The Role of Onsite Water Systems in Advancing Water Resilience in Silicon Valley

Heather Cooley, Anne Thebo, Cora Kammeyer, and Darcy Bostic

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Authors

Heather Cooley

Anne Thebo

Cora Kammeyer

Darcy Bostic

Pacific Institute

654 13th Street

Preservation Park

Oakland, California 94612

510.251.1600 | info@pacinst.org

www.pacinst.org

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ABOUT THE AUTHORS

HEATHER COOLEY

Heather Cooley is Director of Research at the Pacific Institute. Heather holds a Bachelor of Science in Molecular Environmental Biology and a Master of Science in Energy and Resources and from the University of California, Berkeley. She received the US Environmental Protection Agency's Award for Outstanding Achievement for her work on agricultural water conservation and efficiency, and has testified before the US Congress on the impacts of climate change on agriculture and innovative approaches to solving water problems in the Sacramento-San Joaquin Delta. Heather has served on several state task forces and working groups, including the California Commercial, Industrial, and Institutional Task Force and the California Urban Stakeholder Committee, as well as the board of the California Urban Water Conservation Council.

ANNE THEBO

Dr. Anne Thebo is a Senior Researcher at the Pacific Institute. Her research uses spatial analysis and modeling to assess the benefits and trade-offs of integrated water management, water reuse, and alternative supplies. Prior to joining the Pacific Institute, Anne worked as a researcher and a water resources engineer focused on watershed planning; green infrastructure; and water, sanitation, and hygiene (WASH). Anne holds a doctorate in civil and environmental engineering from the University of California, Berkeley, where she focused on de facto water reuse in agriculture and was supported by a US EPA STAR Fellowship. She also holds a Master of Science in Environmental Engineering from Stanford University and Bachelor of Science degrees in Civil Engineering and Environmental Science from Ohio State University.

CORA KAMMEYER

Cora Kammeyer is a Senior Researcher at the Pacific Institute, where she works on corporate water stewardship, integrated water management, California water policy, and more. Much of her work supports the UN Global Compact CEO Water Mandate and the California Water Action Collaborative. Her past work has focused on environmental water markets, water law and policy, and behavioral science techniques to encourage residential water conservation. Cora holds a bachelor's degree in environmental studies with a minor in Spanish II from the University of California, Santa Barbara. She also holds a Master of Environmental Science and Management from the Bren School at the University of California, Santa Barbara, where she was a Sustainable Water Markets Fellow.

DARCY BOSTIC

Darcy Bostic is a Research Associate at the Pacific Institute. Her work focuses on the impacts of climate change on water resources and sustainable water management. Darcy holds a Bachelor of Science and a Master of Science in Hydrologic Sciences from the University of California, Davis. While in her master's program she researched the impacts of sustainability planning on domestic well operation and the governance challenges in sea level rise adaptation in the San Francisco Bay Area. Her interests include groundwater governance, climate change adaptation, and community participation in water management.

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LIST OF ACRONYMS

CII – commercial, industrial, and institutional

CVP – Central Valley Project

MTC – Metropolitan Transportation Commission

ONWS – onsite non-potable water systems

PDA – priority development area

SFPUC – San Francisco Public Utilities Commission

SLR – sea level rise

SSO – sanitary sewer overflow

SVCW – Silicon Valley Clean Water

SWP – State Water Project

SWRCB – State Water Resource Control Board

TAFY – thousand acre-feet per year

WPCP – water pollution control plant

WWTP – wastewater treatment plant

EXECUTIVE SUMMARY

Water is essential for the social, economic, and environmental well-being of Silicon Valley. Yet the region is facing a host of water challenges, affecting the quality and reliability of water as well as the risk of flooding. The region's water and wastewater infrastructure is aging, and in many cases, nearing the end of its useful life. Continued growth and development are putting additional strains on the region, and climate change is adding to that burden through sea level rise, more intense storms, and more severe droughts. These challenges present risks, but also an opportunity to rethink the design, configuration, and operation of water and wastewater systems.

DISTRIBUTED WATER SYSTEMS IN SILICON VALLEY

In response to the water challenges facing Silicon Valley, there is growing interest in the potential for distributed strategies to improve the performance and resilience of urban water systems. Distributed strategies in an urban context generally refer to "dispersed facilities that extend beyond the central infrastructure and are located at or near the point of use." (Johnson Foundation at Wingspread, 2014). These systems include a broad range of water supply, wastewater treatment, and stormwater management strategies, such as water efficiency, onsite stormwater capture and reuse, and onsite wastewater treatment and reuse. These distributed strategies can be implemented in residential and commercial settings at a range of scales.

Many leading companies are investing in distributed water systems at their facilities. In Silicon Valley, several big technology companies — including Facebook, Microsoft, and Google — have implemented onsite non-potable water systems (ONWS) on their campuses. These systems gather wastewater from lavatory sinks, showers, toilets, washing machines, dishwashers, and cooling towers; treat it to safe levels onsite; and then reuse that water for non-potable purposes, such as toilet flushing and outdoor irrigation. In this report, we examine the opportunities and challenges associated with scaling onsite ONWS in Silicon Valley.

REGIONAL STAKEHOLDER PERSPECTIVES

To better understand local perspectives on ONWS in Silicon Valley, we interviewed 23 stakeholders working in the region, including representatives from water utilities, academia, technology companies, engineering consultants, water technology vendors, and environmental organizations. Interviewees were asked about a range of issues related to ONWS in Silicon Valley, including its current and future role, implementation drivers and barriers, the appropriate role of the private sector, and the likely effect of new regulations. It is important to note that the views expressed in the regional perspectives section represent the opinions of those interviewed, and we make no attempt to validate these opinions.

ONWS currently play a minor role in Silicon Valley, and those interviewed had differing expectations about the future role of these systems in the region. Some think they will play an important role in the future, whereas others think they will remain a niche technology. There is general agreement, however, that future water supply portfolios in the region will include projects at various scales (i.e., building, block, district, and regional systems), and some are excited about the opportunities for district-scale systems.

Those interviewed agree that sustainability goals are a major driver of corporate investments in ONWS, as well as long-term positive return on investment. There is broad agreement that by being sustainability leaders and innovators, Silicon Valley companies can strengthen their brand reputation both broadly and within local communities, as well as improve employee recruitment and retention in a competitive labor market. Another key driver is the desire to reduce water-related risks posed by climate change and other water challenges in California. Companies see water and sewer costs rising and want a resilient and independent water supply. While ONWS may not present a strong positive return on investment in the near term, rising water and wastewater costs indicate greater returns over longer time horizons are possible.

All interviewees expressed support, and in some cases enthusiasm, for Silicon Valley companies investing in ONWS. For example, interviewees felt that corporate investments in ONWS can accelerate innovation in treatment, monitoring, project implementation (including regulation), and operation of water systems more broadly. There was also discussion about how private investments in ONWS can alleviate pressure on centralized systems, and perhaps defer, reduce, or eliminate the need for utilities to make capital investments to expand existing water networks.

However, interviewees also expressed concerns over the appropriate role of corporations in managing water resources. These included trepidation about corporate accountability for public health and safety, as well as concerns about equity when it comes to water costs and availability.

Lastly, interviewees were asked how they expect California Senate Bill 966 — which requires the State Water Resources Control Board to adopt regulations for the onsite treatment and reuse of nonpotable water — to affect the development of onsite water systems in Silicon Valley. The bill enjoys wide support, and all agreed that standard regulations for onsite water systems are an absolute necessity. There was some disagreement about whether local permitting and oversight is the appropriate approach for ONWS, but agreement that local authorities need support to effectively implement the legislation. There is confusion about what the lack of a local program means, and some interviewees had doubts about whether SB 966 will be relevant by the time it is finalized.

REALIZING BENEFITS

At scale, ONWS have the potential to fundamentally shift water use and wastewater production patterns, thereby altering water, greenhouse gas, and other resource outputs. This shift, in turn, can provide a wide range of benefits, such as enhancing water supply reliability, improving water quality, reducing local flooding, and increasing urban green space (see, for example, Johnson Foundation at Wingspread, 2014 and Kohler and Koch, 2019). These systems, however, can also create negative impacts if done poorly and without integrating planning with other water systems. They can, for example, result in stranded assets and jeopardize existing and future commitments to recycled water customers.

The outputs of ONWS can lead to an array of cascading outcomes and impacts that occur along various temporal and spatial horizons. Through interviews and a literature review, we identified 26 potential outcomes and impacts associated with ONWS, both positive and negative (Table ES1). Outcomes and impacts, both positive and negative, depend on local context and are proportional to the extent to which ONWS are implemented, such that a small number of ONWS would have no or very little effect on the water and wastewater systems and the broader community.

Table ES1. Potential Outcomes and Impacts Associated with Onsite Non-Potable Water Systems

Theme	Potential Outcomes and Impacts*
Water Quantity	Augment local water supplies (+)
	Inability to meet recycled water commitments (-)
Water Quality	Reduce discharge of wastewater pollutants (+)
	Reduce freshwater discharge into receiving waters (+/-)
Energy Use and GHG Emissions	Greater onsite energy use and associated GHG emissions (-)
	Reduced system energy use and associated GHG emissions (+)
	Reduced urban heat island effect (+)
Infrastructure	Avoided or deferred new water supply/treatment and wastewater infrastructure (+)
	Concentrated wastewater streams that can corrode wastewater collection system and/or create odor concerns (-)
	Creation of stranded assets if centralized and distributed systems are poorly integrated (-)
Finances	Increased site capital and operation and maintenance costs (-)
	Altered operation and maintenance costs for the water and/or wastewater system (+/-)
	Near-term reduction in revenue and shifting cost burden (-)
	Long-term reduction in capital costs for water and wastewater infrastructure (+)
	Greater financial flexibility (+)
Innovation	Creation of new technologies and ways of building and operating water systems (+)
	Creation of innovative shared ownership and operation models (+)
	Creation of innovative partnerships between the public and private sectors (+)
Organizational Reputation	Seen as a leader and innovator (+)
	Improvement in employee recruitment and retention (+)
Policy Goals and Regulatory Requirements	Achievement of public and private sector sustainability goals (+)
	Altered ability to meet NPDES/WDR** requirements (+/-)
Resilience	Diversified water supply portfolio (+)
	Greater operational flexibility (+)
	Reduced vulnerability to sea level rise (on coastal infrastructure and Delta supplies) (+)
	Creation of redundant water and wastewater systems to reduce likelihood of service disruption (+)

*Realization of outcomes and impacts, both positive and negative, depend on local context and are proportional to the extent to which ONWS are implemented.

**NPDES stands for National Pollutant Discharge Elimination System; WDR stands for Water Discharge Permit. Both refer to permitting requirements under the federal Clean Water Act.

Realizing the benefits of ONWS in Silicon Valley for water and wastewater systems and the community — and addressing risks and reservations — requires coordination between the public and private sectors. Failing to incorporate the expansion of ONWS into water and wastewater master plans can lead to unnecessary infrastructure investments and ultimately higher costs to ratepayers. Likewise, large-scale investments in ONWS (and related reduced dependence on public systems) can create a host of financial, operational, equity, and other issues. Integrated planning is key to advancing the benefits, and managing for the trade-offs, of ONWS in Silicon Valley.

OPPORTUNITIES IN SILICON VALLEY

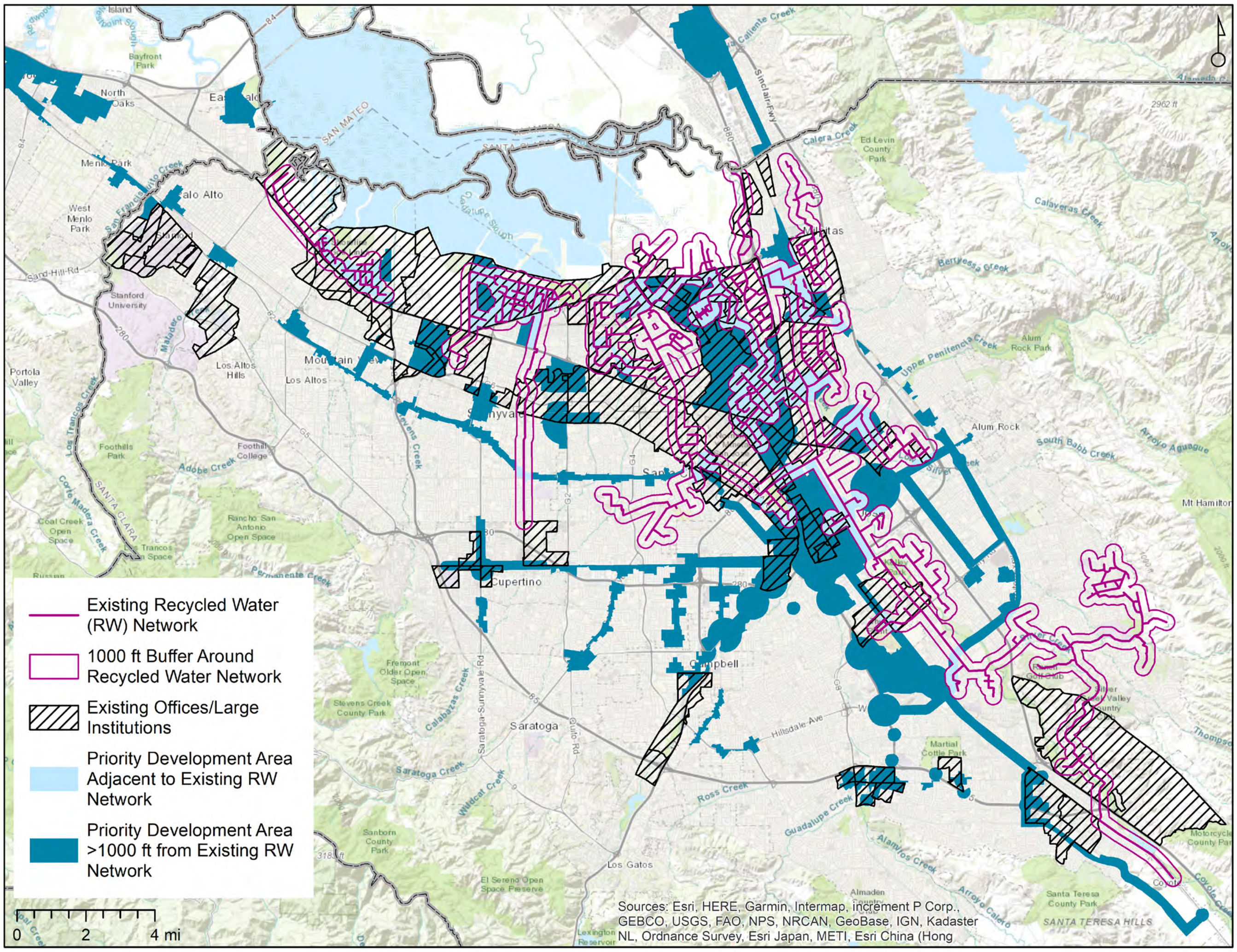
ONWS can provide a multitude of benefits, but realizing these benefits requires integration with existing infrastructure systems and planning decisions. Evaluating the opportunities for ONWS to contribute to these benefits at the system-scale can help identify areas with the greatest potential for realizing and maximizing the value of these benefits. ONWS have relatively modest potential for contributing to the region's water supply portfolio but, if integrated into water planning, may provide water infrastructure augmentation, redundancy, and resilience benefits in some locations.

ONWS are most easily integrated into redevelopment and new development projects due to the challenges of retrofitting buildings and installing dual plumbing systems. We found that there are development areas with little or no recycled water infrastructure in portions of downtown San Jose, around most Caltrain Stations, the Southwest Expressway Corridor toward Campbell, and the Stevens Creek Boulevard corridor. In total, roughly 18 square miles of priority development area are within 1,000 feet of existing recycled water distribution networks, while 50 square miles of priority development area are more than 1,000 feet from existing recycled water supply networks (Figure ES1). Redevelopment areas currently unserved by existing recycled water supplies could be good candidate areas for ONWS. While several of these areas are being explored for future recycled water expansion in the current Countywide Water Reuse Master Plan (Brown and Caldwell, 2020), ONWS could avoid the need for extending recycled water networks into these areas.

ONWS provide a reliable supply of non-potable water for sites implementing these projects. The water reuse potential is limited to the quantity of reusable water on commercial, industrial, and institutional properties, and demand for non-potable water on these sites. Given that ONWS will likely be limited to new developments or major redevelopments, they likely will not result in marked reductions in imported water for the region.

ONWS can augment system-level infrastructure and create redundancy, although these benefits are among the most challenging to realize in practice. Water infrastructure in Silicon Valley is aging, and shoreline infrastructure is increasingly vulnerable to sea level rise. Moreover, some priority development areas are likely to be underserved by existing sanitary sewers. However, multiple engineering, municipal code, ownership, and longevity barriers must be overcome for infrastructure augmentation benefits of ONWS to be realized. Designing ONWS to contribute to system redundancy during times of stress, such as in the aftermath of an earthquake, can help ensure these systems serve both the site and the broader community.

Figure ES1. **Metropolitan Transportation Commission Development Areas Relative to Existing Recycled Water Supplies and Communities of Concern**



Source: City of San Jose Open Data Platform, Metropolitan Transportation Commission Open Data Platform, Valley Water District Draft Recycled Water Master Plan

CONCLUSIONS AND RECOMMENDATIONS

There is often a perceived tension between distributed and centralized systems. However, these systems can work together to build more resilient communities where the whole is greater than the sum of its parts. A desirable outcome would be for ONWS to be deliberately sited and effectively integrated into the broader water network, with an explicit acknowledgement and management of the interconnections. By contrast, an undesirable outcome would be for the haphazard placement of ONWS that ignores system constraints and opportunities.

Realizing the benefits of ONWS in Silicon Valley for the water/wastewater system and the community — and addressing risks and reservations — requires coordination between the public and private sectors. We recommend the following actions to ensure integration and maximize the potential benefits of ONWS while managing for the trade-offs:

Convene regional stakeholders to facilitate a constructive dialogue about the role of ONWS in Silicon Valley. These convenings can help to foster a mutual understanding of stakeholder motivations and concerns and identify areas of agreement and disagreement. Such discussions can help to daylight issues and determine pathways forward. They can also help to build relationships and establish trust among stakeholders, creating opportunities to advance this or other efforts.

Conduct more detailed technical analyses to examine how best to integrate ONWS into existing centralized water and wastewater systems. These analyses should, for example, estimate the supply potential provided by ONWS and impact on recycled water plans. They should also include detailed geospatial analysis to understand where these facilities can provide the greatest benefits and examine possible alternative configurations to achieve desirable outcomes.

Evaluate policies and practices for effectively integrating ONWS into existing water and wastewater systems. This evaluation should examine models for integrated planning with multiple stakeholders, as well as new business and ownership models for developing and operating building- or district-scale ONWS.

Identify opportunities to implement other distributed water strategies in concert with ONWS implementation. By integrating other distributed water strategies — such as rain gardens, rain tanks, natural treatment wetlands, and water efficiency — into new commercial development, sites can maximize the benefits of their onsite water investments. In particular, the opportunity to combine onsite stormwater capture and reuse with ONWS warrants further exploration.

SECTION 1: INTRODUCTION

Silicon Valley is a major population and economic center in California's San Francisco Bay Area. While its boundaries are somewhat nebulous, it is typically defined as the region encompassing Santa Clara County and the southern portions of San Mateo and Alameda counties. Major cities include San Jose, Sunnyvale, Santa Clara, Redwood City, Mountain View, Palo Alto, Menlo Park, and Cupertino.

Once an agricultural region referred to as the "Valley of Heart's Delight," Silicon Valley is now home to more than three million people and continues to grow. It has a bustling economy driven by technology and innovation, with many of the world's largest technology companies and thousands of tech start-ups. Silicon Valley is one of the wealthiest regions in the world but faces mounting concerns about rising income inequality and a severe housing crisis.

Water is essential for the social, economic, and environmental wellbeing of Silicon Valley. Silicon Valley is served by more than a dozen municipal and county governments, along with special districts, and private water companies. The region depends on water imported from the Tuolumne River via the Hetch Hetchy system (referred to as the San Francisco Public Utilities Commission (SFPUC) Regional Water System) and the Sacramento-San Joaquin Delta via the State Water Project (SWP) and Central Valley Project (CVP) (Figure 1). Local sources — including nearby streams, aquifers, and, increasingly, recycled water — are also important water sources for the region. Finally, water conservation and efficiency, along with structural changes in the economy, have made important contributions to water supply reliability for the region.[1] For example, water use in Santa Clara County was 300,000 acre-feet in 2018, nearly the same as in 1992 despite substantial economic growth and a 25 percent increase in population (Valley Water 2019).

The purpose of this report is to examine the opportunities and challenges associated with scaling ONWS in Silicon Valley. While these systems can use water from a variety of sources, we focus here on the reuse of treated wastewater. Section 1 provides an overview of Silicon Valley, its regional water challenges, and potential solutions. Section 2 examines regional stakeholder perspectives on ONWS, drawing on interviews with stakeholders from the public sector, private sector, and non-governmental organizations. Section 3 examines the potential social, economic, and environmental benefits of ONWS, drawing upon the academic and grey literature, and identifies factors affecting the realization of those benefits. Section 4 presents a preliminary assessment of 10 spatially explicit opportunities for ONWS to provide economic, environmental, and social benefits in Silicon Valley. Finally, Section 5 provides conclusions and recommendations.

