IN-SERVICE RETREAT FOR SCHOOL ADMINISTRATORS,
UNIVERSITY OF MINNESOTA ARBORETUM

Solutions to 21st Century Water Challenges

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Environmental
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Contents

Introduction

With financial support from The Medtronic Foundation, The Bush Foundation, and the National Association of State Directors of Agriculture, The Environmental Resource Council developed a modular seminar for school districts on water issues. Attached are several of the pre-readings from a conference held in 2010 at the University of Minnesota Arboretum.

The theme for schools was that, through both education curricula and the management of school property, a sense of environmental responsibility regarding care of water resources was critical. School districts should attempt to model and educate how responsible institutions work with water. Support for the local watershed was also important, as was support for career development in environmental sciences for students.

Solutions to 21st Century Water Challenges

"Even the Zambezi has an island."

—Central African Proverb

Even in a treacherous environment such as the Zambezi River, there are solutions.

"We want science education to help create a better future built on innovation."

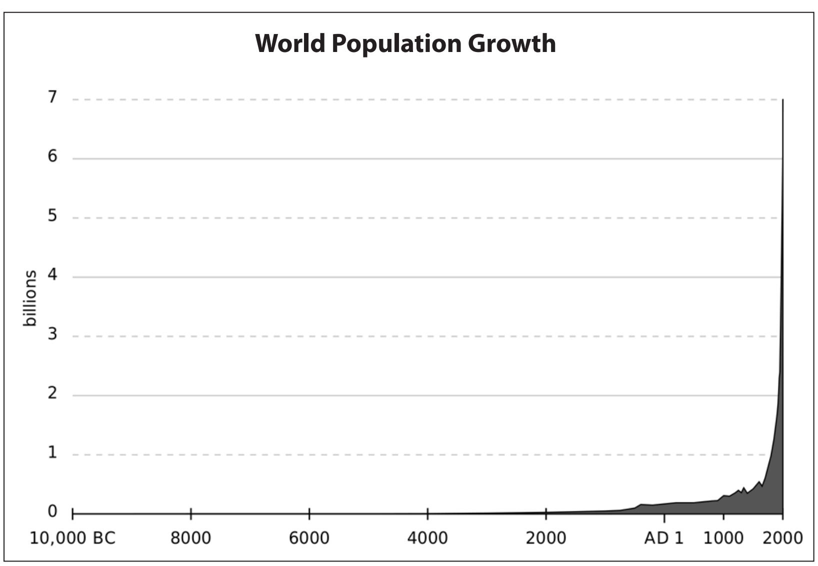
—The Medtronic Foundation

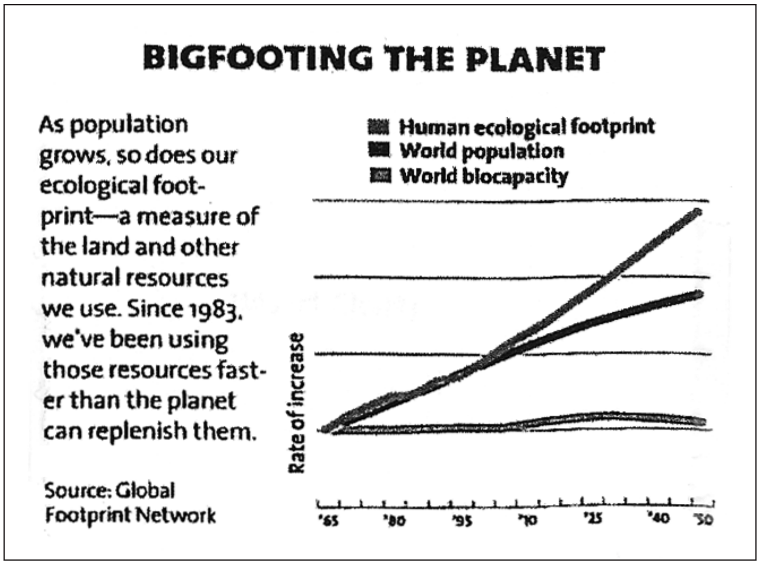
Representing an organization that consistently finds solutions to human risk and suffering.

