



***Indianapolis “smart water grid”
pilot project demonstrates local solution to
national sustainable infrastructure problem***

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A collaborative research effort to support a living laboratory for water technologies in Central Indiana

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National water infrastructure crisis impacts Indiana

The drinking water system in the United States is facing a major crisis.

Pipes installed in the early to mid-1900s have served so well that they have been forgotten and neglected in many areas of the country. As those buried pipes exceed their useful lives, they are beginning to leak and fail in record numbers.

As a result, many cities and towns across the country and here in Indiana now routinely lose more than 20 percent of drinking water through an aging network of leaking underground pipes. This water infrastructure lacks “smart grid” technology to monitor those conditions and identify problem areas. Therefore, undetected leaks grow until pipes fail, resulting in dangerous and destructive water main breaks — wasting clean water, losing revenue, disrupting customers and increasing labor, energy and repair costs for utilities.

With growing water shortages and rising rates, water main breaks are estimated to cause \$3 billion a year in lost water, expensive repairs, damage to surrounding areas and property, dangerous conditions, public health and safety concerns and lost economic activity from business closures.

Now community leaders are seeking ways to reduce the hundreds of water main breaks that occur each day and demanding that utilities find ways to address their “non-revenue water” costs.



Water main break closes 38th Street and entrance to Indianapolis Art Museum

Large financial investments in U.S. water infrastructure will be needed over the coming decades. According to a new report by the **American Water Works Association (AWWA)**, funding for buried drinking water infrastructure over the next 25 years totals more than \$1 trillion nationwide, assuming pipes are replaced at the end of their service lives and local systems are expanded to serve growing populations.

According to the **American Society of Civil Engineers**, pipes installed in the late 19th century have an average life span of about 120 years, but pipes installed after World War II have a shorter life span—about 75 years. Therefore, several generations of pipe will reach the end of their usable life over the coming years, leading to an ever-growing number of leaks and water main breaks.

Customers, regulators alarmed by higher water bills

Clean, cheap water has been considered a right by many in the United States, where drinking water is delivered for approximately \$5 per thousand gallons and customers often pay no attention to water usage and little attention to water utility bills. However, after a decade of outpacing other utility rate increases, water prices are getting increasing scrutiny from both consumers and state regulators.

Since the price of delivering drinking water is largely driven by the capital costs of maintaining aging infrastructure, water bills have been rising dramatically and are expected to continue that trend. At the same time, utilities also face higher costs to treat and deliver water, with stricter regulations and increasing energy prices.

Significant increases in water rates are already causing concern in many parts of the country. As a result, regulatory agencies are expected to push utilities to improve efficiency and reduce the amount of “non-revenue water” lost through leaks and water main breaks with better asset management.

A good example is regulation passed in Indiana during the 2012 legislative session that requires water utilities to annually report to the **Indiana Utility Regulatory Commission** “actions taken to minimize the impact of higher consumer rates.” Technology is a key way to reduce such costs and regulators are increasingly expecting utilities to use it for the benefit of ratepayers.

In addition to the increasing costs of aging infrastructure and higher water bills, efforts to control water main breaks will also be driven by the collateral damage each break produces. Unlike outages in the telecom and electric grids, water main breaks result in destructive flooding that damages surrounding property and threatens public health and safety. From traffic disruptions and loss of pressure