REGIONAL WATER CHALLENGES

Each water supplier in Silicon Valley has a unique mix of water sources. Most water suppliers rely on imported water, for example from the SFPUC Regional Water System, the SWP, or the CVP. While some, mostly on the northern San Francisco Peninsula, rely entirely on water from the SFPUC Regional Water System, others (such as Palo Alto and San Jose) utilize a more diverse mix of sources, including recycled water, groundwater, and local surface water.

Despite the importance of water, the region is facing a host of water challenges, including a less reliable water supply, declining water quality,

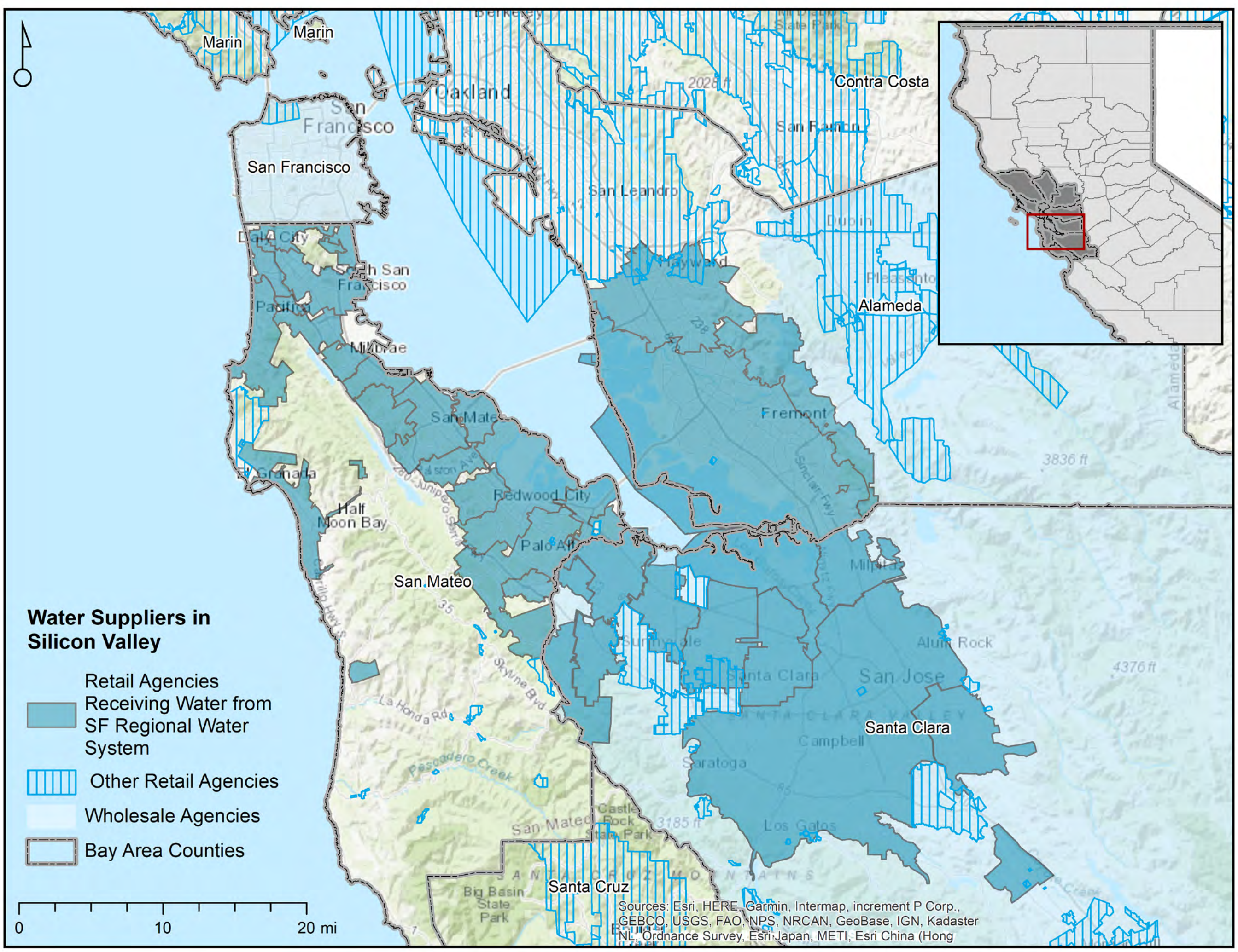
1 Structural changes to the economy refer, for example, to the decline in water-intensive manufacturing and the rise of a less water-intensive service economy.

and increased flood risk. The region's water and wastewater infrastructure is aging, and in many cases, nearing the end of its useful life. Continued growth and development are putting additional strains on the region, and climate change is adding to that burden. These challenges present risks, but also an opportunity to rethink future investments and utility business models.

Water Reliability

There is growing concern about near- and long-term water supply reliability in the region. For example, less water may be available from the Tuolumne River and the Sacramento-San Joaquin Delta due to the declining health of these ecosystems and efforts to protect and restore them. Additionally, the region's largest local source of water, Anderson Reservoir, will be offline until at least 2026 as it undergoes seismic retrofits estimated to cost $576 million ([Rogers 2020](#)). To make matters worse, climate change is increasing the frequency and severity of droughts and causing more precipitation to fall as rain rather than snow, which reduces California's natural water storage capacity ([Swain et al. 2018](#)). Finally, continued growth and development and higher

Figure 1. **Wholesale and Retail Water Supply Agencies in Silicon Valley and the greater Bay Area**



Source: California Department of Water Resources; Bay Area Water Supply and Conservation Agency temperatures due to climate change are putting upward pressure on water demand.

Water Quality

Water quality in the South San Francisco Bay is affected by the quality of the water flowing into it from surrounding areas, as well as freshwater diversions from its tributaries. The surrounding region is densely populated, and urban runoff containing oil, heavy metals, pesticides, trash, toxic residue from past mining, and other contaminants is a major source of pollution. Moreover, upstream diversions have nearly eliminated freshwater discharge from nearby streams into the South Bay, creating "chronic artificial drought conditions" (San Francisco Estuary Partnership and Delta Stewardship Council 2019). Indeed, the largest source of freshwater in the South Bay is treated wastewater. While some is reused, much of the wastewater is discharged — directly or via tributaries — into the Bay, adding nutrients and other pollutants to the estuary. Invasive species have also altered water quality in the South Bay (US Environmental Protection Agency 2012). Despite ongoing efforts to improve water quality and restore ecosystem health, more intense rainfall events, combined with urbanization, threaten to increase pollution from urban runoff.

Flood Risk

The low-lying portions of Silicon Valley and those areas adjacent to streams are prone to flooding. One of the worst floods in San Jose's history occurred in 2017. Coyote Creek overflowed its banks, resulting in evacuation orders for 14,000 homes and $100 million in damages (Rogers 2019). Rising seas and more intense storms due to climate change are increasing flood risk for the region (Kammeyer 2019). Flooding poses a direct threat to private property, as well as critical infrastructure, such as roads and highways, power plants, wastewater treatment plants, schools, and hospitals (Hummel et al. 2018). Moreover, continued development in vulnerable areas will put additional areas at risk and raise protection costs.

POTENTIAL SOLUTIONS

There are a range of solutions to Silicon Valley's water challenges. For much of the 20th century and beyond, the emphasis has been on centralized strategies — massive transfers from distant reservoirs and large-scale wastewater treatment and water recycling facilities — to manage water. Centralized water systems can be extremely efficient from an engineering perspective and have brought enormous benefits to the region, but they are typically expensive to build and maintain, and physically and financially inflexible (Broadview Collaborative 2019). While these strategies will continue to play an important role in Silicon Valley, there is growing interest in the potential for distributed strategies to improve the performance and resilience of urban water systems in the region.

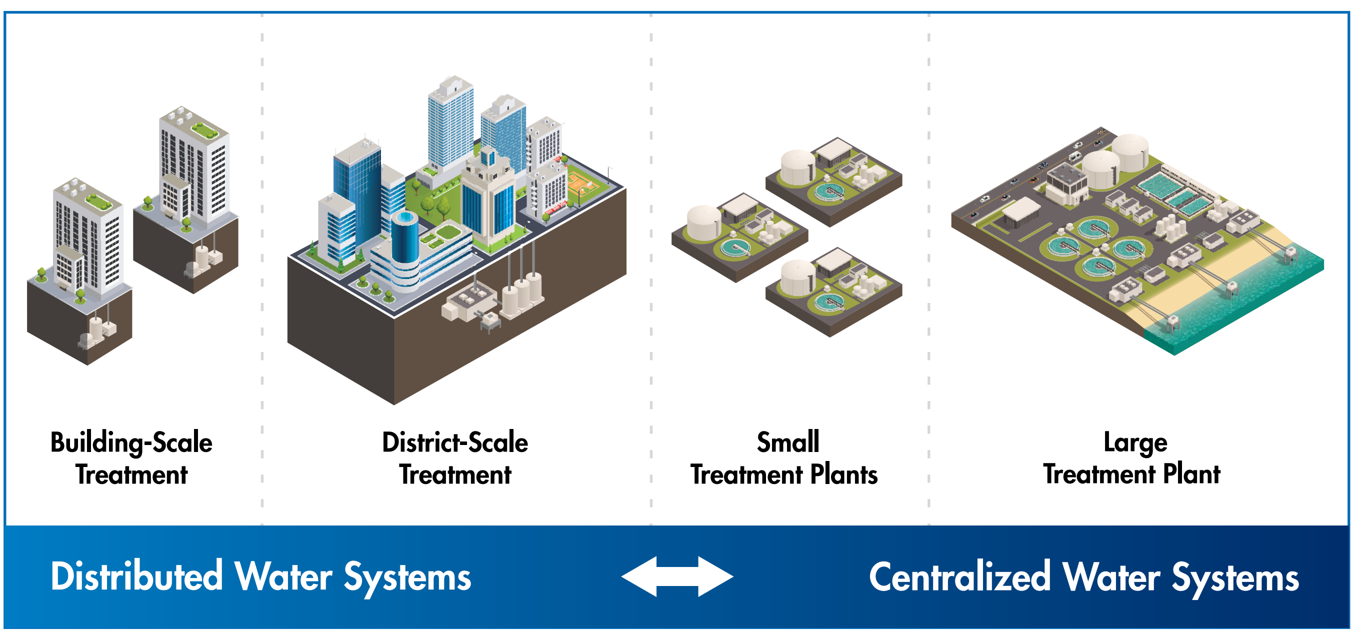
Distributed strategies in an urban context generally refer to "dispersed facilities that extend beyond the central infrastructure and are located at or near the point of use" (Johnson Foundation at Wingspread 2014). These dispersed facilities may function independently or remain connected to a centralized system. They include a broad range of water supply, wastewater treatment, and stormwater management strategies, as shown in Table 1. Distributed strategies can be implemented in residential and commercial settings at a range of scales, from an individual building where water is reused onsite to a district where water is reused in multiple buildings across a neighborhood or development district (Figure 2).

There has been growing interest in onsite non-potable water systems (ONWS) in Silicon Valley, especially among tech companies with large corporate campuses. For example, Facebook installed California's largest blackwater recycling system at its Menlo Park headquarters. Likewise, Microsoft is capturing rainwater and treating wastewater onsite at its new Mountain View campus as part of the site's Net Zero Water certification. Google has plans to implement an ONWS at its new Bay View campus at Moffett Field, and is considering a water system in its San Jose development.

Table 1. **Examples of Distributed Strategies for Water Supply, Wastewater Treatment, and Stormwater Management**

Strategy	Water Supply	Wastewater Treatment	Stormwater Management
Water-efficiency appliance/fixture	X		
Low water-use landscape	X		
Cistern/rain barrel	X		X
Lead line replacement	X		
Private well	X		
Graywater system	X	X	
Onsite or district non-potable reuse system	X	X	
Septic system		X	
Bioswale			X
Rain garden	X		X
Permeable pavement	X		X
Green roof			X

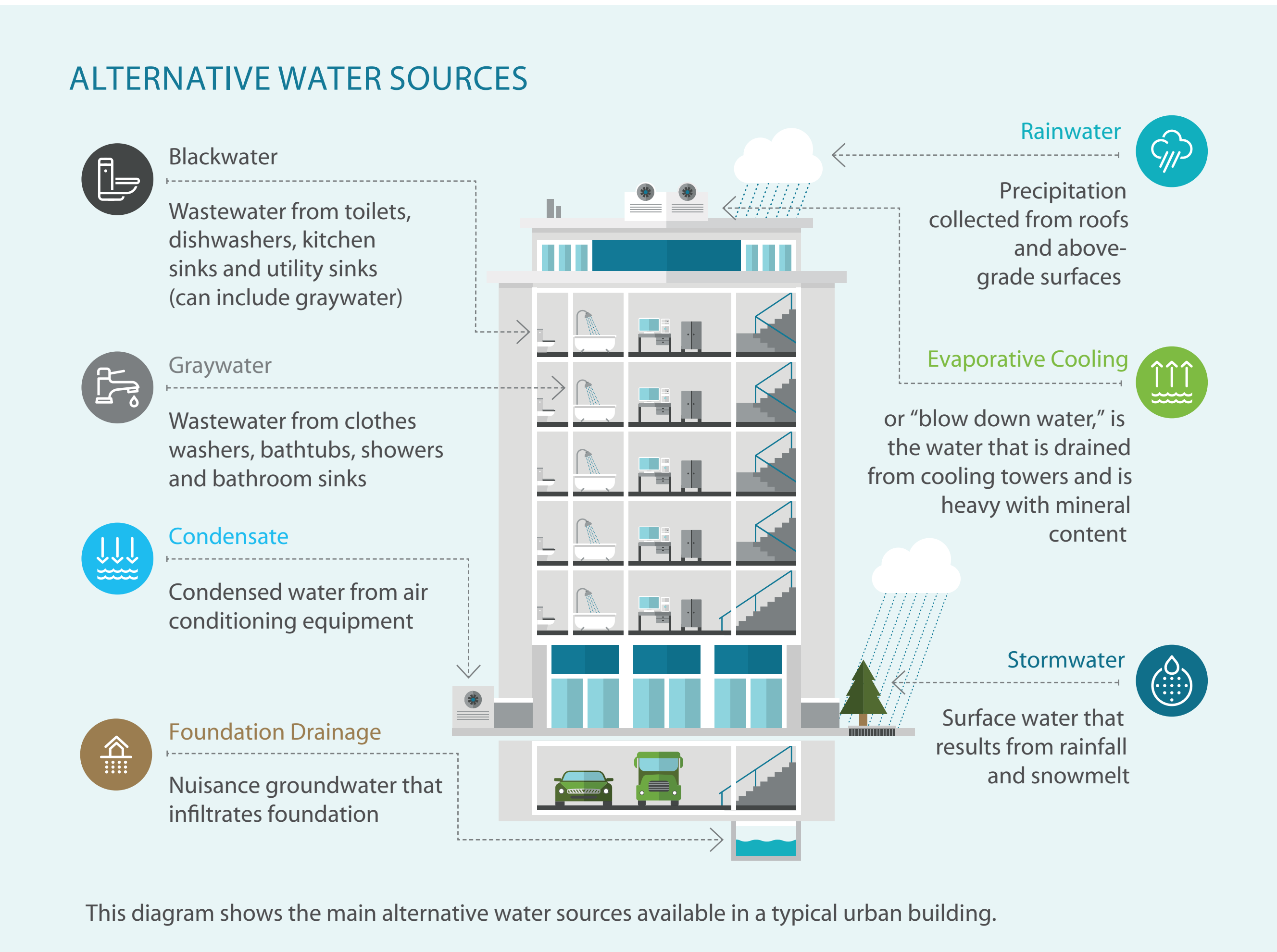
Figure 2. **Scales of Water Treatment and Reuse**



Source: Source images created by macrovector, freepik

ONWS can use water from a variety of sources, including rainwater, stormwater, graywater, blackwater, and foundation drainage (Figure 3). The water generated is used to satisfy non-potable demands, such as for toilets and urinals, landscape irrigation, building cooling, process water, and clothes washers. In multi-family residential buildings, toilet and urinal flushing and clothes washing alone constitute up to 40 percent of indoor water use; in commercial buildings, toilet and urinal flushing comprise up to 75 percent of indoor water use (San Francisco Public Utilities Commission 2020). In both, additional non-potable water demands include irrigation and cooling towers.

Figure 3. Main Alternative Water Sources Available in a Typical Urban Building



Source: The William J. Worthen Foundation 2018

SECTION 2: REGIONAL PERSPECTIVES ON ONSITE NON-POTABLE WATER SYSTEMS

Local context, including hydrologic, geographic, social, and institutional factors, is important for determining the benefits, challenges, and opportunities associated with ONWS. To better understand the local context and perspectives in Silicon Valley, we interviewed 23 stakeholders working in the region. This stakeholder group comprised representatives from water utilities, academia, companies, consultants, water technology vendors, and environmental NGOs. This section provides a synthesis of key insights from these interviews, starting with a high-level summary in Table 2 and then diving into greater detail below.[1] It is important to note that the views expressed in this section represent the opinions of those we interviewed, and we make no attempt to validate them. As a synthesis, any given perspective captured here does not necessarily reflect that of any individual interviewed.

CURRENT AND FUTURE ROLE OF ONSITE WATER SYSTEMS IN SILICON VALLEY

There was general agreement that ONWS currently play a minor role in Silicon Valley's water supply portfolio. There are only a handful of ONWS under construction in the region and even fewer in

1 See Appendix A for the full list of interviewees.

Table 2. Summary of Stakeholder Perspectives

Support
Accelerating innovation: Interviewees felt that corporate investments in ONWS could move much faster than public investments in centralized water systems, and that this would accelerate innovation in treatment, monitoring, project implementation (including regulation), and operation of water systems more broadly.
Leveraging private capital for public benefit: Several stakeholders expressed support for corporate investment in water systems, and some even consider it a company's responsibility as good actors in society. There was also discussion of how private investments in ONWS can alleviate pressure on centralized systems, and perhaps defer, reduce, or eliminate the need for utilities to make capital investments to expand existing water networks.

Concern
Corporate control and accountability for public health: Water and wastewater utilities are responsible for providing water services and have carried the responsibility of ensuring public health as it relates to water resources. The idea of companies treating and reusing wastewater generated onsite is new to many in Silicon Valley, and for some the premise of private corporations holding responsibility and control over public goods is unsettling.
Equity: Expansion of ONWS can reduce the use of potable water for non-potable demands like irrigation, which can increase water availability for other communities or the environment. It can also reduce water utilities' needs to expand capacity, lowering long-term water and wastewater costs. However, some interviewees expressed concern that investment in ONWS could lead to reduced revenue to support the public system, which could shift the cost of maintaining the public systems to the rest of the community. Some people raised concerns about equity as it related to access to water and green space in times of drought or water shortage. For example, a few interviewees noted, there could be a risk of corporate campuses having more reliable access to water during a drought or other water supply disruption, while other nearby communities suffer from water shortage.

operation. Interviewees indicated that the absence of a regional policy and standard regulatory framework are barriers to greater uptake.

Those interviewed, however, disagreed about the future role of ONWS in Silicon Valley. Some thought that ONWS will play an important role in the region's future water supply portfolio, noting that these systems will become more common as consistent regulations are established. Others, however, thought that ONWS will remain a niche technology that will not comprise more than one or two percent of the region's water supply portfolio. Several people noted that installation of these systems is only practical or feasible during new construction, suggesting that adoption would be constrained by the rate of large commercial developments.

Despite disagreement about the future role of ONWS, there is general agreement that Silicon Valley's future water supply portfolio will include a mix of scales, including building, block, district, and regional systems. However, most believe that district-scale makes the most sense for the region, and that those systems should be integrated into the planning and operations of the larger centralized water network.

CORPORATE MOTIVATIONS FOR INVESTING IN ONSITE WATER SYSTEMS

One insight from the regional stakeholder interviews was that the expectation of a positive return on investment over the long term is a major driver for corporate investments in ONWS. While ONWS are not expected to provide a positive return in the typical three- to five-year window often used by corporations, interviewees note that a positive return within 25 years is possible, particularly with rising water and wastewater costs. Technology companies in Silicon Valley typically have more money than many other companies, so they are more willing and able to make investments that may not produce a near-term positive return on investment. For other companies, however, capital cost is likely a major barrier, and it remains to be seen whether this will prevent adoption beyond the tech sector.

Interviewees agreed that sustainability goals are key drivers of corporate investments in ONWS. They note that in Silicon Valley, and the Bay Area broadly, sustainability is shifting from a "nice to have" to a "must have." LEED certification, renewable energy, recycling and composting, and water-efficient landscapes are becoming the norm. Interviewees believed this is due to regulations as well as expectations from employees, communities, and investors. There is broad consensus that it is important for Silicon Valley companies to be seen as sustainability leaders and innovators to strengthen their brand reputation, for employee recruitment and retention in a competitive labor market, and for local reputation within the communities in which they are located. Indeed, some alluded to a reputational risk of not investing in ONWS: that the company risks the perception of using too much of the community's water, especially during a drought.

Another key driver is companies' desire for water security. Interviewees observed a growing recognition among companies of the water-related risks posed by the combination of climate change and water management challenges in California. Several interviewees noted that companies are beginning to understand Silicon Valley's reliance on imported water and the vulnerability of those water sources. Companies also see water and sewer costs rising and want a resilient and secure water supply. ONWS provides an opportunity for companies to have control over water, reducing water costs over the long term and also providing some protection from potential disruptions to regional supplies. Other interviewees, though, emphasized that ONWS do not necessarily lower sewer costs significantly because sites will still need to connect to the sewer system and pay the connection fee (and have the option to discharge to the sewer as a back-up).

