San Francisco Water Quality Protection Plan

Prepared for Mayor Gavin Newsom

May 2008

SFPUC

Water
Wastewater
Power

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San Francisco Public Utilities Commission

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- William Glaze, Ph.D – University of North Carolina, Chapel Hill
- David Hilmoe, P.E., BCEE – Seattle Public Utilities
- Stephen Estes-Smargiassi – Massachusetts Water Resources Authority
- Pankaj Parekh, Ph.D – Los Angeles Department of Water and Power
- Phillippe Daniel – Camp Dresser & McKee Inc.
- June Weintraub, D.Sc – San Francisco Department of Public Health
- Bruce Macler, Ph.D – United States Environmental Protection Agency

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- Phillippe Daniel, Project Manager
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The SFPUC project team included:

- Michael Carlin, Assistant General Manager of Water
- Andrew DeGraca, Water Quality Division Director
- Manouchehr Boozarpour, Water Quality Division Engineering Services Manager
- Andrzej Wilczak, Project Manager/Senior Sanitary Engineer

Additionally, numerous stakeholders participated in the guiding workshop and acted as valuable resources to the project team and panel (see Appendix B for workshop attendees).

Table of Contents

List of Acronyms

AP – Associated Press

AWWA – American Water Works Association

AwwaRF – American Water Works Association Research Foundation

BAWSCA - Bay Area Water Supply and Conservation Agency

CAC – Citizen's Advisory Committee

CCP – Critical Control Point

CDPH – California Department of Public Health

DBPs – Disinfection By-Products

DSOP – Distribution System Operations Plan

EBRPD – East Bay Regional Park District

EDC – Endocrine Disrupting Chemicals

EOP – Emergency Operations Plan

gpm – gallons per minute

HACCP – Hazard Assessment and Critical Control Point

HHWP – Hetch Hetchy Water and Power

HTWTP – Harry Tracy Water Treatment Plant

LADWP – Los Angeles Department of Water and Power

mgd – million gallons per day

MTBE - Methyl tertiary butyl ether

MWRA – Massachusetts Water Resources Authority

NORMAN - Network of Reference Laboratories for Monitoring of Emerging Environmental Pollutants

NPS – National Park Service

NRDC – National Resources Defense Council

NTU - Nephelometric Turbidity Unit

NWQAC – National Water Quality Advisory Council

OEHHA - Office of Environmental Health Hazard Assessment

PHG – Public Health Goal

POE – point of entry

POU – point of use

PPCP – Pharmaceuticals and Personal Care Products

PUC – Public Utilities Commission

SFDPH – San Francisco Department of Public Health

SFPUC – San Francisco Public Utilities Commission

SFWS - San Francisco Water System

SPU – Seattle Public Utilities

SVCF - Sunol Valley Chloramination Facility

SVWTP – Sunol Valley Water Treatment Plant

UNC – University of North Carolina

UNESCO – United Nations Educational, Scientific and Cultural Organization

USEPA – United States Environmental Protection Agency

UV – ultraviolet

WHO – World Health Organization

WQD – Water Quality Division

WSIP – Water System Improvement Program

WS&TD – Water Supply and Treatment Division

SFPUC Water Quality Protection Plan Executive Summary

Mayor's Charge

At a World Water Day event, on March 20th, 2008, San Francisco Mayor Gavin Newsom directed the San Francisco Public Utilities Commission (SFPUC) to "produce a detailed and specific Water Quality Protection Plan" and to "convene a National Water Quality Advisory Council of water quality experts from across California and the nation to assist in the development of the plan." Experts were chosen based on their water quality expertise, knowledge of the SFPUC system and representation of varying perspectives (Table ES-1). The Council reviewed written materials, participated in conference calls and met together on April 28, 2008.

Introduction

Water quality protection is dynamic, involving vigilance over every part of water delivery: sources of supply and their watersheds, water treatment, and transmission/distribution of water to the customer. Over the last few decades the SFPUC has made a series of decisions about its water quality strategy in terms of investments throughout the system based on public health, environment, aesthetics, cost, seismic considerations, regulations, stakeholder input and system specific opportunities and constraints. This has resulted in various capital and operational modifications.

> ***One of the most pristine drinking water sources in the US, Hetch Hetchy Reservoir is the most important element of San Francisco's water quality protection strategy – one that requires protection rather than improvement.***

This summary presents the Water Quality Protection Plan for the SFPUC. It consists of the following sections:

- Background
- Approach to Water Quality Protection
- Findings
- Recommendations
    - Source
    - Treatment
    - Distribution
    - Monitoring, Analysis and Process Optimization
    - Communication with Customers
    - Integrated Risk Management Framework
- Next Steps

Table ES-1: SFPUC National Water Quality Advisory Council Panelists

Panelist	Affiliation	Expertise
Jeffrey Griffiths, M.D.	Associate Professor, Tufts University School of Medicine Member of EPA's Science Advisory Board	Epidemiology, Sensitive Sub-populations
William Glaze, Ph.D	Professor Emeritus, UNC-Chapel Hill Ex- Chair, EPA Science Advisory Board Ex-Editor-in-Chief, Environmental Science & Technology, pre-eminent journal in the field.	Policy, Future Trends, Technology, Water Quality
Dave Hilmoe, P.E., BCEE	Drinking Water Director, Seattle Public Utilities (SPU)	Utility Operations, Water Quality
Stephen Estes-Smargiassi	Director of Planning, Massachusetts Water Resources Authority (MWRA), AWWA Research Foundation (AwwaRF), Research Advisory Council Chair	Public Policy, Utility Operations, Water Quality
Pankaj Parekh, Ph.D	Director for Water Quality Compliance, Los Angeles Dept of Water & Power (LADWP), Chair of Strategic Initiative for Distribution System Research Expert Panel (AwwaRF)	Risk Management, Water Quality, Utility Operations
Phillippe Daniel	Vice President, Camp Dresser & McKee AwwaRF RAC and Strategic Initiative on Endocrine Disrupting Chemicals and Pharmaceuticals and Personal Care Products	Water Quality, Treatment, Risk, Strategic Planning
June Weintraub, Sc.D.	Senior Epidemiologist, San Francisco Department of Public Health	Public Health
Bruce Macler, Ph.D.	USEPA Region 9	Regulations, Toxicology, Risk Assessment

Background

Serving a population of 2.4 million people in over 30 cities, the SFPUC is the largest water purveyor in Northern California. The SFPUC has a history of proactively identifying issues and considerations that influence its capital and operational investments. Indeed, this is part of its charge as presented in the City and County of San Francisco Charter which specified amongst its nine items that the:

Commission shall develop, periodically update and implement programs to achieve goals and objectives consistent with the following:

- *Improve drinking water quality with a goal of exceeding applicable drinking water standards if feasible (item 9).*
- *Utilize state-of-the-art innovative technologies where feasible and beneficial (item 6).*
- *Create opportunities for meaningful community participation in development and implementation of the Commission's policies and programs (item 8).*

Approach to Water Quality Protection

The SFPUC's objectives for water quality protection include: a) public health protection, b) regulatory compliance and c) customer confidence. The SFPUC currently meets all state and federal regulations. It employs a multi-barrier approach to water quality protection (i.e., not relying on any single protective measure but rather utilizing several safeguards to ensure that high water quality is achieved). Furthermore, SFPUC seeks to systematically evaluate the risks to water quality from source to tap. Based on these assessments the SFPUC identifies the most appropriate measures to increase water safety, not only for present risks but with a consideration for potential future risks.

In addition to the primary objectives for water quality protection noted above, other significant drivers include: a) climate change, b) aging infrastructure, and c) emergency preparedness for natural or man-made disasters.

Findings

The National Water Quality Advisory Council was unanimous in affirming that the SFPUC has a superb source of supply and a well-operated system. It is amongst the best in the country. This cannot be emphasized highly enough.

Continued changes in detection techniques, treatment technology, health effects information and customer expectations will require ongoing efforts by the SFPUC. The National Water Quality Advisory Council formulated eleven (11) recommendations towards responding to these changes.

Recommendations

By virtue of its pristine sources (principally Hetch Hetchy, but local sources as well), the SFPUC has delivered exceptional water quality to its customers. SFPUC has sought to protect this quality through an on-going strategy of watershed control, optimized water treatment, sound distribution system operations and focused management. Consequently, SFPUC has not been vulnerable to types of contaminants (e.g., MTBE, pharmaceuticals, pesticides, etc.) that concern many other water suppliers. This strategy has served the customers of the SFPUC well in the past and it serves as a foundation for the future. The future, however, is not static and consequently the water quality protection strategy must adapt to new challenges: evolving regulations, climate change, increased analytical sensitivity, customer demand, and aging infrastructure. The SFPUC National Water Quality Advisory Council along with staff and other stakeholders identified several recommendations for refining the current water quality protection strategy. Addressing both core water system components (source-treatment-distribution system) and cross-cutting issues, the recommendations are presented in Table ES-2.

These recommendations represent the consensus position of the SFPUC National Water Quality Advisory Council as well as staff. They are advisory in nature.

Table ES-2: Recommendations to Further Protect and Improve San Francisco's Drinking Water Quality

1. Protect and retain Hetch Hetchy Reservoir as SFPUC's primary source water.
2. Continue watershed protection efforts at local reservoirs as outlined in the watershed management plans.
3. Continue to evaluate advanced treatment options to bring alternative supply sources to Hetch Hetchy quality.
4. Continue to monitor technology developments.
5. Conduct a formal distribution system operations assessment.
6. Clarify and revise the monitoring framework for emerging contaminants.
7. Evaluate and utilize appropriate on-line water quality monitoring instruments.
8. Improve the depth and frequency of interaction, consultation and engagement with customers.
9. Explore opportunities to extend SFPUC engagement beyond the meter.
10. Develop a comprehensive, analytical integrated risk management framework for guiding allocation of resources.
11. Integrate fundamental objectives for water quality protection across various SFPUC divisions and task Water Quality Director to review capital and operational decisions.

Source

Selection of high quality source water is perhaps the most important factor governing water quality at the tap. Consider these two quotations, one commenting generally on source protection, the other part of a proposal to dismantle Hetch Hetchy:

> *More than a century of experience in public health practice has shown us that prevention is better than cure. These lessons clearly apply to drinking water where we know that, in most cases, source protection measures can prevent problems from developing in the first place.*[1]

> *Given that no one process is likely to be a panacea, or even adequate for treating all contaminants, water systems normally use a multiple-barrier approach to ensuring delivery of safe and healthy water. The first step is at-the-source protection of the watersheds themselves.*[2]

Located in Yosemite National Park and fed by Sierra mountain snowmelt, Hetch Hetchy Reservoir is an extremely pristine source. It comprises approximately 85% of SFPUC's water supply. There is very minimal risk of chemical or microbial contamination due to limited watershed access and no wastewater or urban runoff discharge to the reservoir.

That the vulnerability to contamination increases if one was to extract water from a different point is why the Natural Resources Defense Council (NRDC) rates Hetch Hetchy very differently than the Sacramento-San Joaquin Delta:[3]

> *Source water protection is an essential component of drinking water protection. San Francisco's Hetch Hetchy and, to a lesser extent, Alameda water supplies offer fine examples of strong source water protection. The Hetch Hetchy is located in Yosemite National Park and is protected from most human-caused pollution sources, except occasional recreational use of the watershed.*

> *…the Sacramento-San Joaquin Delta is under extreme stress from heavy upstream agricultural use, including heavy pesticide and herbicide applications, and is rated by EPA's [Index of Watershed Indicators] as a 5 out of 6, due to "more serious problems" with water quality.*[4]

The SFPUC is required to monitor for 64 volatile organic, synthetic organic compounds and radionuclides. On Hetch Hetchy it obtains the same results: zero detections out of 64 contaminants monitored. This supports Mayor

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1 Hrudey, Steve, "Drinking Water Quality: A Risk Management Approach." Journal of the Australian Water Association, January 2001.

2 Rosekrans, Spreck, Nancy Ryan, Ann Hayden, Thomas Graff, John Balbus. "Paradise Regained: Solutions for Restoring Yosemite's Hetch Hetchy Valley," Environmental Defense, 2004. pg 64.

3 Olson, Erik. "What's On Tap? Grading Drinking Water in U.S. Cities" National Resources Defense Council, 2003.

4 Threat of contamination rated on a scale of 1 (least threat) to 6 (highest threat).

Newsom's statement[5] that "Hetch Hetchy water is the cleanest and most pristine drinking water in the nation".

> ***Recommendation #1*** *– Continue efforts to protect and retain its Sierra resources especially Hetch Hetchy Reservoir as SFPUC's primary drinking water source. This will include continuing with the excellent watershed protection program in cooperation and in some cases, partnership with the appropriate local, state and federal agencies to maintain its unfiltered status.*

The local Alameda and Peninsula watersheds compromise 10% and 5% of the SFPUC water supply. Most of the watershed lands are under SFPUC control or influence with comprehensive watershed management plans in place to manage potential threats such as fire, erosion and land development.

> ***Recommendation #2*** *– Continue watershed protection efforts on local watersheds as outlined in watershed management plans and sanitary surveys, plus continue to control access to watersheds. A more comprehensive source water quality management strategy is needed. A first step is the creation of a viable nutrient management strategy to limit growth of algae that can produce off-tastes and odors plus limit capacity of treatment facilities.*

The SFPUC continues to refine its supply reliability strategy through exploration of various alternatives. These alternatives include enhanced conservation, recycling, conjunctive use and alternative sources (e.g., ground water, surface water, brackish and sea water desalination, etc.).

> ***Recommendation #3*** *– Continue to evaluate advanced treatment options for bringing alternative supply sources to Hetch Hetchy quality. Also, assess vulnerability of these sources[6] and potential watershed protection actions.*

Treatment

After source water protection, water treatment is the next barrier protecting against potential contamination. Treatment involves multiple techniques and technologies to remove or inactivate both chemical and microbial contaminants.

The SFPUC has followed its directive in the City Charter to "Utilize state-of-the-art innovative technologies where feasible and beneficial." The SFPUC has conducted site-specific evaluations of various technologies on its sources of supply. This has included high-rate filtration, alternative coagulants, advanced oxidation processes and membranes. Through on-site testing, it was decided to implement ozone for treating the Peninsula sources. This decision was in keeping with its directive in the City Charter: "Improve drinking water quality with a goal of exceeding applicable drinking water standards if feasible." In addition, ultraviolet (UV) light will be used as an additional disinfectant for Hetch Hetchy in the near future.

> ***Recommendation #4*** *– Continue to monitor and report on technology developments. As appropriate, participate in regional or national research efforts.[7] For promising technology, continue to conduct site-specific evaluations to determine effectiveness, secondary impacts and costs.*

Distribution

The water quality changes that occur after it leaves the treatment plant and travels through a distribution system consisting of miles of pipe and storage prior to customer use are of increasing research and regulatory interest to the water industry. This is perhaps one of the most significant and historically neglected water quality issues for water utilities. The SFPUC has been evaluating how it can transport its water to better ensure "freshness" – a

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5 Mayor Newsom, Speaker Pelosi & USEPA Announce $8 Million Grant for Innovative S.F. Drinking Water Contamination Alert System, May 9, 2008 at http://www.sfgov.org/site/mayor_index.asp?id=80543

6 An example of such considerations is the location of artificial turf at a playground 100 feet from a ground water source in the City's Sunset District. How significant is the risk associated with run-off? What protective measures should be considered?

7 SFPUC staff are currently involved in professional committees that address regulatory developments, advances in technology and management, emerging issues, etc. The panel recognizes and affirms the need for continuing such involvements.

challenge given the significant storage of San Francisco's system for maintaining emergency supplies after earthquakes and other potential disasters. In addition, the water industry has become keenly aware of the disease outbreaks that have occurred, not due to source water quality or treatment deficiencies, but due to breaches in the integrity of the distribution system.[8] With approximately 1200 miles of mains and 400 million gallons of storage spread amongst dozens of storage facilities there is potential for breaches, both intentional and unintentional. Many SFPUC studies have been done on particular elements of the water distribution system, but none that integrate them all.

> ***Recommendation #5** – Every aspect of the distribution system needs to be studied so that a comprehensive, multi-dimensional risk assessment can be developed to understand which improvements to the system should have the highest priority for water quality protection. This can be achieved by conducting a formal distribution system assessment using Hazard Analysis and Critical Control Point (HACCP), Distribution System Optimization Plans (DSOP) or AWWA standard G200-04.*[9]

Customers experience SFPUC water after it has traveled through building plumbing systems and reaches their tap. The impact of potential water quality changes within buildings is discussed later under communication with customers due to the social-legal-technical issues associated with private property and personal preferences.

Monitoring, Data Analysis and Process Optimization

The SFPUC has advanced monitoring programs for chemical, biological and radiological parameters from source-to-tap. In 2007, staff conducted approximately 90,000 tests of drinking water quality. It performs both continuous, on-line monitoring that is tracked through its computerized data acquisition system and discrete sampling and analysis which are performed by skilled chemists, biologists and laboratory specialists. State-of-the-art methods are used assuring regulatory compliance, detection of emerging contaminants, and providing customer support.[10]

While SFPUC's proactive stance on monitoring has borne fruit in the past, the question is in what form it should continue. For technological advances are enabling detection of extremely low concentrations of various constituents concurrent with significant ambiguity about their respective health effects (see further discussion under communications with customers).

> ***Recommendation #6** – Clarify and revise rationale for monitoring framework for emerging contaminants.*[11] *This will consider the best available information on substances that are most likely to be in SFPUC source or treated water (and consider the level of public concerns) and the challenge presented by the ability to detect compounds far exceeding our understanding of the health significance of such detections.*

> ***Recommendation #7** – Evaluate and utilize appropriate on-line water monitoring instruments that will give real-time information of chemical, biological and radiological contaminants (currently planned under EPA Water Security Initiative grant).*

Mining data to proactively anticipate and identify issues while viable actions are possible is an important task for SFPUC's water quality professionals.

Communication with Customers

We are all concerned about what we put into our bodies, particularly through our drinking water. As science advances, the ability to detect very low levels of various potential water contaminants increases and yet, simultaneously, lags behind in the ability to interpret and communicate the significance of previously undetected constituents.

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8 Cross-connections lead to the largest portion of US water-borne outbreaks within the distribution system (Regli, 2007)

9 This would include addressing recommendations of the National Academy of Sciences on distribution systems and would consider indirect additives and coatings.

10 The SFPUC's Water Quality Division regularly collects and tests water samples from reservoirs and designated sampling points throughout the system to ensure that the SFPUC's water meets or exceeds federal and state drinking water standards.

11 Emerging contaminants of current interest include those listed on the EPA Contaminant Candidate List and the European Union NORMAN list.

This presents a dilemma for public health professionals, scientists, engineers, regulators, government officials and the public: what is the significance of X? How significant is the risk it poses; how certain is the science on which the risk assessment is based? Is it cause for alarm? Should we invest resources to reduce their levels? If so, what technology should be used? How significant is the risk it poses compared to other potential risks?

Perception of risks can vary widely amongst experts. In the face of significant uncertainties about risks and potentially wide ranging cost alternatives for risk reduction, what role does the customer have? The words of the psychologist, Paul Slovic, are appropriate to consider:

> *Perhaps the most important message from [psychological] research is that there is wisdom as well as error in public attitudes and perceptions. Lay people sometime lack certain information about hazards. However, their basic conceptualization of risk is much richer than that of experts and reflects legitimate concerns that are typically omitted from expert risk assessments. As a result, risk communication and risk management efforts are destined to fail unless they are structured as a two-way process. Each side, experts and public, has something valid to contribute. Each side must respect the insight and the intelligence of the other.*[12]

It is noteworthy that technology enables sharing and transmittal of information with relative ease, but not all methods of transmittal of information guarantee the same scientific robustness of the information. The SFPUC experience in being proactive with *Cryptosporidium* (and to post information to its website) enabled the discussion to be framed with sound information.

> ***Recommendation #8*** *– Improve the depth and frequency of interaction, consultation and engagement with customers. Consider how to better leverage existing avenues (e.g., the Citizen's Advisory Committee) along with conducting surveys utilizing quantitative techniques (e.g., contingent valuation studies and other state-of-the-art methods) to solicit feedback on satisfaction, desired services and willingness-to-pay for improvements. The intent is to engage and inform a representative cross-section of customers to better guide SFPUC decision.*

Historically and legally, water utilities generally do not address water quality protection beyond the water meter.[13] As such, even though problems with building plumbing systems can influence water quality, the SFPUC has generally not included this aspect of water quality protection in its efforts (although SFPUC provides lead-free faucets). Providing additional services that extend to the tap would mark a significant policy decision for the SFPUC.

Customers experience water quality that is influenced by their own plumbing systems yet may attribute water quality deficiencies to SFPUC sources or treatment. Some customers install point-of-use treatment devices to mitigate perceived and real problems.

> ***Recommendation #9*** *– Explore deeper engagement with customers on water quality at the tap. In particular, with customer involvement, determine: a) the degree of changes in water quality as the water flows from the meter to the tap in buildings; b) if changes are significant, what options are available to mitigate these changes, c) potential roles for SFPUC and d) customer willingness-to-pay for such options.*

Integrated Risk Management Framework

SFPUC has excelled in addressing specific issues and system components that require improvement. The cooperation between the SFPUC and public health agencies is one of the best in the United States. Major risks have been addressed. The process for evaluating and addressing risks in the past has served the customers well. As the SFPUC proceeds into the future, customer demand for quality is anticipated to increase and the increasing complexity of identifying, prioritizing and managing threats to water quality will require a more

[12] Slovic, Paul 1986. "Informing and Educating the Public About Risk". Risk Analysis, Volume 6 Issue 4, p403–415. December 1986.

[13] One exception is that the Federal Lead and Copper Rule, which requires water utilities to consider lead and copper concentrations beyond the water meter and all the way to water user's water fixtures and taps.

rigorous, systematic and sophisticated approaches, and attention to wise allocation of capital resources.[14]

> ***Recommendation #10*** *– In close contact with appropriate stakeholders (including the San Francisco Department of Public Health), develop an integrated risk management framework to inform priority setting that is both comprehensive and quantitative (e.g., identifying potential threats to water quality according to where they might be introduced into the system, the factors governing the anticipated magnitude of these threats, the control measures in place, factors influencing their effectiveness, potential risk mitigation alternatives). It is vital that such a framework be informed not only by risks of a retrospective nature, but by anticipation of issues that may emerge (e.g., new pipe materials/tank coatings, climate change, new technologies, etc.).*

Another implication of an integrated risk management approach is that water quality protection is a shared, organizational responsibility. As noted in various organizational assessments of water utilities, including the SFPUC, there is a tendency for each division to focus on its major responsibilities. As noted in the SFPUC Sustainability Plan[15] under organizational effectiveness:

> *Interviewees also noted that the organizational culture at the SFPUC does not encourage teamwork and collaboration, but rather a silo-mentality that focuses on self-interests and resists changes to traditional ways of carrying out work.*

As the SFPUC strives to efficiently meet its multi-objective mission, the trade-offs that naturally arise between regulatory compliance, public perception, costs, emergency response and environmental footprint will require greater innovation and collaboration across divisions, as well as close contact and attention to SFPUC customers. This leads to the final recommendation:

> ***Recommendation #11*** *– As high water quality is one of stated goals of the SFPUC, the Water Enterprise, through its Business Planning process, will integrate the fundamental objectives for water quality protection within its various divisions to better achieve this fundamental goal. Consistent with the Business Planning process and to highlight the importance of the water quality protection program and ensure accountability for implementation, the Water Quality Director should be tasked with reviewing and recommending all related capital and operational investments.*

Next Steps

After distributing the peer reviewed draft of this water quality protection plan Executive Summary to the Commission on May 20, 2008, the recommendations were discussed at the Commission meeting on May 27, 2008. The Commission affirmed the recommendations and the following next steps:

1. SFPUC staff to submit plan to Mayor Newsom.
2. SFPUC staff to report back to Commission in Fall 2008 with a finalized plan along with implementation actions for priority items.
3. SFPUC staff to program resources as part of the budget for fiscal year 2009/2010.
4. SFPUC staff to update Commission on progress annually.
5. SFPUC staff to update Water Quality Protection Plan triennially, in the same year as the Public Health Goals.

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[14] This is consonant with the SFPUC Sustainability Plan to "undertake a comprehensive identification and assessment of risks posed to the organization (such as operational/services, environmental, [f]inancial, [l]icense to operate, political, regulatory, reputational risks)." And "Develop tools and mechanisms to monitor, evaluate, address, minimize, mitigate, manage and control risks as appropriate."

[15] SFPUC. *Sustainability Plan – Sustainability Baseline Assessment F05/06*. 2007.

1. Introduction

1.1 Background

Water quality protection is dynamic and involves vigilance over every part of water delivery: sources of supply and their watersheds, water treatment and transmission/distribution of water to the customer. On an on-going basis, San Francisco Public Utilities Commission (SFPUC) makes decisions about its water quality strategy in terms of investments throughout the system based on Federal and State drinking water regulations, seismic and emergency planning considerations, public health, environment, aesthetics, cost, and system specific opportunities and constraints. This has resulted in various recent capital and operational modifications such as the $4 billion Water System Improvement Program to strengthen facilities seismically, on-going elimination of lead-bearing materials in the distribution system, Partnership for Safe Water at the treatment plants to minimize turbidity spikes, changeover to chloramine disinfectant in the distribution system in 2004 to comply with new Federal regulations, improvement of corrosion control in 2005 for lead and copper, and planning for implementation of UV disinfection for Hetch Hetchy supply in 2012.

At World Water Day on March 20th, 2008, San Francisco Mayor Gavin Newsom directed the SFPUC on several initiatives including preparation of a detailed and specific Water Quality Protection Plan within 60 days that is guided and reviewed by a SFPUC convened National Water Quality Advisory Council. This plan builds on existing efforts including the Water Supply Improvement Program, the Sustainability Plan and the in-progress Strategic Planning for San Francisco's Water Quality Future.

SFPUC continues to look ahead to anticipate emerging challenges so as to maintain and improve water quality.

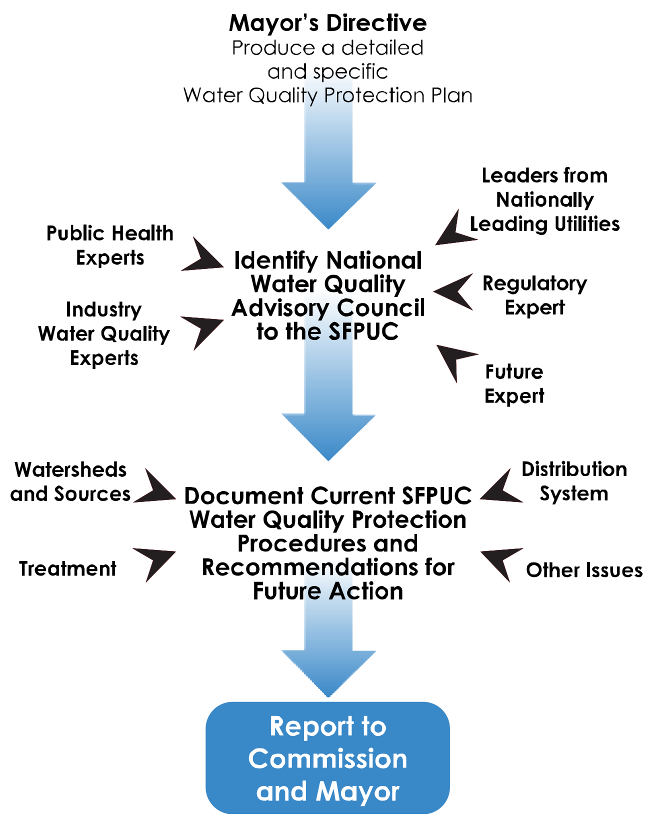
1.2 Objective

This document – the SFPUC Water Quality Protection Plan – assesses both strengths and weaknesses of the water system and makes recommendations to protect and improve San Francisco's high water quality into the future.

1.3 Scope

The plan addresses both overarching/cross-cutting issues and the major components of the SFPUC system (source-treatment-distribution). The plan evaluates SFPUC's water quality in these and other categories. Recommendations are provided on how SFPUC's water quality could be further protected and improved in the future.

It is suggested that the Water Quality Protection Plan be updated every 3 years to reflect the most current knowledge, SFPUC progress and any new circumstances. The timing of the update is suggested to follow the Public Health Goals Report. Public Health Goals (PHGs) are non-enforceable standards set by the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA). Every three years, SFPUC must report on any PHGs it has exceeded. The most recent report was in 2007.



1.4 Advisory Council

To assist with the development and review of the plan, SFPUC convened a National Water Quality Advisory Council (NWQAC). The council consists of water quality experts in academia, the industry and the US Environmental Protection Agency (USEPA) (Table 1-1). The experts provided input through review of draft documents, conference calls and a workshop, held April 28th, 2008 to finalize specific recommendations of how SFPUC can continue to protect and improve San Francisco's water quality. A summary of the principal NWQAC conference call is in Appendix A and agenda and slides for the workshop in Appendix B.

NWQAC Panelists (from left to right: Dave Hilmoe, June Weintraub, Phillippe Daniel, Pankaj Parekh, Jeffrey Griffiths, Bruce Macler, William Glaze; not pictured: Stephen Estes-Smargiassi)

1.5 San Francisco City Charter

The City and County of San Francisco Charter[16] includes a series of goals and objectives related to maintaining clean water:

The Commission shall develop, periodically update and implement programs to achieve goals and objectives consistent with the following:

(1) *Provide water and clean water services to San Francisco and water service to its wholesale customers while maintaining stewardship of the system by the City;*

Table 1-1: SFPUC National Water Quality Advisory Council Panelists

Panelist	Affiliation	Expertise
Jeffrey Griffiths, M.D.	Associate Professor, Tufts University School of Medicine Member of EPA's Science Advisory Board	Epidemiology, Sensitive Sub-populations
William Glaze, Ph.D	Professor Emeritus, UNC-Chapel Hill Ex- Chair, EPA Science Advisory Board Ex-Editor-in-Chief, Environmental Science & Technology, pre-eminent journal in the field.	Policy, Future Trends, Technology, Water Quality
Dave Hilmoe, P.E., BCEE	Drinking Water Director, Seattle Public Utilities (SPU)	Utility Operations, Water Quality
Stephen Estes-Smargiassi	Director of Planning, Massachusetts Water Resources Authority (MWRA), AWWA Research Foundation (AwwaRF), Research Advisory Council Chair	Public Policy, Utility Operations, Water Quality
Pankaj Parekh, Ph.D	Director for Water Quality Compliance, Los Angeles Dept of Water & Power (LADWP), Chair of Strategic Initiative for Distribution System Research Expert Panel (AwwaRF)	Risk Management, Water Quality, Utility Operations
Phillippe Daniel	Vice President, Camp Dresser & McKee AWWARF RAC and Strategic Initiative on Endocrine Disrupting Chemicals and Pharmaceuticals and Personal Care Products	Water Quality, Treatment, Risk, Strategic Planning
June Weintraub, Sc.D.	Senior Epidemiologist, San Francisco Department of Public Health	Public Health
Bruce Macler, Ph.D.	USEPA Region 9	Regulations, Toxicology, Risk Assessment

16 Goals and Objectives Related to Water and Clean Water. http://www.municode.com/content/4201/14130/HTML/ch008b.html

(2) *Establish equitable rates sufficient to meet and maintain operation, maintenance and financial health of the system;*

(3) *Provide reliable water and clean water services and optimize the systems' ability to withstand disasters;*

(4) *Protect and manage lands and natural resources used by the Commission to provide utility services consistent with applicable laws in an environmentally sustainable manner. Operate hydroelectric generation facilities in a manner that causes no reasonably anticipated adverse impacts on water service and habitat;*

(5) *Develop and implement priority programs to increase and to monitor water conservation and efficiency system-wide;*

(6) *Utilize state-of-the-art innovative technologies where feasible and beneficial;*

(7) *Develop and implement a comprehensive set of environmental justice guidelines for use in connection with its operations and projects in the City;*

(8) *Create opportunities for meaningful community participation in development and implementation of the Commission's policies and programs; and*

(9) *Improve drinking water quality with a goal of exceeding applicable drinking water standards if feasible.*

1.6 SFPUC Mission

The Water Quality Protection Plan occurs within the broader mission of SFPUC to[17]:

- *Serve San Francisco and its Bay Area customers with reliable, high-quality and affordable water, while maximizing benefits from power operations and responsibly managing the resources entrusted to its care;*

- *Protect public health, public safety and the environment by providing reliable and efficient collection, treatment and disposal of San Francisco's wastewater;*

- *Conduct its business affairs in a manner that promotes efficiency, minimize wastes, and assures rate payer's confidence; and*

- *Promote diversity and the health, safety, and professional development of its employees.*

[17] SFPUC, 2002. "Long Term Strategic Plan for Capital Improvements".

