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Solution Brief

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Challenges for Non-potable Water Reuse in Northern California

By Dick Luthy and Heather Bischel

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About the Authors

Dick Luthy is the Silas H. Palmer Professor of Civil Engineering and a senior fellow at the Woods Institute for the Environment at Stanford University. His research focuses on water reuse and management of contaminates in sediment. Current projects address the role of natural systems to enhance water quality and the potential for water reuse to benefit ecosystem habitats and urban aesthetics. Dick Luthy is a past chair of the National Research Council's Water Science and Technology Board, and a former president of the Association of Environmental Engineering and Science Professors. He is a member of the National Academy of Engineering.

Heather Bischel is a PhD student in Civil and Environmental Engineering and past president of Stanford University's chapter of Engineers for a Sustainable World. Her research addresses bioaccumulation of emerging contaminants and the technical factors influencing the implementation of water reuse projects for ecological restoration.

The Challenge: Augmenting water supplies with clean recycled water

California is at the forefront of recycled water use, treating municipal wastewater to a high enough degree that it can be returned to the water supply for irrigation, industry and ecosystem enhancement – or even discharged into groundwater. California recycles about 650,000 acre-feet of water per year and seeks to triple this amount by 2030. In February 2009, The California State Water Resources Control Board adopted a Recycled Water Policy that would increase statewide use of recycled water above 2002 levels by at least 1 million acre-feet per year (afy) by 2020 and by at least 2 million afy by 2030.

Prominent examples of water reuse in California include a large-scale agriculture irrigation recycling project in the Monterey area launched in 1998, and the direct injection of recycled water to potable groundwater supplies in Orange County that started in 1976. But not all projects have been successful, and uncertainty about the risk of contaminants in reclaimed wastewater poses new challenges. The promise of using recycled water to augment water supplies in the West is tempered by the twin challenges of dramatic population growth and climate change. In California, the long-term success of water recycling will require a full understanding of the opportunities and barriers to implementation.

Dick Luthy visits the Watsonville Area Water Recycling Project.

Foundation of Success: Decision-Making in Recycled Water Project Implementation

In 2008, the Woods Institute awarded a two-year Environmental Venture Projects (EVP) grant to an interdisciplinary team of Stanford faculty – Richard Luthy (civil and environmental engineering), David Brady (political science) and Thomas Weber (management science and engineering).

The goal of the EVP is to assess the drivers and challenges of water recycling in northern California, where agricultural irrigation is the largest volume use of recycled water. Given the opportunities for growth of water reuse in the region, the EVP team seeks to evaluate why some proposed recycling projects are implemented, while others are aborted or delayed. The following results from the project will be used to inform managers and researchers on developing water-recycling programs for ecosystem enhancement and other uses, and to address new challenges for implementation.