THE ROLE OF CORPORATIONS IN WATER MANAGEMENT

All interviewees expressed support, and in some cases enthusiasm, for Silicon Valley companies investing in ONWS. But while private investment in ONWS may be part of the solution, it is not a panacea, as one interviewee noted. There was widespread agreement that new ideas, technologies, and models for water management are needed and that this kind of innovation is aligned with the spirit of Silicon Valley. Most believe that corporate investments in many kinds of water innovations are widely beneficial for the region. However, there were also several concerns expressed about accountability and, in some cases, corporate control of water.

Advancing Innovation

Most people interviewed welcome the idea of Silicon Valley technology companies bringing their innovative spirit to the water space. Their willingness to invest in and experiment with ONWS is seen as helping to advance the technology and social understanding of distributed water infrastructure. Interviewees believe that corporate investments in ONWS could move faster than public investments in centralized water systems, and that this would accelerate innovation in treatment, monitoring, project implementation (including regulation), and operation of water systems more broadly.

However, there are concerns about the private sector's fast-paced culture and the potential for misalignment with that of public agencies. Public agencies are responsible for providing an essential service and protecting human health, which necessitates caution and consistency.

Leveraging Private Capital for Public Benefit

Several non-corporate stakeholders expressed support for corporate investment in water systems. Some even consider it the companies' responsibility as good actors in society. There was also discussion about how these private investments in ONWS can alleviate pressure on centralized systems, and perhaps defer, reduce, or eliminate the need for utilities to make capital investments to expand existing water networks. This could reduce water and wastewater utilities' need to raise funds for capital projects, which would ultimately benefit rate payers. Individual onsite water systems could potentially act as small nodes in the bigger water infrastructure system, leveraging private dollars to alleviate pressure on and add capacity to the public system.

Corporate Control and Accountability for Public Health

Despite interest in the potential for private investment in ONWS to provide regional benefits, several stakeholders expressed concerns about ensuring public health and safety with companies outside of the water sector treating wastewater and providing (non-potable) water supplies. In the modern urban context, water and wastewater utilities typically maintain control over most of a city's water supplies and have carried the responsibility of protecting public health that comes along with it. The idea of private corporations bearing the responsibility for providing wastewater treatment and reuse is new to many in Silicon Valley and, for some, unsettling. Several interviewees raised concerns about the ability to ensure public health is maintained and environmental impacts addressed, especially when thinking about the long term. What is the process for protecting public health and maintaining accountability for the ONWS should the site change owners? This kind of question was brought up several times.

Protecting human health and safety is the number one priority for any entity building and operating water treatment systems, but the interviews reflected a sense of mistrust from some that private corporations will be as accountable and responsible as public water utilities. While many companies reuse water onsite, for uses such as industrial processing, the public health concern is elevated when treated wastewater is used for purposes with higher potential for human contact, such as irrigation. The primary accountability mechanism is comprehensive and well-enforced regulation, and many interviewees were less concerned about public health risk knowing that Senate Bill 966 will provide a regulatory structure for ONWS. But as is described in the section on Senate Bill 966 below, regulations carry their own challenges too.

In addition, some interviewees raised questions about whether companies should play the role of non-potable water providers in Silicon Valley, even to their own campuses. Many of the concerns raised in interviews on this topic were ideological: there is a broader trend of privatization of public goods and services, and some believe this is not an appropriate role for corporations to play in our society. Even corporations implementing ONWS were quick to point out that all potable water supplies are (and should continue to be) controlled by water utilities.

Equity Concerns

Expansion of onsite water systems can reduce potable water demand, which can increase water availability for other communities or the environment. It can also reduce utilities' need to expand water supply and wastewater capacity, lowering long-term water and wastewater costs. However, interviewees expressed concern that sites with their own water supplies and wastewater treatment capacity would pay less to public water and wastewater service providers, shifting the near-term cost of maintaining those systems to the rest of the community. Interviewees noted that impacts on the near- and long-term cost of water will depend on policies with respect to connectivity to the public system, fees and rate structures, and infrastructure planning.

Some people raised concerns about equity as it related to access to water and green space in times of drought or water shortage. For example, a few interviewees noted, there could be a risk of corporate campuses having more reliable access to water in the face of drought due to ONWS, while nearby communities were facing water shortages. One interviewee gave a vivid description of this risk, saying one could imagine the undesirable juxtaposition of lush, green, cool corporate campuses against dry, brown, hot parks, schoolyards, and backyards (this undesirable future scenario is also laid out in Metcalf 2018). This interviewee clarified that this outcome is avoidable, but one that stakeholders need to be aware of to actively prevent. Another interviewee, though, sees this disparity as a motivation for communities to advocate for recycled water for their own landscapes, parks, and green spaces.

Future Water Supply Portfolio

While all interviewees acknowledge ONWS will be a part of the regional water supply portfolio, several observed misalignment between private and public sector stakeholders on how and to what extent onsite water systems should be adopted. A handful of interviewees suggest that this could be addressed by bringing stakeholders together in constructive dialogue about the appropriate role of onsite water systems in Silicon Valley.

IMPACTS OF SENATE BILL 966

Interviewees were asked how they expect Senate Bill (SB) 966 to affect the development of ONWS in Silicon Valley. The bill enjoys wide support, and all agree that standard regulations for onsite water systems are an absolute necessity. There is some disagreement about whether local oversight is the right approach, but agreement that local authorities need support to effectively implement the legislation. There is confusion about what the lack of a local program means, and some expressed doubts about the bill's efficacy.

Box 1

Background on Senate Bill 966

In 2018, California passed SB 966, which requires the State Water Resources Control Board (SWRCB) to establish uniform risk-based water quality standards for the onsite treatment and reuse of water, and requires municipalities to establish their own local programs in compliance with the state's new standards. The SWRCB has until December 2022 to publish the standards, and the California Department of Housing has until December 2023 to develop any corresponding updates to building standards. A key component of SB 966 is local authority, with either cities or counties being responsible for creating their own programs. The bill explicitly states that it "would prohibit an onsite treated non-potable water system from being installed except under a program established by a local jurisdiction in compliance with the bill's provisions."

Easing the Path for Onsite Water Treatment and Reuse

Those interviewed express high hopes that the adoption of a standard regulatory framework for onsite water systems will make it substantially easier, faster, and less complicated to build and permit onsite water systems. There is widespread agreement that the standard will provide clarity and ease concerns about adequate protection of public health. Many also think it will help to standardize the technologies and processes used to build and operate ONWS, which will drive down costs, make the process more predictable, incentivize a bigger pool of qualified operators, and ultimately make ONWS a more normal part of urban development.

While everyone interviewed acknowledged that local acceptance and adoption of SB 966 will vary, interviewees disagreed on whether a local approach is best. Some think local implementation allows for local control and tailoring of programs to the local context. Others, however, believe that most local jurisdictions do not have the expertise or financial resources needed to adequately implement a local program. Those who expressed concern about this would prefer to see the State Water Resources Control Board (SWRCB) administer the program and have it facilitated by the San Francisco Bay Regional Water Quality Control Board. Another option brought up by interviewees was permitting at the scale of water service providers, such as SFPUC has done.

Dedicating Resources for Robust Local Programs

Nearly all interviewees spoke of the need to provide local jurisdictions with adequate funding, staffing, and training for effective implementation. While the National Blue-Ribbon Commission for Onsite Non-potable Water Systems has developed useful tools and guidance for designing, permitting, and advancing ONWS (US Water Alliance 2020), interviewees spoke to a need for more locally-specific resources. For Silicon Valley, many thought the program should be administered by the counties. However, county public health staff are typically not familiar with onsite water systems and will need capacity-building, education, and likely dedicated staff with expertise on the topic. Dedicated funding is not currently available, but several people suggested permitting fees could cover costs. Others suggest that those companies implementing onsite water systems could provide financial or in-kind support for county staff training.

Reservations and Limitations

Some interviewees were concerned that the standards developed will be overly conservative and rigid. They expressed the need for a mechanism to revisit and adjust the requirements as appropriate to ensure that regulations do not become a barrier to adoption. Others were concerned about the long timeline to implementation of the standards, worrying that by the time they come out, localities will have already moved forward with figuring out the permitting processes to meet the demand for building onsite water systems. Lastly, many believe that while the passage of the bill was positive, a single bill alone is not enough.

There remains some uncertainty about the legal boundaries stipulated in the bill. The text of SB 966 clearly states that an onsite water system cannot be installed if it is in a jurisdiction that has not developed a local program in compliance with the legislation. Many consider this to be a slightly strange provision, and there appears to be some confusion over whether it is completely true. Some believe the letter of the bill. Others, though, seem assured that if there was no local program in place, the San Francisco Bay Regional Water Quality Control Board or the SWRCB would be able to permit the onsite water system instead.

SECTION 3: REALIZING THE BENEFITS OF ONSITE NON-POTABLE WATER SYSTEMS

At scale, ONWS have the potential to fundamentally shift water use and wastewater production patterns, thereby altering water, greenhouse gas (GHG), and other resource outputs (Figure 4). This shift, in turn, can provide a wide range of benefits, such as enhancing water supply reliability, improving water quality, lessening local flooding, and increasing urban green space (see, for example, Johnson Foundation at Wingspread 2014 and Kohler and Koch 2019). These systems, however, can also present challenges for the operation and maintenance of water and/or wastewater systems, such as maintaining sufficient revenue or fulfilling existing or future recycled water commitments. The magnitude and direction of these impacts depend on local context, as well as the extent to which these systems are implemented. Effectively planning for the appropriate integration of these systems can help to maximize the benefits and minimize any adverse impacts.

This section examines the outputs, outcomes, and impacts of ONWS, which can be realized as benefits or costs. Additionally, this section assesses how project location, local context, time, and other factors determine the realization, directionality, and magnitude of the costs and benefits. While this section presents a high-level overview of these issues, Section 4 provides a spatially explicit examination of opportunities for Silicon Valley.

Figure 5 provides a framework for conceptualizing the costs and benefits of ONWS. This framework differentiates between inputs, activities, outputs, outcomes, and impacts associated with ONWS, whereby:

- Inputs refer to the financial, human, and material resources that go into an ONWS project (e.g., time, money, technical expertise, wastewater, and energy).

Figure 4. Water System Diagram

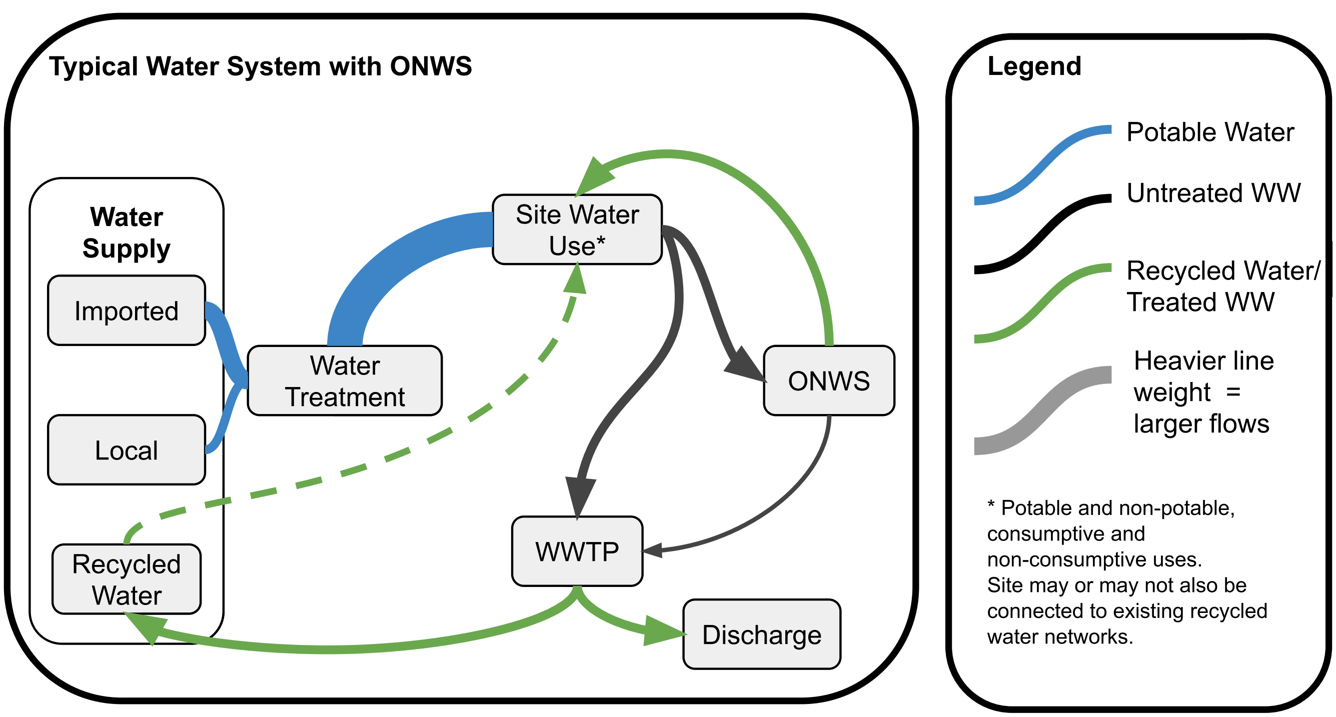
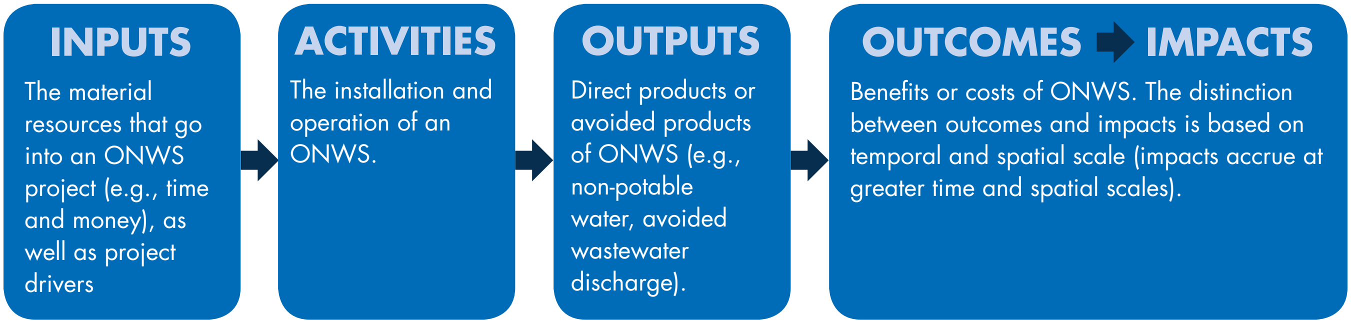


Figure 5. Impact Framework for ONWS



- Activities refer to the actions associated with the installation and operation of an ONWS.
- Outputs refer to the direct, tangible products (or avoided products) of ONWS implementation and operations (e.g., non-potable water, solids from treatment, avoided wastewater discharges).
- Outcomes refer to the indirect benefits or costs arising from the outputs and other determinants (e.g., changes in wastewater rates, opportunities for operations and maintenance (O&M) business models, reducing urban heat island effects).
- Impacts refer to the long-term benefits or costs of ONWS. The realization of most impacts is dependent upon scaling the number of ONWS and integrating ONWS into long-term water planning efforts.

OUTPUTS

The primary outputs of ONWS at the site are non-potable water and solids removed during treatment. Additionally, treating wastewater uses energy and, depending on the source of energy, produces GHGs.[1] In cases where biological systems, such as wetlands, are an integral component of the treatment system, ONWS can also create green space.

ONWS can also cause changes in the water system. For example, reusing water onsite can reduce wastewater flows into the centralized sewer system and alter wastewater quality. The magnitude of these changes depends on the number, type, and size of systems installed, and solids management practices. ONWS can also help reduce potable water demand.

OUTCOMES AND IMPACTS

The outputs of ONWS can lead to an array of cascading outcomes and impacts that occur along various temporal and spatial horizons. Temporal horizons include short- (less than five years), medium- (5–10 years) and long-term (greater than 10 years), and spatial horizons include the site, water and wastewater system, and the larger community. Through interviews and a review of literature on ONWS, we identified 26 potential outcomes and impacts associated with ONWS, some of which are positive and others negative (Table 3). Additional research and analysis are needed to validate this list and, as described in more detail below, determine which outcomes and impacts are relevant for a given project. Outcomes and impacts, both positive and negative, depend on local context and are proportional to the extent to which ONWS are implemented, such that a

1 Considerable energy and other resources are also embedded in the physical infrastructure and chemicals used in the operation of both ONWS and centralized infrastructure (Stokes-Draut et al. 2017).

small number of ONWS would have no or very little effect on the water and wastewater system and the community.

Water Quantity

One of the primary outcomes of ONWS is the creation of a new, local water source. This new source can satisfy non-potable water uses, such as toilet flushing, outdoor irrigation, and cooling towers, thereby reducing potable water demand. The potable water previously used at the site can serve a variety of purposes, such as supporting new development, enhancing water supply reliability, reducing groundwater withdrawals, and/or increasing instream flows. The fate of this

Table 3. **Potential Outcomes and Impacts Associated with ONWS**

Theme	Potential Outcomes and Impacts*
Water Quantity	Augment local water supplies (+)
	Inability to meet recycled water commitments (-)
Water Quality	Reduce discharge of wastewater pollutants (+)
	Reduce freshwater discharge into receiving waters (+/-)
Energy Use and GHG Emissions	Greater onsite energy use and associated GHG emissions (-)
	Reduced system energy use and associated GHG emissions (+)
	Reduced urban heat island effect (+)
Infrastructure	Avoided or deferred new water supply/treatment and wastewater infrastructure (+)
	Concentrated wastewater streams that can corrode wastewater collection system and/or create odor concerns (-)
	Creation of stranded assets if centralized and distributed systems are poorly integrated (-)
Finances	Increased site capital and operation and maintenance costs (-)
	Altered operation and maintenance costs for the water and/or wastewater system (+/-)
	Near-term reduction in revenue and shifting cost burden (-)
	Long-term reduction in capital costs for water and wastewater infrastructure (+)
	Greater financial flexibility (+)
Innovation	Creation of new technologies and ways of building and operating water systems (+)
	Creation of innovative shared ownership and operation models (+)
	Creation of innovative partnerships between the public and private sectors (+)
Organizational Reputation	Seen as a leader and innovator (+)
	Improvement in employee recruitment and retention (+)
Policy Goals and Regulatory Requirements	Achievement of public and private sector sustainability goals (+)
	Altered ability to meet NPDES/WDR** requirements (+/-)
Resilience	Diversified water supply portfolio (+)
	Greater operational flexibility (+)
	Reduced vulnerability to sea level rise (on coastal infrastructure and Delta supplies) (+)
	Creation of redundant water and wastewater systems to reduce likelihood of service disruption (+)

*Realization of outcomes and impacts, both positive and negative, depend on local context and are proportional to the extent to which ONWS are implemented.

**NPDES stands for National Pollutant Discharge Elimination System; WDR stands for Water Discharge Permit. Both refer to permitting requirements under the federal Clean Water Act.

water ultimately depends on policy choices that, in turn, trigger a host of additional outcomes.

ONWS can also affect the supply and demand for recycled water from the regional system. ONWS reduce wastewater flows into the regional wastewater system and the ability to produce recycled water. This could jeopardize the water utilities' ability to meet existing and future recycled water commitments, some of which run through the year 2095. In 2019, for example, the cities of Palo Alto and Mountain View entered into an agreement with Valley Water, in which Valley Water is helping fund a regional recycled water plant in exchange for some of the cities' treated wastewater (Valley Water 2019). Significant reductions in the cities' wastewater flows could affect this agreement. On the other hand, ONWS could reduce the need (and investment required) for regional recycled water and other new water supplies. Effectively accounting and planning for the development of local ONWS can minimize the risk of adverse impacts.

Water Quality

ONWS situated in portions of a wastewater treatment plant service area that is at or near capacity can alleviate pressure on existing infrastructure and ensure water quality is protected. However, in areas where wastewater systems are not at capacity and facilities are successfully meeting water quality permit requirements, this may not be an immediate benefit of ONWS.

Lastly, Silicon Valley wastewater treatment facilities' capacity to protect water quality is under threat due to sea level rise (SLR) (Hummel et al. 2018). By distributing wastewater treatment capacity more broadly throughout the region, especially further away from the shoreline, ONWS can play a role in protecting water quality in the face of rising Bay water levels and increasing storm severity.

Energy Use and Greenhouse Gas Emissions

ONWS have both direct and indirect effects on energy use and GHG emissions. ONWS increase energy use at the site where they are installed, and depending on the source of energy, result in GHG emissions associated energy generation. However, ONWS can also reduce energy use and the associated GHG emissions for the centralized water and wastewater systems due to reductions in potable water demand and the amount of wastewater treated. The net effect depends on site-specific factors, including water and wastewater treatment requirements, the distance and elevation over which water and wastewater would have been pumped, and any differences in energy sources (Kavvada et al. 2016). ONWS that incorporate natural treatment systems or other features that increase green space may reduce the urban heat island effect and use less energy than conventional treatment processes, saving energy for the site and the community (Kadlec and Wallace 2008).