Our goal is to recognize the serious risks that limit and contaminate water resources, and create an atmosphere and acumen that provide solutions.

I. The Risk

The human population is expanding geometrically, combined with a huge increase in freshwater consumption patterns. We simply do not have enough of the right kind of water in the right place for this to continue without human health and ecological catastrophe.





II. Our World

The earth is covered in water but over 97% of it is blended with mineral salts, which are toxic for human consumption. Another 2% or more of the remaining water is fresh, but is "locked" in snow and ice. The vast majority of frozen freshwater is in Antarctica, one of the most inaccessible places on earth. Less than 1% is left to grow our crops, supply water for hygiene/ingestion, and for water-dependent production of energy, food, textiles, and other products.

We are locating more and more freshwater, but almost always, it is in locations far away and hard to access from in need populations. We can convert saltwater to freshwater, but the energy cost to do so is huge.

Unfortunately, where there are concentrations of humans and consequently, where freshwater is most needed, there is typically abusive freshwater contamination. This contamination involves sewage, especially human waste, and within the last half century, water polluting chemicals – the by-products of commerce, industry, and especially agriculture and energy production. There simply is not enough freshwater for human society to continue to thrive without changes and solutions.

Presently, well over 10% of the human population lacks access to clean water that can be safely ingested. The World Health Organization morbidity data concludes that over three million people die each year from water related health problems. Sewage and chemicals are two of the major pollution risks. It has long been understood that basic hygiene with soap and water on a daily basis will reduce all diarrheal disease by nearly 50%, but where there is limited water access, the hygiene is poor. Infant and childhood mortality, often involving diarrhea, is the direct consequence of limited clean water for ingestion and hygiene.

Each American uses close to 100 gallons of water daily. This fact may be hard to accept, until we understand the connection between water, food, textiles, sewage and energy. A little less than 2,000 gallons of water is used to produce one pound of beef, an egg, 400 gallons, a t-shirt nearly 800 gallons, a pair of blue jeans, 2,900 gallons. All foods and most products used by our consumer society absorb freshwater. Most of the water we use relates to our use of energy, especially electricity. With the growth of Second World nations, i.e. Brazil, Russia, China and India, consumer usage habits also grow. Along with the acceleration in population, the human freshwater footprint becomes unsustainable, unless we find solutions.

III. The Hope

There have been significant programs and policies that have found technical paths and inspired behavioral changes, which have reduced the abuse of freshwater and identified new freshwater sources. Some solutions include industrial procedures for washing and processing foods and products. The use of genetically engineered agriculture production to diminish the need for freshwater, or for nitrogen and phosphorous based water contaminating fertilizers, the use of green building technology to limit contaminated storm water from degrading surface waters, along with energy consumption controls, are working to our advantage. In Second and Third World countries, simple installation of basic pumps in remote villages, and PVC piping of freshwater to remote areas, are making a huge difference in global health.

In developing countries, women living in villages without wells walk an average of nearly four miles daily to obtain water for their families. Bringing in local pumping systems or finding more efficient ways to can transfer the nearly nine pounds of weight per gallon of water, plus container have been and can be solutions.

The point is, we can find solutions to water problems and make them a reality. Even the treacherous and often flooding Zambezi River in East Africa can work to our advantage. As the local elders say, even it has an island; we just need to find it.

IV. Our Goals

We want a world that will understand the risk to and hope of 21st Century water resources and focus on solutions. To reach that point, we have to get our heads around some technical realities:

What is Water?

Water is a strange compound – a molecule that is present on many planets and asteroids, often in the form of ice, but in some situations, as with earth, also found in a liquid or gaseous state. Water can basically take three forms: liquid, gas (moisture/clouds) and solid (ice).

Freshwater, the vast majority of it, is locked up in ice in Antarctica. A nearly 1.3 mile high average ice burden rests on top of recently discovered huge lakes of freshwater. Similar sub-ice sheet "lakes" have been detected in Greenland. We have a lot of needed freshwater in the wrong place or wrong condition (polluted).