Circle of Blue's 2011 Water Pricing Survey							
City	Service Area Population (2009)	Average Monthly Bill for Family of Four Using 50 gpd (per month)	% change from 2010 bill (50 gpd)	Average Monthly Bill for Family of Four Using 100 gpd (per month)	% change from 2010 bill (100 gpd)	Average Monthly Bill for Family of Four Using 150 gpd (per month)	% change from 2010 bill (150 gpd)
Uniform Seasonal							
Phoenix	1600	11.31	2.6%	36.59	6.7%	64.37	7.6%
Uniform							
Fresno ¹	122	14.89	0.0%	19.75	0.0%	24.61	0.0%
Chicago ²	N/A	12.06	0.0%	24.12	0.0%	36.18	0.0%
Memphis ³	583	11.01	5.1%	22.02	5.1%	33.02	5.0%
New York	8360	23.60	13.0%	47.20	13.0%	70.80	13.0%
Seasonal Increasing Block							
San Antonio	1000	12.40	1.6%	20.67	5.2%	33.57	1.9%
Salt Lake City	380	15.23	5.2%	24.42	6.7%	34.20	4.7%
Los Angeles	4000	29.65	9.1%	64.80	10.8%	111.29	12.3%
Seattle	630	43.57	3.4%	75.22	3.4%	121.22	3.3%
Santa Fe	78	46.81	8.2%	131.37	8.2%	242.67	8.2%
Increasing Block							
Jacksonville	614	21.68	11.0%	35.56	18.4%	49.46	22.0%
Las Vegas	2000	19.79	15.2%	36.13	9.7%	56.52	7.2%
Denver	1300	20.46	12.2%	37.33	13.1%	66.25	13.6%
Tucson	775	18.99	8.8%	36.32	9.9%	83.12	14.4%
Charlotte	774	14.76	4.2%	36.28	1.7%	78.84	0.8%
Dallas	1306	16.72	3.5%	37.98	0.4%	68.37	4.7%
Houston	2060	25.51	16.1%	49.09	24.3%	87.97	23.6%
San Jose	107	25.40	3.6%	42.42	3.6%	61.30	3.7%
Columbus	1115	25.74	7.5%	46.29	7.5%	66.84	7.5%
Fort Worth	625	22.28	0.4%	43.72	0.6%	67.68	0.7%
Austin	796	20.34	6.0%	50.13	6.3%	101.22	7.3%
San Francisco	2400	36.07	17.8%	69.03	18.1%	101.99	18.2%
Boston	609	32.68	2.6%	67.18	2.6%	102.34	2.6%
San Diego	1300	48.23	9.5%	77.73	9.6%	109.07	9.6%
Atlanta	1200	38.07	12.5%	82.07	12.5%	126.07	12.5%
Decreasing Block							
Milwaukee	661	20.20	25.4%	33.64	25.4%	47.08	25.4%
Detroit	900	17.64	8.8%	30.91	9.0%	44.19	9.0%
Baltimore ⁴	1800	26.91	9.0%	43.06	9.0%	64.58	9.0%
Indianapolis	800	31.54	25.0%	53.34	29.3%	74.51	31.2%
Philadelphia	1672	29.82	9.1%	53.70	9.5%	75.29	9.4%

1) Fresno: 2010 figures have been recalculated using a single-family residential rate instead of a multi-family rate

2) Chicago: 2010 50 gpd figure is corrected
3) Memphis: 2010 figures corrected to remove an erroneous 5.64 fixed charge

4) Baltimore: 2010 figures for 150 gpd and 50 gpd have been corrected

Indianapolis water rates increased 25% in 2011

in fire hydrants to boil water orders and closed businesses, water main breaks have significant impacts on local communities. These are concerns for both water utilities and also for community, business and political leaders



Extensive drought conditions across large parts of the United States in 2012 also helped to underscore the need to improve water efficiency. For example, in Indianapolis a record 233 million gallons of water were delivered as demand surged past available supply and city leaders were forced to implement emergency restrictions on water use for much of the summer.

Severe drought in Indiana restricts water use, kills plants

While such actions can be used to force a reduction in drinking water demand, utilities must also take actions to ensure an adequate supply and especially to reduce the amount of valuable treated water that is lost in their distribution systems. Greater public awareness of the impact of water restrictions will also lead to calls for improved efficiency.

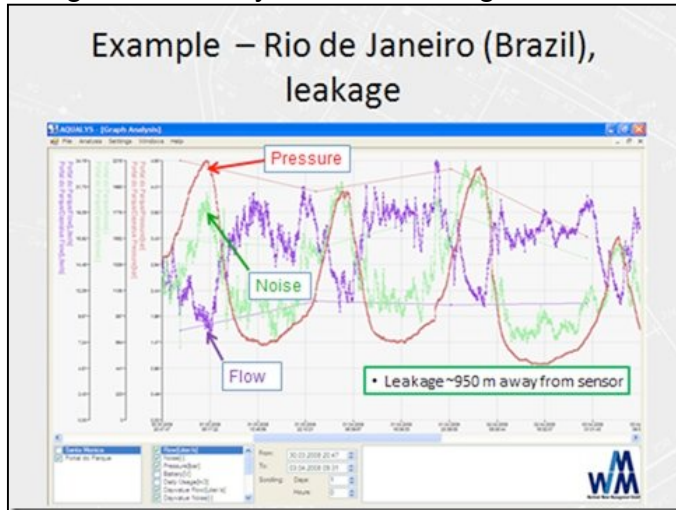
New technologies save money with “smart” solutions

Major infrastructure challenges in areas such as telecommunications and energy have been addressed through the introduction of innovative new technologies that improve efficiency. The same approach is now starting to take place in the water sector, as efforts to develop a “smart water grid” are seeking to introduce better measurement and monitoring to improve efficiency.

