



# Water Innovations Alliance

## Water Technology Trends: A Forward Look

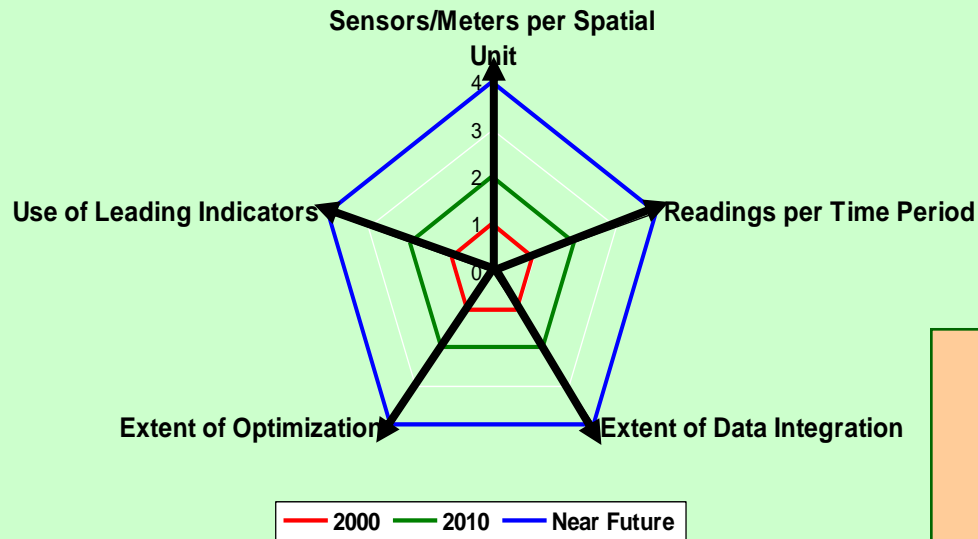
*Peter Williams, CTO, Big Green Innovations, IBM*

*May 11<sup>th</sup> 2010*



# “A Smarter Planet” – the major information technology trend of our time

## The Mesh is Getting Smaller...



- Instrumented
- Interconnected
- Intelligent



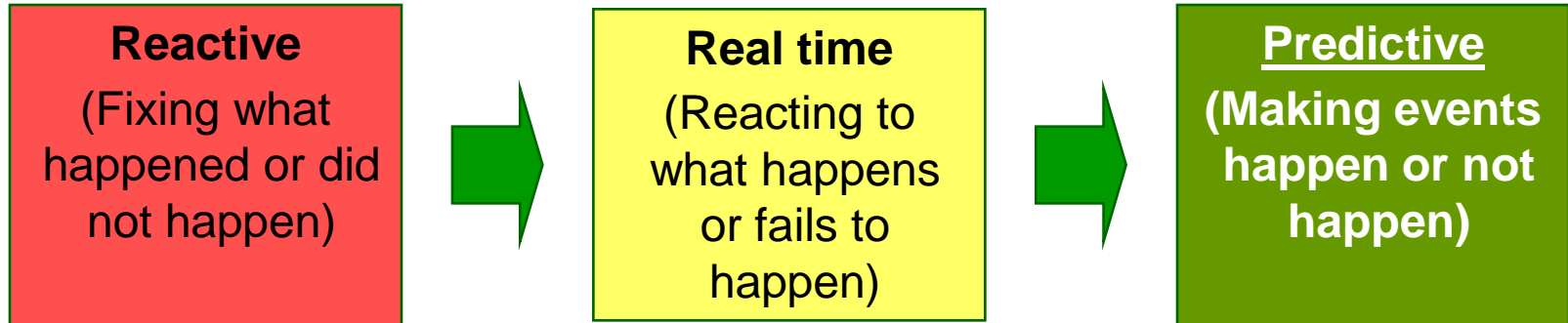


# How this trend will change the planning and delivery of water

Today's Paradigm		Tomorrow's Paradigm
"Fix what happened"		"Manage the future"
"Lab tests"		"Continuous sensing"
"Waste water is a problem"		"Waste water is a resource"
"Water recycling is leading edge"		"Water recycling is the norm"
"Demand is a given"		"Demand is malleable if water is priced effectively"
"Leakage – who cares?"		"Leakage is a service failure"
"Energy is unlimited"		"Energy costs are a major issue"
"Monolithic, fixed infrastructure"		"Decentralized water and waste-water treatment"
"Fragmentation"		"Whole-system collaboration"
"Concrete and steel"		"Ecosystem services" <b>"Information"</b>



# “Manage the Future”



- Trend in process management from reactive to predictive – using real time data about the *preconditions* of events to enhance or prevent those events before they happen.
- Many uses for this kind of thinking in water– and the technology allows it. Why would water be any different?



