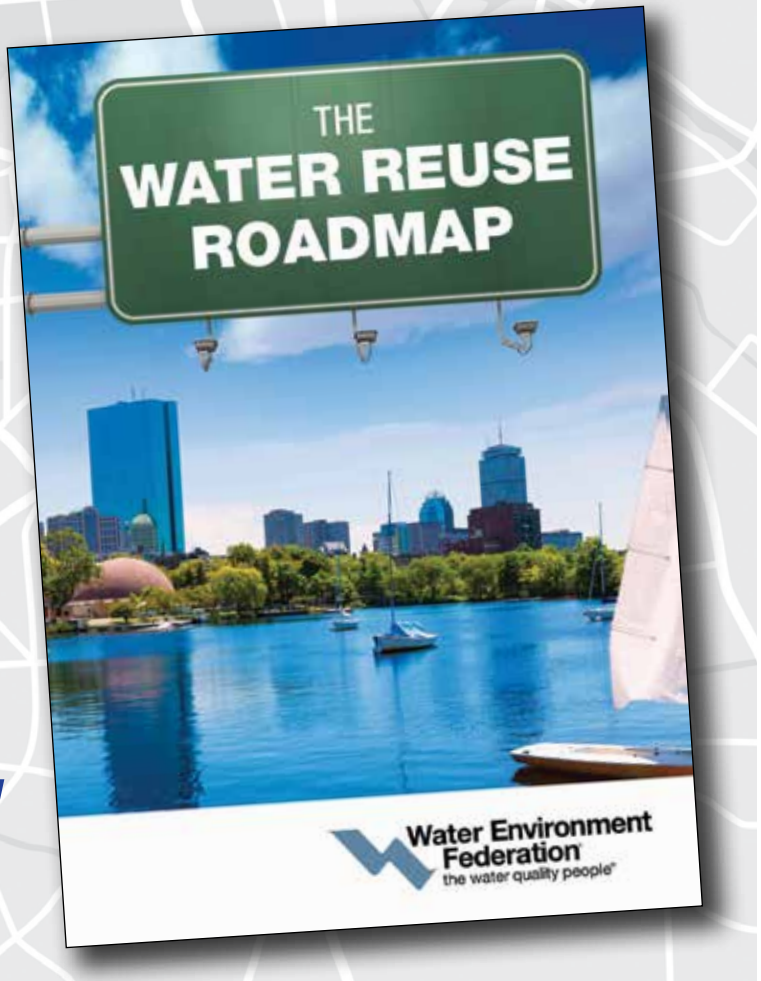
The Water Reuse Roadmap

P R I M E R

Essential practices to make water reuse an element of a diverse and resilient water management strategy



Water Reuse Roadmap Primer

"Water should not be judged by its history, but by its quality."

Dr. Lucas Van Vuuren, National Institute of Water Research, South Africa

Introduction

Two of the Water Environment Federation's (WEF) critical objectives are to "*generate an increased public awareness of the value of water leading to increased funding to protect water quality through appropriate levels of infrastructure, management approaches, and services"* and to *"establish the conditions that promote accelerated development and implementation of innovative technologies and approaches in the water sector.*"

WEF has been successful at striving toward those objectives through the use of a "maturity model" approach with the development of two roadmaps, on Energy (2013) and Nutrient Management (2015). The Reuse Roadmap development process builds on the experience gained developing the two previous WEF roadmap publications, which demonstrated the importance of a sector scan, effective partners, leveraging planned events with a similar theme, and building off of existing WEF programs.

The goal of the Reuse Roadmap is to develop a high-level approach to help guide utilities and industry decision-makers in issues to address when considering water reuse. Like the Energy and Nutrients roadmaps, the Water Reuse roadmap is brief and high level to be accessible to all types of stakeholders, including public officials, utility managers, operators, engineers, and regulators. The roadmap will not "reinvent the wheel," with all of the great technical resources available. Rather, the focus will be to help decision-makers to quickly understand the strategic issues inherent in a water reuse effort.

In February 2016, the Water Environment Federation, the Water Environment & Reuse Foundation (WE&RF), the National Water Research Institute (NWRI), and WateReuse sponsored a 2-day meeting at Orange County Sanitation District (OCSD) in California to take the next steps in developing a roadmap for the vision of sustainable water resources through the implementation of water reuse. OCSD was chosen as the location for the experts' meeting because of the County's leadership in water reuse. OCSD and the Orange County Water District (OCWD) have partnered on water recycling projects for more than 40 years, including the Groundwater Replenishment System (GWRS). Beginning in 2008, the GWRS is the world's largest indirect potable reuse project of its kind that produces 100 MGD.

The OCSD experts' meeting brought together more than three dozen diverse representatives from water utilities, regulatory agencies, academia, consultants, associations, non-governmental organizations (NGO). These attendees built the framework for the Reuse Roadmap based on the aspirational goal developed:

Water reuse is an element of a diverse and resilient water management strategy.

Achieving this goal will require a dedication to integrated resource management (IRM) in order to overcome the public relations challenges, technical barriers, and financial constraints while ensuring public health and environmental quality. The development of the Reuse Roadmap will progress in two phases. This Primer represents the first phase, a matrix of best practices developed from the major topics and subtopics identified by the experts' meeting participants. This matrix will be further developed by a larger group of subject-matter experts into a guidance document to be published in 2017. The guidance document will be supplemented with case studies and additional resources. The Roadmap will also inform future research, training, and advocacy programs to support the movement toward incorporating water reuse into IRM efforts at utilities.