Water utilities need such new technology to monitor their systems — providing **real-time measurement** of water usage and **warnings** when conditions become dangerous. New technology may also allow utilities to make **better projections** on infrastructure replacement, providing justification for proposed projects and also to help **extend the life of the assets** they have in place.

The concept of a “smart water grid” harnesses advances in information technology to provide advanced monitoring of system data and greater efficiency in allocation of resources. It revolutionized the telecommunications industry in the past 20 years and has been used effectively in recent years by electric utilities. Now customers and regulators expect utilities to use new technologies to reduce water loss and improve efficiency.

Water provides some unique challenges in creation of a smart grid, such as buried infrastructure, low water pricing and difficulty in redistributing resources outside local areas. However, it also provides some exciting opportunities. Advances in sensor technology allow better visibility into the dynamics of underground water distribution systems. Rather than waiting for water main breaks to occur and reacting to the massive water loss and collateral damage to property, progressive utilities are proactive in identifying existing leaks that are growing and likely to threaten the system.



Data helps to identify growing leaks before mains break

In addition to the benefits of **early leak detection**, there are also opportunities to develop **better asset management** practices by improving system efficiency in emerging areas such as **demand-driven distribution**. Rather than simply following existing practices that pump water thorough a leaking system under high pressure to reach distant customers, a smarter system could use real-time data, variable-drive pumps and smart meters to balance demand and minimize stress on aging pipes and save energy.

The first step in developing smarter water networks is better measurement within the system. Many utilities rely on calculation, rather than measurement, to determine the amount of water lost between treatment at the plant and metering at the customer location. New technology monitoring real-time data on metrics such as pressure, bi-directional flow and acoustic readings at key points in underground distribution systems allow utilities to better identify and monitor zones where leaks are growing and water main breaks are likely.

Such advanced data can be used to greatly reduce the amount of non-revenue water across the system and may also lead to the development of communications tools that provide actionable intelligence for operators, managers and city leaders. Advanced systems may even use predictive modeling to create an **early warning system for water main breaks**. By identifying and repairing pipes before main breaks occur, communities not only save water, but also reduce property damage, avoid business disruptions and minimize risks to public health and safety.

Smart Water Grid

Just as other major infrastructure challenges have been addressed through the introduction of innovative new technologies that improve efficiency, that approach is now being used to develop a “**smart water grid**” with better measurement, monitoring, communications and control.

Central Indiana has an excellent opportunity to participate in this effort by using innovative technology and exporting solutions that make local communities more sustainable, create new jobs and provide leadership on an important issue for the state and country.

In the past several years, water clusters have developed in cities like Philadelphia, Cincinnati, Milwaukee, Denver and San Francisco. Now **Indianapolis** has a unique opportunity to leverage its **emerging technology community, strong research universities, advanced manufacturing base, skilled and energetic people and local entrepreneurship** to create solutions that improve our water distribution system and can be a model for others.



Global Water Technologies, a small company based in Indianapolis, has secured a patented sensor + software technology from Europe to reduce water loss. It has also developed a comprehensive “people + pipes + policy” approach to sustainable water infrastructure and established relationships to add additional “smart water” components, including:

Smart consumer dashboards

Web-based analytics allowing users to check and compare their water consumption is **being developed in Indianapolis** and allows water utilities to educate the public and incentivize behaviors that encourage conservation.

Two-way smart meters

Proprietary two-way wireless communications currently in development can bring command and control functionality to existing water meters and valves. This new approach allows utilities to collect, analyze and react to data in real time.

Demand-driven distribution

Once real-time data and controls are implemented in a water distribution system, variable drive pumps can save energy and reduce the likelihood of pipe failure by balancing water pressure with demand, rather than maintaining high pressure.