Water molecules consist of two hydrogen atoms strongly bonded to an oxygen atom, with two sets of dual electrons also bonded to the oxygen. They all form a pulsating dynamic tetrahedron of energy surrounding the oxygen atom. The water molecule is inherently in flux unless frozen. What seem to be tranquil streams or lakes are, in reality, always vibrating in rhythmic patterns at a molecular level. This inherent flux of chemical motion can cause the rapid expansion of water when it freezes. This is why, unlike virtually all other compounds, water does not contract when the temperature drops below the point of freezing. It expands, sort of "trapping" the pulsating "motion" of the water molecule.

Understanding water's nature permits us to understand the all-important relationship to solubility. Water's interaction with mineral salt, sewage or other pollutants is profoundly impacted by its affinity for binding with some other compounds or molecules (hydrophilic), and rejecting others (hydrophobic).

Understanding that process of binding and solubility is fundamental to understanding water remedies. For instance, it will guide the development of rain gardens on school property to limit surface water contamination. Solubility and molecular binding is the principal key to freshwater.

Biologically, humans must have consistent access to freshwater. The human body is roughly two-thirds water, with higher proportions of water in critical brain tissue and nervous tissue. If freshwater is denied, portions of the body – the nose, mouth, eyes and lips – will shrivel and the tissue will die within a few days. Ingesting saltwater is toxic, since it contains at least fifty times more salt than can be metabolized by human kidneys.

This fundamental connection to freshwater has played an important part in human history. Societies that have mastered access to and working with water have thrived; societies unable to do so have suffered and been limited in size or have outright collapsed. The Roman aqueducts were absolutely fundamental to the Roman Empire, the canal systems in ancient China permitted its society to prosper for a thousand years with stability; and the strong infrastructure of canals and water hygiene inherent in post-Renaissance Great Britain allowed the British Empire to emerge. The need for freshwater access has been the cause of unrest and conflict in local communities, as well as the basis of wars among large and small nations, from pre-history until the present.

V. Four Water Imperatives

Each epic in human history has had its own water challenges, typically involving four areas. They are:

1. **Ingestion and Hygiene.** A human society needs some sort of access to freshwater and, to the extent it's readily available, there is typically good health and social success. This water is used for direct ingestion, for hygiene, to carry away human waste, and to clean the human body, both outside and inside. It's necessary to provide food and fiber, which can essentially be looked at as stored water.

2. **The Ability to Work With Water.** Water is typically the best means for transporting goods from one place to another. Canals, bridges and, of course boats, permit resources, armies and technologies to be spread to a society's advantage. Moving water to enrich food sources, including the nurturing of plants and animals, is also fundamental to stabilizing large social groups.

3. **Energy.** Water is fundamental to most energy development. For centuries, water has been harnessed as a power source for water wheels/mills, then for steam engines, cooling and transportation linkages, heating and cooling for fossil fuel energy production, and for nuclear energy. New techniques for increasing petroleum and natural gas production require massive amounts of water to be injected into soil. Energy production is the most serious stressor of our water resources.

4. **Pollution.** There have been successes in cleaning up and preventing contamination from manufacturing at a "single point" of contamination. In the United States, progress began with enactment of the 1972 Clean Water Act. There has, however, been an increase in "non-point" pollution, typically tied to the need to mass produce food and fiber products and the necessary and extensive use of fertilizers, including nitrogen, phosphorous and pesticides. This increase in non-point chemical contamination continues to pollute surface freshwater and saltwater, usually through hypoxia or deprivation of oxygen.

Contamination of aquifers is of specific concern. State departments of agriculture are constantly monitoring the base level of certain pesticide burdens, which presently can be found in low doses in many aquifers.

The most typical degrading practice for polluting freshwater is to draw down freshwater aquifers or draw from clean surface water, pollute the water, and then discharge it back into surface water in a contaminated state.

The nature of water and its impact on people, societies, and eco-systems must be better understood as a foundation for learning how to protect and enhance our water resources and our future. ■

The School Facility and Water Ecology Considerations

The Post-World War II Eco-Misstep and American Schools

When the French scholar and author Alex de Tocqueville toured the United States in the 1830s, he was struck by the way American schools worked. A few European nations, including Scotland and Germany had mandated education for "healthy young citizens" but, in all cases, education came from the top down. Education was partially a way to program a population as well as to educate. The central government typically paid for and ran European public schools. In the United States, he found that the schools seemed to emerge from within the community.