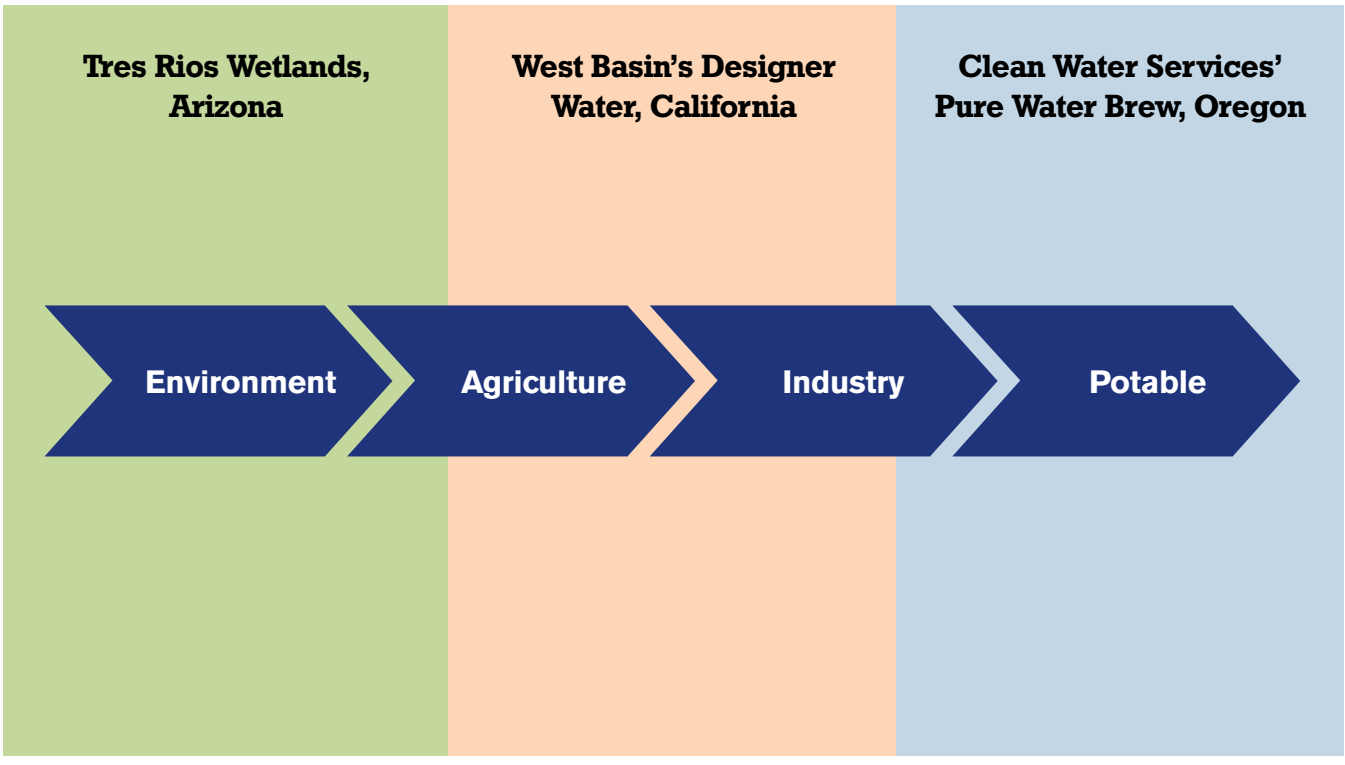
Major Themes

Water reuse is a multifaceted issue and two important terms are used to describe how recycled water is an integral part of the water cycle. **Recycled Water** generally refers to treated domestic wastewater that is used more than once before it passes back into the water cycle. The terms "reused" and "recycled" are often used interchangeably depending on where you are geographically.

While a number of topics were discussed by the experts about how to ensure that water reuse is *an element of a diverse and resilient water management strategy*, two themes were present across the entire conversation: **Fit for Purpose** and **Legitimacy**.

Fit for Purpose

Fit for purpose means matching water of a specific quality to a use appropriate for that quality. For example, a water with quality suitable for irrigation might not be suitable for industrial use as boiler feedwater. Because water can be treated to varying qualities depending on the need, water resource recovery facilities (WRRFs) should be aware of the end use of the product water they treat. This focus on treating to the appropriate use (fit for purpose) ensures both sufficient treatment for public health, environmental, or product needs while also minimizing the cost of overtreating water to a quality level much different than is actually required by the end use. The following three examples show how water reuse can be used for environmental quality and irrigation, industrial, and even for drinking.



Habitat Restoration and Public Recreation at Tres Rios Wetlands

In 1990, the Arizona Department of Environmental Quality released new water quality standards for wastewater discharges into Arizona waterways. The solution that was selected by the City of Phoenix was the construction of the Tres Rios wetland project, meeting water quality requirements while providing habitat for threatened and endangered species, as well as public recreation space. After passing through the wetlands, the water is then used for crop irrigation. Phoenix reuses 100 percent of their effluent, as the water that does not go to the wetland is provided as cooling water for the nearby power plant.

West Basin's Designer Water

In the early 1990s, the West Basin Municipal Water District in Los Angeles, California, added recycled water to its portfolio to serve a population of a million people. To meet the unique needs of their commercial and industrial customers, the utility produces "designer water," or amended tertiary water for industrial and irrigation use. The types of designer water the district produces include the following:

- Irrigation Water: Filtered and disinfected for industrial and irrigation use
- Cooling Tower Water: Tertiary treated water with ammonia removal
- Seawater Barrier and Groundwater Replenishment Water: Secondary water, with either lime clarification or microfiltration and reverse osmosis (RO)
- Low-Pressure Boiler Feed Water: microfiltration and reverse osmosis membranes for pure RO water
- High-Pressure Boiler Feed Water: Ultra-pure RO water treated by microfiltration membranes and passed through RO membranes twice

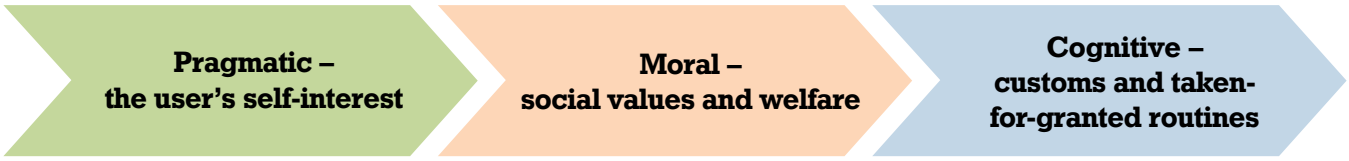
The designer water strategy enables the use of recycled water far beyond the potential of common irrigation applications for street medians, parks, and golf courses. West Basin also helps ensure the economic production in the area by supplying a critical resource to several local refineries and a power generation company.

