Ingham County, MI
A Story of Suppression
Part 1:
The Story of Water Resources At Work

PEER

ABOUT PEER

Public Employees for Environmental Responsibility (PEER) is an association of resource managers, scientists, biologists, law enforcement officials and other government professionals committed to upholding the public trust through responsible management of the nation=s environment and natural resources.

PEER advocates sustainable management of public resources, promotes enforcement of environmental protection laws, and seeks to be a catalyst for supporting professional integrity and promoting environmental ethics in government agencies.

PEER provides public employees committed to ecologically responsible management with a credible voice for expressing their concerns.

PEER=s objectives are to:

1. Organize a strong base of support among employees with local, state and federal resource management agencies;
2. Monitor land management and environmental protection agencies;
3. Inform policymakers and the public about substantive issues of concern to PEER members; and
4. Defend and strengthen the legal rights of public employees who speak out about issues of environmental management.

PEER recognizes the invaluable role that government employees play as defenders of the environment and stewards of our natural resources. PEER supports resource professionals who advocate environmental protection in a responsible, professional manner.

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About This Report

In early 2001, PEER was first approached by a number of Ingham County employees to discuss the suppression of a number of reports assessing the overall environmental health of the county and its residents.

A team of people involved with county health issues conducted an extensive analysis of a variety of public health issues. The information they uncovered details past inaction by the county and state officials that have left serious environmental health problems unaddressed. However, after investing hundreds of thousands dollars in the report, the county, fearing negative public backlash, blocked the release of all the reports and issued one brochure covering a single topic — water.

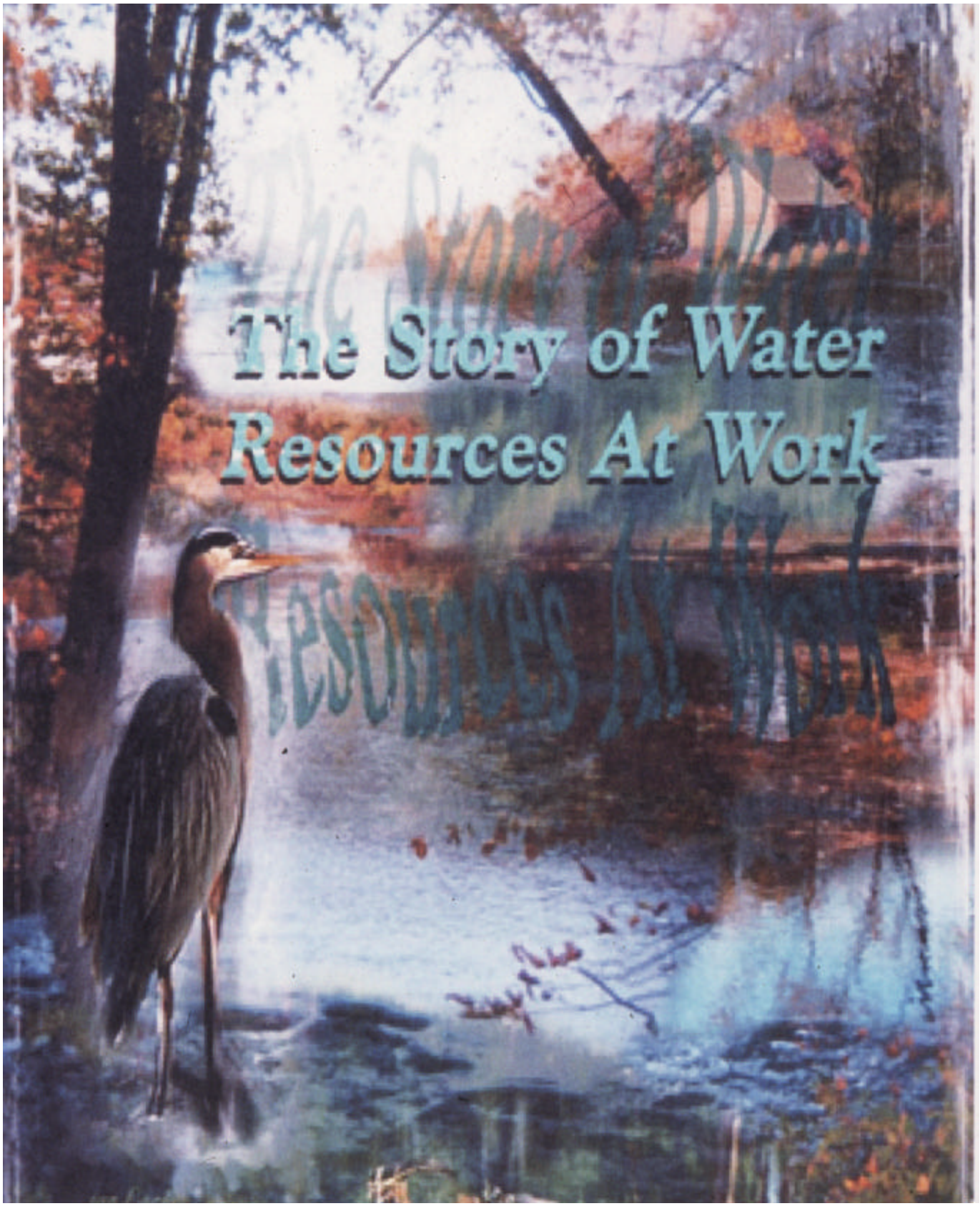
This first report, *Ingham County: The Story of WaterResources at Work*— released by PEER today— is the complete version of a report compiled by a team of public health scientists initiated by the Ingham County Health Department. The Department chose to cull much of the most important information that citizens can use to inform themselves about the potential hazards lurking in Ingham County's water—drinking water, surface water (lakes and rivers), and aquifers. The report has been fact-checked, but is not entirely finished. Therefore, some parts are incomplete.

PEER offers this suppressed report to the Ingham County community as a contribution to improve local public health.

To avoid distracting from the message and avoid the prospect of future retaliation, the authors have chosen to remain anonymous. The authors also believe that the facts presented herein speak for themselves.

PEER is proud to assist conscientious public servants who have dedicated their careers to the protection of our natural resources and to faithful execution of the laws.

Jeff Ruch
PEER Executive Director


The Story of Water
Resources At Work

I n g h a m C o u n t y M i c h i g a n

Final Draft (August 10, 2000)

This publication is intended to describe the condition of Ingham County's water.

All of its water.

Purpose of this Report

We include what can be seen: the rivers, streams, wetlands and lakes.

And what we cannot see: the deep groundwater that serves our drinking water needs every day. We hope to help you better understand the drinking and surface waters in your local environment, be it, for example, rural (Webberville), urban (Lansing) or suburban (Okemos).

The work is divided into two parts. Part One describes the state of your drinking water (and the groundwater from which it comes). Part 2 describes the state of our surface water (our rivers, lakes, wetlands and streams.)

This report is a first step towards a better understanding and appreciation of our environmental health. It is part of a new effort on the part of local government to support the community's right to know about important environmental health issues, to better educate everyone about these issues, and to establish working partnerships throughout the community. The second step is community action! We invite all readers to contact us if they are interested in becoming involved.

Who We Are

The Ingham County Environmental Health Roundtable is a collection of 12 individuals who are knowledgeable and experienced in environmental health issues. The group includes 4 representatives from Michigan State University, 3 from the Ingham County Health Department, 2 from Public Sector Consultants, one from the Michigan Department of Environmental Quality, a medical doctor and a representative from the Michigan Environmental Council. For a list of our names and titles refer to the back cover. We refuse to call ourselves "experts," since the terrain of environmental health is vast and fraught with many uncertainties. As one ventures into the nitty gritty details of a topic, one cannot avoid confronting issues of politics, ideology and culture. Simply put, while environmental researchers can often provide a great deal of information about a given issue, we are not in a position to make decisions that require an open democratic process. We offer this report to the community to spur debate around water-related issues.

Bathers Enjoying Lake Lansing, Spring, 2001.

Our Overall Mission

Ultimately we seek to improve the environmental health of Ingham County. Our approach has three phases. In Phase one, nearly completed, we investigate and report on the most significant environmental health issues in Ingham County. This study on water will be followed by others until we complete the overall assessment. In Phase 2, the assessment will be used by the community through vehicles such as community action panels, citizen groups that will share the unique perspectives of various constituencies (e.g. urban, rural, agriculture, industry, real estate, government) in an effort to help us all identify and prioritize the areas requiring active intervention. We fully expect

community groups to improve or correct the information presented in our reports, and to tell us much more about the specific environmental issues in their neighborhoods or social groups. In Phase three we will support interventions in one or two environmental areas and seek improvement.

Public Hearing Process Not Very Effective

One reason that we have elected to conduct this public campaign is because of the general failure of the public hearing process. The case of combined sewer overflows offers a good example. After a series of public hearings from 1994-97 only about 10% of thirty-five stakeholder groups that were interviewed knew what the project was about. According to Dr. Scott Witter, who led the project, ninety percent of respondents said that the first time they had heard about the almost $200 million project was when they received a bill. Of these less than 10% knew what a combined sewer overflow was or why they should be concerned. If only special interest groups participate in the public hearing process, the entire community loses.

COMMUNITY RIGHT TO KNOW: TRADITIONAL RISK ASSESSMENT AND THE PRECAUTIONARY PRINCIPLE; SOMETHING NEW IN PUBLIC HEALTH COMMUNICATION

There are the 2 major schools of thought on how to communicate with the public. One school, ***traditional risk assessment***, holds the view that communication should be based on scientific methods to best define the risk, whether it be a procedure, scenario or event. According to Michael Allen, toxicologist for the Ingham County Environmental Health department, "traditional risk assessment has been largely reductionist, i.e. it looks at one chemical at a time. It also places the burden of proof on showing the potential of harm." The risk assessment approach is strengthened when scientists can present hard evidence of proven health effects (injury, disease or death) associated with an exposure. The other view, ***the precautionary principle***, abides by the ethic of "community right to know. " According to Allen, "it essentially states the proposition that the more serious the threat (health, economic, cultural) the more willing society (and legislation) should be to limit the change or event until proven safe." It holds that citizens should be informed about known or suspected environmental risks, even those that are unproven, so that alternative strategies can be developed to remove the toxin from the environment.

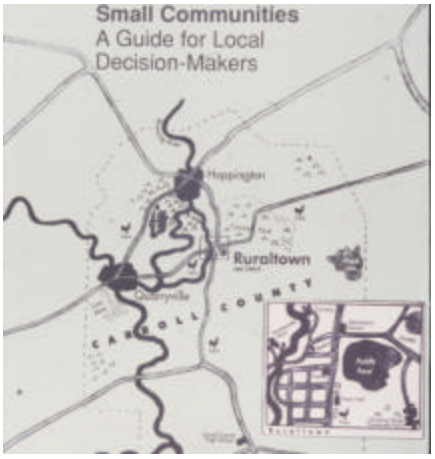
Traditional risk assessment is the strongest component to the U.S. approach to chemical exposures. In contrast, the precautionary principle is more widely used in European countries. It was included in the Rio Declaration on Environment and Development in 1992. Principle 15 stated, "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation."

The Tranquil Red Cedar River at MSU.

The precautionary principle does not avoid traditional risk assessment but is a method of dealing with risk

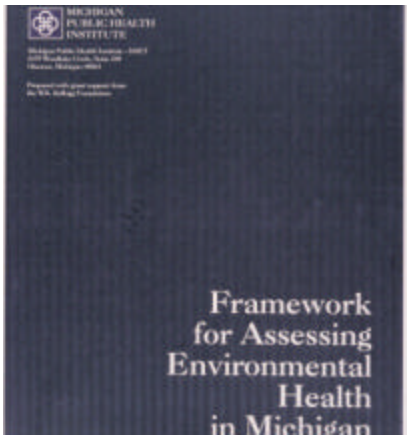
assessment uncertainties. It is more holistic than the traditional risk assessment and places the burden of proof on proving the event safe.