By the mid-1800s, the school building itself had taken on the semblance of the central "community memorial." Like the largest church in a Spanish or Italian city, or a local government palace in Central America, or the ornate city hall in central Europe, the American school building came to define the community. It was a gathering point, and often an example of the best local architecture. Typically, the school was built on prime land in the center of town and it became a symbol of the health and wealth of the community.

In 1965, Librarian of Congress Dr. Daniel Boorstin wrote The American National Experience. In studying the history of the American school, he was surprised to find that no state had formally intervened in local school proceedings until 1839. This first intervention solely involved setting guidelines for how school buildings were to be constructed, ventilated and managed to provide a generally healthy physical environment. The State of Connecticut determined that there were too many variations in the way schools were built and consequently established school facility standards. For a century and a half, the American school became a sort of "local living memorial," with special sensitivity toward occupant comfort. The standards included large windows with full-spectrum light, individualized hot water radiator heat, ventilation the teacher could control, and as much space as possible per student, and rooms with especially high ceilings.

Everything changed after WWII. Part of the change related to the Baby Boom and a need to enlarge school space quickly. Another part of the change was how architects planned "functional" structures. Finally, the automobile opened up new areas of accessibility, as long as you had a huge parking lot.

The ubiquitous "Central High School" was typically located in the middle of town. It had high windows with plenty of full-spectrum light, high ceilings providing maximum dispersal of air, and window plenums over classroom doors to provide fresh air through cross current. Teachers were able to control radiators, windows and amount of fresh air. Comfort was seen as fundamental to learning.

After WWII, buildings were typically of one-story construction and tightly sealed with windows that could be rarely opened, and air exchange rates permitted only legally minimal make-up air. Lights were glaring, pulsating, limited-spectrum florescent, as opposed to the old, full-spectrum light bulbs. Many classrooms had no windows, and almost none had windows that the teacher could independently open. Beyond that, post-war building products were filled with toxins. Formaldehyde and asbestos were common building products and nearly all the early drinking fountains had lead fixtures, causing low dose lead to be leached into the water. A well-read medical textbook from the 1840s warned about dangers of lead fixtures and contaminated drinking water for children, and a medical diagnosis of lung cancer or mesothelioma relating to asbestos exposure had been accepted as a diagnostic fact since the 1960s.

What was going on outside the building was also environmentally problematic. Instead of using citywide athletic facilities, local YMCA's or public libraries, the new buildings sought to be largely a self-contained community, typically constructed on the outskirts of development, often near surface water, such as rivers or lakes, which would permit easy drainage for their new, monstrous footprints. These super-sized plots included green space/athletic fields and parking lots.

The building itself involved low grade asbestos-coated iron supports encased in a thin shell of brick, with limited insulation and huge, flat, black roofs, which often leaked. The run-off water from the facility was eventually contaminated with road salt and other chemicals and blended with run-off from the huge green space, including athletic fields, which held heavy burdens of fertilizer and pesticides. The thousands of new school buildings drained huge quantities of contaminated water into local surface waters.

Whether converting an old school into a new, larger facility, or breaking ground in a new suburban development, the landscape architecture of post-World War II was typically a water ecology disaster.

In the 1950s, '60s and '70s when these post-war school buildings were mostly constructed, water controls typically involved municipalities, or occasionally counties and/or watershed districts, trying to make certain that these huge new buildings did not flood neighboring areas. The goal was to get storm water and snow melt drained as fast as possible into surface water.

In terms of storm water, there was a significant contribution to contamination, flowing first into local surface waters, and then with eventual consequences such as the "dead zone" off the Gulf of Mexico. Heavy doses of fertilizer, specifically nitrogen, phosphorus, and herbicides created hundreds of square miles of lifeless ocean. As this water moves downstream, freshwater is replaced by semi-toxic algae and consequent hypoxia (oxygen deprivation) in downstream states, the Gulf of Mexico, and

Hudson Bay. These new schools were significantly contaminating freshwater.