1.7 Relevant SFPUC Plans

The Water Quality Protection Plan dovetails with the SFPUC Sustainability Plan, the Water System Improvement Program (WSIP) and Strategic Planning for San Francisco's Water Quality Future.

SFPUC has defined sustainability as:

> *"the framework through which SFPUC will responsibly manage the resources under its care, protect public health and balance its social and environmental responsibilities to the citizens and community, while providing cost effective services to its ratepayers."*[18]

This report on protecting San Francisco's water quality helps advance the pertinent four of the six goals identified in the Sustainability Plan:

- *Customers: Provide good service to customers at appropriate rates.*

- *Infrastructure and Assets: Effectively manage and maintain and ensure reliability and efficiency of infrastructure and assets.*

- *Environment and Natural Resources: Ensure effective environmental and natural resources management.*

- *Community: Be actively responsive to community needs and a good citizen of the community.*

WSIP is a $4.6 billion multi-year capital program to enhance SFPUC's ability to provide reliable, affordable, high quality drinking water to its 28 wholesale customers and regional retail customers in an environmentally sustainable manner. The proposed WSIP is structured to meet water quality regulatory requirements[19], improve seismic and delivery reliability, and meet water supply

[18] SFPUC, 2007c. *Sustainability Plan – Sustainability Baseline Assessment F05/06.* http://sfwater.org/msc_main.cfm/MC_ID/18/MSC_ID/121

[19] There is some discrepancy between WSIP which plans to *meet* water quality regulations verse the City Charter which has the goal to *exceed* drinking water regulations, *if feasible.*

reliability goals. The most recent amendments to WSIP were reported on March 31, 2008[20].

The two fundamental principles of the WSIP are:

1) A clean unfiltered water source; and

2) A gravity driven system.

All measures of reliability have evolved and been evaluated from these principles. Projects within the WSIP continue to incorporate key principles of SFPUC, including sustainability and environmental stewardship policies.

The objectives of the program (as defined in November 2005) are to:

- Furnish system improvements to provide high quality water that reliably meets current and foreseeable local, state, and federal requirements.
- Reduce vulnerability of the water system to damage from earthquakes.
- Increase reliability of the system to deliver water by improving redundancy needed to accommodate planned outages for maintenance and unplanned outages resulting from facility failure.
- Provide near-term improvement of water supply/drought protection.
- Set forth long-term water supply/drought management options for technical evaluation, cost analysis, and environmental review.
- Enhance sustainability through improvements that optimize protection of the natural and human environment.

The purpose of the in-progress project Strategic Planning for San Francisco's Water Quality Future is to create a sound basis for capital and operational investments that may be required 20 to 30 years from now. Utilizing the same NWQAC panelists and a group of internal and external stakeholders, SFPUC held a series of workshops to assess what scenarios and concerns are likely to emerge in the future. Agendas for these workshops and summaries are found in Appendix C. Ten priority areas were identified including: water quality management approach, emerging contaminants, customer communication, role as a utility, quantity concerns, climate change, emergency preparedness, sustainability, technological advances and regulations. Currently consideration is being given to the analysis of specific alternatives to address the priority areas which may be implemented circa 2035.

1.8 Guiding Principles

SFPUC has developed draft guiding principles which frame the context of the Water Quality Protection Plan:

1. Consider the total context of contaminant risk – not just particular pieces but the total system from source to tap.

2. Focus efforts on highest opportunities for contaminant risk reduction.[21]

3. Consider "upward compatibility" of improvements with potential future issues (e.g., ability to remove contaminants currently not targeted).

4. Maintain highest source water quality possible

5. Recognize that the ability to measure low levels of some contaminants (and their interactions) exceeds our level of understanding the risk (or potential benefits) of contaminants and their combinations.

6. Consult with public and other stakeholders to obtain guidance, establish internal standards and consider trade-offs:

   - Emerging health issues
   - Aesthetics
   - Consistent quality for industrial customers
   - Sustainability

7. Respond proactively and timely to issues of potential concern.

[20] http://sfwater.org/detail.cfm/MC_ID/13/MSC_ID/167/C_ID/3928/Keyword/Notice%20of%20Changes

[21] Recognizing the precautionary principle may be appropriate. See Appendix D for SEC. 101. The San Francisco Precautionary Principle from The City of County of San Francisco Environment Code.

2. System Overview

Serving a population of 2.4 million people in over 30 cities, SFPUC is the largest water purveyor in Northern California. The SFPUC water system consists of surface water reservoirs, long transmission pipelines, treatment (i.e., corrosion control and disinfection for Hetch Hetchy plus two filtration plants for local sources) and distribution to both retail and wholesale customers (see Figure 2-1). Hetch Hetchy Reservoir, accounting for ~ 85 percent of the SFPUC supply, is of such high quality that it does not require filtration.

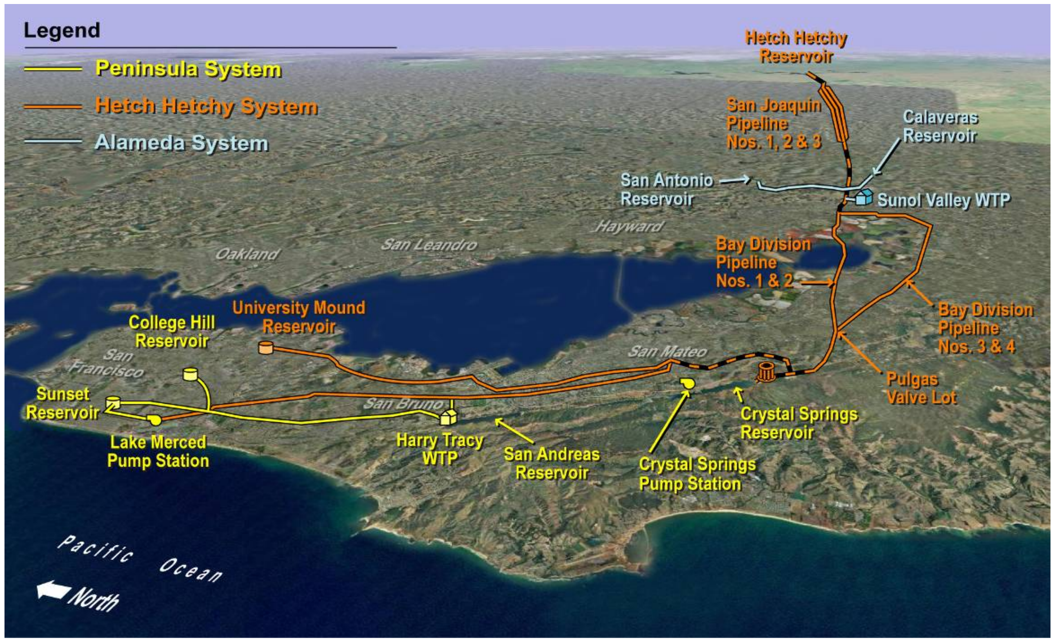


Figure 2-1: Regional Water System Overview

The SFPUC Service Area is shown in Figure 2-2. About one-third of SFPUC's water supply is served to customers in the City and County of San Francisco; the remaining two-thirds are served to regional wholesale and retail customers.

The one-third portion of water serving the residents of San Francisco averages 80 million gallons a day. This water is transported through approximately 1200 miles of mains, of which 800 miles have a diameter of less than 12-inches and 72% are unlined cast-iron. The distribution system also contains over 400 million gallons of storage spread between 12 storage reservoirs and 8 tanks. The City system has several large storage reservoirs (up to 176 MG), with overall system storage volume equal to roughly 5 to 7 times the average water consumed in a day.

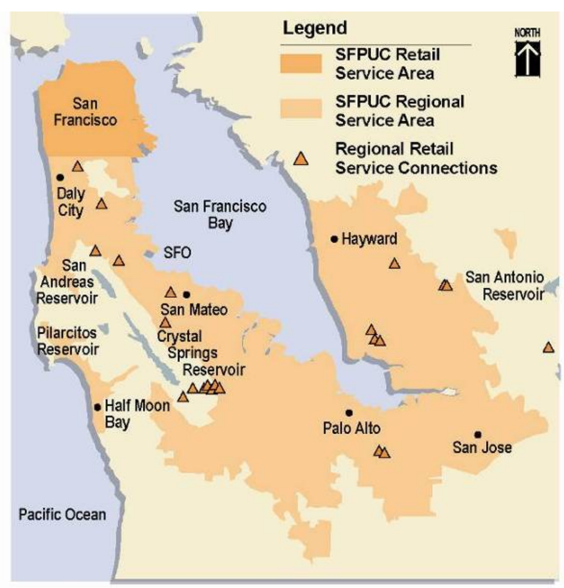


Figure 2-2: SFPUC Service Area

3. Approaches to Water Quality Protection

3.1 How is Acceptable Water Quality Best Assured?

There are a variety of ways to address the question:

1. Contaminant-by-contaminant – Contaminants determined to be of significant health risk are addressed through setting values that must not be exceeded.

2. Treatment technique – Rather than setting numeric targets for all contaminants, certain treatment technologies can be designated instead.

3. Systems approach – This includes multiple-barriers to remove or inactivate contaminants along with an analytical approach to examine potential hazards and determine how they can be managed from source-to-tap.

Each of these approaches is discussed below.

3.1.1 Contaminant-by-Contaminant

The United States Environmental Protection Agency (USEPA), due to Congressional mandates, focuses largely on a contaminant-by-contaminant approach. Maximum contaminant levels are set for various organic and inorganic chemicals, microorganisms, disinfection by-products and radionuclides. Compliance with regulations has been one of the principal factors influencing water quality treatment investments over the last thirty years. A number of regulations have been proposed and promulgated over the last 20 years that SFPUC has focused on addressing (e.g., those governing disinfection, disinfection by-products and lead). SFPUC complies with all federal and state drinking water regulations.[22]

3.1.2 Treatment Technique

Under some circumstances, the USEPA sets specific levels of treatment as the required standard instead of a maximum contaminant level. This has been used for microorganisms where a specified percentage of removal/inactivation has been established. The percentage removal ranges from 99% to 99.99% for various microorganisms. Specifying a treatment technique is often due to the feasibility of monitoring for specific contaminants (e.g., not currently feasible to conduct real-time monitoring for *Cryptosporidium*). By specifying the required treatment standards and appropriate measures for monitoring treatment effectiveness, a reasonable level of safety is assured. SFPUC complies with all treatment technique regulations.

3.1.3 Systems Approach

A more holistic approach to water quality protection is to recognize the specific strengths and vulnerabilities of the entire system. Regulatory agencies have advocated a multiple-barrier approach that provides back-up protection should one barrier fail. This approach has been implemented widely. Increasingly a more analytical systems approach is needed as there is greater pressure to allocate resources as efficiently as possible. This means *more strategically* addressing quality from source selection, watershed management, treatment and distribution to the customers tap. This more wholistic model has been increasingly used by the World Health Organization, the European Union, and Health Canada. The American Water Works Association Research Foundation has developed an application based on this concept for distribution systems[23]. This model is derived from the food industry's approach:

Basic Principles of HACCP

1. Conduct a hazard analysis.
2. Determine the Critical Control Points (CCPs).
3. Establish critical limit(s).
4. Establish a system to monitor control of the CCP.
5. Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.
6. Establish procedures for verification to confirm that the HACCP system is working effectively.
7. Establish documentation concerning all procedures and records appropriate to these principles and their application.

Source: WHO "HACCP - Introducing the Hazard Analysis and Critical Control Point System" http://www.who.int/foodsafety/fs_management/en/intro_haccp_annex.pdf

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22 http://www.epa.gov/safewater/contaminants/index.html

23 Martel, et al. 2006. "Application of HACCP for Distribution System Protection". AwwaRF, 2006.

Hazard Assessment and Critical Control Point (HACCP). HACCP focuses on determining what points in the process are most critical for ensuring quality in order to develop the water quality management strategy.

3.2 Approach for the Water Quality Protection Plan

The SFPUC Water Quality Protection Plan incorporates elements from each of these approaches. SFPUC meets all state and federal drinking water regulations. It employs a multi-barrier approach to water quality protection utilizing watershed protection, filtration, and disinfection as barriers to pathogens and chemical contaminants. This strategy has served the customers of SFPUC well in the past and it serves as a foundation for the future. The future, however, is not static and consequently the water quality protection strategy must be refined to adapt to new challenges as they arise (e.g., climate change, increased analytical sensitivity, customer demand, and aging infrastructure). These new challenges must be addressed as SFPUC refines its water quality protection strategy. The recommended elements for refining the strategy are outlined in this report.

Furthermore, SFPUC seeks to systematically evaluate the risks to water quality from source to tap. Based on these assessments SFPUC identifies the most appropriate measures to increase water safety, not only for present risks but with a consideration for potential future risks.

Pharmaceuticals and Endocrine Disruptors in Drinking Water?

In 2006, SFPUC participated in a nation-wide research project testing for 62 pharmaceuticals, personal care products and endocrine disruptors in untreated and treated waters (see Appendix E for results). One set of samples was collected from the San Andreas Reservoir, HTWTP effluent and the distribution system. Samples were aimed to test a blend of all waters served to SFPUC customers. The American Water Works Association (AwwaRF) report containing the data from all surveyed utilities is to be published in 2008.

On March 10, 2008, an AP Story entitled "*Probe Finds Drugs in Drinking Water*" was published. It noted that a wide array of compounds had been found at low levels in US drinking waters. Plus it noted that " a sex hormone was detected in San Francisco's drinking water." On March 11, 2008, a clarification story ran entitled "*S.F.'s Tap Water Best in Tests, Chemists Say*." It noted that 2 out of 62 tested chemicals were found at parts per trillion levels in the San Andreas reservoir source water (i.e., untreated). These trace amounts were subsequently removed by the ozone treatment at the water treatment plant and none of the compounds were found in drinking water. The Principal Investigator concluded: "SF water is one of the most pristine drinking waters in terms of emerging contaminants" (and this statement was made not considering Hetch Hetchy water which comes from an extremely protected watershed).

4. Water Quality Protection Review

The status of potential water quality issues is provided in Table 4-1 along with potential improvements. Table 4-1 provides an overview for SFPUC water sources and watersheds, water treatment facilities, distribution system, and cross-cutting activities pertaining to the entire water system. A longer description of current activities and potential actions is provided in Section Five of this report.

Table 4-1: SFPUC Water Quality Protection Review

Description	Assessment	Potential Additional Action
Water Sources and Watersheds		
Hetch Hetchy		
Located in Yosemite National Park and fed by Sierra mountain snowmelt, Hetch Hetchy Reservoir is an extremely pristine source with a 459 square mile watershed.	Very minimal risk of chemical or microbial contamination due to limited watershed access and no wastewater or urban runoff discharge to the reservoir. However, Moccasin Reservoir is near a highway crossing.	Continue efforts to protect and retain Sierra resources, especially Hetch Hetchy Reservoir, as SFPUC's primary drinking water source. This will include continuing with the excellent watershed protection program in cooperation and in some cases, partnership with the appropriate local, state and federal agencies to maintain its unfiltered status. Implement improvements at Moccasin and Priest Reservoirs as these are the weak points for the Hetch Hetchy supply.
Alameda		
This watershed encompasses 175 square miles and includes Calaveras and San Antonio reservoirs. SFPUC owns approximately 33 percent of the watershed area. East Bay Regional Park District manages the majority of the watershed land.	Water quality data indicates that water from the Alameda Watershed and the Sunol Filter Galleries is of excellent quality and, after treatment, consistently meets regulatory standards. There is potential for development within the watershed beyond the control of SFPUC.	Implement the Alameda Watershed Management Plan focusing on erosion control and land acquisition. Evaluate the hypolimnetic oxygenation system in Calaveras Reservoir and possibly implement elsewhere. Continue to limit access to watershed.
Peninsula		
The Peninsula Watershed is 36 square miles and includes Crystal Springs (Upper and Lower), San Andreas, and Pilarcitos reservoirs. SFPUC owns approximately 99 percent of the watershed area.	Water quality data indicates that water from the Peninsula Watershed is of excellent quality and, after treatment, consistently meets regulatory standards. Because the Peninsula Watershed has not experienced a fire of any magnitude in over 100 years, the accumulation of fuels is of great concern. Frequency and levels of algae growth and taste and odor in Crystal Springs and San Andreas Reservoirs have increased recently.	Develop and implement nutrient control strategy in Crystal Springs and San Andreas Reservoirs. Implement the Peninsula Watershed Management Plan focusing on fire management and erosion control. Continue to limit access to watershed.

Table 4-1: SFPUC Water Quality Protection Review

Description	Assessment	Potential Additional Action
	Water Treatment	
	Hetch Hetchy Source	
Since the Hetch Hetchy source is well-protected and of high quality it allows SFPUC to meet regulatory requirements with minimal amounts of treatment and without filtration.	Corrosion control is well maintained at the Rock River Lime Plant. Increase of pH to better protect pipe mortar linings is planned for 2012. Tesla Hypochlorite Station provides primary disinfection. UV treatment is planned prior to chlorination to enhance disinfection in 2012. The Sunol Valley Chloramination Facility provides secondary disinfection, fluoridation and corrosion control.	Perform treatability study for ozone at Tesla Hypochlorite Station to improve color and UV transmittance and as an additional disinfection barrier.
	Sunol Valley Water Treatment Plant	
Water from the Calaveras and San Antonio Reservoirs is treated at the Sunol Valley Water Treatment Plant. The process train includes chemical addition, coagulation, mechanical flocculation, sedimentation, dual-media filtration, and disinfection with sodium hypochlorite. Sodium hydroxide is added to filtered water at the plant clearwell to raise pH for corrosion control.	Upgrades to increase firm capacity to 160 mgd are currently underway. Future improvements may be needed for drought reliability or to handle significant future decreases in source water quality.	SVWTP expansion is providing space for future UV installation after the filters, if necessary. Ozone as a disinfectant may need to be revisited for taste and odor concerns. A treatability study is recommended.
	Harry Tracy Water Treatment Plant	
Water from the Crystal Springs, Pilarcitos, and San Andreas Reservoirs is treated at the HTWTP. Under normal operations, the HTWTP provides pre-oxidation with ozone, coagulation with ferric chloride and coagulant aid polymer, flocculation, filtration through dual-media filters, disinfection with sodium hypochlorite and chloramine, fluoridation, and corrosion control with sodium hydroxide.	Modifications are planned for seismic retrofit and rehabilitation of the existing building and facility to provide long-term reliability and process improvements to increase sustained capacity to 140 mgd.	If algae management in source water is unsuccessful, additional treatment processes (i.e., clarification) or additional oxidation processes may be required and treatability studies should be performed to address potential future taste and odor concerns Optimize nutrient removal through improvements to the Pulgas Dechloramination Facility.
	Distribution System	
	Operations	
Distribution system operations includes items such as maintaining pressure, cross-connection control, maintenance of chloramine residual, and proper pH for internal corrosion control.	SFPUC meets all regulations for water quality and system operations. This, in spite of the challenge presented by significant storage and its associated long detention times. In 2004 disinfectant residuals and disinfection by-products were improved due to conversion to chloramine. In 2005 corrosion control was improved due to system wide fluoridation and pH adjustment.	Develop an integrated Distribution System Operations Plan. Employ a dynamic model to evaluate optimal conveyance patterns to maintain water quality, minimize water age, while also evaluating competing demands.

Table 4-1: SFPUC Water Quality Protection Review

Description	Assessment	Potential Additional Action
	Asset Management	
Asset management includes items as main replacement and repair, external corrosion control, flushing, and tank and reservoir cleaning.	More formal program needed to identify and evaluate aged mains and other distribution system appurtenances (e.g., hydrants, valves, meters, etc.). Dead end flushing program is in place. Tank and reservoir cleaning occurs on a three year rotation.	Flushing needed in low flow areas. Monitor the impacts of new lining and coating materials for leaching potential. Develop guidelines for main replacement location and frequency. Maintain mechanical mixers in large storage and evaluate detention time improvements in tanks with lower chlorine residuals.
	Changing Role of the Utility	
Historically, service to the meter at the curb has been the legal mandate, and with the exception of requirements associated with the Federal Lead and Copper Rule, the extent to which services have been provided.	SFPUC has a lead faucet replacement program, which provides low lead faucets to residents of San Francisco at a much reduced price. Additionally, SFPUC has promoted use of tap water, most recently encouraging restaurants to serve tap water and providing stainless steel water bottles to individuals signing a pledge to stop buying bottled water.	Analysis of water quality changes in buildings and appropriate follow-up. Educational material on maintaining water quality within homes.
	Cross-Cutting Activities	
	Integrated Risk Management Framework	
SFPUC has excelled in addressing specific issues and components, leading to a high quality drinking water served to the residents of San Francisco. As SFPUC proceeds into the future, customer demand for quality is anticipated to increase and the increasing complexity of identifying, prioritizing and managing threats to water quality will require a more rigorous, systematic and sophisticated approach to efficiently manage risks to water quality.	The Water Quality Division initiated a project in 2007: "Strategic Planning for San Francisco's Water Quality Future." This on-going project identifies key water quality priority areas facing SFPUC on a 30 year planning horizon.	Development of an integrated risk management framework to aid in priority setting. Determine means and incentives towards more effectively harmonizing the work of various divisions to better achieve fundamental SFPUC objectives for water quality protection. Complete *Strategic Planning for San Francisco's Water Quality Future* report and begin the next phase of planning the most significant research efforts to address future challenges impacting water quality (i.e., climate change).

Table 4-1: SFPUC Water Quality Protection Review

Description	Assessment	Potential Additional Action
Monitoring, Data Analysis and Process Optimization		
SFPUC has advanced monitoring programs at its seven lab facilities which are operated by skilled chemists, biologists and laboratory specialists. State-of-the-art methods are used assuring regulatory compliance, detection of emerging contaminants, and providing customer support. SFPUC actively explores new water supply possibilities through recycled water and desalination projects.	Over the last 20 years, SFPUC has sought to supplement is routine monitoring with special studies to evaluate the potential presence of suspected contaminants. This has included monitoring for *Legionella*, biodegradable organic matter, unregulated disinfection by-products and *Cryptosporidium*. SFPUC remains connected to industry trends though collaborative projects with other agencies and research organizations as well as leadership through professional organizations. SFPUC faces challenges of increasing analytical workload due to emerging contaminants and increasing feasibility of detection (i.e., algal toxins, low-level organics). Currently, SFPUC uses outside contract laboratories for non-routine analyses.	Clarify and revise the rationale for a monitoring framework for emerging contaminants. This will consider the best available information on substances that are most likely to be in SFPUC source or treated water (and consider the level of public concerns) and the communications challenge presented by the ability to detect compounds far exceeding our understanding of the health significance of such detections. Continue to monitor and report on technology developments. When appropriate, participate in regional or national research efforts. For promising technology, continue to conduct site-specific evaluations to determine effectiveness, secondary impacts and costs. Assess the need for a new laboratory to proactively respond to future monitoring and testing challenges.
Emergency Planning		
SFPUC has had a series of Disaster and Emergency Plans dating back decades. Three staff members from WQD are on-call at all times to respond to various types of emergencies.	SFPUC has comprehensive emergency plans. Updates to the plans and exercises of procedures are scheduled for completion through the USEPA Water Security Initiative Grant.	Open the emergency operations center at lower levels to ensure protocol is exercised on a more regular basis. Facilitate clear interfaces across sectors through on-going exercises and discussions (i.e., Red Cross distributing chlorine tablets and bottled water).
Public Health Partnership		
SFPUC and the San Francisco Department of Public Health (SFDPH) have a partnership which first evolved in the early 1980's.	The SFPUC-SFDPH collaboration provides immediate support and response to events related to drinking water that raise health implications and concerns. SFPUC and SFDPH collaborated on water quality issues; e.g., fluoridation, disinfection, DBPs, pharmaceuticals.	More focus is needed on educating customers on risk assessment, uncertainties and prudent risk management. A consistent and logical policy for addressing emerging contaminants is needed.

Table 4-1: SFPUC Water Quality Protection Review

Description	Assessment	Potential Additional Action
Communication with Customers		
Communication with customers occurs mainly through bills and mailings, the website, the Citizen's Advisory Committee, media outlets and responding to individual calls and emails.	More could be done to provide customers integrated information concerning areas of water quality protection.	Share relevant and integrated information with customers through a variety of means (website, Annual Water Quality Reports, media outlets, and public health groups). Move from anecdotal to more systematic assessment of customer needs and concerns through quantitative, analytical, state-of-the-art surveying methods.

5. Analysis of Water System Components

Assessing potential risks starts with the source waters and their watersheds, proceeds through treatment and ends with how water is stored and transported to the customer tap. What follows is an analysis of each of these major components of the San Francisco water system.

5.1 Watersheds and Sources

Selection of high quality source water is perhaps the most important factor governing water quality at the tap. SFPUC and the residents of San Francisco are extremely fortunate to use Hetch Hetchy Reservoir, one of the best drinking water sources in the world. This is primarily thanks to the foresight of City government and engineers 100 years ago to secure the best water sources and build an extremely efficient system to bring this water to the residents.

SFPUC has been proactive in maintaining its high purity source water through watershed management. SFPUC regularly updates its watershed protection plans and has developed stewardship plans for the local watersheds. The following section provides a baseline assessment, on-going activities and potential actions for:

- Hetch Hetchy System
- Alameda Reservoirs
- Peninsula Reservoirs
- Alternate Sources

5.1.1 Hetch Hetchy System

5.1.1.1 Assessment

Located in Yosemite National Park and fed by Sierra mountain snowmelt, Hetch Hetchy Reservoir is an extremely pristine source. There is very minimal risk of chemical or microbial contamination due to limited watershed access and no wastewater or urban runoff discharge to the reservoir. There is active watershed surveillance by the National Park Service (NPS). Educational information is also provided to recreational users.

5.1.1.2 On-going Activities

SFPUC currently monitors the Tuolumne Meadows wastewater treatment plant. The plant operates from spring to fall and discharges wastewater to spray fields within the watershed. SFPUC also monitors the status of the Glen Aulin High Sierra Camp which has a leach mound to dispose of wastewater. SFPUC is currently encouraging the construction of a new composting toilet at the camp. Corrals and stables within the watershed are also monitored to ensure compliance with best practices for containing wastes and drainage facilities.

Erosion control measures are currently on-going with a focus on monitoring of the "Little Blue" slide site as well as erosion control structures around Gaylor Pit. SFPUC also works with the NPS during wildfires in the watershed to limit water quality impacts.

Both Priest Reservoir and Moccasin Reservoir, while quite small, are areas where there is some vulnerability to contamination. Recent episodes have been experienced with elevated levels of turbidity, coliforms and algae.

5.1.1.3 Potential Actions

Continue efforts to protect and retain Hetch Hetchy Reservoir as SFPUC's primary source. This will include continuing with the excellent watershed protection program as well as state and federal involvement on water rights issues.

In the future, climate change is projected to raise the snowline in the watershed, leaving more land uncovered and susceptible to erosion. Larger storms and increased rainfall as compared to snowfall could also pose an erosion threat. It is recommended that SFPUC continue to monitor drainage patterns in the watershed and survey for areas of erosion concern. Higher water temperatures in the reservoir should not be expected in the immediate future; however, continued monitoring is recommended to map any changing baseline conditions.

Support NPS completion of a comprehensive wild and scenic management plan for the Tuolumne River and

the design concept plan for Tuolumne Meadows. The target date for completion of these documents is 2010.

Continue with the Moccasin Reservoir Water Quality Improvement Project and the Priest Reservoir Shoreline Lining/Turbidity Barrier project (currently in the planning phases).

5.1.2 Alameda Reservoirs

5.1.2.1 Assessment

SFPUC's Alameda watershed lands, located in Alameda and Santa Clara Counties encompass 175 square miles. SFPUC owns approximately 33 percent. Within the greater watershed, the East Bay Regional Park District (EBRPD) manages the Sunol and Ohlone Regional Wilderness Areas (with some portions leased from SFPUC). There is the potential for development within the hydrologic boundary beyond the control of SFPUC that could adversely impact source water and the water supply.

SFPUC's Alameda Watershed has two reservoirs: Calaveras and San Antonio. In response to safety concerns about the seismic stability of the Calaveras dam, SFPUC has lowered water levels in Calaveras Reservoir until repair or replacement of the dam. A proposed replacement dam for Calaveras Reservoir is one of the many projects proposed in SFPUC's Water System Improvement Program (WSIP).

Water quality data indicates that the water from the Alameda Watershed and the Sunol Filter Galleries is of excellent quality and consistently meets regulatory standards.

5.1.2.2 On-going Activities

SFPUC has established policies to acquire critical watershed lands. These policies reflect the need to gain greater control of watershed lands, through acquisitions of fee title or conservation easements, in order to sustain water resource values, such as the protection of water quality, water rights, and water storage capacities. Adjacent land uses present a risk to SFPUC's Alameda Watershed source water and water supplies. For example, a new quarry on SFPUC property has been proposed, but development may be years away. In addition, land has been subdivided into developable parcels on a major ridge of the watershed contributing water to both upper Alameda Creek and the Calaveras Reservoir.

A hypolimnetic oxygenation system was installed in Calaveras Reservoir in September 2005 to decrease algal growth, improve taste and odor of the water, and reduce levels of iron and manganese.

Tap Water vs. Bottled Water

"Dissatisfaction with water taste or smell is one of the main reasons why people drink bottled water. Another reason is successful marketing by the bottled water industry that bottled water is pure and safe. "

If customers are to choose tap water over bottled water, then water utilities will need to ensure effective control of off-flavors and other aesthetics such as color.

"Richard Feynman, a Nobel-winning physicist, said, 'For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled'. Despite great public relations efforts, bottled water isn't a sustainable technology, and it's up to bottled water drinkers to stop fooling themselves. "

Quoted from: Pat Kline, "Tap Water vs. Bottled Water: What's the Difference?" Opflow, May 2008, pp.8-9.

SFPUC has taken measures to reduce the potential impacts of erosion, native plant displacement and water quality degradation often associated with grazing through the implementation of its Grazing Management Plan. Exclusion fences around Calaveras have been repaired but they are not as effective as hoped. Major sections of San Antonio Reservoir are unfenced.

SFPUC protects the watershed from fire and manages the watershed fuels through the implementation of its Fire Management Plan. Portions of the Fire Management Plan, however, have yet to be implemented. During last fire season, four fires occurred in the watershed but no resulting increase in turbidity in the reservoirs was observed.

5.1.2.3 Potential Actions

Continue watershed protection efforts on local watersheds as outlined in watershed management plans and sanitary surveys, plus continuing to limit access to watersheds. Currently of critical importance is refining the nutrient management strategy to limit growth of algae that can produce algal toxins, taste and odors and limit capacity of treatment facilities. Other major components of the watershed protection plans include:

- Fuel management projects must be continued and expanded to protect against a catastrophic fire.

- Erosion control strategies, particularly around roadways will protect the reservoirs against turbidity and fillings. Bank erosion is particularly an issue at San Antonio reservoir.

- It is essential that critical watershed lands be acquired or conservation easements created to reduce this risk and enhance the protective function of watershed lands.

- Evaluate the effectiveness of the installed hypolimnetic oxygenation system in Calaveras Reservoir to control algal growth and improve taste and odor.