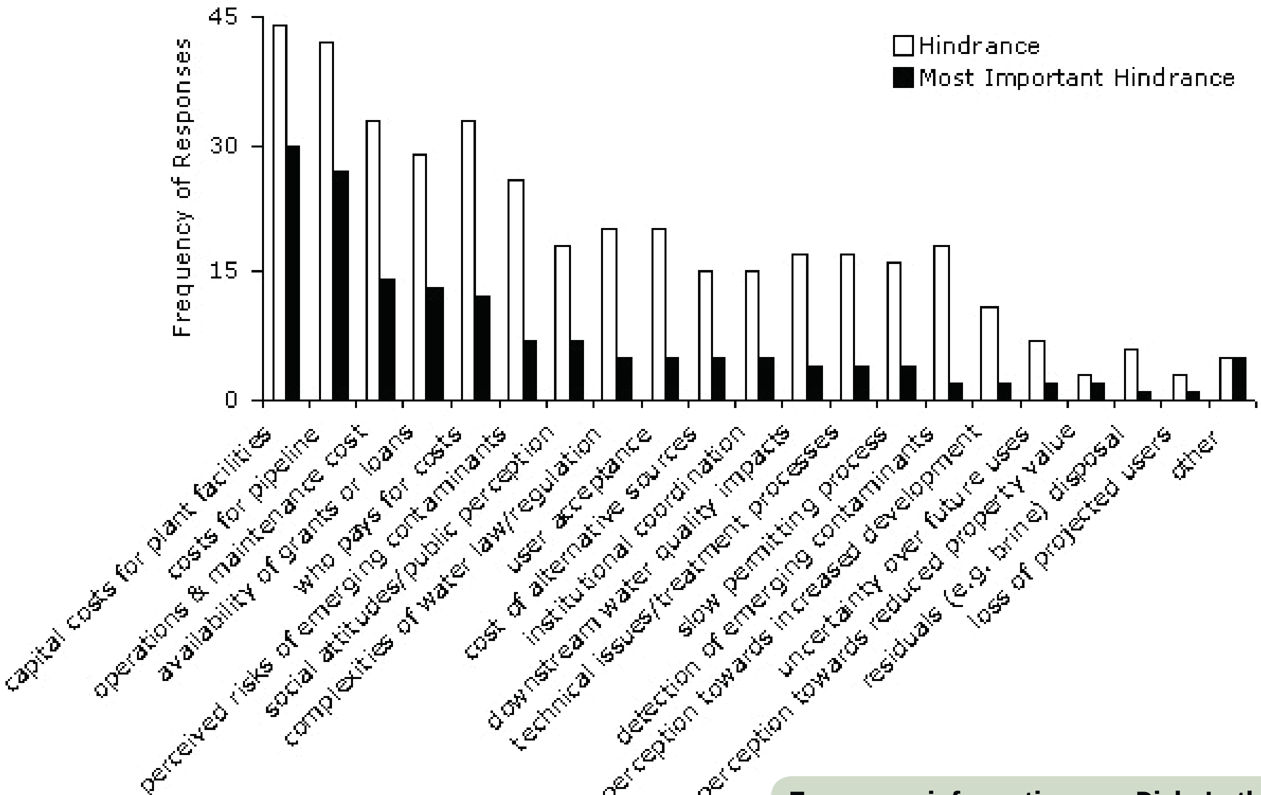
WATER REUSE CASE STUDIES AND SURVEY OF NORTHERN CALIFORNIA WATER MANAGERS

Much attention has been devoted to several large-scale programs in southern California that are considered to be the "gold standard" for water reuse. However, northern California also boasts several widely dispersed, small-scale water recycling projects for agriculture, landscape irrigation, industry (power plant cooling towers) and ecosystem enhancement. Through field visits to the region and interviews with water reuse managers and stakeholders, our EVP research team identified a multitude of factors influencing the timing, cost and public acceptance of several water reuse programs. Based on results from an in-depth survey, we compiled and assessed major factors that influenced the implementation of non-potable water recycling projects in northern California, as well as strategies utilized to address these projects. The survey was completed by representatives from facilities in northern California listed in the National Database of Water Reuse Facilities and in California's 2002 State Recycled Water Survey.

DRIVERS FOR IMPLEMENTING WATER REUSE

Water supply challenges and drought have continuously plagued California and, according to our study, have been major drivers for the implementation of water reuse programs in the state. For example, limited supply and increased demand for water, combined with severe seawater intrusion, were major drivers for the Watsonville Area Water Recycling Projects, which opened their taps for water reuse for agricultural irrigation in 2009.

Below: This bar graph displays the hindrances cited by northern California facility managers regarding the major challenges to implement non-potable water reuse programs and facilities.



For more information on Dick Luthy's research:
http://www-ce.stanford.edu/faculty/luthy/

Hindrances for implementing water reuse

In our survey, a majority (87 percent) of responding agencies cited financial and economic factors as major hindrances to water reuse program implementation. These factors include availability of federal/state grants or loans, capital cost for construction of recycling plants, cost of alternative freshwater sources, cost of pipeline construction and ongoing operations and maintenance cost recovery. The next most-cited hindrances to implementation (cited by 25 percent of respondents) were public perception and social attitudes, including the perception that recycled water will increase development and reduce property values.

Trace contaminants in recycled water

Trace contaminants – or constituents of emerging concern (CEC) – include pharmaceuticals, pesticides and industrial chemicals that may be present in recycled water. However, robust detection methods and toxicological data for assessing potential human or ecosystem health effects of CECs are largely unavailable or nonexistent.

While 26 agencies surveyed said that perceived risk of human or environmental health due to CECs was a hindrance to water reuse program implementation, only seven agencies cited this perceived risk as among the three most important hindrances. Several respondents said that creation of a blue ribbon panel on CECs was a benefit of the California Recycled Water Policy of 2009. However, they also expressed concern over the potential cost of new CEC regulations, as well as the costs associated with the treatment, removal and monitoring of contaminants. Additional challenges include the development of a standard CEC-testing methodology and the willingness of agencies to discuss and compare CEC levels in existing potable water supplies. Other drawbacks identified by respondents include public expectations of action to remove CECs after detection of minute amounts and the perception that the detection of CECs means that water quality is low.

Concerns over trace contaminants that persist through wastewater treatment need to be addressed as water reuse expands in California. For example, Richard Luthy's group has identified perfluorochemicals in wastewater effluent. These persistent contaminants are used in a variety of household and industrial materials, such as food packaging, fire fighting foam and carpet coatings, and have been detected in natural systems and human blood around the world. Potential toxicological effects and bioaccumulation of perfluorochemicals released into sensitive ecosystems via recycled water requires evaluation. Our research has demonstrated that these chemicals can accumulate in organisms living in sediment with low levels of contamination. We also have found that perfluorochemicals bind very strongly to proteins in human blood, providing evidence of the role that blood proteins may play in the distribution of these compounds.