Infrastructure Operations

ONWS reduce the amount of water needed from the centralized water system and the amount of wastewater that must be collected and treated by the centralized wastewater system. They can extend the life of water and wastewater systems at or near capacity, thereby deferring capital costs for new water supply and wastewater treatment facilities. Additionally, many water and wastewater systems are nearing the end of their design life (American Society of Civil Engineers 2017a). If employed at scale, ONWS could allow for the construction of smaller water supply and wastewater treatment facilities, avoiding future capital and O&M costs. However, the failure to integrate ONWS into planning for centralized water and wastewater infrastructure could strand assets if those systems are built too large or too soon.

As ONWS divert wastewater flows from centralized water systems, they can also concentrate wastewater streams. More concentrated wastewater streams can corrode the wastewater collection system and cause odor concerns, potentially requiring changes in maintenance procedures and treatment processes to mitigate those impacts or accelerated replacement of pipelines.

Finances

ONWS can have near- and long-term impacts on water utilities. In the near term, ONWS can reduce the revenue generated for the utility and, to a lesser extent, the cost to operate the water and wastewater system. However, effective rate structures and other mechanisms can help mitigate these impacts (Johnson Foundation at Wingspread 2014). In the long-term, private sector investments in ONWS could reduce, defer, or prevent the need for water utilities to make large-scale investments in centralized water and wastewater infrastructure. These private sector investments could reduce long-term capital and O&M costs to water and wastewater utilities, providing greater financial flexibility to the utility and a cost savings to ratepayers. These savings could be especially valuable in light of the financial strains COVID-19 has placed on the water sector (Kammeyer et al. 2020).

Innovation

Innovation in urban water management will be essential for meeting the scope and scale of current and future challenges (Hering et al. 2013). Based on a survey of the wastewater sector in California, Kiparsky et al. (2016) found that more than 70 percent of responding wastewater managers agreed or strongly agreed that innovation would result in lower costs and better water quality in the long term. To consider adoption of innovative technologies, program managers reported needing a technology to be industry standard and broadly adopted (~25 percent), piloted at full scale (>20 percent), or tested in a demonstration project (~20 percent). ONWS in Silicon Valley could help meet some of these needs by demonstrating novel technologies and approaches, including how distributed systems could be integrated into existing infrastructure. Moreover, they could allow for the development of new ownership models and partnership opportunities among the public and private sectors.

Organizational Reputation

There is broad understanding and acknowledgement of the importance of a positive reputation for a company. It can, for example, help to attract and retain high-quality employees, create loyal customers, and charge a premium for products (Eccles et al. 2007). There is growing interest and acknowledgement of the value of a favorable reputation for public agencies, as well.

ONWS are perceived as innovative and leading-edge, and, as a result, could enhance the reputation of the companies investing in them and the public sector partners supporting them. In 2019, for example, the National Blue-Ribbon Commission for Onsite Non-potable Water Systems received the WateReuse President's Award for exceptional service and leadership. Also in 2019, Paula Kehoe of the San Francisco Public Utilities Commission was recognized for her role in advancing Assembly Bill 966 (WateReuse n.d.). While there may be reputational risks if a system fails to perform or provide anticipated benefits, these risks can be reduced by a sound process, robust monitoring, and appropriate regulatory requirements.

Policy Goals and Regulatory Requirements

ONWS can help the public and private sectors meet policy goals. By reducing non-potable demand from the water system, ONWS could help California's urban water suppliers meet water efficiency goals established through Assembly Bill 1668 and Senate Bill 606. Likewise, these systems could help meet the goal adopted by the State Water Board of reducing all dry weather discharges of treated wastewater into enclosed bays, estuaries, coastal lagoons, and ocean waters (State Water Resources Control Board 2018). The State Water Board also adopted a statewide goal of increasing the use of recycled water to 1.5 million acre-feet per year by 2020 and to 2.5 million acre-feet per year by 2030 (State Water Resources Control Board 2018). While water from ONWS is not currently counted toward that goal, state policy could be revised to account for it.

Furthermore, a growing number of companies, including technology companies in Silicon Valley, are adopting water sustainability goals to reduce their water use and/or increase onsite water reuse. For example, a recent survey by CDP, a leading corporate sustainability disclosure platform, indicated that the number of responding companies setting water targets doubled between 2015 and 2018 (CDP 2018). Both Intel and Microsoft, for example, have committed to achieving a "net-positive water impact," i.e., providing more water to communities and environments than they use (Meyer 2020, Smith 2020). Investment in ONWS are one way for companies to achieve those goals.

ONWS can also affect the public and private sectors' ability to meet regulatory obligations, including National Pollutant Discharge Elimination System (NPDES) permits and/or waste discharge requirements. On one hand, ONWS that are strategically placed and implemented at scale can, for example, help communities avoid sewer system overflows, especially when those systems integrate stormwater capture. However, the failure to adequately manage for more concentrated waste streams could cause wastewater plants to violate their NPDES permit requirements.

Water Resilience

Water and wastewater systems have been built and operated assuming stationarity, i.e., that the past is a good predictor of future weather patterns and water risks. We now know this assumption is no longer valid and the future is increasingly variable and uncertain due to climate change and other stressors and shocks. In response, there is growing interest in improving water resilience by adopting strategies that perform well across a wide range of future scenarios (i.e., are robust) and allow for adjustments to unexpected events (i.e., are flexible) (Smith et al. 2019).

ONWS can enhance water resilience in several ways. By diversifying water sources, for example, ONWS can reduce vulnerability to drought and other water supply constraints. Likewise, integrating distributed and centralized infrastructure can provide operational flexibility and redundancy, reducing vulnerability to flooding from heavy rainfall events and SLR, power outages, and other service disruptions.

In 2012, for example, Hurricane Sandy caused power outages, flooding, and damage to wastewater treatment plants and pumping stations along the eastern United States, sending an estimated 11 billion gallons of raw or partially treated sewage into local waterways and, in some cases, city streets (Rupiper and Loge 2019, Kenward et al. 2013). While many centralized systems suffered damage or operational failures, more than 80 distributed systems remained operational (Johnson Foundation at Wingspread 2014).

FACTORS IMPACTING BENEFIT REALIZATION AND SCALING

While ONWS can provide several important benefits, implementation is still in its infancy. This gap is a major motivation for current research. Common themes in this research include overcoming barriers to ONWS (Hacker and Binz 2020, Rupiper and Loge 2019); developing optimization and decision-support tools for siting (Kavvada et al. 2016, Kavvada et al. 2018, Lee et al. 2013, Lee et al. 2016, Lee et al. 2018, Woods et al. 2013); improving treatment technologies and resource recovery (Diaz-Elsayed et al. 2019); benefits and trade-offs (Arden et al., 2020); and advancing socio-technical systems thinking (Hoffmann et al., 2020). These and other studies underscore the significance of local context and scale in determining the realization, direction, and magnitude of benefits associated with ONWS. Some of these factors are summarized in Error! Reference source not found. and described in more detail in the following section.

Location: Recent research has illustrated the importance of location in determining the magnitude of several common trade-offs between traditional centralized infrastructure and ONWS (Kavvada et al. 2018, Woods et al. 2013). In both studies, proximity to existing water and wastewater facilities, particularly differences in elevation, had a significant impact on energy use, GHG emissions, and cost. Practically, this suggests that ONWS sited further from existing treatment facilities and recycled water networks are likely to result in greater energy and GHG savings due to decreased pumping and infrastructure requirements. This can also translate into cost savings for water and wastewater utilities. As another example, ONWS do not suffer from intrusion of salt water that occurs in some wastewater collection systems along the margins

Table 4. Example of Determinants of ONWS Benefits

Location	Proximity to existing regional recycled water networks, and elevation as compared to those networks
Time	The accrual of benefits and costs over various time scales, e.g., short-term (1–5 years), medium-term (5–10 years), and long-term (10+ years)
Magnitude of outputs	The quantities of water, solids, and GHGs generated relative to existing infrastructure
System scale	Economies of scale are commonly observed, although they may be offset by topographic or other spatially explicit factors
Existing infrastructure capacity and age	The capacity and remaining design-life of nearby water, sewer, and wastewater treatment infrastructure
Governance structure	The number of water, sewer, wastewater treatment, and recycled water operators and their institutional relationships
Institutional support	Institutional structures in place to support implementation and integration of projects into regional water planning efforts
Exposure to risks	Local and regional exposure to external stressors such as climate change and water scarcity

of the Bay, thereby improving the quality of the water produced from these systems and reducing the energy needed to remove salts.

Time: One major challenge in estimating the benefits of ONWS is the temporal scale over which benefits are realized and differences in how stakeholders evaluate benefits over time. While the private sector realizes the upfront costs of ONWS, they also begin accruing benefits much sooner than the public sector. The private sector business case for ONWS emphasizes shorter-term benefits, such as improved employee recruitment and retention by positioning the company as an environmentally progressive actor, though companies are increasingly looking at longer time scales when it comes to climate resilience and water security. Public sector and community benefits accrue mostly as ONWS are scaled up and integrated into agencies' medium- to long-term planning processes. The public sector tends to be risk averse due to their direct public responsibilities and regulatory repercussions of malfunctioning infrastructure (Kiparsky et al. 2016). This, coupled with the long design life of water and wastewater infrastructure, tends to foster planning horizons of years to decades.

Magnitude of Outputs: Most benefits and costs of ONWS are proportional to the outputs and their change relative to a baseline. The quantities of water, solids, and GHGs produced depend on the size of treatment facilities, treatment technologies utilized, solids management, regional energy mix, and other factors. Moreover, these changes are relative to a baseline of existing infrastructure. At scale, ONWS can alter patterns of water use, treatment, and reuse within a watershed. These changes drive linked benefits, such as reduced reliance on imported water, as well as near-term costs, such as changes in sewer maintenance and wastewater treatment operations.

System Scale: Economies of scale are commonly observed in both the capital and O&M costs associated with wastewater treatment and reuse and their GHG emissions. While larger treatment facilities typically cost less and emit less GHG per unit of water treated, these economies of scale are often offset by the energy and resource costs of conveying wastewater to centralized treatment facilities and distributing recycled water back to customers (Guo et al. 2014). Several analyses, such as optimization models developed by Kavvada et al. (2018, 2016) and Lee et al. (2013), demonstrate the trade-offs between different types of distributed infrastructure. Spatial context, especially topography, is a key determinant of the optimal scale of distributed infrastructure for a given location.

Existing Infrastructure Capacity and Age: The capacity of nearby water, sewer, and wastewater treatment infrastructure (relative to demand and/or wastewater flows) and the remaining design life of this infrastructure affect the realization of ONWS benefits. For example, in the eastern portion of San Francisco, ONWS can help divert flows from combined (storm and sanitary) sewer systems operating at or near capacity, thereby reducing or delaying investments needed to increase sewer and/or treatment capacity. In Silicon Valley, by contrast, storm and sanitary sewers are generally not combined, and many sewer systems were designed to handle large wastewater flows from the region's past as home to major agricultural processing operations. However, sewer systems in some parts of Silicon Valley, such as in San Jose, are nearing the end of their useful life. Understanding the role of infrastructure capacity on the realization of benefits for Silicon Valley requires a more granular assessment of local challenges and will be discussed in greater detail in Section 4.

Governance Structure: Governance structures can affect implementation of ONWS. To date, a handful of private companies in Silicon Valley have independently installed ONWS at their facilities. This stands in contrast to San Francisco, where there are requirements for ONWS in new, large developments. The City of Menlo Park is a notable exception to current trends in Silicon Valley; it is currently developing regulations modeled on SFPUC's approach. Wastewater in Menlo Park is collected and conveyed by the West Bay Sanitary District to Silicon Valley Clean Water (SVCW) in Redwood City. Because Menlo Park pays for the quantity of wastewater delivered to SVCW, there is a financial incentive to reduce the amount of wastewater they pay to have treated (via ONWS implementation). In other Silicon Valley utilities, water, sewer, wastewater treatment, and recycled water operations are integrated in varying configurations, altering incentive structures, the likelihood of utility support of ONWS, and ultimately the level of implementation and benefit realization.

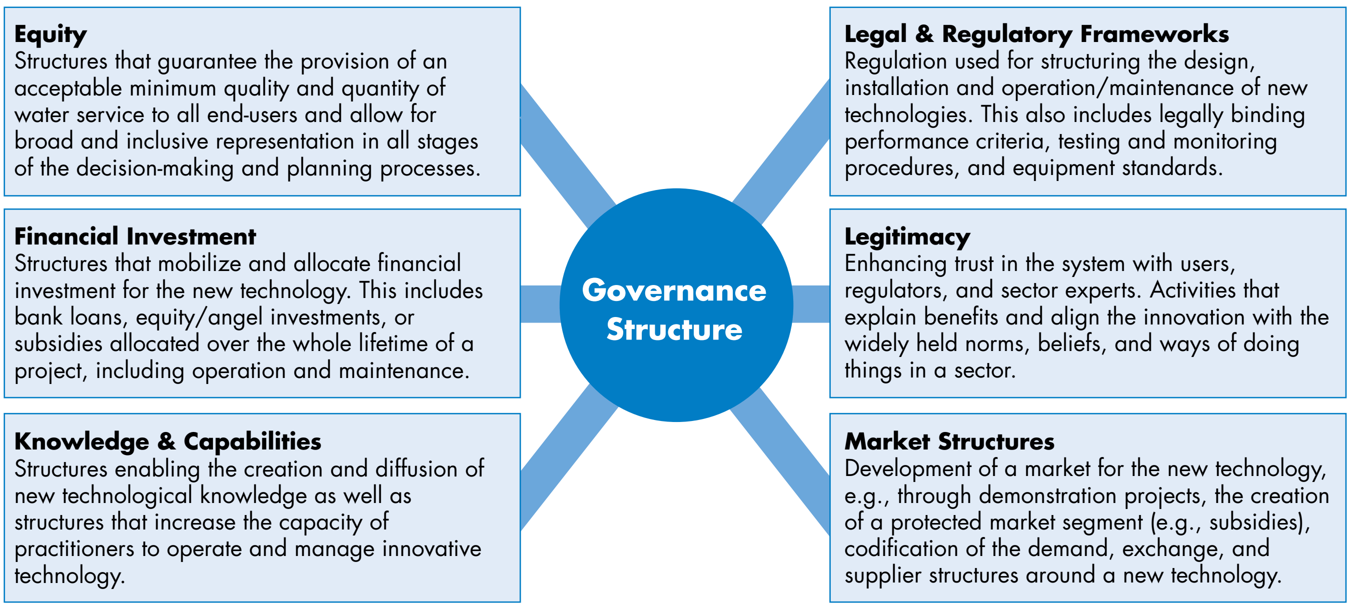
Institutional Support: Institutional structures in place to support implementation and integration of projects into regional water planning affect the realization of benefits. Failing to incorporate the expansion of ONWS into water and wastewater master plans can lead to unnecessary infrastructure investments and higher costs to ratepayers. Likewise, large-scale divestment in public infrastructure can create a host of financial, operational, equity, and other issues. There are a number of regional groups that could provide the institutional support needed, including the Bay Area Regional Collaborative, the Bay Area Water Supply and Conservation Agency, Bay Area Clean Water Agencies, and others.

Hacker and Binz (2020) recently developed an analytical framework of the six "resource pools" of institutional structure needed to advance ONWS (Hacker and Binz 2020). Those are: equity, financial investment, knowledge and capabilities, legal and regulatory frameworks, legitimacy, and market structures (Figure 6). If components of this structure are missing, or ill-equipped for ONWS, it can become a barrier to successful ONWS implementation and thus realization of the benefits.

For example, surveys showed that lack of knowledge is a barrier to successful ONWS outcomes; not only was a dearth of resources cited as a key barrier, but less than 20 percent of respondents had read the resources that were available (Rupiper and Loge 2019). These surveys also showed that lack of a clear regulatory framework for ONWS was a primary barrier, a point echoed in the regional stakeholder interviews for this report. Many stakeholders interviewed expect SB 966, which will provide regulatory clarity for ONWS, to improve ONWS outcomes. Similarly, a lack of legitimacy — trust and alignment across stakeholders — can cause challenges in ONWS implementation, while a shared vision and understanding of the impacts of ONWS and their role in the regional water system can help ensure that positive impacts are realized and negative impacts are minimized.

Exposure to Risks: Water systems in the Bay Area face a multitude of risks, including the impacts of climate change on water supply availability and timing, co-location of critical infrastructure in areas vulnerable to SLR, liquefaction, and earthquake fault zones (Ackerly et al. 2018). However, exposure to these stressors varies spatially and temporally across the Bay Area, leaving some areas and infrastructure systems more vulnerable to adverse impacts than others. For example, water infrastructure along the bay shore is vulnerable to increased seawater intrusion with SLR and liquefaction during an earthquake. When sited in impacted locations and integrated with existing infrastructure, ONWS can help build the adaptive capacity of water systems and reduce vulnerability to stressors by lessening reliance on vulnerable infrastructure and building system redundancy. The realization and magnitude of adaptive capacity-related benefits is dependent upon the stressors faced by a given site and/or system.

Figure 6. Institutional Support Structure and Its Resources Pools



Source: Hacker and Binz 2020

SECTION 4: OPPORTUNITIES FOR ONSITE NON-POTABLE WATER SYSTEMS IN SILICON VALLEY

While ONWS can provide a multitude of benefits, realization of these benefits depends, in part, on local context and the integration of ONWS with existing infrastructure and planning decisions. This section presents results from 10 spatially explicit assessments of opportunities for ONWS to provide economic, environmental, and social benefits in Silicon Valley (Table 5). First, we discuss opportunities for integrating ONWS into land-use planning decisions, including redevelopment activities and relationships with broader planning concerns such as improving green space access and impacts on communities of concern. Second, we assess the opportunity for ONWS to augment existing water supplies and offset imported water supplies. Finally, we identify opportunities for ONWS to augment existing water infrastructure and create redundancy, thereby improving system resilience, including in areas likely to face increased stress from SLR and/or or are underserved by existing infrastructure.

These assessments were limited by the data available. For example, data were not readily available for the entire valley, which extends into San Mateo and Alameda Counties. As a result, we limited our analysis to northern Santa Clara County and San Mateo County for most of the assessments. In some cases, even data for these areas were not readily available; for these, we limited our analysis to the City of San Jose. Table 5 provides an overview of the geographic scope for each assessment. Further, we were unable to examine all potential benefits for ONWS, e.g., how ONWS could work in concert with decentralized stormwater management systems. Additional details on the data used in this analysis are included in Appendix B.

Table 5. Overview of ONWS Benefits in Silicon Valley Assessed in This Section

Opportunity	Assessment	Primary Geographic Scope
Integrating ONWS into Land-Use Planning Decisions	Integrating ONWS into planned development/ redevelopment activities	Northern Santa Clara County
	Addressing needs of communities of concern	Northern Santa Clara County
	Improving access to green space	Northern Santa Clara County
Supply Augmentation with ONWS	Regional water reuse opportunities	Santa Clara and San Mateo counties
	Reduced reliance on imported water supplies	Santa Clara and San Mateo counties
Infrastructure Augmentation and Building Redundancy with ONWS	Sea level rise impacts on water infrastructure systems	Northern Santa Clara County
	Sanitary sewer overflow incidents and ONWS	San Jose/Santa Clara County
	Timing ONWS to coincide with replacement of aging sewer infrastructure	City of San Jose
	Augmenting sanitary sewers	City of San Jose
	Augmenting existing recycled water distribution networks	Northern Santa Clara County

Data sources for these assessments are listed in Appendix B.

Geographic Background: Silicon Valley is relatively flat, with an elevation change of 200 feet over 30 miles, or 0.14 percent from the NW corner to the SE corner of Figure 9. This fact has important engineering and energy implications for the local distribution of water/recycled water and wastewater conveyance. Historically, this region was known for its agriculture, urbanizing over time beginning with the establishment of Stanford University. As a result of its agricultural past, the region has unique utility infrastructure. The sewer system is characterized by large pipes that are able to handle volumes well above current usage. Existing recycled water networks in Santa Clara County are extensive, connecting to many public spaces, like parks, in Santa Clara and San Jose.

Although the sewer system was constructed for a larger capacity than is currently in use, the pipes are aging and vulnerable to natural disasters. Much of the valley floor (62 percent) is susceptible to liquefaction, and areas unlikely to experience liquefaction are vulnerable to landslides (30 percent of the study area). Three percent of parcel area within Silicon Valley lie in a fault zone as well (MTC 2018b, Holzer et al. 2008). Climate change impacts, like SLR, have increased wildfire intensity, and higher intensity precipitation increases the risk of liquefaction and landslides, and thus the vulnerability of Silicon Valley water systems. ONWS could increase resilience to interruptions by providing redundancy and additional treatment capacity.

OPPORTUNITIES FOR INTEGRATION WITH LAND-USE PLANNING DECISIONS

When ONWS are incorporated into land-use planning decisions, their regional benefits can be maximized. In this section we examine how ONWS can integrate with planned development, incorporate the needs of underserved communities, and expand recycled water usage in new and existing parks.

Integrating with Planned Development/ Redevelopment Activities

ONWS require a separate set of pipes to distribute non-potable water for landscape irrigation, toilet flushing, and other uses. Because it can be cost-prohibitive to retrofit existing buildings, particularly for uses inside the building, the greatest potential for implementing ONWS exists in new development or major redevelopment projects. We note, however, that retrofitting an outdoor irrigation system is considerably easier than installing dual plumbing in an existing building; as a result, there may be additional opportunities for outdoor reuse in existing buildings.