**Conclusion: smarter agencies will increasingly seek to “manage the future”**



# “Continuous sensing”

## New targets

- Pathogens (bacterial scale today, soon viral scale... ??)
- Emergent contaminants (estrogen, iodated cyanogens etc)
  - Field continuous spectrometry/chromatography device

## New technologies

- Lab on a chip - MEMs, micro-fluidics, micro-arrays, surface plasmon resonance
  - Multiple dimensions of water quality in a single device
- Fiber - ROTDR, BOTDR - for water pressure, temperature, structural stress, sound
  - The cable is the sensor - many miles on one device

## New applications

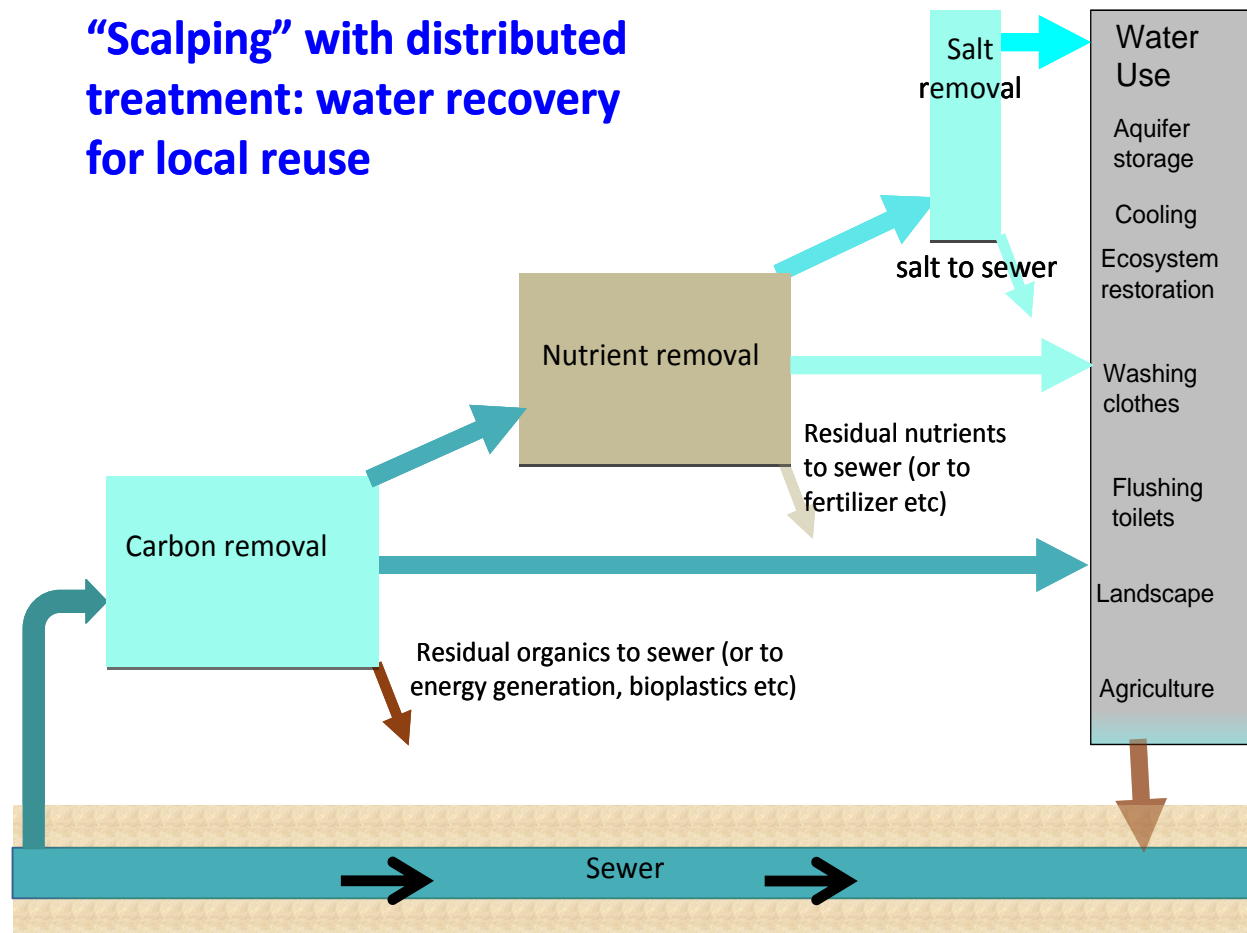
- Water quality - replacing lab samples with continuous measurement
- Smart infrastructure (eg levees, pipes, manholes)

