

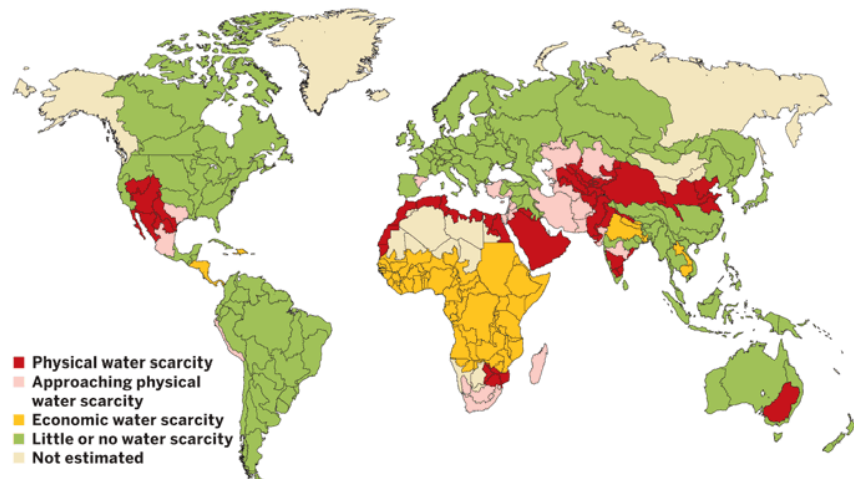
First International Congress on Sustainability Science and Engineering (ICOSSE)



Design Tools For Sustainable Water Transmission and Distribution

Carol Miller and Shawn McElmurry
Department of Civil & Environmental Engineering
Wayne State University

WATERWORLD Areas of physical and economic water scarcity

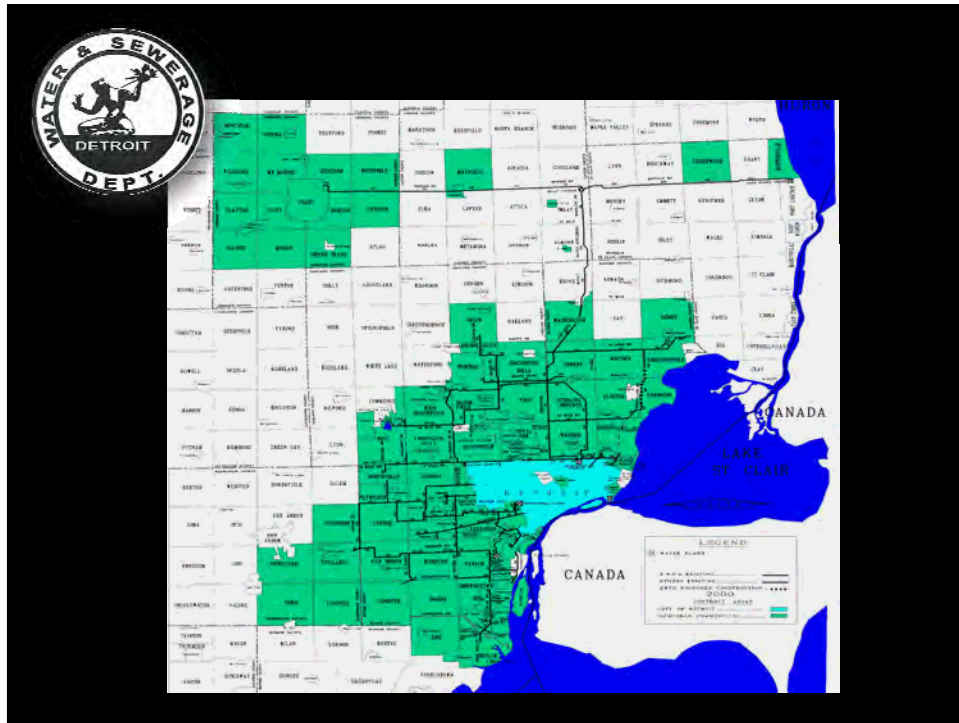


NOTE: When more than 75% of a region's river flows are withdrawn for agriculture, industry, and domestic purposes, it suffers from physical water scarcity. Economic water scarcity is when human, institutional, and financial capital limit access to water, even where water is available locally. **SOURCE:** Comprehensive Assessment of Water Management in Agriculture, 2007



