From: Bill Hickey
To: mi-waterstrategy
Subject: Water Strategy Draft
Date: Friday, August 21, 2015 6:17:36 AM

Dear Sir or Madame,
I live in Detroit. My neighbors cannot pay their water bills. Their water is being turned off. They are forced to borrow water from neighbors or move. There is not enough money in plans to aid such families. Payment plans are unaffordable. I believe that water is a human right. No one should be without it because they can't afford to pay for it. Our State's water strategy must include this principle, as well as establish a strong mandate for water affordability plans. The poor pay a higher percentage of their meager income for water than do our richer citizens and businesses whose water rates go down the more they use. This is not fair or right. We need a commitment to water affordability plans in our State Water Strategy.
Thank you.
William Hickey
14910 Lamphere St.
Detroit, MI 48223
(313) 472-5295

From:	Nicholas Machinski
To:	mi-waterstrategy
Subject:	Water Strategy Draft
Date:	Thursday, August 27, 2015 11:47:46 PM
Attachments:	deq-ogl-Draft_Water_Strategy_and_Appendices__06-04-2015_491266_7.pdf

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Dear Office of the Great Lakes,

I read what I could of the draft available to the public and have attached my comments with the document to this email. Thanks for making this document available for the public to comment on. I believe getting a water strategy figured out for the state is vital for the future of Michigan.

Sincerely,
Nicholas Machinski

From: Mike Cluney
To: mi-waterstrategy
Cc: [redacted]
Subject: water strategy for great lakes freep sunday july 26, 2015 page 6A
Date: Sunday, August 02, 2015 8:37:42 PM

Regretfully I could not attend the Detroit area meetings, however, that in no way lessens my concern for the great lakes. My primary concern for the great lakes and rivers leading to the great lakes ie Muskegon river and the oil pipe line leak there.

Obviously we need energy but we need it to be made available in a fully comprehensive safe and responsible manner and having millions of gallons of crude oil sand leaking into the Muskegon river is not acceptable.

Of even greater concern is the same antique oil pipeline traveling the length of the upper peninsula along the southern coast line of lake superior down under the mackinaw bridge to the lower peninsula is more than worrisome given the past major, major oil leaks that have plaqued the O & G companies not the least of which was the gulf of mexico leak (GROSS NEGLIGENCE) on the part of (BRITISH PETROLEUM) who recently applied to the EPA to allow the BP refinery (whiting Indiana) to increase its pollution of the south tip of lake Michigan.

Fracking has also raised its ugly head in a number of incidents not only in Michigan but other states as well. It not only permanently destroys large quantities of fresh water in its dislodging natural gas 12 miles down but has polluted the air and land around the well sites.

And the only reason the O & G industries frack is to harvest and export nat gas off shore to Europe where natural gas brings $11.00 per cubic foot where in the U S we only pay $2.00 to $3.00 per cubic foot.

If you ask me where the emphases should be placed when it comes to water strategy for the Great Lakes O & G industry regulation should receive high priority. I am for a complete and comprehensive ban on fracking in and around the great lakes !

Michael Cluney
[redacted]

August 18, 2015

To: Michigan Office of the Great Lakes

From: Jay Richardson, Technology Principal
Sustainable Water Works, a 501(c)(3) Michigan Nonprofit

Subject: Draft Review of Michigan Water Strategy

The Michigan Water Strategy Draft for Public Review is a comprehensive and focused document on the role of water in Michigan's future. As we reviewed this document, we appreciate the wide range of current stakeholders from an ecosystem and quality of life perspective. Sustainable Water Works (SWW) believes future stakeholders can diversify Michigan's economy and make them a leader in natural resources sustainability. Retention of Michigan graduates, funding of Michigan university research, and increased economic development in the residential, commercial property and industrial businesses are essential for our future and we are positioned to be the policy and technology leader with implementation and funding of a Michigan Water Strategy.

SWW believes the ecosystem approach must be supported by targeted investment on 4-5 specific priorities for Michigan's future:

1. Eliminate known legacy pollution of rivers, lakes and Great Lakes AOC's in Michigan to support quality of life, recreation, residential, sustainable commercial and industrial development.
2. Manage stormwater runoff to mitigate nutrient, CAFO, industrial and CSO to maintain high quality potable and recreational water resouces.
3. Restore and enhance watershed, riparian green infrastructure, fisheries to promote native fish (supporting a viable commercial fishing and recreation industry) and pollution monitoring.
4. Leverage Michigan's academic, business, NGO and professional groups to focus on water education, outreach, opportunities and solutions to make Michigan a leader in water quality, access and availability for productive and sustainable use.

In reviewing the Strategic Actions, SWW has the following comments:

- Aquatic ecosystems are connected systems of surface, ground and infiltrated water requiring a systems approach that includes in situ remediation of legacy issues, biomimicry, bioremediation and other sustainable technology developments to eliminate water issues at their source.
- Clean and Safe Water is the basis of any water strategy which requires investment in water research, development and businesses, so the economic benefit of global use of these product, processes and technologies is Michigan.
- Vibrant Waterfronts – AOC cleanup and watershed restoration are the keys to creating the capacity to create waterfront development. Pure Michigan has established the tourist and business potential of Michigan shores, environmental restoration will provide for developer investment to expand this to places like Muskegon and Marquette.

- Water Recreation is more than access. It is eliminating the source of beach closures, establishing watersheds and estuaries for retrenching native species of fish and waterfowl, creating fisheries and aquaculture industry to replenish native species in inland and Great Lakes to support commercial and recreational fishing.
- Promoting the water economy is vital to Michigan's future. The Water Strategy should focus government, business, philanthropic and academic efforts toward solving the Michigan priorities using the strength of our universities to do targeted research, government, business and philanthropic investment to use public utilities, land, roads and private funding to implement replicable pilot projects that solve Michigan and global issues supporting business investment to manufacture these products here and export them as an economic growth strategy.
- Investment in water infrastructure is key to restoring water quality and the ability to cope with emerging contaminates such as toxins, pathogens, pharmaceuticals, hormones and biological agents. Maintenance of end of life facilities and replacement of water infrastructure is essential for growth. New processes and technologies can make facility and infrastructure replacement much more affordable, especially if it is provided by Michigan companies.
- Monitoring Water Quality is essential for health, safety and national security, but source control of contaminates to provide high quality water from surface and groundwater intakes is necessary. Monitoring should focus on control and modeling stormwater management, nutrient runoff and groundwater migration to understand and react to ecosystem dynamics.
- Building Governance Tools is important to lead and prioritize solutions for water issues, coordinate academic, nonprofit and business activity toward the most effective and productive approaches, and network key stakeholders to collaborate on implementation of the most promising best practices, technologies and processes.
- Inspire Stewardship for Clean Water is an important aspect to education and outreach of Michigan citizens, businesses and cities. Leadership in sustainable water innovation is important to the State's future, since economic growth happens where innovation happens.

SWW's comments are meant to be constructive on Michigan's Water Strategy as a roadmap for Leadership in water quality and ecosystem restoration. Here are some specific comments:

1. Reduction of agricultural phosphorous runoff by 40% is important, but there is no proven technology to accomplish this level. Supporting collaboration of farmers, watershed organizations, academic experts, design and engineering professionals and innovation entrepreneurs is important to stakeholder acceptance of water quality and cost effective solutions. Several Best Management Practices may be needed, so a range of pilot projects using consistent baseline, modeling and performance metrics are essential build the toolbox.
2. Michigan needs to expand economic development to sustainable water intensive industries such as commercial fishing, electronics manufacturing, indoor agriculture and aquaculture…etc.
3. A new investment paradigm is needed for natural resources that values the economic impact to Michigan's GDP. Manufacturing water technologies in sanitation, purification, stormwater management, watershed restoration, water recycling…etc. solve global water issues. Investment capital is needed to create businesses at scale that can produce and export successful pilot technologies and the ability to introduce these businesses to the world.
4. The Water Strategy should be funded through a focused natural resource economic development organization. This will require networking organizations who have a vested

interest in a robust water ecosystem from an environmental, commercial and utility perspective to translate the Strategy into a “business plan” with the appropriate “scorecard”.

5. Water is important to everyone in Michigan. Education and Outreach must be focused on every stakeholder group. Citizens are interested in clean potable water, recreational users focus on water quality in watersheds, rivers, lakes and the Great Lakes, commercial users need access and a clear future regulatory approach that insures water for beneficial use and uniform standards for discharge. Progressive regulation that require results, but promote innovation is much more conducive than a prescriptive approach that is inflexible toward new technology and processes.

Sustainable Water Works appreciates the opportunity to comment on the Michigan Water Strategy

Jay Richardson, Technology Principal
Sustainable Water Works

EVAN N. PRATT, P.E.

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MEGHAN BONFIGLIO
Chief Deputy Water Resources Commissioner

Telephone 734.222.6860
Fax 734.222.6803

August 11, 2015

TO: Mr. Jon Allan, Office of the Great Lakes

FROM: Evan Pratt, Washtenaw County Water Resources Commissioner, Director of Public Works

RE: Water Strategy document

Dear Water Strategy Team:

Thank you for your comprehensive and challenging work to develop the Water Strategy document. There is a lot in the document, and a lot to like! In particular, I and many of the people I have spent a career working with agree that the concept of water as a sustainable economic engine is an excellent strategy on which to focus. And of course we appreciate the formal acknowledgement of the symbiotic relationship between a cleaner environment and a successful economy.

My understanding from the July public meetings around the state is that while feedback on the positives is always appreciated, the type of feedback you are currently seeking is honest, detailed, and specific feedback on where we might be able to increase our collective chance of success in implementation. With that in mind, the format of my remaining correspondence will be to first identify specific areas of greatest concern to this office, secondly to identify specific areas of greatest concern to this office identify general areas that may not have been specifically addressed in the Strategy, then third to provide feedback on other specific items in the document, by Chapter.

The areas of greatest concern to this office fall into these five main areas:

1. The Strategy calls for implementation via local leadership. Through the MS4 process, dozens of local leaders, mainly in urbanized areas, have been doing everything in their power for cleaner water, particularly in urbanized areas where problems are worst. Progress has been substantial, but many obstacles prevent locals from doing what we know is needed. These obstacles require state leadership and commitment of resources if any different outcome is expected. Three specific examples include enabling more local funding tools, providing high-level public engagement and economic development effort, and providing tools to incent compliance with voluntary Recommendations.

   In short, the Strategy does not provide much new that one would expect to result in a greater commitment or change in local effort levels in the Grand Traverse, Tri-County, SEMCOG, or GVMC regions. Only about 5% of Michigan's population lives outside those regions, so it would be difficult to expect a change in results if these obstacles, repeatedly identified by local leaders all over the state, are not addressed.

2. The outcomes, or Measures of Success are not specific enough in many areas for people to agree in the future that the goal has been accomplished or that significant progress has been made. It appears that most of the Measures that have a specific, measurable outcome are from other plans or initiatives. There is a need for the Measures of Success to be measureable and timebound if the Water Strategy is intended to achieve more than other existing plans and initiatives.

3. The most important Measure of Success would be to improve on existing state efforts to manage water budgets in each aquifer and stream. The current tool falls short of establishing a connection between permitted water use and historic and current groundwater elevations and/or stream flows that is easily understood by the public. Additionally, with respect to cold water fisheries, temperature should be monitored and correlated with withdrawals and stream flows.

4. The Strategy is mute on many developing issues, yet talks about Asset Management, sustainability, and the need to apply these principles to our water resources in order to take full advantage of the economic advantages offered by our abundant resources. By definition, Asset Management is a process of prioritizing needs by multiplying risk factors times failure impacts. Ignoring developing, low-risk, high impact issues such as hydrocarbon transport, fracking, or invasives that are near but not here (yet) is inconsistent with language like Asset Management and sustainability, and subtract from the document's credibility.

5. It may be counter-intuitive, but perhaps worth considering that recruiting sustainable water intensive industries might be more viable economically than the suggestions to foster innovative new water technologies. The latter is normally a strategy of water-poor regions or countries. Two examples of sustainable water intensive industries are renewable energy from wave action and semiconductor fabrication.

Areas not specifically addressed in *"Table 1: Priority Recommendations and Measures of Success"*

- It is unclear why Table 1 (p. 6) does not include all of the Recommendations in the full text document (Table 2, pp. 58-73), and/or why some of the 9 Goal sections included more or less of the Recommendations. The concern is that Table 1 is the "ones that matter", or the "ones that matter more". We do understand that Table 2 is intended to be aiming for 5 years.

- There is a real opportunity (see comments on Goal 5) to find synergy between a more targeted business development strategy and our harbor towns and cities. Some of those communities are not financially equipped to recruit target businesses, and more importantly, there is a small subset of businesses that are particularly well-suited to the transportation advantages of our harbor and port towns or the advantages of our abundant water. It makes no sense for those communities to each have an individual economic development director on a shoestring budget. This is a specific area where the strategy will underperform – why sink the kind of infrastructure money it takes to jump start our harbor towns on their third or fourth life without providing the state's economic development horsepower as a shared resource targeting 3-4 industries on behalf of all of these communities? The Strategy acknowledges a current concern with the ability of small communities to maximize their development potential in this regard.

- Dozens if not hundreds of local agencies have already been leading to the maximum extent possible – some prior to regulatory requirements, some with enthusiastic commitment after adoption of regulatory requirements, and some to the best extent possible given municipal finance constraints. It is a point of fact that many of us are doing this at our current pace ONLY because of state commitment to grant and loan programs that we tap each and every year. For this we are thankful. However, we cannot do anything more, lead any better, or move any faster until the following items (summarized in this bulleted list, expanded on in the comments elsewhere in this document). If the message is that a successful Water Strategy will be through local leadership, our response is that local agencies have made huge contributions in the past 15-25 years but can do no more until the following issues we have repeatedly raised in this and other similar forums are addressed:

    - Continued and expanded funding mechanisms for stormwater management and monitoring
    - Funding for environmental clean-up
    - The State must recognize areas that would be redundant and unproductive if locally led (high-level public messaging, economic development support to name two)
    - Enable local Land Use policy decisions to include authority to discourage the past several decades of inefficient use of resources and added infrastructure burden (60% increase in infrastructure over the past 2-3 decades with no increase in the number of people to pay for it – sprawl costs us all).

- It would be helpful for the Strategy to acknowledge the above issue about expanding infrastructure paid for (or being underfunded) by a stagnant population base, particularly the negative impact if the trend continues.

- Relative to plan elements identified as voluntary, I understand and agree with the policy of the Governor's office that innovation must be market driven, not subsidized by incentives. But there is a different kind of incentive to foster behavior change. The following comment pertains to behavior change of businesses regardless of whether they are innovative with respect to what they sell. Several critical aspects of the Recommendations and Outcomes have neither a carrot nor a stick. History is very informative in painting a CLEAR picture that economically sustainable businesses must behave in a way that first makes economic sense, and history shows that protecting the environment and improving water quality is not normal business behavior, sometimes even when there are clearly established laws. I submit to the reader that behavior will not change without a carrot or a stick. Recognizing that adding rules and requirements might compromise the economic goals of the Strategy, this leads us to the carrot.

  The word "incentive" is absent in the Water Strategy. Incentives do impact the economic math done by businesses and related economic activity, and are also a proven driver toward providing a value proposition for the environment, which is often an abstract that is undervalued or not considered at all in a business' financial planning. Success will be more likely with a thoughtful application of the word "incentive" in the Recommendations and Outcomes. ***If even a large minority of those affected by the Water Strategy were naturally inclined to move in the direction of the Recommendations and Outcomes, we would not need a Water Strategy.*** So again, I only suggest that incentives are applied in a limited way as the only option for meaningful behavior change, not to subsidize any specific industry or product development. An example of the kind of carrot intended would be to have 5 to 15% of any economic development funding to be scored based on the applicant's commitment to the voluntary activities identified in the Strategy – re-use, site clean-up, public-private partnerships on issues in the Strategy, etc. This concept could apply to public or private applicants, depending on the funding source.

- On a somewhat related note, it would seem that brownfield funding helps address two problems – first the sprawl vs. redevelopment dynamics, and secondly the stated need to clean up contaminated sites more quickly. While I understand the Governor's office was a primary driver in removing brownfield funding legislation, at a bare minimum, this report should provide a paragraph comparing the impact on the amount of annual sites cleaned up before and after the brownfield funding programs were changed, and/or recommend a specific longer term analysis if current information is not statistically significant.

- It is a scientifically documented fact (Schuler, 1979-2012) that stormwater drains in road rights-of-way are the greatest collectors of non-point source pollution. Yet road agencies have some of the lowest percentages of stormwater that receives pre-treatment or any other type of treatment, and are not historically structured or funded to provide roads with high performance stormwater goals. The failure to adequately fund road infrastructure is well documented in Michigan. Based on foundational science dating back to the 1970s, over half the stormwater volume (and therefore pollutant loading) in urbanized areas comes from public ROW. All pollutants from vehicles (primarily heavy metals) of course end up on roadways, whether in urban or non-urbanized areas. Phosphorous from residential, agricultural, and other areas also tends to be transported through stormwater infrastructure within public ROW. Thus, road agencies' assets now produce the largest share of pollutant loading of stormwater, but no Recommendations or Outcomes identify what type of progress is anticipated.

  Road agencies have not historically been early adopters of water quality best management practices, as one can see from simply driving around or from talking with progressive agencies about their own departments or neighboring road jurisdictions. While there are legitimate funding and space issues that have resulted in road agencies lagging behind in water quality performance, the fact remains that a 40% phosphorous reduction is impossible without improvement by road agencies. Because this component of water quality is so impactful, it would be unreasonable to expect success without identifying meaningful targets for improvement of water quality treatment for roadways. A phased approach as roads are reconstructed seems logical. In Southeast Michigan, this was once also true of sewer systems and treatment plants, but in the past 20 years, sewage overflows have been reduced by more than 85%, as reported in 2012 by SEMCOG. It is notable that the progress in sewer overflows has only been made due to federal court action setting specific targets – in this case the stick that changed how communities prioritized known problems given limited funds.

- The balance of agriculture-related outcomes vs. tourism/Pure Michigan related outcomes is disproportionate to their relative economic and environmental impacts. Our harbors are important, but 9 of the 62 listed Key Recommendations relate to water recreation (harbors, ports, parks, etc) while there are no recommendations relative to agriculture. We absolutely need to ensure sustainable supplies of clean groundwater for agriculture as the #2 segment of our economy. There is also room in the strategy to add recommendations for funding to incent water conservation on agricultural land, particularly lands that have field tile.

  It is useful to note that water conservation often results in soil conservation as well as improved nutrient retention for a variety of reasons. A relevant Recommendation might be something like ***"Add water conservation incentives to voluntary agricultural programs, and provide mechanisms for local 'matching funds' to allow local agencies to 'sweeten the pot'*** (local funding over and above Farm Bill payments) ***for farmers when there is a local motivation"***. And a relevant Outcome might be ***"20% of stakeholder-targeted Michigan tilled acreage participates in water conservation measures by 2025".*** Stakeholders in the agricultural industry could assist with identifying target lands for water conservation. And stakeholders are likely better suited to construct the Recommendations and Outcomes we need to be aiming for, but the above two ideas are a start.