**Conclusion: smarter agencies will increasingly make use of new water sensing technologies**

# “Waste water is a resource”

- Waste water contains hydrocarbons, nitrates, phosphates – and water!
- Scalping recovers usable water and concentrates the other contents to the point where it becomes economic to recover them too.

## “Scalping” with distributed treatment: water recovery for local reuse



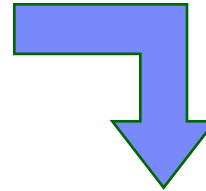
*Adapted from work by Dr Craig Criddle, Stanford University*



# Removal of 75% of the water by volume quadruples the \$/unit volume of the methane and nitrogen remaining

## Before scalping

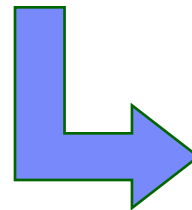
Resource	Per m <sup>3</sup>		
		US \$ per m <sup>3</sup>	US \$ per 1000 gal
Organic soil conditioner	0.10 kg	0.026	0.10
Methane	0.14 m <sup>3</sup>	0.065	0.25
Nitrogen	0.05 kg	0.065	0.25
Phosphorus	0.01 kg	0.013	0.05
Water	1 m <sup>3</sup>	0.325	1.20



*Adapted from work by Dr Craig Criddle, Stanford University, referencing W Verstraete, 2008*

## After scalping

Resource	Per m <sup>3</sup>		
		US \$ per m <sup>3</sup>	US \$ per 1000 gal
Organic soil conditioner	0.40 kg	0.10	0.40
Methane	0.56 m <sup>3</sup>	0.26	1.00
Nitrogen	0.20 kg	0.26	1.00
Phosphorus	0.04 kg	0.05	0.20
Water	1 m <sup>3</sup>	0.325	1.20



(Also note – the world is running out of phosphorous...)

**Conclusion: smarter agencies will plan to manage waste water as a resource**



# “Water recycling is the norm...”

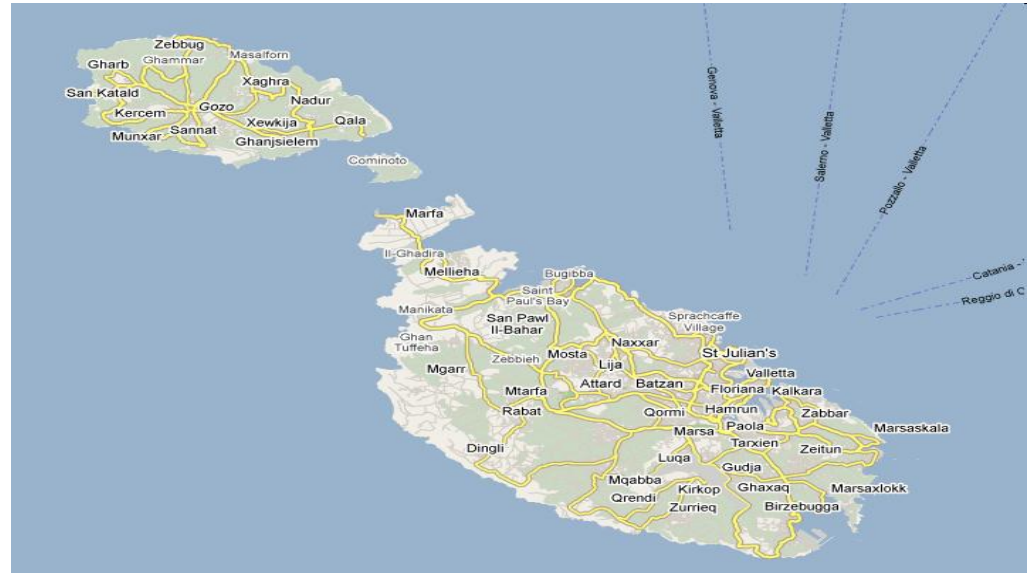
- “Toilet to Tap” is not yet a reality:
  - Most recycling is for irrigation, or the water is stored underground to enable long term purification
  - Even Singapore only adds ‘NeWater’ to the drinking supply at the ratio of 2%
    - (Used by the semiconductor industry who love its purity!)
  - Redwood City in CA bans recycled water even for irrigating road medians.

