average resident, both in California and New Zealand, is unfamiliar with the basics of water chemistry, reticulation, water quality, or public health. While press coverage of the 3 Waters Reform Programme is plentiful, there seems to be significant confusion around the drivers for change, including:

- Which parts of Water Reform are still up for debate (that is, separating Taumata Arowai and Water Services Standards 2022 from organisational changes with regional entities)
- Alignment between new regulations and minimum international standards, and why those standards are in place elsewhere
- How the status quo (for example, lack of chlorination/disinfectant residual) does not serve the most vulnerable of the population (infants, children, aged, and immunocompromised)
- How all communities in New Zealand will be supported with their water infrastructure issues, and how location-appropriate solutions will be identified and implemented
- Reassuring communities which have recently invested in water infrastructure how they will benefit from reforms and consolidation in

the long run, including operational efficiencies they would be unable to take advantage of otherwise

Water professionals have an opportunity to develop trust within our communities to support much-needed changes through Water Reform. We can become trusted advisors to our local communities by sharing the work that we do publicly, speaking with our neighbours or at town meetings. The National Transition Unit and 3 Waters Reform Programme have an overwhelming amount of press coverage, which to date has been under-utilised for promoting the science and purpose behind consolidating water service.

CONCLUSIONS

As New Zealand reinvests in community potable, stormwater, and wastewater systems, engineers must be prepared to adapt our current way of thinking about engineering water infrastructure. Small systems often require incredibly creative solutions, and adaptation of large-scale technologies is seldom appropriate. Projects involve significantly more personal investment from team members to understand why and how the system came to operate as it does, the true technical and managerial needs of the system, and what will assist the community in obtaining long-term safe and affordable water, wastewater, and stormwater solutions. There is ample opportunity to take advantage of press coverage surrounding 3 Waters Reform to promote the benefits of consolidations from a scientific, economic, and public health standpoint.

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