For this assessment, we overlaid priority development areas (PDAs) (from Metropolitan Transportation Commission's Plan Bay Area 2050) with data on Santa Clara County's existing recycled water network, and added a 1,000-foot buffer around the existing recycled water network to identify planned development areas currently lacking recycled water access (Figure 7). The Metropolitan Transportation Commission (MTC) identified PDAs based on transit access, community priorities, and areas planned for future housing and job growth.

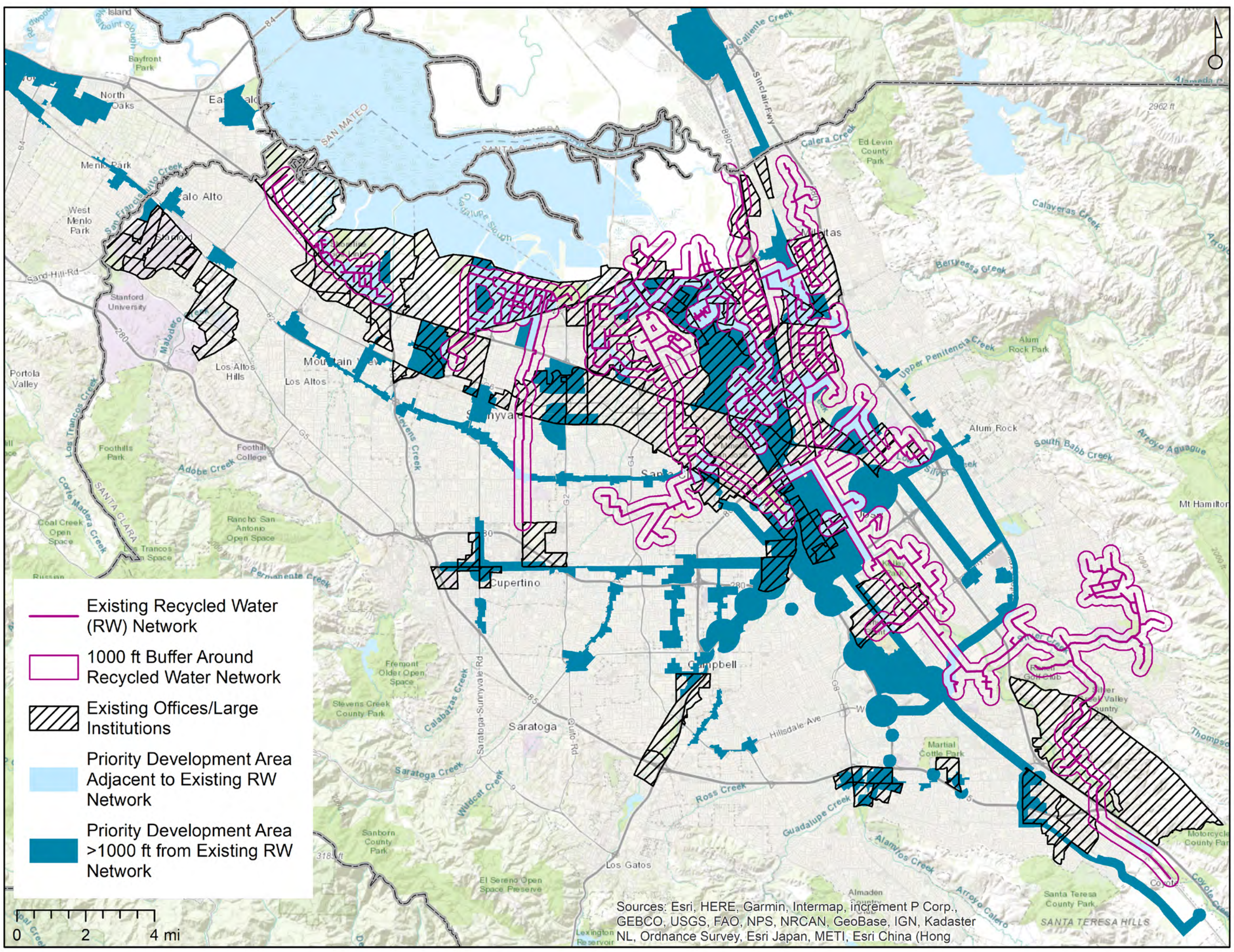
We found that there are development areas with little or no recycled water infrastructure in portions of downtown San Jose, around most Caltrain stations, the Southwest Expressway corridor toward Campbell, and the Stevens Creek Boulevard corridor. In total, roughly 18 square miles of PDA are within 1,000 feet of existing recycled water distribution networks, while 50 square miles of PDA are more than 1,000 feet from existing recycled water supply networks (Figure 7). While several of these areas are being explored for future recycled water expansion in the current Countywide Water Reuse Master Plan (Brown and Caldwell 2020), ONWS could avoid the need for extending recycled water networks into these areas.

Addressing Needs of Communities of Concern

With intentional development and community involvement, ONWS may be able to provide benefits to nearby underserved communities. For example, ONWS located near these regions could support community efforts to increase green space and lower pollution burdens. For this assessment, we compared the location of underserved communities (communities of concern) with that of office parks in Silicon Valley (Figure 8). We used MTC-identified communities of concern, which are defined by a number of metrics that describe socioeconomic stress faced by a high proportion of residents in each highlighted census tract.[1] Many

1 The MTC conducted a comprehensive assessment to identify census tracts with a high proportion of residents

Figure 7. **Metropolitan Transportation Commission Priority Development Areas Relative to Existing Recycled Water Supplies and Communities of Concern**



Source: City of San Jose Open Data Platform, Metropolitan Transportation Commission Open Data Platform, Valley Water District Draft Recycled Water Master Plan of these communities are also in areas facing a high pollution burden (CalEnviroScreen 2018).

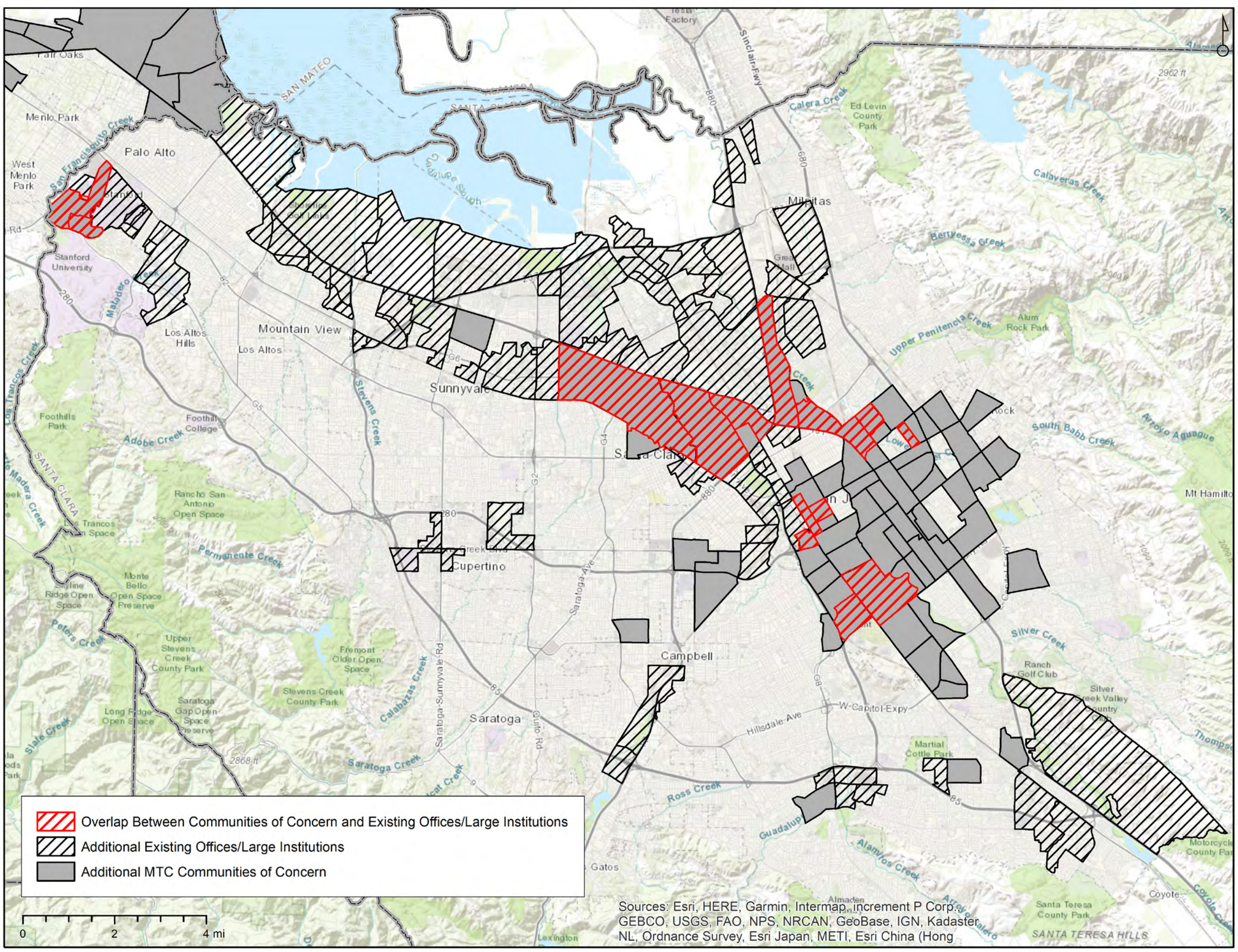
Presently, 19 percent of the study area contains office parks. These office parks are primarily located on or near the bay shore, with additional office parks scattered near the foothills. Communities of concern are mostly south of the industrial section around freeways in East San Jose. We found that 20 percent of office parks are in census tracts with communities of concern, creating an opportunity to consider the needs of the immediate community and the impact of ONWS on the surrounding area when developing ONWS. ONWS built in or near these tracts could provide non-potable water to support community needs as long as there are no adverse effects on water, air, or noise pollution associated with these systems.

Improving Access to Green Space

ONWS could support additional green space around corporate campuses and other buildings where ONWS are in use. More green space can, in turn, help reduce the urban heat island effect and

facing one or more of eight socioeconomic disadvantage factors (MTC 2018). These communities are identified as communities of concern by MTC. https://bayareametro.github.io/Spatial-Analysis-Mapping-Projects/Project-Documentation/Communities-of-Concern/.

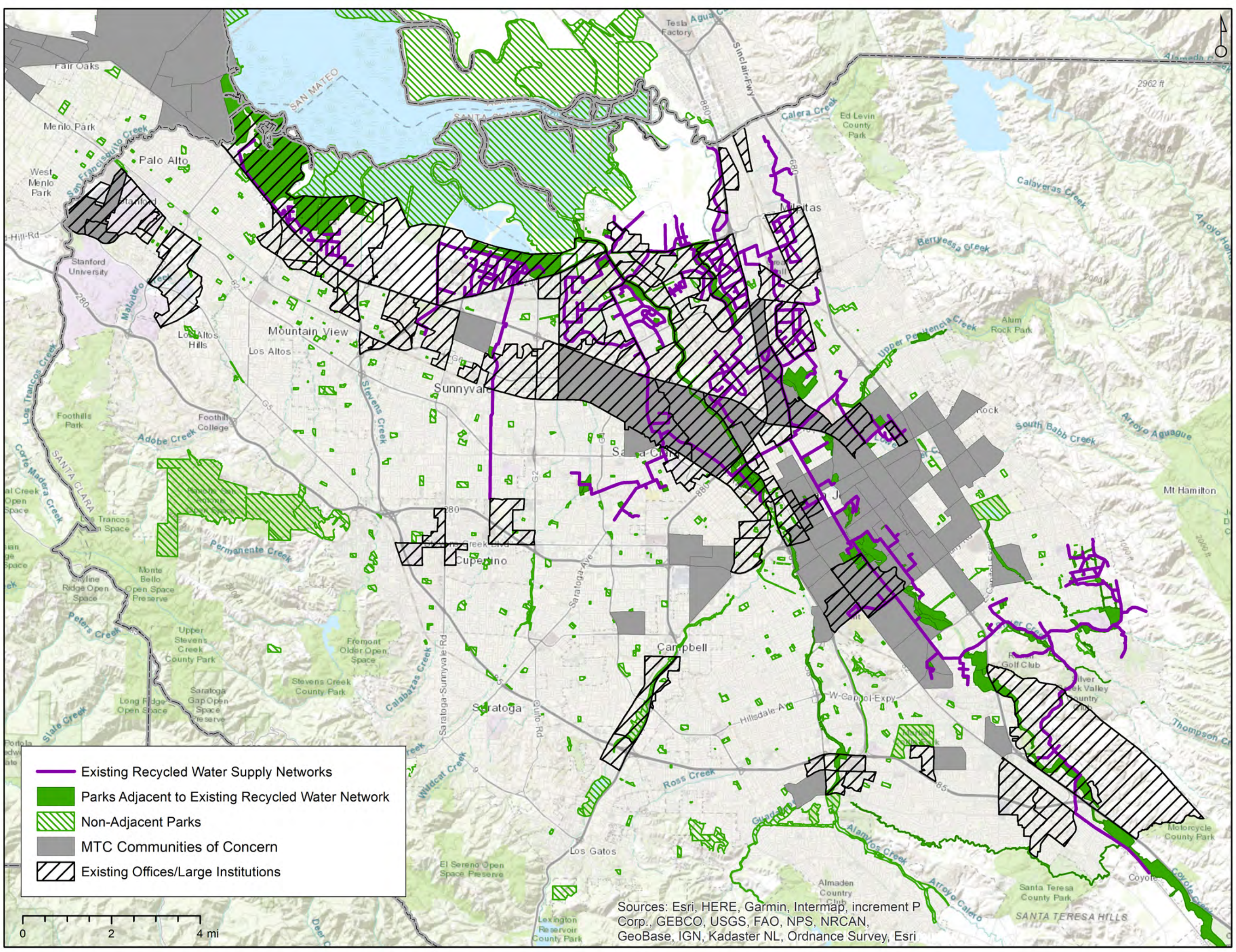
Figure 8. **Spatial Overlay of Communities of Concern and Office Parks in Silicon Valley**



Source: City of San Jose Open Data Platform, Metropolitan Transportation Commission Open Data Platform create habitat for plants and animals. Additionally, these spaces could provide recreational benefits to the community if they are open to the public. For this assessment, we overlaid data on office parks, parks, and communities of concern to assess the need for parks and identify locations where ONWS could provide water to new and existing parks.

Park access in Silicon Valley is high, with 70 percent of people living within 10 walking minutes of a park (Trust for Public Land 2020). Although access to green space is spread evenly throughout the study area, targeted information and events, particularly in nearby communities of concern, could help increase awareness, perceptions of access, and usage of these green spaces. In addition, there are opportunities for expanding the use of recycled water for landscape irrigation in the region. Currently, 17 percent of the 659 parks in northern Santa Clara County are connected to recycled water supplies; these parks contain nearly 7,000 acres of green space. ONWS could increase access to water for landscape irrigation in areas not served by existing recycled water distribution networks (Figure 9).

Figure 9. **Proximity of Communities of Concern to Parks, Office Parks, and Existing Recycled Water Supply Networks**



Source: City of San Jose Open Data Platform, Metropolitan Transportation Commission Open Data Platform, Santa Clara Draft Countywide Water Reuse Master Plan, Trust for Public Land Parks Dataset

OPPORTUNITIES FOR SUPPLY AUGMENTATION

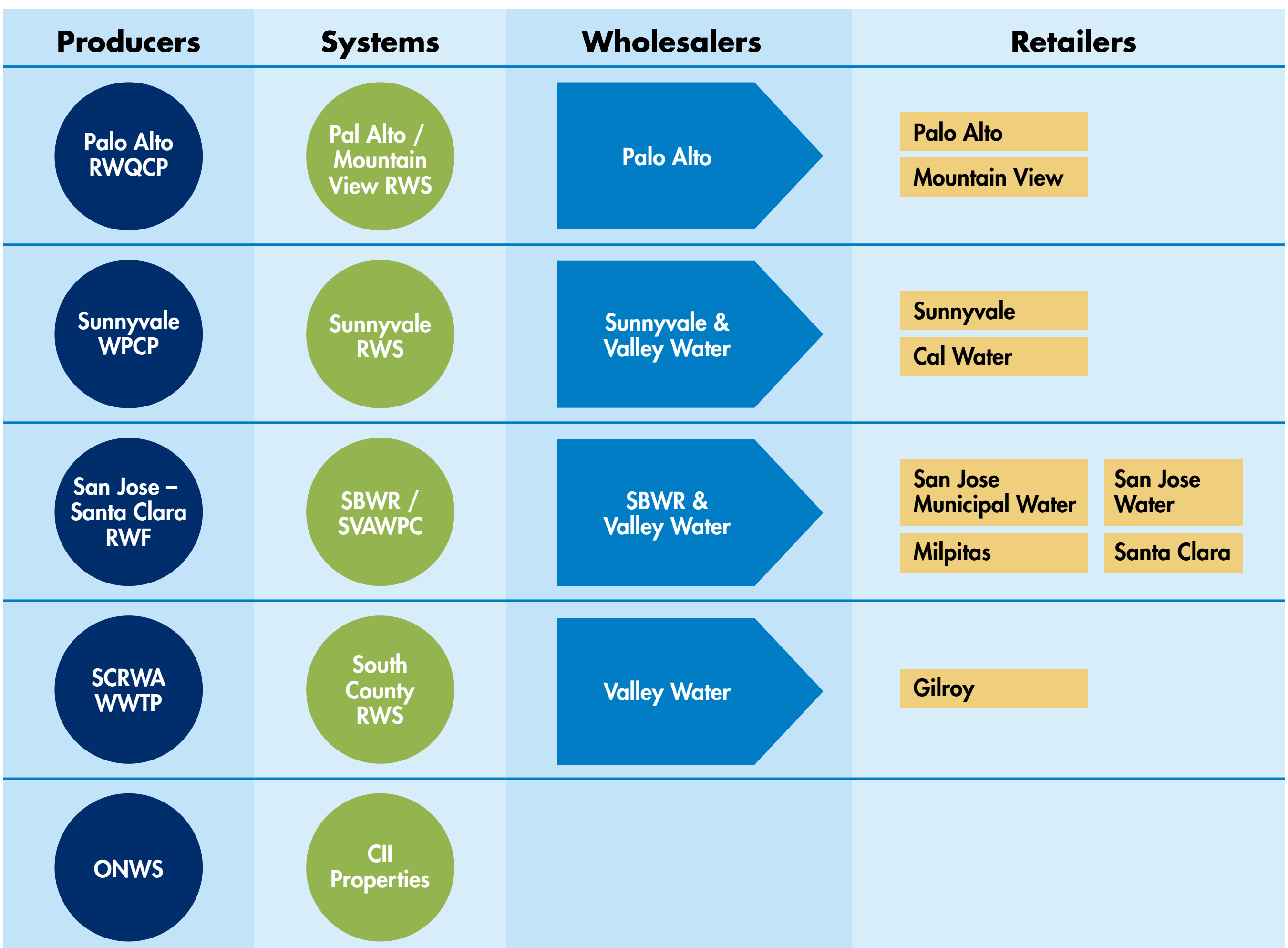
ONWS provide a hyper-local non-potable supply which can offset the use of potable supplies for irrigation and other non-potable uses. This, in turn, could help reduce reliance on imported water. The following assessments quantify the upper bound of water available for reuse via ONWS and compares it to the use of imported water in Silicon Valley.

Regional Water Reuse Opportunities

Current and Planned Water Reuse in Santa Clara and San Mateo Counties: Water reuse can help reduce dependence on imported water by increasing the number of times water is used before being discharged to the environment or used consumptively. Santa Clara County has a large reuse program which includes extensive collaborative and cost-sharing agreements between water suppliers, wastewater agencies, and recycled water agencies (Figure 10).

Santa Clara County is currently developing a Countywide Water Reuse Master Plan (Master Plan) that explores the trade-offs of multiple project portfolios, including the expansion or development of groundwater recharge, non-potable reuse, and/or potable reuse projects (Valley Water 2020). The

Figure 10. Existing Recycled Water Producers, Systems, and Supply Agencies in Santa Clara County



Source: Santa Clara Draft Countywide Water Reuse Master Plan
Note: Acronyms are listed in Appendix B

Table 6. Current and Projected Wastewater Production and Recycled Water Demand

Facility	Current Average Influent	Recycled Water Production Capacity (TAFY)	Current Demand (TAFY)	Business as Usual Projected (2040) Non-Potable Demand (TAFY)	Estimated Potable Reuse (2040) (TAFY)
San Jose/Santa Clara Regional Wastewater Facility	114	43	13	31	24
Palo Alto Regional Water Quality Control Plant	22	6	1	3	11.7-13.2
Sunnyvale Water Pollution Control Plant	13	4	1	2	5.5-9.8
South County Regional Wastewater Authority*	7	10	2	7	1.9
SUM	**156**	**63**	**17**	**43**	**43.1-48.9**

Source: Santa Clara Draft Countywide Water Reuse Master Plan (2020)

Note: TAFY = thousand acre-feet per year

*South County (includes Morgan Hill, Gilroy, and agricultural production)

plan's current and future estimates of influent and recycled water production are summarized in Table 6. Some project portfolios in the Master Plan include greater expansion of reuse than the values reflected in Table 6.