Indianapolis creates “living laboratory” for research

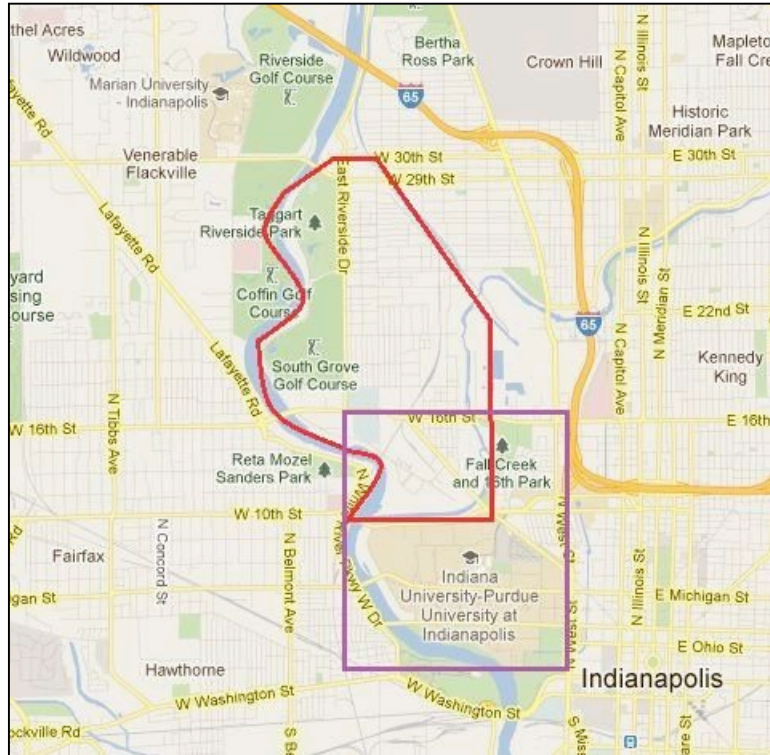
A unique partnership among utility, university and business leaders has created a “living laboratory” to demonstrate how such new technologies and a smarter water grid can be tested locally and then deployed across communities.

An area just north of the **Indiana University Purdue University Indianapolis (IUPUI)** campus has been selected to develop a strategic plan on how to utilize

an urban neighborhood for developing watershed and environmental solutions in sustainability. The **Riverside Watershed Environmental Living Lab for Sustainability (RWELLS)** is an area along the White River that includes 2,000 households, a mix of light industrial and commercial properties, and a city park and golf course. The diverse neighborhood lies along the northern edge of a new technology corridor established by the **City of Indianapolis** to spur redevelopment in the area and just west of a water treatment plant.

Citizens Energy Group

provides integrated water, wastewater and natural gas services to the area. The utility was established in 2011 through an acquisition of the water systems from the City of Indianapolis and serves more than 300,000 households in Marion County and the surrounding counties as charitable public trust.



In 2012, students from the Purdue School of Engineering and Technology began mapping water resources in the RWELLS area under a grant sponsored by IUPUI Solution Center and the **Buried Asset Management Institute-International (BAMI-I)**. The team identified opportunities to apply total asset management principles and introduce new technologies in the area as a way to improve water efficiency.

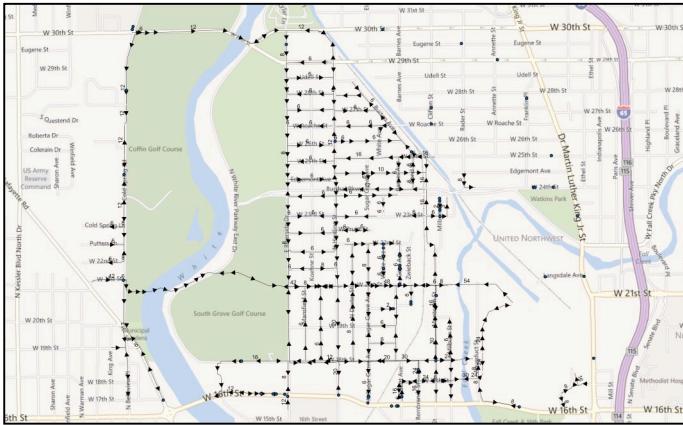
In addition to the university and utility resources, private sector support for the effort was provided by Global Water Technologies and **Peerless Pump**, which has significant manufacturing operations just west of the area and is one of the largest providers of water pumps in North America.