- The need for behavior change and the commensurate effort required for education and public outreach is not reflected in the Water Strategy. It is good that there is a Recommendation to incorporate water literacy into the state curriculum, but the majority of people in the state are not in the k-12 environment suggested in the Recommendation. It is relevant to note that Public Outreach the most substantial component of regulatory compliance and documentation for current stormwater regulations (through the Municipal Separated Storm Sewer System or MS4 permit process) managed by MDEQ since 1998. In 17 years, despite this requirement and honest efforts by many affected agencies to engage and educate people, surveys repeatedly show that while awareness of this subset of water issues has improved, public awareness of the cause and effect the public has as individuals is still poor at best (barely over 50% in high-performing areas, with awareness improving less than a 1% gain per year). And the individual citizen has less financial barriers to behavior change than most businesses.

  To be blunt, it is unreasonable to expect that the somewhat more abstract ideas of the Water Strategy will take hold with individuals and businesses without a public engagement and education effort on at least the scale of the ***Pure Michigan*** campaign, and a longer, possibly permanent effort is also needed. As noted above in the bulleted areas for state leadership on page 2, it is not efficient or effective to have this as a locally lead effort, this is the most reasonable and fundamental area in which the State of Michigan MUST lead and allocate budget.

- Many of the Goals (especially 3-5) could be supplemented with a stated private investment outcome(s). Much of the historic investment in successful harbor towns (and any built environment) was heavily weighted toward private investment, with government a key partner for certain aspects such as shipping channels, lighthouses, public docks, public buildings, etc. The government could weight investment decisions for public funding in any of these areas by favoring (slightly or more) those that include a private investment component, with additional 'points' for public local match funding or other multi-jurisdictional support, similar to criteria for EPA Economic Development funding. This is a particularly logical analogy since the 10 regions of the Water Strategy are the same Regions established by EPA for Economic Development Assistance (EDA) funding.

  A Recommendation might be to re-organize or create a niche at MEDC to target public-private partnerships for the types of investments specifically recommended in the Water Strategy. Another MEDC niche or role would also be relevant for the suggestion in my comments herein on Goal 5 related to targeting water-intensive industries and seeking to site clusters near harbor towns and cities that would benefit from development.

  Finally, if all 10 Regions are not currently eligible for EPA EDA funding, ensuring eligibility or providing state support for establishing eligibility would be a logical Outcome to include. Our region was not eligible until within the last 5-10 years, when the required Plan was finally developed. EDA funds are normally 50% match.

- We have received a pretty clear message in multiple public presentations of the plan that the Water Strategy Team was directed to make clear that the state has a limited ability to lead. We have heard that local leadership commitment is a primary goal and the state is not likely to make substantial budget allocations or legislative efforts to providing more leadership on removing obstacles that have impeded local agencies. Let me make clear that there is virtually NOTHING in the water strategy that agencies capable of demonstrating leadership are not already doing. We are doing as much as we can, as quickly as we can. In the three public sessions I attended, the main thing I heard that is a concern was the idea that the Strategy does not recommend that the state address the major obstacles or newer threats emphatically mentioned by local agencies that are well known for their environmental and water quality leadership (Ann Arbor, Oakland County Water Resources, SEMCOG, Washtenaw County Water Resources, Ypsilanti Township, etc in our Region alone). I would ask for your understanding of my inability to see value in the Water Strategy for the hundreds of agencies across that state who at the very least have been working for 15 years (the above communities for more like 40) on the exact Recommendations and Outcomes listed in the plan to our maximum ability. Please accept the reality that these leaders cannot lead any better or work any harder until the State of Michigan commits to addressing the obstacles pointed out by your most experienced local leaders. When the front line report is "we're out of bullets", there is no way to expect success without more bullets.

- Land preservation is not mentioned anywhere. Several studies have demonstrated that even minor land uses (as low as 10% impervious) in a watershed start to impair waters. Not only does land preservation help with this factor, but programs related to agricultural land preservation typically prioritize prime soils for agriculture. This should be acknowledged, particularly in light of the notion that because prime soils are the best, prime farmland also requires less of the inputs that are the primary concern of the Water Strategy – fertilizer and water. And as noted elsewhere in this document, the economic reality that sprawl is cheaper than sustainable development suggests that land preservation has a role.

- Also, for my department as well as other long-term performers, the Strategy describes the same things about the same old issues (challenges of wellhead protection, septic ordinance, groundwater monitoring, site remediation, etc). At the public meetings we heard that the new issues like hydrocarbon transportation (pipelines, rail, etc), fracking, and Asian carp do not warrant addressing in the Strategy. These are not Malcolm Gladwell's Black Swans; these developing threats are issues that will require much less resources to prevent than to fix. If they are not part of the plan, costs will skyrocket just like CSO's have caused tens of billions of retrofit work.

  The same kind of deaf ears refused to listen to public works experts (the sergeants on the front lines), and instead listened to the economic song of the homebuilding lobby relative to footing drains in the 1960s. Footing drains were known then and are known today to be the SINGLE BIGGEST CONTRIBUTOR to sewer overflows, and tens of billions has been spent to remediate sewer overflows in Michigan.

  I am unable to understand the value of a document that includes no Outcomes associated with issues that, while they may have a low risk of failure, have an astronomical negative impact of failure. This ability to ignore an elephant in the room is particularly disappointing in a document that mentions Asset Management as a valued concept. Asset Management is clearly defined as a prioritization system based on the ***risk times the impact of failure***, to maximize efficiency of resource allocation. Any independent third party conversant in Asset Management would say it is inconsistent with the principles of asset management to ignore low-risk, high-impact issues such as hydrocarbon transport and fracking or at least fracking waste and permanent removal of water from the water cycle.

- Overall, it is encouraging that Table 2 is an ambitious set of goals, and even more encouraging to see that a role is envisioned for numerous related state agencies. The flip side of this is that those agencies have seen repeated staffing and budget cuts over the past 15 years, and it is well known that staff workloads are challenging at best – including in regulatory roles related to business activity. Permits typically take the maximum review time allowed by law, often to the day in a 90 day or 180 day period. While it is difficult to understand what workload from the Strategy is already being performed by staff and what additional effort is envisioned, it is more clear that existing staff is already over capacity, and even if the Water Strategy only requires re-prioritization, there will at best be more work than staff for at

least a 2 year period. While we grasp the point that there is not a huge pot of money at the state for implementation, it would be logical to expect a more successful change initiative if there is some clarity on how the Strategy recommends funding the necessary change for state agencies to be able to assume any new roles implied by the assignment of various Recommendations or Outcomes to their agency.

And further, perhaps there are suggestions for how to fund these new or restructuring activities, such as identifying what would fit within the reasonable range of existing fee adjustments. In short, the concern is that the Strategy shows some measure of extra work and leadership in certain specific areas (groundwater monitoring or a statewide public education campaign as examples), but this extra work is proposed with no budgetary changes, to be done by people who already have full plates.

Comments related to ***Table 1: Priority Recommendations and Measures of Success***

Goal 1:

1. Toxic algae is related to phosphorous, but also related to nitrogen and seasonal weather patterns. Therefore other Recommendations might be needed to reduce blooms and/or nutrient loading. Overall, it is good there is a Measure of Success for harmful algal blooms but it is vague, especially whether the 40% is total phosphorous including that in the lake bed sediment, or just the phosphorous in the water. This is particularly relevant given the scientifically documented impact of embedded or sequestered phosphorous directly tied to toxic algae blooms.

2. There needs to be a Measure of Success/Outcome for our aquifers, something like ***"the average groundwater table for all aquifers is measured, and maintained in a sustainable, stable range"***. This is critical to many aspects of our state, especially our #2 economic driver, Agriculture.

3. Related to the above, a Recommendation should address the further development of the Water Withdrawal Tool, stating something like ***"Leverage the water withdrawal tool to create publicly (and easily) accessible streamflow and groundwater elevation data, along with the total quantity of permitted withdrawals"***. The first listed Outcome in Table 1 is difficult to assess ("…no net loss of cold water habitat due to water withdrawal…") without a tool that can demonstrate the relationship between stream flow (and temperature) and withdrawal(s).

4. There needs to be much greater public transparency about water use, withdrawals, and impacts, and this transparency can also meet education and outreach needs. To promote public awareness of water budgeting, there should be a recommendation to not only improve the user-friendliness of the water withdrawal tool, but any agency that receives funding for certain defined water-related projects should be required to include a link to the tool on their website, along with a paragraph briefly explaining the tool's purpose. ***It should be easy to understand whether any aquifer or stream is being impacted more than it can handle – a dashboard-type dial or reading for each one to keep it simple, before accessing the reams of data and tables that are not as easy for the public to interpret.***

Goal 2:

1. This document would have been the ideal vehicle for recommending a return to brownfield funding and/or other incentives, given the need for contaminated site clean-up funding, and the stated overarching objective of balancing economic and environmental goals. One major (and related) reason that Michigan's infrastructure gets a "D" from the American Society of Civil Engineers is sprawl. We have about the same population (10 million) as 2-3 decades ago, but 60% more pipe and road infrastructure for those same people to support financially. Greenfields are cheapest to develop, so brownfield funding and other incentives, especially in urban areas, make sense not only with the stated economic and environmental goals of the Water Strategy, but also from a long-term infrastructure funding perspective. While it may not be appropriate for this document, it is relevant to note that our state will not be sustainable until the economics of greenfield development vs re-development are more competitive.

2. Fracking is not addressed, nor is transportation of hydrocarbons (pipeline, rail, etc). Nor is radioactive waste storage (low or high level). Some fracking waste is radioactive, and fracking currently PERMANENTLY removes water from

the water cycle in very large quantities. If we are going to allow fracking, we need to recover the water that is used in fracking, not inject it into rock fissures that are disconnected from the water cycle.

Major accidents due to transportation of hydrocarbons are a real and serious threat with measurable (historic) probability. Fracking and hydrocarbon transport must be more soundly addressed if the Water Strategy is to be taken seriously. Recommendations and measurements should include safety, emergency response, and tough operator accountability. Most disinterested geologists would not recommend storage of high level radioactive waste in the Great Lakes Basin, and most would want to see a lot of information before making a professional statement about the safety of our water resources relative to storage of low level radioactive waste in the Great Lakes Basin.

3. There is no stated goal for clean-up of contaminated sites, other than to "accelerate" if more funding is found. It may be difficult for people to take the environmental side of the strategy seriously without stating the number of contaminated sites, total acreage, and what we envision those numbers becoming in the next 5, 10, 20, and 30 years. While brownfield funding is one option, a commitment to a more aggressive legal strategy is another. Either way, a meaningful Outcome would sound something like ***"Reduce the number and acreage of contaminated sites in Michigan xx% in 10 years and yy% in 30 years"***. In my County, it is a great source of frustration that a site identified by MDEQ as "…the 2nd most contaminated site in Michigan…" in 1986 is larger now than it was in 1986, as well as larger now than in 2000 when the judge on the case ordered the clean-up to be completed by 2005. In this situation, originally discovered in the 1960s, "faster" is a pretty low bar.

   We appreciate a stated desire to "find funding to accelerate clean-up", but the reality of "that which is measured will improve" is more important given how long many of these sites have languished. One Recommendation might be ***"Establish a division of the Attorney General's office focused on the technical and legal complexities of contaminated site clean-up, with quarterly update meetings on progress with MDEQ and the Governor's office resulting in a publicly reported 'Dashboard' on the number of sites and acres cleaned up vs remaining".*** Most contaminated sites are the result of economics and business being favored over water. It would be consistent with the stated goals of the Water Strategy to be known as a state that is willing to make the tough choices needed to accelerate the clean-up of contaminated sites. On a related note, the contaminated site mentioned above is owned by a business that has 0 jobs in Michigan, with the exception of their lawyers and lobbyists.

4. The idea of a statewide sanitary code would be beneficial, particularly if it includes something as simple as a "point of sale" inspection requirement for septic fields. Many places that randomly test septics average about a 25% failure rate. Agencies with a "point of sale" requirement typically average about 5-10% failure rates.

Goals 3 and 4:

1. Our harbors, ports, and other maritime infrastructure are important, and these are very expensive assets. There should be a Measure of Success related to Return on Investment, as the state's limited funds also need to incent economic drivers. Harbors should only be "…prioritized…" as stated in the goals if it can be demonstrated that they provide the best return on investment. It should be noted (and is acknowledged on p.33 relative to Water Trails) that a much larger quantity of our state's population will benefit from smaller investments in river corridors and lake access areas, and therefore more likely that the 30% increase in water-based recreation and tourism is achieved through river corridor and lake access than harbors. Even more so for the Measure "…90%... access to swimmable and fishable water."
2. It is possible that urban river corridors and lakefronts have a sound rate of return when compared to investments in our state's harbors/ports. Developing a "Riverwalk" or "Lakefront" district seems similar to the goals of the harbor and port funding, and should perhaps be measured the same way, although maybe would be a "minor" category to the "major" of harbors and ports. The similar goal is having a community "front door" toward the water, which has a major benefit of a greater local commitment to BOTH the environment and the economy. Every one of our major ports has a river that drains into it, so there is a strong relationship, especially on the environmental side, as a dirty river will ruin investment in a clean harbor. This concept is recognized on p. 33 of the Strategy in mentioning upstream sediment management.

3. Adding an Outcome/Measure of Success seeking a ***"Water Quality Plan by 2020 for 100% of the state's*** (recreation) ***harbors"*** would be more consistent with the stated goal of balancing the economy and the environment, and would fit with and balance the Recommendation seeking an infrastructure asset management plan for 100% of the state's harbors.

Goal 5

1. It might be useful to observe other areas of innovation in the world and consider a Recommendation and Measure that relates to identifying water-intensive business sectors, then prioritizing State-supported business development funding to target business recruitment for those sectors. While this report is general and not the place to list specifics, one specific example to illustrate this point is that semiconductor fabrication is not only water intensive but also requires precision manufacturing, both strengths of our state. Likewise with the market segment devoted to harnessing offshore wave energy. There are no doubt several other key market sectors that have similar needs that are well suited to Michigan's strengths.

2. It is useful to note that one might want to consider our harbors/ports as potential areas to site these manufacturing sectors, as a synergistic strategy that would improve the ROI of harbor investments. The synergy comes in at least five (5) ways. First, the water would be close to water-intensive industries. Second, these harbors/ports are all in areas with relatively low-cost development – ports like Frankfort and Oscoda are surrounded by inexpensive open land, and ports like Detroit or Benton Harbor are surrounded by underutilized land that already has full infrastructure in place. Even without brownfield funds these would likely make economic sense for target industries. Third, many contaminated sites are situated in or near these harbors/ports due to their long history as economic drivers, so redevelopment would have the greatest impact on the stated goal of accelerating clean-up of contaminated sites. Fourth, critical multi-modal transportation access is best at these major ports, offering the best multi-modal access of any development sites in the state with shipping, rail, and trucking serving these ports longer than any other locations in the state. Fifth and finally, the above concern about ROI on harbor and port infrastructure would improve simply by more people living in the area as a result of siting target industries nearby. And as suggested in comments elsewhere, our harbors and ports have reinvented themselves by taking advantage of these synergies through 3 or 4 macro-economic cycles. First the fur trade, then timber, then manufacturing, and some for the complex ore/steel/automotive economic cycle.

3. Relative to the first Recommendation, it may be counter-intuitive but important to be fully aware that water-rich areas are historically poorly suited to developing "…water technologies to solve water problems…" Spain, Australia, and Singapore are world leaders in desalination because they lack water. Israel is a leader in many other water technologies for the same reason. The suggestion of targeting water-intensive industries (above) will be a more successful strategic approach. One example where Michigan is currently a leader is in the automotive Research and Design sector. Dynamometers are devices used to test long-term vehicle wear & tear, and are very intensive in water use. Michigan has the densest concentration of dynamometers in the world.

4. The Recommendation for voluntary water efficiency targets might be more successful if a recognition program was also a stated objective. While awards are a one form of recognition, a form of recognition with even better proven results would be including water efficiency as one of the scoring criteria for economic development, tax incentives, or other funding that goes to businesses. It would not have to be heavily weighted; even a 10-15% factor is enough to get a grant applicant's attention in our current world of highly competitive grants.

5. Relative to the water conservation and re-use strategy, we find another example of a water-rich state being poorly equipped and poorly motivated for water conservation success. This is mainly because some forms of water re-use are simply illegal according to the state's Building Code, while other forms of water re-use require local building officials to make case-by-case decisions that take a long time and are unfamiliar to local officials. And situations where water re-use have been permitted are prohibitively expensive – those who have obtained approvals have done so for personal reasons, as the costs ruin any business case for re-use. Where re-use is allowed, a separate, parallel plumbing system is

required, and multiple redundant measures ending with installation of an expensive ultraviolet light filtration device may be required to ensure water purity.

Just take a look at the very short list of buildings in Michigan that have been permitted for water re-use. Less than 10 cases in the entire state have been approved!! States like Oregon, Georgia, California, and Arizona have already addressed a regulatory framework that protects public health while providing a clear path to water re-use. A Measure of Success that would help would be something like ***"Plumbing and building codes are adopted and building official training provided by 2018, to allow for gray and black water re-use along with rainwater harvesting for both potable and non-potable purposes".*** While the code may not be able to address costs, currently 99% of local building officials will simply not issue a permit for water re-use because they are not required to, and are have not had adequate training to determine what would be appropriate without code guidance.

Goal 6

1. The outcome of people supporting investment might be a more likely success with a recommendation that includes a robust public education strategy, similar to the energy put into the Pure Michigan campaign. Human behavior is very difficult to change, particularly when it comes to money. As noted elsewhere, general public understanding of their own impacts on the environment has been measured at less than 1% growth per year in the Huron River Watershed since 1998. Again, this does not include businesses that might still have an economic disincentive to change behavior once the understanding is there.

2. It might be beneficial to specifically mention enabling stormwater utilities so that some local agencies can move forward on the type of local leadership envisioned in the Strategy. Enabling legislation is permissive, but only if there is already public support. A utility is different than a millage because the latter is inherently unfair – the value of someone's property has no direct relationship to the extent to which that property owner uses the utility. This is why water, sewer, electricity, cable, gas, and other utilities are based on use, not property value. Local leadership would be greatly enhanced by providing the fairest tool for those who want to voluntarily use it.

   Some 85% of the water quality projects (nearly $25M of improvements) performed by my office in partnership with the City of Ann Arbor in the past 8 years would NOT have happened without the City's stormwater utility. Dozens of other communities have repeatedly asked for a clearer path to a stormwater utility, and support by the Governor's office would make a difference – imagine dozens of communities doing 85% MORE than what they have been doing.

   As suggested elsewhere, it is unrealistic to expect any impactful change at the local level without providing enabling changes at the state level. If those who are already leading hard could be doing more, they would.

Goal 7

1. As suggested elsewhere, success is more likely with greater transparency to the public of whatever method is used to determine that groundwater depths and stream flows are stable, and long-term monitoring is effective. In addition to making information publicly accessible in both the raw data form as well as a very simple graphic interface (like the Dashboard idea), it might help promote the value add of monitoring if agencies that receive water related funding are required to post a link (to the monitoring tool and results for local groundwater and/or a stream) and a short paragraph about the monitoring tool on their website.

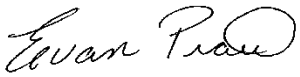
Goal 8

This may be a more appropriate location for the comment above about the state building and plumbing code providing a clear and reasonable regulatory path for water re-use.

Goal 9

1. The recommendation on water literacy as a curriculum component is excellent. However, it only touches those in the k-12 demographic.
2. As noted above, if success is the goal, public outreach must be much more robust and on par with the Pure Michigan campaign. Public outreach must include the business sector, and public outreach must include one or more Measures of Success.
3. Public education, understanding, and agreement would also be greatly facilitated by a simple "Governor's Dashboard", identifying if general progress is being made on each of the 9 goals, with the ability for the public to then drill down for some basic annual reporting statistics. I would further recommend that agencies be required to include this "Governor's Dashboard" on their website if they received grants or loans related to the Strategy.