Energy Management AWWARF, 2005

*Energy use at drinking water utilities represents one of the utilities' largest operating costs, consuming as much as **35 percent of annual operating budgets**....energy use is expected to increase...with implementation of new treatment processes....*

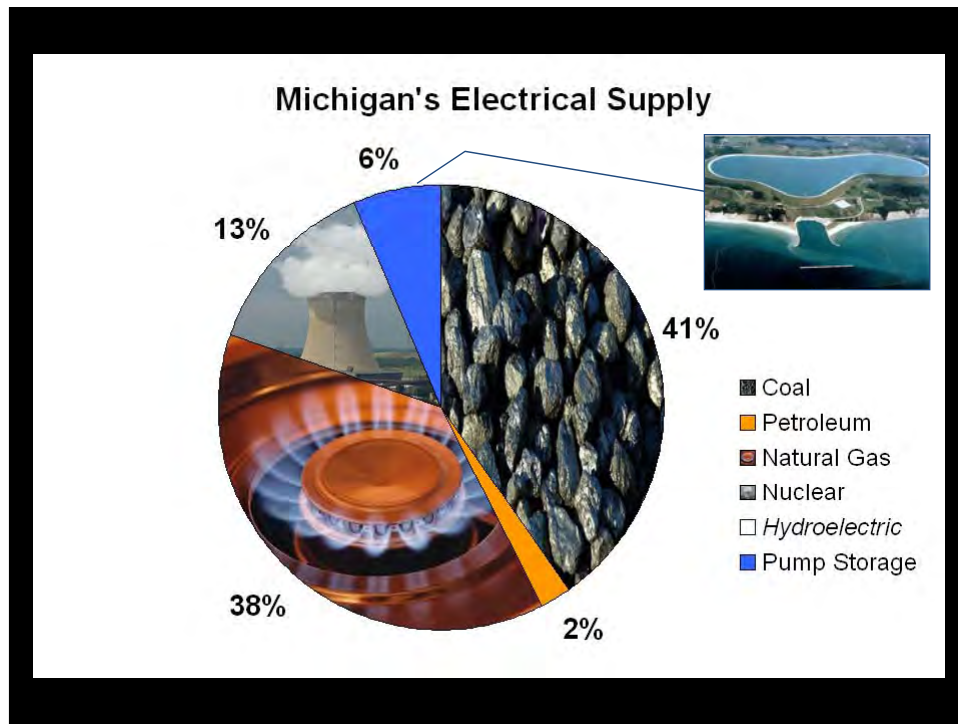


DWSD

Third largest energy customer of DTE

Annual water withdrawal from Lake Huron and Detroit River of 220 billion gallons

~300 Million KW-Hours of electricity annually by high- and low-lift pumps



Contaminant loading to Great Lakes basin

DWSD energy (US DOE, 2002)

- 475 M lbs. carbon dioxide
- 4,400 lbs. methane
- 7,500 lbs. nitrous oxide
- 2 M lbs. sulfur dioxide

Coal-fired electrical plants account:

16 of the top 25 sources of Lake Michigan mercury pollution (Johnson, 2005)

90% of toxic loadings to Great Lakes (GLIN, 2008)

Real-Time System Optimization for Sustainable Water Transmission and Distribution