- In Australia, access to “purple pipe” adds to property values
- Several companies working on household scale waste-water purifiers for local use
  - The technology exists (POU filtration devices, membrane bioreactors - MBRs)
  - Issue is to make it fool-proof and 100% reliable.
- The price of water is rising faster than that of energy...

Conclusion: wide-spread water recycling is only a matter of time.  
**Smarter agencies will plan for it as a matter of course.**

# “Demand is malleable”: advanced metering for water

- Following electricity and gas, implementations are growing in advanced meter infrastructures for water
  - Wireless reporting is preferable to drive-by: it eliminates data latencies and drives more value
- Example: Malta - an arid Mediterranean island nation that desalinates most of its water with high-cost imported energy
  - Advanced energy meters for the entire nation of 400,000 people, plus upgrading water meters to provide interval reporting capabilities.
  - Benefits: conservation and demand management.





# Advanced metering for water - business case

\* Leak detection benefits from better data on actual flows and usage, plus using AMI network to support acoustic leak detectors and loggers

- Cost and politics can still be daunting
- **BUT** - early AMI adopters are finding that:
  - Non revenue water decreases dramatically
    - One Midwest utility: 23% to 5%, from more accurate billing
    - Faster leak detection (example, American Water in Connellsville, PA\*)
  - Risk reduction - less likelihood of structural damage
  - Reduced operations costs
  - More granular data enables better tracking of trends and patterns
    - With user feedback, encourages conservation
  - Energy consumption and therefore GHG emissions, can be reduced
  - Enables future possibilities: differential pricing, re-use of network etc

■ **Conclusion: Smart agencies will take AMI for water as a given and routinely seek to manage demand.**

## “Leakage is a service failure”

- Today 20 - 25% on average of treated water world wide is lost through leaks
  - Range is 2% to > 50%
  - This water has been pumped and treated – so it’s “pure waste”
- Water has not been “worth” investing in...
  - Hitherto, required hydrophones or other expensive technologies to find leaks
  - Easier to cost-justify the lost water
- Now, network-analysis-based services with no capital outlay – available as SaaS
  - Can be integrated with asset management etc
  - Combine with “smart pipes” – pipes that can monitor their own condition via OTDR or conductance sensing



- **Conclusion: smarter agencies will continuously monitor supply networks for wear and leaks, and will routinely achieve <5% “non revenue water”**