Next to farms and possibly roads, the school facility is typically the most contaminating, non-point pollution source in a community.

In addition to storm water run-off, the use of water within school buildings has become a significant issue. When a large number of active people are confined in a closed space over time, water issues will emerge.

The following are significant considerations for the way schools govern water:

Health Issues

General Hygiene. This involves control of "black water," or water contaminated with human waste, human washing areas, including hand-washing stations and showers, and water from food processing in kitchen facilities. Given the large number of individuals in a confined school area, the control of biologically-contaminated water is a primary consideration.

New technologies for responding to "black water" may involve low-flow urinals and two-stage toilets. There have been experiments with waterless urinals, controls for showers integrating reduced water and increased water pressure. Significantly, the use of controlled storm water (gray water) as sewage water, as opposed to using potable water for toilets, has worked in some larger buildings. This conversion of light gray water can also be used for plant irrigation and some cleaning.

It may be helpful to comment on some of the concerns, along with a general warning that being on the leading/bleeding edge of new technologies, particularly involving issues of biologicals and water, can create problems. Water changes must be approached with caution. There have been problems with the use of some no-water urinals, but there has been a better track record with two-stage toilets and low-flow water urinals. Where these have been installed and maintained correctly they appear to be paying for themselves over time. Some Leadership in Energy and Environmental Design (LEEDS) Certified buildings have identified three to five year returns on investment for the two-stage toilets and low-flow urinals. The LEEDS Program for schools is part of an effort supported by the non-profit Green Building Council.

Regarding reduced water strategies for showers, we have concerns regarding **methicillin-resistant staphylococcus aureus** (MRSA). It has become clear that poor hygiene in locker rooms is the principal vector in terms of the spread of MRSA, a debilitating infection that primarily spreads among both male and female young adults, especially athletes. Reducing water flow relative to showering may, in fact, be counter-productive to personal hygiene with unacceptable consequences.* The replacement of showerheads needs to carefully take into consideration potential impact on hygiene and topical infections. Increased water pressure may be part of the solution.

Regarding other important water issues, the most significant increase in morbidity among students in the last decade has been the increase in asthma. Asthma is directly connected to ambient air hygiene, both at home and in schools. Moisture in ventilation systems and behind walls is the necessary component for infestation of insects and mold, and consequent asthma. Asthmatic reactions involve dust mites, dander, and establishment of molds and fungus in buildings, especially air handling systems, although a genetic predisposition is typically part of the asthmatic condition. A "commissioning" or third-party inspection of ventilation systems, including testing for moisture and seeking out and eliminating the source of moisture, is important to safeguarding the health of building occupants, especially in high human density buildings like schools.

Stagnant water, typically found in water pans near heating and ventilation systems can (rarely) relate to Legionella or other potentially toxic microbial growths and, under the right conditions, can integrate itself into the building and cause health problems.

Finally, promoting hand washing, particularly for elementary and middle school students, is critical. The use of disinfectants, soap and warm water, and most importantly, getting across the concept of hand/mouth contact for spreading disease is important.

Ingestion. For those schools using wells, it is well-established that there are sometimes base levels of pesticides/fertilizers in well water. Usually the amount and dosage is small enough so that it does not appear to represent a risk, but the monitoring of wells by local or state health departments is important and periodic testing of well water makes sense. Municipal water systems are typically well monitored by state and local public health departments.

Use of bottled water has become a salient issue in some districts. The limited public trust in "government" potable water has clearly contributed to the use of bottled water. On the other hand, the cost of shipping and storing bottled water is considered by many to be environmentally wasteful. This issue can become significant and has no clear technical resolutions.

The most logical consideration for the direct ingestion of water is to consider a filtration approach at the site of water ingestion. The same filtering process used in bottled water (with a 1,700% mark-up) can be implemented at reasonable cost by most districts with the establishment of water stations. If professionally treated, filtered water is important to occupants, relatively inexpensive water stations can be installed within the school building. Typically, municipal water can be relied upon to be potable and safe. Contamination within the building's plumbing system is a more likely concern and periodic (every five years) testing may make sense, even if the district is using municipal water sources.