Clean Water Services' Pure Water Brew Challenge

In order to demonstrate that water should be judged by its quality, not its history, Clean Water Services (Portland, OR) began partnering with Oregon brewers in 2014 with the goal of raising awareness and starting conversations about the reusable nature of all water. The Pure Water Brew Challenge advances the understanding of how high-purity water can be used for product manufacturing by highlighting one particular product: beer. The utility produced a batch of high-purity water that far exceeds safe drinking water standards and provided it to local brewers to make beer. These beers were featured at WateReuse's One Water Innovations Gala at WEFTEC® 2014 and in the Innovation Pavilion at WEFTEC 2015 and 2016. Beer is a product that Oregon is known for around the world; the Pure Water Brew Challenge is engaging industry professionals, public leaders, and people everywhere in this conversation about water. The hope is that conversations inspired by Pure Water Brew will broaden understanding about the potential of reused water as a source of clean water.

Legitimacy

Three Levels of Legitimacy



Innovative potable reuse projects have often been met with public opposition, despite having proven technology and water quality meeting or exceeding drinking water standards. The general mindset from technical professionals such as engineers and scientists is that the public will accept new technologies when provided with information through marketing and public education activities. A study at OCWD and OCSD about the success of their indirect potable reuse program showed that the success of their program was due to the legitimacy of their effort. In order to have a successful project, answering questions is required to address the concerns of the user at three levels of legitimacy such as:

- **Pragmatic** – How do I benefit? How am I involved in decision-making?
- **Moral** – How are safety and quality guaranteed? How has the organization performed in the past?
- **Cognitive** – How essential is the technology, given any alternatives? How does the technology fit with my daily life?

The OCWD/OCSD exampled showed the benefits of having utility managers become recognized as trustworthy and competent experts through their dedication to the outreach efforts.[1,2,3]

Another key reference that blends technical, regulatory, and public support efforts to foster legitimacy is the *Framework for Direct Potable Reuse* released in 2015. This framework document was developed through a collaborative effort between WateReuse, WEF, and the American Water Works Association through an independent advisory panel administered by NWRI. The panel convened over a period of almost 2 years to identify the subject areas and topics that future direct potable reuse (DPR) guidelines will need to address and prepare the final document. This framework represents a consensus among the panel, while taking into consideration input from a Project Advisory Committee comprised of technical experts in water and wastewater treatment, as well as state and federal regulators.

The Framework document provides a context for DPR, including the costs, benefits, energy requirements, and comparative issues with other water sources and measures. Following this introduction, three key components of a DPR program are examined:

- regulatory considerations (e.g., measures to mitigate public health risks);
- technical issues related to the production of advanced treated water; and
- public support and outreach.

The Framework is freely available at: https://watereuse.org/watereuse-research/framework-for-direct-potable-reuse/

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[1] Binz, C., S. Harris-Lovett, M. Kiparsky, D. L. Sedlak, and B. Truffer (2016). "The thorny road to technology legitimation–Institutional work for potable water reuse in California." *Technological Forecasting and Social Change* 103: 249–263.

[2] Jordi, A. (2015) "Legitimacy – the key to successful implementation." Eawag Aquatic Research News, October 2015. www.eawag.ch/fileadmin/Domain1/News/User_Acceptance_englisch.pdf

[3] Harris-Lovett, S. R., C. Binz, D. L. Sedlak, M. Kiparsky, and B. Truffer (2015). "Beyond user acceptance: a legitimacy framework for potable water reuse in California." *Environmental Science & Technology* 49(13): 7552–7561.

Key Terms

WateReuse has developed a common set of definitions to describe the many technical words, often interchangeably used, to explain the different options for water reuse that a community could choose from:

Potable Reuse refers to recycled water you can drink. The reclaimed water is purified sufficiently to meet or exceed federal and state drinking water standards and is safe for human consumption.

Nonpotable Reuse refers to reclaimed water that is not used for drinking, but is safe to use for irrigation, industrial uses, or other non-drinking water purposes.

De facto, Unacknowledged, or Unplanned Potable Reuse occurs when water intakes draw raw water supplies downstream from discharges of clean water from wastewater treatment plants, water reclamation facilities, or resource recovery facilities. For example, if you are downstream of a community, that community's used water gets put back into a river or stream and is delivered downstream to your community and after further treatment becomes part of your drinking water supply.

Planned Potable Reuse is publicly acknowledged as an intentional project to reclaim water for drinking water. It is sometimes further defined as either direct or indirect potable reuse. It commonly involves a more formal public process and public consultation program than is observed with de facto or unacknowledged reuse.

Indirect Potable Reuse (IPR) water is blended with other environmental systems such as a river, reservoir, or groundwater basin, before the water is reused.

Direct Potable Reuse (DPR) water is distributed directly into a potable water supply distribution system downstream of a water treatment plant or into the source water supply immediately upstream of the water treatment plant.

Matrices

The best practices identified by the participants at the experts' meeting were grouped into 12 themes and displayed in the following matrices. The themes are grouped into three basic topic areas:

TOPIC AREA 1

Product Focus

- Product Development
- Implementing Treatment Technologies
- Monitoring and Control
- Implementing Innovation

TOPIC AREA 2

External Communications

- Message Development
- Communication & Outreach
- Risk Management & Communication
- Regulatory Environment

TOPIC AREA 3

Management and Organizational

- Local Issues
- Strategic Management
- Financial Sustainability
- Resiliency

1: PRODUCT DEVELOPMENT

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Marketing	*Data Collection*
	• Collect data to understand the market
	  • Identify stakeholders and potential customers in the market for water reuse and other recovered resources
	  • Assess competition for product (alternative sources of supply)
	• Identify anchor customers and distribution system
	• Determine end uses, quality requirements, and variability (seasonal, daily) for customers or end use:
	  • Agriculture
	  • Environment/Habitat
	  • IPR
	  • DPR
	  • Industrial uses (cooling, washing, etc.)
		Develop Marketing Strategy
		• Create a value-cost proposition
		  • Identify value of various water quality levels for product
		  • Evaluate sales potential with respect to treatment, monitoring, and distribution costs
		• Develop marketing, sales, and branding strategy
		• Communicate benefits and advantages of water reuse
			Sell Recovered Resources
			• Brand and sell recycled water and other recovered resources
			• View customers as partners in efforts to meet customer needs through sustainable water management