Our assessment team has representatives from both perspectives, meaning that the debate and writing of this document proved vigorous, even heated, at times. We assume that there is middle ground between these two camps and so have sought to integrate these two approaches where possible.



The EPA is encouraging communities to study their local environments.

In 1998 the Michigan Public Health Institute produced a guide to improve community right to know.



ENVIRONMENTAL HEALTH IS ABOUT DISEASE PREVENTION, BUT IS ALSO ABOUT OUR QUALITY OF LIFE

Unlike the 1984 Union Carbide disaster in Bhopal, which resulted in thousands of deaths in a short period of time, environmental health in the U.S. is more often linked with very-long term, more ambiguous, chronic health outcomes. For example, the Environmental Protection Agency (EPA) estimates that secondhand environmental tobacco smoke causes 3,000 deaths, but it is nearly impossible to make a linkage between a specific indoor exposure and a specific case of lung cancer. Thus the oft heard refrain, stated by one DEQ official, frustrated about losing funding for his program, (leaking underground gasoline tanks which have produced no known deaths in Ingham County), ***"but where are the [dead] bodies?"*** That is one reason why the World Health Organization and others (like the Ingham County Environmental Health Roundtable) have decided to make "quality of life" issues a fundamental part of environmental health assessment. This approach invites social scientists and other researchers onto the assessment team, including sociologists, anthropologists and journalists, who often write the first draft of a community's environmental history.

This means that we take seriously how people feel about their local environment. What is the quality of life in a certain area of Ingham County? Does a person's anxiety about a nearby pollution site (e.g. Motor Wheel) warrant investigation by social scientists? Shouldn't the entire community be informed about known or suspected pollution sites? Shouldn't we share neighborhood perceptions about a feared "threat" with the entire community (or should people worry in isolation)? Shouldn't so-called "environmental experts" be frank about topical areas in

which their knowledge is limited? And shouldn't every environmental issue involve citizen participation in resolution of the problem? We believe that the answer is yes to the above questions. As such, this document represents a new and exciting approach to addressing environmental issues. We hope you will join in the process.

THE AUDIENCE

This report is written primarily for the educated layperson, to inspire you to become involved in water-related issues in your neighborhood. One strength of this document is that it synthesizes a wide range of water-related data and thus spurs citizens to think about their communities in a new light.

HOW TO READ THIS PUBLICATION

In this hectic age of the 7 second sound bite, people sometimes want to get the main information fast. If that is you, you can grasp the important points in about 3 minutes. First read the summary of findings to review the main points. Secondly, review the centerfold (this should inspire you to want to read more about a specific item) [Ed. Note #1: the Centerfold was unavailable for this publication.] And third, scan the table of contents for a reference to your neighborhood or to an issue that interests you. Of course, the best way to read this is to leaf through it page by page in an easy chair while drinking a glass of water (from the Saginaw Aquifer)!

A word about the style of writing. The story is written to be read easily and it therefore adopts a colloquial or conversational tone.

Canadian geese and their offspring rummage across an Ingham County wetland up for sale.

EXECUTIVE SUMMARY

The fact that polluted water kills about 4 million people worldwide each year seems like a far off tragedy to most U.S. citizens. We have one of the safest water supplies in the world. But there are reasons we shouldn't be complacent.

Water supplies have several built-in safeguards but dangers still exist. The 1993 cryptosporidium outbreak in Milwaukee, Wisconsin killed 100 people and sickened 350,000. As recently as June 7, 2000 a 16-inch underground gasoline pipeline ruptured, spilling about 75,000 gallons of gasoline in Jackson County, Michigan. Four hundred private well owners were told not to drink their water. Three couples brought a $ 1 billion federal class action lawsuit against the Wolverine Pipeline Company, saying their land was destroyed.

Thanks to the Clean Water Act of 1972, nearly 70% of the nation's rivers and lakes are now safe for fishing and swimming, compared to about 35 percent in 1970. Every year a billion tons of toxic chemicals that were once dumped down the drain are now removed from wastewater. Industries still dump toxins down our sewers, but most now pre-treat their waste, lowering pollutant levels. Locally, thanks to 232 pre-treatment programs at Lansing's industrial facilities and upgrades in our wastewater plants, we are definitely moving in the right direction.

But there are disturbing trends. Simply put, there has been a decline in watershed protection for our rivers, lakes and aquifers. Everyone, it seems, wants to live next to a river or lake, but not everyone cares to know about how to prevent pollution from entering the water. When Lake Lansing's beaches were closed because of high bacteria counts on July 4, 1994 a resulting investigation revealed that there were 12 previously unknown inlets discharging pollutants into the lake. In the Red Cedar River watershed, the Ingham County Soil Conservation District estimates that about 65% of farmers are not doing a good job of preventing water pollution. And some powerful corporations, like W.R. Grace at the Motor Wheel Superfund site in Lansing, choose to litigate rather than repair contamination in the aquifer, the source of our drinking water.

Environmentalist retrieves trash from Red Cedar River on Earth Day 2000.

Polluted water does not necessarily look, smell or taste any different from clean water. Old lead pipes can contaminate household water, unbeknownst to the drinker. And the chlorination that is added to the water at the plant carries a very small health risk, that you should know about, though the consensus is that the benefits far outweigh the risks.

If you think that bottled water is the way to go, think about this. A 1999 study by the Natural Resources Defense Council found that one third of 103 brands of bottled water tested contained

contamination. True, most of the 1000 bottles tested were found to be of high quality, but why pay 75 cents a gallon when you can get a good glass of water for just 0.2 cents [Erratum # 1: $0.005 a gallon or 0.06 cents for a 16 ounce glass]?

Citizens increasingly want to know what is in their water. Where does it come from? Is it safe to drink? Are our rivers clean? We have assembled this document to help answer these and other important questions. We hope to increase citizen awareness about local water conditions, and spur dialogue.

THIS REPORT HAS THREE MAIN MESSAGES:

1) Our drinking water is safe, but it is vulnerable to pollution from leaking underground storage tanks (most from former gasoline stations), abandoned water wells (left behind when households connected to the city's water pipes), and the Motor Wheel plume of contamination (which could affect the Saginaw Aquifer if unaddressed.).

2) Our surface waters (rivers, lakes, wetlands and streams) are impaired. Pesticides and other pollutants from households and farms travel into the rivers during a rain event. Rain also causes millions of gallons of raw sewage to be dumped into the Grand River. Unlike other cities, our rain water flushes into the same pipe that is used for human sewage, instead of having its own separate pipe. While human waste managers think that they have discovered the solution of where to put our toilet wastes – on area farms after the waste has been converted to sewage sludge – new questions are being raised in many circles regarding its safety to human health and the environment.

3) Citizen action is necessary to improve the health of our water. Citizens have identified toxic dumps, reported illegal dumpers, and insisted on learning more about the quality of their water. The first step in becoming active is to become better educated.

Big Wheelers of Development: encroaching on a wetland to build a road

THE BAD NEWS AND THE GOOD NEWS ABOUT INGHAM COUNTY'S DRINKING WATER (A SUMMARY TABLE)

OUR DRINKING WATER: THE BAD NEWS	OUR DRINKING WATER: THE GOOD NEWS
1. Where's the Water? If a 1998 national survey is correct, about 26% of Ingham County citizens (70,000 people) do not know where their drinking water comes from. Many think their water comes from the Grand River. You do not get your drinking water from the Grand River! For those of you on municipal systems (86% of you) your water comes from about 200-450 feet underground.	**1. Where's the Water?** Ingham County citizens are truly blessed to possess one of the most spectacular natural resources in all of Michigan: a fresh, underground formation of water, four times bigger than Lake St. Clair, called the Saginaw Aquifer. The water for your morning coffee might have been sitting underground for the past five centuries or more!
2. Leaking Underground Gas Tanks. About 25% of Ingham County gas stations have or have had huge leaking underground storage tanks (LUSTs) beneath the pump which are leaking, posing hazards to drinking water and the environment. There are 33 sites that the MI Department of Environmental Quality says are "an immediate threat to human health, safety, or sensitive environmental receptors."	**2. Leaking Underground Storage Tanks.** EPA regulations now require all new leaking underground storage tanks near municipal wells to place secondary containment (basically a bathtub beneath the tank or a double walled system around the tank). This helps prevents pollution should a leak occur and potentially saves citizens millions of dollars from tax revenue to clean them up.
3. Old Abandoned Wells. There are an estimated 30,000 abandoned water wells in Ingham County, left when people switched to public water supplies. Less than 600 have been identified so far. Like a needle into the arm, these wells have the potential to inject various toxins into our drinking water. Many of you in older homes have them but do not even know what they are. Like the Love Bug computer virus, what you enter into that well can affect all of us!	**3. Old Abandoned Wells.** Ingham County Conservation District staff are working – through a three year, $78,000 grant -- to locate the wells and seal them up. Using satellites and computers, staff locate the wells and map them. Workers have been active in Meridian, East Lansing and Lansing Township. As of May, 2000, 400 owners have been contacted and 70 have agreed to seal them up. It is hoped that new laws will require well plugging as a condition for receiving a demolition permit.
4. Motor Wheel [1], a former waste disposal area used by the Motor Wheel Corporation, W.R. Grace and other area industries, is responsible for polluting the aquifer with extremely high levels of dangerous chemicals, most notably vinyl chloride, a known carcinogen. A number of city water wells were closed as a precaution. The pollution plume could potentially affect the quality of the entire Aquifer, and the drinking water of 170,000 people, if not properly addressed.	**4. Motor Wheel.** The EPA has approved a three step, $30 million plan to place a huge clay cap over the site to prevent further leaching, pump out the contaminated groundwater, and then treat it. Who will pay for the clean up? Goodyear, owner of the old Motor Wheel site will pay 80%; W.R. Grace and Co. Owner of the old Michigan Fertilizer Company will pay 19.5%; the Lansing Board of Water and Light and Textron will pay less that half a percent apiece.
5. Arsenic. In a recent Ingham County Health Department study, there were 422 wells with arsenic levels of 2-110 parts per billion. Due to increased health concerns, the EPA may soon lower the arsenic standard to just 5 PPB. If and when this new standard takes effect, there will be about 200 well sites that exceed the new standard. Some epidemiological studies have suggested that consuming arsenic, even at low levels over many years, may increase the lifetime risk of lung, bladder, kidney, liver, and skin	**5. Arsenic.** Arsenic is the twentieth most common element in the Earth's crust and is present in many areas of the soil and rocks of the country. It is widely distributed in low concentrations in groundwater in many places of the county. Some studies suggest that one would have to consume more than 500 PPB per day for several years before you exhibit certain chronic health problems such as skin abnormalities, anemia or a tingling feeling in your arms or legs. (Kosnett, 1997).