Storm Water Run-off Controls. Storm water and run-off controls are a significant issue for school districts. There are a number of established engineering controls involving porous surfaces within parking lots, rain gardens, or other civil engineering mechanisms designed to avoid contaminated surface water from infiltrating and damaging ecosystems. However, it is important to note that these rain gardens and other options are fairly new and best practices have not yet been established. There have been significant expenditures by school districts in failed rain garden systems and, in some cases, consequent litigation. The design, implementation and maintenance of rain gardens and other civil engineering storm water controls are sometimes codified in statute or regulation and should be seriously considered by districts as an opportunity for financial support in upgrading facilities. The design, implementation and maintenance of rain gardens need to be carefully thought out and plans should always be made in conjunction with local water planning authorities. It is important to note that the implementation of rain gardens may open up a reduction in a school district's cost for impervious surfaces, even as reduced use of potable water will reduce the water bill.

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There has been some unpublished research indicating that the quality of the shower, the body soap used, and especially the segregation of towels so towels are not shared among students, reduces risk of spreading the MRSA infection.

A Summary of Water and the Human Condition

If you took the earth and "skinned it," peeling off its outer layer from the top of Mount Everest to the deepest portion of the ocean, that "skin" would be proportionally similar to two thick coats of latex paint on a basketball. If you stretched that skin out, ground it down and let it sit for a few thousand years, about two-thirds of the mass would rise to the top as water, and 95% of the water would separate out as salinated mineral salts, i.e. salt water. Oddly enough, if you did the same thing to yourself, i.e. ground yourself up and separated liquid from solid, you would also settle out at about the same ratio of water to dehydrated tissue. We are all a little under two-thirds liquid. When you were a baby, you had a little higher ratio of water to tissue, but as you get older, the amount decreases slightly. That ratio does not hold for most life forms. A potato is 80% water, a tomato is 95% water, and a cow is around 75% water.

There is a reason why the chemical "water" connects with people's sensitive side and often represents a sense of serenity or security. We come into existence surrounded by water, we remain mostly water, and our health and quality of life as individuals and as a society relates to our relationship to water. When that relationship fails, people and societies fail; when it works, people and societies thrive.

Water acts different than just about any other liquid. The rule of thumb in chemical engineering is that when any liquid is chilled, it will contract (get smaller), up to something in the area of 10%. Water actually does the same thing, contracting as it gets colder, down to a certain point, although once it gets within freezing range, it greatly expands. Essentially, the consistently vibrant motion of H20 is frozen in motion and consequently takes up more space.

Water is vital to life and if it is not constantly replenished, the human body quickly falls apart. Within a few days without water, portions of the body – the nose, mouth, lips and eyes – will wither and die. The water we ingest has to be what we call "fresh" or "clean." Ninety-seven percent of the water on earth is poisonous to us; it has been blended over almost four billion years with enough minerals so it has become "salty" or brackish. Humans need salt, but only a small amount. Seawater contains over 50 times more salt than can be safely metabolized by our organs, sometimes up to 75% more. We can't survive on saltwater – it's lethal. If there is too much salt exposure, the blood will carry salt to the kidneys, which quickly become overloaded and shut down. That is why the water we need must be evaporated out of mineralized "salt water" and reintroduced through precipitation into places where we can get at it. This involves surface water, such as rivers and lakes and underground aquifers where freshwater is stored. These potentially clean water sources are recharged periodically through rain, hail and snow as cleansed water drops from the sky. If we contaminate clean water with sewage or chemicals or pull more water out of aquifers than is being recharged, we have serious problems.

When one studies water and human need, one soon learns that the earth has plenty of "water." There are over 300,000,000 cubic miles of water on earth. That amount almost never changes. It is virtually impossible to destroy water. There was a certain amount on the planet well before life began and essentially that same water exists today. There is presently around 366,000,000 gallons of water for every person on earth, but we still have a risky relationship to water.