Tucker, Young, Jackson, Tull, Inc.
Consulting Engineers

Optimization Parameter

Cost



Energy Consumed

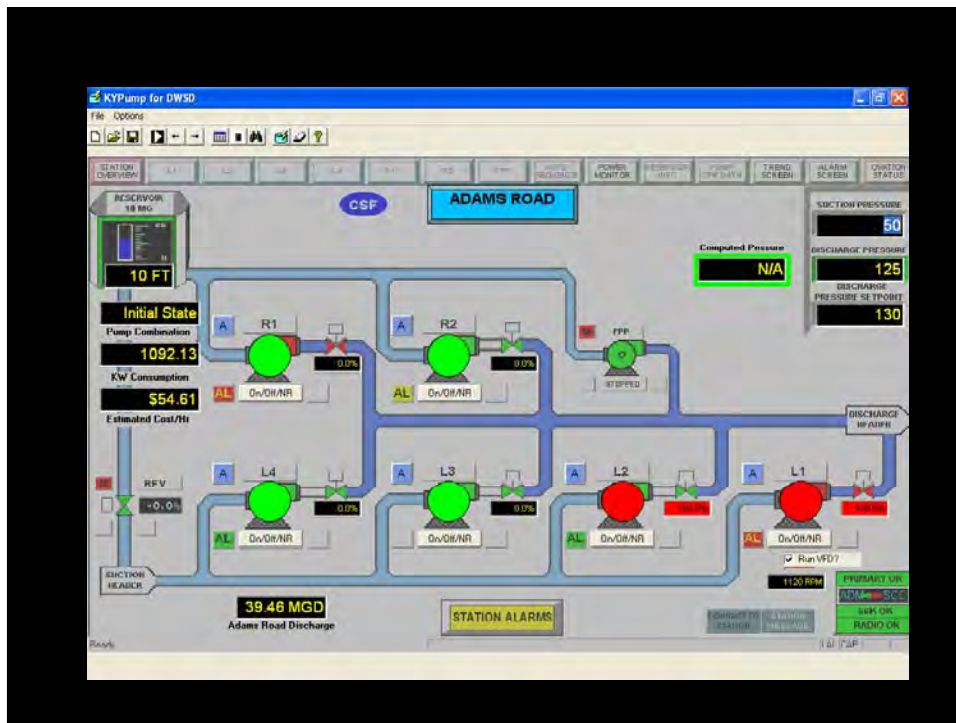
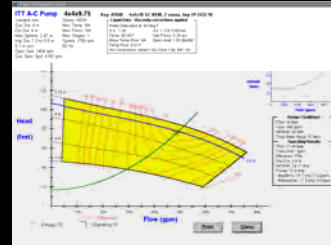


