



**BRINGING ADVANCED
INFORMATION
TECHNOLOGY
OF WATER MANAGEMENT**
Proposed Educational Organization

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Discussion Paper

**Bringing Advanced Information Technology to Water Management –
Proposed Educational Organization**

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Bringing Advanced Information Technology to Water Management – Proposed Educational Organization

Introduction

This paper outlines the concept for an educational and perhaps advocacy organization focused on establishing the value of applying advanced sensing, information technology and modeling to water management in the USA. It solicits interest in joining with IBM to create such an organization (labeled “WaterITOrg” in this paper for convenience – this is not its intended title). IBM is not proposing to lead WaterITOrg, and is keen to ensure that WaterITOrg is entirely open in terms both of its membership (which could include IBM’s competitors), and the technologies and standards that it promotes.

Problem Statement

Government, water agencies and utilities are responsible for the following, that for varying reasons they increasingly find problematic:

- *Ensuring water availability at the required quality, while respecting the environment* – large areas of the US either face or are now experiencing water stress, either from drought-induced surface water scarcity, perhaps exacerbated by climate change, or from the depletion of groundwater resources such as the Ogallala aquifer. In areas such as North Florida/Georgia, the Missouri river and Sacramento River Delta, debate exists on how to balance human and environmental water needs.
- *Ensuring water security* – detection and prevention of contamination, either from deliberate acts or as a consequence of environmental events.
- *Replacing an ageing water infrastructure* – the US has an average annual maintenance backlog of \$23bn¹, and the US Army Corps of Engineers (ACE) alone has a total water and levee infrastructure maintenance and renewal backlog of \$38bn². Water attracts just 0.2% of the Federal public infrastructure investment budget, and this budget has itself declined from 3.9% of the Federal budget in 1960 to 2.6% today.³
- *Managing weather impacts* – as severe weather events become more common, this exacerbates the stresses just described, with increasing risk of outcomes such as levee failure, storm water overflows and pollution, and so on.

The underlying issue is frequently the lack of information in the right temporal and spatial granularity to support effective decision making. Even where the information does exist, it may be fragmented between multiple organizations and stakeholders⁴, or those stakeholders may use different models and

¹ http://www.iwr.usace.army.mil/outlook/docs_out/FactCommunityInfrastructure.pdf

² <http://www.asce.org/reportcard/index.cfm?reaction=factsheet&page=11>

³ http://www.iwr.usace.army.mil/outlook/docs_out/FactCommunityInfrastructure.pdf, op cit

⁴ See, for example, Wired Magazine, “Peak Water: Aquifers and Rivers Are Running Dry. How Three Regions Are Coping”, Matthew Power, April 21st, 2008

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tools that prevent them from coming to agreed conclusions. The Federal Government has recognized this underlying issue, as the following references attest:⁵⁶⁷⁸

Solutions are available today for this underlying issue, based on:

- the application of wide-area sensing and metering to obtain that information, up to and including in real time;
- data integration to allow multiple stakeholders' data to be combined to create the picture for an entire water resource (say, a watershed or aquifer);
- modeling, to augment the data gathered and to generate insight;
- visualization of results, to enable management decision making.

However, the water industry's take-up of these solutions to date has not been as great as the need for them would suggest, for a number of reasons identified below. WaterITOrg seeks to address this situation and create the conditions to enable such solutions to be routinely used in the water industry, to the benefit of all water users and of the environment of the USA.

How WaterITOrg would work

WaterITOrg would build awareness of the potential of the advanced IT and modeling solutions to improve water management decisions, and in effect to "create the category" in the minds of water industry professionals. It would do this by:

- Building awareness of the nature of the information problem in water management, awareness of the types of solutions required and of the capabilities of advanced sensing, IT and modeling to provide these solutions.
- Fostering the collaboration between the different state and local agencies required to implement these solutions, in particular where such agencies share jurisdiction over, or use of, a specific water resource (river basin, watershed, estuary, aquifer) or piece of infrastructure.
- Working with stakeholders to create the supporting collateral for the solutions' success – standards, models, tools reference architectures and so on.