Sincerely,



Evan Pratt
Washtenaw County Water Resources Commissioner

From: Linda Jennette
To: mi-waterstrategy
Subject: water strategy
Date: Monday, August 10, 2015 8:35:26 AM

Antecdotal evidence/problem to address:
It's not just the Great Lakes which are at risk. Many of the small to mid-sized lakes have wells and septic systems. The high water table around a lake makes it difficult to site a septic system far enough away from the lake to make it safe for the lake water. The lakes are filling with water plants since they are being well fertilized from the septic tanks circling the lake. Persons living besides streams feeding these smaller lakes also contribute, through the groundwater, to the problem. The home owners DO NOT want sewers put in because of the expense. Some of these lakes are far from a treatment plant so, what can be done with the untreated sewer water if sewers were installed around the lake?
I'm certain your group has thought through this problem but it needs to be addressed as well.

From: [redacted]
To: mi-waterstrategy
Subject: Water Strategy
Date: Sunday, August 23, 2015 12:41:09 PM

Persons desiring input respecting the proposed Water Strategy for Michigan:

The proposed Water strategy is a bold strike against private property rights and should be viewed as a "cash cow" mechanism for self-aggrandizing state agencies and special interest organizations seeking ever-expanding authority to unlawfully constrain the activities of their neighbors. While it is certainly in the best interests of residents of the State of Michigan to protect the state's water resources, this wide-ranging proposal is not the vehicle for doing so and should be resisted.

I am a fourth generation Michigan farmer and I can assure you that my family have successfully, comfortably, and willingly utilized the water resources available to us by wise purchases, sound investments, and hard work since 1868. In doing so, we have never harmed, degraded, squandered, or in any other way adversely affected the use of those water resources for our neighbors and other state residents "down stream", so to speak. We are not alone in this regard. "Good Stewards" abound in Michigan and are not confined to the ranks of those seeking ever-greater regulatory authority over their neighbors.

The Clean Water Act provided the statutory tools sufficient to the task. Michigan is one of two states (New Jersey the other) who found it desirable to create its own statewide network for CWA enforcement. This distinction should not create an opportunity for self-serving state agencies and special interest organizations to carve out employment security and questionable agenda fulfillment. The list of "stakeholders" identifying themselves as agents of this strategy clearly indicate reasons for caution respecting the proposal. Every perusal of regulatory authority of all stripes in the State of Michigan quickly devolves into pleas for more rigor on the part of regulatory authority while those regulated cry out as their arms are twisted beyond the breaking point. Increased regulatory authority in the hands of state agencies and expanded use of zoning and regulatory authority by municipalities at the expense of private property rights will become ever more counter productive.

Especially troublesome is the notion that Canadian Provincial governments, tribal sovereign nations, NGO's, and special interest organizations, considered as "stakeholders", will assume to acquire decision making authority over the interests of their neighbors. Doing so will clearly violate the guarantees afforded citizens by Natural Law, the Constitutions of the United States and the State of Michigan; and will, in fact, stand those guarantees "on their heads".

I have worked in the area of public policy making for decades at the township, county, and (through my legislators) the state level. I urge anyone within the sound of my voice or the

influence of my words here written to oppose this strategy and to urge others to do the same.

Respectfully submitted as public comment. James Gurr resident, Antrim County

From: Paul Drevnick
To: mi-waterstrategy
Subject: water strategy
Date: Tuesday, August 25, 2015 6:38:29 AM

Dear good people at MI DEQ,

A leading cause of impairment of Michigan's waterways is mercury contamination. Currently, 789 lakes and rivers in Michigan contain fish with mercury concentrations above US EPA's fish tissue criterion (0.3 ppm ww). The Clean Water Act requires that for each of these waterbodies, a TMDL be written by the State and approved by US EPA, to begin the process of fixing the problem (too much mercury in fish). So far as I am aware, most of these waterbodies are affected entirely or primarily by atmospheric deposition of mercury, and the DEQ has drafted one state-wide TMDL, which is appropriate for the problem, but also details the daunting task of reducing the non-point source load by 82%, both for in-state and out-of-state sources.

My comment, regarding the Water Strategy, is that comprehensive research and monitoring, as called for in the statewide mercury TMDL document, is necessary to understand how waterbodies respond to changes in mercury deposition rates. Monitoring of mercury should involve measurements of wet and dry deposition, outputs from watersheds to lakes, and mercury concentrations in fish.

Thanks for your interest,

Paul Drevnick
Assistant Research Scientist
University of Michigan
Biological Station, 2541 Chemistry Building, 930 North University Ave.
School of Natural Resources and Environment, G168 Dana Building, 440 Church St.
Ann Arbor, MI 48109 USA
telephone: +1 734 763 6280; email: drevnick@umich.edu

From:	Bobby Litwin
To:	mi-waterstrategy
Subject:	Water
Date:	Thursday, August 13, 2015 9:08:33 AM

Please do not deny water due to people who cannot afford the outrageous prices. The last time this happened there was a big scandal in the
Water department. Don't let that happen again!

From: Paul Beach
To: mi-waterstrategy
Subject: water
Date: Thursday, August 27, 2015 1:36:18 PM

Dear Panel Members; I think that you have not given the Drain Code the attention it deserves regarding environmental impacts, surface water quality, and citizen participation in water matters. A comparison of our drain code with others, especially those of Minn., Wisc. and Ontario would be very instructive as would a reading of the 1980 Special Task Force Report on Drains. I hope that your effort meets a kinder fate. I think that you will receive significant resistance from the MACDC and its hundreds of associate members and its numerous devoted friends in our legislature.

Respectfully, Paul Beach
P.O. Box 207 Merrill, Mi.

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Water Policy

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Water is an economic good: How to use prices to promote equity, efficiency, and sustainability

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1. Introduction

In 1992 the Dublin Water Principles claimed "water as an economic good" for the first time in a UN setting. But water has been recognized as an economic good for many centuries before 1992. Throughout Europe and the early United States private water supply companies thrived in a wide variety of settings. The "sanitary revolution" of the 19th century saw the demand for public ownership and management of most of these companies in the name of public health. This, of course, did not obviate the need for water to be treated as an economic good, but a heavy emphasis on the public-good nature of water and its disposal led to the development of heavily subsidized public systems. With the exception of France, this was the path followed in most countries around the world. In the late 1980s, however, the World Bank and other multilateral and bilateral institutions discovered the virtues of "privatization" in the provision of public services and with privatization all of the attendant problems of setting tariffs and prices.

There are many different ways to promote equity, efficiency and sustainability in the water sector and water pricing is probably the simplest conceptually, but maybe the most difficult to implement politically. For example, the typical *command and control* approach taken in most countries with respect to water management leads to large government involvement because of its needs for detailed hands-on monitoring and measurement. Using price policies, however, still requires significant government intervention to ensure that equity and public goods issues are adequately covered. This paper focuses on the role of prices in the water sector and how they can be used to promote equity, efficiency, and sustainability.

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1.1. Effects of price policies

Economic theory has long ago explained how correct pricing of private and public goods can lead to gains in economic efficiency. From this literature, however, it is assumed that, given the typical price and income elasticities for water and the typical income distributions encountered, raising prices is regressive and therefore reduces equity. We argue in this paper that the conventional wisdom is incorrect increasing prices can improve equity. Higher water rates allow utilities to extend services to those currently not served and those currently forced to purchase water from vendors at very high prices. More surprisingly we argue that price policy can help maintain the sustainability of the resource itself. When the price of water reflects its true cost, the resource will be put to its most valuable uses. In Table 1 we list the three generally accepted effects of price policy; demand reduction, efficient reallocation of the resource, and increasing the supply, together with three effects which are not generally associated with price policy, namely; improved equity, improved managerial efficiency, and improved sustainability of the resource. Here "water resources" encompasses surface water, groundwater and wastewater. We show that if water resources are managed in an integrated fashion where the economics, legal and environmental aspects complement each other, increased prices do improve equity, efficiency and sustainability of the resource.

Table 1
Three well known and three lesser known effects of price policy

(a) *Increased price reduces demand*
  (i) Substitutes become cheaper
  (ii) Conservation becomes affordable
  (iii) Change consumption preferences
(b) *Increased prices increase supply*
  (i) Marginal projects become affordable
  (ii) Provides economic incentives to reduce water losses
(c) *Increased price facilitates re allocation between sectors*
  (i) From irrigation to domestic and industrial
  (ii) From off stream to in stream uses
(d) *Increased prices improve managerial efficiency due to increased revenues by*
  (i) Improving maintenance
  (ii) Improving staff training and education
  (iii) Making modern monitoring techniques affordable
  (iv) Making modern management techniques affordable
(e) *Increased prices leads to sustainability*
  (i) Reduces demands on resource base
  (ii) Reduces pollution loads due to recycling of industrial water
(f) *Increased prices reduce the per unit cost of water to poor people*
  (i) Increases coverage of poor urban and peri urban populations because additional water is available for extending the system
  (ii) Reduces reliance by the poor on water vendors

1.2. Full cost pricing of water

The problem faced by the water sector is that prices and tariffs are almost universally below the full-cost of supply. This means that almost everywhere there are large inefficiencies in the water sector and that water prices need to be raised. The recent World Water Commission strongly endorsed the need for full-cost pricing of water services:

> Commission members agreed that the single most immediate and important measure that we can recommend is the systematic adoption of full-cost pricing of water services (World Water Commission, 2000, p. 33).

Unfortunately, there is some ambiguity on the exact definition of full-cost pricing. Here we use the definitions given by Rogers, Bhatia, and Huber (1998) for full-cost pricing of water services. That paper shows the relationships between full-supply cost, full-economic cost, and full-cost. They also provided definitions of the value-in-use of water services showing the relationship between economic value and full-value. In addition to cost and value, the third parameter needed for implementation of water price policy is the tariff, or price, to be charged for the water service. Unfortunately, the literature on water pricing often confuses costs, value, and price. For a clear policy analysis it is important to keep these three concepts distinct. Table 2 and Fig. 1 show these

Table 2
Three important concepts from water economics

COST	O&M costs, capital costs, opportunity costs, costs of economics and environmental externalities
VALUE	Benefits to users, benefits from returned flows, indirect benefits, and intrinsic values
PRICE	Amount set by the political and social system to ensure cost recovery, equity and sustainability. The price may or may not include subsidies. Prices for water are not determined solely by cost

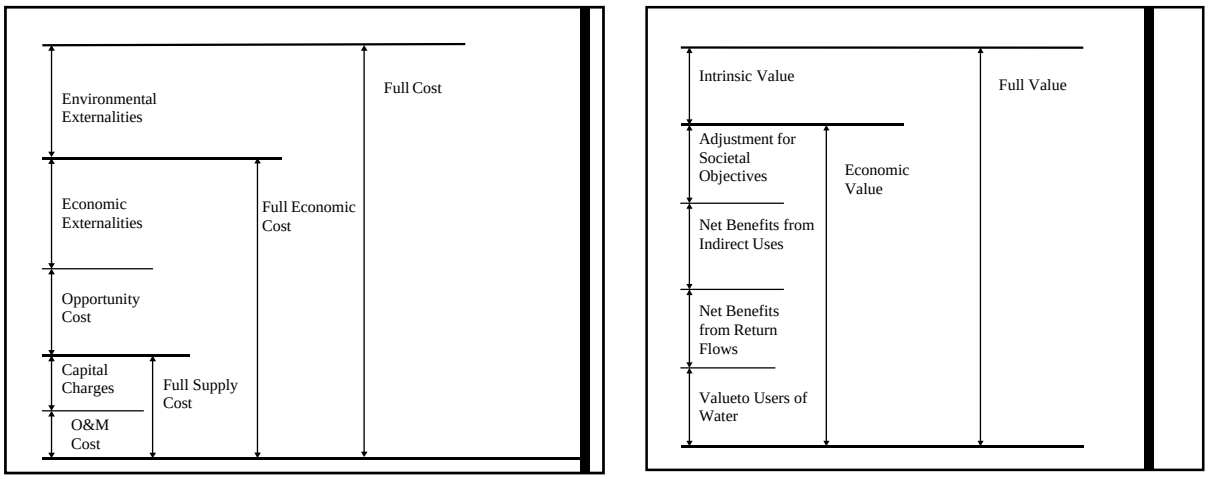

Fig. 1. General principles for cost and value of water.

concepts and how they relate to each other. Rogers et al. (1998) give detailed definitions of each of these components.

1.3. Pricing policies in OECD countries

Jones (1998) and OECD (1987, 1999a d) summarize the recent developments in water pricing in the OECD countries. The Polluter Pays Principle (PPP) and the User Pays Principle (UPP) are now widely accepted in the OECD countries. The UPP was recommended as a measure to "at least cover the opportunity costs of capital, operation, maintenance, and environmental impacts." OECD (1989). This mirrors the recommendations of Rogers et al. (1998) and the Commission on Water for the 21st Century's Report (2000).

There has been increasing participation by the private sector with the government moving away from the role of "provider" to "regulator" of water services. Most countries have, however, chosen the "concession" rather than the "full privatization" model for development. The precise form of private sector participation still varies considerably. "Full" privatization (asset ownership and management) are found in England and Wales, and the Czech Republic; investor-owned in the US; and concessions (delegation of authority to fully private concerns) in France, Spain, Portugal, Hungary, Poland. Traditional direct/delegated public management is still found in Belgium, Denmark, Canada, Greece, Korea, and Sweden, and some areas in Austria and Italy (OECD, 1999c).

1.4. Pricing policies in Asian development bank member countries

The Asian Development Bank (1993, 1997) has carried out two surveys of water utilities in 38 large Asian cities at two intervals five years apart. Over the period water production rose 14%, per capita consumption dropped from 182 to 159 liters per capita per day (l/c/d), the average tariff rose 88%, unaccounted-for-water remained unchanged at 35% of production and the coverage of the population rose from 75% to 79%.

There were large variations in the per capita water consumption in different cities. Dhaka, Bangladesh, had the lowest of 43 l/c/d, and Apia, Western Samoa, the highest with 475 l/c/d. As a point of comparison Singapore had 168 l/c/d and Brussels 108 l/c/d. One assumes that Asian countries cannot afford the luxury of more than 200 l/c/d of water for domestic consumption, yet Taipei has 282 l/c/d, Delhi 257 l/c/d, Bangkok 217 l/c/d (Asian Development Bank, 1997). These large per capita consumption values may demonstrate the lack of metering and low tariffs in these cities.

Of the 50 utilities surveyed in 1997, only half had 100% metering of production and consumption; about a dozen have very little or no metering. Overall, 82% of the house connections, 97% of industrial connections, 80% of commercial connections, and 88% of institutional connections were metered. While these figures seem impressive, it is important to note that utilities do not provide 100% coverage. Fifteen utilities provided 100% coverage, but utilities like Cebu, Philippines, provided as little as 23%.

In the domestic sector, 32 of the 50 utilities used meters to determine payment; 7 utilities used flat rates, and 10 used a combination of the two forms. In the industrial sector, 35 utilities used a metered method, 2 used flat rates, and 12 used a combination. While total water production

increased between 1993 and 1997, the groundwater component in production volume decreased from 12% to 10.8%. Yet this was a net increase in volume.

The ownership and management of utilities take many different forms in these countries as well. Sixteen of the 38 utilities surveyed in 1993 were government departments, 18 were government enterprises, and 4 were more autonomous enterprises. Seoul, Bangkok, Singapore and Taipei had no grant financing of capital investments; at the other end of the spectrum Hong Kong, Manila and Shanghai required significant grant financing (Asian Development Bank, 1993). Private sector participation (PSP) has been on the rise in Asian utilities. PSP take many different forms and degrees in different cities and utilities. Among these: contracts for services; management contracts; leasing contracts; operating concessions; build, operate, and transfer; and full privatization. Twenty-seven of the 50 utilities had no PSP; 11 had some production contracts; 8 had distribution and leak repair contracts; 14 had bill collection and meter reading contracts; and 4 had management contracts.

2. Water prices

In the past most cities and utilities in the world have provided water to their customers almost free of charge because water is considered a basic necessity, and because water was a relatively cheap and abundant resource. But now with much larger communities requiring service, the only way to ensure that everyone has access to this basic need is to ration it in some way. And perhaps the best way to utilize water to the best and most-valued uses is to put a price on water, and construct appropriate tariff structures to meet different social, political and economic goals in different situations.

2.1. Objectives to be fulfilled when setting water tariffs

A tariff can take many different forms. Each form or design will address a specific objective. The "best" tariff design for a particular community and situation is one which strikes the most desirable balance among the objectives that are important to that community (Boland, 1997).

Consumers and suppliers of water have different expectations of water tariffs. Consumers like high quality water at an affordable and stable price. Suppliers like to cover all costs and have a stable revenue base. The level and structure of fees for water and wastewater services have consequences far beyond these expectations. Water-related fees can be expected to generate revenue, improve efficiency of the supply and supplier, manage demand, facilitate economic development and improve public welfare and equity (Potter, 1994). The following is a list of objectives that different tariffs can fulfill. No one tariff design can meet all objectives. But the key is for the utility or community to identify the objectives most relevant to its situation. The reader is referred to Boland (1997), OECD (1987, 1999a, c), Potter (1994), Howe (1997), and Wong (1999) for a more complete discussion of these objectives.

- The tariff must maximize efficient allocation of the resource.
- Water users should perceive the tariff as fair.
- Rates must be equitable across customer classes.

- They must bring sufficient revenue.
- Provide net revenue stability.
- The public must understand the rate-setting process.
- Promote resource conservation.
- Tariff-setting process should avoid rate shocks.
- Be easily implemented.
- Water must be affordable.
- Rates must be forward looking.
- The rate structure must attempt to reduce administrative costs.
- Include environmental costs.
- Not conflict with other government policies.
- Water prices must also reflect supply characteristics like water quality, supply reliability, frequency of supply.
- Tariff structure must vary depending on consumption measurability.
- More sophisticated rate structures may also account for daily peaks and seasonal variations in water demand.

2.2. *Tariff elements*

In order to achieve the goals listed above for tariffs, most OECD countries use some combination of the following elements in their tariff structures (OECD, 1999c). The exact combination of these elements depends on the specific situation and characteristics of the city, utility and behavior of customers.

- Connection charge.
- Fixed charge.
- Volumetric charge.
- Block charge.
- Minimum charge.

The two-part tariff system and increasing block tariff structure are two such popular combinations.

2.3. *Two-part tariff system*

Several OECD countries, for example Australia, Austria, Denmark, Finland and the United Kingdom, with successful water pricing schemes use a two-part tariff structure. This has fixed and variable elements. In these countries the fixed element varies according to some characteristic of the user, and the variable element often uses average cost pricing (OECD, 1999a). This method can be improved upon by using an increasing block tariff system (IBT) for the variable part. One of the main advantages of the two-part tariff system is the stabilized revenue base it affords the supplier. The fixed element protects the supplier from demand fluctuations and reduces financial risks. The variable element charges the consumer according to his consumption level and therefore encourages conservation.

2.4. Increasing block tariff structure

This is a more refined form of the two-part tariff system. IBT provides different prices for two or more pre-specified blocks of water. The price rises with each successive block. The utility must decide on the number of blocks, volume of water use associated with each block, and price to be charged for each block when designing an IBT structure (Boland & Whittington, 1998). While the first of these is more a management decision the second and third are political and social decisions.