While two cities in San Mateo County, Daly City and Redwood City, have recycled water programs, several others (Brisbane, Foster City, Pacifica, San Bruno, South San Francisco, and San Mateo) are considering recycled water programs (San Mateo County Civil Grand Jury 2013). While there are some interagency agreements (e.g., City of Menlo Park's wastewater is treated at Silicon Valley Clean Water in Redwood City, water and wastewater tend to be managed independently by each city within San Mateo County. This contrasts with the more integrated wastewater and recycled water planning efforts in Santa Clara County.

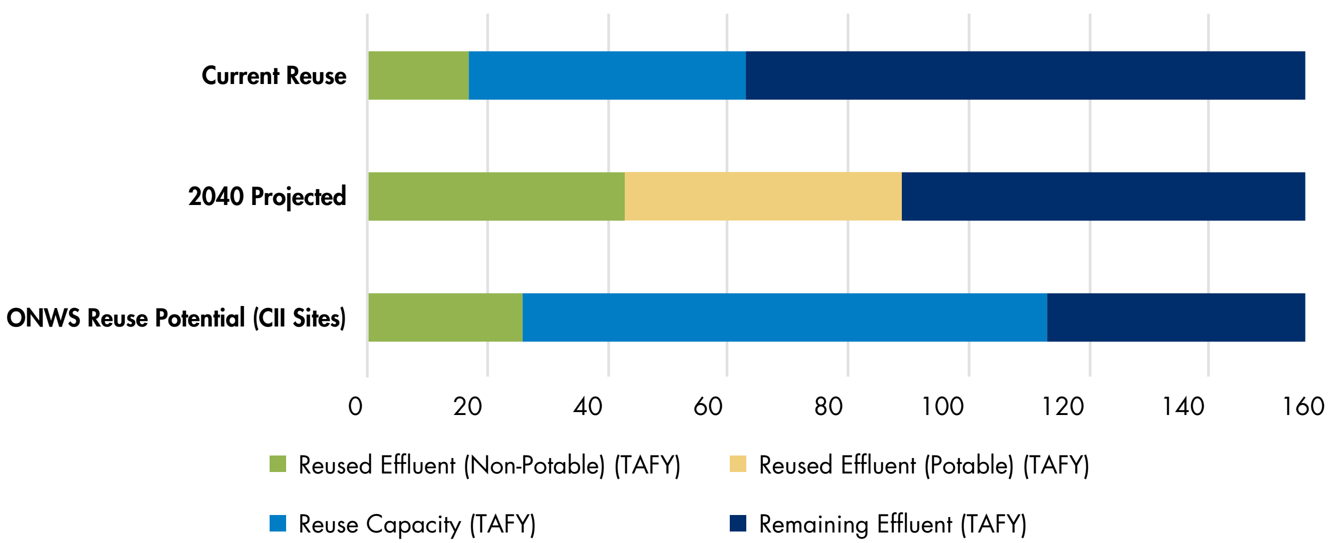
Opportunities for ONWS to Contribute to Regional Water Reuse: Water can be used consumptively (e.g., efficient irrigation, incorporated into a product) or non-consumptively (e.g., flushing toilets, showers). Only non-consumptively used water can be reused, either onsite or via regional recycled water facilities. Most indoor use is non-consumptive while outdoor use is generally consumptive. As such, we used the sum of water use at commercial and industrial facilities in Santa Clara and San Mateo counties as a proxy for the maximum quantity of water available for reuse in ONWS. This is an extreme upper bound assuming 100 percent adoption of ONWS. Actual reuse via ONWS will be considerably lower and scale with adoption of ONWS. A major challenge in ONWS design is balancing the quantity of water available for reuse with demand for non-potable supplies. Water demand for landscape irrigation, the most common use of non-potable water in the

Bay Area, is generally less than the quantity of reusable water available.

Figure 11 compares current water reuse in Santa Clara County with projected water reuse in 2040 and ONWS reuse potential. Recent inflows to wastewater treatment facilities in Santa Clara County averaged 156 thousand acre-feet per year (TAFY). This value (156 TAFY) represents the maximum amount of currently reusable water in the county (Figure 11). Existing recycled water production capacity in Santa Clara County is roughly 63 TAFY, though current demand for recycled water in Santa Clara County is only around 17 TAFY. By 2040, demand for non-potable recycled water is projected to rise to 43 TAFY (Valley Water 2020). If potable reuse or groundwater recharge projects are implemented, reuse in Santa Clara County is estimated to equal roughly 86 to 92 TAFY in 2040 (Valley Water 2020). In Santa Clara County, average commercial, industrial, and institutional (CII) water use was 112 TAFY between 2010 and 2015, or approximately 50 percent of all likely non-consumptive use in the county. CII water use in San Mateo County was significantly lower at 18 TAFY. We estimate that 130 TAFY is the upper bound of reusable water from CII facilities in Santa Clara and San Mateo counties, though actual reusable quantities are likely much lower due to unaccounted for consumptive uses, conveyance losses, and other factors.

A major challenge in designing ONWS is the fact that indoor water use often greatly exceeds demand for water for outdoor irrigation (the most common end use of water from ONWS). In Santa

Figure 11. Comparison of Reused or Reusable Water Under Existing, 2040 Projected, and Full Adoption of ONWS Scenarios in Santa Clara County



Source: Santa Clara Draft Countywide Water Reuse Master Plan

Notes: While there are existing city-level recycled water programs in San Mateo County (Redwood City and Daly City), long-term recycled water planning projections for San Mateo were not available. All scenarios evaluate reuse as a proportion of existing wastewater influent in Santa Clara County. Current reuse scenario includes existing reuse and current built capacity for reuse. 2040 Projected includes median estimates of potable and non-potable reuse from the 2020 Countywide Master Plan. Estimates of ONWS reuse potential compare existing use for large landscapes (as a proxy for demand for non-potable reuse) and CII water use (as a proxy for the potential for non-potable, onsite reuse).

Clara and San Mateo counties, CII water use was more than four times greater than water used for irrigating large landscapes (30 TAFY). This represents the lower end of the maximum quantity of supply available for reuse via ONWS at CII sites (Figure 11). However, outdoor water use at CII sites is often not metered separately and may be incorporated into estimates of commercial and industrial water use. Likewise, large landscapes include commercial sites, as well as parks and golf courses, and therefore may overestimate outdoor use opportunities at CII sites. Even with these caveats, a comprehensive onsite reuse program could potentially offset outdoor water use on CII properties with additional supply available to supplement irrigation in other nearby greenspaces, such as parks.[2] Because indoor water use is much greater than outdoor uses on these types of properties, full realization of the benefits of a ONWS projects will likely require adoption of both indoor and outdoor reuse to address gaps between supply and demand. Site-level water balance modeling can help address these questions for each project, as indoor and outdoor needs vary widely across sites.

Reduced Reliance on Imported Water Supplies

Current Reliance on Imported Supplies in Santa Clara and San Mateo Counties: Imported water exposes water suppliers and businesses to multiple risks. Imported water is often shared with a diverse range of stakeholders across the state, and annual allocations can vary widely, particularly during times of drought and scarcity. Existing supplies have already proven inadequate to meet all existing water demands across California in every year because of the state's variable hydrology (CA Department of Water Resources 2018). Existing water rights allocations in California are based on historical "average" flows, which has proven increasingly problematic for less senior water rights holders. Climate change is expected to exacerbate these challenges, with significant changes in precipitation timing, quantity, and form predicted. Many of the large aqueducts conveying water to the Bay Area cross seismically active regions and are vulnerable to damage from a major earthquake. Likewise, much of the water used in the Bay Area is sourced from wildfire-prone regions. When pumping is required, conveying water can be energy intensive (Stokes-Draut et al. 2017). Reducing dependence on imported water can help reduce exposure to these risks.

This assessment evaluated reliance on imported water in two counties — San Mateo and Santa Clara — that account for most of Silicon Valley. Both counties include large areas of office parks located close to the Bay along the US Highway 101 corridor and suburban housing developments in the upland areas, but their exposure to risks associated with imported water supplies varies significantly. Santa Clara County has a more diverse water supply portfolio, but consistently uses upwards of 80 percent of all water supplies in the two-county region. By contrast, San Mateo County relies almost exclusively on supplies from the SFPUC Regional Water System, but uses less water overall (Figure 12).

Dependence on imported supplies[3] was measured using two metrics: 1) the total quantity of imported water used; and 2) the proportion of the

2 While irrigation of nearby parks via an ONWS is possible technically, the regulatory and institutional feasibility of doing so is currently unclear.

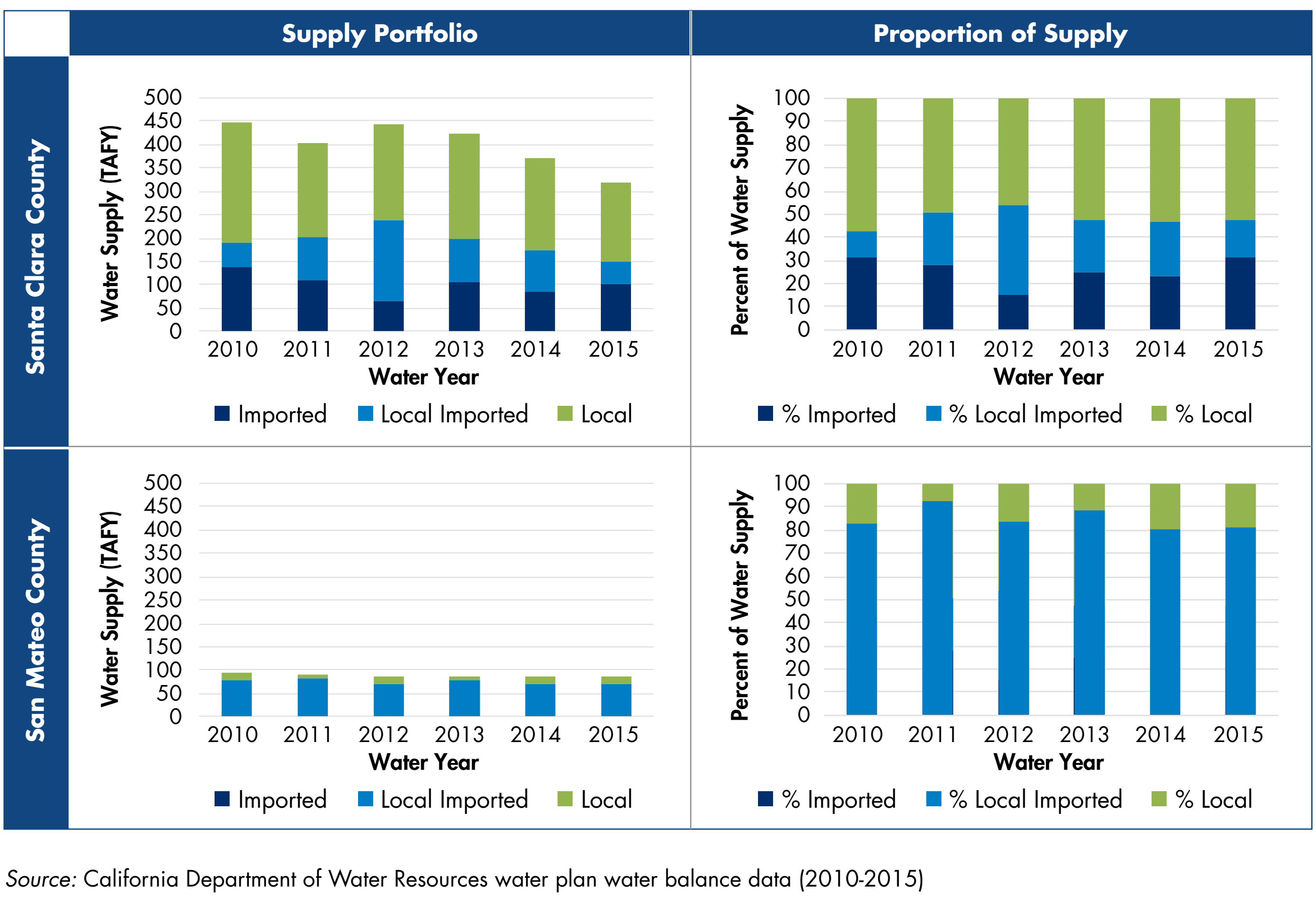
3 The Department of Water Resources water balance data included data using the terms "local imported supplies" and "imported supplies." In the Bay Area, "imported supplies" include supplies from the SWP and CVP. "Local imported supplies" are those imported via the SFPUC Regional Water System.

supply portfolio comprised of imported water. We evaluated both metrics (Figure 11) using data from 2010 to 2015. Precipitation in 2010 was "normal," whereas 2011 was a wet year, and 2012 marked the beginning of California's record-breaking five-year drought. The water supply portfolios in the two counties were vastly different due in part to access to SWP and CVP water and investments in local supplies (Figure 11). Water agencies in both counties received water from SFPUC, though it constituted nearly 80 percent of the supply in San Mateo County and 11–39 percent of the supply in Santa Clara County.

Total water supply in Santa Clara County declined from 445 TAFY in 2012 to 318 TAFY in 2015. During the peak drought years of 2013–15, 47 percent of Santa Clara County's supply portfolio was from imported supplies, though the exact balance of supply from the SWP, CVP, and the SFPUC Regional Water System varied year-to-year (Figure 12). Reliance on local supplies declined from 222 TAFY in 2013 to 167 TAFY in 2015. In 2012, imported water from the CVP and SWP declined by 50 percent (relative to 2010) in Santa Clara County, but imported water from the SFPUC Regional Water System increased by more than 200 percent (Figure 12). This is an extreme case in a broader, long-term (1999–2015) trend towards reduced reliance on SWP and CVP imported supplies and greater reliance on local imported supplies in Santa Clara County.[4] Local

4 In 2002–2009, Santa Clara County supplied an average of 151 and 58 TAFY from imported and local imported

Figure 12. **Water Supply Portfolio (Including Imported Supplies) in Santa Clara and San Mateo Counties**



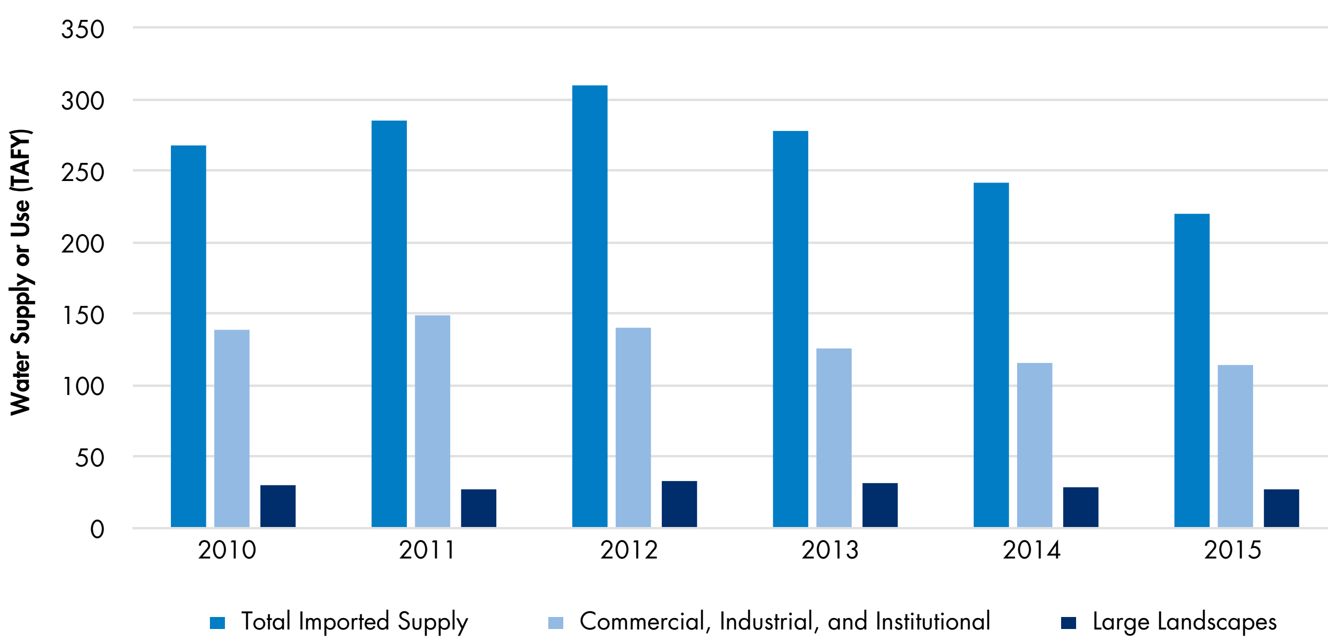
Source: California Department of Water Resources water plan water balance data (2010-2015) supplies such as groundwater and recycled water ranged from 46 percent (2012) to 58 percent (2010) of Santa Clara County's water supply portfolio.

The total water supply in San Mateo county was 95 TAFY in 2010 and approximately 85 TAFY during the drought (2012–15) (Figure 12). San Mateo County does not receive water from the SWP or CVP and is entirely dependent upon the SFPUC Regional Water System for its imported supplies. Local supplies ranged from a low of 8 percent of San Mateo County's water supply portfolio (2011) to a high of 20 percent in 2014. The lower levels of supply diversification and high levels of dependence on imported supplies in San Mateo County make it more vulnerable to interruptions or declines in imported supplies.

supplies, respectively. In 2010-15, average reliance on imported supplies (101 TAFY) declined while reliance on local imported supplies increased (91 TAFY).

Opportunities for ONWS to Reduce Reliance on Imported Water: In the previous section we estimated the absolute maximum quantity of water that could be reused via ONWS in Santa Clara and San Mateo counties was in the range of 30 to 130 TAFY, where 30 TAFY is the quantity of water currently used to water large landscapes and 130 TAFY is average CII use. These values are also reflective of the uppermost potential for ONWS to offset the use of imported supplies in Silicon Valley. Historical data on imported supplies relative to water use for CII and large landscapes is plotted in Figure 13. On average, CII use equaled 49 percent of imported supplies, while irrigation of large landscapes equaled 10 percent imported supplies. These values assume 100 percent implementation of ONWS across all CII parcels. Due to the difficulties and cost of retrofitting existing buildings for onsite reuse, ONWS projects are more likely to occur in new

Figure 13. Comparison of Imported Supplies in Santa Clara and San Mateo Counties Relative to CII Water Use and Use for Irrigation of Large Landscapes on CII properties



Source: California Department of Water Resources water plan water balance 2010-2015 developments and major redevelopment projects. Imported supply offsets will scale with the degree to which ONWS are implemented and policy and management decisions on regional water supply portfolios, but will be lower than the upper bounds reflected here.

INFRASTRUCTURE AUGMENTATION AND BUILDING REDUNDANCY

In addition to reducing reliance on imported water supplies, ONWS can help Silicon Valley remain resilient under the impacts of climate change and infrastructure upgrades. In this section we examine where ONWS could add redundancy to water infrastructure as sea level rise alters the capabilities of coastal treatment systems. We also assess where ONWS could potentially help address sewer capacity challenges like aging infrastructure and sanitary sewer overflows.

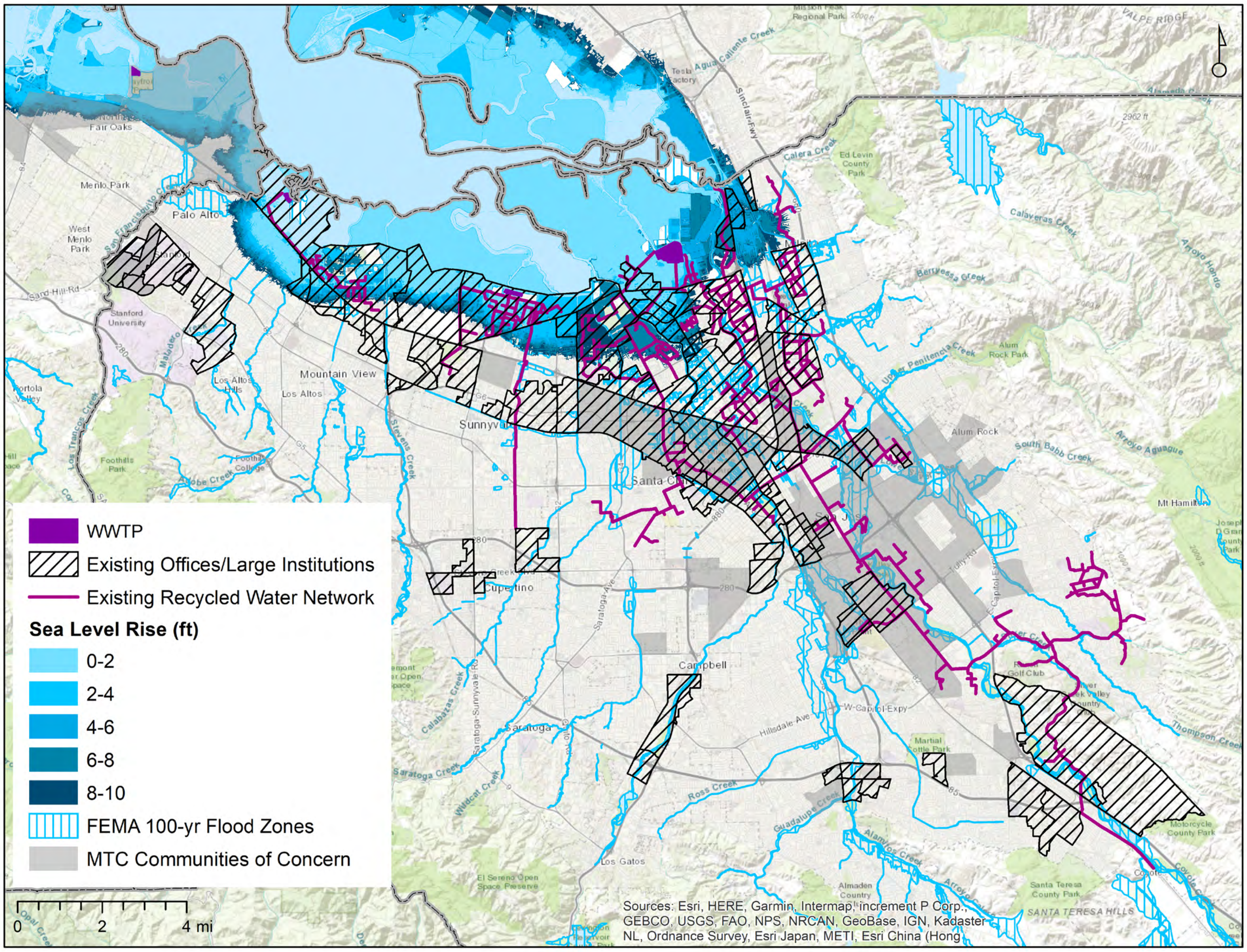
Sea Level Rise Impacts on Water Infrastructure Systems

SLR poses a risk for coastal infrastructure, including wastewater collection systems and treatment plants and recycled water infrastructure. In the San Francisco Bay, SLR of 50 cm (or 1.6 ft relative to 2000 levels) is nearly certain to occur within the next 30 years (NRC 2012). ONWS can provide redundancies for non-potable supplies of water when wastewater treatment plants (WWTPs) need to go offline due to flooding or seawater intrusion. To assess risk to current water infrastructure and understand how ONWS could support operations, particularly for those most vulnerable, SLR projections, water infrastructure, the existing recycled water network, and communities of concern were overlaid to identify the areas within Santa Clara County that are most vulnerable to SLR.