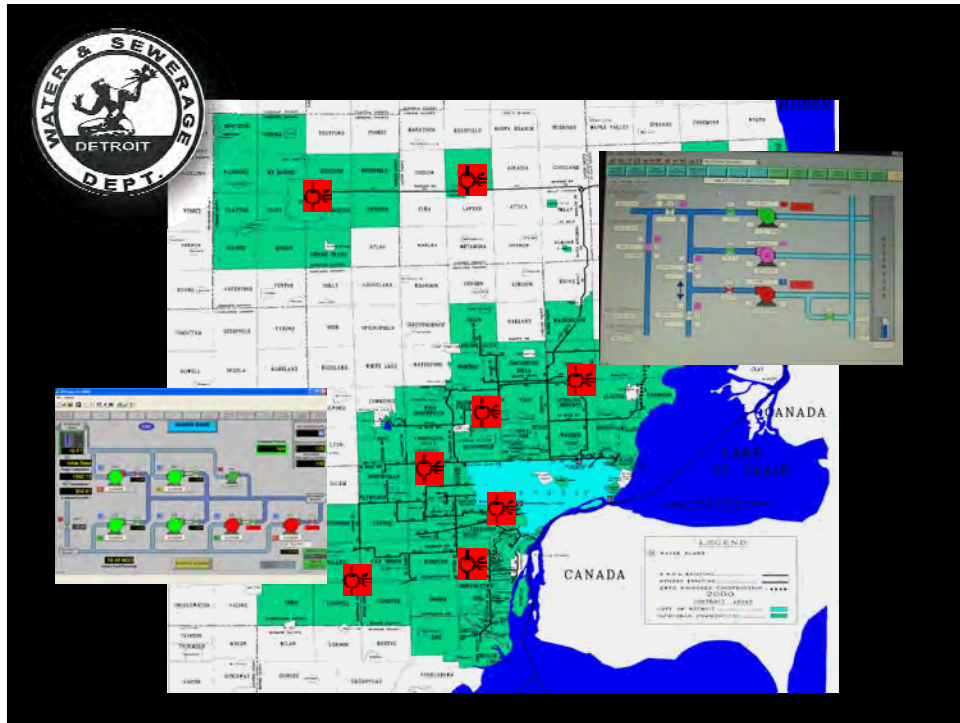
Environmental Benefit



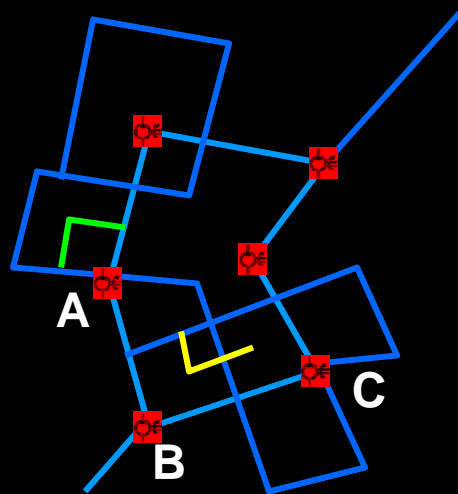
Previous Optimization

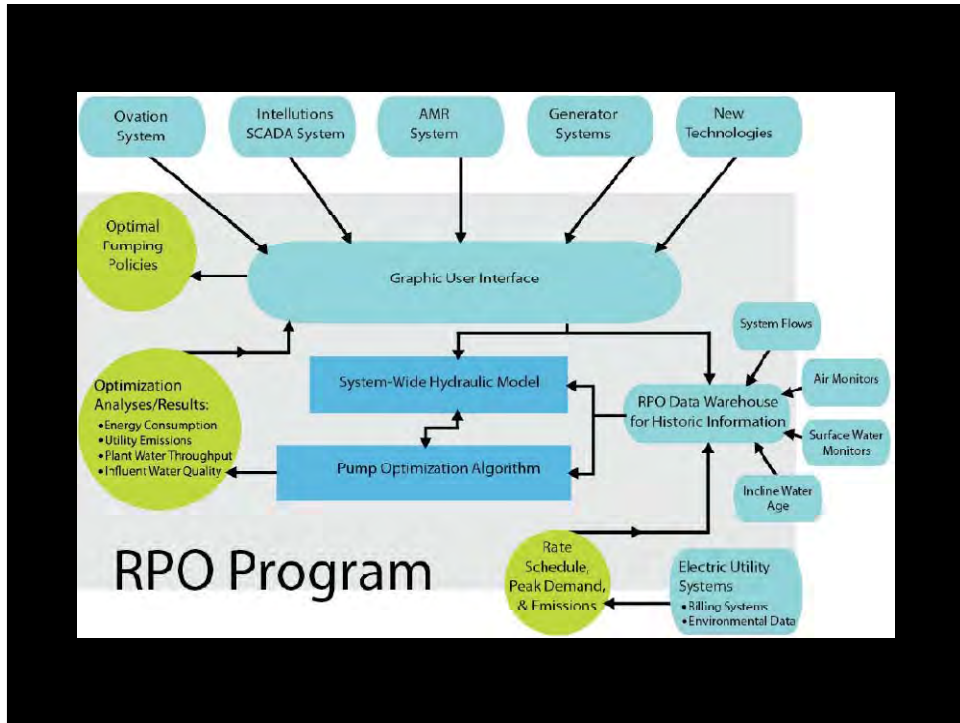
- Developed a computer program and guidelines for operators to **optimize pump** operations
- Provided SCC operators with the ability to **minimize energy** use by selecting energy efficient pump operations to reliably meet system demands





Hypothetical Pumping Network:





Hydraulic Model: EPANet

The screenshot shows the EPANet software interface. On the left is a web browser window displaying the 'Drinking Water Research' website, which includes a description of EPANet as 'Software That Models the Hydraulic and Water Quality Behavior of Water Distribution Piping Systems'. The main window shows a 'Network Map' with a complex network of pipes and nodes. A legend on the left indicates pipe diameters (18 in, 24 in, 30 in, 36 in, 42 in, 48 in, 54 in, 60 in, 66 in, 72 in, 78 in, 84 in, 90 in, 96 in, 102 in, 108 in, 114 in, 120 in, 126 in, 132 in, 138 in, 144 in, 150 in, 156 in, 162 in, 168 in, 174 in, 180 in, 186 in, 192 in, 198 in, 204 in, 210 in, 216 in, 222 in, 228 in, 234 in, 240 in, 246 in, 252 in, 258 in, 264 in, 270 in, 276 in, 282 in, 288 in, 294 in, 300 in, 306 in, 312 in, 318 in, 324 in, 330 in, 336 in, 342 in, 348 in, 354 in, 360 in, 366 in, 372 in, 378 in, 384 in, 390 in, 396 in, 402 in, 408 in, 414 in, 420 in, 426 in, 432 in, 438 in, 444 in, 450 in, 456 in, 462 in, 468 in, 474 in, 480 in, 486 in, 492 in, 498 in, 504 in, 510 in, 516 in, 522 in, 528 in, 534 in, 540 in, 546 in, 552 in, 558 in, 564 in, 570 in, 576 in, 582 in, 588 in, 594 in, 600 in, 606 in, 612 in, 618 in, 624 in, 630 in, 636 in, 642 in, 648 in, 654 in, 660 in, 666 in, 672 in, 678 in, 684 in, 690 in, 696 in, 702 in, 708 in, 714 in, 720 in, 726 in, 732 in, 738 in, 744 in, 750 in, 756 in, 762 in, 768 in, 774 in, 780 in, 786 in, 792 in, 798 in, 804 in, 810 in, 816 in, 822 in, 828 in, 834 in, 840 in, 846 in, 852 in, 858 in, 864 in, 870 in, 876 in, 882 in, 888 in, 894 in, 900 in, 906 in, 912 in, 918 in, 924 in, 930 in, 936 in, 942 in, 948 in, 954 in, 960 in, 966 in, 972 in, 978 in, 984 in, 990 in, 996 in, 1000 in). The interface also shows a 'Status' window and a 'Time' window.