5.1.3 Peninsula Reservoirs

5.1.3.1 Assessment

SFPUC's 23,000 acre Peninsula Watershed is located in San Mateo County. Although the Peninsula Watershed is located in a densely populated urban area, it supports many complex biological and ecological communities, serves as a State of California Fish and Game Refuge, and has earned recognition by UNESCO as an International Biosphere Reserve. SFPUC owns approximately 99 percent of Peninsula Watershed lands within the hydrologic boundary. A large degree of protection is afforded this watershed, helping to assure maintenance of a high quality drinking water supply.

The Peninsula Watershed has three reservoirs: Crystal Springs (Upper and Lower), San Andreas, and Pilarcitos. Water quality data indicates excellent quality that consistently meets regulatory standards.

5.1.3.2 On-going Activities

Although SFPUC owns nearly all of the land within the hydrologic boundary of the Peninsula Watershed, there are a few key parcels within the boundary that are privately owned

Because the Peninsula Watershed has not experienced a fire of any magnitude in over 100 years, the accumulation of fuels is of great concern. Since 1977, the Peninsula Watershed has been designated as a hazardous fire area by the State of California Department of Forestry. SFPUC takes many actions to protect the watershed from fire and manage the watershed fuels through the implementation of its Fire Management Plan. Portions of the Fire Management Plan, however, have yet to be implemented.

5.1.3.3 Potential Actions

Continue watershed protection efforts on local watersheds as outlined in watershed management plans and sanitary surveys, plus continuing to limit access to watersheds. Currently of critical importance is refining the nutrient management strategy to limit growth of algae that can produce algal toxins, odors and limit capacity of treatment facilities. Other major components related to the watershed protection plans include:

- SFPUC should implement the recommendations made in the *San Andreas Reservoir Shoreline Erosion Assessment.*

- It is essential that critical watershed lands be acquired to reduce water quality risk due to development and enhance the protective function of watershed lands.

- To reduce fire hazard, fuel management projects must be continued and expanded. The establishment and maintenance of fuel breaks on the Peninsula Watershed is particularly important.

- SFPUC should develop Memorandums of Understanding with the county agencies that have jurisdictional control over planning and developing

lands within the watersheds to manage growth. The lands should be zoned as watershed lands with specific policies and development procedures designed for water quality protection tied to the designation.

5.1.4 Alternative Water Sources

5.1.4.1 Assessment

Currently SFPUC has sufficient capacity with its Hetch Hetchy and local sources. However, SFPUC continues to refine its supply reliability strategy through exploration of various alternatives. These alternatives include enhanced conservation, recycling, conjunctive use and alternative sources (e.g., ground water, surface water, brackish and sea water desalination, etc.). There has been precedent to utilize transfers through the South Bay Aqueduct (i.e., State Project Water) during drought situation, although this has resulted in deteriorated treated water quality. Alternative water sources are likely to be of lower quality than current SFPUC water sources. This may include increased mineral content, salinity, manganese, DBP precursors, organics, and microbial contaminants.

5.1.4.2 On-going Activities

SFPUC is actively evaluating alternatives to shore up its supply reliability including enhanced conservation, recycling, conjunctive use and desalination. There has been precedent to utilize transfers from the Bay-Delta though this has resulted in deteriorated treated water quality.

5.1.4.3 Potential Actions

Continue to evaluate advanced treatment options[24] for bringing alternative supply sources to Hetch Hetchy quality. Also, assess vulnerability of these sources[25] and potential watershed protection actions. The use of alternative sources should not degrade quality of water to which the residents of San Francisco are accustomed.

All potential changes in source and treated water quality (including vulnerability to new contaminants) needs to be carefully evaluated. Potential for additional treatment processes at the Sunol Valley Water Treatment Plant may be indicated. Mixing of different waters in the distribution system also requires careful assessment.

5.2 Water Treatment

After source water protection, water treatment is the next barrier protecting against potential contamination. Treatment involves multiple techniques and technologies to remove or deactivate both chemical and microbial contaminants. SFPUC operating staff (Hetch Hetchy Water and Power, Water Supply and Treatment Division, Water Quality Division) maintains constant vigilance to provide treated drinking water that surpasses all federal and state drinking water regulations.

Both Sunol Valley and Harry Tracy Water Treatment Plants are certified by the USEPA/AWWA Partnership for Safe Water program. The purpose of the program is to encourage US water suppliers to survey their facilities, treatment processes, operating and maintenance procedures, operator training and management practices to identify areas that will enhance a water system's ability to minimize potential for contamination from *Cryptosporidium*, *Giardia* and other pathogens.

SFPUC has a history of evaluating new technologies through joint research efforts regionally and nationally, as well as particular evaluations on SFPUC facilities. These evaluations have included ozone, UV and membrane technology. Staff needs to continue tracking technology developments, particularly those that may be necessary for removing taste and odor compounds and newly recognized contaminants, and testing them in laboratory and pilot tests. This section addresses treatment for each of the three current water sources.

5.2.1 Hetch Hetchy Source

5.2.1.1 Assessment

Since the Hetch Hetchy source is well-protected (the first barrier to contamination) and of high quality it allows SFPUC to meet regulatory requirements with

[24] The SFPUC is currently considering a share of a 60 million gallon per day regional desalination project.

[25] An example of such considerations is the location of artificial turf at a playground 100 feet from a ground water source in the City's Sunset District. How significant is the risk associated with run-off? What protective measures should be considered?

minimal amounts of treatment. Treatment consists of three steps (additional barriers):

1. Corrosion control – Corrosion control through pH adjustment is necessary in the transmission and distribution systems to limit leaching of pipe materials and to protect pipelines and plumbing from pre-mature deterioration. Slaked lime (calcium hydroxide) is added at Rock River at a very low dose (i.e., 2 to 4 milligrams per liter) to increase the pH to 9.4.

2. Primary disinfection - Chlorine (sodium hypochlorite) is added for disinfection at Tesla Portal. The dosage is determined by chlorine demand and historical data but is typically in the order of 1.8 mg/L. The detention time of the Coast Range Tunnel is used to meet disinfection requirements for 99.9% *Giardia* inactivation and 99.99% *Virus* inactivation.

3. Secondary disinfection –The purpose of secondary disinfection is to provide disinfection residual to counteract any potential contamination inside the distribution system and prevent bacterial regrowth. In 2004, SFPUC switched to chloramine for secondary disinfection to limit disinfection by-products created through the use of chlorine. Chlorine is converted to chloramine by addition of ammonia at the Sunol Valley Chloramination Facility (SVCF).

5.2.1.2 On-going Activities

Within the next 5 years, SFPUC will further enhance disinfection by installing ultraviolet (UV) light (a regulatory mandate). UV light will be designed to provide *Cryptosporidium* inactivation prior to chlorination at Tesla Portal.

5.2.1.3 Potential Actions

Continue to monitor and report on technology developments. When appropriate, participate in regional or national research efforts. For promising technology, continue to conduct site-specific evaluations to determine effectiveness, secondary impacts and costs. Some examples for the Hetch Hetchy source include:

- The current design for the Tesla Treatment Facility is planned to allow for space and power to accommodate future ozonation. Ozonation would improve the color and UV transmittance of Hetch Hetchy water.

- Additional optimization of corrosion control may be possible to limit leaching of pipe materials and to protect pipelines and plumbing from pre-mature deterioration. Current plan is to increase pH at Rock River to 10.2 to protect the pipelines in Central Valley and lower pH with fluoride and carbon dioxide before UV disinfection.

- Addition of both chloramine and fluoride holds some concern for a subset of customers. There may be opportunity to further optimize chloramine.

5.2.2 Sunol Valley Water Treatment Plant

5.2.2.1 Assessment

Water from the Calaveras and San Antonio Reservoirs is treated at the Sunol Valley Water Treatment Plant before being conveyed into the SFPUC system. The SVWTP currently has a nominal capacity of 80 mgd and a peak capacity of 160 mgd. The process train includes chemical addition, coagulation, mechanical flocculation, sedimentation, dual-media filtration, and disinfection with sodium hypochlorite. Sodium hydroxide is added to filtered water at the plant clearwell to raise pH for corrosion control.

During drought conditions in 1990 and 1991, Delta water via the South Bay Aqueduct was sent to San Antonio Reservoir and then treated at the SVWTP. As a consequence, concentrations of disinfection by-products increased throughout the system. The SVWTP would require modifications to treat a blend of local and Delta water in the future.

5.2.2.2 On-going Activities

In the next 5 years, improvements will be made to the SVWTP to increase the “sustainable” treatment capacity to 160 mgd. Sustainable capacity, in this context, refers to the available capacity with the largest piece of equipment or treatment train out of service. The sustainable capacity is important so that system demands can be met when unfiltered Hetch

Hetchy water is not available. At times this means diversion of Hetch Hetchy water through the SVWTP since it would be too turbid to serve directly. The planned expansion will refurbish filters, provide a new chlorine contact tank and chemical feed equipment and a new treated water reservoir that will be chloraminated.

5.2.2.3 Potential Actions

Continue to monitor and report on technology developments. When indicated, participate in regional or national research efforts. For promising technology, continue to conduct site-specific evaluations to determine effectiveness, secondary impacts and costs. Some examples for SVWTP include:

- Both ozone and UV were examined as primary disinfectants in the Advanced Disinfection Workplan (July 2007). UV treatment post-clearwell is the recommended alternative. The SVWTP expansion is providing space after the new chlorine contact basin for future UV installation. However, installation of UV will not address taste and odor concerns and ozone may need to be revisited.
- Future improvements may be needed for drought reliability or to handle significant future decreases in source water quality.
- Impacts of source water measures (hypolimnetic oxygenation) on controlling tastes and odors are not yet known.

5.2.3 Harry Tracy Water Treatment Plant

5.2.3.1 Assessment

Water from the Crystal Springs, Pilarcitos, and San Andreas Reservoirs is treated at the HTWTP. California Department of Public Health Services (CDPH) has authorized the HTWTP to operate at filtration rates up to 8.0 gpm/sf when the raw water turbidity is less than or equal to 5.0 NTU and up to 6.0 gpm/sf when the raw water turbidity is greater than 5.0 NTU. But due to hydraulic limitations and treatment process deficiencies (e.g., short filter run cycles, ozone dose limits, reservoir discharge toxicity), SFPUC considers current sustainable HTWTP treatment capacity to be 120 mgd under most raw water quality conditions. Under challenging raw water quality conditions such as high turbidity and/or significant algal blooms in San Andreas Reservoir, the plant production is limited to approximately 90 mgd.

Under normal operations, the HTWTP provides pre-oxidation with ozone, coagulation with ferric chloride and coagulant aid polymer, flocculation through two baffled flocculation basins, filtration through ten dual-media filters, disinfection with sodium hypochlorite and chloramine, fluoridation with hydrofluosilicic acid, and corrosion control with sodium hydroxide.

5.2.3.2 On-going Activities

Modifications are planned for seismic retrofit and rehabilitation of the existing building and facility to provide long-term reliability and process improvements. The modifications will increase the sustained treatment capacity of the plant to 140 mgd for 60 days under normal water quality conditions (i.e., low algae and turbidity levels in source water). These improvements will include:

- Replacement and upgrade of the ozone generation system for primary disinfection
- Improvements to solids handling facilities
- New, redundant pipeline from the treatment plant to the finished water storage reservoir
- Raw water pump station improvements
- Upgrade and replacement of electrical and instrumentation components, including improvements to process and plant security facilities

5.2.3.3 Potential Actions

Continue to monitor and report on technology developments. When appropriate, participate in regional or national research efforts. For promising technology, continue to conduct site-specific evaluations to determine effectiveness, secondary impacts and costs. Some examples for HTWTP include:

- Optimizing nutrient removal through: a) improvements to the Pulgas Dechloramination Facility and b) control of phosphorus inputs.
- Developing a viable algaecide program.
- If algae management in source water is unsuccessful, additional treatment processes (i.e., clarification or oxidation) may be required to help control taste and odor.

5.3 Transmission and Distribution System

The distribution system is the next component of the multi-barrier water delivery to customers. Key measures include: positive water pressure, cross-connection control, and disinfectant residual (chloramine). Water quality may change after it leaves the treatment plant and travels through miles of pipe prior to customer use. These potential water quality changes in the distribution systems are being recognized and are of increasing research and regulatory interest in the industry. SFPUC has been evaluating how it can transport its water to better ensure "freshness" – a challenge given the significant storage of San Francisco's system maintained for emergency supplies during earthquakes and other potential disasters.

The San Francisco Water System (SFWS) serves the residents of San Francisco an average demand of approximately 80 million gallons a day. This water is transported through approximately 1200 miles of mains, of which 800 miles have a diameter of less than 12-inches and 72% are unlined cast-iron. The distribution system also contains over 400 million gallons of storage spread between 12 reservoirs and 8 tanks. This section addresses operations, asset management and changing role as a utility.

5.3.1 Operations

5.3.1.1 Assessment

SFPUC meets all regulations for water quality and system operations. This, in spite of the challenge presented by significant storage and its associated long detention times. Nitrification has been successfully limited thus far through a multi-faceted approach including: aggressive nitrification monitoring, a nitrification response plan, in-situ cleaning program, reservoir inlet-outlet design modifications, installation of mixers (twelve 2,500-10,000 gpm mixers installed), and operational changes as needed (e.g. seasonal drawdown, basins off-line).

Corrosion control has been achieved through pH adjustment and has resulted in compliance with regulatory limits for copper and lead.

Chloramine disinfectant is maintained through control of detention time and resulted in consistent chlorine residuals, lower bacterial counts, and lower DBPs[26].

5.3.1.2 On-going Activities

While there is currently no program within the WQD to monitor pressure in the distribution system; plans are in place to install gauges and telemetry within service areas. This will serve both a security benefit and will address some of the concerns being raised during EPA's discussion of revisions to the Total Coliform Rule.

Projects are currently in place to enhance reservoir mixing/turnover by separating inlets and outlets as well as optimizing mechanical mixer operation.

Some concern has been expressed over trade-offs between seismic strengthening and water quality – improvements may reduce mixing without additional mitigations.

SFPUC has an all-pipe model of the city distribution system used for static modeling purposes. A dynamic model for real-time simulations as well as a PipelineNet model to analyze possible contamination scenarios is currently under development.

SFPUC has cross connection control program and has a successful testing rate of over 17,000 devices each year. There was a successful testing rate of > 99% in 2006.

[26] 2007 AWWA Presentation on the Impact of Chloramine on San Francisco's Water Quality http://sfwater.org/detail.cfm/MC_ID/13/MSC_ID/166/MTO_ID/399/C_ID/3578

There is a three year cycle to clean large reservoirs and tasks. An in-situ dive team is available for cleaning so the reservoirs and tank can be left operational.

SFPUC's disinfection procedures in the "Manual of Procedures: Disinfection/ Dechlorination and Related Tasks" are followed for flushing, disinfection and return of facilities to service.

SFPUC is implementing capital improvements to add flexibility and seismic reliability to distribution facilities. Redundancies are soon to be placed to add operational flexibility.

5.3.1.3 Potential Actions

Every aspect of the distribution system needs to be studied so that a comprehensive, multi-dimensional risk assessment can be developed to drive the improvements in the system. This may be achieved by conducting a formal distribution system operations assessment using Hazard Analysis and Critical Control Point (HACCP), Distribution System Optimization Plans (DSOP) or AWWA standard G200-04.[27]

Operational evaluations, including dynamic modeling can be employed to evaluate optimal conveyance patterns to maintain water quality, minimize water age, while also evaluating competing demands such as energy efficiency of pumps, pumping schedules, reservoir mixing, and simplicity of operations.

Potential effects of climate change should be monitored for the distribution system. Potential effects include an increased finished water temperature leading to more disinfection by-products, nitrification, bacterial regrowth, and palatability issues.

Further optimization of quality via flushing program and tank operations should be considered.

A monitoring and operational procedures program could be developed for pressures and water usage within each service area along with contingency plans for alternative supplies.

Future groundwater development in the City will require operational evaluations for blended water quality, treatment, regulatory compliance, and customer impacts.

5.3.2 Asset Management

5.3.2.1 Assessment

Maintaining assets in top condition is a necessary requirement of water quality protection to ensure a fully operational system. Older pipelines are more prone to failure, can leach chemicals into the water and may promote more bacteriological growth along rougher surfaces. Currently, SFPUC does not have a comprehensive asset management plan.

5.3.2.2 On-going Activities

External inspections for vandalism, security, and water quality purposes (such as identifying missing vents, open hatches, and leaks) are performed weekly.

5.3.2.3 Potential Actions

The City has a complex network of aged mains. Prioritization for main repair and rehabilitation will be a challenge over the next few decades. Methods for such prioritization should be developed to guide main replacement and rehabilitation. Other design options to improve water quality in the distribution system such as removing dead ends and improving circulation should be considered. Active record keeping of, main breaks, (and operations that contribute to them) should be analyzed to inform priority-setting. Operational practices such as flushing, disinfection and other post-construction procedures should be assessed for their effectiveness in improving and/or preserving water quality.

Continue to optimize corrosion control, not only for public health concerns (e.g., lead release) but for other pipe materials. Preserving the pipe materials is a significant economic benefit. Additionally, the impacts of new lining and coating materials should be monitored for leaching potential.

[27] This would include addressing recommendations of the National Academy of Sciences on distribution systems and would consider indirect additives and coatings. See Appendix F.

5.3.3 Changing Role as Utility

5.3.3.1 Assessment

Historically and legally, water utilities generally do not address water quality protection beyond the water meter.[28] As such, even though problems with building plumbing systems can influence water quality, SFPUC has not included this aspect of water quality protection in its proactive efforts. SFPUC does, however, address water quality issues at a customer's tap when a complaint is logged.

5.3.3.2 On-going Activities

SFPUC has a program which provides low lead faucets to residents of San Francisco at a much reduced price. Lead enters the drinking water primary through leaching from lead solder joints and lead in brass faucet parts while water is left to sit in pipes overnight. Running the faucet to flush out old water can solve this problem; however, replacing faucets is another method to cut down lead exposure.

SFPUC has been active in promoting use of tap water, most recently encouraging restaurants to serve tap water and providing stainless steel water bottles to individuals signing a pledge to stop buying bottled water.

5.3.3.3 Potential Actions

Providing additional services that extend to the customer tap would mark a significant policy decision for SFPUC.[29] A number of challenges would be associated with implementation including: a) property rights and privacy concerns, b) defining base level of service, c) setting of and pricing for different levels of service (e.g., point of use treatment devices, tailored higher level treatment, sampling and inspection, etc.), d) social justice considerations e) the possibility of decentralizing a portion of treatment, and f) increased staffing needs.

It is recommended to explore deeper engagement with customers for water quality at the tap. In particular, determine: a) the degree to which there are changes in water quality as the water flows from the curb to the point of use in schools, major buildings, apartments and homes; b) if deemed significant, what options are available to mitigate these changes, c) potential roles for SFPUC and d) customer willingness-to-pay for such options.

Large buildings and especially hospitals and schools are a reasonable first step to evaluate. Office buildings can especially pose challenges since water left standing over the weekend may be compromised.

Educational materials on maintaining quality within buildings and homes should be developed.[30] Monitoring of point-of-use (POU) and point-of-entry (POE) device advances should be considered and reference material developed for provision to customers. In addition, consideration should be given to provision or subsidies for POU's for low-income residents and/or schools. An assessment of the potential demand for in-home plumbing services may also be beneficial.

[28] One exception is that the Federal Lead and Copper Rule, which requires water utilities to consider lead and copper concentrations beyond the water meter and all the way to water user's water fixtures and taps.

[29] There is precedent outside the United States for greater utility involvement with the UK charging utilities with responsibility at the tap for public buildings. More details on such programs are found in Appendix G.

[30] In Hong Kong, there is extensive educational outreach given the number of high-rise buildings and significant water quality issues (NAS, 2006).

6. Cross Cutting Issues

The full scope of water quality protection goes beyond the core components of watershed protection, treatment technology and distribution system operation. Related fields and concerns cut across and extend beyond these areas and are important for water quality protection.

6.1 Integrated Risk Management Framework

6.1.1 Assessment

As SFPUC proceeds into the future, concurrent with increased customer demand for quality, the increasing complexity of identifying, prioritizing and managing threats to water quality will require a more rigorous, systematic and sophisticated approach to efficiently manage risks to water quality.[31] There currently is no such formal framework.

6.1.2 On-going Activities

The WQD initiated the project, Strategic Planning for San Francisco's Water Quality Future, to identify key priorities areas facing SFPUC on a 20 to 30 year planning horizon.

6.1.3 Potential Actions

Development of an integrated risk management framework will aid in priority setting. The risk management approach should be both comprehensive and quantitative (e.g., identifying potential threats to water quality according to where they might be introduced into the system, the factors governing the anticipated magnitude of these threats, the control measures in place, factors influencing their effectiveness, potential risk mitigation alternatives). It is vital that such a framework be informed not only by water quality risks of a retrospective nature, but by anticipation of issues that may emerge in the future (e.g., due to introduction of new materials, due to climate change, due to new technologies).

Another implication of an integrated risk management approach is that water quality protection can no longer be the purview of a single division. As water quality is a core, stated goal of SFPUC, determine means and incentives towards more effectively harmonizing the work of various divisions to better achieve fundamental SFPUC objectives for water quality protection.

Complete *Strategic Planning for San Francisco's Water Quality* report and engage in recommended follow-up activities efforts to address future challenges impacting water quality (i.e. global warming).[32]

6.2 Monitoring, Data Analysis and Process Optimization

6.2.1 Assessment

SFPUC has advanced monitoring programs at its seven lab facilities which are operated by skilled chemists, biologists and laboratory specialists. State-of-the-art methods are used assuring regulatory compliance, detection of emerging contaminants, and providing customer support.

SFPUC remains connected to industry trends though collaborative projects with other agencies and research organizations (Table 6-1) as well as leadership through professional organizations.

6.2.2 On-going Activities

Over the last few decades, SFPUC has supplemented its routine monitoring with special studies to evaluate the potential presence of suspected contaminants. This

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[31] This is consonant with the SFPUC Sustainability Plan to "undertake a comprehensive identification and assessment of risks posed to the organization (such as operational/services, environmental, financial, license to operate, political, regulatory, reputational risks)." And "Develop tools and mechanisms to monitor, evaluate, address, minimize, mitigate, manage and control risks as appropriate."

[32] Some of these potential impacts include (ESA/Orion, 2007):
- Reductions in the average annual snowpack due to a rise in the snowline and a shallower snowpack in the low- and medium-elevation zones, such as in the Tuolumne River basin, and a shift in snowmelt runoff to earlier in the year
- Changes in the timing, intensity, and variability of precipitation, and an increased amount of precipitation falling as rain instead of as snow
- Long-term changes in watershed vegetation and increased incidence of wildfires that could affect water quality

Table 6.1: Recent and On-Going SFPUC Industry Involvement

Involvement Type	Research Organization	Project
Collaborative Research Projects	AWWA	Fundamentals and Control of Nitrification in Chloraminated Distributions Systems (2006)
		Internal Corrosion Control in Water Distribution Systems (2007 to 2009)
	AWWARF	Toxicological Relevance of EDCs and Pharmaceuticals in Drinking Water (2008)
	USEPA	Survey of iodo-DBPs (2006)
		Utility Workgroup for Emergency Response Tool Box
Professional Organization	American Water Works Association (AWWA)	Participation on Various Project Advisory Committees
		Journal AWWA Peer Review Editorial Board
		Water Utility Council Technical Advisory Group (2002-2005)
		AWWA DBP Technical Advisory Workgroup
		Water Quality Division Chair (2004-2007)
	American Water Works Association Research Foundation (AWWARF)	Participation on Various Project Advisory Committees
		Unsolicited Research Program Chair (2005-2008)
		Research Advisory Council, Efficient Customer and Responsive Organization Workgroup (2001-2007), Chair (2002, 2004)
	Association of California Water Agencies (ACWA) Safe Drinking Water Committee	Water Quality Committee Member (2002-2003)
		Safe Drinking Water Sub-Committee Member
	Association of Metropolitan Water Agencies (AMWA)	Regulatory Committee Member (2005+)
	California Water Works Standards Regulation Development	Utility Workgroup, Active Participant
	International Ultraviolet Association (IUVA)	Member
	International Water Association (IWA)	Member
	Water Environment Foundation (WEF)	Member
	Water Environment Research Foundation (WERF)	Member

has included *Legionella*, biodegradable organic matter, unregulated disinfection by-products and *Cryptosporidium*. While never entirely clear what exactly the presence or respective concentrations of these constituents meant from a public health perspective, these data have been useful for informing internal policy decisions. For example, monitoring for *Cryptosporidium* from 1988 to 1991 developed an occurrence database. When suggested that the potential presence of *Cryptosporidium* alone was a sufficient basis for deciding to invest $500M for a filtration plant, SFPUC convened County Health Officers from 4 Bay Area Counties, regulators, public health specialists and physicians at San Francisco General Hospital in 1992 to discuss the significance of *Cryptosporidium* in water. The outcome of that discussion was clear direction that other public health investments were merited, direction that informed the SFPUC stance on keeping Hetch Hetchy an unfiltered source.

More recently, SFPUC Laboratory has been developing molecular methods for the detection of microorganisms as part of contaminant monitoring. SFPUC WQD has just completed investigation and implementation of corrosion and DBP control at Moccasin Compound, which resulted in significant improvements in water quality for that system. WQD is currently investigating the fouling rate of UV lamps to be selected for the UV disinfection facility of Hetch Hetchy water at Tesla.

6.2.3 *Potential Actions*

While SFPUC's proactive stance on monitoring has borne fruit in the past, the question is in what form should it continue. Technological advances are enabling detection of extremely low concentrations of various constituents concurrent with significant ambiguity about their respective health effects.

It is recommended to clarify and revise the rationale for a monitoring framework for emerging contaminants.[33] This will consider the best available information on substances that are most likely to be in SFPUC source or treated water (and consider the level of public concerns) and the communications challenge presented by the ability to detect compounds far exceeding our understanding of the health significance of such detections.

Evaluate and utilize appropriate on-line water monitoring instruments that will give real-time information of chemical and biological contaminants in the water system (see Appendix H for the water security initiative monitoring program).

Algal toxin monitoring should occur during a full algae bloom. Algal toxin monitoring was performed in October 2007 and all results were below the current detection limits; however a large algal bloom was not present during the monitoring. Algal toxins are a class of potential emerging contaminants, produced by algae under specific conditions.

SFPUC faces challenges of increasing analytical workload due to emerging contaminants and increasing feasibility of detection (i.e.., algal toxins, low-level organics). SFPUC currently uses outside contract labs for non-routine analyses; the need for a new laboratory to more pro-actively respond to future testing challenges should be accessed.

[33] Contaminants that might be of concern were identified through several sources including EPA's CCL, EPA's UCMR2 and the European Union's efforts. The European Union list was created by the Network of Reference Laboratories for Monitoring of Emerging Environmental Pollutants (NORMAN Network). The NORMAN Network is a European Union project to improve the exchange of information and data for emerging contaminants as well as to validate and harmonize measurement methods (see Appendix I).

6.3 Emergency Planning

6.3.1 *Assessment*

Water quality can be threatened by either natural disasters or purposeful contamination. In such circumstances, SFPUC has a series of Disaster and Emergency Plans dating back decades (see Table 6-2). Per SFPUC policy, WQD has been assigned the responsibility to facilitate responses to potential water contamination events and other water quality emergencies. Three staff members from WQD are on-call at all times to respond to various types of emergencies: one from the Engineering Services Section for potential water quality regulatory violations and operational water quality problems and response to on-line contaminant warning system alarms; one from the Laboratory Section for emergency and after-hours testing; and one from Environmental Field Services Section for fires (cross-connection issue), consumer complaint response, and emergency sampling/field testing.

6.3.2 On-going Activities

Updates to the emergency operations plans and exercises of the current procedures are scheduled for completion through the EPA Water Security Initiative Grant.

6.3.3 *Potential Actions*

It is important to communicate to customers the levels of service SFPUC is prepared to offer for a variety of situations from unusual to catastrophic. If the public knows and agrees with what to expect under ranges of circumstances, they can plan accordingly. It is recommended to test emergency notices on unfamiliar staff to ensure understanding and clarity. The public needs to understand exactly what a 'boil water' notice means or what a 'do not use' notice involves. This will eliminate misunderstandings within real emergency situations.

Develop standard procedure and infrastructure for emergency calls to customers. A variety of standard notifications should be prepared for varying events. Alerting the public quickly of an event could be more

Table 6-2 SFPUC Emergency Operations Plans

Document	Revision Date	Area of Coverage
SFPUC Emergency Operations Plan (EOP)	September 2007	In a PUC or City-wide emergency, provides coordination, communication, & notification protocols among other City Departments, outside agencies and the PUC organization.
City Distribution Division (CDD) EOP	April 2002	Provides Distribution Division protocols on response, remediation/recovery, & notifications, in response to emergencies relating to City reservoirs, tanks, pump stations, mains, and other facilities
Water Supply & Treatment Division (WS&T) ERRP	April 2005	Provides WS&T Division protocols on response, remediation/recovery, & notifications, in response to emergencies relating to Regional water transmission system, water treatment plants, source reservoirs, and other facilities
Hetch Hetchy Water & Power Division (HHWP) EOP	April 2002	Provides HHWP Division protocols on response, remediation & recovery, & notifications, in response to emergencies relating to source water reservoirs & transmission system tunnels, pipelines, and other facilities
Water Contamination Response and Consequence Management Plan	October 2007	Provides response protocols in the coordination of the overall response in incidents relating to water quality; Field & Laboratory Emergency testing methods & procedures
Water Quality Notifications & Communications Plan	January 2006	Provides water quality target levels that require regulatory or other notification, contact information, public notification templates, & communication instructions for water quality emergencies
City Emergency Drinking Water Alternatives	February 2005	Provides an emergency drinking water plan to deliver drinking water for public health and safety following a major disaster
Cryptosporidium Detection Action Plan	March 2007	Provides response & action protocols in the event of a Cryptosporidium detection (daily monitoring in the SFPUC water system). Provides trigger levels for response
WQB Nitrification Response Plan	February 2008 (original 2003)	Provides water quality parameter triggers for specific actions to maintain water quality in the distribution system

critical to protecting health than restoring water quality quickly.

Regular exercise of procedures is essential to respond to unusual and emergency events efficiently. It may be beneficial to open the emergency operations center at lower levels to ensure protocol is exercised on a more regular basis. Table-top and on-ground exercises are also recommended to ensure everyone is familiar with procedures and to resolve potential bottlenecks. Timely communication is critical because it takes 24-hours for bacteriological analysis, and once results are available, response must proceed efficiently.

It is important to absorb important emergency activities into the routine so that an emergency event is just an extension of managing normal events. The same workers and the same tools will be utilized in an emergency as are utilized everyday.

Efficiency can be increased by eliminating redundant efforts and streamlining activities. SFPUC should facilitate clear interfaces across sectors through on-going exercises and discussions (i.e., Red Cross distributing chlorine tablets and bottled water).

6.4 Public Health Partnership

6.4.1 Assessment

The main purpose of delivering high quality drinking water is to protect public health. Aiding to advance this goal, SFPUC maintains a strong relationship with the San Francisco Department of Public Health (SFDPH). The partnership first evolved in the early 1980's with the establishment of a cross connection control program. This was one of the earliest formal activities that involved both the water utility and the health department. Subsequently after the 1989 Loma Prieta Earthquake, SFPUC and SFDPH collaborated to provide immediate support and response.

The SFPUC-SFDPH collaboration provides immediate support and response to events related to drinking water that raise health implications and concerns. This includes:

- coordinating surveillance in the event of water quality problems
- providing fact sheets or press releases in response to public concerns when water quality study results are reported in the media
- responding to media and consumer inquiries regarding water information related to SFPUC water quality
- providing health perspective on proposed regulations and legislative measures concerning water quality issues

6.4.2 On-going Activities

The San Francisco Bay Area Cryptosporidiosis Surveillance Project is coordinated by SFDPH in cooperation with SFPUC along with the California Emerging Infections Program and local health departments. This is an active surveillance program, using phone, email, and fax to obtain reports of confirmed cryptosporidiosis from clinical laboratories serving patients in five counties: San Francisco, Alameda, San Mateo, Santa Clara, and Tuolumne. In addition to the Cryptosporidiosis Surveillance Project, the SFDPH monitors incidence of infection of eight potentially waterborne microbes.