This collaborative effort to address water issues in real-world conditions allows innovative technologies to be tested, analyzed and refined so they can be adopted on a wider scale. As such, RWELLS provides a model for other communities and cities in Indiana and across the country.

Exploring local water conservation methods

In August 2012, Citizens submitted a Water Wise Plan to the Indiana Utility Regulatory Commission that outlines ways to encourage conservation and reduce water loss. As the owner and operator of the state's largest drinking water system, Citizens recognized its leadership role in addressing both supply-side and demand-side methods to provide safe, adequate water resources for both current use and future generations.

Citizens identified three main factors to providing reliable drinking water; water supply, customer demand and infrastructure capabilities. The utility reviewed historic demands on the system and made projections for future requirements. It also outlined a number of recommended measures to address greater water efficiency, including leak detection, meter replacement, automatic meter reading and pressure management.



Water mains, flow diagram and breaks in RWELLS area

In addition to these measures, where new technologies can improve water supply, the plan also stressed the importance of effective communications and customer education. Such efforts can impact demand, not only among homeowners, but also to those using water in multi-family housing, commercial and industrial facilities and institutions.

Citizens announced its intention to perform a utility-focused water audit with component analysis, using AWWA guidelines to determine real and apparent water losses and make a plan to implement the identified measures in an economically responsible manner. Such cost-benefit analysis is increasingly important as utility regulators are increasing scrutiny of rate requests.

Therefore, the RWELLS research platform is an ideal way to test and refine water conservation strategies on a limited scale, before deploying them across the system.

Leveraging local resources and expertise

The goal of reducing water loss in Indiana has already benefited from collaboration generated from the RWELLS research platform.

In early 2012, an IUPUI team of students and professors compiled initial research on the area's water infrastructure and the needs of its residents. Findings ranged from data on pipe ages and materials (cast iron, ductile iron, polyethylene, PVC and reinforced concrete) to attitudes in the neighborhood (welcoming attention to the community and an urgent need for jobs with 27% unemployment). Findings of the research were presented to Citizens at the end of June.

At the same time, Citizens and Global Water Technologies had been reviewing new sensor + interpretive software technology that has been deployed in Europe to provide early leak detection as part of a smarter water grid. Global Water brought the inventor of the system to Indianapolis in July for a briefing to Citizens and IUPUI on how a pilot system in the RWELLS area could be used as a demonstration of new water technologies. Global Water and IUPUI also coordinated with local companies including **Mezzetta** and **Midwest Mole** to prepare for installation of the system and have proposed a three-year demonstration that can be used to showcase both the monitoring technology and the living laboratory concept.



New sensor + software technology

In July, the RWELLS initiative was featured in *UIM, the Journal of Finance and Management for Water and Wastewater Professionals* and will also be featured in *Subsurface Asset Management*, an industry publication in Asia.

An additional collaboration was established with **Compression Institute**, an organization founded by Robert “Doc” Hall, a pioneer on lean manufacturing and thinking who retired after 32 years at the Indiana University Kelley School of Business. The RWELLS research platform is one of two national case studies for the institute's focus on water and a local working group was formed, including:

- *Dr. Tom Iseley* – Director of Construction Engineering Management Technology at IUPUI
- *Andrew Warrington* – President of Peerless Pump
- *Erik Hromadka* – CEO of Global Water Technologies
- *Stephen Nielsen* – Director of Wet Distribution Engineering at Citizens Energy Group
- *Matthew Klein* – former executive director of Indianapolis Department of Waterworks

Global Water also has promoted the Indianapolis effort with the **Confluence Water Technology Innovation Cluster**, a joint project of the Environmental Protection Agency (EPA) and Small Business Administration (SBA) in the Indiana-Ohio-Kentucky region; the **Water Innovations Alliance**, a national policy group promoting infrastructure investment at the federal level; and the **Milwaukee Water Council**, which is getting international support for its efforts as a United Nations Compact City for water technologies.

Building on the foundation

Now that initial steps have been taken to create and promote the RWELLS platform, it presents an excellent opportunity to facilitate a number of projects and research opportunities in a cost-effective manner.