IBT is a progressive tariff. This allows the utility to provide lifeline to the poor at below-cost rate, and charge higher prices for use beyond this minimum volume. This subsidy allows the poor access to water and sanitation and promotes public health. Thus IBTs are acclaimed for improving equity. Under this system poorer households get access to low-rate water since they possess fewer water consuming appliances (Whittington, 1997), and allow for rich-to-poor subsidies and industrial-to-household subsidies as well (Boland & Whittington, 1998).

3. The need for full-cost pricing

Basic economics require that the price of a service be at least as high as the cost of providing that service. Rogers et al. (1998) argued that sustainable and efficient use of water require the tariff to match not only costs of supply (i.e. O&M and capital costs), but also opportunity costs, economic externality costs, and environmental externality costs. Very often the tariffs do not even meet the full supply costs, and sometimes the value of water is lower than the cost of supply! The evidence presented below is from the Subernarekha Basin in India.

Fig. 2 compares costs and values associated with agricultural water use in the Subernarekha River Basin. The total economic value, calculated as the sum of net value of crop output, value of return flow, value of water in non-irrigated uses, and value of other societal objectives, is 9.7 cents/m^3. The total economic cost, calculated as the sum of O&M costs, capital costs, pumping costs and opportunity cost, is 65 cents/m^3. Shortage of information and data prevented Rogers et al. (1998) from estimating the intrinsic value of water and the environmental costs of providing irrigation water. Nevertheless, the disparity between value-in-use and cost is very large. Even if the intrinsic value were large it probably would not be large enough to meet this 55.3 cents/m^3 gap plus environmental costs.

Fig. 3 compares costs and values associated with urban and industrial water use in the Subernarekha River Basin. Assuming that both sectors use the same source, we use the same cost structure for both. Rogers et al. (1998) calculated the full cost of water to be 46.7 cents/m^3. The value in industrial use was \$2.60/m^3; the value in urban use was 25 cents/m^3.

Why is there such a gap in the value of water in the two sectors? Fig. 4 shows that the industrial tariff is more than double the urban tariff. So the urbanites over-consume and value the resource less. In this case there is an industrial-to-domestic-to-agriculture subsidy and each of the tariffs is much smaller than cost of supply.

In the above figures, "cost" includes supply costs and opportunity costs, but not environmental and economic externalities costs. Yet the tariff falls well below this cost. In the agricultural sector,

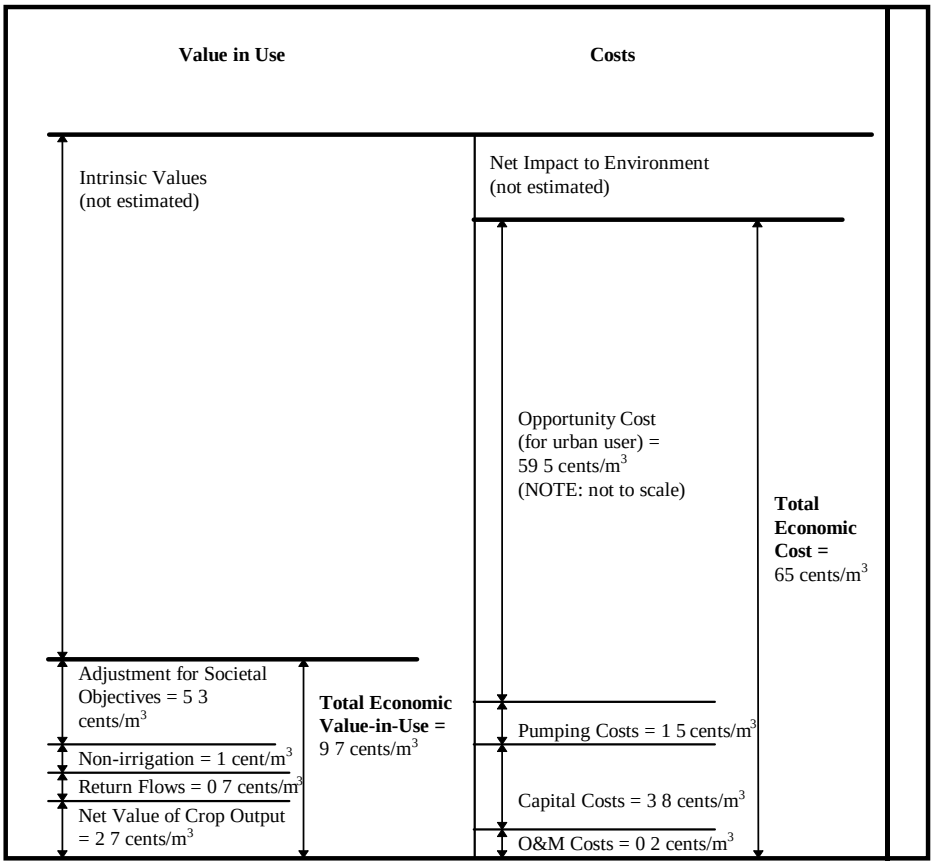

Fig. 2. Estimation of value in use for irrigated agriculture and costs of water in Subernarekha River Basin, India. Source: Rogers et al. (1998).

costs exceed value of the crop as well. Such low-priced water will only encourage wasteful use. Water suppliers must progressively increase tariffs to cover full cost of water.

Opportunity cost is the largest cost component in the irrigation costs given above. When the agricultural tariff increases and more water becomes available to the other two sectors, the opportunity cost of agricultural water will decrease. And because of reduced availability in this sector, the value of water in irrigation will increase. The story will be different in the other two sectors. As more water becomes available, the reduced capital and pumping costs will decrease the cost of industrial and urban water. And because of the more abundant resource, its value will also decrease. So values and costs can be expected to converge across sectors.

Although the above examples were taken from developing countries, water price differentials in different sectors are not unique to those countries. Such examples are rampant in industrialized countries as well. The Northern Colorado Water Conservancy District in the US, for instance, charges irrigators about \$3.50/acre-ft (about 0.3 cents/m^3), and about \$7/acre-ft (about 0.6 cents/m^3) for cities and industries. The capital costs not covered by direct water-related revenues are paid for from real-estate taxes levied against all urban and rural real estates in

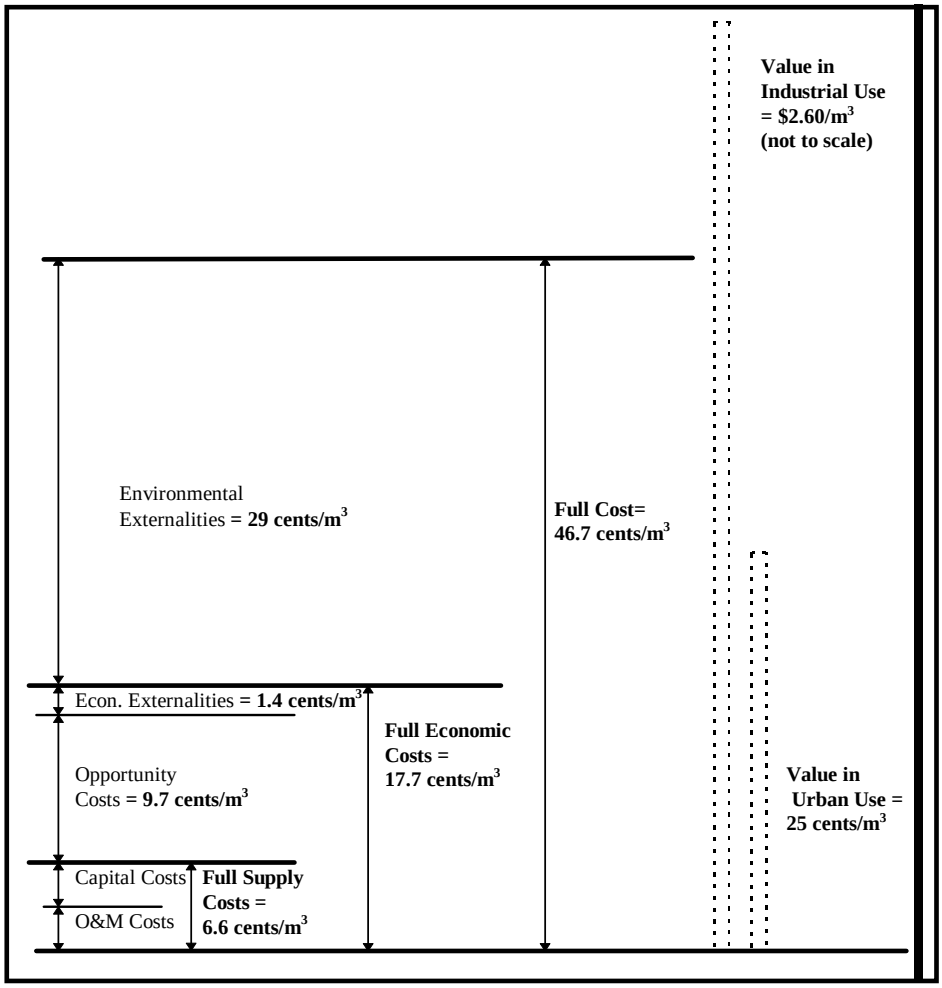

Fig. 3. Estimation of costs and values for the urban and industrial sectors in Subernarekha River Basin, India. Source: Rogers et al. (1998).

the District (Howe, 1997). In effect, industries and households subsidize water for the agricultural sector.

The large variations in values, costs and prices will allow for trading between sectors. Currently agriculture is the largest water user in most countries. On average, 69% of world's water is used in agriculture, and 23% in industry. In OECD countries, however, 65% is used in industry, while only 30% is used in agriculture (OECD, 1999b). Trading does not require that all agricultural water be transferred to the urban and industrial sectors. A small transfer of agricultural water can meet all the demands in urban and industrial sectors. On the other hand, since the required transfer is small, the required price increment is also small. At least on the first pass, a small increment in irrigation water prices (where the tariff can still be less than urban or industrial tariff) can help meet the highly valued needs in the other two sectors.

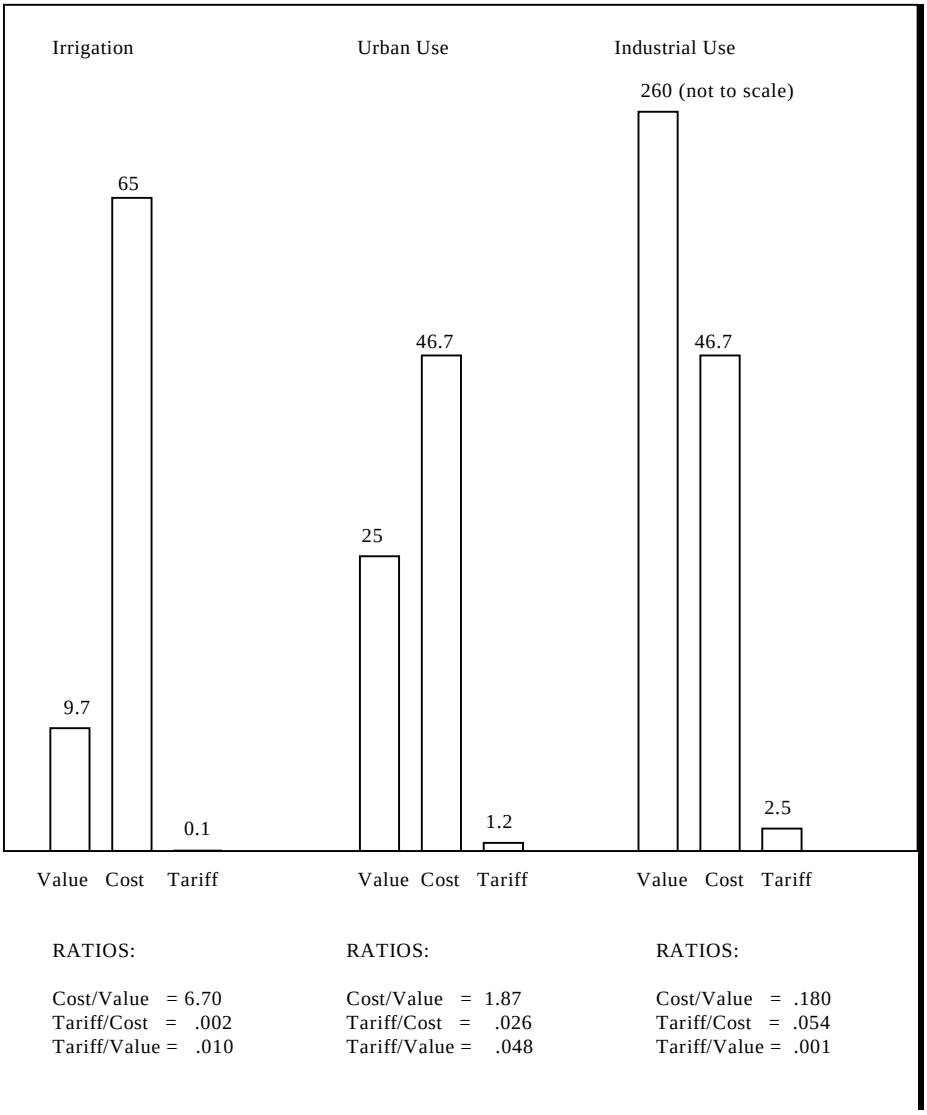

Fig. 4. Comparison of value in use, costs and tariffs for three sectors in Subernarekha River Basin, India (figures in cents/m^3). Tariffs are as follows: Agriculture 0.1 cents/m^3, urban households 1.2 cents/m^3, and industry 2.5 cents/m^3. Source: Rogers et al. (1998).

3.1. Backstop technology for water

While the previous subsection requires that water rates be increased, utilities' capacity to increase water rates is limited by the availability of alternate freshwater sources. The ultimate alternate source the backstop source of freshwater is seawater or brackish water.

A recent bid to design, build, own and operate a 25 million gallons-a-day sea water desalting plant made by Stone and Webster to the Tampa Bay Water's Board of Directors has

revolutionized the pricing capabilities of water utilities. Stone and Webster plans to use reverse osmosis for desalting sea water, and plans to provide water at a cost between \$1.71 and \$1.86/1000 gal (\$0.45 and \$0.49/m^3) in the first year of operation (Leitner, 1999). With desalting technologies being able to produce such low-cost water, water providers to urban and industrial areas will be hard-pressed to match and improve on this price.

Leitner (1999) notes that this particular cost is quite unique to Florida and its environs. Low sea water salinity at the proposed locations; low power costs in the US; no-cost cooling water; use of large-scale reverse osmosis trains; economies of scale; amortization over the 30-year contract period, and tax-exemptions all contribute to this low cost.

The net present value of Stone and Webster's plant is \$222.60 million of which 48.6% is attributed to fixed costs, 29% to power costs, 4.7% to chemical costs, and 17.7% to other costs. So even if these proposed costs were modified to represent conditions at other locations, they would still prove to be substantially lower than previously known desalting costs. If this project were to be successful, industries and large cities in coastal areas may be increasingly motivated to switch to desalted water for future supply increments.

3.2. Subsidies

Many support measures and subsidies are used to promote growth, employment and increase incomes in particular sectors. There is also a growing awareness in OECD countries that subsidizing water use is not necessarily the best way to achieve sectoral economic or social objectives. In fact, some economic and social goals are harmed over the long-run by using a subsidy-based approach. This is especially true when these support measures are used to prop-up ailing industries that invariably contribute to significant environmental damage (Potier, 1996). General reduction in water prices shields all consumers from important economic and environmental signals. Any support measure that lowers the user costs of resource consumption, rather than encourages reduced or more efficient use of the resource, will contribute to potentially higher volumes of inputs, throughputs and pollution (OECD, 1998). Subsidy removal therefore is a step towards full-cost pricing of environmentally harmful activities. Subsidy removal is not a substitute for, but a complement to, policies which internalize social and environmental costs of these harmful activities (OECD, 1998).

Cross subsidies from industrial users to farmers and households have long been characteristic of OECD water pricing policies. These cross-subsidies are increasingly being recognized and are gradually being reduced (OECD, 1999b). But many cities in Asian and Pacific Region still allow for industrial water consumers to subsidize domestic consumers. The ADB uses the ratio between industrial tariff and domestic tariff as a measure of the subsidy. ADB (1993) showed that 85% of these subsidies are in the range of 1.4 3.9. Subsidies in larger cities ranged from 1.8 to 2.2, while in smaller cities they ranged from 2 to 3. A few cities Cebu, ChiangMai, Kathmandu, Mandalay, Nukualofa, Port Vila, Shanghai and Taipei had no subsidies while others Delhi (10.9). Colombo (12.1), Bombay (28), and Medan (30) had very large cross subsidies.

The reform of current subsidy and tax disincentives seems to offer room for a clear win-win situation. But the actual effects of any reductions will depend on the context in which the subsidies are granted in the first place and on the specific way in which they are reduced (Potier, 1996).

4. Need for integrated water resource pricing

The above sections motivated the need for full-cost pricing and listed some of the main requirements of a pricing structure. We further explained how increased water rates could actually help foster efficient use and improve equitable distribution of water. But proper water rates imposed by the public water supplier alone are insufficient to manage the resource. If the suppliers charged the full-cost of water and there were no regulations to protect groundwater sources, consumers will gradually exploit the groundwater sources. If there were no proper wastewater charge structure, consumers will pump groundwater and discharge the waste into the public wastewater system with no penalty.

> "The holistic management of freshwater as a finite and vulnerable resource, and the integration of sectoral water plans and programs within the framework of national economic and social policy, is of paramount importance for actions in the 1990s and beyond" (UNCED, 1992, Agenda 21; Briscoe & Garn, 1995).

The holistic management of freshwater requires water-related authorities to work together and formulate complementary pricing schemes that will allow overall efficient use of the resource. In addition, policy-makers must formulate a regulatory backbone that will encourage consumers to adhere to the pricing schemes. This section motivates the need for integrated pricing structures especially in groundwater extraction and wastewater disposal.

Industries' decision to buy from public water suppliers, directly abstract, or treat and reuse depends on many factors. Among these are water quality required by that industry, whether the public supplier charges full-cost from industrial users, and whether direct abstraction licenses whose charges reflect the full economic cost of water are available (OECD, 1999a). If one or more water source components is weakly regulated, industries will exploit that weakness to minimize their production costs. Due to the common-property nature of groundwater and wastewater disposal services firms are likely to ignore social costs unless they are reflected in effluent taxes or extraction taxes. Examples of industrial exploitation of such weak points are rampant. A few examples are given in Sections 4.1 and 4.2.

Integrated water resource pricing requires that the region or utility or the group of water-related service providers integrate water prices, sewerage prices, additional charges for extra-strength effluents, direct industrial abstraction charges, and for direct discharge to watercourses (OECD, 1999a). Unfortunately, in both developing and industrial countries there is a huge gap between the concept of integrated water resources planning and how water resources planning and policy making are actually done. In practice, most water resources planning is done incrementally and is driven by the need to find solutions to relatively immediate and specific problems, and not grand issues of river basin or regional development (Whittington, Donald Lauria, & Xinming Mu, 1989). The World Water Council and the Global Water Partnership's recent attempts to formulate a Water Vision are aimed at bridging that gap. It is inevitable that developing countries gear many of their plans to meet pressing and urgent needs. However, having a longer-term vision that incorporates expanding water supply, managing groundwater, disposing wastewater and charging appropriate fees for different services will help put even those urgencies into perspective.