WaterITOrg would be patterned closely on Gridwise.Org, a DOE-sponsored organization of which IBM is a member. Gridwise has sought to "create the category" for advanced IT in the energy transmission and distribution industry, just as WaterITOrg would do for water. Like Gridwise,

⁵ NSTC, "A Strategy For Federal Science And Technology To Support Water Availability And Quality In The United States, - Report Of The National Science And Technology Council Committee On Environment And Natural Resources Subcommittee on Water Availability and Quality", September 2007 (see especially pp 7-14)

⁶ GAO, "Water Infrastructure: Information on Financing, Capital Planning, and Privatization", Report to Congressional Requesters, August 2002

⁷ GAO, "Environmental Indicators: Better Information is Needed to Develop Environmental Indicator Sets that Inform Decisions", Report to Congressional Requesters, November 2004

⁸ GAO: "Climate Change: Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources".

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WaterITOrg would begin life as an educational organization; as with Gridwise, we would need to seek a Federal government sponsor. Over time, WaterITOrg may evolve to advocating policy positions, via a separate offshoot, just as Gridwise has done by creating the Gridwise Alliance.

Overcoming barriers

WaterITOrg would exist to overcome the barriers to the water industry's adoption of advanced sensing, IT and modeling solutions to water management problems. It is important to understand these barriers and how they operate, and then to be clear about how WaterITOrg can help to address them. First, the barriers themselves:

- *Pricing of water.* Water has rarely to date been consistently priced in line with its value as an “ecosystem service”, or with the environmental impact of usage and discharge. Some large cities are not even metered; some industrial and agricultural users pay little or nothing for their water. Therefore the financial ROI for implementing advanced IT solutions is often hard to demonstrate.
- *Organizational fragmentation.* Any given water resource in the US will usually have multiple parallel and/or overlapping federal, state and local bodies with jurisdiction over its management. For example, in the case of a large natural water resource such as San Francisco Bay, there are 25 separate bodies responsible for some aspect of its management; and US-wide there are 54,000 US water systems, of which 50,000 serve fewer than 10,000 people⁹, sometimes with a 2-tier wholesale/retail structure superimposed. This fragmentation translates into major requirements for stakeholder management in gaining approval for and executing any given project; and into tiny budgets unable to address major improvements.
- *Data fragmentation and availability.* Largely as a consequence of the above, data about any given water resource will usually be fragmented between multiple owners, if indeed it exists in the right spatial and temporal granularity at all. Shared access to real time event data may be particularly at a premium. Private supply owners (about 15% of Americans)¹⁰ may not be required to provide any information at all about their water holdings.
- *Lack of awareness.* The US water industry is in many cases apparently satisfied with its current management capabilities and ignorant or skeptical of the potential to improve these. As a very specific example, a forthcoming paper¹¹ identifies that dynamic pump optimization is rarely considered by water agencies, despite its potential to reduce energy consumption (often the agency's largest or second-largest cost) by 10-20%.
- *Lack of funding.* As described above, funding for water infrastructure in the US, let alone in maintaining ecosystem services, is inadequate for purpose.

⁹ Environmental Protection Agency, “Water on Tap”, 2003, p.7

¹⁰ EPA, op cit, p15

¹¹ Bunn, S and Reynolds, R, “The Environmental Benefits of Water Pumping Optimization”, IBM Journal of R & D, forthcoming, Spring 2009.

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However, there are reasons for optimism that the situation is starting to change, and that the timing is right for WaterITOrg to make a difference to how the US water industry defines its needs and the solutions to those needs. The reasons for optimism are:

- *Water pricing:* it is possible to detect a trend to increasing prices: municipal water rates increased over the past five-year period by an average of 27 percent in the United States. (This is a world-wide trend: some equivalent data are 32 percent in Britain, 45 percent in Australia, 50 percent in South Africa and 58 percent in Canada¹²). One may predict that as water scarcity becomes more acute, the laws of supply and demand will drive these trends to continue, at least in water-stressed areas. This will promote a business climate in which the ROI from water management improvements will be both more important and easier to demonstrate.
- *Fragmentation:* Federal and state water agencies (CA DWR is just one example) are known to be attempting to address the data fragmentation that exists.
- *Awareness.* In IBM's perception, far-sighted water agencies are now starting to look seriously at applying advanced sensing, IT and modeling solutions to their activities. The work that IBM is itself doing on the Hudson River is one example; others (where IBM is not engaged at this time) might include the modeling and simulation work undertaken by some Florida water agencies. In addition, there is now a growing recognition of the need to manage such water risks as
 - Drought – where for example California and other states are now actively planning for a water stressed future¹³.
 - Levees - following Hurricane Katrina, and most recently the 2008 Midwest floods, this has attracted considerable congressional interest. Damage from the 2008 floods alone is projected to cost \$3bn in infrastructure repairs¹⁴ and at one point looked set to cost \$7bn in lost food production¹⁵, although good weather since the floods has enabled a recovery in this respect.
- *Recognition of need for infrastructure renewal.* As the earlier US ACE and GAO references show, recognition of the need for renewal of the US's water infrastructure is growing. As a further example, California is planning a bond issue of \$9.4bn (up from the \$5.5bn originally intended) for water management.