Through funds provided by the EPA Water Security Initiative the public health surveillance program is planned to be expanded with more initiatives aimed at building collaboration between regional water agencies and the public health community.

6.4.3 Potential Actions

More focus is needed on educating customers on risk assessment, uncertainties and prudent risk management. Too often customers perceive risk as binary, where any level of contaminant in the water is inappropriately considered bad. Dissemination of integrated risk management information to the customer base may reduce the burden of interpreting too much information. For example, 3rd party guidance on safer pregnancy can replace dozens of fact sheets on the effect of individual chemicals on pregnancy. As sensitive populations are identified, amendments may be made for these targeted subpopulations.

Public Communications about Emerging Contaminants in Drinking Water

PPCPs, and EDCs have been documented in some US waters for over 40 years. Ever lower concentrations of these contaminants will be detected due to advances in analytical technology. The impacts on the environment have been observed and must be addressed. The impacts on humans are unknown; however, concentrations in drinking waters are below Acceptable Daily Intake Levels.

The public has difficulty with the concept of relative concentrations. Instead, a “present/absent” litmus test is applied and adverse health effects are presumed if a compound is present. The issue will remain in the public consciousness.

PPCPs and EDCs can be oxidized with ozone, chlorine, UV advanced oxidation process, and even to some extent with chloramine. Activated carbon and nanofiltration membranes are also highly effective. Yet even the most effective treatment technologies available will not likely achieve “zero”.

It is critical to communicate effectively with the public. Make information relevant, keep it simple but do not sacrifice science, acknowledge the unknowns but do not withhold information (transparency). We cannot afford to lose public trust.

Quoted from: AWWA Webcast Program: Endocrine Disruptors, Pharmaceuticals and Personal Care products: Actions and Communications, May 7, 2008

A consistent and logical policy for addressing emerging contaminants is needed. A standard approach, which has been vetted externally and internally, will be helpful for SFPUC in engaging with

customers and regulators as new contaminants and potential health risks emerge.

One currently emerging contaminant of concern to SFPUC is mixtures of disinfection by-products (DBPs) which are increasingly understood to pose measurable health risks. Continued attention should be paid to nitrosamine formation in the distribution system.

6.5 Communication with Customers

6.5.1 Assessment

SFPUC surveys wholesale customers every two years. The survey is a joint effort by the Water Supply & Treatment Division and the Water Quality Division. The purpose of the surveys is to track performance, customer satisfaction and receive feedback on desired improvements. During the 2005/2006 survey, the average water quality rating was 4.3 with a 4 rating signifying “exceeds expectations”.

SFPUC also periodically surveys customers in the City of San Francisco who have called to register complaints or ask questions through the Customer Service Department. Questions typically center around the customer’s experience with the Customer Service Department; however an opportunity exists to include water quality perception questions on the surveys.

6.5.2 On-going Activities

The Water Quality Division can reach out to the community through inserts in bills that reach all rate payers bi-monthly and the Consumer Confidence Report on water quality is delivered annually. Staff attends fairs where blind taste tests of tap water are held at the SFPUC booth. Numerous community meetings are set up to inform the public of new projects or changes in operations. The SFPUC website is updated regularly and contains information on various chemical and microbial risk factors written in conjunction with SFDPH, cross connection control and backflow prevention, *Cryptosporidium* and *Giardia* monitoring, fluoridation, chloramines and lead information.

SFPUC utilizes a Citizens Advisory Committee (CAC) to provide recommendations regarding the agency's long-term strategic, financial and capital improvement plans. The committee members are appointed by the Mayor and Board of Supervisors. There are four smaller subcommittees, one dedicated to water, to explore specific issues in greater depth. Members of the subcommittee typically come from the larger CAC, although interested member of the general population may apply. The subcommittee meets once a month with the meetings open to the public and agenda and minutes posted to the SFPUC website. Specific water quality issues could be covered more regularly with the CAC to gage customer opinion.

A recent effort focused on customer communication centered on the conversion to chloramine. A group of San Mateo and San Francisco County residents expressed concerns about the amount of health information available; the decision to convert the system; perceived health effects such as skin rashes, inhalation issues and digestive disturbances; and other concerns obtained through Internet searches. Once these concerns were expressed, SFPUC met with and listened to the concerned individuals, consulted with the medical community, held public meetings, reviewed the literature, conducted tests, engaged water professionals, surveyed other utilities, compiled analyses and posted information to the SFPUC web-site. Nevertheless, many of the original concerns of these individuals seem unresolved. The information has not appeared to have allayed concerns that were based largely on erroneous information (e.g., lead corrosion and trichloramine formation).

6.5.3 Potential Actions

Improve the depth and frequency of communication with customers. Consider how to better leverage existing avenues (e.g., the Citizen’s Advisory Committee) along with conducting surveys utilizing state-of-the-art techniques to solicit feedback on satisfaction, desired services and willingness-to-pay for improvements. The intent is to engage a representative cross-section of customers to better inform SFPUC decisions.

Refine internal disclosure policy of new information. SFPUC is a large organization and many staff members interact with the citizens of San Francisco on a regular basis. It is essential that SFPUC staff who interface with the public know the current status of water quality initiatives. This increases the accuracy of

information provided to customers and increases transparency.

Move from anecdotal to more systematic assessment of customer needs and concerns through continued surveying efforts and response to concerns highlighted both from wholesale customers and retail consumers. Set numeric goals for number of water quality complaints per month.

Continue to update the SFPUC website with current information. Review semi-annually the websites of CDPH, USEPA, AWWA, AwwaRF, WHO, Australian National Health and Medical Research Council and summarize or provide links to relevant topics. Also monitor the websites of other major national utilities for relevant information.

7. Priority Recommendations

Out of the potential actions listed in the main body of the report, the most significant recommendations to better protect and improve San Francisco's drinking water quality as determined by the SFPUC-convened National Water Quality Advisory Council include:

1. Continue efforts to protect and retain its Sierra resources especially Hetch Hetchy Reservoir as SFPUC's primary drinking water source. This will include continuing with the excellent watershed protection program in cooperation and in some cases, partnership with the appropriate local, state and federal agencies to maintain its unfiltered status.

2. Continue watershed protection efforts on local watersheds as outlined in watershed management plans and sanitary surveys, plus continue to control access to watersheds. A more comprehensive source water management strategy is needed. A first step is the creation of a viable nutrient management strategy to limit growth of algae that can produce off-tastes and odors plus limit capacity of treatment facilities.

3. Continue to evaluate advanced treatment options for bringing alternative supply sources to Hetch Hetchy quality. Also, assess vulnerability of these sources[34] and potential watershed protection actions.

4. Continue to monitor and report on technology developments. As appropriate, participate in regional or national research efforts.[35] For promising technology, continue to conduct site-specific evaluations to determine effectiveness, secondary impacts and costs.

5. Every aspect of the distribution system needs to be studied so that a comprehensive, multi-dimensional risk assessment can be developed to understand which improvements to the system should have the highest priority for water quality protection. This can be achieved by conducting a formal distribution system assessment using Hazard Analysis and Critical Control Point (HACCP), Distribution System Optimization Plans (DSOP) or AWWA standard G200-04.[36]

6. Clarify and revise rationale for monitoring framework for emerging contaminants.[37] This will consider the best available information on substances that are most likely to be in SFPUC source or treated water (and consider the level of public concerns) and the challenge presented by the ability to detect compounds far exceeding our understanding of the health significance of such detections.

7. Evaluate and utilize appropriate on-line water monitoring instruments that will give real-time information of chemical, biological and radiological contaminants (currently planned under EPA Water Security Initiative grant).

8. Improve the depth and frequency of interaction, consultation and engagement with customers. Consider how to better leverage existing avenues (e.g., the Citizen's Advisory Committee) along with conducting surveys utilizing quantitative techniques (e.g., contingent valuation studies and other state-of-the-art methods) to solicit feedback on satisfaction, desired services and willingness-to-pay for improvements. The intent is to engage and inform a representative cross-section of customers to better guide SFPUC decisions.

9. Explore deeper engagement with customers on water quality at the tap. In particular, with customer involvement, determine: a) the degree of changes in water quality as the water flows from the meter to the tap in buildings; b) if changes are significant, what options are available to mitigate

[34] An example of such considerations is the location of artificial turf at a playground 100 feet from a ground water source in the City's Sunset District. How significant is the risk associated with run-off? What protective measures should be considered?

[35] SFPUC staff are currently involved in professional committees that address regulatory developments, advances in technology and management, emerging issues, etc. The panel encourages continued involvement.

[36] This would include addressing recommendations of the National Academy of Sciences on distribution systems and would consider indirect additives and coatings.

[37] Emerging contaminants of current interest include those listed on the EPA Contaminant Candidate List and the European Union NORMAN list.

these changes, c) potential roles for SFPUC and d) customer willingness-to-pay for such options.

10. In close contact with appropriate stakeholders, develop an integrated risk management framework to inform priority setting that is both comprehensive and quantitative (e.g., identifying potential threats to water quality according to where they might be introduced into the system, the factors governing the anticipated magnitude of these threats, the control measures in place, factors influencing their effectiveness, potential risk mitigation alternatives). It is vital that such a framework be informed not only by risks of a retrospective nature, but by anticipation of issues that may emerge (e.g., new pipe materials/tank coatings, climate change, new technologies, etc.).

11. As high water quality is one of stated goals of SFPUC, the Water Enterprise, through it Business Planning process, will integrate the fundamental objectives for water quality protection within its various divisions to better achieve this fundamental goal. Consistent with the Business Planning process and to highlight the importance of the water quality protection program and ensure accountability for implementation, the Water Quality Director should be tasked with reviewing and recommending all related capital and operational investments.

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SFPUC, 2004. "2004 Annual Report and Updates on Watershed Control Program and Sanitary Survey for the Hetch Hetchy Water Supply", 2004.

SFPUC, 2002. "Long Term Strategic Plan for Capital Improvements", May 2002.

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Slovic, Paul 1986. "Informing and Educating the Public About Risk". Risk Analysis, Volume 6 Issue 4, p403–415. December 1986.

WHO "HACCP - Introducing the Hazard Analysis and Critical Control Point System" http://www.who.int/foodsafety/fs_management/en/intro_haccp_annex.pdf

Links to More Information

SFPUC Sustainability Plan
http://sfwater.org/msc_main.cfm/MC_ID/18/MSC_ID/121

2008 Notice of Changes to Water System Improvement Program
http://sfwater.org/detail.cfm/MC_ID/13/MSC_ID/167/C_ID/3928/Keyword/Notice%20of%20Changes

USEPA Drinking Water Contaminants
http://www.epa.gov/safewater/contaminants/index.html

2006 Watershed Sanitary Survey Update for the Alameda and Peninsula Watersheds and the Sunol Filter Galleries
http://sfwater.org/detail.cfm/MC_ID/20/MSC_ID/177/MTO_ID/349/C_ID/3039

2001 Alameda Watershed Management Plan
http://sfwater.org/detail.cfm/MC_ID/20/MSC_ID/188/MTO_ID/372/C_ID/1686

2002 Peninsula Watershed Management Plan
http://sfwater.org/detail.cfm/MC_ID/20/MSC_ID/177/MTO_ID/349/C_ID/2162

2007 AWWA Presentation on the Impact of Chloramine on San Francisco's Water Quality
http://sfwater.org/detail.cfm/MC_ID/13/MSC_ID/166/MTO_ID/399/C_ID/3578

USEPA Drinking Water Contaminant Candidate List and Regulatory Determinations
http://www.epa.gov/safewater/ccl/index.html

USEPA Unregulated Contaminant Monitoring Program
http://www.epa.gov/safewater/ucmr/index.html

2007 SFPUC Public Health Goal (PHG) Report
http://sfwater.org/detail.cfm/MC_ID/13/MSC_ID/166/C_ID/3593/Keyword/public%20health%20goal

2006 SFPUC Water Quality Report
http://sfwater.org/detail.cfm/MC_ID/13/MSC_ID/166/MTO_ID/299/C_ID/3488

Appendix A
NWQAC Conference Call Summary

Appendix A
NWQAC Conference Call Summary

Prior to the conference call, the National Water Quality Advisory Council (NWQAC) was sent a draft version of the Water Quality Protection Plan and a draft power point presentation of key points for review. On April 18 from 7:30 to 9:00, a teleconference was held to discuss the following questions:

- How should we frame the protection plan?
- What should be our guiding principles?
- What issues are most important to raise in the plan?
- What issues are missing in our listing?

In attendance were:

<u>NWQAC Panelists</u>
- William Glaze, Ph.D
- Jeffrey Griffiths, M.D.
- Dave Hilmoe, P.E.
- Stephen Estes-Smargiassi
- Pankaj Parekh, Ph.D
- Bruce Macler, Ph.D
- Phillippe Daniel

<u>SFPUC Participants</u>
- Manouchehr Boozapour, P.E.
- Andrzej Wilczak, P.E.

Key points made included:

1. Overall the provided document for review was well written.
2. The message needs to be clarified. Suggested major points were:
    a. Public health is the paramount concern.
    b. Overall, San Francisco's water is exceptional.
    c. SFPUC is committed to assuring water of the highest quality possible.
    d. SFPUC is currently vigilant about issues that could challenge San Francisco in the future. This should be maintained and perhaps expended.
    e. Communication with customers/stakeholders is an area that will continue to grow. The nuanced nature of risk, the ability to detect contaminants but limited ability to interpret effects, and willingness-to-pay are all areas needing more public discussion.
    f. SFPUC's operating margin above regulatory requirements supports the City's precautionary principle.
3. A good executive summary is needed
4. Miscellaneous
    - There is a need to better weave in tap verse bottled water discussion, pharmaceuticals and guiding principles.
    - Risk needs to be better defined in the text.

- More calibration is necessary to ensure the document meets the public's and the Mayor's interest.
- More information is needed on the Mayor's intent/interest/goal with his request.
- Ensure stakeholders are being engaged with the document's development.
- Customer communication and outreach is a central point to further develop. SFPUC is doing a lot, but there is still more which can be done.
- A discussion of monitoring should be included as proof of 2C.
- A discussion of contingency planning should be included as part of 2D
- Shy away from overly detailed table 4-1 within the current document.
- Highlight partnerships within the document, particularly SFDPH and CDPH
- Avoid using the document as a list of things to be done.
- The panel sensed that there was a lot of material and more detail was not needed.
- An executive summary needs to be written for general public use.
- On-site residential plumbing issues should be highlighted, its impact on WQ and what SFPUC is doing (e.g. lead free faucets, lead free plumbing components) and what can be done.
- A discussion of chloramine should not be ignored.
- The basic message is San Francisco's water quality is good but we need to maintain good practices (continue watershed controls, etc).

Appendix B
NWQAC Workshop Agenda, List of Attendees and Slides

SFPUC
Water Quality Protection Plan
Meeting Agenda
April 28th, 2008
10:00 to 4:30
Millbrae, CA

This workshop convenes the National Water Quality Advisory Council to the SFPUC to elicit their direction and opinions into the formulation of a Water Quality Protection Plan mandated for completion by May 20, 2008 by Mayor Gavin Newsom. Interested parties have been invited both to observe and to provide feedback both to the Advisory Council and to the SFPUC.

1.	Objectives	10:00
2.	Introductions	10:05
3.	Charge to Advisory Council	10:15
4.	Related Efforts	10:20
5.	Approach to Water Quality Protection	10:30
6.	System Overview	10:45
7.	Component analysis	11:00
	a. Sources	
	b. Treatment	
	c. Distribution	
8.	Discussion	11:50
	Break	*12:20*
9.	Cross-cutting elements	12:40
	a. Monitoring	
	b. Customer Surveillance and Communications	
	c. Public Health Surveillance and Partnerships	
	d. Emergency Planning	
	e. Other	
10.	Discussion	1:35
11.	Additional elements	2:00
12.	Priorities	2:20
13.	Discussion	2:50
14.	Other	3:30
15.	Action Items	4:10

List of Attendees

Name	Affiliation
Pankaj Parekh	Los Angeles Dept of Water & Power
Jeffrey Griffiths	Tufts University School of Medicine
William Glaze	Consultant, University of North Carolina Chapel Hill
Dave Hilmoe	Seattle Public Utilities
Bruce Macler	USEPA
June Weintraub	San Francisco Dept. of Public Health
Stephen Estes-Smargiassi (via teleconference)	Massachusetts Water Resources Authority
Andrew DeGraca	SFPUC – Water Quality Division
Manoucher Boozarpour	SFPUC – Water Quality Division
Andrzej Wilczak	SFPUC – Water Quality Division
Mike Williams	SFPUC – Water Quality Division
Eddy So	SFPUC – Water Quality Division
Enio Sebastiani	SFPUC – Water Quality Division
Ken Payne	SFPUC – Water Quality Division
Alan Wong	SFPUC – Water Quality Division
Rod Miller	SFPUC – Water Quality Division
Paul Gambon	SFPUC – Water Supply and Treatment
Douglas Chun	Bay Area Water Supply and Conservation Agency – Alameda County Water District
Dan Heimel	Bay Area Water Supply and Conservation Agency – Redwood City
Ruth Gravanis	San Francisco Commission on the Environment
Phillippe Daniel	CDM
Jenny VanCalcar	CDM

Towards Development of a Water Quality Protection Plan: A Workshop

SFPUC
Water Quality Division
April 28, 2008

Mayor's Directive: *Produce a detailed and specific Water Quality Protection Plan*

Public Health Experts

Industry Water Quality Experts

Identify National Water Quality Advisory Council to the SFPUC

Leaders from Nationally Leading Utilities

Regulatory Expert

Futures Expert

Watersheds and Sources

Treatment

Document Current SFPUC Water Quality Protection Procedures and Recommendations for Future Action

Distribution System

Other Issues

Report to Commission and Mayor

Overview

1. Objective
2. Introductions
3. Charge
4. Related Efforts
5. System Overview
6. Approaches
7. Component Analysis
   - Source
   - Treatment
   - Distribution
8. Cross-cutting Issues
   - Monitoring
   - Public health
   - Emergency planning
   - Communications
   - Other
9. Other potential elements
10. Priorities
11. Discussion
12. Action items

Objectives

1. Present key elements for consideration in Water Quality Protection Plan
2. Receive input and direction from advisory panel
3. Surface issues not yet addressed
4. Obtain feedback from interested parties
5. Confirm direction for Water Quality Protection Plan

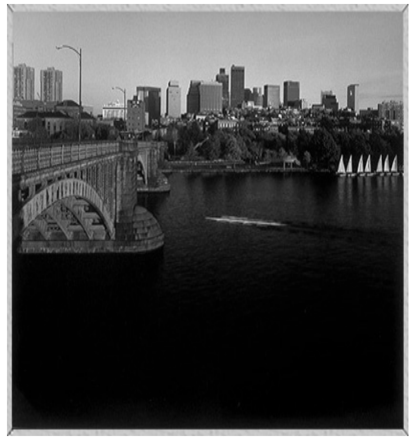
Introductions

National Water Quality Advisory Council to the SFPUC

Panelist	Affiliation	Expertise
Jeffrey Griffiths, M.D.	Associate Professor, Tufts University School of Medicine Member of EPA's Science Advisory Board	Epidemiology, sensitive sub-populations
William Glaze, Ph.D	Professor Emeritus, UNC-Chapel Hill Ex- Chair, EPA Science Advisory Board Ex-Dean of Research for the School of Science and Engineering at Oregon Health and Science University	Policy, Future Trends, Technology, Water Quality
Dave Hilmoe, P.E.	Drinking Water Director, Seattle Public Utilities (SPU)	Utility Operations, Water Quality
Stephen Estes-Smargiassi	Director of Planning, Massachusetts Water Resources Authority (MWRA)	Public Policy, Utility Operations, Water Quality
Pankaj Parekh, Ph.D	Director for Water Quality Compliance, Los Angeles Dept of Water & Power (LADWP)	Risk management, Water Quality, Utility Operations
Phillippe Daniel	Vice President, Camp Dresser & McKee Research Advisory Council, AWWA Research Foundation	Water Quality, Treatment, Risk, Strategic Planning
June Weintraub, D.Sc.	Epidemiologist, San Francisco Department of Public Health	Public Health
Bruce Macler, Ph.D.	USEPA Region 9	Regulations, Toxicology, Risk Assessment

Massachusetts Water Resources Authority

- Serves over 2 million people in greater Boston area: water and wastewater.
- Serve 61 cities and towns (50 water)
- Just completed $4B capital program to shore up water supply reliability
- 405 mgd – unfiltered
- Ozone treatment: adding post-UV



Investment: Resource Allocation Based on an Integrated View of Mission and System

- $180 M for watershed protection
- $680 M (and counting) for redundancy and reliability (major new tunnel complete, on-going additional work)
- $200 M to eliminate open distribution storage reservoirs
- $340 M for new centralized ozone treatment plant – 2 –log crypto target
- $25-$35 M per year for whole sale system pipe renewal
- $250 M in zero -interest loans to spur local distribution system rehabilitation

Massachusetts Water Resources Authority: Key Issues

- Redundancy and asset management
- Wholesale/retail water quality partnership
- Customer expectations given investments = rates ↑
- Demand reduction provides opportunity to consider new customers
- Environmental considerations for reservoir releases
- Changing role of robust regional supply given climate change

Seattle Public Utilities

SERVICE AREA

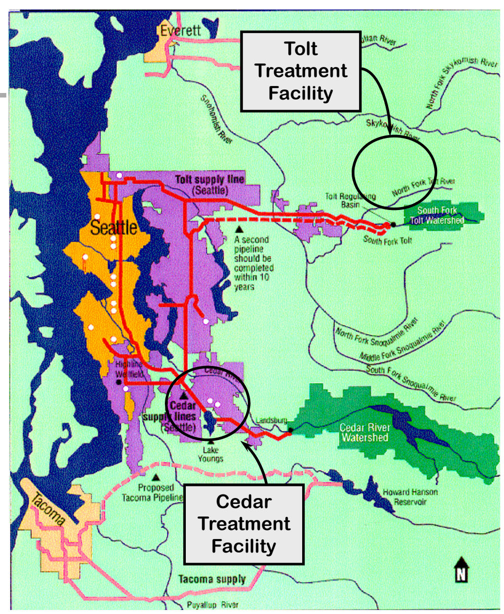
1.4 Million (50% Retail;
50% Wholesale)
Ave. Demand: ~140MGD

SOURCES

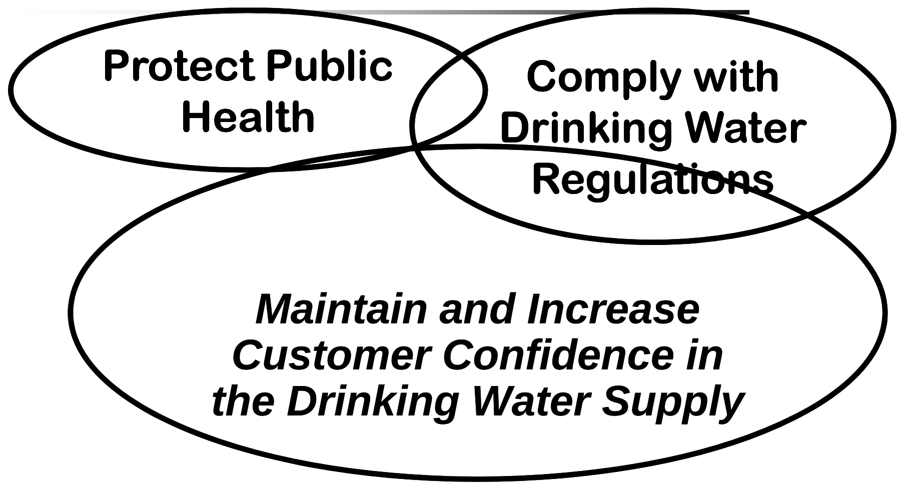
1. Cedar (180 MGD/60%)
90,000 acre watershed
Unfiltered/UV/ozonation

2. Tolt (120 MGD/40%)
14,000 acre watershed
Direct filt/ozonation

3. Seattle Wells (10 MGD/1%)



Water Quality Program Goals

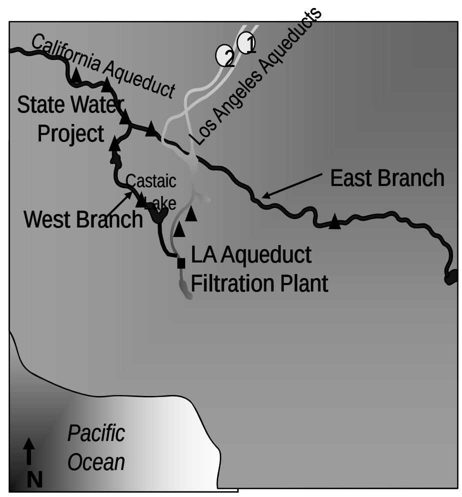


A Few Key SPU Drinking Water Program Priorities

- Asset management applied to capital – and soon – to O&M investments
- Water supply flexibility program – in general and in response to climate change
- Covering open distribution reservoirs
- Distribution system strategic planning – assets & water quality.
- Engaging our customers in service level setting.

Los Angeles Department of Water and Power

- Serve 3.9 million
- Sources
  - LA Aqueduct (48%)
  - MWD (41%)
    - State Project
    - Colorado River
  - Ground water (11%)
  - Recycled (1%)
- Capital program
- Risk
- Communications



Charge

- Mayor Newsom’s March 20, 2008 directive to the SFPUC was to:
  - Produce a detailed and specific Water Quality Protection Plan within 60 days
  - Convene a National Water Quality Advisory Council to provide input and direction

GOALS AND OBJECTIVES RELATED TO WATER AND CLEAN WATER – I
(City and County of San Francisco Charter)

The Commission shall develop, periodically update and implement programs to achieve goals and objectives consistent with the following:

(1) Provide water and clean water services to San Francisco and water service to its wholesale customers while maintaining stewardship of the system by the City;

(2) Establish equitable rates sufficient to meet and maintain operation, maintenance and financial health of the system;

(3) Provide reliable water and clean water services and optimize the systems' ability to withstand disasters;

(4) Protect and manage lands and natural resources used by the Commission to provide utility services consistent with applicable laws in an environ-mentally sustainable manner. Operate hydroelectric generation facilities in a manner that causes no reasonably anticipated adverse impacts on water service and habitat;

GOALS AND OBJECTIVES RELATED TO WATER AND CLEAN WATER – II
(City and County of San Francisco Charter)

(5) Develop and implement priority programs to increase and to monitor water conservation and efficiency system-wide;

(6) Utilize state-of-the-art innovative technologies where feasible and beneficial;

(7) Develop and implement a comprehensive set of environmental justice guidelines for use in connection with its operations and projects in the City;

(8) Create opportunities for meaningful community participation in development and implementation of the Commission's policies and programs; and

(9) Improve drinking water quality with a goal of exceeding applicable drinking water standards if feasible.

Related Efforts

- Water Supply Improvement Program
  - Seismic strengthening
  - Regulatory compliance
  - Supply reliability
- Sustainability Plan
  - Enterprise-wide
  - Some specific water quality related elements
- Strategic Planning for SF’s Water Quality Future
  - Scenarios that may influence future investments
  - Same panel serves in advisory capacity

Sustainability Plan Purpose – Extract I

The SFPUC’s Sustainability Plan will help the Department better manage its effects across the triple bottom line (financial, social and environmental) and become a model of a sustainable organization.

The purposes of the Sustainability Plan are to:

- Provide a roadmap, including transparent Department-wide goals and targets, for how the SFPUC will become a model of an environmentally, socially and financially sustainable organization
- Provide tools to strategically manage SFPUC’s current sustainability issues, and to build capacity in the organization to undertake future strategic planning and decision-making in a sustainable manner
- Institutionalize/Activate Department-wide and sustainable strategic planning and decision making
- Highlight performance and risks periodically and performance trends over time
- Establish communication with stakeholders in Department-wide performance review and renewal into the future.

Sustainability Plan – Proposed WQ Related Strategies – Extract II

- Build partnerships and agreements to incentivize water conservation, recycled water, and groundwater.
- Advance programs for recycled water, groundwater, desalination, stormwater and rainwater collection and/or other innovative technologies and practices to maintain and increase water supply.
- Develop as appropriate departmental, enterprise and division risk management tools.
- Develop and implement a Department-wide asset management plan that includes an overarching framework and standards, encompasses the asset management process of the individual enterprises, and is institutionally and operationally integrated with the Finance function.
- Roll-out the Emergency Operations Plan throughout the SFPUC.
- Optimize system maintenance and renewal performance through appropriate integration and alignment with the department-wide asset management plan.

Approaches to Water Quality Protection

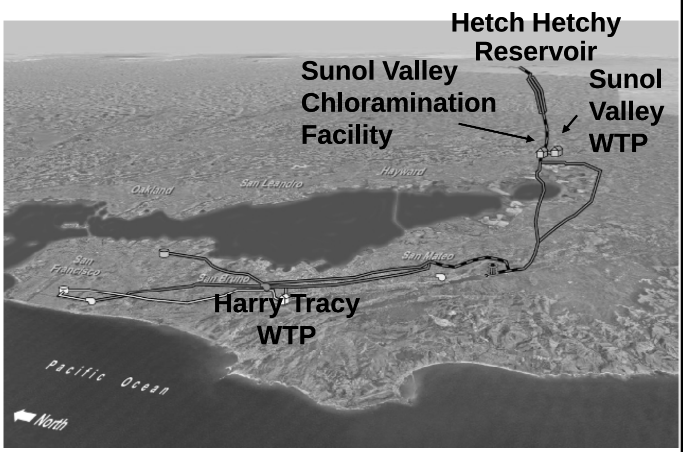
- Treatment technique
- Individual contaminant
- Systems analysis
- State-of-the-science monitoring going beyond regulatory compliance

Strawman of Guiding Principles for Water Quality Protection

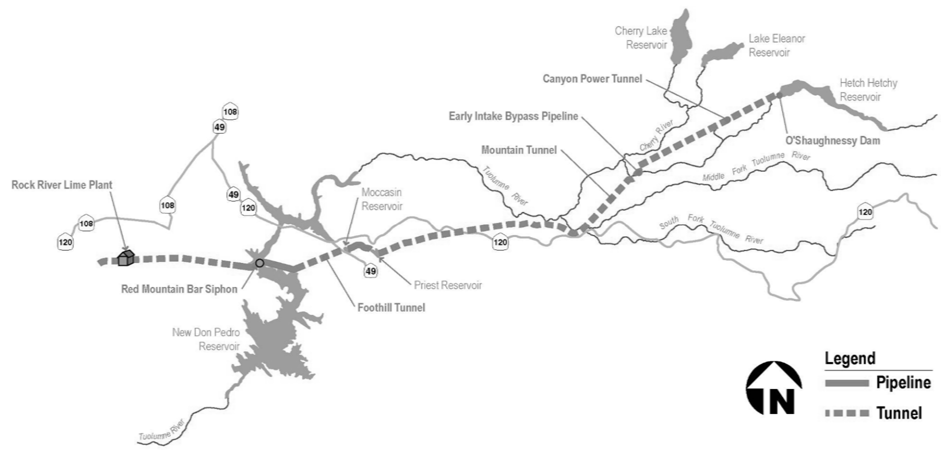
1. Consider the total context of risk – not just particular pieces but the total system from top to bottom.
2. Focus efforts on highest opportunities for risk reduction. (footnote: while recognizing precautionary approaches may be appropriate).
3. Keep an eye towards “upward compatibility” of improvements with potential future issues (e.g., can remove other contaminants currently not targeted).
4. Maintain highest source water quality possible
5. Recognize that the ability to measure very low levels of potential contaminants (and their interactions) exceeds our understanding of their risks (or potential benefits).
6. Embody transparency through consulting with public and other stakeholders to obtain guidance, establish internal standards and consider trade-offs:
   - Aesthetic
   - User-specific issues (e.g., industrial, high purity).
   - Emerging health issues
   - Sustainability
7. Provide timely (and proactive) responses to issues of potential concern

SFPUC System

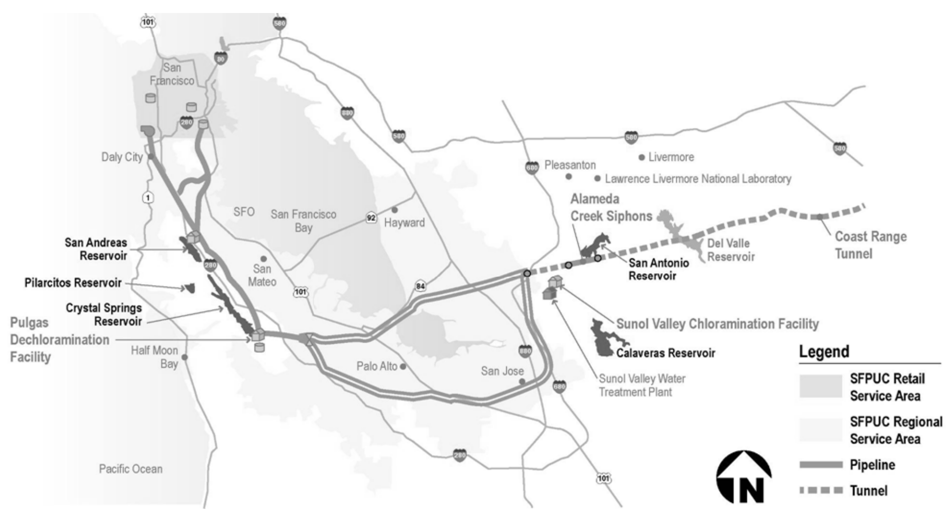
- Majority comes from Hetch Hetchy
- Gravity flow
- Conveyed through tunnels and large diameter pipelines
- Various treatment facilities
- SFPUC complies with all Federal and State water quality standards.