4.1. Groundwater extraction charges

Groundwater abstraction charges are common in most OECD countries. Belgium, Canada, Czech Republic, France, Germany, Hungary, Italy, Japan, Mexico, Netherlands, Poland, Spain, Australia, and UK (OECD, 1999a) are examples of these. In most countries the abstraction charge depends on the type of use whether it is consumptive or non-consumptive, and by type of industry. In addition, Belgium, Czech Republic, Finland, France, Hungary, and the Netherlands include an environmental premium in the abstraction charge (Jones 1998). Although the extent of groundwater use in these OECD countries is significant compared to the use of publicly supplied water, direct abstraction charging schemes and structures are still quite new. Nevertheless, the introduction of direct abstraction charges has introduced better management capabilities to authorities and instilled better water use patterns among industries.

The less well-coordinated groundwater extraction policies in Metro-Manila, in the Philippines, on the other hand, are allowing for 6 12 m per year decline in groundwater levels, and salt-water intrusion into freshwater aquifers (Ebarvia, 1997). Since the government does not levy a charge on groundwater extraction, the only expenses to the consumer are the installation and operation of a well and pump.

A similar situation is found in Bangkok. Here the water supplied through the public supply system is already very cheap (about 5 baht/m^3 or 13.5 cents/m^3). But for large-scale industries, groundwater (including its pumping and transportation) costs even less (about 2 baht/m^3 or 5.4 cents/m^3). In addition, the groundwater supply is more reliable and is of better quality, therefore, industrial units steadily turn to groundwater sources. The estimated quantity of groundwater pumped in the Bangkok Metropolitan Area (BMA) is over 1.2 million cubic meters per day (MCM/day). The sustainable pumping rate is about 0.6 0.8 MCM/day. The high stress on aquifers is thus causing depletion of aquifers and ground subsidence (Potter, 1994). A Japan International Cooperation Agency (JICA) study showed that, on average, 22% of industrial water consumption can be reduced by conservation measures at costs ranging from 1.30 to 10.10 baht/m^3 depending on the industrial sector (Potter, 1994). These conservation costs are less than the BMA-purchased water, but are greater than groundwater costs. So industry has little incentive to conserve. The water supply situation is worsened because the low groundwater costs pull-down the public supply rates. If suppliers were to raise prices to full-cost, all consumers will eventually turn to low-cost, more-reliable groundwater. The only remedy is to set appropriate groundwater charges as well.

4.2. Wastewater and sewerage charges

Charging households and industries directly for their wastewater discharges is not common even today. Usually, the wastewater fee is a fixed percent of the water bill or is a fixed charge per house or is included in the property tax (OECD, 1999c). Charging wastewater dischargers according to the strength and quantity of wastewater will motivate them to conserve water, reuse or recycle water, and switch to cleaner production processes.

Utilities in the Czech Republic, Denmark, Finland, Germany, Hungary, Japan, Korea, Poland, Sweden, England and Wales are among those who levy a composite charge for water supply and wastewater collection services to households. Unfortunately, the bill rarely distinguishes the two

cost components. Although the high combined water and sewerage rates in cities like Boston have prompted residents to reduce water consumption, separating the two charges will further motivate consumers to reduce water use and wastewater discharges. Utilities in developing countries are far behind OECD ones with regards to sewerage billing. Of the 38 utilities surveyed by the ADB in 1993, only 11 even included sewerage surcharges in their water bills to households. By 1997, 25 of the 50 utilities included sewerage charges in the water bill. All other utilities, if they provided sewerage service, provided it free (Asian Development Bank, 1993, 1997).

Sewerage and strength-dependent effluent charges have been more widely used with the industrial sectors in OECD countries. The volume and characteristics of industrial sewage vary considerably from one company to another. Thus, industrial water consumption levels do not represent a good proxy for industrial sewerage and sewage disposal costs. The number of countries in which the costs of industrial sewage services are included in the price of water supply has therefore been decreasing steadily. Utilities in Australia, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Sweden, Turkey, UK, and USA are a few that use an effluent charge based on pollution content in water (OECD, 1999b).

While residential users have little freedom of choice for wastewater disposal and for altering the composition of their effluents, commercial and industrial water users have a wide range of technology, input and project choices that affect their water-borne waste loads (Howe, 1997). In countries where sewage service costs have risen significantly, industrial users often find that the public sewer system is no longer the most cost-effective means of sewage disposal. Instead, in-house treatment, recycling and reuse emerge as more economical options, and industries choose to switch to more self-treatment and effluent reuse (OECD, 1999b). Such changes in industrial wastewater discharges invariably affect production processes and reduce water use patterns as well. Therefore appropriate wastewater charges can postpone water utility expansion needs by several years.

Due to increased water rates and more stringent regulation, several industries, including chemical, pulp and paper, textiles, and metallurgy industries, have changed production processes and have made significant progress in reducing their water demands in recent years. Industrial abstractions from public supply in West Germany decreased by one-third since the 1970. There was a sharp decrease in industrial water use in Sweden between 1970 and 1980, and a slow decrease from then on. Industrial water use in the Czech Republic fell by 40% between 1985 and 1993 to cite a few examples (OECD, 1999d). Industry innovates when it has sufficient incentive. Production cost reduction is often its best incentive.

5. More equitable distribution of water with increased water rates

5.1. The "poor" are willing to pay more

One of the main arguments for maintaining low tariffs is to allow the "poor" access to water. This argument has little credibility.

- In the agricultural sector, farmers often spend large amounts of money for pumping groundwater to improve reliability and timeliness of water supply. In Haryana, India, where

irrigation charges for surface water supplies are less than $10 per hectare per year, farmers are known to spend about $90 per hectare per year for groundwater irrigation. This is approximately 20% of the net value of output from crops. As such, the farmers have a high willingness to pay for timely, reliable water (Rogers et al., 1998). Farmers will benefit if suppliers improve reliability through improved management that will be possible with higher water charges.

- Low-priced water encourages excessive consumption by those connected to the supply system. This limits utility's coverage. The poor are left to purchase higher priced water from vendors. In OECD countries households spend about 1% of their income on water (OECD, 1999b). In Onitsha, Nigeria, the poor spend as much as 18% of their income on water (Whittington et al., 1989). Water costs in other developing countries' households span the entire spectrum between these two values. Because of the high water price the poor can afford only small quantities of water enough for bare necessities; and often not enough to meet hygienic needs. If utilities were to supply water at higher prices it would encourage conservation, improve water service coverage to reach the poor, and there will be far more equitable water distribution than there is now. If water must be provided to the poor at low-rates, utilities can use tariff structures such as lifeline rates, IBTs, or provide lump sum credits to low-income customers as in the Los Angeles' Metropolitan Water District (Boland, 1997). These strategies allow the utility to improve both equity and fairness towards its community.

6. Sustainable use of water with increased water rates

The UN's Agenda 21 sees sustainable development as a way to reverse both poverty and environmental degradation. A major theme is to eradicate poverty by giving poor people more access to the resources they need to live sustainably. Agenda 21's definition of sustainability includes; economic development, social development, and environmental protection. As discussed above, water pricing can improve economic efficiency and improve social equity, and by using less of the resource more efficiently lead to environmental enhancement. Hence, water pricing helps address all three of Agenda 21's concerns about sustainability of the resource.

In addition to the examples given above, a comparison of water rates in two cities reflects on the sustainability of water resources. The regional municipality of Waterloo in Canada, for instance, uses summer rates that reflect higher water demand in that season (Pearce & Markandya, 1989). This helps to conserve the water available in the summer. In Metro Manila, on the other hand, the user faces the same low cost for the resource regardless of the time of day or season of year (Pearce & Markandya, 1989; Ebarvia, 1997). This leads to deterioration of the resource.

7. Conclusions

Based upon the cases reviewed in this paper we can draw the following conclusions:

- There is ample evidence to support the contention that water is already viewed as an economic good in many, if not most, countries in the world.

- There is ample evidence for the success of pricing policy in water management from many countries in many different sectors of water use.
- This evidence indicates that unless there is integrated pricing of the resource supplied from all sources, the use of pricing will not necessarily lead to the desired outcomes.
- There are clear examples that water pricing can and has improved the distributional equity for the poor in many settings.
- There are clear cases where appropriate pricing has led to improved sustainability of the water resource.

Two policy issues also arise from the discussion of price policy; how to implement the price policy, and how high to raise the prices? The answers to these questions depend upon the nature of the property rights assigned to water in different countries. With completely privatized ownership rights to water one could expect that under a laissez-faire approach, something akin to the full-economic cost would be charged for water. If the environmental externalities were to be protected, then the government would have to intervene with some sort of command and control or tax policies. If in addition there were many poor people demanding water the government may wish to intervene with subsidies to the weakest users. If government controls the water rights it may wish to push for full-cost recovery including environmental externalities. Under no circumstances should the price of water be allowed to sink below the full-supply cost. There is a wide range of policy options available to implement price policy in the water sector. These range from direct pricing to green taxes, to effluent fees, to direct subsidies to utilities or the users. We do not say that subsidies should not be used at all. But the choice of policy depends crucially upon the local political and social conditions. Finally, we have not advocated that full-cost be unequivocally the only criterion for setting water prices. We argue that knowledge of the full-cost is the most important ingredient in water policy formulation.

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Water Quality Implications and the Toxicological Effects of Chloride Based Deicers

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Abstract

Traditionally, the main priority of winter road maintenance has been assigned to level of service, cost-effectiveness, and corrosion rather than other less well-characterized effects such as impacts to water quality. It is increasingly vital to understand the environmental footprint of deicers, including their impacts on aquatic ecosystems. Chloride based deicers do not degrade in the natural environment and their application on winter pavements can lead to accumulation in adjacent environments over time. Information presented to date on deicers generally includes chemical composition and performance of deicers, while additional information on deicer aquatic toxicity is needed to enable fully-informed decisions by stakeholders. This work presents a state-of-the-knowledge review of the impacts of chloride based deicers and additives on water and aquatic species, and the issue of heavy metal leaching. Toxicity associated with the direct effect of deicers or with the indirect effect via their interactions with runoff chemistry is reviewed as well. This work will assist the stakeholder agencies in the search for effective practices to reduce the toxicity and other water quality implications of chloride based deicers.

INTRODUCTION

Chloride based deicers are well known as essential tools for increasing the safety and mobility of winter roadways (Andrey, 2010; Strong et al., 2010; Usman et al., 2010; Shahdah and Fu, 2010; Ye et al., 2013). Increasing contamination derived from the continued use of deicers has become a significant environmental concern as

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detrimental effects on water, soil, vegetation, and wildlife have been observed in the field and a variety of risks have been assessed in the laboratory (Ramakrishna and Viraraghavan, 2005; Levelton Consultants Limited, 2007; Fay and Shi, 2012; Wang et al., 2012; Fay et al., 2013a, 2013b; Ke et al., 2013; Cooper et al., 2014; Dudley et al., 2014; Dailey et al., 2014; Baek et al., 2014; Devitt et al., 2014). Of particular interest are the toxicological effects of chloride based deicers in the natural environment. Specifically, the chloride based deicers may present cumulative risk over time, as they are highly mobile (migrating quickly in the environment) and conservative (non-degradable). It is thus difficult to remove them from environment (Environment Canada, 1999; Mason et al., 1999; Kaushall et al., 2005; Winston et al., 2012). The impetus for this work was the assessment of water bodies by US Environmental Protection Agency (EPA) and the designation of some of these water bodies as "impaired" because of chlorides and their potential effects on stream biota (Keller and Cavallaro, 2008). This has in part led to the establishment of total maximum daily loads (TMDL) requirements restricting departments of transportation (DOTs)' use of chloride based deicers.

RESEARCH OBJECTIVES

The objectives of this work are to synthesize the available information in the published domain on the increasingly important water quality issue associated with chloride based deicers and then use this information to assist agencies in developing guidelines, standards and practices to protect water resources from this risk.

BACKGROUND

Since the 1960s, chloride salts have been the primary products used by roadway agencies for deicing (breaking the ice-pavement bond, typically by application of solid chemical after the bond formation). More recently, they are also used for pre-wetting (addition of chemicals to solid salt or abrasives) and anti-icing (prevention of the ice-pavement bond, typically by application of liquid chemical in advance of the bond formation). Road salts can enter the roadside environment through a wide variety of pathways, such as runoff, splash and spray from vehicles, or from snow that has been plowed or hauled off site (Zinger and Delisle, 1988; Ramakrishna and Viraraghavan, 2005). Figure 1 outlines the pathways of deicer movement in the environment (Rubin et al., 2010; Ratkevičius et al., 2014). Once applied, deicers can become a part of road runoff or be dispersed aerially. Once in runoff, they can be part of a surface flow (40-50%) or groundwater transportation (50-60%) and therefore impact soil, flora and fauna. If distributed aerially, deicers can impact the soil, water (mostly surface water), flora, and air quality (Rubin et al., 2010; Ratkevičius et al., 2014; Cheng and Guthrie, 1998; Fischel, 2001).

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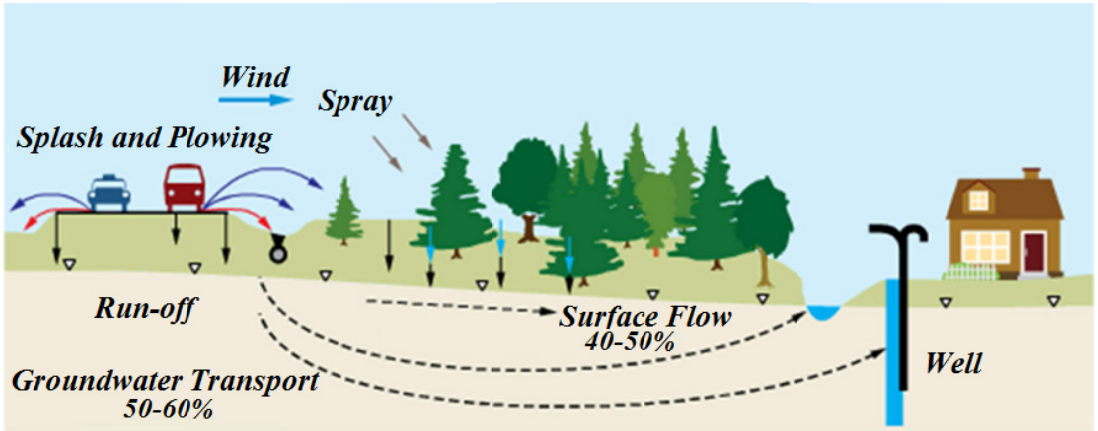

Figure 1. Pathways of deicers into the environment (adapted from Rubin et al., 2010; Ratkevičius et al., 2014).

Information presented to date on the aquatic toxicity of chloride based deicers generally includes chemical composition and properties of deicers. Additional information on their aquatic toxicity such as impacts of chlorides on aquatic species is needed to enable fully-informed decisions by stakeholders. Such toxicity could be associated with the direct effect of deicers or with the indirect effect via their interactions with runoff chemistry. Toxicity testing has not been required of manufacturers or vendors producing chloride based deicers and the associated additives (e.g., corrosion inhibitors and thickeners). As such, little toxicity data has been collected or published in the field of winter maintenance (Corsi et al., 2010). Toxicity research has been conducted on similar products used in other fields including aircraft or airfield deicers (Corsi et al., 2006) and dust suppressants (Williams and Little, 2011), but available data are still very limited. For roadway winter operations, deicers tend to have limited inclusion of additives, which are generally more toxic component compared to the aircraft or airfield deicers (Pillard, 1995; Corsi et al., 2009). Roadway deicers may have additives such as anti-caking agents, corrosion inhibitors, dyes, beet juice, molasses, corn, and other agricultural products (Levelton Consultants Limited, 2007; Fay and Shi, 2012).

Concerns associated with the use of chloride based deicers include increased salinity in waterways and soils, infiltration of cations (e.g., Na^+, Ca^{2+}, and Mg^{2+}) and chloride anion (Cl^-) into soils and drinking water, degradation of the environment along the roadside, and potential risk to biological diversity (TRB, 1991a; Environment Canada, 2001). Studies have demonstrated that sodium chloride (NaCl) can pose significant risks to vegetation, soil, water, and aquatic life and mammals (Vitaliano, 1992; Robidoux and Delisle, 2001; Fay and Shi, 2012). Since the 1970s, road salts have also been shown to impact flora and fauna in the near-road environment, including water bodies (Crowther and Hynes, 1977; Dickman and Gochnauer, 1978). According to Environment Canada (2010), "increased salt concentrations in lakes can lead to stratification, which retards or prevents the seasonal mixing of waters, thereby affecting the distribution of oxygen and nutrients." Bowen and Hinton (1998) found elevated chloride concentrations in surface water affected the spatial patterns of total phosphorous concentrations and induced higher

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turbidity and bacteria growth, degrading the overall health of streams and making them potentially inhospitable for fish populations. Field research has found that elevated background and spike chloride concentrations in waterways have reduced the richness of amphibian species in some waterways (Turtle, 2000; Houlahan and Findlay, 2003; Collins and Russell, 2009). Deicers have been found to negatively impact aquatic community structures, such that elevated chloride concentration are correlated with reduced species richness and food web dynamics (Sanzo and Hecnar, 2006; Collins and Russell, 2009; Van Meter et al., 2011). Laboratory and field studies in Canada found that in southern Ontario, Quebec and other areas of heavy road salt use, chloride concentrations in ground and surface water are often sufficient to affect biota (Environment Canada, 2001). While changes in macroinvertebrate drift behavior and mortality caused by elevated salt concentrations were found to be highly dependent on concentrations and exposure time, and vary among taxa (Blasius and Merritt, 2002).

Work by Granato (1996) found that in addition to adding the chemical constituents (Na^+, Ca^+, and Cl^-) to aquatic systems, the use of NaCl and $CaCl_2$ deicers can also be considered a source of constituents in runoff:

- NaCl deicer – sulfate, calcium, potassium, bromide, vanadium, magnesium, and fluoride
- Calcium chloride ($CaCl_2$) deicer - sodium, potassium, sulfate, bromide, silica, fluoride, strontium, magnesium

This work did not list potential constituents associated with the use of $MgCl_2$ based deicers.

Chloride salts are readily soluble in water, difficult to remove, and tend to accumulate over time (Howard and Haynes, 1993). Chloride anions are highly mobile, do not "significantly absorb into mineral surfaces", and do not "biodegrade, volatilize, (or) easily precipitate" (Bowen and Hinton, 1998). It has been shown that a high percentage of deicers can migrate from the road as surface runoff and then enter streams and rivers (Crowther and Hynes, 1977; Scott, 1981; Hoffman et al., 1981; Demers and Sage, 1990). Evidence shows that chloride salts can accumulate in aquatic systems, and are conservative (Environment Canada, 1999; Mason et al., 1999; Kaushall et al., 2005; Winston et al., 2012). According to Environment Canada (2001), "research has shown that 10-60% of the salt applied enters shallow subsurface waters and accumulates until steady-state concentrations are attained." Road salt applied by the Swedish National Road Administration contributed to more than half of the total chloride load for the river basin of Sagan (Thunqvist, 2004). Dailey et al. (2014) sampled central Ohio rivers in 2012-2013 and "high Cl^-/Br^- mass ratios in the Ohio surface waters indicated the source of Cl^-" was in part road salt. They also revealed "increasing trends in Cl^- and Na^+ concentration beginning in the 1960s at river locations with more complete historical datasets."

Elevated chloride concentrations are generally linked to spring flushing events. Of special importance is the study of snowmelt runoff from the first major snowmelt due to high concentrations of pollutants contained in this "first flush". A field study in Ohio (Dailey et al., 2014) also observed "higher Cl^- and Na^+ concentrations and fluxes…in late winter as a result of increased road salt application during winter months". Elevated chloride concentrations have been observed in summer, due to

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recharge of surface water by ground water during times of low flow (Environment Canada, 2001). Shallow wells, reservoirs, and low-flow surface waters adjacent to roadways or storage sites are most susceptible to contamination by deicers as they can infiltrate into groundwater aquifers (TRB, 1991a). The Pennsylvania DOT and some other northern state DOTs have had to purchase wells or provide replacement water where contamination has occurred (TRB, 1991a).