cancers. Most of the higher concentrations of arsenic were in central Aurelius Township and in Meridian townships, near Lake Lansing. Those with private wells in these areas should get their water tested.	
6. Boron. Boron is a mineral associated with shale bedrock and natural softness in groundwater. Long-term exposure (usually 7 years or more) to elevated boron can have negative effects on the male reproductive system. The U.S. EPA drinking water health advisory limit for boron is 0.9 parts per million. Elevated levels of boron can also be toxic to certain plant species. An analysis of well construction records revealed slightly elevated boron levels in Williamston and in the eastern part of Meridian township. For those on private well water, a boron test is recommended in these areas as well as all areas with soft-water.	**6. Boron.** Elevated levels of boron may provide a benefit in helping to reduce osteoporosis, a bone disorder in older women.
7. Water Conservation. We waste too much water in Ingham County. Only a tiny fraction (0.003 %) [Erratum #2: "0.3%"] of all the water pumped from the Saginaw Aquifer is actually used for drinking! In fact, the amount of water used to manufacture 2 new cars (about 38,000 gallons per car) is enough to satisfy the drinking needs all Ingham County citizens (280,000 people) in a day (though the local General Motors plant, which receives many of its car parts from elsewhere, only uses about 500 gallons per car in its phase of automobile production).	**7. Water Conservation.** The Saginaw Aquifer has plenty of water for many decades to come. In contrast, many areas of the world are faced with rapidly depleting aquifers which are already over-utilized. For example the Oglala Aquifer in Arizona lost 150 feet in just 50 years.
8. We do not drink enough water. We only we only drink about 4.6 glasses a day, when 8 glasses are the recommended amount. This lowers the body's hydration needs and can hurt our health.	**8. Consumer Confidence reports,** first issued in 1999, are a governmental attempt to help educate the public about the quality of their water. This information may encourage more citizens to trust the drinking water (or it may not, depending on how one interprets it). All three of Ingham County's consumer confidence reports (for Lansing, East Lansing/Meridian and Michigan State University) provided data indicating that their drinking water is safe. (Note # 3: But please read the review of the CCR reports for a critical interpretation).
9. Private Water Wells are More Vulnerable. If you get your water from a well, you should have it tested if it's near a gas station, a leaking underground storage site, a chemical facility, a pipeline or livestock confinement area, within 50 feet of a septic tank, or near a junkyard or road-salt storage site.	**9. Private Well Owners can have Safe Water.** For well owners (about 95 percent of rural residents), the U.S. Department of Agriculture through its cooperative extension agencies maintains a program called Home*A*Syst that offers a step-by- step tour of potential sources of well contamination. Home water filters can do a good job of removing many contaminants. However a home filter does require a strict maintenance

	schedule.
10. Urban Sprawl. According to the Ingham County environmental Health Roundtable, "increased residential, commercial, and industrial land uses in formerly agricultural areas can lead to increased chemical accidents, soil contamination, surface and groundwater contamination and surface water runoff."	**10. Groundwater Management Board** The Tri-County Area has one of the most energetic and successful organizations in the state dedicated to protecting our aquifers, the Groundwater Management Board, housed at the Tri-County Regional Planning Commission. For example, they conducted a quarter million dollar Water Regionalization Study in 1990 and a $380,000 Regional Aquifer study with the U.S. Geological Survey in 1994, that shaped water policy throughout the decade. They are actively involved in educating the public about "smart growth" policies as an antidote to urban sprawl.

Note:
1. "Motor Wheel" is shorthand for the old Motor Wheel pollution site. In fact the Motor Wheel Corporation is not one of the responsible parties since it long ago sold the facility to other corporations. They include: Goodyear; W.R. Grace and Co; the Lansing Board of Water and Light and Textron. The term Motor Wheel is widely used as a referent for the site in the public domain, and is used by the DEQ for its filing purposes.

The Bad News and the Good News About Our Rivers, Lakes, Wetlands and Streams (A Summary Table)

What's Bad About Our Rivers, Lakes, Wetlands and Streams	What's Good About Our Rivers, Lakes, Wetlands and Streams
1. Loss of Wetlands. Wetlands have declined from about 20% of Ingham County surface area in 1800 to just over 3% today.	**1. Tollgate Wetlands.** A human made wetland that filters and cleans a good portion of the surface pollution in the Groesbeck area of Lansing.
2. Raw Sewage in Grand River. During a rain storm, each inch of rain releases about 21.7 million gallons of raw sewage into the Grand River.	**2. Sewage System Repair.** Ingham County has taken care of 4% of the combined sewer overflows and all work should be done by 2019.
3. Impaired Rivers. Portions of the Grand and Red Cedar Rivers are polluted with high phosphorous, ammonia and pesticide runoff from farm fields.	**3. The Red Cedar River Watershed Initiative.** A landmark intergovernmental/university collaborative begun in 1999, that will collect baseline data on the watershed and create a plan to improve the river basin.
4. Fish advisories in all surface water bodies, due to PCBs, mercury and other contamination. In addition, testing fish for contaminants is infrequent. For example, the last time fish were tested in the Red Cedar was 1991 (as of this writing).	**4. The local fishing is better than ever.** A fisherperson can catch many beautiful looking steelhead, salmon, carp, and largemouth bass in our rivers and lakes. Catch and release is a popular sport. But please refer to the MI Dept. of Community Health's Fish Advisory guidelines if you intend to eat the fish.
5. Growth of Impervious surface, like parking lots and roads funnel pollutants into our rivers streams and lakes.	**5. Michigan State University is reclaiming 1,100 parking spaces and turning them into green space.**
6. Non-point source pollution – like pesticides from household lawn care – continues to be a growing problem. This pollution is difficult to control because it comes from so many places and is so common. Oil drippings from cars, pet waste and road salt are other examples of pollutants that enter our rivers, lakes and streams.	**6. Growth in Citizen Use of Ingham County's Household Hazardous Waste Collection Program** Between 1986 and 1997 the amount of pounds collected in the program increased by about 350% [Erratum #3: "230%"]. There were 8,656 pounds collected in 1986. This improved to 28,508 pounds in 1997.

7. Land Application of Sewage Sludge. Our human waste is not dumped into rivers like it once was. Today much of it is converted to sewage sludge and sent to local farms. In 1999, Ingham County generated 6,345 tons of sewage sludge and about 65% of it was trucked to more than 20 farm fields in Clinton, Eaton and Ingham Counties. The EPA and the DEQ strongly support this activity, but some environmentalists and waste management specialists are paying increased critical attention to this growing practice of our human waste disposal which potentially threatens to pollute groundwater and surface water with heavy metals and other pollutants.	**7. Land Application of Sewage Sludge.** The Michigan Department of Environmental Quality is devoting increased resources to its sewage sludge and septic waste monitoring programs in mid-Michigan, which includes Ingham County.
8. Agricultural Runoff. According to the Ingham County Soil Conservation District, an estimated 65% of the agricultural areas in the Red Cedar River watershed do not use "best management practices" such as buffer strips to prevent runoff from going onto our waters. In other words, farms are major water polluters.	**8. Farm*a*Syst.** A County program that provides a voluntary and confidential assessment tool that helps farmers identify risks to our water resources. It provides technical assistance on pesticide handling, well protection and hazardous waste disposal. Since 1996 FAS has served about 10 to 15% of Ingham County farmers.
9. Atrazine Pollution There is controversy about this pesticide (a weed killer used for the corn crop). It is classified as a possible human carcinogen by the EPA and is banned in several countries including Italy, Germany and Sweden. In 1997 atrazine was the Number 1 restricted use pesticide on Ingham County farms, with 59 tons used. Given the controversy, the issue needs better study locally.	**9. Rise in Organic Farming.** There are 23 individuals/organizations involved in organic farming in Ingham County. MSU Extension recently published a directory of these resources, "Sustainable Food and Farming Directory of Michigan Expertise." For more information call MSU Extension at (517) 355-0117.
10. Urban Sprawl. When a city or municipality haphazardly extends its urban boundary – its publicly financed water and sewer lines – the result can be a dramatic increase in land values and increased urban sprawl. According to the Ingham County Environmental Health Roundtable, "increased residential, commercial, and industrial land uses in formerly agricultural areas can lead to increased chemical accidents, soil contamination, and surface and groundwater contamination."	**10. The Tri-County Regional Planning Commission's (TCRPC) groundbreaking initiative, "Regional Growth: Choices for the Future Project," due to begin its public campaign in 2001.** The TCRPC will soon complete a comprehensive "Trends Data Book," that will serve as the backbone for the campaign. Using computerized mapping software, the Commission will demonstrate alternate data-based forecasts/scenarios in about 30 topical areas (education, housing, and travel/congestion) that will assist planners and citizens in their land use decision making.

IN 1800 INGHAM COUNTY WAS 65% FOREST AND 20% WETLANDS.

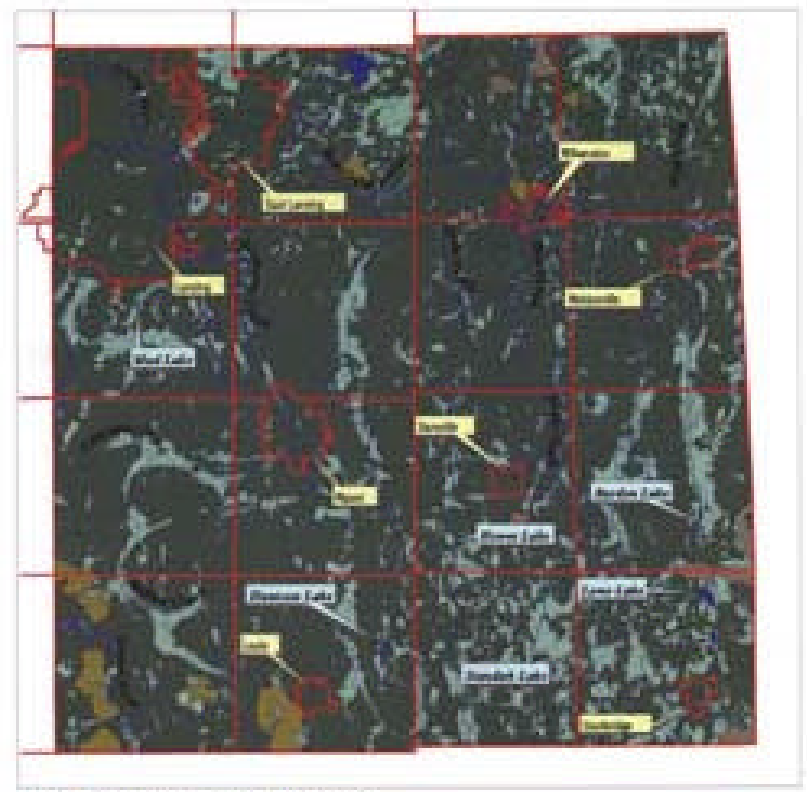
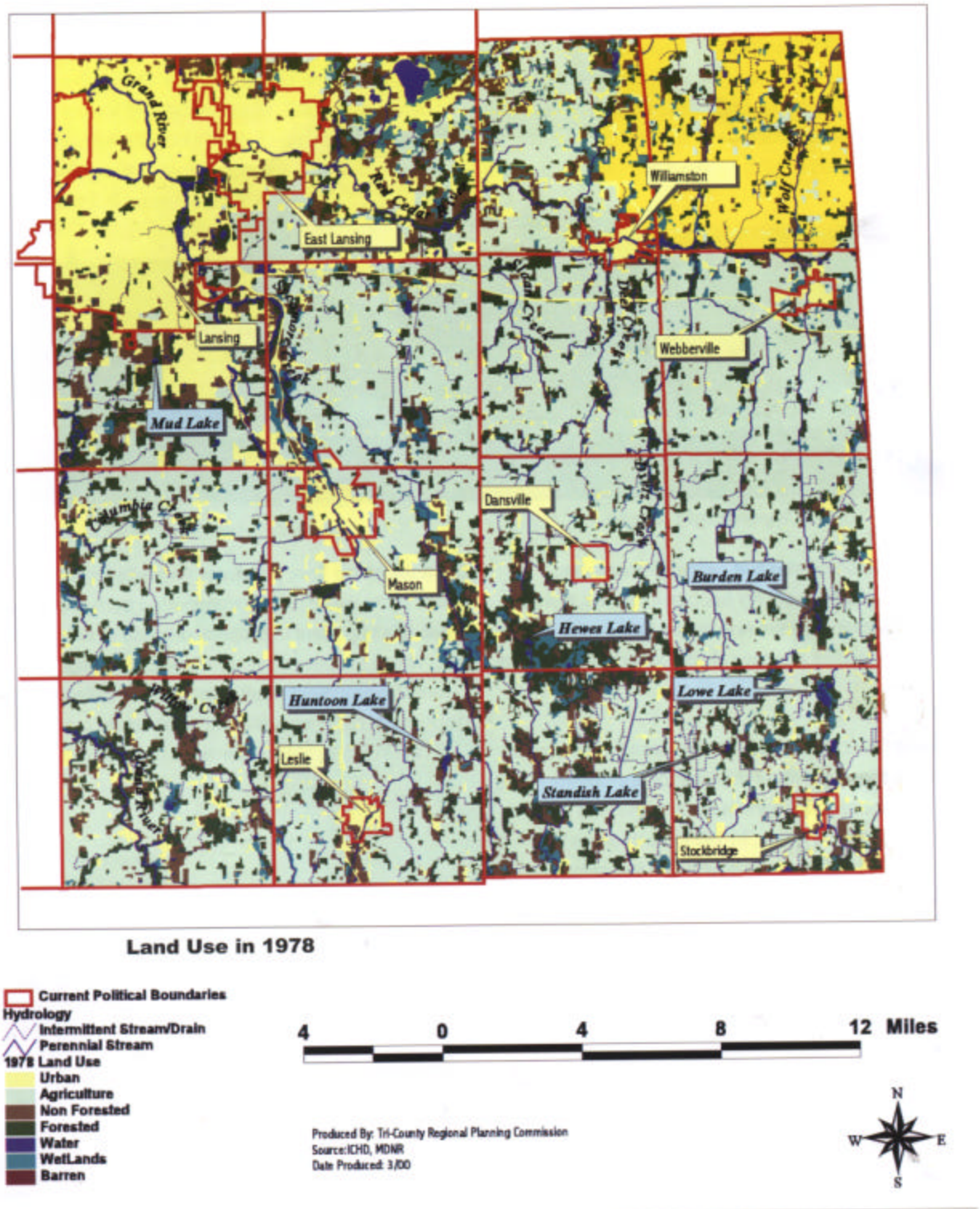