Ways of working

WaterITOrg would help to overcome the barriers and build on the encouraging trends just described in four main ways.

1) *Articulate a Vision.* WaterITOrg needs to articulate a vision of how water management could be improved with advanced sensing, IT and modeling, and “sell” this vision to decision makers in the water industry. Given that water is not a globally fungible commodity, the vision will need to be

¹² Earth Policy Institute, quoted in International Herald Tribune, April 26 2008.

¹³ <http://redgreenandblue.org/2008/06/04/schwarzenegger-declares-statewide-drought-orders-agencies-to-address-californias-urgent-water-needs>

¹⁴ http://www.geotimes.org/aug08/article.html?id=nn_deluge.html

¹⁵ American Farm Bureau, quoted in

<http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=969&tstamp=200806>

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expressed at the level of regions or water resources – ie addressing all of the owners and users of a given resource¹⁶. The vision would then need to be promoted through such tactics as:

- Conferences, symposia.
- Educating legislators and policy makers on the value of implementing advanced sensing, IT and modeling solutions
- Surveys of best practice (and publicizing these)
- Marketing
- Partnering with journals and other opinion formers to create content for them

2) *Pilot implementations.* WaterITOrg could accelerate the market's readiness by seeking to obtain federal funding for, supporting (through collaboration between its members), and publicizing, pilot implementations of advanced IT solutions. Ideally these would demonstrate the value of collaboration between water agencies in overcoming data and organizational fragmentation. These pilot implementations need to be clearly linked to the overall vision and would need to include a demonstration of ROI, including the return from risk mitigation¹⁷.

3) *Standards.* WaterITOrg could identify and promote open standards for data and model exchange, and reference open IT architectures for the water sector. WaterITOrg would not be a “standards organization” per se, but would work with bodies such as the Open Geospatial Consortium (OGC) and the Consortium of Universities for the Advancement of Hydrological Science (CUAHSI) to input business needs to those bodies' work. It is stressed that these standards should be open – WaterITOrg should not support the use of proprietary standards, as these will become (indeed, are today) barriers to the types of progress that WaterITOrg will try to enable.

4) *Advocacy.* WaterITOrg could in the future, and with the agreement of its members, create an offshoot to advocate for certain regulatory changes, for example:

- Requiring water agencies working with a given water resource (river basin, watershed, aquifer, major infrastructure item) to co-plan, and to exchange and aggregate data, to allow the resource to be managed holistically.
- Requiring agencies to report on water usage, availability and resource drawdown within a given geography, as they do for water quality today.
- Requiring the adoption of specific data standards.
- Enabling metering and differential pricing of usage and discharge.
- Water rights – obligations to report on water use and availability.
- Economic pricing of water.

¹⁶ Parts of the Federal Government recognize this – see, for example NSTC, op cit., which states the following: “Without an adequate assessment of water supplies on a watershed or aquifer basis, optimal water management cannot be achieved”.

¹⁷ For example, flood control work, on average, prevents \$22 billion in damages per year, saving \$6 for every \$1 spent (<http://www.asce.org/reportcard/index.cfm?reaction=factsheet&page=11>, op cit).

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Advocacy remains an option only at this stage: as already stated, WaterITOrg’s initial focus would be on educational, not advocacy activities.