Fit for Purpose	*Identify Level of Treatment*
	• Determine levels of treatment required to meet needs of customers and environment
	  • Is reuse desirable, given source water constraints, environmental needs?
	  • Is nutrient removal necessary or are nutrients desirable for irrigation?
	  • What levels of constituents (metals, total dissolved solids, etc.) are needed by end use?
	  • What are the seasonal, diurnal, or daily variations in source water and product water demands?
		Identify Opportunities
		• Produce products for market needs, such as:
		  • Irrigation (agriculture, municipal, residential)
		  • Cooling
		  • Fire protection
		  • Boiler makeup
		  • Wash water
		• Dual treatment or flexible treatment options available to produce varying quality of water for intended purposes
		• Consider decentralized infrastructure to optimize recovery
		  • Treatment (sewer scalping)
			Prioritize and Implement
			• Technical solutions design/tailored to fit-for-purpose water demands
			• Water allocation are prioritized among various users based on water supply needs and business considerations
			• Designer water approach provides operational flexibility to supply “flavors” of water

2: IMPLEMENTING TREATMENT TECHNOLOGIES

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Technology Evaluation	*Identify Treatment Levels*
	• Determine level of treatment available
	• Determine level of treatment required or desired
	• Define operational/process changes required to provide water quality
	• Identify available technologies to provide appropriate multi-barrier protection.
	  • Where used/experience with technology
	  • Maturity of technology
	  • Alternative analysis
	  • Waste stream (brine, other) implications
	  • Regulatory issues
		Identify Opportunities
		• Ensure adequate treatment vs. overtreating to meet regulatory requirements with minimum concentrate generation
		• Consider storage
		  • Emergency
		  • Process upsets
		  • Demand variability
		  • Equalization
		  • Monitoring
		  • Attenuation
		• Identify additional opportunities requiring more time or capital to implement, and develop a plan to finance/implement
		• Assess liquid vs. solid recovery (water reuse vs. land application/struvite recovery)
			Evaluate and Implement
			• Multi-barrier approach using cost-effective and low carbon footprint technology to provide right quality reuse
			• Unintended consequences are evaluated through scenario planning or other means, such as
			  • No return flows
			  • Collection system issues from scalping
			  • Aggressive water
			• Identify research and development needs to drive innovations
			• Identify water quality trading and greenhouse gas offset credit opportunities

Treatment Management	*Plan for the Future*
	• Identify unit operations/basins for use in future iterations of designer water production
	• Long-term planning such as leaving space in the facility hydraulic profile to accommodate future processes
	• Develop scenario analysis in master planning
	  • Future regulations
	  • Water supply/demand
	  • Treatment resiliency and failsafe planning
		Mitigate Risks
		• Design for current requirements with an eye toward future requirements
		• Validate technologies
		  • Reliability
		  • Long-term prospects
		  • Path dependency
		  • Public support
		  • Intellectual property issues
		  • Operational efficiency
		  • Scalability
		  • Monitoring requirements
		  • Byproducts and coproducts
			Manage Tradeoffs
			• Understand tradeoffs
			  • Reliability vs. advanced technology
			  • Regulatory requirements vs. business needs
			  • Resource recovery vs. treatment

3: MONITORING AND CONTROL

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Monitoring	*Collect Information*
	• Parameter monitoring for decision-making, potentially includes
	  • Upstream
	  • Collection system
	  • Industrial dischargers
	  • At treatment facility
	  • Influent, in-facility, and effluent
	  • End Use
	  • Customer (agriculture, industrial)
	  • Environment (receiving body, aquifer)
	• Laboratory capacity at facility and throughout region analyzed for analytical, biological services for cation-exchange capacity, CCL3, and unregulated contaminant monitoring rule
	• WRRF considers frequency of sampling to account for diurnal and seasonal variations
		Analyze Data
		• Process information to understand options, examples include
		  • Rate of accumulation and control of salts and metals
		  • Technical resiliency (e.g, dynamic response time to spike loading)
		• Model the treatment process to understand its constraints and opportunities, and ensure redundancy in design
		• Assess current facility performance for varying water quality needs of customers
		• Bioassay tools for process monitoring are developed
		• Reliable online/early warning monitoring systems are in place
		• Data analytics management plan developed
			Proactively Use Data
			• Use data to improve
			  • Facility operations
			  • Trading programs
			  • Source control
			  • Next design upgrade
			  • Continual improvement of monitoring program
			• Sensor and monitoring advances for reporting are tracked
			• Well-developed laboratory capabilities and/or partnerships for performance and compliance
			  • UCMR
			  • CCL3
			  • LEC
			• Unregulated water quality parameters

Process Control	*Get the Big Picture*
	• Baseline performance (water quality, energy use, etc.) and benchmarks are determined
	• Supervisory control and data acquisition (SCADA) and other control system capabilities and needs are identified
		Understand Key Processes
		• Proactive maintenance is in place through computerized maintenance management system
		• Technologies for remote monitoring system are in place (e.g., wide integration including satellite systems)
		• Real-time monitoring and control strategy in place
		• Developed mass balances
		  • Water
		  • Organics (energy)
		  • Nutrients (nitrogen and phosphorus)
		  • Salts
		  • Metals
			Monitor for Real-Time Control and Optimization
			• Real-time control is in place (e.g., SCADA) to optimize water quality, chemical use, energy use, and efficiency
			• System learning algorithms (data driven) that incorporate dynamic supply–demand challenges are in place

Quality Control	*Product Development*
	• Develop a quality assurance program and process for products
	• Implement adaptive management techniques
		Product Production
		• Quality assurance processes in place
		  • Water quality (including chemical addition)
		  • Water quantity (to avoid supply disruptions)
			Quality Verification
			• Utility has adopted a quality standard (HACCP, Six Sigma, ISO 9001)
			• Permit and compliance program exists with established water analysis protocol
			• Active partnership with agriculture exists to ensure downstream product quality