Figure 1 Land Use in the Early 1800s



By 1978, Ingham County comprised 54% farmland and 3 % wetlands.

INTRODUCTION

In 1800, if you were to have flown over Ingham County you would have seen rich forests of beech, sugar maple and oak/hickory trees. For miles on end you would have witnessed black ash wetlands and wet prairies. Blue herons and snowy egrets were all about. You might have spotted Chippewa Indians swimming in the Red Cedar River.

Today, a landscape that once resembled parts of the Upper Peninsula, looks like many other Midwestern state capitol regions: an inner urban core surrounded by expanding suburbs, and agriculture in retreat. The wetlands have given way to roads, farms and parking lots. The forests were reduced from 65 to 17 percent of the surface area. The wetlands were drained from about 20% to just over 3 percent of land cover. Where there were Indian trails there are now roads, thousands of miles of them

Today, when the Grand River empties into Lake Michigan near Grand Haven, the water is so polluted that a sharp line can be drawn between the brown water of the river and the blue water of the lake. Most of this is sediment from soil erosion, construction, and farming. But some of it comes from raw sewage. In fact, there were 713 million gallons of untreated waste dumped into Grand River from 30 combined overflow sites as a result of 27 inches of rain in 1997 in Lansing alone.

Non-point pollution -- like pesticides from household lawn care -- is difficult to track because its point of origin cannot be easily located. Rain carries much of this pollution into our rivers. The rain water doesn't settle easily into the soils as it once did 200 years ago, when it percolated gently into the ground. Instead it hits the concrete (or compacted soils) and absorbs a host of 21st century chemicals: petroleum byproducts from automobiles, heavy metals from industry and fertilizers from farming practices. It then transports these chemicals into rivers, lakes and streams. Pollutants like lead, copper and mercury have been found in storm water discharges.

Parking lots, like this rarely used section of concrete at Burlington, off of Michigan Ave. in Lansing, affect water quality.

Certain fish, like brown rainbow trout, once seen everywhere in the Red Cedar, cannot survive these dramatic hydrological and chemical changes. With development, the river is significantly warmer and there is less available oxygen. This leads to stress for some aquatic organisms and interferes with their reproduction. For example, the freshwater mollusk, once so common to the Red Cedar River that it spawned a pearl industry, has not been able to withstand these pressures.

When a new development like a mall, industrial park, or housing project is proposed to the community, governmental planners are concerned about "impervious surfaces" – paved over areas like parking lots, roads, housetops, or even

compacted soils – that increase water pollution by surface runoff. They're called "impervious" because water cannot infiltrate into the soil. Studies have shown that decreases in watershed quality (a watershed is an area that drains into a river) become apparent when about 10 - 15% of a watershed is paved over. Ingham County has three large watersheds: the Grand River, the Red Cedar and the Sycamore Creek watersheds. All of these river and creek basins are still below this threshold. However there are sections of Lansing, like center city, which are substantially above it.

On the other hand, residents of Ingham County possess one of the most spectacular natural resources in all of Michigan: an underground formation of water called the ***Saginaw Aquifer***. It is called "Saginaw" because of its far-reaching underground connection to Saginaw Bay where it discharges water. The water does not sit in a big space, like a lake, but fills the spaces between rock particles, a little like a sponge. A remnant from the Prehistoric Era, the Saginaw Aquifer is the principal source of drinking water (from the tap) for 99% of Ingham County residents. The Lansing metropolitan area draws about 90 million gallons a day from the Aquifer, more than any other groundwater withdrawal in Michigan.

Unlike river water sources like the Huron River in Washtenaw County, which is often heavily polluted with biological contaminants and other chemicals making the water very expensive to treat, the Saginaw Aquifer offers us one of the most secure drinking water sources in the country. Many also like the taste. In fact, in 1988, Lansing's water was ranked second best to taste in the country by the American Water Works Association.

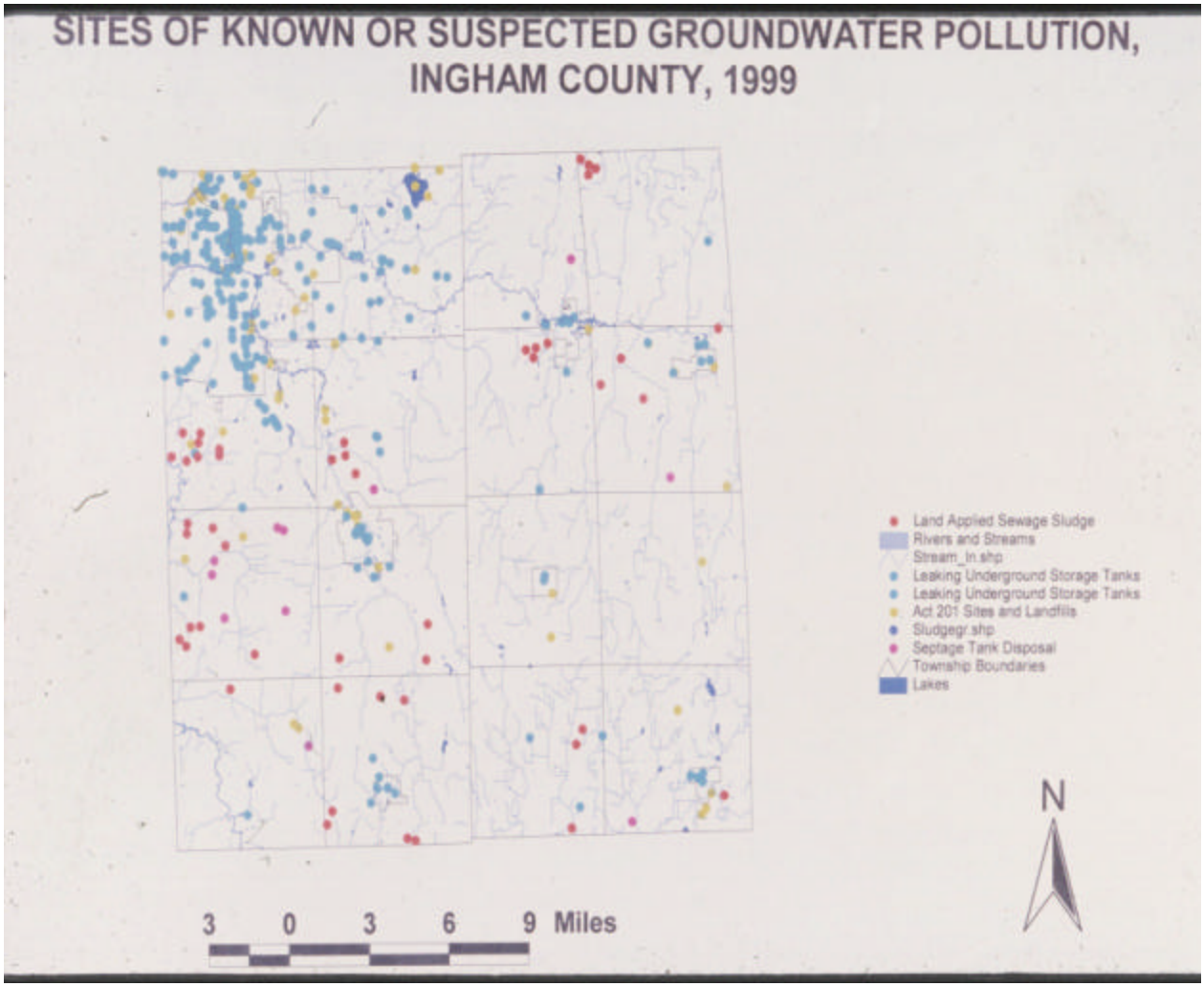
But the Aquifer is under serious threats from various forms of past development, most significantly from old gas stations and their leaking underground storage tanks. Another former automotive business, the Motor Wheel Disposal Area site, has leaked carcinogenic chemicals such as Vinyl Chloride into the Aquifer, resulting in the closing of a number of municipal wells. Approximately 230,000 cubic feet of waste remains on the site.

What you do around your home is just as serious to the health of the Aquifer. Septic tanks (which can cause bacterial/viral contamination) and water softeners are a problem because they are more widespread. And old water wells, abandoned when residents switched to public water systems, are a ready conduit to the groundwater. However the location of most of these wells, which stick 80 feet of more into the Aquifer, are largely unknown. There may be 30,000 of them in Ingham County. Many of you reading this have an abandoned well in your basement or backyard without even knowing it.

An open gate to the disastrous Motor Wheel Contamination site in North Lansing.

Ingham County residents are today spending millions to repair sewers, spills and sprawl due to a lack of knowledge or foresight. Fortunately, Ingham County's leaders are working hard to resolve many of the above problems. For example, "Adopt a River" programs help to clean-up refuse from the Grand, the Ingham County health officials conduct daily water well inspections to assure safe drinking supplies, and the Groundwater Management Board is working to create wellhead protection plans that will prevent groundwater pollution.

But their efforts are not enough.



WHY SHOULD YOU CARE? BECAUSE YOU PLAY AN IMPORTANT ROLE WHY SHOULD YOU CARE? BECAUSE YOU PLAY AN IMPORTANT ROLE

- Have you stopped drinking your tap water for fear of getting sick? According to the first ever *Report Card on Safe Drinking Water Attitudes, Knowledge and Behaviors* (RCS), in 1998, 65 million Americans (24%) report they do not drink tap water at all. For Ingham County that represents about 65,000 people. Such a fear might cost you hundreds of dollars a year for bottled water, when, in fact, your municipal water is basically safe.