Current standards used by US EPA for chloride in surface waters are 230 mg/L maximum chronic exposure for a four-day average concentration of dissolved chloride, associated with sodium, and 860 mg/L maximum acute exposure for a one-hour average concentration, no more than once every three years on the average [US EPA 440/5-88-001)] (US EPA, 1988). The US EPA standard should apply to most locations except where more conservative values may be necessary, such as where locally important and sensitive species are present. When chloride concentrations in streams reach or exceed the acute and chronic standards, toxicity to aquatic species can result. In addition to toxicological impacts, elevated chloride concentrations can disrupt normal functions of surface water; e.g., cause density stratification and late vertical mixing in waters. A state can adopt these standards or develop a site-specific or pollutant-specific standard if it is adequately justified, which can be higher or lower than the federal standard. Work completed by the Iowa DNR and US EPA can be used as the basis to set site-specific acute and chronic chloride criteria based on measured water hardness and sulfate levels (Iowa DNR, 2009). The established equations are provided as follows: acute chloride threshold = $287.8\times[\text{hardness}]^{0.205797}\times[\text{sulfate}]^{-0.07452}$ and chronic chloride threshold = $177.87\times[\text{hardness}]^{0.205797}\times[\text{sulfate}]^{-0.07452}$. The new chloride criteria "appear to provide a more accurate representation of the potential toxic effects of elevated chloride levels in freshwater streams and rivers" (MassDOT, 2012).

Impaired or threatened waters (rivers segments, streams, lakes) identified by states, where the required pollution controls are not enough to maintain or reach applicable water quality standards are added to the 303(d) list maintained by the US EPA, and will have TMDLs established based on the severity of the pollution and the sensitivity of the waters (US EPA, 2012). The 977 waterways currently considered impaired or threatened waterways are on 303(d) listings due to impacts associated with elevated salinity, chlorides, and total dissolved solids (TDS). The following parameters that are of interest to chloride toxicity and are covered by the 303(d) listing include chlorides, TDS, total suspended sediments (TSS), and biological oxygen demand (BOD). In 2004, New Hampshire added five waterways along I-93 to the list of chloride impaired, reaching a total of nine streams violating the states standard for chloride, after elevated ground water chloride levels were detected, associated with years of heavy salt use (Fredrick and Goo, 2006). Cooper et al. (2014) mentioned that groundwater is a "long-term reservoir for accumulating road salts" and as a result, these accumulated "road salts represent a risk to the safety of drinking water sources." The mechanism proposed by Corsi et al. (2015) suggests that during the snowfall seasons, chloride is stored in shallow groundwater systems and after that is slowly released into the baseflow.

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WATER QUALITY IMPACTS BY CHLORIDE DEICERS AND ADDITIVES ECOSYSTEM HEALTH IMPACTS OF CHLORINE DEICERS AND ADDITIVES

Chlorides are readily soluble in water and difficult to remove, and thus concerns have been raised over their short-term and long-term risks to water quality, on aquatic organisms, and on human health (TRB, 1991b; Environment Canada, 2010). The chloride salts applied on winter roads can migrate into nearby surface waters and impact them via various pathways. NaCl from road runoff is responsible for increased salinity or osmolality of surface and ground waters several months after the last road treatment (Thunqvist, 2004). Ramakrishna and Viraraghavatan (2005) reported that this could reduce water circulation and re-aeration in lower depths, resulting in changes in population or community structure of aquatic biota.

Impacts of chloride based deicers on water. Karraker et al. (2008) investigated the effects of road salt on water quality, by measuring water quality variables at 28 roadside pools and 14 forest pools. Water temperature, pH, dissolved oxygen, and conductivity in each pool were measured monthly May through August. The results showed that the conductivity, pH, dissolved oxygen, and water temperature differed between forest and roadside pools. Mean conductivity was nearly 20 times higher in roadside (357.8 µS; range 11.6 – 2904.8 µS) than forest pools (18.6 µS; range 5.7 – 41.4 µS). Conductivity was strongly correlated with both sodium and chloride. Sixty-one percent of roadside pools had higher average conductivity than all forest pools. Conductivity in roadside pools declined exponentially with increasing distance from road (Karraker et al., 2008). Mean water temperature was lower in roadside (48.9°F, 9.38°C) than forest (55.6°F, 13.1°C) pools. Mean pH was higher in roadside (5.3) than forest (4.7) pools. On the other hand, the dissolved oxygen (mg/L) was nearly one-third higher in roadside pools (3.6 mg/L) than in forest pools (2.0 mg/L). The results also showed that water quality variables varied over time. Conductivity, pH, and water temperature increased between May and August in both roadside and forest pools. Conductivity and dissolved oxygen in pools were similar in May among years. However, pH decreased and temperature decreased. Forest ponds were larger in perimeter than roadside ponds, but similar in maximum pond depth and canopy cover (Karraker et al., 2008).

Deicer impacts on surface and ground waters depend on the site-specific properties of the receiving water body. The quantity of precipitation affects the dilution rate of the applied deicers and the flushing rate of the system (TRB, 1991a). Factors unique to each site can also influence potential impacts – temperature, topography, sunlight, wind, etc. Additionally, surface waters have a wide array of physical, biological, and chemical cycles and interacting processes (Mayer et al., 1999). Field testing of chlorides has produced widely variable results from no observed effects (Jones et al. 1992; Baroga, 2005), to highly elevated chloride concentrations (TRB, 1991a; Godwin et al., 2005; Environment Canada, 2010). It is very important to understand how the size and flow rate of the water body influence the impacts of chloride contamination on aquatic species. Questions remain on: how do cold temperatures or other seasonal factors affect the tolerance on aquatic species,

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before seasonal standards or criteria can be established; what are the appropriate location and frequency of water quality sampling for determining representative chloride concentration non-compliance due to deicer applications; what are the guidelines for optimizing the potential of road right-of-way in mitigating the flow rate and composition of chloride-laden stormwater runoff. These issues should be explored by future studies.

Impacts of chloride based deicers on aquatic species. Salt has negative effects on aquatic organisms by altering the osmotic balance between the organism and its surrounding environment. Salt concentrations less than those of the organism's protoplasm or other fluids are common in freshwaters and most terrestrial soils, and so the organisms must expend energy to prevent simple diffusion of salts out of their bodies (Findlay and Kelly, 2011). If concentrations rise to surpass the isotonic point of the organism, it faces the converse problem of an inwardly directed diffusion gradient and must either exclude ions or actively excrete those that may cross their integument/membrane. Threshold levels for salt effects vary widely across organisms and/or life stages (Findlay and Kelly, 2011).

Many studies have addressed the effects of chloride based deicers on wildlife species and research has shown that road salt exposure negatively affects mammals, birds, invertebrates, and amphibians that utilize roadside habitats (Vitt et al., 1990; Mineau and Brownlee, 2005; Ramakrishna and Viraraghavan, 2005; Harless et al., 2011; Karraker and Gibbs, 2011). However, most field data are correlative, where investigators survey a range of water bodies that may vary in salt loads but undoubtedly also vary in other contaminants (Peters, 2009). In a survey of macroinvertebrates in urban streams, Cuffney et al. (2010) found that the chloride ion was frequently and strongly associated with indicators of poor macroinvertebrate communities, but it was acknowledged that other measured (and probably unmeasured) solutes co-varied with chloride, which may have included stream geomorphology, habitat availability, metals or organic compounds associated with urban runoff or wastewaters. Furthermore, Corsi et al. (2010) found road salt to cause detrimental impacts to surface water on local, regional, and national scales, with short- and long-term impacts to stream water quality and aquatic life.

Fay et al. (2013a) cited that by increasing the volume of water or the flow rate of stream, the tolerability towards deicers will increase which is due to the diluted incoming chloride. In general, the degree to which the surface water is contaminated from deicers is a function of the amount of time the deicer takes to reach the water body, the dilution factor, the residence time of the water body, and the frequency and rate of deicer application (D'Itri, 1992).

Amphibian toxicity. The deposition of chemical pollutants into roadside wetlands from runoff is a current environmental concern. In northern latitudes, a major pollutant in runoff water is NaCl from deicers. Collins and Russell (2009) conducted a survey from 26 roadside ponds for amphibian species richness as compared to chloride concentration and concluded that chloride concentrations in ponds associated with deicing salts, influenced community structure by excluding salt intolerant species. Many studies have found that as salinity increases survivorship and mobility

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decrease (Sanzo and Hecnar, 2006; Karraker and Ruthig, 2009; Denoël et al., 2010). Amphibians are likely to be the most affected by chemical and deicer runoff. Amphibians possess highly permeable skin and have aquatic larval stages, and many use roadside wetlands for breeding (Harless et al., 2011). Amphibians are considered good indicators of ecosystem health, and inhabit a wide range of habitats (wetlands, ephemeral water bodies, road side ditches, etc.) and for these reasons extensive toxicity testing has been conducted using amphibians (Vitt et al., 1990). Of the amphibian species tested, salamanders may be the most intolerant amphibians to varying salt concentrations (Collins and Russell, 2009).

Road salts and heavy metals have been shown to have the greatest impacts on amphibians (Birdsall et al., 1986; Sanzo and Hecnar, 2006). Studies have found that chloride concentration spikes that occur during spring runoff and from direct runoff from the road threaten embryonic and larval stage of amphibians (Collins and Russell, 2009). The effects of hyposalinity on the wood frog (Rana sylvatica) included a significant decrease in body weight, not undergoing metamorphosis, decreased activity and increased developmental abnormalities, and death (Sanzo and Hecnar, 2006). Kim and Koretsky (2013) collected sediment cores in fall and spring from a freshwater wetland fringing an urban kettle lake in Michigan and "incubated for 100 days in deionized water (control) or with treatments of 1 or 5 g/L $CaCl_2.2H_2O$ or 5 g/L NaCl to simulate addition of road salt deicers". Their study revealed that the influx of chloride deicers would significantly affect the microbial activities in wetland and biogeochemistry of wetland sediments. In contrast, a cold-climate outdoor study of bioretention mesocosms with soil, mulch and vegetation layers (Denich et al., 2013) indicated that the application of a salt/aggregate mixture did not significantly affect the mobility of heavy metals in the simulated bioretention facility.

Even between amphibian species, toxicity is highly variable. For example road salt were found to significantly affect embryonic survival of the spotted salamander (Ambystoma maculatum), while having little effect on the green frog (Rana clamitans) (Karraker and Ruthig, 2009). In a study conducted by Collins and Russell (2009), it was found that spotted salamander (Ambystoma maculatum) and wood frogs (Rana sylvatica) did not occupy high chloride ponds, and acute toxicity tests (LC50) found them to be more sensitive than the American toad (Bufo americanus) to chloride. Spring peepers (Pseudacris crucifer) and green frogs (Rana clamitans) showed intermediate sensitivities (Table 1).

A case study in North Carolina on the impacts of deicers to amphibians found that the amount of snow, or water equivalent, is important because for many DOTs the application rate is relatively constant (250 lbs/l-m) per snow or ice event (Winston et al., 2012). Therefore smaller snow and runoff events can have a greater impact on amphibian populations than larger snowfalls.

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Table 1. A summary of example different toxicity studies including chemicals used, species tested and the observed LC50 values at 48 h and 96 h of exposure to chemical deicers.

Reference	*Chemical used*	*Species tested*	*LC50 (g/L Cl^-)*	
			48-h	*96-h*
Collins and Russell (2009)	NaCl	Spotted salamander		1.18
		Wood frog		1.72
		Spring peepers		2.83
		Green frogs		3.11
		American toads		3.93
Harless et al. (2011)	CH_4N_2O	Wood frog	14.37	14.29
	NaCl	Wood frog	7.82	7.56
	$MgCl_2$	Wood frog	7.28	7.11
	CH_3COOK	Wood frog	5.42	4.23
	$CaCl_2$	Wood frog	4.72	3.98
	$C_8H_{12}CaMgO_8$	Wood frog	3.39	3.23
Baek (2014)	$CaCl_2$	Cloeon dipterum	6.14	
	$CaCl_2$ (Deicer)	Cloeon dipterum	6.50	
	$CaCl_2$	Ecdyonurus levis	6.32	
	$CaCl_2$ (Deicer)	Ecdyonurus levis	8.34	
	$CaCl_2$	Glyptotendipes tokunagai	3.84	
	$CaCl_2$ (Deicer)	Glyptotendipes tokunagai	5.69	
	$CaCl_2$	Gammarus sobaegensis	3.54	
	$CaCl_2$ (Deicer)	Gammarus sobaegensis	5.85	
	$CaCl_2$	Caridina denticulata denticulata	18.88	
	$CaCl_2$ (Deicer)	Caridina denticulata denticulata	20.73	

A study looked six commonly used deicers (urea, NaCl, $CaCl_2$, $MgCl_2$, KAc, and CMA) and their toxicity to larval wood frogs (Rana sylvatica). Survival was inversely related to higher concentrations for all deicers tested (Harless et al., 2011). Tadpole survival had significantly lower threshold concentrations for all deicers. Acetate based deicers had lethal effects on tadpoles at the lowest concentrations. $CaCl_2$ and $MgCl_2$ were found to be more toxic to frog tadpoles than NaCl, most likely because they have two chloride ions per molecule (Dougherty and Smith, 2006; Harless et al., 2011). Interestingly, LC50 values decreased with time, suggesting that organisms were either less capable of tolerating deicers overtime, or that there was a lag in the lethal effect (Harless et al., 2011). The relative toxicity scale for larval and tadpole frogs was: NaCl<$MgCl_2$<$CaCl_2$<Acetate based (Table 1) (Harless et al., 2011).

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Benthic species toxicity. Riva-Murray et al. (2002) found that declines in several indices of macroinvertebrate "health" were correlated with higher chloride concentrations, but the absolute levels were so low (<50 mg/L) that it is unlikely that direct toxicity was causing the patterns. Thus, while it is fair to say that chloride is associated with negative effects on benthic insects at low concentrations, other contaminants and stressors are most likely affecting populations as well. This is confirmed by a more recent study by Baek et al. (2014), which reported that "Cl^- concentrations (from $CaCl_2$ deicer) in the field sites (<25 mg/L) were much lower than the LC50 values of five selected macroinvertebrate species (Gammarus sobaegensis, Caridina denticulata denticulata, Glyptotendipes tokunagai, Cloeon dipterum, and Ecdyonurus levis)". The laboratory test revealed that the LC50 value of the five select species ranged from 3.54 to 20.73 g/L.

Experiments focused on altering salt levels in surface waters have been rare but do provide more direct links between salt concentrations and response variables. For example, NaCl was added to reach ambient concentrations of 1,000 mg Cl^-/L in a stream, and resulted in changes in benthic algae and protozoans within one to a few weeks after initiation of the experiment (Dickman and Gochnauer, 1978; Evans and Frick, 2002). In another study, Cl^- was added to levels of 2,165 mg/L, and caused an increase in drift of benthic insects out of the experimental sub-channels placed in an Ontario stream within a few hours (Crowther and Hynes, 1977).

Baek et al. (2014) conducted quantitative field sampling of benthic macroinvertebrates at eight surface water sites exposed to $CaCl_2$ deicer applications in South Korea and reported that "despite the heavy application of road deicers during the snowy season, the deicer may not directly affect benthic macro-invertebrate communities over short time periods." Casey et al. (2014) mentioned that highway deicing chloride seldom can harm fish, and have no significant harmful effect on microfauna and invertebrates.

Invertebrate species toxicity. Research testing the acute toxicity of chloride to four freshwater invertebrate species, including water flea (Ceriodaphnia dubia), fingernail clam (Sphaerium simile), planorbid snail (Gyraulus parvus), and tubificid worm (Tubifex tubifex), was completed under different levels of water hardness (all four species) and sulfate concentrations (C. dubia only) (Linton and Soucek, 2008). Tests with C. dubia acclimated and tested under different levels of total water hardness and sulfate were performed simultaneously by two different laboratories (Linton and Soucek, 2008). Results were comparable. The 48-h LC50 for C. dubia acclimated and exposed to acutely lethal chloride concentrations at 25 to 50 mg/L hardness (i.e., 919 mg Cl^-/L) is approximately half that of C. dubia exposed at 600 to 800 mg/L hardness. Conversely, sulfate over the range of 25-600 mg/L exerted only a small (inverse) effect on chloride toxicity to C. dubia. The mean 48-h LC50 at 25 mg/L for sulfate was approximately 1,356 mg Cl/L, while at 600 mg/L sulfate, it was 1,192 mg Cl^-/L (reduction of 12%). Again, LC50 values between labs were consistent. Ninety-six hour LC50 values for three other freshwater invertebrate species ranged from a low of 740 mg Cl^-/L for S. simile exposed to chloride at 50 mg/L hardness, to a high of 6,008 for T. tubifex exposed to chloride at 200 mg/L hardness. For both these species, increasing the acclimation and dilution of water hardness reduced the acute toxicity

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of chloride by approximately 1.4 to 1.5 times. Water hardness did not appear to influence the acute toxicity of chloride to the planorbid snail, G. parvus. Acute LC50 values at 50 and 200 mg/L hardness were 3,078 and 3,009 mg Cl/L, respectively. Rank order of sensitivity to acutely lethal chloride at a given water hardness is in the order (most to least): S. simile>C. dubia>G. parvus>T. tubifex. Siegel (2007) tested toxicity thresholds for NaCl and chloride for various species and found freshwater aquatic species react differently to varying exposure concentrations. Based on these findings, invertebrate species appear to be more sensitive to chloride than are vertebrate species, with fathead minnow being the most sensitive species tested (Siegel, 2007).

Fish toxicity. Salt tolerance of aquatic species varies tremendously. Depending on whether fish are fresh or salt water species, fish have been reported to tolerate between 400 and 30,000 mg/L (Siegel, 2007). Road salting and increased salinity can lead to excess growth of salt tolerant species (Siegel, 2007). Interestingly, aquatic species may adapt to increased levels of chloride with time, such that surviving organisms may develop the means by which to handle the osmotic shock imposed by the excess chloride (Mineau and Brownlee, 2005). Furthermore, saltwater species are not vulnerable to anthropogenic sources of NaCl, except for fluctuations of greater than 10%.

There is a wide range in salt concentrations known to have negative effects on organisms, and most of these data come from laboratory exposures under controlled conditions with only one stressor (salt) acting at a time. For many organisms, the short-term lethal concentrations are far above levels seen in the environment, except under extreme conditions (Findlay and Kelly, 2011). For example, adult freshwater fish species do not show lethal effects until concentrations approach tens of grams of salt per liter. Young fishes show negative effects at much lower levels, but even so, these concentrations are roughly equivalent to those in direct road runoff, much higher than concentrations occurring after dilution by water sources. Effects near roads are, of course, more evident than for points further from the actual area of salt application with reasonably sharp declines in concentrations within tens of meters of the road (Albright, 2005; Lax and Peterson, 2009).

Spring rains have been postulated to dilute deicers following input into waterways. One study tested this theory and found spring rains may help when low to moderate chloride concentrations are present, but in situations where water lacks outflow or flushing and chloride concentration reach 1000 mg/L, permanent damage can occur to egg membranes (Karraker and Gibbs, 2011).