4: IMPLEMENTING INNOVATION

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE
Research and Development (R&D)	*Prepare for R&D* • Collaboration with research organizations as WE&RF drives innovation and understanding and adoption. • Staff well-versed in existing technologies • Opportunities are identified by survey of emerging technologies • Reduce risk through collaborative research and information sharing • Have WRRF leadership/managers recognize and reward innovative approaches	*Preform R&D* • Utility budget includes R&D funding to demonstrate culture of embracing innovation • Utility actively participates in water innovation partnerships (e.g., Water Innovation Centers, research foundations, university partnerships, etc.)	*Expand R&D* • Site visits to facilities utilizing innovative technologies occur regularly • Completed trials and research projects provide the foundation for further advancement within the industry • Utility serves as a demonstration facility for public education and collaboration with research organizations like WE&RF
Test Beds	*Evaluate Technologies* • Technologies that reduce energy use or increase generation are identified • Test beds are identified to enhance collaboration with universities, R&D of the equipment supplies and agencies and other stakeholders • Validation and data requirements for new/alternative technologies are identified	*Initiate Trials* • Treatment technologies are demonstrated • Standard validation protocols developed to evaluate technologies for effectiveness and sustainability • Develop mobile treatment testing for field testing • Plans are made to leverage test beds and communicate results with data base of results • Institutional resistance is overcome by demonstration facility, pilot projects, specificity of design and technology options, and goals of the reuse project	*Implement Full-Scale Solution* • Flexible and effective technologies are implemented to meet the needs of the various quality levels of recycled waters

Alternative Management Approaches	*Identify Alternatives*
	• Decentralized treatment options are considered
	  • Package plants and technologies
	  • Scalping plants
	  • On-site reuse
	  • Green infrastructure
	• Planning is performed on a watershed basis and includes consideration of robustness of satellite nodal structure of decentralized infrastructure
		Implement Alternatives
		• Green Infrastructure technologies such as treatment wetlands and riparian buffers are implemented where appropriate as part of multiple barriers approach
		• Enhanced regionalization (e.g., biosolids processing) has been considered and implemented where appropriate
			Expand Integration
			• Alternative management approaches (e.g., decentralization, regionalization, etc.) are used, where appropriate, to maximize overall, regionwide benefit

5: MESSAGE DEVELOPMENT

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE
Legitimacy	*Identify Resources* • A transparent planning process is developed to establish legitimacy of project owner • Independent advisory group or expert panel considered • Success stories and best practices from relevant organizations are identified	*Collaborative Communication* • Appraisal conducted of public perception of: utility competence legitimacy, public health issues, water supply, risks • Plans in place to address Pragmatic, Moral, and Cognitive Legitimacy	*Ongoing Leadership* • Legitimacy of project and project owner established to meet the region's water needs • Organizational commitment to public health protection is accepted by public • Utility is the trusted source of quality
Stakeholder	*Identify Stakeholder Values* • Identify values of community and utility board of trustees • Shift cultural mindset from "meeting the permit" to recovering resources • Identify environmental, social, and economic incentives for water reuse • Identify visible agency champion	*Public Outreach & Intake* • Develop public understanding of the new purpose of a WRRF • Gather input from all stakeholder categories	*Shared Experience* • Share best practices with other utilities and the sector • Identified stakeholder groups vested in each benefit/service
Message Development	*Develop Message* • Understand local cultural values • Positive messaging (NOT "do not drink from purple pipe") developed for reuse Themes to include • Resiliency • Water independence • Drought proofing • Sustainable • Safety • "All water is reused" – de facto reuse • "Water should be judged by its quality, not its history" • "One Water" – reuse is just another part of the portfolio • Value of water • Water as a valuable service which enhances health and wealth of community • Water as critical product for agriculture, industry, commercial uses and the associated economic development	*Enhance Message* • Consistent terminology used • Counter-argument developed to counter false information • Message uses easy-to-understand common terminology for reuse technologies and presents them in exciting and enticing ways	*Continually Evaluate Message* • All utility members know the "elevator speech" of the reuse mission and can clearly articulate the message whether at work or in the community • Partner agencies are consistent in messaging on reuse • "Flavors" of water used to demonstrate fit for purpose • Measures of public opinion are used on a periodic basis to evaluate program and update messaging to ensure public acceptance • Ongoing engagement with opponents with respect • Educational activities are engaging for appropriate audiences (e.g., field trips focusing on environment and technology for students, reuse beer tasting for adults)

6: COMMUNICATION & OUTREACH

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Customers and Community	• Community education on fit for purpose water, the urban water cycle, and is continuously updated. Education precedes customer outreach and education strategy on specific project needs
	• Community groups are identified for outreach to develop understanding
	• Early education and outreach to the public avoids opposition based on yuck factor for all reuse sources but particular drinking water
	• Agency obligation to initiate discussion with the public
	• Ensure that "Community" leaders are involved in the decision process
	• Speakers Bureau trained for effective communication with the public (educated volunteers)
	• Public volunteers representing different interests are essential to serve as community ambassadors
		• Proactive customer education and outreach program (e.g., bill inserts, tours, fact sheets, website) that focuses on public health, economic growth, environmental benefits, and cost-effectiveness is established
		• Community opinion leaders are engaged
		  • Politicians
		  • Reporters
		  • Environmental interests
		  • Clergy
		  • Physicians and other medical professionals
		  • Farmers
		  • Teachers
		  • Service groups
		• Early adopters are identified and encouraged to educate those with questions (doubters)
			• Utility engages customers in helping to achieve sustainable water resources management
			• Utility and public employees are ambassadors to community
			• Transparent process for community-driven decision-making is in place to demonstrate respect for community
			• "Hands on" engagement opportunities exist
			  • Demonstration and visitor center
			  • Interactive and static displays and exhibits
			  • Water tastings
			  • Beer tasting
			  • Technology tours
			  • Utilitize information that already exists through the WateReuse Association and others
			  • "Downstream"
			  • "The Global Connections Map
			  • "The Ways of Water" video
			  • Water: Think & Drink animations

Media	• Media outlets are identified and strategies are developed	• Media kit is developed (e.g., video, sound-bites, pictures, and press releases) • Deal proactively with national water crisis in news (Flint, food contamination, floods, droughts, etc.)	• Dedicated utility staff work on messaging with media, both news and social • Media champions are nurtured to inform public of factual benefits and issues with respect to reuse, especially potable applications