- Do you use a home water treatment device for your tap? Nearly one-third (32%) of consumers currently do, an increase from 27% in 1995 (according to the RCS survey).

- Do you use bottled water as your preferred method of drinking water? Do you know that a study by the Natural Resources Defense Council has determined that in many cases bottled water is not as safe as tap water?

- Do you use a private well for your drinking water? Did you know that there are many potential threats to your health from pesticides, petroleum products and bacteria? Yet, according to a recent national survey, less than one-third of adults ever report having their water tested.

- Do you avoid fishing in the local waters because the fish might not be safe to eat?

- Did you stop kayaking on the Red Cedar River in Williamston because the water was declared unsafe if you fell in?

- Are you tired of hearing about combined sewer overflows into the Grand River (or what the Lansing State Journal referred to as the "rain tax") but never stopped to really look at the issue?

- Did you know that some of the county's most significant sites of environmental contamination, like Crego Park and the Gunn Road Dump, were originally uncovered by citizens who brought them to the attention of public officials?

- Do you know about the significance of the Motor Wheel plume of groundwater contamination in Lansing? Read on. . . . . .

A Citizen Volunteer Pulls two bicycles from the Red Cedar River, Earth Day, 2000

PART 1: THE GROUNDWATER (SOURCE OF YOUR DRINKING WATER)

A. BASIC FACTS

Whom Can You Trust?

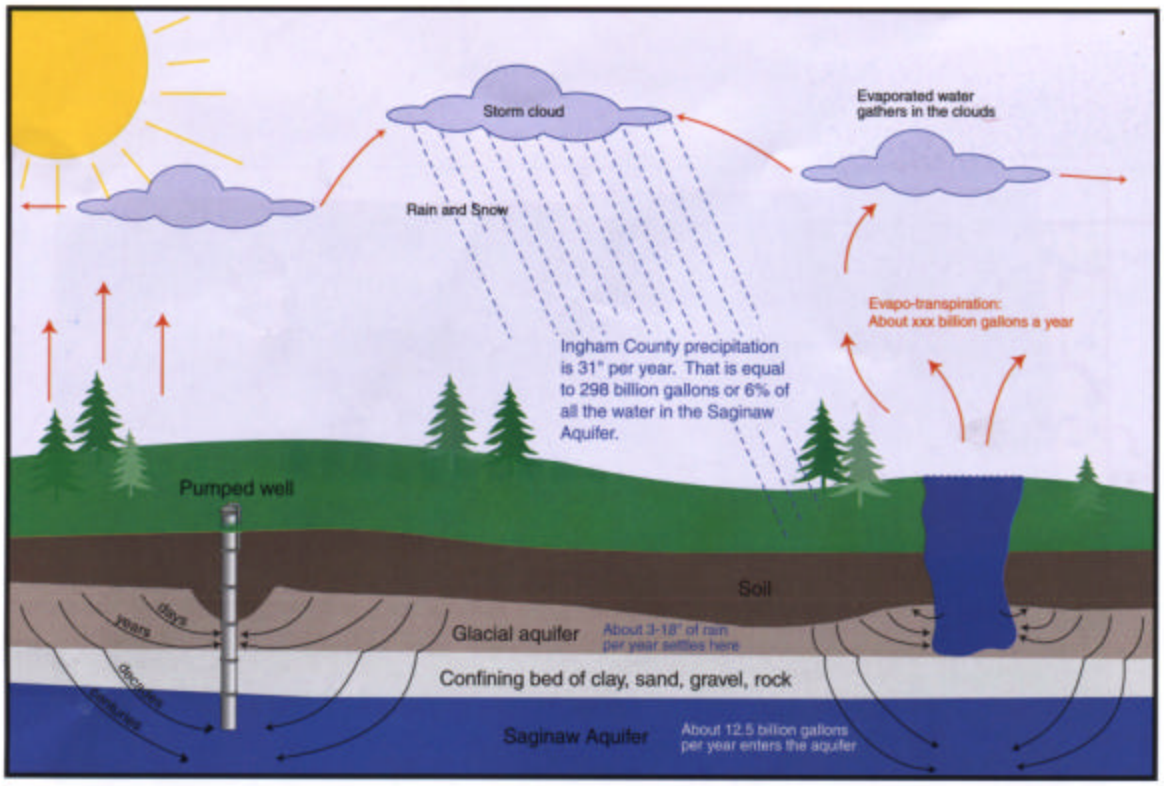
Consumer Confidence Reports, a Historic First

Responding to public outcries for "right to know" what is in the drinking water, the Federal Government, under requirements of the National Safe Drinking Water Act, required water utilities serving 10,000 or more people to release new annual "Consumer Confidence Reports" in Fall 1999. The reports contained data on the state of your water as it leaves the treatment plant, information about the level of potential contaminants like barium and arsenic (all within safe ranges according to EPA guidelines) and about additives like fluoride and chlorine. The reports were a historic first step in addressing communication barriers between water utilities and consumers. But the reports only address a small part of the issues related to water quality. With this report we shall fill many of the gaps.

Where Does Your Drinking Water Come From?

ANSWER: The Saginaw Aquifer: Ingham County's Greatest Natural Resource

The water streaming out of your kitchen faucet comes at the tail end of a long water journey. It begins its trip about a tenth of a mile beneath the earth. Mingled among sandstone, shale, coal and limestone it sits, the Saginaw Aquifer. The pore spaces surrounding the stones are filled with water. But the water wasn't there forever.



The Hydrologic Cycle

Note: The amount of water that evapo-transpires is 24 inches, or about 231 billion gallons a year.

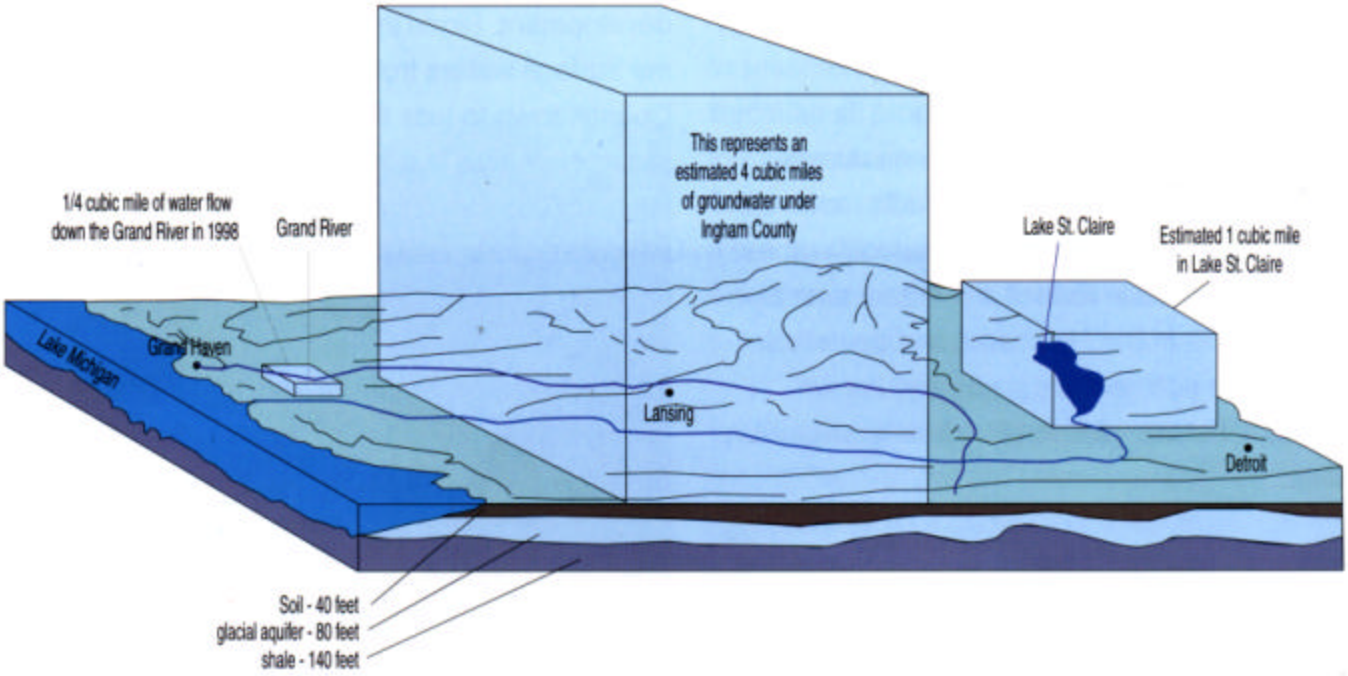
Where Did the Water in the Aquifer Come From?

From the rain and snow! How did rain water get so far beneath the ground? It infiltrated there slowly over days, years and millennia. Hydrologists call this phenomenon percolation. The hydrologic (or "water") cycle is the natural flow of moisture over the land and through the air. The heat of the sun powers this movement. Water is stored in groundwater, lakes and rivers, ice-caps, oceans and the atmosphere. Water is constantly being exchanged between these areas via evaporation into clouds, transpiration (the loss of water vapor from a plant) infiltration and precipitation, followed by runoff or deep percolation.

Think about it, the water you had for your coffee this morning might have been lurking underground for the past five centuries or more!

How Much Water is Beneath our Feet in Ingham County?

Few people can appreciate the significance of the Saginaw Aquifer because, unlike a ranging forest or the Grand River, we cannot see it. According to a rough estimate by Lansing's USGS, there are about **4 cubic miles** of water beneath as in the Saginaw Aquifer. So much so that if it were above ground it would extend above our head about 70 feet! The graphic below helps illustrate the magnitude of that number.



The Saginaw Aquifer Water Reserve

The Saginaw Aquifer, under Ingham County, holds four times the water as Lake St. Clair.

The water beneath us has four times greater volume than Lake St. Clair and 16 times greater volume than all the water that flows down the Grand River is a given year.

But don't let the gigantic size of the Saginaw Aquifer fool you into complacency. It is possible for the Aquifer to become so polluted that it might be rendered unusable.

Who Uses the Water?

The Saginaw Aquifer, stretches between 25 and 600 feet below the surface and provides drinking water to 89.4 percent of residents in the Tri-County region. Another 9.7 percent get their water from glacial deposits, which sit above the Saginaw Aquifer. And about 1 percent get their water from the Marshall Aquifer which sits below the Saginaw Aquifer. Eighty six percent of you get your water from a treatment plant, the rest from domestic wells.

Before European settlement in the 19th century, this drinking water resource was untouched by humans (save for the discharge areas and streams that emitted from the earth and were probably a source for the native Americans). The City of Lansing's first municipal well was drilled in 1885, but this was only dug into the surface, or glacial, aquifer. It wasn't until 1895 that wells into the deeper Saginaw Aquifer were added. Webberville switched from glacial to the Saginaw Aquifer in 1956. Other Ingham County municipalities such as Mason and Williamston use combinations of wells from the glacial deposits and the Saginaw Aquifer. Noteworthy is the fact that the Lansing metropolitan area withdraws the largest amount of groundwater in the state, about 15% of the total. In 1999, the city of Lansing pumped 8.1 billion gallons from 110 wells.

Michigan State University's coal-fired electrical utility plant uses more water than any other MSU use (domestic, industrial or commercial). Incidentally, in 1997 the plant's smokestacks released the highest amount of the pollutant PM<10 (particulate matter less than 10 microns) – 37 tons – than any other Ingham County facility. The amount of mercury released is

Ingham County is truly privileged by our water resource. Generally speaking, aquifers are far better sources of drinking water than rivers and streams. This is because the water has been kept sheltered from human contact for a long time, away from the pollutants carried in our air and streams, many of which, like radiation, cannot be treated in a water treatment plant. One question that can be raised in this context is whether or not industrial users require a superior quality of water (paid for at public expense) to conduct their operations, or could they use lesser quality water like the Grand River?