## “Energy costs are a major issue”

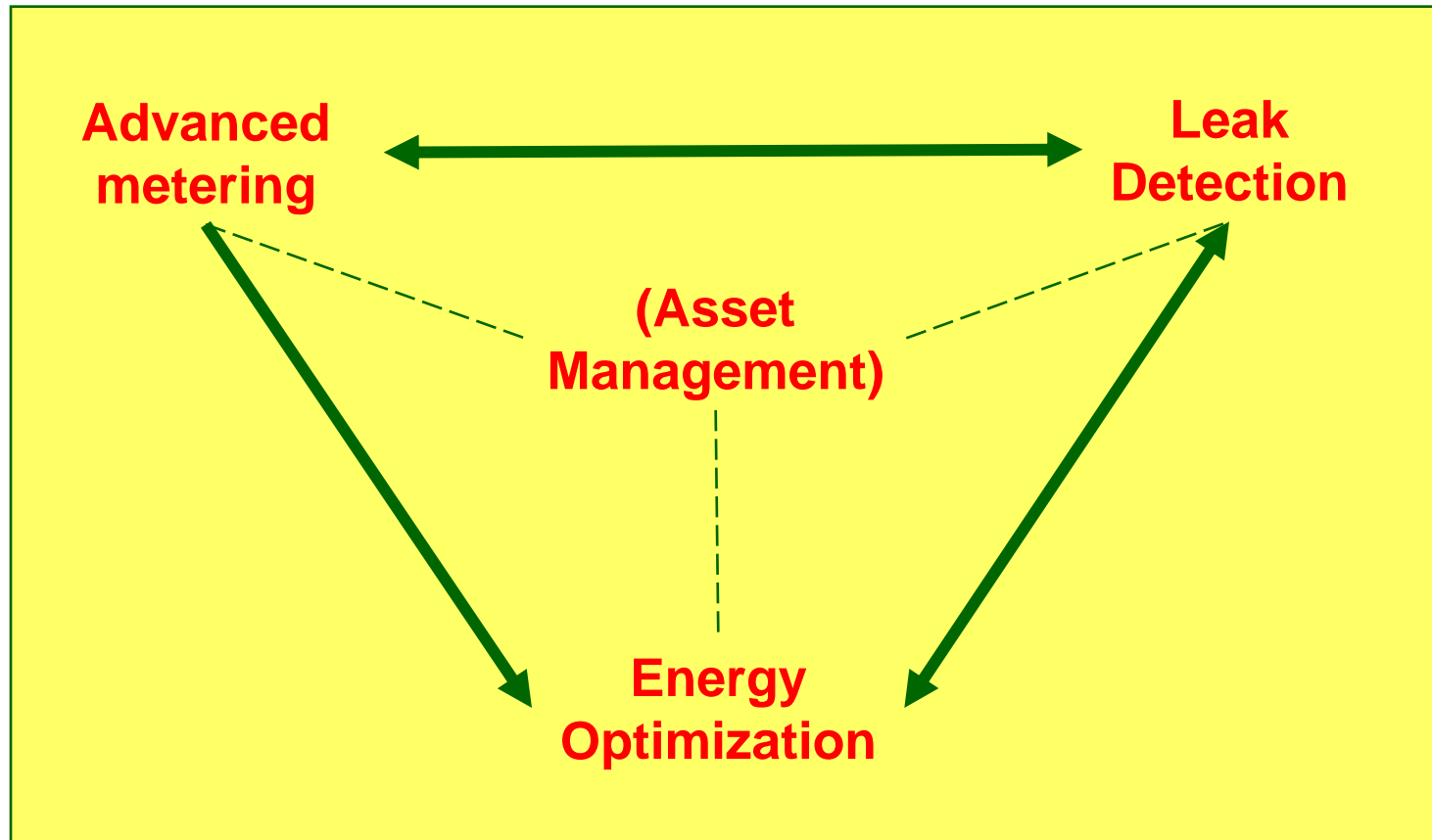
- Moving and treating water consumes 3-5% of the US’s energy output
  - Energy to move or treat water may be an agency’s 2nd biggest cost
- Many agencies try to tune energy consumption, but few optimize it by:
  - Actual and predicted demand (and weather)
  - Pipe network layout – distance, alternative routes
  - Tank-turn/quality requirements
  - Pump performance, maintenance
  - Energy price, lowest cost
  - Dynamically, every 30 minutes...

Derceto’s US References: Water Utility System* <i>Source: Derceto</i>	Annual Energy Cost Savings	Average MWh / Year	Annual CO2 Reduction (Metric Tons)
East Bay MUD (California)	13%	26,000	800
Eastern MUD (California)	12.5% to date	13,600	600
Washington Suburban (Maryland)	11%	99,000	4,500
WaterOne (Kansas)	20%	94,000	4,800

- **Conclusion – smarter agencies will dynamically optimize pumping activity, and build water infrastructures that better enable this – instrumentation, redundant routes etc**