Biotoxicity work for the Colorado DOT on the boreal toad tadpole, juvenile rainbow trout, Ceriodaphnia (aquatic invertebrate), and Selenastrum (algea) found that application rates of $MgCl_2$ typically used are highly unlikely to cause or contribute to environmental damage at distances greater than 20 yards for the roadway (Lewis, 1999). Work in Chautauqua Lake, New York on sunfish found that NaCl contributed to toxicity but zinc and cadmium were also found to be of concern (Adams-Kszos et al., 1990). A study in Washington observed deicer impacts on Steelhead (Oncorhynchus tshawytscha), Chinook salmon (Oncorhynchus mykiss), and bull trout (Salvelinus confluentus), threatened and endangered species, and

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general stream ecology (Yonge and Marcoe, 2001). Elevated chloride concentrations from 5 to 8 mg/L were found, but the authors suggested the deicing activities did not adversely impact the stream ecology.

Models have shown that cyanide has potential to impact some species in areas of high road salt use (Environment Canada, 2001). Sodium ferrocyanide and ferric ferrocyanide are used to prevent clumping of solid chloride based deicers while in storage and during deicing operations (Letts, 2000). In Canada, sodium ferrocyanide was added to rock salt at a range of 30 to 240 mg/kg of salt. Potassium ferro- and ferricyanide solutions were originally believed to be much less toxic (no effect at 2000 to 8732 mg/kg), but due to a fish kill in a stream caused by ferro- and ferricyanides from industrial effluent, it was found that photo-decomposition can release the cyanide ion (Burdick and Lipschuetz, 1950). Experimental results found ferro- and ferricyanides to be toxic at 1 – 2 mg/kg when photodecomposition was considered (Burdick and Lipschuetz, 1950).

Letts (2000) tested the issue of photodecomposition of ferrocycanide to create free cyanide, a much more toxic substance, in the ecosystems that commonly receive deicer laden runoff. Letts (2000) concluded that in most situations the ferrocyanide will precipitate, break down via photolysis volatilization, or biological degradation before it can cause harm to the ecosystem. Additionally, dilution rates commonly seen in ecosystems receiving deicer laden runoff will reduce the potential for harm to organisms. Letts (2000) does caution that impacts could occur to organisms in roadside ditches in urban areas with heavy salt use. Photoenhancement, or increased aquatic toxicity due to a chemical transformation of a substance due to UV exposure, was also observed by Little and Calfee (2000), when testing the toxicity of sodium ferrocyanide (from yellow prussiate of soda (YPS) used in fire retardant). Rainbow trout (Onchorhyncus mykiss) and Southern leopard frog (Rana sphenocephala) were exposed to various fire retardants and UV light treatments. Rainbow trout were always more sensitive to fire retardants than the Southern leopard frog, and both species were equally affected by low concentration of YPS alone when exposed to UV. Cyanide agents can interfere with a fish's gills impeding breathing causing death (MN Pollution Control Agency, 2000). In Minnesota, run-off from the salt piles was reported to contain between 5 and 40 times the amount of free cyanide that is toxic to half of the fish exposed, caused by concentrated runoff from salt piles that were improperly managed at that time (MN Pollution Control Agency, 2000). Environment Canada (2001) concluded that "road salts that contain inorganic chloride salts with or without ferrocyanide salts are 'toxic'."

Aquatic invertebrates' toxicity. In Iowa, the US EPA tested acute toxicity of chloride to four freshwater species, water flea (Ceriodaphnia dubia), fingernail clam (Sphaerium simile), planorbid snail (Gyraulus parvus), and tubificid worm (Tubifex tubifex) under varying concentration of sulfate and levels of water hardness (Linton and Soucek, 2008). The study found that for two species (S. simile & T. tubifex), increasing the acclimation and dilution of water hardness reduced the acute toxicity of chloride by up to 1.5 times, while sulfate was found to negatively impact chloride toxicity by up to 12% for C. dubia.

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Research conducted on aircraft and airfield deicers and dust suppressants has laid the foundation for toxicity testing of roadway deicers. Work by Pillard (1995) investigated the toxicity of ethylene and propylene glycol and the associated aircraft deicer additives on Ceriodaphnia dubia and Pimephales promelas. Corsi et al. (2006; 2009) reported aquatic toxicity data for airfield pavement deicers, KAc and Sodium Formate (NaFm) using US EPA tests methods (US EPA 2002a,b), and aquatic organisms Vibrio fischeri, Pimephales promelas, Ceriodaphnia dubia, and Selenastrum capricornutum. The Airport Cooperative Research Program (ACRP) published an extensive document on developing new formulations for aircraft deicers that have lower toxicity and BOD (ACRP, 2008). Aircraft deicers tested were acetate and formate based products and ethylene and propylene glycols. Toxicity testing was conducted using US EPA methods on fathead minnow, daphnia magna, and rainbow trout. Chauhan et al. (2009) reported that airport runway deicers (e.g., acetates) feature a typical Daphnia magna 48-hr LC50 value of 1,000 mg/L and a typical Pimephales promelas (fathead minnows) 96-hr LC50 value of 1,000 mg/L, whereas the more eco-friendly proprietary alternatives featured LC50 values up to 4,875 mg/L. For chronic toxicity, common airport runway deicers had C. dubia IC25 values typically in the range of 400-820 mg/L, and P. promelas LC25 values typically in the range of 180-280 mg/L, whereas the more eco-friendly proprietary alternatives featured IC25 values in the range of 1,100 to 2,600 mg/L.

Aquatic vegetation is similarly vulnerable to the changes in salt concentrations. One algal species has demonstrated extreme sensitivity to exposures to chloride; with concentrations of 71 mg Cl^-/L inhibiting growth and chlorophyll production, while others can tolerate chloride concentrations between 886 and 36,400 mg/L (US EPA, 1988). An increase in chloride may also allow for non-native species to become more predominant. Other aquatic plants exhibit various sensitivities, with growth inhibition observed in desmids at 200 mg Cl^-/L, EC50 equal to 1482 mg Cl^-/L in diatoms, and reduced growth and reproduction at 1820 mg Cl^-/L in angiosperm (US EPA, 1988). Although noteworthy, the sensitivities exhibited by the algae and desmids do not weigh into the final threshold determination because the toxicity tests were not conducted with measured concentrations of chloride, a biologically significant endpoint, and an aquatic plant of consequence in U.S. waters.

Heavy metal leaching by deicers. Research conducted in Sweden found that concentrations of cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) in soil adjacent to roadways were related to the use of deicing salts (Backstrom et al., 2004). The methods of mobilization of the heavy metals included ion exchange, lowered pH, chloride complex formation, and possible colloid dispersion. The researchers express concern about mobilization of heavy metals due to the use of NaCl as a deicing product and potential contamination to shallow ground water.

Soil columns leached with NaCl mobilized organic materials and iron oxides. The potential to carry adsorbed heavy metals along with them increases as electrolyte concentrations decrease (Amrhein, 1992; Norrström, 1998). Zinc and cadmium are far more susceptible to changes in pH and become more mobile with increasing acidity (Backstrom, 2004; Amrhien, 1992). Doner (1978) also performed soil column experiments with both chloride and perchlorate salts to test the theory of

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complexation as a mechanism of metal transport. Perchlorate has an ionic strength equal to chloride but is known to form very weak metal complexes. The results showed 1.1 to 4 times as much movement of cadmium, nickel and copper for chloride salt leachate as compared to the perchlorate leachate. Cadmium tends to be associated with readily leached compounds and is more mobile than other heavy metals when in soils (Norrström, 1998). The addition of chloride from deicer salts increases the mobility of cadmium via complexation with the chloride. The resulting negatively charged ligand complexes further compete with clay for cadmium ions (Lumsdon et al. 1995). This is also true, to a lesser extent, when CMAs are used by complexation with acetate (Amrheim, 1992). Cadmium has also been demonstrated to be more mobile in high salt concentrations by cation exchange with sodium, magnesium and calcium (Amrhein, 1992; Backstrom, 2004). Chromium is more closely associated with the transport of organic materials and occurs at higher levels when CMAs are used as deicers. This was also true for lead, copper and nickel (Amrhein, 1992).

In the Netherlands, a remediation facility consisting of a detention basin and a constructed wetland were tested for retention of heavy metals and Poly-Aromatic Hydrocarbons (PAHs) from road runoff (Tromp et al., 2012). This study found the system was very effective at removing PAHs, 90-95% removal; however, during application of deicers, concentrations of copper (Cu), zinc, (Zn), cadmium (Cd), and nickel (Ni) were found to be much higher in the wetland effluent. The researchers recommended modifying the hydraulic management of the system, to bypass the road water runoff, during times when deicers are being used so as to maintain the integrity of the remediation facility.

CONCLUDING REMARKS

Environmental risks of chloride based deicers, indicating that the actual effects depend on individual site conditions as well as the type and amount of deicers applied. Overall, maintenance yards have the potential to for releasing high chloride concentration runoff into the adjacent environment and pose a risk of point source pollution. In contrast, stormwater runoff from roads where deicers have been applied at controlled application rates tends to be diluted by precipitation (averaged at 500:1) and poses a risk of non-point source pollution.

Spikes in chloride concentrations in waterways near roads are often observed in the first flushing event, or with spring melting of accumulated snow. If elevated chloride concentrations are observed in times of low flow or when baseflow dominates surface waters near roads, groundwater recharging the waterways may be the source of chlorides.

The density of road networks and the application rates used can directly influence the chloride concentrations observed in surface and groundwater. Land use, soil characteristics and subsurface geology influence groundwater chloride concentrations, as well as precipitation and deicer application rates. Based on these findings, mapping of sensitive areas, road density, annual precipitation, etc. can aid in identifying areas for reduced salt use or where alternative products may be better suited.

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Species that have been shown through laboratory testing to be good indicators of the impacts on chlorides are salamanders for amphibious species and fathead minnow. Generally speaking, invertebrate species appear to be more sensitive to the effects of chloride than vertebrate species. Recent laboratory testing has shown that increasing species acclimation to and diluting water hardness reduces the toxic effects of chloride by 1.4 to 1.5 times. The presence of sulfate during chloride toxicity testing was found to increase toxicity by 12% for the same species. This testing was completed with a limited number of species at this point in time.

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Dear Office of the Great Lakes,

The Michigan League of Conservation Voters' (LCV) members commend you for taking the initiative to consider and strategize on how best to protect our state's unique freshwater resources.

Michiganders from across the state are encouraged to see our Governor prioritizing protections for the Great Lakes and Michigan's clean water. The release of your vision for strong, long-term water policy is a strong step in the right direction and we look forward to seeing a more concrete plan of action to turn that vision into reality for the Great Lakes State.

All of us in Michigan deserve access to clean drinking water and healthy rivers, lakes and streams. The Governor's initial water strategy is an opportunity for meaningful action to address the most serious threats facing our Great Lakes, like the toxic algae blooms in Lake Erie that led to contaminated drinking water and closed beaches last summer.

Clean water drives our economy and our way of life in Michigan, and our policies should reflect that. Developing a strong water strategy is a good first step, but we urge the Governor to dig into the specifics of how he can turn this innovative strategy into an actionable plan.

On behalf of Michigan LCV, our members, and our Board of Directors, I look forward to your continued engagement in protecting our precious clean water and hope to work with you to find policy solutions that work for our state.

Thank you for your consideration.

Sincerely,

Lisa Wozniak
Executive Director, Michigan LCV

On behalf of the more than fourteen hundred undersigned Michigan LCV members, I urge you to take the good ideas and opportunities outlined in your Water Strategy and turn them into policies that work to keep the Great Lakes State the best state to call home.

Darlene Byrd 48002-2115
Peggy Moody 49801-0261
Sarah Nash 48162-7909
Katie Petersen 49648
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L. Hammermeister 91344
Sharron Bjornbak 48154
James Carrell 46514-9798
Kathy Dunham 49707-1120
Robert Linzmeier 60074
Judith Moran 32404-5312
Judy Wisboro 01606-3527
C. Carter 49769
Vickie Wagner 49128-9559
Tim Lovell 55731-0542
Mick Degraeve 49686
Annette Gilson 48309
Mario Maraldo 48045-2403
Maya Moiseyev 94306
Dan Fogarty 95409-3840

R. Goodrich 99507-5389
C. Sherman-Jones 49816
Marjorie Frazier 48327
Elizabeth Noren 48103
Arshad Ameen 38125-2508
David Bonnell 75234
Mark Johnsen 48390-1735
John Korovilos 48183-3605
Dorothy Delehanty 48341
Barry Zuckerman 10940
Harry Grace 14214-1018
Amy Stevens 49650-9721
Norman Hines 06070-2163
Donald DeYoung 49006
Sandra Zielinski 61704
Jonathan Peter 13905-4114
Marcia Curran 49635-9531
Marian Volkman 48105
Tom Emmott 55411-1759
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Merian Soto 19119-3110
Andrea Geralds 19104
David Ford 91030-4636
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Kara Norman 48150-2493
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Anna Tangi 19148-4410
Susn Bourgault 48186
Chris Lavin 06484-4437
R. Dressler 49512-5697
Andrea Hildebrandt 48126

Jeaneen Andretta 07932
Julie Harris 97078-1903
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Shirley Gorski 48152-3411
Julia Hernandez 48209
Tia Pearson 96786-8563
Guy Kimble 28215-9333
Thomas Turner 20112
James Hanselman 97365
Patricia Ridgley 49233
Mary Wolney 49014-9118
Erika Hunt 85711-3428
Ruth Carlone 22556-6722
Allie Pace 10552-2925
C. Mahan 49713-9326
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Robin Poppe 55707-8766
Alice Littlefield 49674-0087
Ted Shatz 91401-1506
Robert Aguirre 48451-9793
M. Stanger 48329-1157
DonaldWelch 48130-8571
Ben Cachola 94587-3856
BarbChenicek 49221-1755
Cheryl Elsass 44907-1717
Karen Zwart 49423-4532
LeeHegstrand 49506-3566
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MonicaJackson 92651
Llanda Richardson 01532
Lynda Barondes 85603
E. Bechmann 21122-3514
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Peggy Moody 49841-2703
Thor Sorensen 49506
G. Bartnick 49506-1653
Richard Lawrence 48189
Larry Massie 49010-8906
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Mary Grant 22903-7409
Ilene Kazak 48212-3111

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Shane Worth 20007
M.Musialowski 48047-1781
Alan Connor 48103-2567
Mary Charnetski 48105
Lynn Marie Suits 48103
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Kurt Hilden 87111-5143
Christine Mohr 48312-5663
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David Dwyer 49701-1091
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C. Vichiola 06790-3823
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Michael Wolk 48301-1462
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H Gentry 94609-1346
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Guy Swansbro 53704
Colin Dunnigan 85711
Tim Simandl 44240-3646
Roberta Paschk 48169
Megan Faber 80210-1512
Michael Kwitt 48089-1230
Sue Riopelle 48150-2868
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RuthScheidler 49036-7535

Ellen Hopkins 48105-2847
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bill butler 48428-9316
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Kory Stone 48458-8829
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Joel Kahaner 48322-2868
Paulett Simunich 15904
Emma Myles 48207-5000
Tracey Smallwood 20601
judy valine 89061-8783
Deirdre Coval 99669-7558
S. Christensen 48423
Luise Knutson 48728-9712
M. Oconnor 48895-9747
Carol McIlwaine 49453
Yvonne Barker 53214
Martha Buchan 53092
K. Waldmann 48167-1629
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Mike Dotson 62918-1202
Larry Bright 48197-8985
Jason Younk 48205-4218
Jan Ealy 49686-4932
jeri brain 48302-2052
S. Corbett 49525-3025
David Field 48103-3451
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Rita Hogan 38560-4166
A. W. Schemahorn 46737
Maureen Grzanna 53108
Maureen Hicks 48888
Steven Dupuis 48864-1901
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M. Wildner 49696-8930
Vlad Vandalov 48371-5224
Nanette LaFata 49780
Peter Bec 48186-4120
Amy Hansen 08802-2106

Donna Southwell 49107
Scott Bloom 49935-9763
Erin Groom 48895-9348
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Robert Shearer 49056
DaveSprecher 17522-9214
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Ed Haynor49337-9204
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hugh croce 49068-1104
M. Peterson 48763-9313
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Laura Herndon 91505
Joe Stoner 1801
C. Zilke 49106-9714
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Christine Esch 60642-4153
Daniel Cracchiolo 48310

Evelyn Krueger 98502
Betty Hankins 48176-1024
Dick Dierks 54911-5439
Steven Egler 48640-4190
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K devereaux 48009-5739
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C. Devinney 14530-9763
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Paul Markillie 48439-2533
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S. Zangwill 19038-4303
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Carlos Montoya 75159
DarleneWyber 48081-3644
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John Dancause 32714
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M. Kalinowski 10032-6044
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Michael Vogel 48116-9705
Brian Shea 02129-1648
Aaron Fekaris 48377-4537
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JustinEldridge 49519-2301
K. Pepelko 48323-3220

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Matt Walker 60657-5334
G. Malueg 53511-2729
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David Collet 49423-9210
Scott Matash 48044-5922
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Janice Postma 49506
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Keith Johnson 48084-1432
Karen Paul 19053-6521
Tsee Lee 10001-5603
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Chad Hayes 19119-2707
Leon Boodry 54914-8205
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Laura Savoie 49629-0234
R. Kane 48027-3310
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JolantaNowak 98345
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Arlene Tilly 49546-5871
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Elaine Tokarski 48083
Pat Trahan 48706-1239
J. Tollison 49270-9381
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WilliamFrey 48219-4041
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Chris Fries 49866-9522
Pamela Meyer 49004-1908
Mark Meyer 48185-1619
Phil Micklin 49006-4467
S. Michael 48420-8231
Fred Townsend 48462
C. micklin 49006-4467
Donald Garlit 48187-1163
Susie Garlick Rn 48604
S. Garrison 49221-9421
WilliamGardner 49622
Jason Garloch 48237-1806
Rick Gardner 48093-2716
R. Trumbull 49505-3382
JudyGabrielse 49315-9001
CarolGagliardi 48103-9549
Nick Tsurui 48327-3794
Tim Fulwylie 48228
Cynthia Miller 49022-9758
Allan Turner 48307-4609
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K, Tweedale 48021-3023
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Kevin Geary 48642-3558
DeanneUpson 49014-7549
Dan Moerman 48198-9632
S. Gerlach 49749-9736
Brad Gerlach 49749-9736
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Arthur Wolfe 49617-9618
Shirley Wolfe 49617-9618
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Yolanda Mitts 49088-8719
B. VanDuinen 48176-1549
D. Vanderkolk 49441-1342
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Marie Vasquez 49221
Carol Glidden 49008-3949
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Jerry Gillissen 48912-3426
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C. Vigneron 49046-8407
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V. Strader 49037-1312
R. Gonsalves 48076-4162
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Kristine Morris 49670-9336
Robert Aiello 48002-2104
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Lori Mulvey 49321-9523
Alan Walczak 49504-6086
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KarenGraham 49014-9524
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David Green 49055-8806
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Rolf Amsler 48176-9555
Flora Greig 49103-9752
MikeAnderson 48854-9607
R. Anderson 48186-4638
CarlGrenadier 48025-4320
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Anne Andries 49410-0007
Karen Nichols 49715-0128