Stanford researcher Heather Bischel sampling the Watsonville, CA., wastewater treatment facility for analysis of perfluorochemicals.

Stanford Professor Martin Reinhard's research group recently detected perfluorinated surfactant residues in the tens to hundreds of nanograms per liter in recycled water from four California wastewater treatment plants. Perfluorochemicals have also been detected sporadically at very low levels in the secondary effluent in the City of Watsonville's treatment facility.

Woods Institute for the Environment

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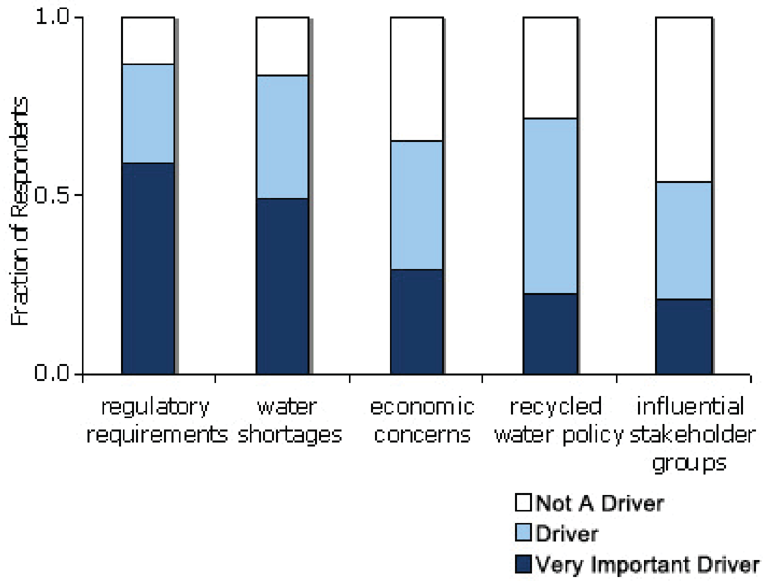
Water Reuse for Ecosystem Benefits and Environmental Enhancement

As urban populations grow, the impacts of wastewater effluent and urban stormwater on aquatic ecosystems have become more evident, with many urban streams exhibiting poor ecological integrity and providing few recreational opportunities or aesthetic benefits. According to the Environmental Protection Agency, 94 percent of wetlands and 97 percent of rivers, streams and creeks in California are either threatened or impaired. Among the top 10 causes of wetland impairment are habitat alteration (rank 2) and flow alterations (rank 5).



Northern California facility manager responses regarding factors that influenced decision to implement non-potable water reuse programs and facilities.

Although habitat creation projects may be attractive to water resource planners, many are reluctant to invest in such projects due to a lack of rigorous design criteria and uncertainties about costs and long-term performance. Barriers to water reuse for ecosystem enhancements identified by our survey respondents include economic cost, competition with other uses (residential, agricultural, industrial, indirect potable supply), water shortages, regulatory requirements and public acceptance and trust.

While 48 percent of our survey respondents said that ecological protection or enhancement goals were drivers for water reuse programs, only 12 percent identified them as among the most important drivers. According to the Bay Area Regional Water Recycling Program, further investigations are necessary to determine appropriate water quality criteria for successful ecosystem restoration, and more science is needed to develop bio-assessment tools for monitoring wetland habitats. Additionally, more coordination is needed at the state level to develop these projects and assess the environmental benefits.

Future Research Projects: Center on Reinventing America's Urban Water Infrastructure

In 2009, Richard Luthy and David Kennedy (Woods Institute senior fellow and Stanford professor, emeritus, of history) convened a Woods Institute Uncommon Dialogue with government representatives, academics and nonprofit leaders on the theme of Water in the West. These discussions led to a proposal for a 10-year, multi-institution National Science Foundation Engineering Research Center on the theme, "Re-inventing America's Urban Water Infrastructure." The proposed center would be a partnership among Stanford University, UC-Berkeley, Colorado School of Mines and New Mexico State University, along with overseas research institutions, industry, NGOs and local K-12 schools. The center seeks to advance new strategies for water/wastewater treatment and distribution that will 1) eliminate the need for imported water; 2) recover resources from wastewater; and 3) generate rather than consume energy in the operation of the urban water infrastructure, while simultaneously enhancing urban aquatic ecosystems. A key thrust of this proposal focuses on integrating managed natural systems into the water infrastructure to improve water storage and quality, while rehabilitating urban hydrology and aquatic habitat. The proposed center is under final consideration by the National Science Foundation.

For information on Woods Institute freshwater research: http://woods.stanford.edu/freshwater

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