As Aquifers go, the Saginaw Aquifer is known to have hard water, meaning that it's not the best water to wash in unless it is treated. But that's getting ahead of the story. Before we talk about what's in it the water, it's important to appreciate some basic facts about it: how big is it? Do we use too much water? Will we ever run out?

According to the USGS, in 1992 about 34.4 million gallons-per-day were withdrawn by large public suppliers in the Tri-County area. This represented about 85% of the total groundwater withdrawal. The largest public supply was for domestic use (54.4%), followed by commercial (28.3%), industrial (14.2%) and thermoelectric power (2.2%).

If we look at water use by city or municipality, we see the following:

The Board of Water and Light, which distributes 24% to industry, came out the highest at 156 gallons per capita per day. Michigan State University, whose largest water uses are for its electrical utility plant, came in at just 75 gallons per capita per day.

Gasoline prices might rise a few dimes per gallon, but few citizens are aware of the extraordinary number of gallons of water that it takes to make a car: about 39,000 gallons. Industry is as concerned about access to cheap water supplies as are drivers to cheap gasoline

Do We Use Too Much Water?

Well, very little of it goes for drinking. For example, of the 22 million gallons withdrawn each day by the Board of Water and Light, only 65,773 gallons per day goes for drinking, that's just 0.003% [Erratum #4: "0.3%]. Another way of looking at this is that it only takes about 23 million gallons of water to satisfy the drinking needs of Lansing's population over the course of a year, that's just a little over one day's withdraw! This is assuming that the average person consumes 8 glasses of 8 ounces of water per day (2 quarts).

Where does the rest go? Few people know about the large quantities of water devoted to industrial pursuits. For example, according to the American Water Works Association, it takes 39,090 gallons of water to manufacture a new car and its four tires. That means that the manufacture of two automobiles surpasses the drinking water requirements of Lansing's population every day! Though the local General Motors plant, which receives most of its car parts from elsewhere, only uses about 500 gallons per car in its phase of automobile production.

How about you, individually?

According to the American Water Works Association, the average use of water in a single family home goes to toilets (26%) followed by clothes washers (23%), showers (18%), faucets (including drinking, 15%) and leaks (13%). Significant amounts of water are used for lawn and garden sprinkling and car washing as well.

The U.S. Department of Health and Human Services just issued a new goal for personal domestic water consumption. They want us to use less water in the home. According to its newly released publication, *Healthy People 2010*, the target amount of water to use is 90.9 gallons per day.

In the U.S. as a whole we use 101 gallons domestically per day. Michigan as a state has already attained the goal! Unfortunately no data was available for Ingham County and estimates were hard to come by.

Could We Run Out of Water?

In 1969 our leading water planners thought so! The U.S. Geological Survey in cooperation with the Tri-County Planning Council and the Michigan Department of Natural Resources published a 111 page study which asserted that, *"during the next two decades many communities in Lansing will find it increasingly difficult to obtain adequate water supplies from underlying groundwater reservoirs* (p. 77)."

Having witnessed a dramatic draw-down in the depths to water in the Saginaw Aquifer in the Lansing region (from 50 feet below the land surface in 1935 to 170 in 1967, what is called a "cone of depression"), they were spurred to look at a number of other factors affecting the Aquifer. They speculated about scenarios in which the Great Lakes and even the Grand River might have to be utilized to compensate for inadequate water resources. They recognized that the key impediment to building a pipeline to Lake Michigan was "primarily an economic one." Today, such a scenario would be a logistical nightmare costing tens of millions of dollars in construction and additional millions in eminent domain buy-outs and litigation.

The good news is that their fears never materialized. The Lansing Board of Water and Light began to dig new wells away from the cone of depression. Population declined in the region and the cone of depression in the Lansing area made a dramatic come-back.
But the question remains. Could we ever use up the Saginaw Aquifer? This is not an absurd thought. Aquifers have been pumped dry across the world. For example in Libya two Aquifers were pumped dry over a fifty-year period. Over the next century this question might have to be reconsidered. But for today, the consensus among water planners is that it's not the *quantity* but the *quality* of the water that is a concern. This means that it is theoretically possible, some time in the far-off future, that the Aquifer could become so polluted as to be rendered unusable. In fact a number of municipal wells have already been closed because of contamination concerns, as we'll see.

The key point here is that the Saginaw Aquifer, though still of very high quality, has been intruded upon by human activity. How has the Saginaw Aquifer changed in 200 years? One way to envision our intrusion is to calculate the number of wells and tanks that we place into the ground, many of which could serve as potential conduits of pollution.

There were none in 1800, but today there are at least 40,000 wells and tanks stored underground. The wells include oil, gas, irrigation domestic, municipal, monitoring and abandoned wells. And the number of penetrations increases yearly. For example, in 1998 the Ingham County Health Department issued about 400 new well permits.

B. What About your Municipal Drinking Water? Is it Safe?

If we abide by federal standards for public water supplies the answer is yes, the water is safe. According to ***Healthy People 2010***, the goal is to "reduce water related health effects by increasing to at least 95% the proportion of people served by a the community water systems who receive a supply of drinking water that meets Safe Water Act regulations." According to Pat Cook, a water specialist with the DEQ, public water supplies for Ingham County meet all federal standards. Moreover, Cook reports that there is evidence of pesticides in the public water supply.

Indeed, in the U.S. as a whole, almost 90 percent of the nearly 55,000 public water systems report no violations of the EPA's limits for drinking water contaminants. According to Rebecca Calderon of the EPA, "You can travel the length of this country, drink the water at every stop, and probably never get sick."

But that doesn't begin to tell the whole story. In fact, there is no absolute guarantee that the water in a public system will not make some citizens sick. For example, in a January 2000 study, public water in Philadelphia, that met EPA standards, appeared to increase gastrointestinal illnesses among the elderly (Journal of Epidemiology and Community Health 54: 45, 2000). The study, conducted by Joel Schwartz, an epidemiologist at the Harvard School of Public Health, found an association between drinking water turbidity (suspended solids in water often associated with cloudiness), and a 9 percent increase in hospital admissions for those over 65. In an earlier, 1997 study, Schwartz found a similar association for children under 3, who had a 9.9 % increase in emergency visits to Children's Hospital of Philadelphia for gastrointestinal illness.

There are no such studies on the relationship between turbidity and gastrointestinal illness in Ingham County [Note # 5: this is primarily due to the fact that Ingham County draws its water from the groundwater, not surface waters; though we consider this further below.] Nor are there local studies on another area of concern: the relationship between chlorine and illness.

Chlorine, added to the drinking water to kill microbes, also carries a health risk. One of the greatest public health achievements of the twentieth century, chlorine has been very effective in reducing waterborne illness such as cholera, typhoid and dysentery. But the disinfectant can combine with decaying leaves and other organic substances to form disinfection byproducts

(DBPs). The EPA estimates that between 2 and 17 percent of all bladder cancer cases in the U.S. are attributable to DBPs.

Mike Kamrin, an MSU toxicologist, points out that the lack of technical knowledge may lead citizens to make poor policy decisions regarding water disinfection. As an example he cites Peru's decision to stop chlorinating water because of the possible risk of cancer. Tragically, this soon resulted in a severe cholera outbreak and many deaths. Clearly public water supplies need to be disinfected when microbiological contaminants are known or suspected of being a threat. But under the precautionary principle, we need to further investigate whether or not there are safer alternatives to chlorine.

The East Lansing – Meridian Water and Sewer Authority apparently thinks so. In a June 2000 correspondence with its customers, the authority announced that on June 26, "we're starting a new treatment process to improve the quality of drinking water" for its residents. The treatment change involves replacing chlorine with chloramines as a disinfectant. By "quality of drinking water," the East Lansing authority appeared to mean, only, that there will be "less taste and odor in the water due to the absence of free chlorine." In their memo, they did not refer to any health risks associated with chlorine, such as an increased risk of bladder cancer, though this was probably one of the main considerations in the switch, given the extensive scientific literature reporting on a probable relationship. East Lansing also plans to become integrated with Lansing's water supply, which had switched to chloramines earlier. The East Lansing authority did point out that "kidney dialysis patients and fish owners will need to take special precautions," but this directive was no different than the previous directive for chlorine. That is, like chlorine, dialysis patients have to by remove chloramines from the water (via a water conditioner or a granular activated carbon filter).

East Lansing-Meridian Water & Sewer Authority believes in alternatives to chlorine-based water disinfection systems.

There are 26 "type 1" public suppliers in Ingham County. These are suppliers that provide year-round service to not less than 25 residents or not less than 15 living units. The top three utilities are Lansing (serving 131,500), East Lansing-Meridian (serving 62,500) and Michigan State University (serving 19,500 residents). All tolled they serve about 75% of Ingham County residents. Other type 1 suppliers include municipalities like Mason, Stockbridge, Williamston, Webberville, Leslie and mobile homes such as Windmill Park. Only the three largest suppliers will be analyzed here.

These utilities are the middle act in a three-part drama that begins underground. To assess the safety of one's water requires a wide-angle view that reviews: 1) what's in the water as it sits in the Saginaw Aquifer; 2) as it leaves the three top treatments plants; and 3) as it comes out of your tap.

THERE ARE FOUR LEVELS TO ASSESS THE QUALITY OF YOUR DRINKING WATER:
1. At the source (that is, in the groundwater, the source for all of us)
2. In the distribution system (are you on public water or do you own a well?)
3. In your home (reflecting the quality of your plumbing; for example, do you use lead pipes?)
4. In the general community (churches, restaurant, etc.)

One quick point: You live near a contamination site. Does that mean your water is unsafe?

No. Not if you are on the public water supply. For example, if you live in Lansing near the Motor Wheel plume of contamination, some of you might worry about your tap water. If you get city water, there is no concern. This is because the Board of Water and Light pumps its water from among 110 area wells and combines that water at two central conditioning plants. This process helps to dramatically dilute any contaminants that might be present. Moreover the Board has closed 10 wells near the Motor Wheel site meaning that the contaminants in those areas never enter the huge water stream. However, if you rely on private well water and live near Motor Wheel or some other of the scores of contamination sites (listed below), then you are strongly urged to get your water tested immediately!

The Journey of water. From the Aquifer to the treatment plant to your home.

1. What's in the Saginaw Aquifer?

In 1983 a group called the Southwest Michigan Groundwater Survey and Monitoring Program (now called the Michigan Groundwater Survey), initiated a project to evaluate the quality of groundwater throughout the State of Michigan. As a member of this group, Ingham County was able to create a database of water quality information. The database was made from the results of 518 survey wells tested for 33 different parameters or chemicals.

Be aware that we shall begin to talk about microscopic particles like parts per million (ppm). If you are skeptical about whether these invisible-to-the-naked-eye levels can have any real affect on a person, consider that 2 aspirin tablets in a 130 pound person is a concentration of 11 parts per million. Most people believe in the power of such a small quantity of chemicals to relieve headache, so, if you can, try to be open minded (while retaining a healthy skepticism) about the possible negative health affects of some of the chemicals.

Garry Rowe, a groundwater specialist with the Ingham County Health Department, produced a report in 1985 from this work titled

Report on the Aquifers of Ingham County. An additional review of the groundwater data was completed by staff from Western Michigan University in 1988, found in a report titled *Groundwater Chemistry Statistical Summaries for Ingham County, Michigan.* Additional work in 1999 focused on levels of arsenic, chloride and water hardness in the County. This section summarizes some of this work.

We'll organize the discussion by identifying those chemicals that 1) exceeded the Maximum Contaminant Level (MCL), which is an enforceable limit; 2) Secondary contaminant levels (which is a non-enforceable standard for taste, odor, or other aesthetic considerations); and 3) parameters like hardness which have no federal guidelines.