Source Water Protection – Upcountry



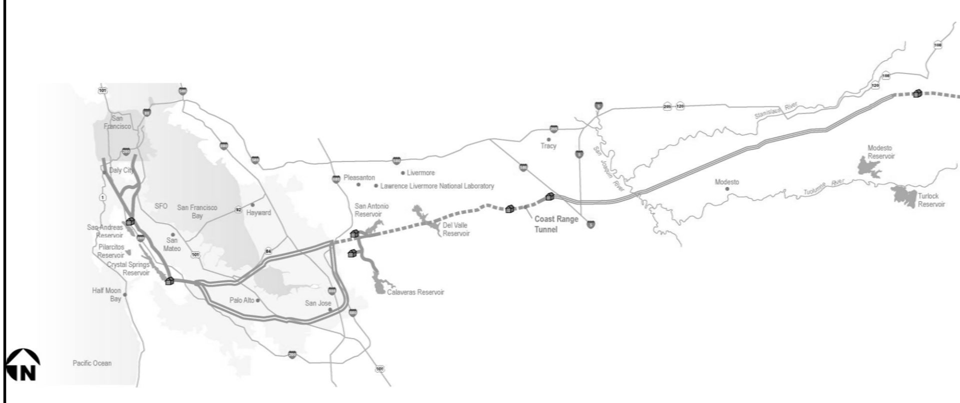
Source Water Protection – Local Watersheds



System Assessment – Sources Potential Options

1. Continue to shore up Hetch Hetchy rights
2. Address vulnerabilities at Priest and Moccasin Reservoirs
3. Maintain limited access.
4. Intensify nutrient control efforts at Crystal Springs and San Andreas Reservoirs
5. Step-up fire management efforts

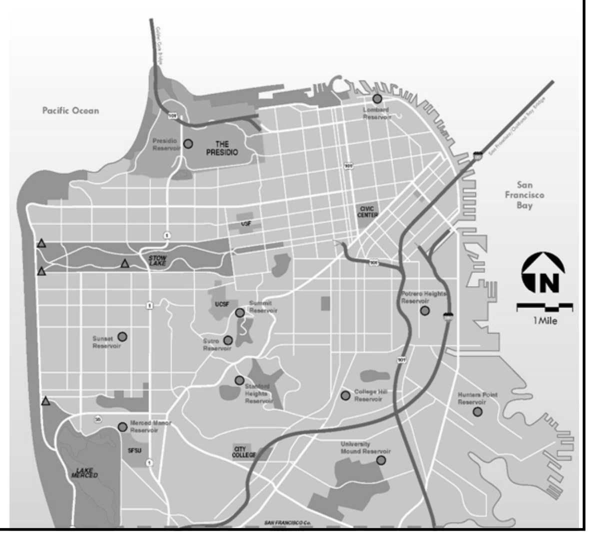
Treatment Facilities



System Assessment – Treatment Potential Options

1. Continue treatment investigations of promising technology through studies and leveraged research.
2. Evaluate improvements at Sunol for drought reliability (i.e., treating a blend of local sources with Delta water).
3. Develop plans for HTWTP improvements if source control measures not effective for algae.
4. Better assess risk of algal toxins for both local sources.

The Distribution System – To the Curb and Beyond



System Assessment – Distribution System Potential Options

1. Conduct a formal distribution system operations assessment using Hazard Analysis and Critical Control Point (HACCP), Distribution System Optimization Plans (DSOP) or AWWA standard G200-04.
2. Appropriate level of repair and replacement to not only ensure level of service but water quality.
3. Explore deeper involvement with customers in addressing water quality at their tap.
4. Assess risks of coatings.

Cross-Cutting Issues

- Water quality monitoring
- Public health surveillance
- Emergency planning
- Customer complaint tracking and communications
- Other

Water Quality Monitoring

- Sources
  - Routine
  - Periodic
  - Sanitary surveys
- Treatment
  - Routine
  - Special studies
- Distribution
  - Routine
  - Customer-initiated
  - Special studies

Water Quality Monitoring – I

- SFPUC labs fulfill four primary functions:
  1. Perform regulatory compliance analytical testing required under the Safe Drinking Water Act, the Clean Water Act, and associated permits;
  2. Provide real-time, in-house process control testing for associated water and wastewater operations;
  3. Oversee the Quality Assurance/Quality Control (QA/QC) Program for on-line water system instruments
  4. Provide 24/7 response to operational emergencies
- Seven lab facilities employing a professional staff of 66 chemists, biologists and laboratory specialists
- From July 1, 2006 to June 30, 2007, the integrated SFPUC Lab network analyzed over 59,750 samples and reported 223,174 individual analyte concentrations

Water Quality Monitoring – II

- Sampling Locations: In October 2005, the SFPUC completed a Comprehensive Water Quality Monitoring Plan for the Regional Water System. This document, in conjunction with the SFPUC's Water Quality Sampling Manual, outlines the water system sampling plan for the SFPUC. Fourteen strategically located sample points have been used to develop baseline data.
- Sampling Frequency: SFPUC system water quality is reviewed each week and is presented to other divisions at a weekly coordination meeting.
- Emergency Procedures: As water quality issues or triggers from on-line systems arise, SFPUC initiates investigative procedures to evaluate the water quality issue, assess its significance as a health risk, evaluate mitigation options and develop an implementation strategy.

Issues in Water Quality Monitoring

- History of being ahead of the curve on emerging concerns:
  - 1988 *Legionella* studies
  - 1989 *Cryptosporidium*
  - 1990 Disinfection by-product survey
  - 2006 Pharmaceutical survey
  - 2007 Algal Toxins
- Communications dilemma: Our ability to detect outpaces our ability to determine the health significance.

Public Health Surveillance

- Convening of County Health officers, regulators and medical professionals on Cryptosporidium prior to Milwaukee incident.
- Participation in Emerging Disease Surveillance with CDC and California Department of Public Health
- Partnership with SF Department of Public Health
- Cryptosporidium detection action plan
- Co-authored papers and fact sheets
- Joint communications with customers (e.g., chloramine)

Emergency Planning

- SFPUC-wide and individual divisions for fire, earthquake, etc.
- City Emergency Drinking Water Alternatives
- Water Quality Division special plan for intentional contamination threats.
- Drought planning

Customer Communication

- On-going efforts
  - Consumer Confidence Reports
  - Bill inserts
  - Web page features
  - Special education pieces
  - Surveys of BAWSCA (biannual)
- Forums
  - Customer Advisory Committee (monthly)
  - SFPUC-BAWSCA meetings (quarterly)
  - Attend BAWSCA water quality committee
- Complaint tracking

Customer Perceptions

- Value and cost of water
- Safety
- Other

Two Case Studies: Bisphenol-A and Pharmaceuticals

- What do we learn from each of these cases?

Bisphenol – A

- Used in creation of hard plastics and for epoxy coatings.
- Studied since 1930's
- Has been debated extensively over last 10 years
- Recent reporting has heightened concerns
- Exposure via polycarbonate plastic bottles and food containers
  - Canned foods appear to contribute greater levels of exposure than drinks
  - Concern is highest for pregnant women and infants

Bisphenol – A: Scientific Assessments – I

- **The National Toxicology Program (NTP) 2008 draft Program Brief used a five level scale:**

  1. **Serious Concern**
  2. **Concern**
  3. **Some Concern**
  4. **Minimal Concern**
  5. **Negligible Concern**

- **Concurs with the Expert Panel on Bisphenol A that there is *some concern* for neural and behavioral effects in fetuses, infants, and children at current human exposures. The NTP also has *some concern* for bisphenol A exposure in these populations based on effects in the prostate gland, mammary gland, and an earlier age for puberty in females.**

Bisphenol – A: Scientific Assessments – II

- **The NTP has *negligible concern* that exposure of pregnant women to bisphenol A will result in fetal or neonatal mortality, birth defects, or reduced birth weight and growth in their offspring.**
- **The NTP concurs that there is *negligible concern* that exposure to bisphenol A causes reproductive effects in non-occupationally exposed adults and *minimal concern* for workers exposed to higher levels in occupational settings.**

Bisphenol – A: Scientific Assessments – III

- **What is the bottom line? Can Bisphenol A affect human development or reproduction?**
- **Possibly.** Although there is no direct evidence that exposure of people to bisphenol A adversely affects reproduction or development, studies with laboratory rodents show that exposure to high dose levels of bisphenol A during pregnancy and/or lactation can reduce survival, birth weight, and growth of offspring early in life, and delay the onset of puberty in males and females. Recognizing the lack of data on the effects of bisphenol A in humans and despite the limitations in the evidence for "low" dose effects in laboratory animals, the possibility that bisphenol A may impact human development cannot be dismissed. More research is needed.

Pharmaceuticals in our water?

2006

- SFPUC participates in research project testing for 62 pharmaceuticals, personal care products and endocrine disruptors.

2008

- AP Story – March 10 "Probe Finds Drugs in Drinking Water"
  - Wide array of compounds found at low levels in US drinking waters
  - Sex hormone detected in San Francisco's "drinking water"
- Clarification Story – March 11 "*S.F.'s Tap Water Best in Tests, Chemists Say*"
  - *0 out of 62 tested chemicals found in SF drinking waters*
  - *2 out of 62 tested chemicals found at parts per trillion levels in the local reservoir source water (trace amounts subsequently removed by ozone treatment)*
  - *Principal Investigator concludes: "SF water is one of the most pristine drinking waters in terms of emerging contaminants" (and that was not looking at Hetch Hetchy water).*

Pharmaceuticals or something else in our water?

- On-line discussion @ www.sfgate.com
  - Over 120 comments on story.
  - Some respondents focused on deterioration of water quality in system plumbing:

yosemiteowb wrote:

- For all of you that claim your water still has a nasty taste to it, consider replacing the pipes in your house. Your own home is probably contaminating the water with corroded pipes. If you've ever been to Tuolumne Meadows, then you know how clean and pristine our water is.

budinsf wrote:

- SF water would be really great if we could get it directly from Hetch Hetchy and it didn't have to travel through pipes and if it wasn't contaminated by chloramine and flouride. I drink bottled water and not from Desani or other rebottled tap water. Those who criticize bottled water for being in plastic bottles don't say anything about fruit juice, milk or soda, which comes in plastic bottles. As for taste, that is a matter of opinion.

Communications: Chloramine and Fluoride

- Fluoride has long history of controversy.
- Chloramine has been more recently a controversy.
- Both debates involve risk trade-offs.

Other?

Additional Elements

Other Potential Recommendations – I

1. Further develop a comprehensive risk management tool to compare risks and allocate resources. This is consonant with the SFPUC Sustainability Plan
   - "undertake a comprehensive identification and assessment of risks posed to the organization (such as operational/services, environmental. Financial. License to operate, political, regulatory, reputational risks).
   - Develop tools and mechanisms to monitor, evaluate, address, minimize, mitigate, manage and control risks as appropriate."
2. Improve depth and frequency of communication with customers
   - Perform surveys to solicit feedback on satisfaction, desired services and willingness-to-pay for improvements.
   - Provide integrated advice drawing from public health, medical and water professionals as indicated.

Other Potential Recommendations – II

3. Open discussion on trade-off between environmental foot-print and margin of safety for regulatory compliance

Priorities

- Individual panelists
- Discussion amongst panel
- Differences amongst panel
- Queries from other participants
- Opinions expressed from other participants

Action Items

Appendix C
Strategic Planning for San Francisco's Water Quality Future Workshop Agendas and Summaries

Workshop #1 – SFPUC Water Quality Planning Horizon Considerations
SFPUC, 1000 El Camino Real, Millbrae, CA 94030, Large Conference Room
Wednesday August 29, 12:00-5:00PM - Thursday August 30, 8:00AM – 3:45PM, 2007

Duration: 1.5 days
Attendees: Open to all stakeholders

Objectives

1. Brainstorm water quality issues of importance to SFPUC and stakeholders likely to influence nature and extent of investments in 2030.
2. Group and prioritize issues.
3. Identify action items for finalizing the planning horizon.

Wednesday, August 29, 2007 12:00 - 5:00PM

1.	Introductions and Lunch (provided)	12:00 to 1:20
2.	Objectives a. Strategic Planning b. Workshop	1:20 to 1:35
3.	System Review a. Key features b. Strengths and weaknesses c. Planning baseline	1:35 to 1:55
4.	Regulatory Review	1:55 to 2:40
5.	Non-regulatory Drivers	2:40 to 3:30
6.	Observations from Other Utilities	3:30 to 4:20
7.	Process of Setting Priorities	4:20 to 4:45
8.	Actions for Tomorrow	4:45 to 5:00

Thursday, August 30, 2007 8:00AM - 3:45PM

1.	Introductions	8:00 to 8:20
2.	Review	8:20 to 8:35
3.	Comments	8:35 to 8:50
4.	Brainstorm Issues of Importance	8:50 to 11:20

Perspective #1: Source-Treatment-Distribution
– Strengths and vulnerabilities
– Alternate sources, Watershed management, Treatment technologies, Distribution system operations

Perspective #2: Proposed Regulations
- Current

- Proposed
- Other regulatory perspectives (e.g., EU, Project XL)

Perspective #3: Public Health Issues

– Community-based Public Health, DALYs, Sensitive populations, Risk Assessment
– Emerging contaminants

Perspective #4: Region Specific Issues

– Demographics (i.e. increased affluence, aging population), Priority on Reducing Greenhouse Gases, “Green Design,” Bottled water culture
– Drought and Seismic Risks

Perspective #5: Other Emerging Issues

5. Grouping of Horizon Issues 11:20 to 12:00

6. Lunch (provided) 12:00 to 12:45

7. Preliminary Ranking 12:45 to 2:45
   a. Consensus areas
   b. Divergences areas and rationale

8. Action Items 3:15 to 3:45

Workshop #1 Summary

To create a sound basis for capital and operational investments that may be required 20 years from now, the SFPUC is assessing what scenarios and concerns are likely to emerge, leading to consideration and analysis of potential alternatives that may be implemented circa 2030[1]. This workshop brought together various stakeholders, outside experts and representatives from other utilities to brainstorm possible future drivers and areas of concern. A complete list of attendees is appended.

Key Points

Core items of concern to SFPUC in the future were deemed to be similar to today:

1) *Maintain Supply Reliability:* Deliver potable water to customers 100% of the time.
2) *Provide High Water Quality:* At the minimum, deliver water meeting all required regulations.

The challenge in the future will be to mitigate externalities that may hinder the provision of the core components as well as to continue to advance beyond the minimum quality requirements. A summary of the workshop within general categories is provided in this document. Areas of discussion included:

- Role as a Utility
- Public Health and Emerging Contaminants
- Technological Advances
- Regulations
- Communication with Customers
- Distribution System
- Quantity
- Climate Change
- Sustainability
- Catastrophic Events
- Wholesale Customers

Role as a Utility

<u>*Situation*</u>

Historically, service to the meter at the curb has been the legal mandate, and with the exception of requirements associated with the Lead and Copper Rule, the extent to which services have been provided.[2]

<u>*Trends*</u>

Given concerns over water quality and the significant role of household plumbing, full service to the customer tap may be an appropriate service to offer. This is a plausible position since it is the tap water for which customers invariably hold SFPUC accountable. Currently, some private water utilities are offering in-home services. In addition, phone service providers will offer in-house wiring services. Water utilities may get involved in providing and managing point of use devices (POUDs) at customer taps. Currently, 50% of customers in Los Angeles use POUDs of some form.[3]

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1 It was suggested that a 30-year planning horizon might be more appropriate.
2 The SFPUC has also provided lead-free faucets and low-flush toilets, which move beyond the curb.
3 Per Pankaj Parehk, Los Angeles Department of Water and Power

Implications
Providing full service to the tap would mark a significant policy decision for the SFPUC. A number of challenges would be associated with implementation including: a) property rights and privacy concerns, b) defining base level of service, c) setting of and pricing for different levels of service (e.g., point of use treatment devices, tailored higher level treatment, sampling and inspection, etc.), d) social justice considerations, and e) decentralize a portion of treatment.

The basic message is that the methods and options of service delivery as well as service goals should be revisited.

Public Health and Emerging Contaminants

Situation
Protecting public health is foundational to the genesis of water treatment. It forms one part of the SFPUC's mission statement and collaboration with the public health community has been an on-going SFPUC priority.

Trends
The dilemma is that while protecting public health is the end goal, significant uncertainty exists about the significance of drinking water in context with other public health issues. Environmental threats in the past have been mostly (if not all) surprises. Research is being conducted in potential problem areas (e.g., endocrine disruptors, pharmaceuticals, etc.). Surprises, however, will almost certainly occur in unforeseen areas.

The current diseases affecting the population of San Francisco based upon disease adjusted life years (DALYs) and morbidity were highlighted. Currently, heart disease, depression, and HIV/AIDS, diabetes and asthma had the largest known effects; however, this is likely to change within the planning horizon. HIV/AIDS would not have been on the list 30 years ago, so there will likely be changes in the next 30 years with some diseases playing a less prominent role and emerging diseases increasing in significance. Emerging diseases may be transmitted through drinking water or lead to susceptibility within the population to constituents we currently consider safe. The role water will play in the transmission of emerging diseases is unknown. Nor is it fully clear what contribution water makes to various current diseases (e.g., various cancers, MS, Lou Gerig's, etc.)

Increasing characterization and knowledge of individual health susceptibilities will lead consumers to tailor their lifestyle choices (e.g., environment, diet, water source, etc.) to their individual genetic susceptibilities.

Implications
Determining the priorities and what concerns need to be addressed centrally and which issues should be managed individually is a policy conundrum. Certain individuals may have reactions to provided tap water but there may be a limit of the degree to which a population sub-group should influence policy choices. More options and communication may be needed for appropriate risk management options for consumers having specific concerns.

Technological Advances

Situation
Regulations are formulated, in part, on the availability and cost-effectiveness of technology. The SFPUC is currently in the process of modifying its disinfection practices and optimizing its surface water treatment facilities. SFPUC will be installing UV disinfection on the Hetch Hetchy supply designed for 3-log *Cryptosporidium* inactivation and conservative UV-transmittance. Point-of-use options have not been a major consideration, although SFPUC began to install water dispensers at some of its facilities for CT compliance as well as taste and odor concerns for employees. Some consideration is being given to membrane treatment for drought year supply reliability.

Trends/Implications
It is certain that technological advances will strongly affect the water industry over the 30-year planning horizon – the exact nature of that change is unclear.

- Rapid revolution of membrane/nanofiltration technology could revolutionize desalination efforts by lowering energy input requirements to filter the water (e.g., desalination membranes at 50% lower cost). Membrane technology could be significant for providing a robust multi-barrier treatment. Advances could also lead to the ability to selectively remove particular constituents within the water (e.g., removal of lead).

- Improvements in remote sensing, wireless devices and data management will increase real-time information concerning water quality. New methods for data analysis and storage will need to be implemented to utilize the increase in data. More effort should be dedicated to data reduction, evaluation and follow-up action.

- Development of highly specific analytical methods and lowering of detection limits will increase knowledge of the microbes and chemical compounds within the water, raising unknown concerns.

- Advances in genetics will increase people's knowledge of their individual susceptibilities. This may lead to the desire for tailored point of use water treatment devices.

Regulations

Situation
Regulations have been the strongest driver for SFPUC's current water quality investments with disinfection and disinfection by-products accounting for most of the current and planned investments.

Trends
Distribution-related improvements are likely to be the most significant upcoming regulatory driver with anticipated revisions to the Total Coliform Rule expected to increase monitoring, intensify operations and stimulate some capital improvements in the distribution system.

NDMA has a reasonable chance of becoming regulated within the next 20 years but levels within the SFPUC service area tend to be below detection limits. USEPA 6-year reviews of additional rules, other than TCR, should not impact SFPUC.

Implications
SFPUC will need to continue to meet regulations but moving beyond what is regulated is seen as the larger goal. However, treatment beyond regulations may result in secondary consequences (e.g., increased disinfection with ozonation leading to increased energy consumption and potential higher concentrations of bromate).

Communication with Customers

Situation
The SFPUC has communicated formally with customers through mailings, public meetings and advisory groups. In addition, web-based fact sheets and other information have regularly been provided on issues of interest on the SFPUC website.

The dramatic increase in bottled water usage and point-of-use treatment devices over the last 20 years underscores public preferences for alternatives to their tap water. Yet it is not clear what response from the SFPUC, if any, is appropriate.

Risk communication to the customers is hampered by the tendency of water agencies to say water is "safe", making it difficult to address issues of increasing safety or talking candidly about drinking water concerns. Generally, the public wants zero risk in water but accepts large risks in other consumed items considered optional (e.g., cigarettes, alcohol, cholesterol).

Customers have an inherent mistrust of government agencies including the water utility and instead look towards community, religious and other special interest groups along with trusted media outlets as reliable sources of information.

Trends
Use of survey tools including focus groups and willingness-to-pay studies will increase as utilities seek to determine customer's desire for greater quality and higher levels of service.

The population is becoming increasingly elderly, increasingly educated and has increased access to information. This demographic change in the customer base will impact communication needs and services required.

Implications
The SFPUC should consider convening focus groups to gain an understanding of the customer's point of view, reasoning for seeking alternative drinking water sources and gage willingness to pay[4].

SFPUC should work with community groups to build trust with consumers. Communication to consumers should not focus solely on risk communication but also on benefits the public gains from a consistent source of high quality tap water.

Distribution System

Situation
As the pipes in the distribution system age (i.e., many nearing 100-years) potential for breaks and water quality deterioration will increase. Premise plumbing is a key concern for cross connections and other potential contamination (e.g., rooftop tanks). Generally, the distribution system has been overlooked in water quality planning and is now becoming a focus for public water systems. Water loss and firefighting in San Francisco is about 7% of total water demand.

Trends
Distribution-related improvements are likely to be the most significant upcoming regulatory driver with increased monitoring and different management strategies within the distribution system expected.

New construction is required to provide dual piping to allow for the use of recycled water except within residential units.

Implications
Accurate assessment of the weaknesses and the opportunities for improving distribution water quality will be essential for the SFPUC as it seeks to ensure that it has the greatest regulatory flexibility to cost-efficiently manage water quality.

[4] Note that SFPUC staff observation of such processes is vital to interpretation of results.

Quantity

Situation
The current water demand is 265 mgd for retail and wholesale customers. To prepare for dry weather conditions, SFPUC utilizes a design drought comprised of two years of extreme drought followed by six years of less severe dry weather. The upstream reservoirs are kept at 85% to 90% capacity to ensure water supply for these conditions. Staff feels comfortable that the current operations could handle the design drought and that the design drought is a conservative scenario. SFPUC does not tap directly into Delta water but has imported Delta water into San Antonio Reservoir in 1991 plus has interties that can supply treated Delta water in emergency situations.

Trends
Demand projections for retail users over the next 25 years show water use staying flat in San Francisco, while the demand from wholesale customers will increase 19%.

There is currently no recycled water use in San Francisco buildings. Ground water is utilized for irrigation at Golden Gate Park and the Zoo. Utilizing recycled water instead would free 4 mgd of groundwater for potable uses. Golden Gate Park and golf courses are already dual plumbed but other areas will require improvements.

Local activist groups have been campaigning for the removal of Hetch Hetchy reservoir. The likelihood of eliminating the reservoir appears very low since significant storage capacity upgrades elsewhere would be necessary if it was dismantled.

Implications
Desalination is currently being considered as an additional dry weather supply option. SFPUC is considering a share of 20-30 mgd of a 60 mgd plant. The location of the plant is still being considered. Aiding wholesale customers in developing alternative supplies to counteract increasing demand is also an option through subsidization. With all alternative supplies considered, the issue of non-degradation in the eyes of the customers was highlighted as a major issue.

Climate Change

Situation
Consensus is that changing climate will affect water resources throughout California. The nature and extent, however, is unclear.

Trend
Climate change is predicted to raise the snowline in the Sierra's from the current elevation of 6000 feet to 7500-8000 feet. This will decrease the percentage of the basin covered with snow from 87% to around 70%. However, water supply on average is projected to remain about the same.

Implications
More open ground will mean greater effects from violent storms, with a larger flush of rainfall and increased turbidity within SFPUC supply reservoirs. The spillway has capacity to handle the largest storms predicted but there is currently not capacity to treat increased turbidity within the reservoirs. A turbidity of 2.0 NTU is generally the trigger for a pump away or additional treatment for upcountry sources. These turbidity spikes, although significant for SFPUC, are not considered high by industry standards and likely will not result in increased pathogen load. The current capital improvement program is increasing capacity of both filter plants to 300 MGD for treating normal water quality but additional treatment capacity for treating adverse raw water quality remains a long-term treatment option. A unit process and overall treatment capacity evaluation is needed for various source water degradation scenarios.

Sustainability

Situation
Having a sustainable system will mean balancing the triple bottom line of economics, the environment and society.

Trends
Recently the SFPUC launched a $4.3 billion Water System Improvement Program to address seismic integrity, aging infrastructure and capacity.

Environmental concerns such as energy conservation, reduction of green house gas emissions, the complete lifecycles of chemicals and construction practices are of increasing importance.

Power costs are likely to increase in the future; however, power costs of water delivery are very small at SFPUC because the Hetch Hetchy system is gravity based. Elsewhere 20% of cost is spent on electricity to pump water.

Implications
Methods of economic support should be developed for the future so that multi-billion dollar bond measures will not be needed.

Alternatives analyzed should include methods to incorporate energy conservation, decreasing greenhouse gas emissions and look at life-cycle analyses. Methods for water conservation such as promoting the installation of low flow toilets and use of drought resistant landscaping should also be considered.

Catastrophic Event

Situation
Change can occur through a slow evolution process or through larger discontinuities. It is the discontinuities which are hard to plan for but which may require analysis if there is a significant probability of occurrence.

The SFPUC has much more storage (7-30 days) than a typical system due to past earthquakes.

Trends
There is a 60% chance of an earthquake in the 6.9 range occurring in the Bay Area over the next 30 years, with the chance of occurrence within San Francisco of 15-40%. Tesla Portal, Sunol Valley Water Treatment Plant and Harry Tracy Water Treatment Plant are all located near seismic fault lines. There is no seismic risk for the Hetch Hetchy supply; however, pipelines cross several seismic faults. Currently seismic upgrades are occurring throughout the transmission system to decrease the risk of water service interruption.

Implications
Single points of failure identified in the vulnerability and reliability studies should be addressed so that accidents or terrorist acts cannot threaten the entire system.

If an event does occur, the public perception will likely dramatically shift. More personal control and direct assurance of water quality may be desired.

Wholesale Customers

Situation
SFPUC's wholesale customers receive two-thirds of the water demand. Water rates are below average as compared with other California and nationwide utilities. However, the public is sensitive to increases.

Trend/Implication
Wholesale customers will expect accountability from SFPUC for stewarding resources and also requested a larger voice in future decisions. Willingness to pay must be evaluated

Next Steps

The difficulty of looking at the 20 (or 30) year planning horizon is how to move forward in the face of uncertainty. By looking at the probability of events taking place and the consequences if scenarios do occur, priorities will begin to emerge. During the strategic planning process, priority areas will be further investigated and recommendations for monitoring, research and outreach efforts will be developed. Immediately moving forward from the workshop, the following will take place:

- Prioritization of future events based on the probability of occurrence and the consequences if scenarios do occur.
- Concurrence with the Technical Advisory Committee and SFPUC on priority issues.
- Analysis of options to address priority issues of concern.
- Discussion of findings at Workshop #2.

List of Attendees

Name	Affiliation
Andrew DeGraca	SFPUC – Water Quality Bureau
Manoucher Boozarpour	SFPUC – Water Quality Bureau
Andrzej Wilczak	SFPUC – Water Quality Bureau
Mike Casteel	SFPUC – Water Quality Bureau
Mike Williams	SFPUC – Water Quality Bureau
Eddy So	SFPUC – Water Quality Bureau
Enio Sebastiani	SFPUC – Water Quality Bureau
Paul Gambon	SFPUC – Water Supply and Treatment
Ellen Levin	SFPUC – Water Resources
Bruce McGuirk	Hetch Hetchy Water & Power
Pankaj Parekh	Los Angeles Dept of Water & Power
Jeffrey Griffiths	Tufts University School of Medicine
William Glaze	Consultant
Tracy Ingebrigtsen	Stanford University Utilities
Douglas Chun	Alameda County Water District
Jennifer Clary	Clean Water Action
Bruce Macler	USEPA
Catherine Ma	California Dept. of Public Health
Vlad Rakhamimov	California Dept. of Public Health
Dean Petersen	San Mateo County of Public Health
June Weintraub	San Francisco Dept. of Public Health
Phillippe Daniel	CDM
Jenny VanCalcar	CDM

Workshop #2 –Alternatives Analysis

Thursday November 29, 2007

8:30 am to 4:30 pm
Attendees: Open to all stakeholders

1. Introductions
2. Workshop Objectives
3. Near-Term Issues being addressed by the Water Quality Division
4. Review of Issues from Workshop #1
5. Panel Comments & General Discussion of Issue Areas
6. Detailed Discussion of Issue Areas
    a. Regulations
    b. Quantity
    c. Technological Advances
    d. Public Health and Emerging Contaminants
        i. Setting Priorities for Monitoring and Evaluation
        ii. Los Angeles and Experience with Labor Issues
    e. WQ Management Approach
        i. Risk Analysis – Cancer and non-cancer health endpoints
        ii. Sensitivity Analysis
    f. Catastrophic Events
    g. Communication with Customers
        i. Los Angeles Experience
        ii. Boston Experience
        iii. Seattle Public Utility Experience
    h. Utility Role Continuing to Move to Customer Tap
    i. Sustainability
    j. Climate Change
7. Cross-cutting Issues
8. Action Items

Workshop #2 Summary

To create a sound basis for capital and operational investments that may be required 20 years from now, the SFPUC is assessing what scenarios and concerns are likely to emerge in the future, leading to consideration and analysis of potential alternatives that may be implemented circa 2030[5]. This workshop brought together various stakeholders and representatives from other utilities to discuss the ten priority areas identified in Workshop #1 and brainstorm potential actions necessary to be better positioned to respond to emerging challenges.

This summary is organized according to:

- Project objectives
- Review of Workshop #1
- Workshop Agenda #2
    - Overarching Issues
    - Discussion of Priority Areas and Potential Actions
    - Synthesis of Priority Areas
- Next Steps

A complete list of workshop attendees is appended.

Project Objectives

The principal outcome of this strategic planning effort is to develop the research-study program necessary of the SFPUC Water Quality Bureau (WQB) to be responsive to emerging issues. This will entail indications on scope and budget for the priority actions that will be selected to be carried forward.