IUPUI has agreed to serve as a program sponsor through the Purdue School of Engineering and Technology. This provides the expertise of Dr. Tom Iseley, who has more than 35 years of experience in planning, designing and construction of underground water infrastructure systems and is recognized as an industry leader in trenchless technology. Dr. Dan Koo is also a co-principal investigator and brings experience in numerous water, wastewater and storm water projects, from design and feasibility studies to specialized expertise in horizontal directional drilling, pipe relining, case boring and tunneling. IUPUI also has graduate and undergraduate students to support ongoing research efforts.

Global Water, Mezzetta and Midwest Mole are ready to install the new sensor + software technology to demonstrate how real-time monitoring can be used for **early leak detection** and to reduce water main breaks. This initial data collection and monitoring service is the first step to creating a scaled down version of a “smart water grid” in Indianapolis. Global Water is also working with a local data analysis specialist to explore how predictive modeling could be applied to the network to diagnose likely breaks and create a possible **early warning system** that would have public safety benefits to the community.



Hydrant pressure tested at working fire in RWELLS area

IUPUI is also developing **total asset management** approaches for use in water infrastructure and distribution systems, as such new requirements are emerging from state regulators across the United States.

Coordination on methods to collect, analyze and use data will allow best practices to be developed with real-world information from RWELLS.

Working with neighborhood outreach and city leaders will also be helpful in developing **public education** and **communications tools** for addressing water conservation and explaining water issues. This will also help to identify ways to improve such efforts before they are deployed on a wider scale.

The living laboratory is also an ideal place to test **new smart meters** and **automatic meter reading**, areas identified with potential for water savings. New approaches, such as **demand-driven distribution** can be also tested in RWELLS by incorporating innovating approaches to water system pressure, an area of interest for Peerless Pump and its parent company.

Supporting innovative research

Utilizing the RWELLS platform and established partnerships to achieve these research goals is an opportunity for the City of Indianapolis and other Indiana communities. As other cities and regions around the country are just starting to identify opportunities in water technologies, the living laboratory and its partners present an immediate vehicle for making progress to solve local problems and export solutions in a way that can serve as a regional and national example.

Efforts to date have been funded through a small grant from the BAMI-I and the IUPUI Solution Center and were used to pay students working during the Spring 2012 semester. In-kind contributions from participating companies and organizations have also assisted the project.

Now sponsored research funding is needed to maintain the initial effort, begin deployment of new technologies and move forward with additional research. Funding is suggested within the framework of an initial one-year period to launch the platform and deploy monitoring technology, followed by ongoing support to allow continuity in the research effort and coordination of projects in a cost-effective manner.

Local water utilities are the primary beneficiary and logical supporters of the RWELLS research effort and resulting information and technology advances. Funding for the effort can also take the following forms:

- grant funding of RWELLS research via IUPUI and BAMI-I
- specific project funding to coordinate with local utility plans
- seed funding for new technology development
- equity investment in a new technology startup

The return on investment for such funding would be calculated by measuring savings in water efficiency (reducing water loss and extending lifespan of infrastructure assets) and lower operational costs (reduced labor and energy consumption) plus benefits from improved relations with customers and local

organizations that benefit from efforts to reduce costs and improve the drinking water system.

This effort will also assist state regulators by addressing the intent of new legislation by finding ways to minimize future water rate increases. Additional benefits may result from raising the region's profile by taking a leadership role in the national water sector.

Although it is anticipated that local utilities would be a primary supporter of RWELLS research and new technology initiatives, such funding should also be leveraged with additional resources, including:

- grants from local, state and federal sources (SBIR, STTR, etc.)
- in-kind and financial contributions from businesses and organizations
- potential investors in new water technologies

Funding commitments are being sought now to continue the RWELLS research efforts with the launch of an initial monitoring system for the area and expanded research efforts in 2013 and beyond.