In Silicon Valley, approximately 4,000 acres, including 800 acres of solid waste facilities, seven contaminated sites, one energy substation, and 30 miles of local roads, could be inundated under this scenario. Additional upland areas are also located within FEMA's 100-year flood zone (Figure 14). Three wastewater treatment plants are located on the shoreline and will incur damage from even small rises in water levels. With a 50 cm increase in sea levels, 40 acres in the three wastewater treatment plants will be inundated, with an estimated cost of $1.4 billion in economic consequences. Thirty acres are likely to be flooded in the region's largest wastewater treatment plant, the San Jose-Santa Clara Water Pollution Control Plant (Silicon Valley 2.0 2020). Moreover, much of the existing recycled water supply distribution network in Santa Clara County is in regions vulnerable to SLR (Figure 14). Groundwater levels are also likely to rise above the land surface in some areas, putting additional areas at risk of flooding and degrading groundwater resources (Befus et al. 2020). For example, many sanitary sewers installed in Bay mud are currently struggling with brackish water infiltration into the pipes. Significant investments and additional energy are required to treat or remove the increased salinity at the wastewater treatment plant.

Planning with SLR in mind underscores the need for resilient and redundant infrastructure. There are a few commercial properties that will also be inundated by SLR (about 200 acres of commercial property is vulnerable), but many are just beyond the predicted flood zone (Figure 14). ONWS implementation on those commercial properties unlikely to experience flooding or increased liquefaction risk due to SLR and are located on the San Jose sewer main (and auxiliary pipes) could remove burden from the inundated wastewater treatment plant by diverting flow away from the plant. At minimum, ONWS can create redundancies, removing wastewater from the sewers and insulating WWTPs from outages as storm surges, SLR, and other climate change

Figure 14. **Existing Communities of Concern, Offices, Wastewater, and Recycled Water Infrastructure in Silicon Valley Impacted by Sea Level Rise and/or Flooding**



Source: City of San Jose Open Data Platform, Metropolitan Transportation Commission Open Data Platform, National Oceanic and Atmospheric Administration Sea Level Rise Projections, Pacific Institute Sea Level Rise Data, Santa Clara Draft Countywide Water Reuse Master Plan

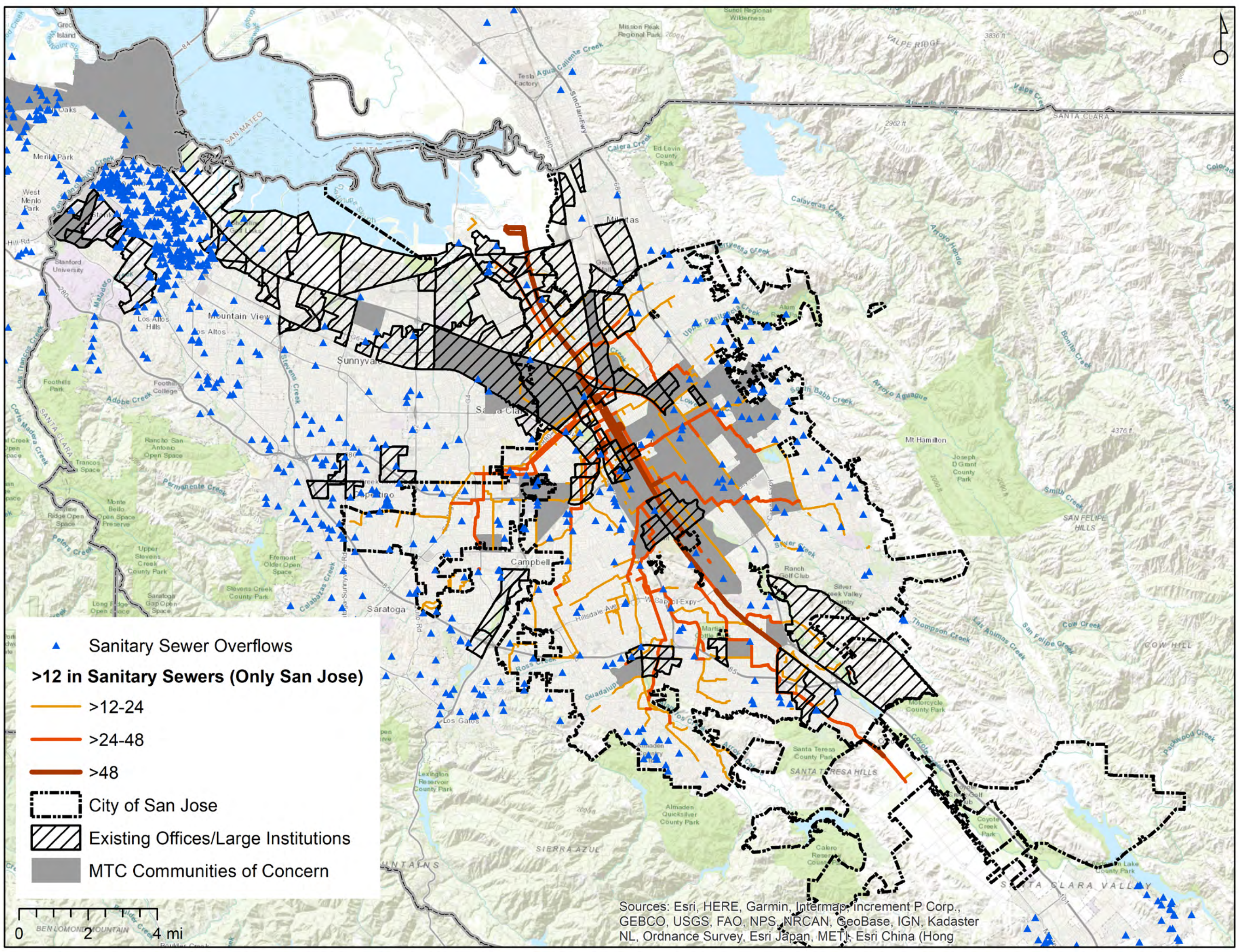
impacts affect wastewater infrastructure. Water infrastructure networks that are flexible, have distributed capacity, and contain multiple systems that can provide back-up are more resilient to disruption than systems without these features.

Sanitary Sewer Overflow Incidents

One of the ways ONWS can contribute to infrastructure augmentation is by reducing the volume of wastewater in sewer lines to help reduce sanitary sewer overflows (SSOs). Sewers located in flood-prone areas are subject to greater inflow and infiltration. From 2016 to 2020, there were 74 sewer overflows where the wastewater reached a surface water body or storm sewer (Category 1 overflow), and an additional 694 sewer overflows where the wastewater did not reach a surface water body. These events occurred primarily in the foothills surrounding northern Santa Clara County and in Palo Alto in smaller diameter pipes (Figure 15). Many incidents were caused by root intrusion, grease, or other debris blocking the pipe.

For this assessment, we overlaid sewer overflows, commercial properties, and communities of concern to examine where ONWS could alleviate SSOs in Silicon Valley. While communities of concern cover 11 percent of the study area, they experienced 16 percent of all sewer overflows. Conversely, commercial sites comprise 20 percent of Silicon Valley but experienced 10 percent of overflows. Commercial sites are typically closer to the Bay, connected to larger diameter sewers (less prone to blockages), and are lower in elevation than the sewer overflow incidents. Commercial properties downstream from these overflows are unlikely to increase capacity in the pipes by removing wastewater from the sewer system, since many of these events are attributable to hyper-local phenomenon such as root intrusion. However, ONWS near or in communities of concern may be able to reduce local SSOs by removing volume from nearby sewer pipes.

Figure 15. **Location of Sanitary Sewer Overflows Relative to Large Diameter Sewers (San Jose), Communities of Concern, and Offices**



Source: City of San Jose Open Data Platform, Metropolitan Transportation Commission Open Data Platform, Santa Clara Draft Countywide Water Reuse Master Plan, State Water Resources Control Board Sanitary Sewer Overflow Data

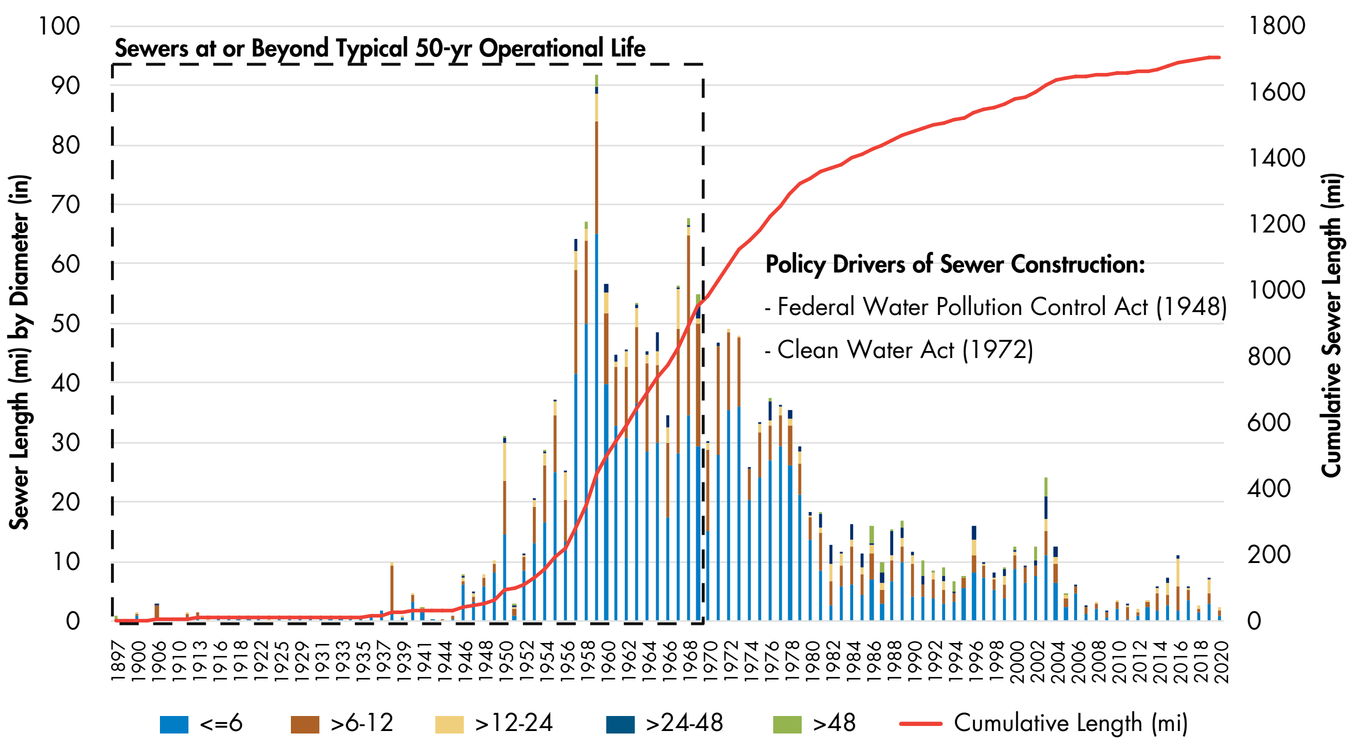
Note: Each triangle represents an overflow incident that occurred between 2016 and 2020

Aligning Timing with Replacement of Aging Sewer Infrastructure

Water infrastructure in the United States has suffered from many years of chronic under-investment (ASCE 2017a, 2017b). Although the Clean Water Act (1972) spurred massive investments in wastewater treatment in communities across the country, much of that infrastructure is nearing the end of its operational life while facing the concomitant stressors of climate change, population change, and additional factors. The City of San Jose is no exception to these challenges, and is taking many steps to address them and advance sustainable water management in the South Bay. Water, wastewater, and recycled water agencies in the South Bay have developed institutional agreements to facilitate interagency collaboration. These efforts led to the development of an extensive and growing recycled water supply system to support the dramatic shifts in housing and jobs in the South Bay. These systems coexist with aging infrastructure built to support the region's agricultural past. ONWS can help overcome these operational challenges and contribute to system modernization.

For this assessment, we summed the length of sewers in San Jose by size and install date (Figure 16). We found that 57 percent of San Jose's sewers exceed the standard operational life of 50 years (Figure 11), though larger diameter mains (median age: 1980) tended to be newer than small diameter neighborhood laterals (median age: 1966). Twelve

Figure 16. Distribution of Sewers in San Jose by Age and Diameter



Source: City of San Jose Open Data Portal

Notes: Only sewer mains with identified install years are included here. In total, 318 miles of sewers did not have an identified install year.

percent (192 miles) of San Jose's sewers are greater than 12 inches in diameter. The remaining 1,514 miles of San Jose's sewers largely serve residential areas and are smaller in diameter. When ONWS projects can be timed to precede or coincide with sewer upgrade projects, there may be opportunities to incorporate ONWS into sewer system planning and design efforts. The degree to which ONWS are able to impact the design (sizing) of local sewer upgrades depends on local municipal codes, assurances of sustained operation of the ONWS over extended time periods, and other regulatory and engineering factors.

Augmenting Sanitary Sewers

The MTC's Plan Bay Area 2040 identified more than 200 PDAs that are prioritized for future compact, transit-oriented housing development and job growth. Developing some of these areas will likely require significant utility work, including water and sewer upgrades. Incorporating ONWS into new development or major redevelopment projects could help reduce the scale of infrastructure upgrades and expansion needed.

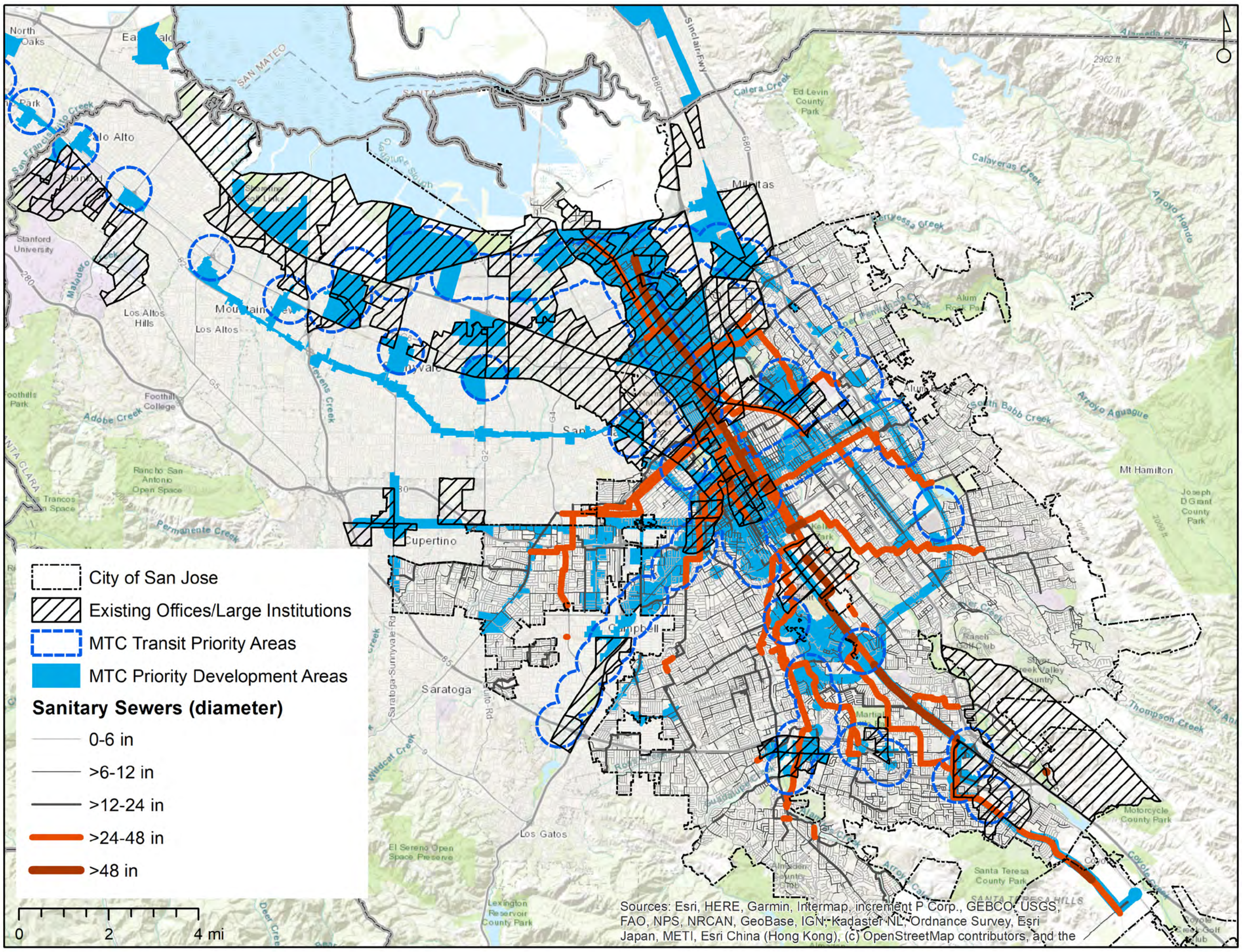
For this assessment, we overlaid PDAs and MTC Transit Priority Areas with existing sewer networks in San Jose[5] to identify areas where (1) existing sewer networks may be insufficient for increased housing and/or job density; and (2) ONWS could integrate with sewer infrastructure upgrades. Only sewer mains with identified install years are included in this analysis. While there appear to be some PDA currently only served by small diameter sewers (e.g., southeast of downtown San Jose) (Figure 17), more detailed engineering analyses are needed to assess the potential for ONWS to augment existing sanitary sewer networks.

Santa Clara County has an extensive recycled water supply network (Figure 18). However, there are areas with potential demand for recycled water that are not currently served by this network. Constructing recycled water distribution infrastructure can be a major challenge when highways or railways need to be crossed with recycled water pipelines. ONWS can help provide infill in areas that are difficult or expensive to reach with a traditional recycled water distribution network.

For this assessment, we compared the location of existing office parks/institutions and parks to the current recycled water distribution network in Santa Clara County. Most office parks and parks not served by recycled water are located south/west of US Highway 101 and north/east of the Caltrain rail corridor in Santa Clara, Sunnyvale, and Mountain View. There are also several isolated office parks in Cupertino, Campbell, and other outlying areas which could benefit from recycled water access. Notably, when Apple built their new campus in Cupertino, they opted to enter into a cost-share agreement (renewable every five years) with Valley Water, Sunnyvale, and Cal Water to extend recycled water supply out Wolfe Road (near the center of Figure 18). The draft Countywide Recycled Water Master Plan explores the trade-offs of expanding recycled water service to many of these areas (Brown and Caldwell 2020). ONWS could present an alternative to expanding the recycled water supply network to some of these currently unserved areas.