Review of Workshop #1

The first workshop held August 29th and 30th, 2007 brought together members of the technical advisory committee: Dr. William Glaze, Professor Emeritus, UNC Chapel Hill; Dr. Jeffrey Griffiths, Tufts University School of Medicine; Dr. Pankaj Parekh, Los Angeles Department of Water and Power along with stakeholders from SFPUC, wholesale customers, USEPA, California Department of Public Health (DPH), public health professionals, and representatives of citizens groups. The purpose of the workshop was to brainstorm drivers and areas of concern on the 20 to 30 year planning horizon. The result of the workshop was ten priority areas of future concern, which are highlighted in the following section.

Workshop Agenda #2

The priority areas developed in Workshop #1 were discussed and expanded during Workshop #2 deliberations. For each area the key discussion question, main points raised and potential action items are described.

Overarching Issues

Discussion by the Panel prior to workshop underscored the question as to how this effort will move from simply being an exercise and a document on a shelf to a strategy that guides future actions.

[5] It was suggested that a 30-year planning horizon might be more appropriate.

In addition, guiding thoughts were provided:

- Look beyond current planning horizons, so that mid-term decisions do not foreclose future options. The projects and policies implemented now should benefit and not hinder those who will follow at the SFPUC 20 and even 50 years from now.
- When planning for the future, political leadership, utility leadership, regulatory leadership and customers should be included in the process; the future of water supply and services needs to match trends in customer expectations.
- When embarking on a new project, consider what support or experience could be provided by other city departments. Interdepartmental coordination may yield surprising efficiencies and partnerships to deliver high quality water.
- As technology for detection improves, it is important to have a consistent approach to evaluating and prioritizing actions for the contaminants that will emerge.

Discussion of Priority Issues and Potential Actions

The following discussion is organized according to the ten priority areas. The lists of potential action items are those discussed at the workshop. Further potential actions will be developed and prioritized as the project progresses.

Regulations

Question: What changes will new regulations bring, especially for distribution system monitoring and emerging contaminants?

Discussion Items: The most significant upcoming regulation is modification of the Total Coliform Rule (TCR). Changes affecting SFPUC will likely be minor; however, the updated rule will bring more awareness to water quality levels within the distribution system. Issues such as pressure loss and cross-connections will become increasingly recognized and an increased standard of care is expected to evolve.

Moving beyond regulations, it is important to look at where the largest benefits to customers can be realized. If items are identified, planning is needed for sufficient data to be collected to maximize regulatory flexibility. Achieving regulatory support and necessary funding may be difficult, but worthwhile if there is sufficient information to show increased benefits to customers.

Potential Actions:

Potential Action Item	Rationale
▪ Look for ways to advance the intent of regulations instead of focusing solely on compliance. If areas outside of the regulatory framework are identified as needing improvement, gather the necessary data to support a strong case for action.	▪ Provide the best protection of public health and level of service possible through being proactive about maximizing regulatory flexibility.
▪ Augment implementation of best practices for distribution system management (i.e., biofilm control as proxy for bacterial pathogens) through the use of a self-assessment model.	▪ Several self-assessment models are available for distribution system management such as Hazard Analysis and Critical Control Point (HACCP) and Distribution System Optimization Plans (DSOP).
▪ As part of the upcoming TCR revisions, assess the SFPUC policy on responding to positive total coliform samples. Determine whether improvements in consistency or response are warranted.	▪ TCR will focus more attention on events in the distribution system

Quantity and Related Quality Issues

Question: Will increased demand affect finished water quality through the introduction of new source waters, e.g., groundwater or Delta water?

Discussion Items: Residential customers tend be highly sensitive to changes in the aesthetic qualities of water (taste, odor, temperature, chlorine levels, TDS) and prefer consistent quality. Similarly, commercial-industrial customers also prefer consistent water quality especially if industrial processes depend on specific water parameters. In the future, changes in aesthetics due to blending in new sources or wheeling may create concern.

In the face of drought or environmental restrictions, maintaining water quality equity may become an issue. SFPUC should be prepared to respond to customer concerns over inequity if situations arise both from residential and commercial/industrial clients.

Potential Actions:

Potential Action Item	Rationale
▪ Track alternate supply studies undertaken by BAWSCA members. Set up system for information transfer between agencies.	▪ Need to stay abreast of potential changes resulting from increased regional cooperation and to weigh in on potential concerns.
▪ Continue to examine reuse as a desirable alternative for many water uses.	▪ Conservation will be a desirable outcome even if there are no major quantity deficits during the planning horizon.
▪ Use the current project of developing wells within SF to interact with customers over changes in water quality. Customers concerns over harder water should be assessed and documented. Identify appropriate response (e.g., educational information, different blending techniques or other).	▪ Advance level of customer service and use as a pilot study for possible future water quality changes.

Technological Advances

Question: What implications will advances in membranes, nanotechnology, remote sensing, genetics and others have on SFPUC?

Discussion Items: Much science advances before we know the significance. For example, detection limits will continue to decrease before we understand the health implications of low level exposure. Technology should not be expected to provide a 'magic bullet' for future issues; it will likely raise as many new concerns as solutions.

When new technologies are adopted, consider all aspects of SFPUC operations, which may be affected (e.g., obtaining union approval for new job responsibilities).

Potential Actions:

Potential Action Item	Rationale
▪ Develop a way to efficiently and soundly examine new technologies. Potentially have an annual internal briefing on new technology to keep staff up to date.	▪ Need to stay abreast of industry changes to assess potential for enhanced service.
▪ Participation in research testing new technology (i.e, UV application to unfiltered water, new disinfects).	▪ Enable the SFPUC to stay at the forefront of new advances with a particular focus on conditions distinctive to the SFPUC system.

Public Health and Emerging Contaminants

Question: What is the best way to prepare for emerging health effects that may be attributed to contaminated water supplies? Are there risk management options for consumers with specific health concerns?

Discussion Items: With such a large unknown arena of emerging contaminants, the most important aspect is determining a consistent and logical approach for handling newly recognized constituents. A contaminant-by-contaminant approach was not considered a good strategy. In addition, the impetus for monitoring and treatment of new constituents should not be political pressure but instead providing the largest benefits to public health. In many cases, such as lead poisoning, water is a relatively insignificant contributor to morbidity when compared to other causes; however, water quality improvements should still be made when they can have an impact on the occurrence of disease.

The public health sector can help determine the health-related priorities for water quality and SFPUC is well positioned through its association with the SFDPH. Some options for addressing emerging contaminants include: (1) do nothing and wait for regulations, thus saving resources, (2) wait for action but monitor since it may beneficial for public relations to have data, and (3) monitor and consider treatment when there are health concerns.

When examining new constituents, it is important to determine what benchmarks can be used to assess and communicate monitoring results against. If no benchmarks are available, participation in research within a group can help provide context and improve the likelihood of determining the significance of results.

More focus is needed on educating customers on public health risks. Too often customers perceive risk as binary, where any level of contaminant in the water is inappropriately considered bad. Dissemination of integrated risk management information to the customer base may reduce the burden of interpreting too much information. For example, 3rd party guidance on safer pregnancy can replace dozens of fact sheets on the effect of individual chemicals on pregnancy. As sensitive populations are identified, amendments may be made for these targeted subpopulations.

Potential Actions:

Potential Action Item	Rationale
▪ Create consistent and logical policy for addressing emerging contaminants. ▪ Use the laboratory research group to keep abreast of emerging contaminants and improvements in detection levels.	▪ A standard approach, which has been vetted externally and internally, will be helpful for the SFPUC in engaging with customers and regulators as new contaminants and potential health risks emerge.
▪ Continue liaison with public health and medical community locally to ascertain shifts in infection patterns.	▪ Early signals of emerging microbes are more likely to be detected on the clinical side than through drinking water research channels.
▪ Partner with county health departments to distribute health information in larger context (i.e., lead in water as a portion of lead exposure).	▪ General public receives multiple and often fragmented messages. Decreasing the number of sources of information and integration of messages across media will improve clarity.
▪ Continue to monitor algal toxins.	▪ As these have posed known impacts on livestock and have the potential to occur, it would be advisable to develop baseline data on occurrence and removal.

Potential Action Item	Rationale
▪ Assess risks of organics leaching into system from materials-coatings, flame retardant application policy by CFD in watersheds and effects of new invasive species in the watershed, if consistent with internal emerging contaminant policy.	▪ An initial desk-top screening of these potential contaminant sources is advisable.
▪ Mixtures of DBPs are increasingly understood to pose measurable health risks. Continued attention should be paid to nitrosamine formation.	▪ Occurrence is demonstrated in SFPUC sources. The chemical risk analysis shows DBP being a contributor.
▪ Partner with other public agencies to shift funding for the greatest public health benefit. Participate in USEPA, AwwaRF surveys or in funding to CDC to promote research.	▪ There is a civic duty to rate-payers to highlight and advocate for large risk reduction actions, even if these are outside the normal purview of the water industry. This will help interpret the data and put results in context.

Water Quality Management Approach

Question: What practices should SFPUC adopt to go beyond regulations? Should a risk management model be the main driver?

Discussion Items: A chemical mixture risk model was presented for SFPUC finished water from Alameda East, Harry Tracy Water Treatment Plant (HTWTP) and Sunol Valley Water Treatment Plant (SVWTP). The risk level associated with the water ranged from approximately 100-200 on a scale where water just meeting all MCLs is scored as ~ 1400 and water with all constituents meeting all PHG is ~ 40. Of note on these bounding numbers is that all the constituents are assumed to occur, whereas the analysis conducted on SFPUC water calculated the risk index with non-detected compounds as zero. The greatest apparent risk within SFPUC finished water was low-level arsenic (below 1 µg/l) in all the sources. In addition, bromate formation at HTWTP was a significant contributor to the risk, even though the concentration was below the regulatory limits. A sensitivity analysis of detection limits was completed but no other plausible significant contaminants were identified.

Microbial contaminants within the distribution system were seen as a potentially higher risk than chemical contaminants. The San Francisco Department of Public Health reviews data for ten waterborne diseases each month and communicates any water-related occurrence to the SFPUC, which in turn reports to the California Department of Public Health. Typically, microbial pathogens are foodborne; however, it is impossible to positively determine all contributing causes even when an outbreak can be traced back to a specific source. Notably, pathogens may exist in the water system without causing any measurable disease. For example, despite documented *Legionella* occurrence in the water system in 2003, no cases of legionellosis occurred in San Francisco that year. However, mycobacterium avium complex (MAC) is known to infect immunocompromised individuals but it appears that soil is the predominant environmental reservoir rather than water. However, occurrence of MAC in the water and its relationship to disease bears further evaluation.

Potential Actions:

Potential Action Item	Rationale
▪ Conduct a formal distribution system assessment using Hazard Analysis and Critical Control Point (HACCP), Distribution System Optimization Plans (DSOP) or AWWA standard G200-04.	▪ Identify key vulnerabilities and critical control points. ▪ Use as an input into regulatory development.

Potential Action Item	Rationale
▪ Continue to conduct arsenic survey of the source waters and watershed. Consider expansion of bromate monitoring at HTWTP and within the distribution system.	▪ According to the chemical risk analysis, arsenic and bromate are the key contributors to health risk within the SFPUC system.
▪ Revisit MAC analysis both in terms of disease occurrence and exposure routes.	▪ This opportunistic pathogen continues to cause infections in the population. Water contributes an undefined exposure.

Catastrophic Events

Questions: Is SFPUC fully prepared to maintain level of service for possible catastrophic events? What should the expected level of service be (minimum day potable water within 24 hours)?

Discussion Items: It is important to communicate to the customer base the levels of service SFPUC is prepared to offer for a variety of situations from unusual to catastrophic. The Water System Improvement Program (WSIP) has addressed levels of service after a maximum credible earthquake as part of the rationale for the $4.3 billion portfolio of projects.

However, small unusual events happen more frequently than catastrophic events, and can still lead to loss of public confidence. If the public knows and agrees with what to expect under ranges of circumstances, they can plan accordingly. Some example benchmarks for service from Seattle Public Utilities are to respond to high priority emergencies within an hour at least 80% of the time and to ensure that not more than 4% of customers are without service for more than 4 hours within a year. However, even achieving these benchmarks may not prevent dissatisfaction if the public expects SFPUC to react as quickly as Police and Fire.

Regular exercise of procedures is essential to respond to unusual and emergency events efficiently. It may be beneficial to open the emergency center at lower levels to ensure protocol is exercised on a more regular basis. Table-top and on-ground exercises are also recommended to ensure everyone is familiar with procedures and to resolve potential bottlenecks. Timely communication is critical because it takes 24-hours for bacteriological analysis, and once results are available, response must proceed efficiently.

It is important to absorb important emergency activities into the routine so that an emergency event is just an extension of managing normal events. The same workers and the same tools will be utilized in an emergency as are utilized every day.

Potential Actions:

Potential Action Item	Rationale
▪ Continue to update and exercise contingency plans for emergency scenarios.	▪ Eliminate bottlenecks and improve response
▪ Lower the threshold for opening the emergency operations center and exercise any specialty equipment. Try to absorb whatever is important into routine operations.	▪ Increase familiarity with equipment and procedures within real life context.
▪ Communicate with public what SFPUC is prepared to handle in emergency and atypical water quality events and follow through. Partnership with community and with Fire Department	▪ Improve customer confidence and ensure customers are prepared for their role in emergencies. Need to give information as close to real time as possible because that affects customer confidence.
▪ Concentrate on handling the unusual events with precision and efficiency.	▪ Serves to sharpen SFPUC staff ability to effectively respond to emergencies and improves customer confidence.

Potential Action Item	Rationale
▪ Test emergency notices on unfamiliar staff to ensure understanding and clarity – make sure the customer base understands exactly what a 'boil water' notice means or what a 'do not use' notice involves.	▪ Eliminate misunderstandings within real emergency situations.
▪ Facilitate clear interfaces across sectors through on-going exercises and discussions (i.e., Red Cross distributing chlorine tablets and bottled water).	▪ Increase efficiency by eliminating redundant efforts and streamlining activities.
▪ Develop standard procedure and infrastructure for emergency calls to customers. Prepare variety of standard notifications to different events.	▪ Alerting the customer base quickly of an event could be more critical to protecting health than restoring water quality quickly.
▪ Become mutual assistant utility.	▪ Improves regional network cooperation and allows SFPUC staff to gain valuable experience.
▪ Maintain and review simple checklists.	▪ Large binders of detailed information are rarely helpful unless individuals are familiar with content. Simple checklists will improve efficiency of response.
▪ Allow staff time at work to familiarize with the SFPUC system and emergency procedures.	▪ Familiarity with procedures will increase effectiveness of response during events.

Communication with Customers
Question: How can SFPUC better communicate information and needs back to customers? Will focus groups and willingness-to-pay studies aid SFPUC's understanding of customer concerns and suggest new services?

Discussion Items: Survey tools including focus groups and willingness-to-pay studies have been used for ascertaining customer's desire for greater quality and higher levels of service. SPU recently completed a survey of their customer base to assess satisfaction with water quality, reasons for dissatisfaction, suggestions for improving water quality, and to gauge interest and willingness to pay for some enhanced services. The enhanced services included in-home sampling of tap water, a referral service for plumbers and alternative methods to receive advice/consultation on water quality issues. The survey showed 56% of customers being extremely or very satisfied with their water quality. Of those customers with lower satisfaction level, taste concerns (38%) and chlorine/fluoride in the water (17%) were the largest percentage responses.

Other than surveys, the City of Seattle has a 15-person citizen advisory group selected based on responses to advertisements and approved by the City. The group encompasses a variety of skills and interests which can be utilized as a focus group by the utility.

The Los Angeles Department of Water and Power (LADWP) has performed surveys at a minimum of every two years to assess customer trends. Over the last 15 years there was a gradual but steady increase in the percentage of customers drinking bottled water at least once per day. The percentage increased from 40% in the early 1990s to 72% in 2003. In 2006 the trend started to shift away from bottled water use; however, this was not due to action by the utility but instead an awareness of the environmental impact of plastics. Consequently, the use of point-of-use devices (POUDs) has continued to increase from 15% to 42% of the population using some type of barrier method. Within the survey, when customers were asked what they wanted from LADWP, many requested guidance as to which POUDs were safe. LADWP is beginning to research POUDs by type (not by brand) to provide the requested guidance.

Potential Actions:

Potential Action Item	Rationale
▪ Perform surveys to solicit feedback on customer satisfaction and desired services.	▪ Move from anecdotal to more systematic assessment of customer needs and concerns.
▪ Utilize citizen's advisory committee to ascertain advisability of future actions.	▪ Since the SFPUC has this in place, it can be used both as a proxy for larger customer base input and advisory as to outreach efforts.
▪ Concentrate on providing integrated advice.	▪ Information should directly address customer concerns broadly rather than simply providing water-specific information (i.e., more health end point driven).
▪ Refine internal disclosure policy of new information.	▪ It is essential that SFPUC staff who interface with the public know what is occurring. This increases the accuracy of information provided to customers and transparency.
▪ Determine the values SFPUC wants to be known for (i.e., honesty, efficiency, responsiveness) and align SFPUC structures with them.	▪ There is much discussion about branding these days. At its heart, it has to do with an agency's distinctiveness. Understanding and identifying these is important for directing actions.

Role as a Utility

Question: Should the role of SFPUC continue to move from the meter to the tap?

Discussion Items: Large buildings and especially hospitals are a reasonable first step to move beyond the tap. Office buildings can especially pose challenges since water left standing over the weekend may be compromised. A large building can be a mini-system in itself with no information on the types and configuration of pipes as well as the presence of tanks to maintain pressure. There is often a huge disparity between the care given to other parts of the water system and what occurs in large buildings. However, when Seattle Public Utilities tested many of its own facilities they found that flushing out water on Monday morning was needed to remove metals and bad taste but otherwise water was fine even in older buildings and use of bottled water was unnecessary.

Water quality can sometimes change in the distribution system. For example, high bromate levels were discovered in the LAWDP distribution system while plant effluent met regulations. This was due to a combination of special conditions including groundwater high in bromide, superchlorination, and a finished water reservoir open to sunlight. Water quality changes can also occur within home pipe systems (i.e., leaching of metals, bacteria growth) which may have health impacts.

Customers are taking their own steps to move treatment to the tap as evidenced by increased utilization of point-of-use devices (POUDs.) Utilities have the opportunity to open communication with customers through involvement with this trend.

Potential Actions:

Potential Action Item	Rationale
▪ Characterization of water quality in large buildings. Provide guidance on flushing or pipe replacement if issues are determined.	▪ Ensure water quality in large buildings.
▪ Encourage AWWA to support carefully designed studies to establish the most effective approaches for extending service to the tap based on public health, cost and feasibility	▪ Service to the tap has growing support from the general public and public health authorities, but it is not clear whether service to the tap will result in measurable improvement in water quality or public health.

Potential Action Item	Rationale
▪ Identification of alternatives for additional in-home treatment. Provide information on POUD treatment types to customers. Encourage NSF International and AwwaRF to provide guidance about currently available POUDs and cooperate with other utilities to development of information.	▪ Respond to current customer concerns with useful information.

Sustainability

Question: What are the key sustainability concerns? How can a sustainability ethic be better implemented into SFPUC's culture and services?

Discussion Items: Globally, sustainability is a bigger issue in some other developed countries than in the United States (i.e., EU nations). SFPUC should attempt to push the industry towards 'greener' technology through requirements of increasing energy efficiency and pollution prevention. For example, solar mixers are being used on large storage reservoirs; however, the push should continue for improvements in efficiency.

Potential Actions:

Potential Action Item	Rationale
▪ Review current evaluation metrics for alternatives analysis; determine gaps and additional metrics that would assist in decision-making reflective of sustainability concerns.	▪ Incorporate sustainability concerns into routine activities and decisions.
▪ Push industry for greater sustainability in design (i.e., energy efficiency, GHG emissions).	▪ Use influence to advance sustainability concerns.

Climate Change

Question: How will a changing climate (larger storms, more severe drought, less snow pack) affect SFPUC operations?

Discussion Items: Climate change could cause a significant change in water resources and population movement in society. Monitoring of key indicators should be a collaborative effort since climate change will be everyone's problem and not SFPUC specific.

Potential Actions:

Potential Action Item	Rationale
▪ Monitor key water quality and quantity indicators for annual and seasonal trends (i.e., temperature, turbidity, coliforms, TOC, DBPs, chlorine demand, metals, nitrite).	▪ Remain up to date on status of issue.
▪ Create partnerships with other agencies to monitor and analyze information on snow pack, sea level rise, mean air temperature, weather patterns and other water quantity/quality indicators in California.	▪ Collaborate since issue effects multiple sectors.

Synthesis of Priority Items

Within the workshop the interlinked aspects of many of the ten priority items were raised. An effort was made to reorganize and consolidate the areas into a smaller group of overarching themes and priorities. To this end, each TAC member was asked to list three of the priority areas or themes they thought were important.

Dave Hilmoe, Seattle Public Utilities:

- Customer Confidence
- Distribution Water Quality
- Adaptive Management

Pankaj Parekh, Los Angeles Department of Water and Power:

- WQ Management Philosophy
- Role as Utility
- Emerging Contaminants

Stephen Estes-Smargiassi, Massachusetts Water Resource Authority:

- Listen and Respond
- Customer Expectations
- Response to Catastrophic Events

The comments from all TAC members were included to expand upon the themes suggested by Dave Hilmoe.

- *Customer Confidence:* Being a public agency makes serving the public's needs the main responsibility. Customer confidence can be built through listening to the customer's needs and responding with appropriate action and information. In many cases, the expectations of the customers may move SFPUC away from traditional service since concerns with the tap water and not with the meter are of paramount concern. SFPUC should also manage customer expectations by being upfront about the type of service to expect in typical, unusual and emergency circumstances. When expectations are agreed upon and met, confidence can be built.

- *Adaptive Management:* A fluid planning process is needed within SFPUC to respond to emerging technology, increased information from monitoring efforts, emergency preparedness, sustainability requirements and customer concerns. Strategic planning concerns will need to be incorporated into routine activities to remain upfront and relevant.

- *Distribution Water Quality:* Increased monitoring of and attention to water quality changes within the distribution system was seen as a large upcoming challenge within the planning horizon. Methods of monitoring will need to adapt as population increases and traffic prohibits fast access to distant locations. It is water quality at the tap which customers are likely to be most concerned about leading to possible changes in SFPUC's role as a utility.

Next Steps

Moving forward the potential actions items will be analyzed, expanded and prioritized. Precedents will be identified. Scheduling, steps, approximate cost and potential partnerships will be developed and identified leading to an integrated list of recommendations for future action.

Attendees

Name	Affiliation
Andrew DeGraca	SFPUC – Water Quality Bureau
Manouchehr Boozarpour	SFPUC – Water Quality Bureau
Andrzej Wilczak	SFPUC – Water Quality Bureau
Alan Wong	SFPUC – Water Quality Bureau
Jackie Cho	SFPUC – Water Quality Bureau
Eddy So	SFPUC – Water Quality Bureau
Enio Sebastiani	SFPUC – Water Quality Bureau
Jina Tin	SFPUC – Water Quality Bureau
Rod Miller	SFPUC – Water Quality Bureau
Mike Conroy	SFPUC – Water Quality Bureau
Mike Williams	SFPUC – Water Quality Bureau
Bruce McGuirk	Hetch Hetchy Water & Power
Pankaj Parekh	Los Angeles Dept of Water & Power
Dave Hilmoe	Seattle Public Utilities
Stephen Estes-Smargiassi	Massachusetts Water Resources Authority
Douglas Chun	BAWSCA – Alameda County Water District
Vlad Rakhamimov	California Dept. of Public Health
June Weintraub	San Francisco Dept. of Public Health
Dan Heimel	BAWSCA – Redwood City
Phillippe Daniel	CDM
Jenny VanCalcar	CDM

Appendix D
Precautionary Principle

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Precautionary Principle

The following excerpt is from SEC. 101. of the City of County of San Francisco Environment Code[1].

SEC. 101. THE SAN FRANCISCO PRECAUTIONARY PRINCIPLE.

The following shall constitute the City and County of San Francisco's Precautionary Principle policy. All officers, boards, commission, and departments of the City and County shall implement the Precautionary Principle in conducting the City and County's affairs:

The Precautionary Principle requires a thorough exploration and a careful analysis of a wide range of alternatives. Based on the best available science, the Precautionary Principle requires the selection of the alternative that presents the least potential treat to human health and the City's natural systems. Public participation and an open and transparent decision making process are critical to finding and selecting alternatives.

Where threats of serious or irreversible damage to people or nature exist, lack of full scientific certainty about cause and effect shall not be viewed as sufficient reason for the City to postpone cost effective measures to prevent the degradation of the environment or protect the health of its citizens. Any gaps in scientific data uncovered by the examination of alternatives will provide a guidepost for future research, but will not prevent the City from taking protective action. As new scientific data become available, the City will review its decisions and make adjustments when warranted.

Where there are reasonable grounds for concern, the precautionary approach to decision-making is meant to help reduce harm by triggering a process to select the least potential threat. The key elements of the Precautionary Principle approach to decision-making include:

1. Anticipatory Action: There is a duty to take anticipatory action to prevent harm. Government, business, and community groups, as well as the general public, share this responsibility.

2. Right to Know: The community has a right to know complete and accurate information on potential human health and environmental impacts associated with the selection of products, services, operations or plans. The burden to supply this information lies with the proponent, not with the general public.

3. Alternatives Assessment: An obligation exists to examine a full range of alternatives and select the alternative with the least potential impact on human health and the environment including the alternative of doing nothing.

4. Full Cost Accounting: When evaluating potential alternatives, there is a duty to consider all the reasonably foreseeable costs, including raw materials, manufacturing, transportation, use,

[1] http://www.municode.com/content/4201/14134/HTML/ch001.html

cleanup, eventual disposal, and health costs even if such costs are not reflected in the initial price. Short- and long-term benefits and time thresholds should be considered when making decisions.

5. Participatory Decision Process: Decisions applying the Precautionary Principle must be transparent, participatory, and informed by the best available science and other relevant information.

(Added by Ord. 171-03, File No. 030422, App. 7/3/2003)

Appendix E
SFPUC Results of a 2006 Survey of Pharmaceutical and Potential Endocrine Disrupting Compounds

SOUTHERN NEVADA
WATER AUTHORITY

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Southern Nevada Water Authority
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14th March 2008

RE: AwwaRF Tailored Collaboration Project #3085 "*Toxicological Relevance of EDCs and Pharmaceuticals in Drinking Water*"

Dear Participating Utility,

On behalf of our entire team, we are pleased to share with you the final results from our study. As you well know, there has been tremendous interest regarding the findings of this research, as well as our previously published AwwaRF study (Project# 2758). We greatly appreciate your proactive approach to this emerging issue and sincerely thank you for participating in the study. The final report has been drafted and final edits are being made now. As soon as we have provided AwwaRF and the PAC with time for a cursory review, we will provide the entire report to you for review prior to any publication. We look forward to your comments and questions.

There has been some confusion regarding how this project relates to the recent barrage of Associated Press (AP) stories over the past week, which of course generated additional media inquiries for many water utilities. Much of this confusion surrounds the source of data used by AP. What we know for certain is that neither the project team nor AwwaRF released data to the AP. Everyone involved in this study respects the anonymity of the participating utilities. The only data released to the AP by the SNWA's Research and Development group was specific to Southern Nevada's water supply. It is our understanding that some participating utilities may have provided the AP raw data provided to them by the project team at the study's onset, which was of course their prerogative. However, as a result, there has been some inconsistency between initial raw data released to the AP by utilities and the final data that will be published in the AwwaRF report. All utilities are anonymous within the report, but I am sending your specific utility's final data as a separate file accompanying this letter. We kindly ask you to acknowledge receipt of the data and verify that it is correct in terms of site names and classifications. We also ask you to let us know whether or not your utility is willing to be named as a participating utility in the AwwaRF final report. Generally, we acknowledge each and every utility, but in this case, we understand that some of you may wish to remain completely anonymous. If you are willing to be acknowledged, please provide us with the names of any particular people from your agency that you believe should be specifically acknowledged. We need your confirmation as soon as possible.

Below is a concise summary of the results that will be presented in the AwwaRF final report. Table 1 provides the complete list of compounds (n=62), use/source information, and the method reporting limits (MRLs). Initial MRLs were based upon of instrument sensitivity and method precision. These calculated values; however, could not take into account contamination from travel blanks that were collected and analyzed throughout the project. Upon completion of the project, reporting limits were re-evaluated for compounds that had high frequencies (>5%) of contamination in both laboratory and travel blanks (n=68). The MRL was set at two standard deviations (95% confidence interval) above the mean concentration in the blanks. This impacted only three of the target analytes (Table 2). For a few rare instances where a known point source of contamination occurred, reporting limits for individual samples affected by the contamination were adjusted to a value greater than the contamination level in corresponding blanks. The affected samples are noted in the individual results spreadsheets. Analogous evaluations and adjustments were performed for E-screen assay results based on laboratory and travel blanks. All laboratory and travel blanks were evaluated (n=118) and the reporting limit for estradiol equivalents (EEq) was adjusted to two standard deviations above the mean (Table 2).

Table 3 shows the combined results for finished drinking water evaluated in this project. For brevity, only compounds that were observed in more than 20% of the samples are shown. Table 3 also provides the maximum detected value (based on averaged replicates), median, and frequency of detection. Table 4 provides a summary of EEq results for raw, finished, and distribution system samples.

Tables 5 and 6 present the risk assessment data with the acceptable daily intake (ADI) levels, drinking water equivalent levels (DWELs), and maximum observed concentration (based on individual samples rather than on averages of replicates) in drinking water. In Tables 5 and 6, the last column on the right shows the number of liters of water one would have to consume per day at the highest reported contaminant concentration in drinking water to ingest a dose equal to the ADI. When the compound was not detected in drinking water, as was the case for several analytes, the MRL was substituted for a maximum detected concentration to represent a "worst-case" scenario.

These data show that although some pharmaceuticals were detectable at trace levels in drinking water, the concentrations were far below any predicted health effects. The ADIs and DWELs calculated include conservative safety factors in accordance with EPA risk assessment guidelines for drinking water regulation. Our study concludes that for the pharmaceuticals and suspected EDCs evaluated, the concentrations detected in water from the utilities participating in this study present no meaningful risk to human health.

Again, the entire team would like to express our thanks for your participation in this important project. We look forward to your questions, comments, and suggestions.