From the human perspective, most water winds up in the wrong place or in the wrong form to be helpful. Clean water becomes loaded with salt, freezes or becomes "polluted" and is consequently pulled out of the freshwater bank of clean, wholesome water that is necessary for human life. As our population and drive for consumption expands, clean water in the right place becomes a huge human challenge. Getting the right kind of water to the right place and controlling toxic water become primary human endeavors and the ability to work that vital rhythm is directly connected to the success or failure of human societies. Nations have and will rise and fall in their ability to work with water.

On the planet, only 3%+ of the water actually is fresh and not loaded with toxic mineral salts. The vast majority of that freshwater is loaded in ice sheets, and almost all of that (90%) is located at the South Pole or Antarctica. Antarctica is essentially a low moisture desert, but when there is precipitation in Antarctica, it simply stays. Occasionally, ice cleaves off the Antarctic mainland and, with climate changes, increased freshwater is entering earth's oceans. Antarctica has a huge amount of valuable freshwater, yet, it is arguably the most inaccessible place on earth.

Only a small percentage of the earth's water is in lakes, rivers, reservoirs, or the air (clouds) and is non-toxic, non-ice, or inaccessible. Still, we have over 12 million gallons of potentially freshwater per person. The problem, and it is of crisis proportion, is that the needed water is often both in the wrong place and subject to geometrically expanding human need and toxic contamination. The contamination is usually closest to where the human need is greatest.

The problem stems from the increase in human population, consumption trends, our enhanced tendency to contaminate, and a potential to draw our best water from aquifers faster than they recharge.

We need a world that recognizes our risky relationship with the earth's water and is focused on solutions. ■

Reuse of Roofing System Soft Water

An example of a future potential water control option for a school facility.

When we begin looking at the way a school district can best approach water controls, one of the calculations that may be helpful is to identify the amount of roof surface run-off and find ways to use it to advantage. The alternative is to run it through the typical storm water system, where it becomes part of the problem of freshwater contamination.

While run-off from parking lots and athletic fields or maintained green areas may also be considered "gray water run-off," the roof run-off is many times cleaner and typically has no major toxic burdens. Roof water can be treated through a filter and with ultraviolet radiation, and then safely introduced for both toilets and internal cleaning, but not used for potable purposes. It is naturally "soft" and is unlikely to scale or calcify plumbing and in many ways is superior to municipal treated water for plumbing and cleaning. It is also obviously cheaper.

You can assume that between eight and nine thousand gallons of water per thousand square feet of roof is deposited on a Minnesota school roof per year. This water can be captured, stored, and used. Depending upon the present or future potable water cost in your community and the estimated cost of plumbing, underground or above ground storage and energy costs for independent pumping and ultraviolet treatment of the water, there could be a favorable cost balance over time. You would be saving money by not using and paying for potable water for non-potable purposes, ecologically reducing the draw on our limited potable water supplies, and reducing storm water run-off, possibly reducing impervious surface fees to the school district.

The ultraviolet treatment process is compact and straightforward, although there are energy costs.

Putting this all together is new and there is ambiguity with anything new.

Use of non-potable water for washing or even for human waste control, i.e. black water, may represent some community concerns. Also, people often confuse ultraviolet radiation with potentially hazardous ionizing radiation. Public perception and thoughtful cost estimates are important considerations in configuring internal use of roofing system run-off.

Typically, the roof run-off for non-potable use involves water run-off being stored underground, treated with filters and ultraviolet decontamination, and then pumped into higher areas, so gravimetrically, it can be used for flushing toilets, watering plants, cleaning building surfaces, etc.

Such procedures for decontamination and to replace the use of potable water with snow melt or rainwater do not apply to storm water that has gone through parking lots or green spaces, which would introduce fertilizer, pesticides and a heavy burden of suspended particles (dark gray water).

Mechanisms for temperature exchange relative to storm water have been successfully implemented and they appear to have great promise in terms of being financially viable in energy savings. Essentially, storm water is maintained in a contained area deep enough (15 feet) so it will not freeze, and chemicals are pumped through the sitting storm water under the ice in the winter. Essentially, the process involves "squeezing heat" out of dark gray pond water or capturing cold underwater temperatures for summer building cooling. The process involves pressurization and heat exchange.