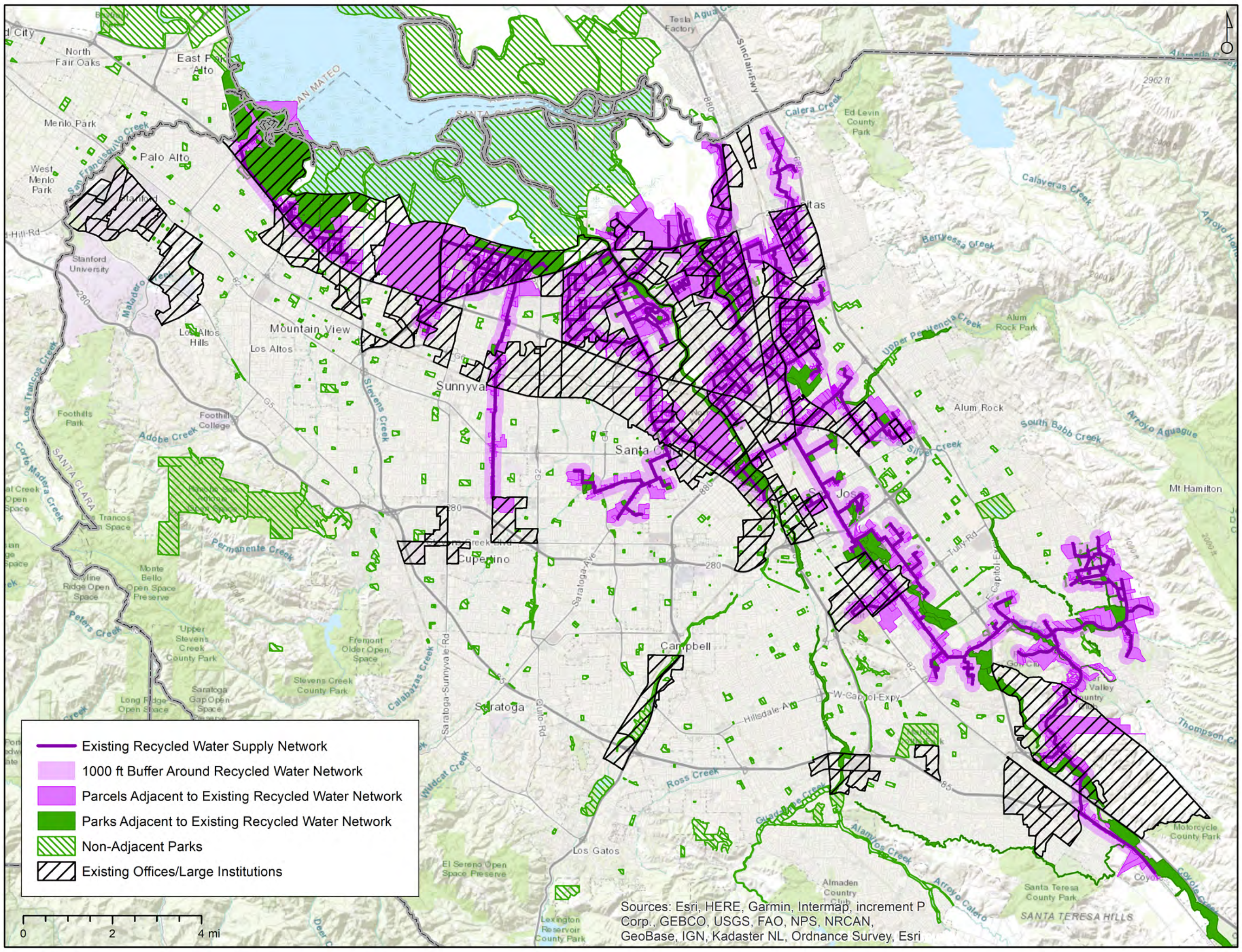
5 At the time of this analysis, San Jose was the only city with publicly available sewer data in a compatible geospatial data format.

Figure 17. **Size and Location of Sanitary Sewers in San Jose Relative to Metropolitan Transportation Commission Priority Development Areas**



Source: City of San Jose Open Data Platform, Metropolitan Transportation Commission Open Data Platform, Santa Clara Draft Countywide Water Reuse Master Plan Augmenting Existing Recycled Water Distribution Networks

Figure 18. **Existing Recycled Water Supply Network and Proximity to Offices, Institutions, and Parks in Santa Clara County**



Source: City of San Jose Open Data Platform, Santa Clara Draft Countywide Water Reuse Master Plan, Trust for Public Land Parks Dataset

SECTION 5: CONCLUSIONS AND RECOMMENDATIONS

ONWS can provide benefits to the site, water and wastewater system, and the community. While benefits to the site can be realized with the installation of just one system, benefits to the water and wastewater system and the community generally accrue over time as more ONWS systems are installed.

Additionally, the value of these benefits can vary according to location and time. For example, benefits are likely to be higher in those areas served by older and overburdened sections of a wastewater system or served by facilities vulnerable to SLR. By contrast, there may be fewer benefits — and in some cases adverse impacts — in those areas with excess water and/or wastewater capacity or with large recycled water commitments. The value of these benefits can also vary over time, for example, becoming more important with continued growth and development and as floods, droughts, and other climate impacts intensify.

In this report, we conducted a preliminary assessment of opportunities for integrating ONWS into land-use planning, augmenting existing water supplies, and contributing to infrastructure redundancy in Silicon Valley.

- **Land-Use Planning:** ONWS are most easily implemented in redevelopment and new development projects. Roughly 74 percent (50 square miles) of PDA in Santa Clara County is located more than 1,000 feet from existing distribution networks. Redevelopment areas currently unserved by existing recycled water supplies could be good candidate areas for ONWS.
- **Water Supply Augmentation:** ONWS provide a reliable supply of non-potable water. The water reuse potential is limited to the quantity of reusable water on CII properties and demand for non-potable water on these sites. ONWS have relatively modest potential for contributing to the region's water supply portfolio but, if integrated into water planning, may provide water infrastructure augmentation, redundancy, and resilience benefits in some locations. Actual adoption of ONWS on CII properties is likely to be far less, suggesting that the impacts of ONWS on imported water use may be relatively modest.
- **Infrastructure Augmentation and Redundancy:** System-level infrastructure augmentation and redundancy benefits of ONWS are among the most challenging to realize in practice. While water infrastructure in Silicon Valley is aging and some PDAs are likely to be underserved by existing sanitary sewers, there are multiple engineering, municipal code, ownership, and longevity barriers that must be overcome for the infrastructure augmentation benefits of ONWS to be realized. Designing ONWS to contribute to system redundancy during times of stress, such as in the aftermath of an earthquake, can help ensure these systems serve both the site and the broader community.

There is often a perceived tension between distributed and centralized systems. However, these systems can work together to build more resilient communities where the whole is greater than the sum of its parts. A desirable outcome would be for ONWS to be deliberately sited and effectively integrated into the broader water network, with an explicit acknowledgement and management of the interconnections. By contrast, an undesirable outcome would be for the haphazard placement of ONWS that ignores system constraints and opportunities.

Realizing the benefits of ONWS in Silicon Valley for the water/wastewater system and the community — and addressing risks and reservations — requires coordination between the public and private sectors. Indeed, failing to incorporate the expansion of ONWS into water and wastewater master plans can lead to unnecessary infrastructure investments and ultimately higher costs to ratepayers. Likewise, large-scale investments in ONWS (and related reduced dependence on public systems) can create a host of financial, operational, equity, and other issues.

RECOMMENDATIONS

We recommend the following actions to ensure integration and maximize the potential benefits of ONWS while managing for the trade-offs:

Convene regional stakeholders to facilitate a constructive dialogue about the role of ONWS in Silicon Valley. These convenings can help to foster a mutual understanding of stakeholder motivations and concerns and identify areas of agreement and disagreement. Such discussions can help to daylight issues and determine pathways forward. They can also help to build relationships and establish trust among stakeholders.

Conduct more detailed technical analyses to examine how best to integrate ONWS into existing centralized water and wastewater systems. These analyses should, for example, estimate the supply potential provided by ONWS and impact on recycled water plans. They should also include detailed geospatial analyses to understand where these facilities can provide the greatest benefits.

Evaluate policies and practices for effectively integrating ONWS into existing water and wastewater systems. This evaluation should examine models for integrated planning with multiple stakeholders, as well as explore new business, governance, and ownership models for developing and operating building- or district-scale ONWS.

Identify opportunities to implement other distributed water strategies in concert with ONWS implementation. While not the focus of this report, there are opportunities to achieve multiple benefits by implementing ONWS in coordination with other distributed water management approaches. By integrating other distributed water strategies — such as rain gardens, rain tanks, natural treatment wetlands, and water efficiency — into a new commercial development, sites can maximize the benefits of their onsite water investments. In particular, the opportunity to combine onsite stormwater capture and reuse with ONWS warrants further exploration.

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Appendix A

REGIONAL STAKEHOLDER INTERVIEWEES

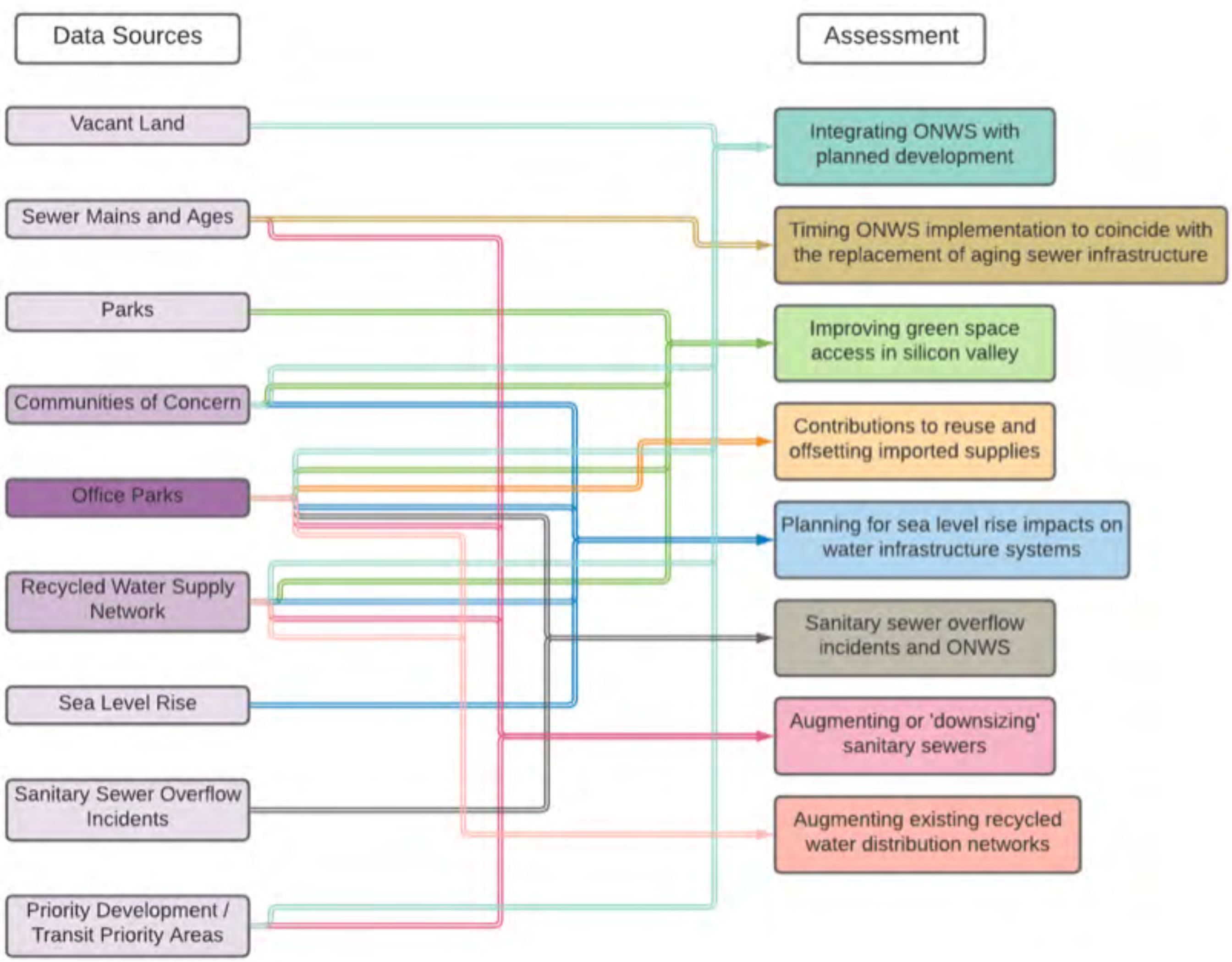
Name	Organization
Newsha Ajami	Stanford, San Francisco Regional Water Quality Control Board
Hossein Ashktorab & Justin Burks	Valley Water
Lane Burt	Ember Strategies
Peggy Brannigan & Efrain Garcia	LinkedIn
Cindy Clark	CERES
Paul Fleming	Microsoft
Robin Grossinger	San Francisco Estuary Institute
Melissa Gunter	San Francisco Bay Regional Water Quality Control Board
Miriam Hacker	Eawag
Eric Hansen	Silicon Valley Clean Water
Pedro Hernandez	City of San Jose, South Bay Water Recycling
Eric Hough	Natural Systems Utilities
Paula Kehoe & Taylor Chang	San Francisco Public Utilities Commission
Cynthia Koehler	WaterNow Alliance
Amelia Luna	Sherwood
Dick Luthy	Stanford, ReNUWIt
Felicia Marcus	Water Policy Group
Azalea Mitch	City of San Mateo Public Works
Dennis Murphy	Sustainable Silicon Valley
Karin North	City of Palo Alto
Lauren Swezey	Facebook
Aaron Tartakovsky	Epic Cleantec
Ian Wren	San Francisco Baykeeper

Appendix B

DATA SOURCES

Data is incorporated into the geospatial analysis as follows:

Figure B1. Data Incorporation in Geospatial Analyses with Scope of Analysis Included



Metropolitan Transportation Commission Data

Communities of Concern

This data set represents all tracts within the San Francisco Bay Region and contains attributes for the eight Metropolitan Transportation Commission communities of concern tract-level variables for exploratory purposes.

Creator: Metropolitan Transportation Commission

Link: https://mtc.maps.arcgis.com/home/item.html?id=28a03a46fe9c4df0a29746d6f8c633c8#overview

Parcel Hazard Exposure (Liquefaction, Landslide, Fault Lines)

Parcels are marked as being susceptible to a hazard if any portion of the parcel is affected by it. The reason for this is the potential effects of future hazard events cannot be precisely delineated. This means all polygons representing a given hazard or severity level are estimates, with boundaries between values being fuzzy in real world conditions.

Creator: Metropolitan Transportation Commission

Link: https://opendata.mtc.ca.gov/datasets/parcel-hazard-exposure

This MTC dataset was created by compiling the following three natural hazards layers:

Alquist-Priolo Fault Zones
Publication Date: 2018
Publisher: Department of Conservation, California Geological Survey
https://maps.conservation.ca.gov/cgs/metadata/SHP_Fault_Zones.html

California Geological Survey Deep-Seated Landslide Susceptibility
Publication Date: 2011
Publisher: Department of Conservation, California Geological Survey
https://maps.conservation.ca.gov/cgs/metadata/MS58_metadata.pdf

US Geological Survey Liquefaction Susceptibility Zones
Publication Date: 2005
Publisher: US Geological Survey
https://pubs.usgs.gov/of/2000/of00-444/

Priority Development Areas

This feature set contains the Priority Development Areas used by the Metropolitan Transportation Commission and the Association of Bay Area Governments for analysis and mapping related to Plan Bay Area 2050. Plan Bay Area 2050 is the latest update to the long-range Regional Transportation Plan and Sustainable Communities Strategy for the nine-county San Francisco Bay Region. The Priority Development Areas were adopted by the Metropolitan Transportation Commission and the Association of Bay Area Governments on July 16, 2020 and represent areas local jurisdictions have identified for new and/or intensified development.

Creator: Metropolitan Transportation Commission

Link: https://opendata.mtc.ca.gov/datasets/priority-development-areas-plan-bay-area-2050

Transit Priority Areas

This dataset contains Transit Priority Areas in the nine-county San Francisco Bay Region as defined in the California Public Resources Code, Section 21099 as existing within 1/2 mile of a Major Transit stop. A Major Transit stop is defined as any of the following:

- Existing rail stations
- Planned rail stations in an adopted Regional Transportation Plan
- Existing ferry terminals with bus or rail service
- Planned ferry terminals with bus or rail service in an adopted Regional Transportation Plan
- Intersection of at least two existing or planned bus routes with headways of 15 minutes or better during both the morning and evening peak periods

The dataset was developed using several sources that include Planned Transit Systems identified in the Plan Bay Area 2040 Regional Transportation Plan, existing transit locations extracted from the 511 Regional Transit Database, and manual editing conducted by the Spatial Modeling team at the Metropolitan Transportation Commission.

Creator: Metropolitan Transportation Commission

Link: https://opendata.mtc.ca.gov/datasets/transit-priority-areas-2017?geometry=132.646%2C36.246%2C-111.739%2C39.285

Santa Clara Recycled Water Master Plan Data

Current and Projected Wastewater Production and Recycled Water Demand

Wastewater production and recycled water demand shown in Table 6 is a Summary of Projected Long-Term NPR Demands by Partner Agency in the Valley Water District Draft Recycled Water Master Plan. Digitized and converted to table in September 2020.

Creator: Valley Water District

Link: https://fta.valleywater.org/dl/q8o39c7Xa0/

Current Reuse Roles

Figure 10 of this report is remade from Figure 2-2 in the Master Plan. Current roles and interagency relationships supporting reuse throughout the county in the Valley Water District Draft Recycled Water Master Plan.

Acronyms listed in Figure 10:
- RWF – Regional Wastewater Facility
- RWS – Recycled Water System
- RWQCP – Regional Water Quality Control Plant
- SBWR – South Bay Water Recycling
- SVAWPC – Silicon Valley Advanced Water Purification Center
- WPCP – Water Pollution Control Plant

Creator: Valley Water District

Link: https://fta.valleywater.org/dl/q8o39c7Xa0/

Existing Recycled Water Supply Network

Water supply network given in Figure 7-1 of the Countywide Draft Recycled Water Master Plan. Planned expansion of existing recycled water distribution systems throughout Santa Clara County in the Valley Water District Draft Recycled Water Master Plan. Digitized and converted into .shp format in September 2020.

Creator: Valley Water District

Link: https://fta.valleywater.org/dl/q8o39c7Xa0/

California Department of Water Resources Data

Aqueducts

Data derived from secondary canal features within the water delivery system throughout the State of California.

Creator: California Department of Water Resources

Link: https://data.cnra.ca.gov/dataset/canals-and-aqueducts-local

Water Balance Data

Data distilled from Department of Water Resources water balance 2010–2015.

Creator: California Department of Water Resources

Link: https://tableau.cnra.ca.gov/t/DWR_Planning/views/Water_Balance/HRButterflyChart

Retail/Wholesale Agencies Receiving Water from San Francisco Regional Water System

Data derived from Department of Water Resources Water Districts Layer.

Creator: California Department of Water Resources

Link: https://atlas-dwr.opendata.arcgis.com/datasets/45d26a15b96346f1816d8fe187f8570d_0

City of San Jose Data

Existing Offices/Large Institutions

Business layer (City of San Jose) subset by number of jobs and aerial imagery (via Google Earth) to get block groups with a high number of jobs that are office parks. Residential areas were excluded from dataset.

Creator: City of San Jose

Link: https://data.sanjoseca.gov/dataset/business-type-summary1

Sewer Mains and Age

Sanitary sewer gravity main pipes within the City of San Jose. Distribution of ages is derived from the attributes of the dataset.

Creator: City of San Jose

Link: https://data.sanjoseca.gov/dataset/sanitary-gravity-mains1

Vacant Land

Inventory of vacant land in San Jose, CA.

Creator: City of San Jose

Link: https://data.sanjoseca.gov/dataset/vacant-land-inventory1

Miscellaneous Sources

Parcel Vulnerability by Use Type

Table dataset created through a query on the site. A scenario was run using the website to generate the table/data used.

Selections were made as follows:

1. Countywide Geography
2. Sea Level Rise Climate Variable
3. Horizon Year Mid-Century: 2050
4. Parcel Land Use
5. Wastewater

Creator: Santa Clara County

Link: http://siliconvalleytwopointzero.org/home

Parks

Shapefile of all parks in the United States, subset to study area (Santa Clara County). This data also provides “spheres of influence” for parks, encompassing all land that is within a 10-minute walking distance of each park.

Creator: Trust for Public Lands

Link: https://www.tpl.org/parkserve/downloads

Sanitary Sewer Overflows

Text file of the location, date, and type of sewer overflow occurrence.

Creator: California State Water Resources Control Board

Link: https://www.waterboards.ca.gov/water_issues/programs/sso/docs/index.html

Sea Level Rise

Shapefile to visualize community-level impacts from coastal flooding or sea level rise (up to 10 feet above average high tides). Photo simulations of how future flooding might impact local landmarks are also provided, as well as data related to water depth, connectivity, flood frequency, socioeconomic vulnerability, wetland loss and migration, and mapping confidence.

Creator: National Oceanic and Atmospheric Administration

Link: https://coast.noaa.gov/slrdata/

Wastewater Treatment Plants

This dataset shows the footprints of wastewater treatment plants in the San Francisco Bay that are potentially vulnerable to a 100-year coastal flood with a 1.4 meter sea level rise. The footprints of the treatment plants were digitized over aerial imagery from National Agricultura Imagery Program (2005) and Google Earth.

Creator: Pacific Institute

Link: https://pacinst.org/reports/sea_level_rise_data/SF_Bay_WWTP_Polygon.html

PACIFIC
INSTITUTE

Pacific Institute
654 13th Street
Preservation Park
Oakland, California 94612
510.251.1600 | info@pacinst.org
www.pacinst.org

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