Sincerely,

Shane A. Snyder
Principal Investigator

Table 1
Compound List with Method Reporting Limits (MRLs)

Compound	Use / Source	MRL (ng/L)
Pharmaceuticals		
Atenolol	Beta-blocker	0.25
Atorvastatin	Antilipidemic	0.25
o-Hydroxy atorvastatin	Antilipidemic metabolite	0.50
p-Hydroxy atorvastatin	Antilipidemic metabolite	0.50
Carbamazepine	Anticonvulsant	0.50
Diazepam	Tranquilizer	0.25
Diclofenac	NSAID	0.25
Enalapril	ACE Inhibitor	0.25
Fluoxetine	Antidepressant	0.50
Norfluoxetine	Antidepressant metabolite	0.50
Gemfibrozil	Antilipidemic	0.25
Meprobamate	Anit-anxiety	0.25
Naproxen	NSAID	0.50
Phenytoin	Antiepileptic	1.0
Risperidone	Antipsychotic	2.5
Simvastatin	Antilipidemic	0.25
Simvastatin hydroxy acid	Antilipidemic metabolite	0.25
Sulfamethoxazole	Antibiotic	0.25
Triclosan	Antimicrobial	1.0
Trimethoprim	Antibiotic	0.25
Steroids		
Estradiol	Human estrogen	0.50
Estrone	Human estrogen	0.20
Ethynylestradiol	Synthetic birth control	1.0
Progesterone	Human estrogen	0.50
Testosterone	Human estrogen	0.50
Potential EDCs		
α-BHC	Pesticide	10
β-BHC	Pesticide	10
δ-BHC	Pesticide	10
γ-BHC (Lindane)	Pesticide	10
Atrazine	Pesticide	0.25
Benzophenone	Preservative	25
BHA	Anti-oxidant	25
BHT	Anti-oxidant	25
Bis(2-ethylhexyl)phthalate	Plasticizer	120
Bisphenol A	Plasticizer	5.0
Butylbenzyl phthalate	Plasticizer	50
DEET	Pesticide	25
Diazinon	Pesticide	10
Galaxolide	Fragrance	25
Linuron	Pesticide	0.50
Methoxychlor	Pesticide	10
Metolachlor	Pesticide	10
Musk Ketone	Fragrance	25
Nonylphenol	Surfactant	80
Octachlorostyrene	Pesticide	10
Octylphenol	Surfactant	25
TCEP	Fire Retardant	50
TCPP	Fire Retardant	50
Tonalide	Fragrance	25
Traseolide	Fragrance	25
Vinclozolin	Pesticide	25
Phytoestrogens		
Apigenin	Leafy plant	1.0
Biochanin A	Legumes and red clover	1.0
Chrysin	Passiflora caerula (Passion flower)	1.0
Coumestrol	Alfalfa	1.0
Daidzein	Legumes and red clover	1.0
Equol	Daidzein metabolite	10
Formononetin	Clover	1.0
Genistein	Legumes and red clover	1.0
Glycitein	Legumes	1.0
Matairesinol	Oilseeds (such as sesame)	5.0
Naringenin	Citrus fruits and tomatoes	1.0

Table 2
Compounds with high frequencies of blank contamination and reporting limits (RL)

Description	Initial RL (ng/L)	Final RL (ng/L)
Risperidone	0.25	2.5
Nonylphenol	50	80
Bis(2-ethylhexyl) phthalate	50	120
EEq	0.03	0.16

Table 3
Results for finished drinking water (n=18, >20%)

Compound	Max (ng/L)	Median (ng/L)	Frequency (%)
Atrazine	870	49	83
Meprobamate	42	5.7	78
Dilantin	19	6.2	56
Atenolol	18	1.2	44
Carbamazepine	18	6.0	44
Gemfibrozil	2.1	0.48	39
TCEP	470	120	39
DEET	93	63	33
Metolachlor	27	16	33
TCPP (Fyrol PCF)	510	210	28
Sulfamethoxazole	3.0	0.39	22

Table 4
Estradiol equivalent (EEq) results in utility water samples

Description	Max (ng/L)	Median (ng/L)	Frequency (%)
Raw (n=17)	2.1	1.2	12
Finished (n=16)	0.77	0.19	13
Distribution (n=15)	0.20	0.20	7

Table 5
Comparison of pharmaceutical DWELs with maximum finished drinking water concentrations and amount of water (liters) per day to equal ADI dose

Drug	Class	ADI (µg/kg-d)	DWEL (µg/L)	Maximum finished water conc. (µg/L)	Minimum margin of safety	Liter per day for 1 ADI dose*
Atenolol	Beta-blocker	2.0	70	0.026	2,700	5,400
Carbamazepine	Anticonvulsant	0.34	12	0.018	670	1,300
Diazepam	Benzodiazepine tranquilizer	1.0	35	0.00033	110,000	210,000
Fluoxetine	SSRI antidepressant	1.0	35	0.00082	43,000	85,000
Gemfibrozil	Antilipidemic	1.3	45	0.0021	21,000	43,000
Meprobamate	Antianxiety agent	7.5	260	0.043	6,000	12,000
Phenytoin	Anticonvulsant	0.19	6.8	0.032	210	420
Sulfamethoxazole	Anti-infective	510	18,000	0.0030	6,000,000	12,000,000
Triclosan	Antibacterial	75	2,600	0.0012	2,200,000	4,400,000
Risperidone	Antipsychotic	0.014	0.49	<0.0025	>200	>390
Atorvastatin	Antilipidemic	0.54	19	<0.00025	>76,000	>150,000
o-hydroxy atorvastatin	Metabolite	0.54	19	<0.00050	>38,000	>76,000
p-hydroxy atorvastatin	Metabolite	0.54	19	<0.00050	>38,000	>76,000
Diclofenac	NSAID	67	2,300	<0.00025	>9,200,000	>19,000,000
Enalapril	ACE inhibitor	0.23	8.1	<0.00025	>32,000	>64,000
Norfluoxetine	Metabolite	1.0	34	<0.00050	>68,000	>140,000
Naproxen	NSAID	570	20,000	<0.00050	>40,000,000	>80,000,000
Simvastatin	Antilipidemic	0.54†	19	<0.00025	>76,000	>150,000
Simvastatin hydroxy acid	Metabolite	0.54†	19	<0.00025	>76,000	>150,000
Trimethoprim	Antibacterial	190*	6,700	<0.00025	>27,000,000	>53,000,000

* Assumes an average weight of 70 kg.

Table 6
Comparison of EDC DWELs with maximum finished drinking water concentrations

Chemical	Class	ADI (µg/kg-d)	DWEL (µg/L)	Maximum finished water conc. (µg/L)	Minimum margin of safety	Liter per day for 1 ADI dose*
Atrazine	Herbicide	5.0	180	1.0	180	350
Bisphenol A	Industrial chemical	0.0020	0.070	0.025	2.8	6.0
Butylbenzyl phthalate	Phthalate plasticizer	100	3,500	<0.050	>70,000	>140,000
Bis(2-ethylhexyl) phthalate	Phthalate	12	420	<0.12	>3,500	>7,000
17ß-Estradiol	Endogenous estrogenic steroid hormone, drug	0.017	0.58	<0.00050	>1,200	>2,400
Estrone	Endogenous estrogenic steroid hormone, drug	0.013	0.47	<0.00020	>2,400	>4,600
Ethynylestradiol	Pharmaceutical estrogen	0.00010	0.0035	<0.0010	>3.5	>7.0
Lindane	Organochlorine pesticide	0.056	2.0	<0.010	>200	>390
Linuron	Herbicide	8.0	280	0.0083	8,400	67,000
Methoxychlor	Organochlorine pesticide	0.020	0.70	<0.010	>70	>140
4-Nonylphenol	Surfactant, chemical synthesis intermediate, degradate of nonylphenol ethoxylates	50	1,800	0.10	18,000	35,000
Octylphenol	Surfactant, chemical synthesis intermediate, degradate of octylphenol ethoxylates	13	440	<0.025	>17,000	>36,000
Vinclozolin	Agricultural fungicide	12	420	<0.010	>42,000	>84,000

* Assumes an average weight of 70 kg.

Sample ID #	06050564-001	06050564-002	06050564-004	06050564-005	06050564-006
SPE Batch ID #	060806-1	060806-2	060806-4	060806-5	060806-6
Description	Raw Water	Raw Duplicate	Finished	Distribution	Trip Blank
Analyte	ng/L	ng/L	ng/L	ng/L	ng/L
Sulfamethoxazole	<0.25	<0.25	<0.25	<0.25	<0.25
Atenolol	<0.25	<0.25	<0.25	<0.25	<0.25
Trimethoprim	<0.25	<0.25	<0.25	<0.25	<0.25
Fluoxetine	<0.50	<0.50	<0.50	<0.50	<0.50
Norfluoxetine	<0.50	<0.50	<0.50	<0.50	<0.50
Meprobamate	<0.25	<0.25	<0.25	<0.25	<0.25
Dilantin	<1.0	<1.0	<1.0	<1.0	<1.0
Carbamazepine	<0.50	<0.50	<0.50	<0.50	<0.50
Atrazine	<0.25	<0.25	<0.25	<0.25	<0.25
Diazepam	<0.25	<0.25	<0.25	<0.25	<0.25
Linuron	<0.50	<0.50	<0.50	<0.50	<0.50
Atorvastatin	<0.25	<0.25	<0.25	<0.25	<0.25
o-Hydroxy atorvastatin	<0.50	<0.50	<0.50	<0.50	<0.50
p-Hydroxy atorvastatin	<0.50	<0.50	<0.50	<0.50	<0.50
Risperidone	<2.5	<2.5	<2.5	<2.5	<2.5
Enalapril	<0.25	<0.25	<0.25	<0.25	<0.25
Gemfibrozil	<0.25	<0.25	<0.25	<0.25	<0.25
Bisphenol A	<5.0	<5.0	<5.0	<5.0	<5.0
Simvastatin	<0.25	<0.25	<0.25	<0.25	<0.25
Simvastatin hydroxy acid	<0.25	<0.25	<0.25	<0.25	<0.25
Diclofenac	<0.25	<0.25	<0.25	<0.25	<0.25
Naproxen	<0.50	<0.50	<0.50	<0.50	<0.50
Triclosan	<1.0	<1.0	<1.0	<1.0	<1.0
Testosterone	<0.5	<0.5	<0.50	<0.50	<0.50
Progesterone	2.5	2.5	<0.50	<0.50	<0.50
Estrone	0.21	0.21	<0.20	<0.20	<0.20
Estradiol	<0.5	<0.5	<0.50	<0.50	<0.50
Ethynylestradiol	<1.0	<1.0	<1.0	<1.0	<1.0
Genistein	<1.0	<1.0	<1.0	<1.0	<1.0
Daidzein	<1.0	<1.0	<1.0	<1.0	<1.0
Formononetin	<1.0	<1.0	<1.0	<1.0	<1.0
Biochanin A	<1.0	<1.0	<1.0	<1.0	<1.0
Apigenin	<1.0	<1.0	<1.0	<1.0	<1.0
Naringenin	<1.0	<1.0	<1.0	<1.0	<1.0
Coumestrol	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysin	<1.0	<1.0	<1.0	<1.0	<1.0
Matairesinol	<5.0	<5.0	<5.0	<5.0	<5.0
Equol	<10	<10	<10	<10	<10
Glycitein	<1.0	<1.0	<1.0	<1.0	<1.0
BHA	<25	<25	<25	<25	<25
BHT	<25	<25	<25	<25	<25
DEET	<25	<25	<25	<25	<25
octylphenol	<25	<25	<25	<25	<25
Benzophenone	<25	<25	<25	<25	<25
a-BHC	<10	<10	<10	<10	<10
b-BHC	<10	<10	<10	<10	<10
g-BHC	<10	<10	<10	<10	<10
TCEP	<50	<50	<50	<50	<50
TCPP (Fyrol PCF)	<50	<50	<50	<50	<50
Diadzinon	<10	<10	<10	<10	<10
d-BHC	<10	<10	<10	<10	<10
Traseolide	<25	<25	<25	<25	<25
Galaxolide	<25	<25	<25	<25	<25
Tonalide	<25	<25	<25	<25	<25
Vinclozolin	<10	<10	<10	<10	<10
Metolachlor	<10	<10	<10	<10	<10
Musk Ketone	<25	<25	<25	<25	<25
Octachlorostyrene	<10	<10	<10	<10	<10
Butylbenzyl phthalate	<50	<50	<50	<50	<50
Methoxychlor	<10	<10	<10	<10	<10
Dioctyl phthalate	<120	<120	<120	<120	<120
Nonylphenol	<80	<80	<80	<80	<80
EEq	<0.16	<0.16	<0.16	<0.16	<0.16

Appendix F
National Academy of Sciences Recommendations on Distribution Systems

Appendix F
National Academy of Sciences Recommendations on Distribution Systems

National Academy of Sciences Recommendations[1]	SFPUC Actions[2]
Physical Integrity	
Storage facilities should be inspected on a regular basis.	Frequency of inspections for vandalism, security, and water quality purposes (such as identifying missing vents, open hatches, and leaks) is performed weekly. More detailed internal inspections are performed once every three years.
Better sanitary practices are needed during installation, repair, replacement, and rehabilitation of distribution system infrastructure.	SFPUC provides a specifications section for sanitary practices in all construction contracts. This section specifies use of NSF61 materials only, SVOC/VOC testing, disinfection procedures, & other special requirements. SFPUC contractors must cap and store pipe in a secure area (i.e. fenced) during staging/storage. If needed, pipes are scrubbed and flushed prior to installation. AWWA standards and SFPUC's disinfection procedures (Manual of Procedures: Disinfection/ Dechlorination and Related Tasks, 2005) are followed for flushing, disinfection and return to service
External and internal corrosion should be better researched and controlled in standardized ways.	SFPUC has conducted extensive research on corrosion. Lead solubility appears to be the major driving force, with pH identified as the key corrosion control parameter.
Hydraulic Integrity	
Water residence times in pipes, storage facilities, and premise plumbing should be minimized.	Significant storage and linear configuration of the SFPUC system leads to long detention times. The focus has been on managing nitrification. A multi-faceted approach has been taken, with efforts including: aggressive nitrification monitoring, a nitrification response plan, in-situ cleaning program, reservoir inlet-outlet design modifications, installation of mixers (twelve 2,500-10,000 gpm mixers installed), and operational changes as needed (e.g. seasonal drawdown, basins off-line).
Positive water pressure should be maintained.	Typical pressures range from 35 to 80 psi in the distribution system. Pressure transients are not monitored.
Distribution system monitoring and modeling are critical to maintaining hydraulic integrity.	A comprehensive water quality monitoring program in place. SFPUC has an all-pipe model of the city distribution system used for static modeling purposes. A dynamic model for real-time simulations as well as a Pipeline.Net model to analyze possible contamination scenarios is currently under development.

National Academy of Sciences Recommendations[(1)]	SFPUC Actions[(2)]
Water Quality Integrity	
Microbial growth and biofilm development in distribution systems should be minimized.	Corrosion control is optimized for lead and copper. Biodegradable organic matter has been characterized. There is a reservoir cleaning program, dead end flushing program, AOB studies with Univ. of Pennsylvania, and routine *giardia* and *cryptosporidia* monitoring.
Residual disinfectant choices should be balanced to meet the overall goal of protecting public health.	In February of 2004, SFPUC switched to chloramine as its disinfectant residual due to public health concerns over disinfection byproducts.
Standards for materials used in distribution systems should be updated to address their impact on water quality.	The majority of the distribution system is cast-iron, which can exert a significant chlorine demand without proper corrosion control. SFPUC has highly effective corrosion control through maintaining high pH. Construction practices are monitored and controlled. SFPUC has a policy addressing indirect additives to be used in its water system(Indirect Additive Procedure Manual, 2004), use of NSF61 materials only are specified in contracts (e.g. patching, curing, sealant compounds). Recommendation for EPDM-P materials resistant to chloramine provided to WS&TD, CDD as well as CIP programs.
Integrating Approaches	
Distribution system integrity is best evaluated using on-line, real-time methods to provide warning against any potential breaches in sufficient time to effectively respond and minimize public exposure.	SCADA is maintained and is being further developed. SFPUC maintains 24-hour staffing for dispatch and hotlines. Pending project to install pressure gauges at key locations in the distribution system for emergency response, operational monitoring.
Research is needed to better understand how to analyze data from on-line, real-time monitors in a distribution system.	Trending package is maintained which stores SCADA operational data and is periodically reviewed by operational engineers.
Premise Plumbing	
Communities should squarely address the problem of *Legionella*, both via changes to the plumbing code and new technologies.	SFPUC conducted a 2-year, prospective, environmental study to evaluate whether converting from chlorine to monochloramine for water disinfection would decrease *Legionella* colonization of hot water systems. Water and biofilm samples from 53 buildings were collected for *Legionella* culture during 6 intervals. It was determined that chloramination effectively reduced *Legionella* levels.
To better asses cross connections in the premise plumbing of privately owned buildings, inspections for cross connections and other code violations at the time of property sale could be required.	SFPUC has a cross connection control program and has a successful testing rate of over 16,000 devices each year. Successful testing rate of > 99% in 2006.

[(1)]National Research Council Committee on Public Water Supply Distribution Systems, 2006. Assessing and Reducing Risks. *Drinking Water Distribution Systems: Assessing and Reducing Risk*. The National Academies Press, 2006.

[(2)] SFPUC responses provided by or checked by Alan Wong of the Water Quality Division staff.

Appendix G
Role of the Utility at the Tap – Worldwide Perspectives

Appendix G
Role of the Utility at the Tap – Worldwide Perspectives

The following draws on "Drinking Water Distribution Systems: Assessing and Reducing Risks" published by The National Academies Water Science and Technology Board in 2006. The full document can be found online at:
http://books.nap.edu/openbook.php?record_id=11728&page=330 ff.

A survey was conducted of approaches for controlling premise plumbing problems in other Asian cities, and the results are included in Table G-1. In general, the survey revealed that consumers in many of the Asian cities do not drink water from the tap (< 0.5 percent drink tap water directly in Hong Kong).

Other findings include:

1. English water companies are required to meet all water quality regulations for potable water *at the tap* in public buildings, including schools, hospitals, and restaurants.

2. In the Netherlands, the owners of collective water systems including hotels, camp sites, and sports facilities have been required to complete a risk analysis for microbial regrowth (i.e., mostly *Legionella*).

3. In Hong Kong, the Advisory Committee on the Quality of Water Supplies (ACQWS) began meeting to discuss strategies that would protect water to the tap. The key concerns were turbidity and discolored water from older galvanized plumbing. Various strategies were initially considered including:
    a. encourage designers of new buildings to design plumbing with water quality at the tap in mind
    b. educate the public to increase confidence and encourage drinking of water from taps and to maintain plumbing systems
    c. encourage renovation of plumbing systems as part of routine maintenance
    d. inspection programs for older buildings to determine if they need maintenance, with potential issuance of orders requiring repair
    e. require building owners to inspect internal plumbing using licensed plumbers and submit a report, with possible fines for non-compliance
    f. empower utilities to make repairs or remediation for consumers when problems are persistent

    A voluntary certification program was developed (i.e., *Fresh Water Plumbing Quality Maintenance Recognition Scheme*) for buildings and overseen by the water department.

TABLE G-1: World-wide Perspectives on Responsible Party to Prevent Degradation of Water Within Premise Plumbing (NAS, 2006)

Country	Approach
U.S.A.	Explicit requirements for Lead and Copper only. Utility has responsibility to "Optimize" corrosion control to minimize Pb/Cu at the tap of select homes. Regulated by "action levels" for lead and copper. Lead pipe and solder banned in new construction. Guidelines for lead in schools but no regulation.
U.K.	By-laws in some instances requires draw off point for potable water directly from utility services, thereby completely avoiding home plumbing and allowing direct access to drinking water. Compliance with all regulations required at the tap in public buildings.
Hong Kong	Utility publishes free books and TV ads to encourage upgrades to plumbing and to clean storage tanks. Inspection for dirt and testing for bacteria (utility inspects based on complaints).
Singapore	Code of practice for consumers and their agents recommends that samples from various premise plumbing locations be examined periodically by water analysis. Chemical examination is beneficial in showing if corrosion is taking place, and bacterial contamination can be determined by sampling. Storage should be inspected at least once a year and cleaned. For "housing estates" and government buildings the recommendations are followed, but for "private estates" recommendations are voluntary. Reports are made to the water department. Making the recommendations into law was being considered.
Shenzen, China	At least every half year, water tanks must be cleaned and sterilized, with testing of water quality at the inlet and outlet by labs. The water company has responsibility for this task for low-rise buildings whereas the building owner has responsibility in high rises. The building management bears the cost, and a financial penalty can be given to those not complying. Reports are required to the water utility and department of health.
Taipei, Kuala Lumpur, Malaysia	Consumer generally has complete responsibility. However, Kuala Lumpur requires sufficient residual chlorine, and the desirability of regularly cleaning cisterns is publicized in newspapers and on television in Taipei.
SOURCE: Adapted from ACQWS (2005), except the entry for the United States.	

Amongst the recommendations made by the NAS, two were particularly relevant to the SFPUC in its considerations of the future:

> **"To better assess cross connections in the premise plumbing of privately owned buildings, inspections for cross connections and other code violations at the time of property sale could be required.** Such inspection of privately owned plumbing for obvious defects could be conducted during inspection upon sale of buildings, thereby alerting future occupants to existing hazards and highlighting the need for repair. These rules, if adopted

by individual states, might also provide incentives to consumers and building owners to follow code and have repairs conducted by qualified personnel, because disclosure of substandard repair could affect subsequent transfer of the property."

"EPA should create a homeowner's guide and website that highlights the nature of the health threat associated with premise plumbing and mitigation strategies that can be implemented to reduce the magnitude of the risk. As part of this guide, it should be made clear that water quality is regulated only to the property line, and beyond that point responsibility falls mainly on consumers. Whether problems in service lines are considered to be the homeowner's responsibility or the water utility's varies from system to system."

Appendix H
EPA Security Initiative Grant to SFPUC

Appendix H
EPA Security Initiative Grant to SFPUC

In carrying out its mission to provide "reliable, high-quality and affordable water," protecting the water supply from contamination events with nuclear, biological or chemical substances is vital. In September 2007, San Francisco Public Utilities Commission submitted a grant application to the United States Environmental Protection Agency (EPA) for a Contamination Warning System Demonstration Pilot Project. In March 2008, EPA notified the SFPUC that its application was selected for funding and that EPA is ready to award SFPUC its requested amount of $8,119,150. The EPA Contaminant Warning System Grant enables the SFPUC to extend its current efforts in developing technology and protocols to provide early warning for such potential events.

The SFPUC will use the grant funds to implement a demonstration project with five specific monitoring and surveillance components: 1) on-line water quality monitoring, 2) sampling and analysis, 3) enhanced security monitoring, 4) consumer compliant surveillance, and 5) public health surveillance. In addition, the grant requires development of a consequence management plan to respond to possible contamination events, and a review and evaluation plan that addresses operation, performance and sustainability of all the elements developed under this demonstration project for sharing and eventual use by other utilities throughout the nation. The grant requires local matching funds of at least 20% which SFPUC is meeting with primarily accounting for its staff time related to the operation and maintenance of the contamination warning system and planned physical security enhancements. The total cost of this project is $11,256,645 based on an EPA's grant of $8,119,150 and a SFPUC in-kind match of $3,137,496. The project schedule is 3 years from the Notice to Proceed and it is tentatively scheduled for July 2008 to July 2011 but may extend an additional 6 months to formally close out the project.

The on-line water quality monitoring element is to provide on-line contamination monitoring in the City distribution system. Goals of the project include providing greater contamination monitoring coverage for up to two city pressure zones, improvements in the accuracy of detection algorithms, testing and use of EPA hydraulic modeling tool for monitoring site selections, data management efficiency improvement, and radiological monitor evaluation. The on-line water quality monitoring systems includes several instruments and sensors within an instruments panel, a communication panel, an automatic sampler, and an uninterruptible power supply.

The on-line monitoring systems will be installed in two phases. In Phase I, four of these systems will be installed in existing city-owned facilities at the Sunset and University Mound Reservoirs. The plan is to install two monitoring systems at the chemical feed site at University Mound Reservoir and two at the chemical feed building at Sunset Reservoir. The Phase I installations are scheduled for completion in the first six months after the notice-to-proceed.

Appendix I
Emerging Contaminants

Appendix I
Emerging Contaminants

Emerging contaminants were identified through several sources including EPA's CCL, EPA's UCMR2 and the European Union's efforts.

Contaminant Candidate List (CCL)

Under the Safe Drinking Water Act (SDWA), the USEPA is required to identify and list unregulated contaminants which may require a national drinking water regulation in the future. The EPA must periodically publish this list of contaminants – the Contaminant Candidate List (CCL) – and uses this CCL to prioritize its research and data collection efforts to determine whether to regulate a specific contaminant.

The CCL contains contaminants that were not targeted by any national primary drinking water regulation(s) at the time of publication, but that are known to occur in public water systems and that may require regulation under the SDWA. Additional health, treatment, or analytical methods data must be collected for the contaminants on the list. Based on the additional research, EPA establishes the Regulatory Determination List, which contains at least five or more contaminants from the CCL that merit further EPA evaluation on whether regulation on these contaminants would present a meaningful opportunity to reduce health risk.

The first CCL, CCL1, was announced in March 1998; and the second CCL, CCL2, was announced in February 2005. The Regulatory Determinations List for CCL1 was signed in July 2003, and was signed for CCL2 in April 2007, announcing that no regulatory action is appropriate or necessary for the contaminants listed in Table I-1. A draft of CCL3 was announced in February 2008 (Table I-2). CCL2 had built directly off of CCL1, but the new list used a different procedure for development than the previous two CCLs. The process began by looking at a broad selection of possible contaminants. Then initial screening criteria shortened the list, and finally further study and expert opinion determined the final contaminants for inclusion on the list.

Table I-1: Contaminant Candidate List and Determinations

Contaminant	No Regulatory Action Necessary
Microbial Contaminants	
Acanthamoeba	CCL1
Adenoviruses	
Aeromonas hydrophila	
Caliciviruses	
Coxsackieviruses	
Cyanobacteria (blue-green algae), other freshwater algae, and their toxins	

Table I-1: Contaminant Candidate List and Determinations

Contaminant	No Regulatory Action Necessary
Echoviruses	
Helicobacter pylori	
Microsporidia (Enterocytozoon & Septata)	
Mycobacterium avium intracellulare (MAC)	
Chemical Contaminant	
1,1,2,2-tetrachloroethane	CCL2
1,2,4-trimethylbenzene	
1,1-dichloroethane	
1,1-dichloropropene	
1,2-diphenylhydrazine	
1,3-dichloropropane	
1,3-dichloropropene	CCL2
2,4,6-trichlorophenol	
2,2-dichloropropane	
2,4-dichlorophenol	
2,4-dinitrophenol	
2,4-dinitrotoluene	CCL2
2,6-dinitrotoluene	CCL2
2-methyl-Phenol (o-cresol)	
Acetochlor	
Alachlor ESA & other acetanilide pesticide degradation products	
Aldrin	CCL1
Aluminum	
Boron	CCL2
Bromobenzene	
DCPA mono-acid degradate	CCL2
DCPA di-acid degradate	CCL2
DDE	CCL2
Diazinon	
Dieldrin	CCL1
Disulfoton	
Diuron	
EPTC (s-ethyl-dipropylthiocarbamate)	CCL2
Fonofos	CCL2
Hexachlorobutadiene	CCL1
p-Isopropyltoluene (p-cymene)	
Linuron	
Manganese	CCL1
Methyl bromide	
Methyl-t-butyl ether (MTBE)	
Metolachlor	
Metribuzin	CCL1

Table I-1: Contaminant Candidate List and Determinations

Contaminant	No Regulatory Action Necessary
Molinate	
Naphthalene	CCL1
Nitrobenzene	
Organotins	
Perchlorate	
Prometon	
RDX	
Sodium	CCL1
Sulfate	CCL1
Terbacil	CCL2
Terbufos	
Triazines & degradation products of triazines	
Vanadium	

Table I-2: Draft Contaminant Candidate List 3 (EPA, 2008)

Contaminant	CASRN	Information about the contaminant
Microbial		
*Caliciviruses**	-	Virus (includes Norovirus) causing mild self-limiting gastrointestinal illness
Campylobacter jejuni	-	Bacterium causing mild self-limiting gastroentestinal illness
Entamoeba histolytica	-	Protozoan parasite which can cause short as well as long-lasting gastrointestinal illness
Escherichia coli (0157)	-	Toxin-producing bacterium causing gastrointestinal illness and kidney failure
*Helicobacter pylori**	-	Bacterium sometimes found in the environment capable of colonizing human gut that can cause ulcers and cancer
Hepatitis A virus	-	Virus that causes a liver disease and jaundice
Legionella pneumophila	-	Bacterium found in the environment including hot water systems causing lung diseases when inhaled
Naegleria fowleri	-	Protozoan parasite found in shallow, warm surface and ground water causing primary amebic meningoencephalitis
Salmonella enterica	-	Bacterium causing mild self-limiting gastrointestinal illness
Shigella sonnei	-	Bacterium causing mild self-limiting gastrointestinal illness and bloody diarrhea
Vibrio cholerae	-	Bacterium found in the environment causing gastrointestinal illness
Chemical		
alpha-Hexachlorocyclohexane	319-84-6	It is a component of benzene hexachloride (BHC) and was formerly used as an insecticide.
1,1,1,2-Tetrachloroethane*	630-20-6	It is an industrial chemical used in the production of other substances.
1,1-Dichloroethane*	75-34-3	It is an industrial chemical used as a solvent.
1,2,3-Trichloropropane	96-18-4	It is an industrial chemical used in paint manufacture.
1,3-Butadiene	106-99-0	It is an industrial chemical used in rubber production.
1,3-Dinitrobenzene	99-65-0	It is an industrial chemical and is used in the production of other substances.
1,4-Dioxane	123-91-1	It is used as a solvent or solvent stabilizer in the manufacture and processing of paper, cotton, textile products, automotive coolant, cosmetics and shampoos.
1-Butanol	71-36-3	It is used in the production of other substances, and as a paint solvent and food additive.
2-Methoxyethanol	109-86-4	It is used in consumer products, such as synthetic cosmetics, perfumes, fragrances, hair preparations, and skin lotions.

Table I-2: Draft Contaminant Candidate List 3 (EPA, 2008)

Contaminant	CASRN	Information about the contaminant
2-Propen-1-ol	107-18-6	It is used in the production of other substances, and in the manufacture of flavorings and perfumes.
3-Hydroxycarbofuran	16655-82-6	It is a carbamate, and is a pesticide degradate. The parent, carbofuran, is used as an insecticide.
4,4'-Methylenedianiline	101-77-9	It is used in the production of other substances, and as a corrosion inhibitor and curing agent for polyurethanes.
Acephate	30560-19-1	It is used as an insecticide.
Acetaldehyde	75-07-0	It is used in the production of other substances, and as a pesticide and food additive.
Acetamide	60-35-5	It is used as a solvent, solubilizer, plasticizer, and stabilizer.
Acetochlor*	34256-82-1	It is used as an herbicide for weed control on agricultural crops.
Acetochlor ethanesulfonic acid (ESA)*	187022-11-3	Acetochlor ESA is an acetanilide pesticide degradate. The parent, acetochlor, is used as an herbicide for weed control on agricultural crops.
Acetochlor oxanilic acid (OA)*	184992-44-4	Acetochlor OA is an acetanilide pesticide degradate. The parent, acetochlor, is used as an herbicide for weed control on agricultural crops.
Acrolein	107-02-8	It is used as an aquatic herbicide, rodenticide, and industrial chemical.
Alachlor ethanesulfonic acid (ESA)*	142363-53-9	Alachlor ESA is an acetanilide pesticide degradate. The parent, alachlor, is used as an herbicide for weed control on agricultural crops.
Alachlor oxanilic acid (OA)*	171262-17-2	Alachlor OA is an acetanilide pesticide degradate. The parent, alachlor, is used as an herbicide for weed control on agricultural crops.
Aniline	62-53-3	It is used as an industrial chemical, as a solvent, in the synthesis of explosives, rubber products, and in isocyanates.
Bensulide	741-58-2	It is used as an herbicide.
Benzyl chloride	100-44-7	It is used in the production of other substances, such as plastics, dyes, lubricants, gasoline and pharmaceuticals.
Butylated hydroxyanisole	25013-16-5	It is used as a food additive (antioxidant).
Captan	133-06-2	It is used as a fungicide.
Chloromethane (Methyl chloride)	74-87-3	It is used as a foaming agent and in the production of other substances.
Clethodim	110429-62-4	It is used as an herbicide.
Cobalt	7440-48-4	It is a naturally-occurring element and was formerly used as cobaltus chloride in medicines and as a germicide.
Cumene hydroperoxide	80-15-9	It is used as an industrial chemical and is used in the production of other substances.
Cyanotoxins (3)*		Toxins naturally produced and released by cyanobacteria ("blue-green algae"). Various studies suggest three cyanotoxins for consideration: Anatoxin-a, Microcystin-LR, and Cylindrospermopsin.
Dicrotophos	141-66-2	It is used as an insecticide.
Dimethipin	55290-64-7	It is used as an herbicide and plant growth regulator.
Dimethoate	60-51-5	It is used as an insecticide on field crops, (such as cotton), orchard crops, vegetable crops, in forestry and for residential purposes.
Disulfoton*	298-04-4	It is used as an insecticide.
Diuron*	330-54-1	It is used as an herbicide.
Ethion	563-12-2	It is used as an insecticide.
Ethoprop	13194-48-4	It is used as an insecticide.
Ethylene glycol	107-21-1	It is used as an antifreeze, in textile manufacture and is a cancelled pesticide.
Ethylene oxide	75-21-8	It is used as a fungicidal and insecticidal fumigant.
Ethylene thiourea	96-45-7	It is used in the production of other substances, such as for vulcanizing polychloroprene (neoprene) and polyacrylate rubbers, and as a pesticide.
Fenamiphos	22224-92-6	It is used as an insecticide.
Formaldehyde	50-00-0	It has been used as a fungicide, may be a disinfection byproduct, and can occur naturally.