Water Sector	• Key energy staff network at local/regional industry events and information sharing groups supporting
	  • National goal supporting reuse and conservation
	  • Uniform criteria for IPR/DPR projects
	  • Risk-based reuse guidelines for agriculture, industrial, and commercial projects
		• Successes, failures, and lessons learned are shared at industry events
		• Staff contributes to development of guidelines for design and operation of relatively newer treatment and monitoring technology
			• Staff leads industry initiatives to support sector advancements in water reuse, specifically
			  • National reuse framework
			  • National regulatory standards

7: RISK MANAGEMENT & COMMUNICATION

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Public Health	*Identify Public Health Issues*
	• Engage public health tracking networks (Center for Disease Control and Prevention it)
	• Project plans consider public health and environmental risk for both new and established riparian projects
		Mitigate Public Health Risks
		• Systems approach is used for reliability analysis mitigating risks of
		  • Contaminating potable water source IPR
		  • Recontamination of groundwater
			Enhance Public Health Network
			• Multiple barriers are in place to reduce health and environmental risks
			  • Robust/redundant treatment
			  • Cross-connection control
			• Real-time pathogen monitoring and risk management throughout treatment and distribution

Risk Management	*Identify and Prioritize Risks*
	• Risk of high consequence of a single dramatic failure is understood
	• Strategy for risk mitigation is developed
	• Planning includes consideration of
	  • Measures for climate change adaptation (e.g., extreme events)
	  • Overtreatment vs. public safety
	  • Water shortage
	  • Not recovering reclaimed water in GWR/augmentation projects
	  • Treatment technology
	  • Cyber technology
	  • Unintended consequences
	  • Health, environmental, social
		Mitigate Risks
		• Risk is reduced through water source diversification
		• Risk allocation ensures each party takes the risk that they can manage/control
		• Cyber-security capabilities and contingency plans are in place
			Leverage Innovation
			• Have contingencies to deal with uncertainties
			• Technology risk level set so that no single failure of an active component shall result in health risk
			• Organization can successfully trial and implement innovative projects and is adaptable to emerging opportunities and changing environments

Risk Communication	*Define Risk Message*
	• Agency, community, regulatory risk tolerances identified
	• Risk concepts include
	  • Opportunities instead of challenges
	  • Uncertainty instead of risk
	  • Cost vs. risk
	  • Risk of status quo
	  • Risk vs. benefits, without overselling
	  • Testing and monitoring framework and controls in place
	  • Needs vs. risk
	  • Meeting regulations vs. cost of over-treating
	  • Zero risk does not exist, and safety is what the public wants
		Refine Risk Communications
		• Risk information on CECs, toxicology, and other probabilistic statements are crafted in plain English
		• Communication efforts learn from other sectors (HACCP, etc.)
			Validate Approach
			• Independent expert panel in place to evaluate and provide oversight for risk management

8: REGULATORY ENVIRONMENT

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Regulatory and Legislative	*Identify Regulations*
	• Key regulators are identified and effective working relationships are established prior to project development
	• Legislative strategy is developed to enhance opportunities and minimize hurdles for water reuse
	• Regulatory framework and gaps are identified
	• As part of an ongoing relationship, key regulators are educated on potable and nonpotable reuse issues
		Seek to Unify Regulations
		• Utility advocates for unified regulations that
		  • Are science based
		  • Protect health and environment while maintaining flexibility for types of technologies
		  • Incentivize collaboration across district borders and across disciplines
		  • Are flexible for small systems
		  • Encourage innovation
		  • Are clear and consistent, without conflicts (such as between National Pollution Discharge Elimination System and recycled water permits, or water vs. air, groundwater vs. watershed)
		• Regional collaboration with other agencies occurs (e.g., for funding or policy changes)
			Resolve Differences
			• Utility works with industry associations to influence regulators/legislature to create incentives to encourage reuse, where appropriate
			• Utility influences funding agencies to prioritize water sector projects
			• Regulators and utility work together to resolve cross-media issues
			• Mechanism exists for resolving differences in conflicting regulations, dealing with externalities, and creating the space for innovation

Regulatory Risk Management	*Identify and Prioritize Risks*
	• Evaluate legal/regulatory implications of voluntary action
	• Identify early technology adoption risks
	• State-of-the-art technology vs. new technology vs. technology specified by regulation
	• Evaluate costs of overtreatment or regulations that are not practicably implementable
		Mitigate Risks
		• Develop strategy for risk mitigation and/or sharing
		  • "Creating the Space for Innovation"
		  • "Safe Harbor"
		• Encourage policies that enable rapid new technology evaluation and adoption
			Leverage Innovation
			• Organization successfully implements innovative projects and is adaptable to emerging opportunities
			• Anticipate future regulations and impacts
			• Organization supports integrated, systems-thinking approach to regulations, such as
			  • Reuse as crop irrigation source and other Food Energy Water Nexus issues
			  • Public–private partnerships

Water Rights	*Evaluate Legal Framework*
	• Evaluate positive and negative implications of policies such as
	  • Conservation mandates
	  • Water rights (agriculture, urban)
		Manage Permits
		• Permitting reuse projects address legal risks of water rights
			Source Ownership
			• Ownership of source (wastewater) and the product (recycled water) is well-defined

9: LOCAL ISSUES

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Local Drivers	*Identify Drivers*
	• Key drivers are considered, including
	  • Economic development
	  • Water scarcity
	  • Climate change
	  • Regulatory requirements
	  • Urbanization
	  • Diversification of water sources
	  • Reduced dependency on external sources
		Evaluate Impacts
		• Evaluation of impacts to local needs developed
		• Project boundaries are identified
		• Economic impacts quantified (gross domestic product growth, job creation)
		• Natural resources, impacts are identified (land subsidence, wildlife habitats, water sources)
			Maintain Vigilance
			• Plans are in place to adapt to changes of drivers