Timeline

Significant progress on this project began in 2012, with research on the RWELLS community and infrastructure, introduction of new technology, and positioning for Indianapolis to become a national example of how “smart water” technologies can be deployed. Milestones include the following:

2012 Q1

- Initial meetings with Citizens to discuss new sensor + software technology
- Initial research by IUPUI students on RWELLS community and infrastructure
- Promotion of water infrastructure issues at national and regional events

2012 Q2

- Presentation of project and technology to leadership group at Citizens
- Presentation of initial IUPUI research on RWELLS to Citizens
- Promotion of water technology to Central Indiana tech and innovation leaders
- Discussion of RWELLS concept with water policy leaders in Washington DC

2012 Q3

- Presentation to Citizens and IUPUI by Global Water's European tech partner
- Mezzetta and Midwest Mole become local partners for technology installation
- Water study group formed with Citizens, IUPUI, Global Water, Peerless Pump
- Citizens releases Water Wise Plan for conservation
- Initial introduction of living laboratory concept to national water industry groups

2012 Q4

- Announcement of collaborative effort among RWELLS partners
- Launch of initiative to promote “smart water grid” in Indianapolis

2013 plans

Having an initial system installed in RWELLS establishes the living laboratory as a working platform that can be used to test and develop solutions in 2013. It meets the state mandate to demonstrate ways to reduce water loss and save infrastructure. And it will be a valuable asset for coordination and testing with other utility and community efforts to utilize new water technologies.

- Begin public education and outreach efforts in Riverside neighborhood
- Begin initial pilot project using sensors + software to monitor conditions
- Establish data monitoring service of RWELLS conditions
- Coordinate with utility to utilize collected data and develop new tools
- Begin development of a total asset management plan
- Begin evaluation and testing of demand-driven distribution
- Educate local community on project goals and water issues
- Seek additional funding from federal, state and local grants
- Develop additional partnerships and support from industry groups

Funding for 2013 projects will be identified from a number of sources, allowing Indianapolis to leverage its initial investment in the RWELLS living laboratory with outside funding and to utilize the platform to support other internal projects and goals of the organization.

Goals and objectives

Research conducted through the RWELLS platform will be coordinated by a project team of faculty and graduate students at IUPUI to provide third-party validation of new technologies and procedures to improve water efficiencies. Specific goals and objects of each effort in RWELLS will be outlined on a project basis, but generally they will include the following:

- Engage water customers in the RWELLS area to inform and educate them on water conservation and “smart grid” efforts to reduce water loss.
- Introduce “smart water” practices, using real-time data and measurement to provide more accurate information than traditional calculations to estimate the amount and location of lost water in the system.

- Test new approaches, such as demand-driven distribution where monitoring data can be combined with smart meters and pumps to reduce system pressure while saving energy costs and extending the life of aging pipes.
- Refine the approach to such new technologies in a real-world setting with university and industry partners so that solutions can be implemented in other areas of Indianapolis and also exported as solutions to other communities.
- Provide leadership in the state by supporting research that can be used by smaller communities who adopt best practices developed in this process.
- Explore other benefits of a smarter water system, such as addressing homeland security concerns for infiltration and disruption scenarios and expansion of monitoring to include anticipated federal guidelines on contaminants.

Return on investment

Taking the initial steps to create a pilot “smart water” grid in the RWELLS living laboratory platform is a wise investment that will generate returns in a number of areas. A primary metric for calculating the benefit of this project is reduction of water loss through better condition assessment and the creation of a process that can be deployed across the system to identify undetected leaks and warn of impending water main breaks. Such returns to the City of Indianapolis include:

- A reduction in lost (non-revenue) treated water
- Lower infrastructure repair costs (pipes, roadways, etc.)
- Reduced collateral damage to surrounding property (buildings, cars, etc.)
- Improved public safety (fewer closed roads, disruptive main breaks, etc.)
- Improved public health (less water contamination, fewer boil orders, etc.)
- Less economic disruption (reduced impact on area businesses)

In addition, the project will support the mission of water utilities to:

- Demonstrate responsiveness and stewardship to the IURC
- Extend asset life and improve operational efficiencies
- Improve customer relations by demonstrating steps to reduce water loss
- Support sustainability efforts with the City of Indianapolis and IUPUI
- Provide leadership that benefits smaller utility and municipal water systems
- Support city and community development efforts in the Riverside neighborhood
- Communicate success to Indiana stakeholders and a national industry audience

Next steps

For more information on participation in this effort and the next steps being taken to move it forward, please contact Dr. Tom Iseley at IUPUI or Erik Hromadka at Global Water Technologies.

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