Creating WaterITOrg

Objectives

Summarizing the paper so far, and as a first attempt at a formal statement, the objectives of WaterITOrg would be to:

- Secure the participation of Federal and State water organizations, water utilities and other businesses in defining how IT should evolve to support water management.
- Articulate and gain consensus behind a vision that sets this out
- Define and secure funding for pilot implementations of water management solutions that engage multiple stakeholders and jurisdictions responsible for entire water resources (river basins, watersheds, aquifers) or major pieces of infrastructure.
- Monitor and publicize the outcomes of those pilots.
- Create reference open architectures for water industry IT to maximize ease of data sharing and interconnectivity.
- Via other standards bodies, create data exchange and business process standards to support water management.
- Via subgroups, create supporting tools and collateral such as models, ROI calculators, case studies and so on.
- Possibly, in the longer run, to advocate for changes in how water is regulated that will encourage the use of IT to improve water management.

Scope of activity.

WaterITOrg would initially work in the US.

The scope of WaterITOrg’s activities can be thought of as a set of “scales” of application. The proposal applies to these scales as follows:

Scale	Application
Natural scale (rivers basins, watersheds, aquifers)	Applies – to government agencies’ and utilities’ roles in managing these
Utility scale (federal, state or local water infrastructures, including advanced meter infrastructures)	Applies - to utilities’ activities at multiple levels, including groups of utilities
Enterprise scale (enterprise use of water for manufacturing)	Applies indirectly – Government agencies can be major water users in their own right; and enterprises with heavy water consumption may become involved in natural or utility scale projects.
Flood management	Applies – both to traditional high risk geographies

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Scale	Application
	but to a much wider range of regions that are experiencing severe weather events on a more frequent basis

Establishment

WaterITOrg would start life as an educational organization and it would therefore be possible for Federal agencies to establish, seed-fund and collaborate with it (much as the DoE did for Gridwise)¹⁸. We need a nucleus around which to build WaterITOrg and approach the central government for seed-funding – see below. Options for a Federal organization to approach for sponsorship include:

- Department of Energy
- Department of Interior - Bureau of Land Management,
- Department of Interior - Bureau of Reclamations
- US Geological Survey
- Environmental Protection Agency
- US Army Corps of Engineers
- US Department of Agriculture - National Forest Service
- Department of Commerce
- National Oceanic and Atmospheric Administration
- Possibly, Department of Homeland Security (although interest in the environmental aspects of what we propose will be low).

Clearly some of these have a better fit with WaterITOrg's proposed overall mission than others; and there may well also be others not on this list. The initial nucleus of WaterITOrg would collectively decide on its preferred approach.

Participants

Participants, aside from the sponsoring Federal department/agency (see above), would include:

- State water agencies such as state Departments of Water Resources.
- Civil engineering companies active in the water
- Water providers, at the wholesale and retail levels
- Water industry associations
- Major water industry suppliers such as SCADA system manufacturers, sensor manufacturers and IT providers – IBM and others

¹⁸ In the event that we also build an advocacy organization, this will need to be at arms-length so that the agency is not in the position of funding advocacy.

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- Enterprises with a significant business interest in water (such as energy, paper, semiconductor, food and chemical companies)
- Key water industry journals such as Water Efficiency
- Possibly, a data standards organization such as Open Geospatial Consortium (OGC)
- Water research laboratories.

Legal basis

WaterITOrg would begin its life as an educational organization, focused on educating the industry and government about the scope of IT to improve water management. It may, as noted, create a separate offshoot for advocacy purposes at a later time. The legal basis for these activities remains to be discussed.

Next Steps

IBM is seeking to create a nucleus of 5-6 organizations drawn from the list of possible participants just set out, to:

- Agree initial terms of reference and basis for association
- Agree initial tactics
- Create and execute on approach to Federal agencies for seed funding
- Establish a conference to create initial membership
- Define a mission, constitution and governance framework
- Define a revenue model (subscription or other)
- Create a small permanent organization

Timeline targets would be

- Begin publicizing idea of WaterITOrg etc – Q4, 2008
- Establish nucleus – end of 2008
- Have a Federal sponsor engaged (allowing for the turbulence that will inevitably follow the change of administration in Washington) – end of Q2, 2009
- Hold inaugural conference – Q3 2009
- Establish WaterITOrg governance etc – Q3 2009
- Have an active membership and commence meaningful work – Q4 2009.

Conclusion

This paper has outlined a purpose and path to establishing WaterITOrg. Comments are sought to Peter Williams, at peter.r.williams@us.ibm.com, or on (925) 648 7975.