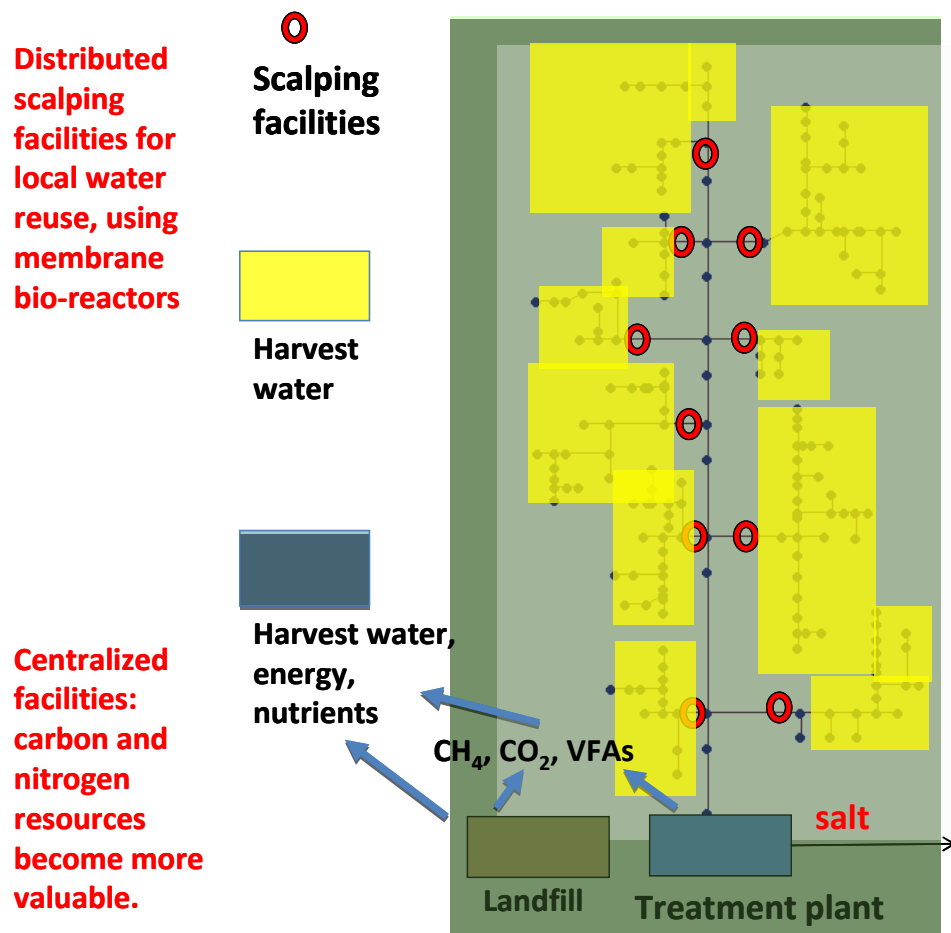
# Metering, leak detection and energy optimization – and asset management



# “Decentralized water and waste water treatment...”

- Today’s monolithic infrastructures are often obsolete
- Attention is turning to alternative – distributed - styles of infrastructure, both for water and waste water
- These may offer significant benefits – cost, resilience (fewer single points of failure), energy consumption, easier capacity planning, etc – and enable the “scalping” discussed earlier