Most of the 1983 study work surveyed inorganic chemicals such as iron and nitrate levels. Based on the results of the inorganic sampling and a well site review, a selection process was used to determine water well sites for testing of organic compounds such as herbicides and cleaning solvents. The water well sites chosen where [Erratum #5: "were"] based on the vulnerability of the site to potential groundwater pollution and if organic chemicals are used at this location. An example of a selected site might be a farm using gasoline fuels and weed control herbicide chemicals with sandy soils over sandstone bedrock material. A total of 50 water wells were selected and sampled for these organic chemicals. All 50 well locations showed negative results for the presence of these chemicals. Since Ingham County has a protective thick layer of soil material over the bedrock aquifer, (from 40 to 60 feet in thickness), the negative results were not surprising. [Note # 6: Still, these results are now nearly 20 years old and do not reflect the more sophisticated water sampling techniques available today. In the final analysis, domestic well owners are advised to get their water tested. A recent CDC study found high coliform bacteria levels in 41% of wells tested, as well as detectable herbicide levels in many wells. See discussion on domestic wells below.]

The general findings, in the 1985 and 1988 study was [Erratum # 6: "were"] that the groundwater in Ingham County has objectionable levels of water hardness, iron and occasionally manganese for domestic use, but for the 33 parameters tested, the levels were within EPA standards for drinking water [Note # 4: for that point in time]. Since these two reports were done the EPA has tightened some of these standards and has also created new ones. In conjunction with these new standards and some additional data collected since the 1985 report, some new concerns have been raised, especially with arsenic levels.

It is important to keep in mind that the 1985 study did not sample areas near known contamination sources, therefore the numbers below reflect, to the degree possible, the state of the Aquifer at its "background" state, though some human impact is assumed in certain areas**.** ***The data shows that the condition of the Aquifer is generally free (or well below the maximum contaminant levels) of any dangerous contaminants in most of the study areas.*** When the Aquifer is tested at or near polluted wells, it is a much different story. In fact, there is no comprehensive statistical analysis of the state of the Saginaw Aquifer in Ingham County. Ideally a water specialist would conduct a statistical analysis of a distinct geographical area and a distinct depth, by taking a random sample of wells and analyzing the contaminants of concern. In the absence of this data, the Michigan Groundwater Survey offers a close approximation.

Exceedences of the Maximum Contaminant Levels, or an EPA Health Advisory

Five of 15 regulated chemicals had some samples that exceed EPA standards. The EPA has issued a "health advisory" for another chemical, boron, which is currently under review as a possible candidate for an MCL.

Arsenic: According to 1999 data, about 10% of wells tested have arsenic levels that exceed the EPA's newly proposed maximum contaminant level of 5 parts per billion (ppb). One well (of the 1,819 wells tested) had a reading of 422 ppb. These areas are concentrated in central Delhi Township and around Lake Lansing (see map. Page 62). Anybody who has a private well in these areas should get their water tested. In contrast, municipal water supplies are well below the EPA standard. In Lansing's BWL arsenic is a "non-detect" as it leaves the plant; it's 1 ppb at East Lansing/Meridian and 2 ppb at MSU. The majority of arsenic comes from erosion from natural deposits, though some arsenic in one specific area may be associated with an herbicide application. For a fuller discussion of the health affects of arsenic, please see Section D below.

Boron: In 1999 Rowe analyzed the water chemistry of 1,509 wells in Ingham County and discovered boron was associated with soft-water bedrock wells, which constituted about 15% of his sample. In 207 soft water wells studied, the median boron level was 1.41 parts per million. The EPA's health advisory is 0.9 parts per million. The elevated levels were concentrated in a few pockets of the northeast quadrant of Ingham County's groundwater. All three major municipalities recorded a non-detect for boron in their distribution systems. For a fuller discussion of boron, including possible health effects, please see Section D below.

Barium: In the 1985 Rowe study approximately 1 percent of the groundwater samples contained barium levels at or exceeding the then standard of 1.0 parts per million. The highest level detected was 2.3 ppm. Since 1985, the standard for barium was relaxed to 2 ppm. Based on this new standard, the percentage has dropped significantly below 1 percent. Barium block nerves and affects blood vessels, according to the Michigan Public Health Institute (MPHI).

Antinomy: Antinomy is a silver white solid used in alloys. Its sources are "rock, weathering, soil runoff [and] mining," according to the MPHI. In animals it causes decreased life-span and weight. When Rowe completed his original study, in 1985, there was no EPA standard for antinomy. Since then a standard of 0.006 ppm was established. Based on this new standard, about 1% exceed the limit (the 99th percentile in 1985 was 0.05 ppm). Importantly, more than 95% of wells tested did not detect any antinomy, so this is not a concern to all but a few Ingham County citizens.

Nickel: The present standard is 0.1 ppm. In Rowe's study, 95% of the samples were at non-detect, however there was one reading of 0.11 ppm, exceeding today's standard. It is "rarely found in water supplies but may occur due to human activities such as mining or smelting," according to MPHI. Believed essential to humans in low doses, higher doses of nickel may cause some health problems. Citizens who live near these wells should have their wells tested.

The survey sampled for 11 of the 16 inorganic chemicals that are now regulated with enforceable MCL limits. The survey tested for elements for which there were expected concerns in a given area. Budgetary constraints limited the scale of the survey as well. The survey did not test for asbestos, beryllium, cyanide, nitrite and total nitrate and nitrite. None of the six other inorganic chemicals tested in the survey (cadmium, chromium, fluoride, mercury, selenium, and thallium) exceeded the MCL.

Secondary Contaminants (taste, odor and appearance concerns)

What strikes one immediately, in the matter of aesthetics, is the high amount of iron in the Aquifer. In 1985, 87.1 % of Ingham County survey wells had iron levels exceeding the 0.30 ppm MCL standard. As a general rule groundwater contains more minerals like iron and manganese than surface water because the water percolates through rocks picking up minerals on the way. What strikes one immediately, in the matter of aesthetics, is the high amount of iron in the Aquifer. In 1985, 87.1 % of Ingham County survey wells had iron levels exceeding the 0.30 ppm MCL standard. As a general rule groundwater contains more minerals like iron and manganese than surface water because the water percolates through rocks picking up minerals on the way.

The survey sampled for 9 of the 16 secondary maximum contaminant level (SMCL) parameters. These aesthetic features are non-enforceable limits. Of these, five exceeded the SMCL: chloride, copper, iron, manganese and sulfate.

If you are on a public supply system, the iron, calcium and manganese, (which constitute "hardness, " see below), is treated by limestone and other products that soften the water. However if you own a private well, you might experience odors, staining of bathroom fixtures and unpleasant taste because your water is not so treated. Water will have a metallic taste and fresh water drawn in a glass will cloud and form red or black particles when left standing for a period of time. Private well owners may also notice bacteria that grow in iron, sulfur and manganese. Iron bacteria can be introduced into the groundwater as part of the well drilling process. They can cause staining and provide a home for sulfur bacteria. Sulfur bacteria can clog or corrode pipes or can give off a foul smell like rotten eggs. Manganese bacteria can cause black staining and give your coffee and tea a bitter taste.

The highest observed level of copper was 1 ppm. This is equal to the 1 ppm secondary standard for copper. Copper is known to be necessary for human health but too high levels can irritate the gastrointestinal tract.

Hardness

Saginaw water is very hard. Rowe called it "objectionable." Hardness is due to excessive amounts of calcium and magnesium from natural deposits. Interestingly, the concept was developed to measure soap requirements for lather formation. The harder the water, the less clean you become in the shower! There is no federal standard for hardness, but the Michigan Environmental Health Association called levels above 150 ppm "undesirable" (though there is no affect on health). Given this number, over 90% of the water is naturally hard. Of the 509 wells

tested, the median level (the middle value in a value sequence from lowest to highest) was 291. The highest level, in 1985, was 700 ppm.

2. What is the General Condition of the Water as it leaves the treatment plant?

In their 1999 Consumer Confidence Reports, the county's top three water authorities (Lansing's BWL, East Lansing/Meridian, and MSU) reported no violations at all. We noted, however, that each authority was selective in the information that it chose to share with the public. We followed-up with officials at each plant for more data, and this allowed us to create a table that compared the three utilities across 44 categories. Representatives from each water authority patiently endured our questions, and we thank them. The table is available at the Health Department.

Upon review, all three utilities easily passed the EPA primary standards for safe drinking water. There were a few instances, however, of exceedences in secondary (or aesthetic) contamination levels, which were not noted in the reports (the utilities were under no obligation to report them). We provide capsule summaries of each of the three major utilities below.

Drinking Water Quality
Selected Comparison of the Top Three Public Water Systems
Of Ingham County, Michigan
(Most of the data was Derived from Consumer Confidence Reports Issued Fall 1999)

Parameter	Lansing	East Lansing/ Meridian	Michigan State Univ.	Maximum Contaminant Level (or other standard)	Violation?
Population Served	131,546	62,550	50,000 total (19,500 residents)	--	--
Quantity per day (1998)	22 million gallons	7.9 million gallons (1999)	4.6 million gallons	--	--
Number of Wells	110	29	17	--	--
Lead	90% of the samples were at or below 7.6 ppb	90% of the samples were at or below 7 ppb (range 0 to 14 ppb)	90% of the samples were at or below 0	Action level: 90% of the samples at or below 15 ppb	None
Hardness	Non-detect	90 to 110ppm	Typically 400 ppm in buildings with no water softening	None	None
Boron	Non-detect	Non-detect	N/A	0.9 ppm	None
Sodium	Range: 30 to 60 ppm	22 ppm	13 ppm	Not regulated	--
Iron	Range: 0.1 to 0.3 ppm	0.04 at plant tap	0.1 ppm	Secondary MCL: 0.3 ppm	None
Turbidity	0.15 (range: 0.1 to 0.5)	0.38 treatment technique	1.0 to 3.0 [Note # 7: it sometimes exceeds 5 NTUs when a well is flushed]	0.5 treatment Technique [Note # 8: The above number is for surface water sources only. According to some sources there is no turbidity level for groundwater-based water systems; but according to other sources, the turbidity MCL for groundwater is 5 NTU	Yes, MSU [Note # 9: this is true for some of our information sources, not for others]
Chlorine (product)	None added.	1.2 at tap (liquid).	0.5 at plant tap and 0.3 in the distribution system (gas).	Not regulated.	--
Chloramine (product)	2.7 ppm (highest) (range: 0.8 –	None added in 1999 (began adding in		Not regulated.	--

	2.7)	2000)			
Total Trihalo-methenes	8 ppb (range: 1-8)	27.5 ppb (range: 17.1 to 27.5)	10.3 ppb (range: 2.5 to 10.3)	100 ppb	None
Lime (removes calcium and magnesium (which constitutes hardness)	Yes 350 ppm	Yes	No centralized water softening plant where lime is added. However all major buildings on campus have softeners for their hot water.	--	--
Soda Ash (removes more Ca and Mg compounds)	70 ppm	Yes	Does Not Use.	--	--
Sand Filtration	Yes	Yes	Does not use.	--	--

Lansing Board of Water and Light (Lowest Level of Disinfection Byproducts):

The Board of Water and Light has 110 wells; most of them 12 to 14 inches in diameter and 400 feet deep. Water is pumped from about 25 to 30 wells at any given time and transmitted to two central conditioning plants where about 80 percent of the natural hardness is removed. When water leaves the plant the hardness has been reduced to a range of 85 to 100 ppm. Lime (350 ppm) and soda ash (70 ppm) are used for this purpose. Disinfectant and fluoride (1 ppm) are added before the finished water is sent to reservoirs and pumped to customers.