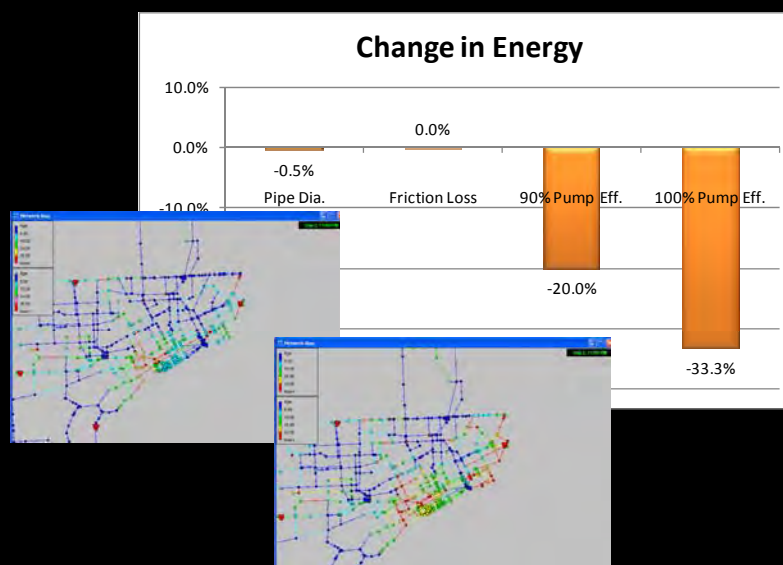
Example Scenario Modeling



Scenarios:

1. Current System
2. Increase Pipe Diameter (<54" to 72")
3. Eliminate Friction Losses
4. Increase Pump Efficiency (90%)
5. Increase Pump Efficiency (100%)

Scenario Modeling



Scenario Modeling Environmental Benefit

For **every 5% reduction** in energy:

- 50 lbs Pb managed (0.5 lbs – air)
- 1.17 lbs Hg managed (0.85 lbs – air)
- 47.5 lbs As managed (46 lbs – land)
- 4,487 lbs Ba managed (4,467 lbs – land)
- 0.13 lbs PAHs (0.12 lbs – land)
- ~25 Million lbs CO₂ emitted
- ~40,000 lbs NO_x emitted
- 115,000 lbs SO_x emitted