**■ Conclusion: smarter agencies will plan to decentralize water infrastructures**

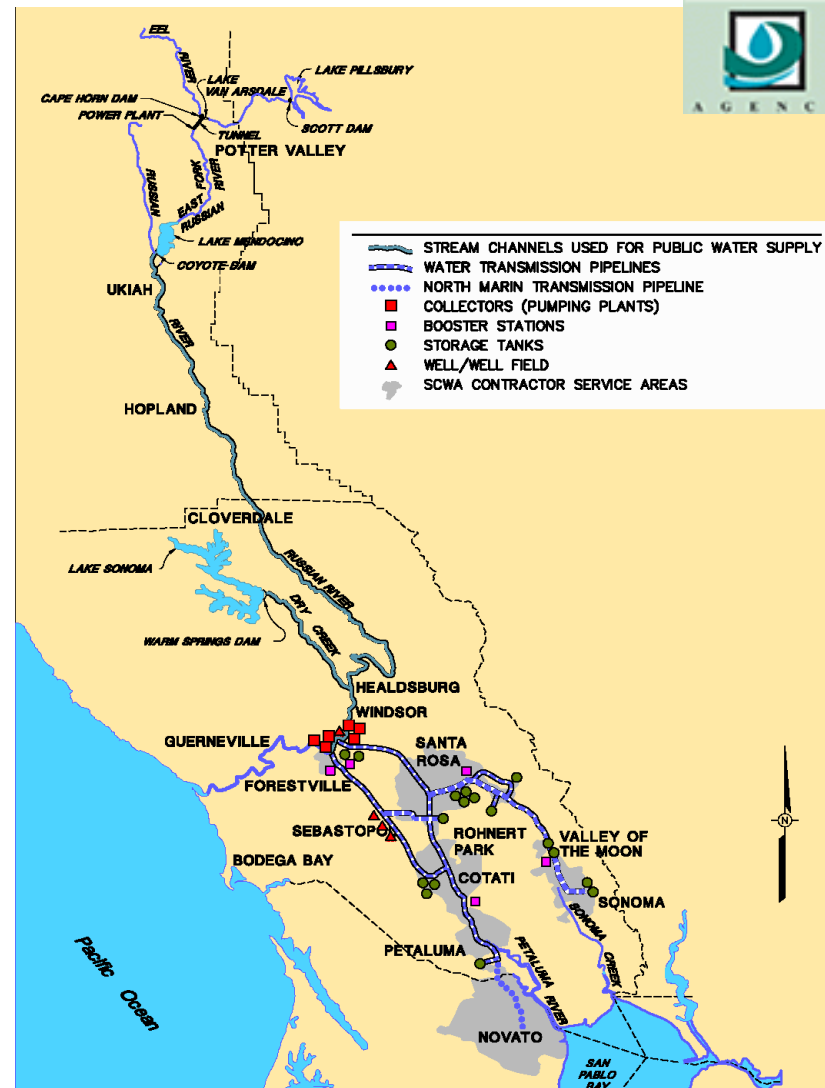


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# “Collaboration”: Sonoma CWA

- Single portal integrating SCADA systems of SCWA, Santa Rosa, Cotati & Rohnert Park
  - Flow, pressure, tank levels
  - Turbidity, pH, chlorine residuals
- USGS and ACE flow/stream gauge data
- Telemetered meters on relevant infrastructure turn-outs (supplied and installed by Badger Meter)
- Weather forecasting
- Operator support:
  - Bulletin board, live chat, alerts and alarms
  - Geographical and system-map views, with full zoom and pan as needed

■ **Conclusion: “collaboration platforms” will be the “killer app” for water**





# “Ecosystem Services”

- As well as quenching thirst, water provides fisheries, recreation, transport, industrial raw material, source of hydrogen, etc etc
  - Wetlands process pollution and waste, and help to control floods
  - Gravels enable water filtration and reduce the need for artificial purification
- The US EPA is researching the scope for creating and recreating small wetland areas to manage urban run-off
  - They are also looking at porous blacktop to avoid run-off altogether – allow water to recharge aquifers directly
- These services have financial value in terms of infrastructure \$ and/or risk avoided
  - Attention is turning now to calculating that value explicitly and including it in investment appraisals

**Smarter agencies will understand the value of the ecosystem services they receive and will start to charge for the degradation of those services. This will have a major impact on land use, building codes, and infrastructure design.**



# “Information” – enables the other dimensions discussed (1/2)

Smarter City Theme	Application of Information and IT
“Manage the Future”	▪ SPC, modeling and optimization
“Sensing”	▪ Sensor networking in a massive scale, plus data analytics
“Waste water is a resource”	▪ Management systems, oversight, application of SPC to extraction processes, management of residues and discharges
“Water recycling is the norm”	▪ Management and assurance of localized water treatment, injection and recovery facilities ▪ Water quality monitoring
“Demand is malleable if water is priced effectively”	▪ Demand modeling, management and prediction ▪ AMI for water



# “Information” – enables the other dimensions discussed (2/2)

Smarter City Theme	Application of Information and IT
“Leakage is a service failure”	<ul style="list-style-type: none"><li>■ Permanent in situ leak and pipe condition monitoring</li><li>■ Optimization of pumping activity to avoid scouring, pressure bursts</li></ul>
“Energy costs are a major issue”	<ul style="list-style-type: none"><li>■ Routine dynamic optimization of energy consumption, system wide</li></ul>
“Decentralized water and waste-water treatment”	<ul style="list-style-type: none"><li>■ Centralized management of distributed water &amp; waste-water plants</li><li>■ Reduced capacity requirements – optimization enables same level of demand to be met through smaller capacity</li></ul>
“Ecosystem services...”	<ul style="list-style-type: none"><li>■ Monitoring of ecosystem health and service “performance”</li></ul>



**Thank you!**

[peter.r.williams@us.ibm.com](mailto:peter.r.williams@us.ibm.com)