The approach school facilities take in dealing with water that will be responsive to quality ecology and cost effectiveness will likely evolve over the next few years as potable water and non-potable water disposal become more costly and new technologies become less expensive. ■

A Living Water Ecology Project for Schools

In 2006, Hamline University, Minnesota's oldest post-secondary higher education institution, piloted a water ecology program involving students, educators, and others working with local water control authorities and civil engineers to control the school's storm water contamination potential and provide a remarkable water ecology education experience.

It worked.

A Geotechnical Engineer working with 4th grade students to plan storm water controls at St. Paul's Hancock Elementary School. The students wanted a dry playground and to stop contaminating surface water.

Hancock Elementary School was constructed pre-World War II in the old style of educational buildings. It had high windows, high ceilings, thick walls, and a small multi-story footprint. It was replaced with the new, environmentally insensitive, post-war school construction style building. It had a large, impervious parking lot, a huge flat roof, and an increased ecological footprint. Without complementary civil engineering alterations, the playground area flooded consistently and produced extensive run-off. The students were often denied the use of their playground and the extensive surface water generated was contaminated with fertilizer, pesticides, and road salt from the huge new property footprint.

Hamline's Center for Global Environmental Education (CGEE) financed an effort, under the direction of Peggy Knapp, Assistant Professor at the Hamline School of Education, to bring together concerned students, educators, school facility managers, local water planners, and a number of other local groups to work as a team to "fix" the storm water problems and to learn and model from the fix.

The 4th grade students came to understand not only the relevant engineering criteria, but the long-term eco-impact of responsible controls for storm water. Those involved in professional water planning also learned from faculty, students, and educators regarding what would enhance the school property and the school experience as they designed the controls.

We believe that the project proved that wisely responding to school property water concerns can become a living part of a school's life, motivating students toward finding responsible environmental solutions. ■

Minnesota's First Wetland

In 1972, the Federal Clean Water Act was passed and the State of Minnesota's response, probably in part to clarify response to the federal act, was the Minnesota Environmental Rights Act.

Minnesota's first "wetland" and use of the Minnesota Environmental Rights Act to protect water involved a farmer, Bill Bryson (near Albert Lea), who wanted to preserve a wetland he owned from being bisected under eminent domain for a road project undertaken by Freeborn County.

After a long and emotional conflict involving both the local water authority and an attorney, Charles Dayton, who at the time was working with an environmental group associated with Ralph Nader, the matter wound up in the Minnesota Supreme Court.

The court action involved a team of attorneys, engineers, and the judge travelling to actually see the wetland. They were struck by the beauty of the property and were enchanted by the opportunistic landing of a number of ducks and the general presence of wildlife. They supposedly were impacted by both the beauty of the wetland and the obvious role it had in the ecology of the area.

The Minnesota Supreme Court eventually found that the land should be protected under the Act, overruling lower courts. The Justices wrote the following as part of their finding:

> **To some of our citizens, a swamp or marshland is physically unattractive, an inconvenience to cross by foot and an obstacle to road construction or improvement… It is (also) quiet and peaceful—the most ancient of cathedrals—antedating the oldest of manmade structures. More than that, it acts as nature's sponge, holding heavy moisture to prevent flooding during heavy rain falls and slowly releasing the moisture and maintaining the water tables during dry cycles.**
>
> **In short, marshes and swamps are something to preserve and protect.**
>
> **—Minnesota Supreme Court**

Minnesota had its first legally protected "wetland."

The action was not supported by local water authorities nor the community. Below is a sample of one of many letters that Mr. Bryson and his wife received:

Mr. William Bryson:

What do you mean by spending the taxpayers money on a dam old slough. Now this is a threat. Drop this whole matter or there will be a quick fire at your place soon. You won't even know it until it is out of control. We mean business. This sure stinks . . . (some expletives).

(Signed)

Taxpayers

The 2010 Legacy Act Legislation again includes a legislative intent to provide funding for school facilities to develop water ecology programs (especially rain gardens to control run-off), and again, the school facility language is suggested, not mandated. It is probable that support from local political leaders and local water agencies will be important in school districts reducing surface water contamination and developing water programs through the Legacy Act. ■