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Beth Armstrong 49004
PeterArmstrong 49460-9554
N. Weatherwax 49224-9107
Douglas Haan 49423-8855
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Ken Grunow48223-1216
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John Guinn 48359-1526
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Robert Gurzick 48430-3240
I. Weingarten 48104-4424
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Gwen Wellman 48348
Robert Welker 48198-3801
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Karen Bacula 49855-3314
Nancy Bahlman 48067-4056
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Kurt Baker 48060-1626
George Oliver 48060-4305
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David Werner 48130-9818
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S. Westergaard 48103-5846
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R. Hammersley 49684-4144
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Dave Hanna 48089-5905
Donald Handy 48043-2221
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Richard Han 48103-5290
Gwen Handelman 48104
Matt Hanes 48035-5117
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Dawn Bartok 48173-9729
HeatherWhitman 48071-4323
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Tris Palmgren 48236-1734
Craig Owen 49079-8301
Larry Widigan 48449-9755
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B Bassett 49727-9691
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Roger Bauer 49636-5129
C. Williams 49055-8694
Veronica Hayes 48220-2428
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Judith Begin 48047-2056
N. Belanger-lott 48827-1048
Ralph Bekker 49505-3860
Bobby Belknap 49635-9247
Victor Bella 49453-1233
Kevin Haynes 49740-9335
Lucia Heinold 48103-2542
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R. Benjamin 48881-9754
Eliza Becuidoin 48158-8652
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dennis palmer 49621-9403
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Ken Hermonat 48237-2331
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Cindy Heister 48813-9741
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Liz Paxson 49686-3917
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Carol Berard 48855-6449
K. Berg 49953-1844
Sidney Berkowitz 48322
Joe Henne 49726-9639
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S. Blankenship 49270-9716
Ann Wright 48103-3131
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Edmond Hileski 49006
Carol Higgins 49072-8748
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shira blum 48076-1335
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BarbaraHolcomb 49221-9700
Mary Boehm 49418-2054
Don Bollinger 49706-9810
george piner 48116-5196
CandacePinaud 48197-2028
Larry Pliska 48025-1940
Jan Wright 48197-8733
Kenneth Wright 48653-7410
Richard Booth 48138-1601
Teresa Boomer 48503
Jon Wyss 48195-1120
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Thomas Yocum 49629-9425
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Michele York 48316-3522
Mary Homan 48080-1623
Rob Honeyman 48075-2115
Roger Hoos 48317-6202
Cheryl Plute 49913-2111
M. Polidori 48025-4660
A. Holbrook 49735-8929

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Dan Hornaday 49014-8314
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C. Pomerleau 48104-4059
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Andrea Zajac 48895-1505
Jack Brandmeier 48106-2377
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Joanne Popp 48911
Ruth Ziel 49855-9518
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Janna Zeilstra 49512-2776
Colleen Zlydaszyk 49686
Marilyn Hotaling48073
Karen Zyczynski 48374-3870
Patricia Hubbard 49503-1844
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Jacque Potoski 48195-1149
Tim Poxson 48842
Peggy Huebner 49127-1235
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C. bramlett-hawes 48079
Dan Ingall 48849-9412
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Marty Jennings 48236-1128
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Robert James 48166-9431
Matt Brzezinski 48081-1511
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Dorr Bugbee 49017-9451
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James Bull 48146-4020
John Renfrew 49855-9552
Ann Remkus 49221-1755

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James Renaud 48441-9493
M. buttenheim 48103-3257
Jackie Byars 48104-3864
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John Jellema 48197-2143
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C. Ritsema 49506-5232
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Matt Roberts 49093-9690
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Joan Jones 48160-9729
Joseph Kaleel 48759-1234
Paul Caswell 49829-3113
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Manuel Rosenbaum 48237
Fred Cepela 49684-7602
Vince Cerutti 48104-4928
L Kaniarz 49008-2908
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Terry Keck 48081-3119
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Joseph Sackrider 48609
Judy Clark 49445
Betty Kennedy 60660-6842
Don Rumelhart 48105-9336
ReneeKermeen 49333-8966
thelma kew 48186
Elena Chesney 48105-1142
Kat russell 49507
Emmy Cholak 49684
Holly Chisholm 48371-3229
AmandaSalvner 48104-3205

Richard Kelley 49684-9003
Kathleen Kibbie 48169-9313
Kay Clifford 48103-5937
Lance Climie 49525-1814
Ken Kiel 49341-9236
Kaaren klingel 48169-9016
Daniel Cline 48640-8543
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Robert Klein 48433-1021
AlvinSaperstein 48207-2717
Janice Colville 49964-0027
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Sharon klotz 49269-9525
John Sauntry 49006-2169
Leah Knapp 49068-1930
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Ron Cober 48023-2200
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Sara King 48103-9728
larry connell 48130-9447
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V. Conover 48067-4602
K.Connaughton 48880-9419
Margaret Conti 48428-0321
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S. Knoppers 49345-9762
Liz Kirkwood 49686-2730
Tatiana Scavnicky 48220
Andy Sayles 49009-8547
Roland Schaedig 48104
Patricia Schachtner 97503
Matthew Schaut49938
Mary Korde 48324-2519
Ken Schilling 49507-3155
william scharf 49686-1885
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David Cope 49418-1120
Kathleen Cool 49080-1294
Bridget Cooper 48823-2420
tim coon 49770-8543
C. Schultz-Condon 48098
Jen Schuham 60148-2603
BarbaraKuhn 48138-1746
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Bernie Schupbach 48823
Julie Collins 48167-1008
John Korstange 49017-9448

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J. Kotlinski 48150-2822
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M. Shaffer-O'Connell 49774
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A Cu 49008
Gary Crump 48809-0176
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Russell Davis 48197-8706
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Myles Davis 48381-2425
John Davis 48070-1526
Jeff LeClair 48906-6815

Howard Lederman 48072
Robert Deaton 49017
Bob DeKorne 49664-9637
Jennie deBeausset 48138
Terri Defilippo 49621-0254
Leonard Lewis 49201-8542
Rose Lewis 48342
Beyce Smith 49783-9026
Ruth Lezotte 49682-9563
Victoria Lewis 13601-6619
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August 28, 2015

Director Jon Allan
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Lansing, Michigan 48909

RE: Sustaining Michigan's Water Heritage Draft for Public Review; WMEAC Comments

The Office of the Great Lakes and collaborating state partners at the DEQ, DNR, MDARD, and the MEDC are to be commended for this comprehensive draft. The Strategy is thoroughly researched, organized and well written. It reflects many perspectives, citizen and expert input, and was built upon a facilitated Community Water Dialogue. The breadth and scope of the issues covered are matched with 62 specific policy recommendations, and an early attempt has been made to identify lead actors and clear metrics.

WMEAC appreciates the strategy's "ecosystems approach" and recognizes that the core values of our relationship with water — economic, environmental, social and cultural — are equally important. This means that in both times of economic growth and contraction we must hold up the environment as a foundationally important value. It means that sometimes citizen access might have to be curtailed to allow for the restoration of ecosystems. It means that sometimes brownfields will have to be 'clean enough' to clear the way for appropriate new developments. It also means that some areas should never by developed; ever. It means that we can't cut environmental corners to create economic activity. It means that government, private and NGO environmental efforts will have to be expanded, not curtailed, to meet the ambitious recommendations herein. It means that Michiganders will have to pay more in taxes and fees to protect our natural resources, and it means that Michigan's leaders, public and private, will have to stand up and unabashedly embrace new sources of funding as an investment in Michigan's future.

Our water resources have to be protected, maintained, restored and Michigan people and businesses are going to have to pay more to accomplish that. There's just no way around that basic fact. The Strategy's Community Water Dialogue participants agreed citing "funding and participation" as the most common barriers to success. If we are serious about pursuing this Strategy, and if we are to have success in meeting some of the ambitious objectives and recommendations it outlines, this basic fact has to be embraced, owned, and recognized up front. It has to be communicated clearly, loudly, and without apology.

Recommendation Highlights*

WMEAC supports the vast majority of the recommendations in this document. It would probably be easier to pick out those that we do not find terribly compelling than to list those we support. Therefore, neither list would be all that useful. What might helpful to identify are those recommendations that WMEAC is not only particularly supportive of, but those that we are ready and willing to invest resources into now, and into the future.

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Strategy recommendations that WMEAC is excited to join local, regional, and statewide collaborations to see executed:

- Develop and implement a uniform statewide sanitary code, establish a long-term, sustainable funding source and inspection requirements for onsite wastewater.
- Establish a long-term Water Fund to achieve Water Strategy goals including water infrastructure management.
- Promote green infrastructure, low impact development and green spaces to rebuild hydrologic integrity and address storm water.
- Evaluate and implement necessary changes to laws including state and local land-use statutes as well as the drain code to create a more integrated, watershed based system for managing water at the landscape level and achieving water quantity and quality outcomes.
- Water efficiency targets for all major water dependent sectors. Develop a water conservation and reuse strategy.
- Support groundwater and surface water monitoring.
- Integrate water literacy into state of Michigan curriculum standards.
- Develop and implement a water trails system.

*Attached you will find a memo identifying specific overlap between the City of Grand Rapids' Downtown Development Plan GR Forward Grand River Restoration and the Draft Water Strategy. This is just one example of a local initiative WMEAC is engaged in that can be used as a vehicle to move forward priorities from the draft Strategy.

Draft Implementation Metrics

The implementation metrics represent a very interesting column in Table 2 Water Strategy Implementation Plan. In general the metrics are very good. They are clear and specific. However, many of them are associated with an implementation date that at times is aggressive, and that at other times seems to be more of a placeholder than a real timeline metric. For example, many of the metrics seem to have somewhat arbitrarily identified 2020 as their date for completion.

Many of the date metrics also post-date the Snyder Administration. Therefore, it is only useful to include such a timeline if a Strategy Implementation Process is established to survive the Snyder Administration. This is certainly possible, but a robust value-add process must be outlined in the strategy (more on this later) describing how this will be accomplished. The strategy certainly acknowledges this fact in Chapter 8, and it makes a recommendation for the creation of an interdepartmental implementation team. Perhaps this should not be a recommendation, and instead should be issued as a statement, and paired with an outline of the process. The "recommendation" status leaves Strategy readers unsure of whether or not such an initiative will occur, and calls into question the State's internal buy-in and overall commitment to the strategy.

Lead Actor

Laudably, Table 2 Implementation plan attempts to identify Lead Actors responsible for moving recommendations forward. This is an important component of any implementation plan, and one WMEAC would love to see included in the final document. More, this feature would be even more useful if the identified Lead Actor has been contacted, briefed, and has committed to their role as such.

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For example, the Legislature has been identified as the Lead Actor for the recommendation "Develop and implement a uniform statewide sanitary code that is flexible and provides standards for site suitability based on risk." What is the appetite for legislative leadership to implement such an initiative? Indeed, if the Senate Majority Leader and Speaker of the House were willing to include this in their legislative platform, then identifying them as Lead Actor would be entirely appropriate. On the flip side if they have little knowledge of or interest in this priority, then it does the document a disservice to identify them as lead.

Careful thought should be given about how best to communicate in the Strategy likelihood of the Lead Actor actually owning responsibility for leading implementation of the recommendation for which they have been identified.

For many of the recommendations the Lead Actor is critically important. Community Water Dialogue participants reinforced this notion. They indicated their willingness to participate in many of the strategies initiatives, but they were very hesitant to lead. Therefore, a formal process for identifying, recruiting, and tagging Lead Actors might need to be established so that the final version of the Strategy will include a Lead Actor that has been briefed on the issue and that has some level of buy-in as a leader.

Strategy Implementation Process

Chapter 8 Page 54 expresses one of the most important ideas in the entire strategy. WMEAC agrees with the authors that this concept is fundamental to making the Strategy successful.

> "In order to ensure the Water Strategy is durable over time and across administrations, the elements of the Strategy need to be fully integrated into decision processes, governance structures, and the culture of state and local governments, other organizations, and individuals."
>
> "If the critical elements of this Strategy are not adopted and deeply engrained into ongoing decision-making processes, then little will come of them over time."

We are happy the authors recognize the challenge before them, and offer our support in any way we can be helpful. Perhaps there are a few ways, in addition to brute bureaucratic force, to make the Strategy durable over time. The first has already been identified as a recommendation:

1. Create an Interdepartmental Water Team to unite agencies to ensure a cohesive common strategy around implementation of the Water Strategy. The team will establish a process for stakeholder collaboration, criteria for setting implementation priorities, identifying cross agency joint projects, and an approach to assess and evaluate progress achieved against the metrics and outcomes.

The team should be formally established, well-organized, resourced, and directly connected to cabinet level decision makers and the Executive Office. As mentioned earlier, moving this from a Strategy

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recommendation to a confirmed fact – one that is announced with the finalized version of the Strategy would be highly valuable in building external confidence that State is committed to the Strategy.

2. The Governor has to invest political capital in the Strategy. WMEAC understands that every important issue can't be a priority for the Governor, but we also believe that for the Strategy to be effective the Governor will need to demonstrate privately and publicly that key pieces of the Strategy are very important to him. Public support from the Governor and top representatives will send signals across Michigan that the Strategy will be valued, resourced, and utilized. A high level of commitment will inspire reciprocity and commitment from external partners, funders, and the general public.

3. The Strategy should produce new and signature initiatives.
One or several big, signature initiatives will inspire and motivate people to get behind the Strategy. A great example is recommendation 5 on page 65: "Fund a pilot project, through a competitive bid process, for the initiation and evaluation of a new model for wastewater management." A host of recommendations from the Strategy would fit this bill: An aggressive push on statewide septics policy, the creation of a statewide water infrastructure fund and new revenue stream, etc...

In addition to a signature initiative, the creation of new programs, policies, and initiatives will breathe life into the Strategy. While existing DEQ, DNR, MEDC, and MDARD activities are certainly part and parcel to the Strategy, recounting, reorganizing, and rehashing a litany of existing DEQ/DNR activities will not inspire citizen, stakeholder and partner momentum.

4. Don't be shy about new funding, fees, and taxes
Strategy Community Water Dialogue participants identified funding as one of the top potential barriers to success. The majority of participants named external funding (state, federal, grants, foundations, etc.) as a potential source, but many participants also identified local sources, user fees, and even additional taxes. Dialogue participants were vocal and transparent about the need for new water funding. Strategy communicators and State representatives working with the Strategy should follow their lead. Strategy messaging should not be coy or defensive about the need for new funding. It is a fact that many in the Legislature are incredibly reluctant to create new revenue streams at the State or Local level. Many citizens are also reluctant, but the best way to confront that challenge is to be clear, open, and honest about the need.

Maintaining, expanding, and building new water infrastructure will be expensive. Protecting our incredible, world-class, fresh water resources will require serious expenditures; but Michigan is worth it, and we should be proud of it investing in its protection.

Sincerely,

Nicholas Occhipinti
WMEAC Policy Director

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From: **Nicholas Occhipinti, West Michigan Environmental Action Council**
To: **Ann Armstrong Cusack, Office of Urban Initiatives**
Date: **8/25/2015**
RE: **Grand River Restoration Water Quality Recommendations; Opportunities for Integration with State of Michigan (Draft) Water Strategy**

Background: Grand Rapids is currently undergoing a major planning initiative and visioning process (GR Forward) that will steer development of the downtown and Grand River corridor for the next decade and beyond. At the center of that process is the restoration of the Grand River. Citizen access, water quality, recreation, and downtown economic development improvements are central goals of this initiative.

The GR Forward River Restoration plan shares strategic and tactical approaches with the State of Michigan water strategy. Harnessed effectively, the projects will feed off and support each other. More, Grand River Restoration is ripe with specific project, policy, and programming opportunities that will fulfill recommendations and metrics detailed in the Governor's Draft Water Strategy.

Many of the proposed issues are big, complicated, and difficult multi-year issues. That is precisely why it is so important to pursue them at a moment like this – when a unique opportunity has aligned many stakeholders behind two big visions. Grand River Recommendations (in no particular order):

River Restoration Recommendation	**Governor's Water Strategy Recommendation**
Improve **septic** programs and policies in the Grand River watershed area. Work with the Snyder Administration on a statewide septic code and with local health departments to adopt operational inspections and maintenance requirements in their septic regulations.	Develop and implement a uniform statewide sanitary code that is flexible and provides standards for site suitability based on risk. Establish a long-term, sustainable funding source to support onsite wastewater programs at the state and local levels and to assist financially distressed owners of private on-site wastewater systems with repair and replacement costs. (P. 23)
Address high impact **point-source** water quality infrastructure opportunities in the Grand River watershed area.	Establish sustainable funding mechanisms to achieve the Water Strategy goals including water infrastructure management. (P. 67)
Maximize implementation of **green infrastructure and low-impact development** (LID) within the River Restoration Project Corridor area by encouraging local policies and incentives that favor LID.	Utilize pricing and funding strategies to support infrastructure improvements while allowing for water conservation. By 2020, increase the number of communities that have pricing and funding strategies as part of their asset management plans to support infrastructure Improvements (p. 44)
The notion of improving the quality of the water in the Grand River should be **imbedded in the messaging, branding and funding initiatives** of the river restoration effort.	Implement a communication strategy focused on messages that link the relationship between investments in water infrastructure and clean water and the benefits infrastructure provides for drinking water, recreation, and cultural and economic

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	opportunity. (P 66)
Implement projects identified by the City of Grand Rapids **Green Infrastructure Opportunity Assessment**. Inspire a similar assessment and implementation process for managing stormwater runoff in upstream communities.	Provide technical and financial support to communities to plan and implement green infrastructure techniques and low-impact development while preserving natural spaces in the design of new developments, redevelopments and road projects to ensure storm water management and improve hydrology. (P. 60) Rec 17 Use existing authority to work with local units of government with storm water discharge or storm water-related hydrologic impairments in their waterways to establish Phase II storm water plans for impaired water bodies. (P. 60)
Address **livestock and cropland pathogen pollutants** in the Direct Drainage Subwatershed management unit of the Lower Grand River Watershed and in the Urban Waters Federal Partnership area. Plant buffer and filter strips along priority acreage adjacent to and encompassing the Direct Drainage Subwatershed and Urban Waters Partnership area.	Eliminate impairments in priority watersheds that have degraded water quality and/or aquatic ecosystems due to nutrient runoff and soil erosion. Engage landowners through a collaborative and adaptive community-based natural resource management process to identify local actions to change behaviors and solution to achieve those outcomes. (PP. 60-61)

Summary:
The chart serves as a side-by-side comparison of similarity in tactical and strategic approaches in the two plans. It is not a comprehensive list, but it does suggest the type and quality of synergies present. This list focuses on recommendations coming out of the water quality sub-group – additional water/river related synergies with the State Strategy can be found in the GR Forward Plan outside of the list focusing on the water itself. For example, dam removal, flood wall and riparian edge design, public access and recreational opportunities typify these other synergies

As with any visioning plan, each recommendation presented herein is at different stage of its conceptualization and implementation. Some have active government, private, and non-profit staff and resources behind them. Whereas others are new and exist mostly in the conceptual realm of literature and best practice. Finally, some of the recommendations have been previously forwarded through one initiative or another, but have hit significant political, economic, or social barriers.

Conclusion
A more sophisticated and formal analysis could be established to find the specific (existing and potential) ways in which synergy can be created between the two visions. Ideally, this could occur through a cooperative, formal, and resourced process in partnership with State of Michigan staff and River Restoration stakeholders. It is clear that several of the recommendations above will require this type of investment, coordination, and cooperation to move forward.

From:	Nicholas Occhipinti
To:	mi-waterstrategy
Subject:	WMEAC Water Strategy Comments
Date:	Friday, August 28, 2015 5:48:26 PM
Attachments:	WMEAC Water Strategy Comments 8.28.pdf

Attached

Thank you!

Nick

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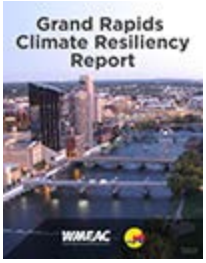

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