Integrated Water Resources Management for "One Water"	*Evaluate Opportunities*
	• Explore and analyze opportunities for collaboration on water resources between water, wastewater, and stormwater utilities, as well as other water stakeholders such as those in industry and agriculture
	• All available sources of water are identified, including reuse, surface water, groundwater, seawater, stormwater
	• Potential partners and neighboring agencies are involved in watershed-based planning
	  • Utilities
	  • Agriculture
	  • Industry
	  • Power plants
	  • All relevant sectors
		Establish Connections
		• Utility planning efforts are integrated with other agencies regarding multiple resources (e.g., water, stormwater, etc.)
		• Implement contracts with partners to facilitate data exchange and planning
		• Regulatory issues have been addressed and satisfactorily resolved
		• Consider embedded resources in water such as nutrients and energy in water resource planning
		• Consider accumulative constituents (salts, metals) and develop long-term management strategy
		• Partners understand relationships between treatment, discharge, and reuse
		• Framework for future potable reuse developed, even if initial reuse is nonpotable
			Leverage Resources
			• Holistic evaluation methodologies (e.g., triple bottom line) are used to regional (watershed) water supply plan
			• Mature protects participate in dialogue to promote water valuation that is consistent with regional/watershed sustainability
			  • Return to river
			  • Local issues (desalination plant next to flood farming)
			• Optimized supply demand model exists of future growth and resiliency plans
			• Opportunities exist for water trade between community and regional users
			• Water resources managed in an integrated manner (integrated water resources utility with water/wastewater or multi-agency approach with embedded leadership at all levels of organization

Collaborative Partnerships for "One Water"	*Evaluate Opportunities* • Identify markets/opportunities for reuse water, as well as applicable water quality and treatment requirements • Source water and treatment objectives are identified according to market and water quality needs	*Establish Connections* • Connect with customers and potential customers to ensure they understand opportunities for diverse, sustainable sources of water	*Leverage Resources* • Utility uses partnerships to maximize water reuse sales revenues and/or reduce demand for water and energy, and optimize the need for advanced and costly levels of treatment • Systems thinking integration of systems – water, energy, food – is in place

10: STRATEGIC MANAGEMENT

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Vision	*Develop Vision*
	• Leadership Group develops Water Reuse Vision
	  • Long-term 5 years to 50 years
	  • Resilience and drought-proofing
	  • Water independence
	  • Flexibility
	  • Utility financial sustainability
	  • Economic development
	  • Environmental enhancement
	  • Resource recovery
	  • Health and ecological
	• Become climate-ready
	  • Reduce direct and indirect emissions
	  • Improve resilience – address water scarcity and diversify water sources
	  • Improve efficiency of water supply
		Communicate Internally
		• WRRF leadership/managers link the vision to staff performance plans
		• WRRF leadership/managers incorporate sustainability goals and key performance indicators into strategic plan
			Communicate Externally
			• Utility shares vision with external stakeholders and the industry
			• Long-term, yet flexible, plans are in place to embrace external market changes
			  • Future regulations
			  • Political outlooks
			  • Changing demand
			  • Changing public acceptance
			• Robust asset and risk management in place
			• Review performance against goals
			• Reassess long-term goals

Strategic Direction	*Set Goals* • Goals and key performance indicators are established for both water conservation and water reuse to encourage efficient use of integrated water resources • Investigation conducted of organizational capacity (technical, managerial, and financial) to handle interdependencies of a reuse program	*Gather Support* • Utility incorporates goals and key performance indicators into strategic plan • Adequate organizational capacity exists to ensure effective practices can be developed and adopted to meet demands of reuse programs	*Prioritize & Implement* • Program initiatives are prioritized using tools such as Strategic Business Planning • Utility utilizes triple bottom line approach for sustainability project decision-making • Interdisciplinary collaboration exists to ensure thorough understanding of timescale and resources required for reuse programs

Staff Development and Alignment	*Set Training Plan*
	• Utility fulfills training needs for all relevant positions: management, engineering, and operations
	• Current practices are evaluated for training needs with respect to potential impact of water reuse/ resource recovery activities
	  • Technology complexities
	  • Flexibility to meet multiple objectives
		Train and Support Staff
		• Relevant staff are trained according to current and future knowledge requirements, including
		  • Technology operations
		  • Potable applications constraints
		  • Predictive analytics
		  • Safety
		• Staffing and institutional knowledge issues, including recruitment, enhancement, and succession are planned for
			Empower Staff
			• Standard operating procedures and SCADA system are suitable for new processes and technologies
			• Operations staff are certified in both wastewater and drinking water operations
			• WRRFs mentor and guide other local and regional utilities to advance reuse goals
			• Team connects to other organizations to maintain currency of knowledge

11: FINANCIAL SUSTAINABILITY

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Benefit Identification	*Identify Benefits*
	• Benefits of water available through reuse are identified and associated with specific beneficiaries
	• Benefits are quantified
	• Long-term view is undertaken to represent future generations
		Analyze Benefits
		• Benefits are expressed in monetary terms to demonstrate the inherent value in wastewater
		• Benefits are evaluated on triple bottom line for sustainability
		• Deferred capital and other opportunity costs related benefits are identified and quantified
			Obtain Benefits
			• Benefits are internalized through reduced costs and revenue enhancement
			• Reward incentives are created for operations staff
			  • Energy efficiency
			  • Water resource management
			  • Inorganic salt management
			• Carbon management resource recovery

Cost Identification	*Identify Costs*
	• Costs of service for reuse are identified
	  • Treatment, distribution, marketing, customer service
	  • Capital, operations and maintenance
	  • Absolute and marginal
		Allocate Costs
		• Costs are allocated to functions and organizations (water, wastewater, customer)
		• Ancillary benefits to water reuse are included in cost analysis with respect to other water sources to ensure consistent calculation and comparison between alternatives
			Ensure Fairness
			• Environmental justice/water as a basic human right is recognized and accommodated in the cost model to ensure affordability

Financial Viability	*Identify Funding Options*
	• Develop financial strategy to support water reuse projects
	• Sources of potential funding are identified
	  • State Revolving Fund (SRF), federal, and state grants
	• Consider alternate financing methods
	  • Public–private partnerships (P3) and joint ventures
	• Alternative project delivery (design-build-operate, build-own-operate-transfer, etc.)
	• Recovery of costs from ratepayers is evaluated to ensure full understanding of legal framework (including regulatory and tax reform laws)
	• Incentives and tax credits for new/innovative or available technologies are investigated
		Budget for Success
		• Use lifecycle analysis for project decision-making
		• Water reuse is considered on all capital project designs, in operating budget decisions, and standard operating practices
		• Sustainable revenue model is in place to address
		  • Equitable cost allocation
		  • Variability of demand (seasonality, drought, abundance)
		  • Diversification of financial portfolio
			Invest in the Future
			• Effective utilization of available sources of funding (public, private, bonds, SRF, grants)
			• Full value of water is recovered in reuse rates, including variable costs based on “flavor” of water used and incentives for upstream reuse and recycling
			• Local industry and NGOs are engaged to ensure continuous support for funding
			• WRRF’s recovered resource revenues generate sufficient funding to invest in other priorities and reduce upward pressure on rates