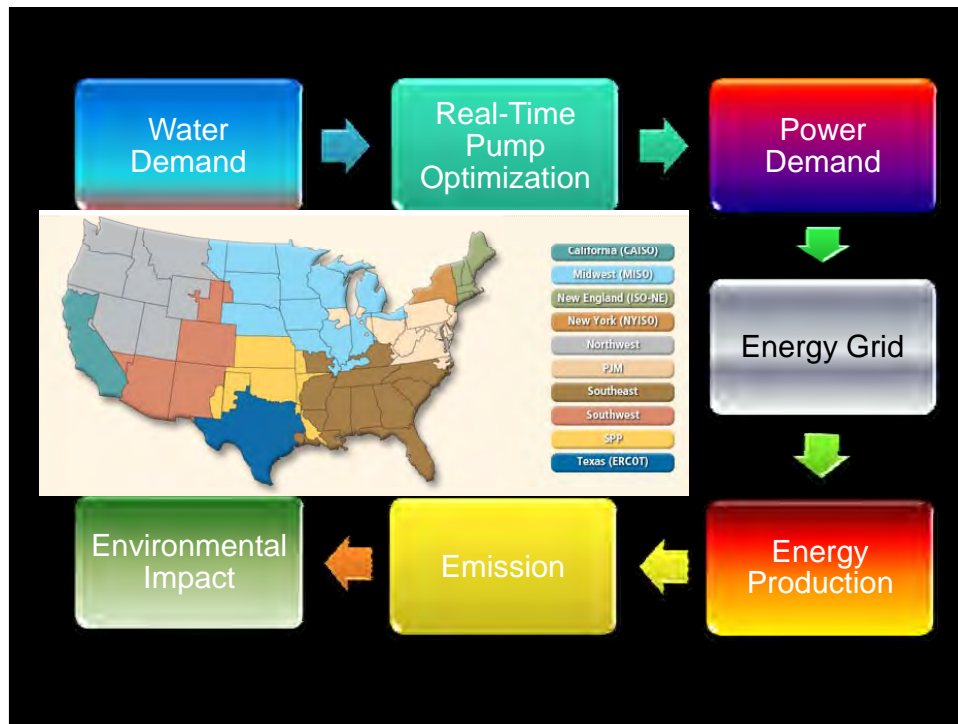


Challenges

1. Operator Control



2. Multi-Utility Collaboration



The New York Times

Web-Enabled Smart Grids

Clay Risen

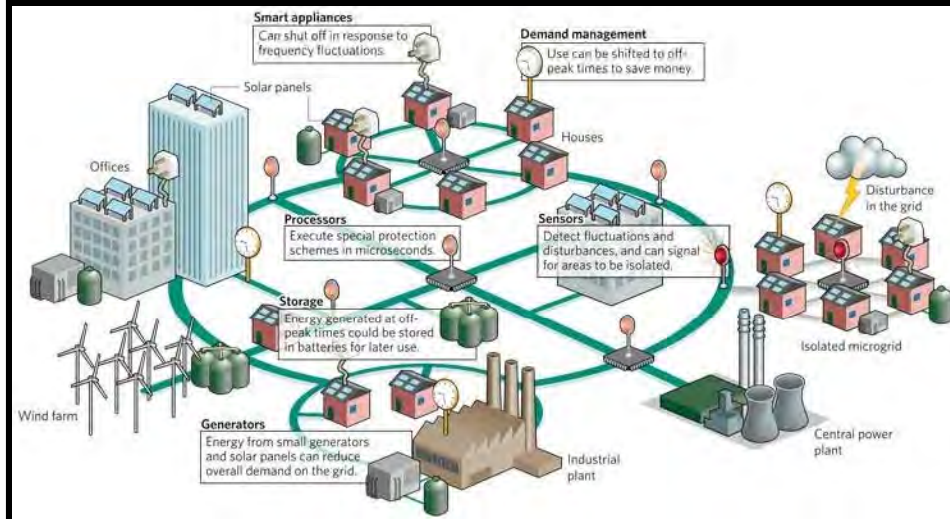
December 12, 2008

Xcel Energy of "plans to build the country's first city-scale 'smart grid' is "a response to what economists would call a tragedy of the commons: people use as much energy as they are willing to pay for, without giving any thought to how their use affects the overall amount of energy available."

Because "there's no way to monitor power use once it leaves the station -- utilities error on the side of oversupply, which wastes energy and harms the environment."

But, "Xcel's \$100 million initiative, called *Smart Grid City*," is "a set of technologies that give both energy providers and their customers more control over power consumption. It relies on a network of fiber-optic cables, high-tech meters, and sensor-laden transformers to provide power stations with **real-time data on demand all along the grid**, allowing them to fine-tune the electrical supply, detect failing equipment, and predict overloads." A "Web-enabled control panel in their homes" allows consumers "to regulate their energy consumption more closely -- for example, setting their AC system to automatically reduce power use during peak hours."

Integrated Grid (*Smart Grid*)



Source: Energy: Upgrading the grid, *Nature*, vol. 454, pp. 570-573, 2008

Beyond the Obvious



- H₂O Pricing Strategies
- The **New** Economy
 - Taking Advantage of Existing Infrastructure





**Great Lakes
Protection Fund**

Ideas in Action





Tucker, Young, Jackson, Tull, Inc.
Consulting Engineers