Table I-2: Draft Contaminant Candidate List 3 (EPA, 2008)

Contaminant	CASRN	Information about the contaminant
Germanium	7440-56-4	It is a naturally-occurring element and is commonly used as germanium dioxide in phosphors, transistors and diodes, and in electroplating.
HCFC-22	75-45-6	It is used as a refrigerant, as a low-temperature solvent, and in fluorocarbon resins, especially in tetrafluoroethylene polymers.
Hexane	110-54-3	It is used as a solvent and is a naturally-occurring alkane.
Hydrazine	302-01-2	It is used in the production of other substances, such as rocket propellants, and as an oxygen and chlorine scavenging compound.
Methamidophos	10265-92-6	It is used as an insecticide.
Methanol	67-56-1	It is used as an industrial solvent, a gasoline additive and also as anti-freeze.
Methyl bromide* (Bromomethane)	74-83-9	It has been used as a fumigant as a fungicide.
Methyl tert-butyl ether*	1634-04-4	It is used as an octane booster in gasoline, in the manufacture of isobutene and as an extraction solvent.
Metolachlor*	51218-45-2	It is used as an herbicide for weed control on agricultural crops.
Metolachlor ethanesulfonic acid (ESA)	171118-09-5	Metolachlor ESA is an acetanilide pesticide degradate. The parent, metolachlor, is used as an herbicide for weed control on agricultural crops.
Metolachlor oxanilic acid (OA)	152019-73-3	Metolachlor OA is an acetanilide pesticide degradate. The parent, metolachlor, is used as an herbicide for weed control on agricultural crops.
Molinate*	2212-67-1	It is used as an herbicide.
Molybdenum	7439-98-7	It is a naturally-occurring element and is commonly used as molybdenum trioxide as a chemical reagent.
Nitrobenzene*	98-95-3	It is used in the production of aniline, and also as a solvent in the manufacture of paints, shoe polishes, floor polishes, metal polishes, explosives, dyes, pesticides and drugs (such as acetaminophen), and in its re-distilled form (oil of mirbane) as an inexpensive perfume for soaps.
Nitrofen	1836-75-5	It is used as an herbicide.
Nitroglycerin	55-63-0	It is used in pharmaceuticals, in the production of explosives, and in rocket propellants.
N-Methyl-2-pyrrolidone	872-50-4	It is a solvent in the chemical industry, and is used for pesticide application and in food packaging materials.
N-nitrosodiethylamine (NDEA)	55-18-5	It is a nitrosamine used as an additive in gasoline and in lubricants, as an antioxidant, as a stabilizer in plastics, and also may be a disinfection byproduct.
N-nitrosodimethylamine (NDMA)	62-75-9	It is a nitrosamine and has been formerly used in the production of rocket fuels, is used as an industrial solvent and an anti-oxidant, and also may be a disinfection byproduct.
N-nitroso-di-n-propylamine (NDPA)	621-64-7	It is a nitrosamine and may be a disinfection byproduct.
N-Nitrosodiphenylamine	86-30-6	It is a nitrosamine chemical reagent that is used as a rubber and polymer additive and may be a disinfection byproduct.
N-nitrosopyrrolidine (NPYR)	930-55-2	It is a nitrosamine used as a research chemical and may be a disinfection byproduct.
n-Propylbenzene	103-65-1	It is used in the manufacture of methylstyrene, in textile dyeing, and as a printing solvent, and is a constituent of asphalt and naptha.
o-Toluidine	95-53-4	It is used in the production of other substances, such as dyes, rubber, pharmaceuticals and pesticides.
Oxirane, methyl-	75-56-9	It is an industrial chemical used in the production of other substances.
Oxydemeton-methyl	301-12-2	It is used as an insecticide.
Oxyfluorfen	42874-03-3	It is used as an herbicide.
Perchlorate*	14797-73-0	It is both a naturally occurring and man-made chemical. Most of the perchlorate manufactured in the United States is used as the primary ingredient of solid rocket propellant.
Permethrin	52645-53-1	It is used as an insecticide.

Table I-2: Draft Contaminant Candidate List 3 (EPA, 2008)

Contaminant	CASRN	Information about the contaminant
PFOA (perfluorooctanoic acid)	335-67-1	It is used for its emulsifier and surfactant properties in or as fluoropolymers (such as Teflon), fire-fighting foams, cleaners, cosmetics, greases and lubricants, paints, polishes and adhesives and photographic films.
Profenofos	41198-08-7	It is used as an insecticide and an acaricide.
Quinoline	91-22-5	It is used in the production of other substances, and as a pharmaceutical (anti-malarial) and as a flavoring agent.
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)*	121-82-4	It is used as an explosive.
sec-Butylbenzene	135-98-8	It is used as a solvent for coating compositions, in organic synthesis, as a plasticizer and in surfactants.
Strontium	7440-24-6	It is naturally-occurring element and is used as strontium carbonate in pyrotechnics, in steel production, as a catalyst and as a lead scavenger.
Tebuconazole	107534-96-3	It is used as a fungicide.
Tebufenozide	112410-23-8	It is used as an insecticide.
Tellurium	13494-80-9	It is a naturally-occurring element and is commonly used as sodium tellurite in bacteriology and medicine.
Terbufos*	13071-79-9	It is used as an insecticide.
Terbufos sulfone	56070-16-7	Terbufos sulfone is a phosphorodithioate pesticide degradate. The parent, terbufos, is used as an insecticide.
Thiodicarb	59669-26-0	It is used as an insecticide.
Thiophanate-methyl	23564-05-8	It is used as a fungicide.
Toluene diisocyanate	26471-62-5	It is used in the manufacture of plastics.
Tribufos	78-48-8	It is used as an insecticide and as a cotton defoliant.
Triethylamine	121-44-8	It is used in the production of other substances, and as a stabilizer in herbicides and pesticides, in consumer products, in food additives, in photographic chemicals and in carpet cleaners.
Triphenyltin hydroxide (TPTH)	76-87-9	It is used as a pesticide.
Urethane	51-79-6	It is used as a paint ingredient.
Vanadium*	7440-62-2	It is a naturally-occurring element and is commonly used as vanadium pentoxide in the production of other substances and as a catalyst.
Vinclozolin	50471-44-8	It is used as a fungicide.
Ziram	137-30-4	It is used as a fungicide.

*Contaminants also contained on CCL2

Unregulated Contaminant Monitoring Regulations (UCMR)

The Unregulated Contaminant Monitoring Regulations (UCMR) program collects data for contaminants suspected to be present in drinking water but which do not yet have an established regulatory standard under the Safe Drinking Water Act (SDWA).

Through the 1996 amendments of the SDWA, the USEPA established several changes to the UCRM program, including the monitoring requirement of no more than 30 analytes in a 5-year cycle. Development of each cycle of the UCMR is done in coordination with the Candidate Contaminant List (CCL) and the National Drinking Water Contaminant Occurrence Database (NCOD). The data collected through the UCMR program may guide the development of subsequent CCLs and ultimately support the EPA Administrator's regulatory determination.

In 1999, EPA promulgated the rule to support the first cycle (2001-2005) of this revised UCMR program, known as UCMR 1. UCMR 2 was promulgated in January 2007, with the monitoring under this cycle targeted to start in 2008.

UCMR 2 includes a two-tiered monitoring approach – the Assessment Monitoring and the Screening Survey – to monitor for 25 contaminants as shown in Table I-3. Large public water systems serving 100,000 or more people are required to sample for all 25 contaminants listed under the UCMR2 during a 12-month period between January 2008 and December 2010. SFPUC serves approximately 2.4 million people and is therefore subject to the UCMR 2.

Table I-3: UCMR2 Contaminants

Contaminant	***SFPUC Concern?***
Assessment Monitoring	
Dimethoate	No – Minimal Insecticide Use in Watershed
Terbufos sulfone	No – Minimal Insecticide Use in Watershed
Five Flame Retardants	
2,2',4,4'-tetrabromodiphenyl ether (BDE-47)	No – Pristine Hetch Hetchy Source
2,2',4,4',5-pentabromodiphenyl ether (BDE-99)	No – Pristine Hetch Hetchy Source
2,2',4,4',5,5'-hexabromobiphenyl (HBB)	No – Pristine Hetch Hetchy Source
2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153)	No – Pristine Hetch Hetchy Source
2,2',4,4',6-pentabromodiphenyl ether (BDE-100)	No – Pristine Hetch Hetchy Source
Three Explosives	
1,3-dinitrobenzene	No – Pristine Hetch Hetchy Source
2,4,6-trinitrotoluene (TNT)	No – Pristine Hetch Hetchy Source
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	No – Pristine Hetch Hetchy Source
Screening Survey	
Three Parent Acetanilides	
Acetochlor	No – Minimal Herbicide Use in Watershed
Alachlor	No – Minimal Herbicide Use in Watershed
Metolachlor	No – Minimal Herbicide Use in Watershed
Six Acetanilide Degradates	
Acetochlor ethane sulfonic acid (ESA)	No – Minimal Herbicide Use in Watershed
Acetochlor oxanilic acid (OA)	No – Minimal Herbicide Use in Watershed
Alachlor ethane sulfonic acid(ESA)	No – Minimal Herbicide Use in Watershed
Alachlor oxanilic acid (OA)	No – Minimal Herbicide Use in Watershed
Metolachlor ethane sulfonic acid(ESA)	No – Minimal Herbicide Use in Watershed
Metolachlor oxanilic acid (OA)	No – Minimal Herbicide Use in Watershed
Six Nitrosamines	
N-nitroso-diethylamine (NDEA)	Yes - Chloramination Byproduct
N-nitroso-dimethylamine (NDMA)	Yes - Chloramination Byproduct
N-nitroso-di-n-butylamine (NDBA)	Yes - Chloramination Byproduct
N-nitroso-di-n-propylamine (NDPA)	Yes - Chloramination Byproduct
N-nitroso-methylethylamine (NMEA)	Yes - Chloramination Byproduct
N-nitroso-pyrrolidine (NPYR)	Yes - Chloramination Byproduct

European Union NORMAN Network List

The European Union list was created by the Network of Reference Laboratories for Monitoring of Emerging Environmental Pollutants (NORMAN Network). The NORMAN Network is a European Union project to improve the exchange of information and data for emerging contaminants as well as to validate and harmonize measurement methods.

Table I-4 summarizes key emerging contaminants. The table is organized into broad categories and smaller sub-categories. Where available, SFPUC water quality data is presented and preliminary recommendations are given for further action.

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
Organic Chemicals				
Algal Toxins				
Algal Toxins	Anitoxin-A	<0.05 ug/L	Raw and treated water samples from 9/28/07	Retesting should occur during future algae blooms and annually to develop a baseline.
	Cylindrospermopsin	<0.05 ug/L		
	Microcystin	<0.04 ug/L		
	Saxitoxin	<0.1 ug/L		
Detergents				
Aromatic sulphonates	Naphthalene sulphonic acid			Protected watersheds mean detergents should not be a significant issue.
Alcohol ethoxylates (AEs)				
Alkanol amides				
Alkyl glucamides (AGs)				
Alkyl polyglucosides (APGs)				
Alkyl sulfates (AS)				
Alkylether sulfates (AES)				
Alkylphenol ethoxylates (APEOs)				
alpha-Olefin sulfonates (AOS)				
Amine ethoxylates				
Cocamidopropyl betaine				
Fatty acid diethanolamides (FADAs)				
Organosilicones				
Polyethylene glycols				
Secondary alkane sulfonates (SAS)				
Linear alkylbenzene sulfonates (LAS)	C1-C14-LAS			
	C12-LAS			
Ethoxylates/carboxylates of octyl/nonyl phenols	4-Nonylphenol di-ethoxylate (NPE2O)			
	4-Nonylphenol mono-ethoxylate (NPE1O)			
	4-Nonylphenoxy acetic acid (NPE1C)			
	4-Nonylphenoxyethoxy acetic acid (NPE2C)			
	4-Octylphenol di-ethoxylate (OPE2O)			
	4-Octylphenol mono-ethoxylate (OPE1O)			
	4-Octylphenoxy acetic acid (OPE1C)			
	4-Octylphenoxyethoxy acetic acid (OPE2C)			

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
Disinfection By-Products				
Iodo-trihalomethanes	Bromochloroiodomethane	<62 ng/L in finished water	7/26/2006 at HTWTP	Within the survey, SFPUC had some of the lowest values for iodo-DBPs within the 23 participating utilities.
	Dichloroiodomethane	90 ng/L in finished water		
Iodo-acids	Iodoacetic acid	<1 ng/L in raw and finished water		
	Bromoiodoacetic acid	<1 ng/L in raw water; 7 ng/L in finished water		
	(Z)-3-Bromo-3-iodopropenoic acid	12 ng/L in raw and finished water		
	(E)-3-Bromo-3-iodopropenoic acid	4 ng/L in raw and finished water		
	(E)2-Iodo-3-methylbutenedioic acid	4 ng/L in raw and finished water		
Bromoacids				
Bromoacetonitriles		**BCAN** - 0.7 ppb at HTWTP effluent in 2001 **DBAN** - 0.6 ppb at HTWTP effluent in 2001 No Data for SVWTP Below detection for Alameda East		
Bromoaldehydes				
Haloacetic acids (chloro-, bromo-, iodo-)		Total HAAs (Average Since 2005): Alameda East - 26 ppb HTWTP Effluent - 5.6 ppb SVWTP Effluent - 24 ppb		
Other disinfection by-products	Bromate	< 5 ug/L in all treated water		
	Cyanoformaldehyde			
	Decabromodiphenyl ethane			
	Hexabromocyclododecane (HBCD)			
	NDMA	**NDMA**: Highest recorded reading to date is 4.6 ng/L in Dec 2006 downstream of HTWTP at CHS#13. Within the last year, four out of five samples at this location had a positive detection. Sampling points for HH, SVWTP and blended water were all below detection (2 ng/L)	C	

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
		Plasticizers		
Phthalates	Benzylbutylphthalate (BBP)	< 50 ng/L all sites	A	Protected watersheds mean plasticizers should not be a significant issue.
	Diethylphthalate (DEP)			
	Dimetylphthalate (DMP)			
	Di-n-butylphthalate (DBP)			
	Di-n-octylphthalate (DOP)	<120 ng/L all sites	A	
Other	Bisphenol A	< 5 ng/L all sites	A	
	Triphenyl phosphate			
Benzophenone derivatives	2,4-Dihydroxybenzophenone			
		Flame Retardants		
Brominated flame retardants	1,2,5,6,9,1-Hexabromocyclododecane (HBCD)			Some flame retardants will be tested for under the UCMR2 requirements. Testing will take place between 2008 and 2010.
	Tetrabromo bisphenol A (TBBPA)			
	Tetrabromo bisphenol A bis (2,3 dibromopropylether)			
	Hexabromocyclododecane (isomers)			
	Decabromodiphenyl ethane			
Polybrominated diphenylethers	2,2\',3,4,4\',5\',6-Heptabromodiphenyl ether (BDE 183)			
	2,2\',4,4\',5,5\'-Hexabromodiphenyl ether (BDE-153)			
	2,2\',4,4\',5,6\'-Hexabromodiphenyl ether (BDE-154)			
	2,2\',4,4\',5-Pentabromodiphenyl ether (BDE-99)			
	2,2\',4,4\',6-Pentabromodiphenyl ether (BDE-1)			
	2,2\',4,4\'-Tetrabromodiphenyl ether (BDE-47)			
	2,2',3,3',4,4',5,5',6,6'-Decabromodiphenyl ether (BDE-29)			
	Technical Decabromodiphenyl ether			
	Technical Octabromodiphenyl ether			
	Technical Pentabromodiphenyl ether			
Organophosphates	Tri-(dichlorisopropyl)phosphate			
	Triethylphosphate			
	Tri-n-butylphosphate			
	Triphenylphosphate			
	Tris(2-chloroethyl)phosphate			
Chlorinated paraffins	Long chain PCAs (lPCAs, C>17)			
	Medium chain PCAs (mPCAs, C14-17)			
	Technical PCA products			
		Fragrances		
Fragrances	Acetylcedrene			Protected watersheds and source water which is unimpacted by treated wastewater means fragrances should not be a significant issue.
	Benzylacetate			
	Benzylsalicylate			
	Camphor			
	g-Methylionone			
	Hexylcinnamaldehyde			
	Isoborneol			
	Isobornylacetate			
	Isoquinoline			
	d-Limonene			
	Methyldihydrojasmonate			
	Methylsalicylate			
	p-t-Bucinal			
	Terpineol			

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
Nitro musks	Muskketone	< 25 ng/L all sites	A	Protected watersheds and source water which is unimpacted by treated wastewater means fragrances should not be a significant issue.
	Muskxylene			
	Musk ambrette			
Macrocyclic musks				
Polycyclic musks	AHTN (Tonalide)	< 25 ng/L all sites	A	
	Galaxolide	< 25 ng/L all sites	A	
	OTNE			
	AHDI (Phantolide)			
	ADBI (Celestolide)			
	ATII (Traseolide)	< 25 ng/L all sites	A	
Gasoline Additives				
Dialkyl ethers	Methyl-tert-butyl ether (MTBE)	< 0.5 ug/L in all source and treated water	B	Protected watersheds mean gasoline additives should not be a significant issue.
Nanoparticles				
Carbon fullerenes	Buckyballs (Fullerene C-6)			
Carbon nanotubes	Carbon nanotubes - single-wall			Protected watersheds and source water which is unimpacted by treated wastewater means nanoparticles should not be a significant issue. However, the fate of nano-particles in the environment is not well understood and SFPUC should follow advances in the field.
	Carbon nanotubes - multi-wall			
	Carbon nanotubes - coated			
Carbon black	Carbon black			
Silicon-based	Silicon Carbide			
	Silica	Silica (Average since 2005): Alameda East - 4.8 mg/L with one high reading of 16,000 mg/L HTWTP Effluent - 5.2 mg/L SVWTP Effluent - 7.7 mg/L		
Titanium dioxyde	Titanium dioxyde			
Aluminium Oxide	Aluminium Oxide (powder)			
	Aluminium Oxide (fibre)			
Perfluoroalkylated Substances (group of chemicals commonly used in carpet, textiles, leather & paper protection, fire-fighting foam and surfactants)				
Perfluoroalkylated substances	2-(N-ethylperfluorooctanesulfonamido)-ethyl alcohol (N-Et-FOSE)			No industrial development in the watersheds decreases the likelihood of perfluoroalkylated substances. Collaboration with the fire department needs to ensure proper fire fighting chemicals used in the case of a large scale fire.
	2-(N-methylperfluorooctanesulfonamido)-ethyl alcohol (N-Me-FOSE)			
	6:2 Fluorotelomer sulfonate (6:2 FTS)			
	Alcohol N-methylperfluorooctane sulfonamidoetanol (N-MeFOSE)			
	N-ethylperfluorooctanesulfonamide (EtFOSA)			
	N-methylperfluorooctanesulfonamide (MeFOSA)			
	N-methylperfluorooctanesulfonamidoethyl acrylate (N-MeFOSEA)			
	Perfluorobutanesulfonate anion (PFBS)			
	Perfluorodecane sulfonate (PFDS)			
	Perfluorodecanoic acid (PFDA)			
	Perfluorododecanoic acid (PFDoA)			
	Perfluorododecanoic acid (PFDoA)			

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
	Perfluoroheptanoic acid (PFHpA)			No industrial development in the watersheds decreases the likelihood of perfluoroalkylated substances. Collaboration with the fire department needs to ensure proper fire fighting chemicals used in the case of a large scale fire.
	Perfluoroheptanoic acid (PFHxA)			
	Perfluorohexane sulfonate (PFHS)			
	Perfluorononanoic acid (PFNA)			
	Perfluorooctane sulfonamide (PFOSA)			
	Perfluorooctane sulfonamidoethanol (FOSE)			
	Perfluorooctane sulfonate (PFOS)			
	Perfluorooctanesulfonyl fluoride (POSF)			
	Perfluorooctanoic acid (PFOA)			
	Perfluorosulfonamide			
	Perfluorotetradecanoic acid (PFTDA)			
	Perfluoroundecanoic acid (PFUnA)			
Fluorotelomer alcohols	4:2 FTOH			
	6:2 FTOH			
	8:2 FTOH			
	1:2 FTOH			
	12:2 FTOH			
Perfluorosulfonamido alcohols				
Personal Care Products				
Sun-screen agents	4-Methylbenzylidene camphor			Protected watersheds and source water which is unimpacted by treated wastewater means personal care products should not be a significant issue. Limited testing to ensure non-detects recommended.
	Benzophenone	< 25 ng/L all sites	A	
	Benzophenone-3			
	Butyl methoxydibenzoylmethane			
	Ethylhexyl methoxycinnamate			
	Eusolex			
	Homosalate			
	N,N-Diethyltoluamide			
	Octocrylene			
	Oxybenzone			
Insect repellents	N,N-diethyl-m-toluamide (DEET)	< 25 ng/L all sites	A	
	Bayrepel			
Carriers	Octamethylcyclotetrasiloxane (D4)			
	Decamethylcyclopentasiloxane (D5)			
	Dodecamethylcyclohexasiloxane (D6)			
	Hexamethyldisiloxane (HM or HMDS)			
	Octamethyltrisiloxane (MDM)			
	Decamethyltetrasiloxane (MD2M)			
	Dodecamethylpentasiloxane (MD3M)			
Parabens (hydroxybenzoic acid esters)	Methyl-paraben			
	Ethyl-paraben			
	Propyl-paraben			
	Isobutyl-paraben			
Pesticides				
Polar pesticides and their degradation products	Amitrole			Protected watersheds mean pesticides should not be a significant issue.
	Bentazone	<2 ug/L in surface waters	D	
	Bromofos-ethyl			
	Carbazole			
	Carbendazim			
	Carboxin			
	Glyphosate	<6 ug/L in surface waters	D	
	Chloridazon			
	Clopyralid			
	Chlorpropham			

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
CONTINUED: Polar pesticides and their degradation products	Chlorpyrifos			Protected watersheds mean pesticides should not be a significant issue.
	Chlorotoluron			
	2,4 D			
	Dicamba	< 1.5 ug/L in surface waters	D	
	Desethylterbutylazine			
	Desmedipham			
	Desmetryn			
	Diazinon	<0.25 ug/L in surface water	D	
	Diclobenil			
	d-Dichlorvos			
	Dinoterb			
	Endosulfan-sulfate			
	Ethoprophos			
	Ethofumesate			
	Fluroxypyr			
	Heptenophos			
	Iodofenphos			
	Imidacloprid			
	MCPA			
	MCPB			
	MCPP (Mecoprop)			
	Metalaxyl			
	Methomyl	< 2 ug/L in surface waters	D	
	Metamitron			
	Mevinphos			
	Phenmedipham			
	Prometryn	< 2 ug/L in surface waters	D	
	Prometon	ND in surface waters	D	
	Secbumeton			
	Terbutryn			
	Terbutylazine			
	Thiabendazyl			
	Triadimefon			
Other pesticides	Cypermethrin			
	Deltamethrin			
	Permethrin			
New pesticides	Sulfonyl urea			
Degradation products of pesticides	Desisopropylatrazine			
	Desethylatrazine			
Antimicrobial agents	Dichlofluanide			
Pharmaceuticals				
Analgesic	Acetaminophen (paracetamol)			Source water unimpacted by treated wastewater means that pharmaceuticals should not be a significant concern. However, levels of estrone and progesterone were above detection in HTWTP raw water meaning continued surveillance may be warranted.
	Codeine			
	Hydrocodone			
Anorexic	Fenfluramine			
Anthelmintic	Ivermectin			

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
Antibacterial	Amoxicillin			Source water unimpacted by treated wastewater means that pharmaceuticals should not be a significant concern. However, levels of estrone and progesterone were above detection in HTWTP raw water meaning continued surveillance may be warranted.
	Ampicillin			
	Azithromycin			
	Chloramphenicol			
	Chlortetracycline			
	Ciprofloxacin			
	Clarithromycin			
	Cloxacillin			
	Danofloxacin			
	Dicloxacillin			
	Doxycycline (anhydrous)			
	Doxycycline (monohydrate)			
	Enoxacin			
	Enrofloxacin			
	Erythromycin			
	Flumequine			
	Josamycin			
	Lincomycin			
	Methicillin			
	Minocycline			
	Norfloxacin			
	Novobiocin			
	Ofloxacin			
	Oleandomycin			
	Oxacillin			
	Oxytetracycline			
	Penicillin G			
	Penicillin V			
	Roxithromycin			
	Spiramycin			
	Sulfadiazine			
	Sulfamerazine			
	Sulfamethazine			
Anticonvulsant	Sulfamethoxazole	< 0.25 ng/L all sites	A	
	Sulfapyridine			
	Carbamazepine	< 0.50 ng/L all sites	A	
	Primidone			
Antidepressant	Tetracycline			
	Tiamulin			
	Citalopram			
	Escitalopram			
	Sertraline			
	Fluoxetine	< 0.50 ng/L all sites	A	
	Fluvoxamine			
	Paroxetine			
Antidiabetic	Glyburide (glibenclamid; glybenzcyclamide)			
	Metformin			
Antiemetic	Diphenhydramine			
Antihistaminic	Loratadine			

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
Antihypertensive	Nadolol			Source water unimpacted by treated wastewater means that pharmaceuticals should not be a significant concern. However, levels of estrone and progesterone were above detection in HTWTP raw water meaning continued surveillance may be warranted.
	Verapamil			
Anti-inflammatory	Aceclofenac			
	Acemetacin			
	Acetylsalicylic acid (aspirin)			
	Alclofenac			
	Diclofenac	< 0.25 ng/L all sites	A	
	Fenoprofen			
	Fenoprofen calcium salt dihydrate			
	Ibuprofen			
	Indomethacin			
	Ketoprofen			
	Meclofenamic acid			
	Mefenamic acid			
	Naproxen	< 0.50 ng/L all sites	A	
	Phenylbutazone			
	Phenazone			
	Propyphenazone			
	Tolfenamic acid			
Antimicrobial agent	Clotrimazole			
Antineoplastic	Cyclophosphamide			
	Cyclophosphamide (anhydrous form)			
	Daunorubicin			
	Doxorubicin			
	Epirubicin			
	Fluorouracil			
	Ifosfamide			
Antiulcerative	Famotidine			
	Lansoprazole			
	Omeprazole			
	Ranitidine			
Antiviral	Acyclovir			
Anxiolytic	Alprazolam			
	Bromazepam			
	Diazepam	< 0.25 ng/L all sites	A	
	Lorazepam			
	Medazepam			
	Meprobamate	< 0.25 ng/L all sites	A	
	Nordiazepam			
	Oxazepam			
	Temazepam			
Beta-Blockers	Acebutolol			
	Atenolol	< 0.25 ng/L all sites	A	
	Betaxolol			
	Bisoprolol			
	Carazolol			
	Metoprolol			
	Oxprenolol			
	Pindolol			
	Propranolol			
	Sotalol			
	Timolol			

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
Blood viscosity agents	Pentoxifylline			Source water unimpacted by treated wastewater means that pharmaceuticals should not be a significant concern. However, levels of estrone and progesterone were above detection in HTWTP raw water meaning continued surveillance may be warranted.
Bronchodilators	Albuterol			
	Albuterol sulfate			
	Clenbuterol			
	Fenoterol			
	Salbutamol			
	Terbutaline			
Diuretic	Caffeine			
	Furosemide			
	Hydrochlorothiazide			
Lipid regulators	Bezafibrate			
	Clofibric acid			
	Etofibrate			
	Fenofibrate			
	Fenofibric acid			
	Gemfibrozil	< 0.25 ng/L all sites	A	
	Lovastatin			
	Mevastatin			
	Pravastatin			
	Simvastatin	< 0.25 ng/L all sites	A	
Sedatives, hypnotics	Acecarbromal			
	Allobarbital			
	Amobarbital			
	Butalbital			
	Hexobarbital			
	Pentobarbital			
	Aprobarbital			
	Secobarbital sodium			
Steroids and hormones	17-alpha-Estradiol			
	17-alpha-Ethinylestradiol			
	17-beta-Estradiol			
	Beta-sitosterol			
	Cholesterol			
	Diethylstilbestrol			
	Estriol	< 0.50 ng/L all sites	A	
	Estrone	0.21 ng/L in raw HTWTP water <0.20 treated	A	
	Progesterone	2.5 ng/L in raw HTWTP water <0.50 treated	A	
	Estrone 3-sulphate			
	Prednisolone			
	Dexamethasone			
	Bethametasone			
	Mestranol			
Psychiatric drugs	Amitryptiline			
	Doxepine			
	Imapramine			
	Nordiazepam			
	Zolpidem			
X-ray contrast media	Diatrizoate			
	Iohexol			
	Iomeprol			
	Iopamidol			
	Iopromide			

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
Anticorrosives				
Benzotriazoles				No industrial development in the watersheds or wastewater discharge decreases the likelihood of anticorrosives.
Methylbenzotriazoles (MBT)	4-Methyl-1H-benzotriazole			
	5-Methyl-1H-benzotriazole			
	5,6-Dimethyl-1-H-benzotriazole			
Tolyltriazoles (TT)	Tolyltriazole			
	4-/5-Tolyltriazole (TTri)			
Phenols	para-Cresol			
Other				
Antifoaming agents	Surfinol-14			Protected watersheds with minimal development and no wastewater discharge decreases the likelihood of a wide range of contaminants.
Antioxidants	2,6-Di-tert-butylphenol			
	4-tert-Butylphenol			
	BHA	<25 ng/L all sites	A	
	BHQ			
	BHT	<25 ng/L all sites	A	
Antifouling compounds	Irgarol			
	Dibutyl tin ion			
	Monobutyl tin ion			
	Tetrabutyl tin ion			
	Diphenyltin ion			
	Triphenyltin ion			
Bio-terrorism/ sabotage agents	Chloropicrin			
Complexing agents	*DTPA*			
	EDTA			
	NTA			
	Oxadixyl			
	TAED			
Industrial chemicals	TCEP	< 50 ng/L all sites	A	
	Triphenyl phosphine oxide			
Biocides	Triclosan	< 1 ng/L all sites	A	
	Methyltriclosan			
	Chlorophene			
Drugs of abuse	Cocaine			
	Codeine			
	Dihydrocodeine			
	Heroin			
	Hydrocodone			
	Morphine			
	Oxycodone			
Benzothiazoles (BT)	Benzothiazole			
	2-Mercapto-benzothiazole			
	Benzothiazole sulfonic acid			
Nicotine metabolite	Cotinine			
Inorganic Chemicals				
Trace Metals and Their Compounds				
Trace metals and their compounds	Tetramethyllead			
	Tetraethyllead			

Table I-4: Emerging Contaminants from the European Union's NORMAN Network

Sub-class	Individual Substances	SFPUC WQ Data	Sampling Event	Recommendations
Microorganisms				
Bacteria	E. Coli 0157			It is telling that there is very little published information about the microbial ecology of distribution systems. At this point in time, the detection methods are expensive, are time consuming, require optimization for specific conditions, and are appropriate only for the research laboratory.
	Legionella	Sampled 53 buildings before & after conversion to chloramine, chloramine virtually eliminated Legionella.		
	Aeromonas			
	Heliobacter			
	Mycobacterium avium			
Protozoan	Microsporidia			
Virus	Caliciviruses			
	Echovirus			
	Coxsackieviruses			
	Adenovirus			

(1)Sampling Events:

A: Special AWWARF sampling event for emerging contaminants taking place in June 2006. Sites tested included: HTWTP raw, HTWTP effluent and SA#2 with the distribution system.

B: Title 22 Sampling from 7/11/06 - 77/13/06 of all sources waters and plant effluents

C: NDMA sampling data current as of 10/24/07

D: Sampling Event on 6/26/01

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