12: RESILIENCY

	PLAN	PREPARE & IMPLEMENT	EVALUATE & IMPROVE

Resiliency	*Evaluate Water Resources*
	• Available water resources are quantified to evaluate resiliency of current supply and the current systems ability to meet future demands based on growth and supply shortage
	• Importance of diverse water supply portfolio is understood, including
	  • Reuse
	  • Surface water
	  • Groundwater
	  • Seawater
	  • Stormwater
	  • Conservation
		Implement Water Supply Plan
		• Methods developed to define value for long-term sustainability through diversification
		  • Water portfolio and resiliency and sustainability
		  • Climate change, urbanization, etc.
			Optimize Supply
			• No stranded assets as full utilization of reuse as a new water supply
			• Diverse water resource portfolio is resilient and adaptable to changes in demand, water quality

Continuity of Operations	*Prepare Plans*
	• Integrated continuity of operations plan is developed
	  • Natural disasters (hurricane, earthquake, flooding, fires, etc.)
	  • System integration risk
	  • Water quality dynamics impacting customer agreements
	  • Public safety
	• Worker safety (gas, chemical spills, etc.)
		Test, Implement, Improve
		• Plan is tested and reviewed for currency on annual basis
			Continuous Monitoring
			• Proactive controls and monitoring analytics manage process risk

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About WEF

The Water Environment Federation (WEF) is a not-for-profit technical and educational organization of 33,000 individual members and 75 affiliated Member Associations representing water quality professionals around the world. Since 1928, WEF and its members have protected public health and the environment. As a global water sector leader, our mission is to connect water professionals; enrich the expertise of water professionals; increase the awareness of the impact and value of water; and provide a platform for water sector innovation. To learn more, visit www.wef.org.

About WateReuse

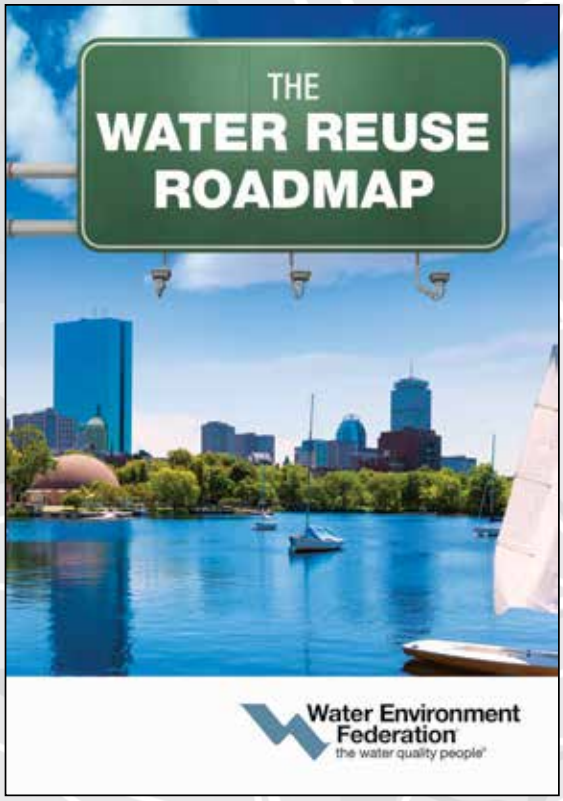
WateReuse is an international thought-leader on alternative water supply development and the global go-to source for applied research, education, and advocacy on water reuse. Representing a coalition that includes utilities, government agencies, and industry, WateReuse works to educate policy-makers and the public on the science, economic value, and environmental benefits of treating water to safely use it for designated purposes, such as irrigation, manufacturing, and drinking. To learn more, visit www.watereuse.org.

About NWRI

The National Water Research Institute (NWRI) is a 501c3 nonprofit based in Fountain Valley, California. Their focus is to sponsor projects and programs dedicated to ensuring safe, reliable sources of water for both now and future generations. Since NWRI's founding in 1991, they have participated in collaborative efforts with more than 100 partners the world over to fund and further efforts in water education, outreach, and research. To learn more, visit www.nwri-usa.org.

About WE&RF

The Water Environment & Reuse Foundation (WE&RF) is a 501c3 charitable corporation seeking to identify, support, and disseminate research that enhances the quality and reliability of water for natural systems and communities with an integrated approach to resource recovery and reuse, while facilitating interaction among practitioners, educators, researchers, decision-makers, and the public. To learn more, visit www.werf.org.



The Water Reuse Roadmap

Create a diverse and resilient water management strategy with *The Water Reuse Roadmap*.

Available Now

Other resources available at www.wef.org/ShopWEF

The Nutrient Roadmap

The Nutrient Roadmap is a first step toward accelerating the transition to smarter nutrient management, facilitating the shift from removal to recovery, and anticipating future requirements to conserve energy and reuse resources. Case studies explore the innovative, cost-effective solutions employed by pioneering wastewater resource recovery facilities.

The Nutrient Roadmap acknowledges that each utility faces unique challenges and provides you with a variety of paths to follow and alternative destinations from which to choose as you embark on the road toward sustainability.

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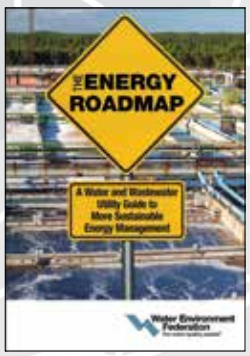

The Energy Roadmap

The Energy Roadmap serves as a guide for utilities of all sizes on the path to sustainable energy management. In it, you will explore innovative approaches to cost-effectively recover and reuse resources to transform "wastes" to valuable products. The book outlines six stops on the path to resource recovery, presenting insights and models for

1. strategic management,
2. creating an organizational culture,
3. effective communication and outreach,
4. demand-side management,
5. energy generation, and
6. innovating for the future.

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