The disinfectant is chloramine, a carefully processed mixture of chlorine and ammonia that is considered to be a significant improvement, by many toxicologists, over chlorine alone. Indeed, one advantage of chloramine is that there are far fewer disinfection by-products (DFB) like chloroform, which increase cancer risk. The EPA's limit for DFBs is 100 ppb, scheduled to drop to 80 ppb next year because of the health concern. ***The BWL had the lowest number of DFBs (maximum of 8 ppb; range 1-8 ppb) than the two other utilities which both used chlorine (not chloramine) in 1999. MSU had a high of 10.3 pbb (range 2.5 to 10.3 ppb) while East Lansing-Meridian had a high of 35.3 ppb DFBs (range 17.1 to 35.3 ppb).***

Why is chloramine preferable? According to Richard Bull, a scientist funded by the American Water Works Association, "assuming chloramine produces by-products similar to chlorine but at reduced levels, its

Lansing's drinking water has the lowest level of disinfection byproducts among the three major Ingham water utilities.

use could reduce potential cancer risk in a given water supply by as much as 80 percent. This figure is quite variable, however, depending upon whether there is significant contact with free chlorine prior to adding ammonia. The only by-product in water that seems more prevalent with chloramine is cyanogen chloride, a very poorly studied compound." Lansing's BWL had a range of "less than 0.5 to 1.3 ppb" of cyanogen chloride.

The Lansing BWL's pH value range of 9.3 to 9.6 exceeded the secondary MCL which is 6.5 to 8.5. In other words, Lansing's water is more alkaline than the secondary standard permits. A spokesman for BWL said that he disagreed with EPA's standard, attributing the high pH to an outcome of the "overall treatment process." He added that it results in "lower corrosiveness and better tasting water." According to the Michigan Public Health Institute, "acidic waters [a lower pH like 5.5] tend to dissolve lead when it comes in contact with it, and can result in increased concentration in drinking water." It seems then that Lansing's waters, which are alkaline, would result in decreased lead concentration in the drinking water, a good outcome. Interestingly, it happens that the BWL had the highest lead concentrations of the three systems. Ninety percent of the Board's samples were at or below 7.6 ppb. This is about half of the EPA's MCL for lead which requires that "90 % of the samples at or below 15 ppb." East Lansing/Meridian's value was 7 ppb. MSU had the lowest levels, 90% of the samples were at zero.

The BWL was well within the EPA's safe levels for all other regulated chemicals. Comparatively however, Lansing had the highest chloride, sulfate and total coliform bacteria reports than did the two other utilities. Total coliform bacteria was found in 2% of samples in the highest month. The EPA's standard requires that a utility must not detect coliform bacteria in more than 5% of samples. Also, Lansing had the highest levels of one chemical that is not regulated, sodium.

East Lansing/Meridian (the Switch to Chloramine, a New Bug Killer):

This utility has 29 wells, at an average depth of 400 feet, which pumped 7.9 million gallons per day in 1999. Like BWL, lime and soda ash are added at the conditioning plant to remove most of the natural hardness in the water.

As previously noted, East Lansing/Meridian is in the process of switching from chlorine disinfectant to chloramine. The process will begin at the southern edge of Meridian Township. According to the utility, "as the change takes place, customers may notice less taste and odor in the water due to the absence of free chlorine. At first, however, there may be a slight taste difference, odor and discoloration briefly until the free chlorine is flushed from the system. These short-term effects pose no health threat. Running the tap for a few minutes is all it takes to clear the water."

Spartan drinking water is often "hard" and a little metallic tasting. MSU has no centralized water softening plant where lime is added. However all major buildings on campus have softeners for their hot water.

One noteworthy feature of East Lansing's water is its extremely low iron content. The iron, after treatment, is just 0.04 ppm at the plant tap. In contrast, Lansing's range is 0.1 to 0.3 ppm while MSU's maximum was 0.1 ppm. The standard is 0.3 ppm.

Michigan State University (Turbid Waters):

MSU has 17 wells, at an average depth of 400 feet, which pumped 4.6 million gallons per day in 1999. Unlike the other utilities, MSU's water is very hard because there is no water softening plant where lime is added. According to Doug McDonald, a Supervisor at the MSU plant, "hardness is typically 400 ppm in the buildings on campus that do not have their own water softening [device]." He estimates that about 70% of MSU consumers drink hard water.

MSU's water also has a higher turbidity level than the other two systems, a level that appears to exceed drinking water standards [Note # 10: according to some sources there is no turbidity level for groundwater-based water systems; but according to other sources, the turbidity MCL for groundwater is 5 NTU.]. Cloudiness in the water is one sign of turbidity. But most of the time turbidity is not so obvious. Normally, in surface water systems, turbidity occurs when fine particles of silt, clay, decaying plants, parasites and other matter become suspended in water. In Ingham County's groundwater systems, much of the turbidity is related *to iron oxides* in the water, according to McDonald. He said that Lansing and East Lansing can reduce turbidity via their water conditioning plant, something that MSU does not have. MSU's turbidity average level is 1 to 3 NTUs, and it sometimes exceeds 5 NTUs when the plant flushes a well. This compares to Lansing's lower level, which ranges from 0.1 to 0.5 NTU and East Lansing's level (a high of 0.38 NTU in 1999). What does this mean?

According to McDonald, there is no turbidity rule for groundwater systems. But there is one for surface water systems. It requires that "systems that filter must ensure that the turbidity go no higher than 1 NTU. . . in at least 95% of the daily samples in any month." The rule stipulates that, "at no time can it go above 5 NTU." Yet, according to the Michigan Public Health Institute, there is a national standard that applies to all drinking water systems (groundwater and surface water) [Errata # 7: the MPHI only reports on a turbidity rule for surface water systems]. It says that there must be less than 1 NTU per month and less than a 5 NTU average over a 2-day period. According to this standard, MSU frequently exceeds these levels [Note # 11: Since MSU is a groundwater-based system, the turbidity rule does not seem to apply to it. Still, given that MSU turbidity sometimes exceeds 5 NTUs, which according to some sources exceeds the groundwater MCL, one can speculate on possible concerns.] Is this a concern? According to MPHI, exceedences are "not a health threat; however, [exceedences] may reduce [the] efficiency of disinfection by shielding bacteria and interfere with total coliform measurements." In other words, high turbidity can be a problem because disease-causing microorganisms can cling to particles and escape death by chlorination. The good news is that MSU has a spotless record with coliform bacteria.

According to its 1999 Consumer Confidence Report, "Michigan State University is required to do 240 tests per year for coliform bacteria in our distribution system. In 1998, we tested 480 samples, and found no coliform at all."

3. At the tap in Your Home (or on the Campus)

Tap water always contains much more than the two hydrogens and one oxygen (H2O). Minerals, vitamins, bugs, and even low level contaminants combine to give one's water a unique flavor. A cup from East Lansing has a little less iron. Lansing's a dash more sodium. At MSU, the water tastes a little more metallic.

But given a clean bill of health from the water utility does not mean anything if there are high *lead* levels coming from the pipes inside ones home. The EPA estimates that about 40 million U.S. citizens drink water with too much lead. This accounts for about 20% of our exposure to the toxic metal. According to the Michigan Public Health Institute, lead "affects almost every organ and system; most sensitive is [the] central nervous system; [it] can damage kidneys and [the] immune system; [cause] hypertension; [and] deficits in learning abilities. There is no way to know about the lead levels unless you test your water.

According to the RCS survey, about a third of consumers use some kind of water treatment device for their tap (that is about 70,000 Ingham County citizens). Many filters are effective in reducing lead and other contaminants to levels well below the EPA's safe water drinking standards. But some units are overpriced and offer little added protection. Some water specialists argue that filters for Ingham County's tap water are a waste of money. Others disagree. Units can range from about $10 a month to thousands of dollars a year. It's best to check if a filter has been tested and certified. NSF International is a non-profit independent testing organization that has a good reputation. The web address is www.nsf.org.

4. Domestic wells: Survey Finds High Coliform Bacteria in 41% of wells

Most of Ingham County's domestic well owners do not get their water tested on an annual basis. That is, the level of contaminants in much of the water that services about 39,600 people (14% of Ingham County's population) is unknown. In the absence of recent local data on the quality of these wells, we can turn to an excellent 1994 study of domestic wells conducted by the Center for Disease Control and Prevention and the National Center for Environmental Health, for an approximation of the water quality. "A Survey of the Quality of Water Drawn from Domestic Wells in Nine Midwest States," summarizes samples collected from 5,520 domestic wells with an average age of 27 years and mean depth of 154 feet. Unfortunately, Michigan was not included among the nine Midwest states in the survey, but the states that were included, such as Wisconsin, Iowa and Nebraska, are a close approximation of local practices.

The study's main conclusions were the following:

1) Coliform bacteria was present in 41.3% of the samples at levels in excess of one per 100 milliliters. Nitrate concentrations (an indicator of fertilizer contamination) above 10 mg/liter were present in 13.4% of the samples. Atrazine, a weed killer, was detected in 13.6% of the samples, but was found in concentrations above the standard of 3 ppb in only 0.2% of the samples.

2) The key factors associated with high bacteria and nitrate levels were related to construction and condition of the well. These pollutants were more likely to come from an old, shallow, large-diameter dug or bored wells with tile or brick casings than the small-diameter drilled wells with a steel or plastic casing.

3) Samples from wells located near pollution sources were slightly more likely to contain pollutants. These sources included: application of agricultural chemicals; and septic tanks or cisterns within 100 feet of the well.

4) People who drank water with coliform bacteria had a similar rate of self-reported diarrhea as people who drank water that did not contain these bacteria. One explanation for this finding is that coliform bacteria is a sensitive measure of pollution but are weak predictors of diarrhea episodes.

Among the CDC's recommendations were that people who rely on dug or bored wells should be warned about the potential hazards. They also said that, given the frequency of high nitrate levels, infants under 6 months of age should not drink well water with nitrates exceeding 10 mg/liter. This places babies at risk for "blue baby syndrome."

The authors noted that domestic well owners should be periodically monitored for water quality and sanitary surveys. They pointed out that, unfortunately, "once a well is constructed and its water declared potable, domestic well water systems are subject to few regulations."

5. Restaurants, Churches and Others With Private Wells Often Fail to Monitor Their Water

It's one thing for a head-of-household to put a family at risk by failing to test the well water. It's quite another to place scores of unsuspecting customers or students at risk. Indeed, an eating establishment, church, place of employment or civic organization might possess a private well with excessive coliform bacteria, with no one's knowledge. There are 131 of these "Non-Community Public Water Supply" facilities in Ingham County, serving 14,400 people. They are frequently in violation of safe drinking water regulations.

There were 103 violations by non-community systems in Ingham County for the 7 quarters between January 1, 1998 and September 30, 1999. Ninety-one percent (N=94) of the violations involved the failure to collect water samples at the prescribed frequency (a monitoring violation). But nine of the violations (9%) were for coliform bacteria contamination over the maximum contaminant level. These nine facilities included two parks, a VFW post, a golf club, an agricultural school, an oil and gas firm, a U.S. postal service outlet, a state governmental MDOT office and, ironically, an environmental services firm. For a list of the most frequent violators, contact the Health Department.

5. Bottled Water Has Less Strict Standards Than Municipal Tap Water

A March 1999 study by the Natural Resources Defense Council found that one third of 103 brands of bottled water tested contained levels of contamination (including synthetic organic chemicals, bacteria and arsenic) that exceeded allowable limits under either state or bottled industry water standards. While most of the 1000 bottles tested were found to be of high quality, the NRDC noted that even when bottled waters are covered by FDA rules, they are held to less rigorous standards than those which apply to city tap water. Among their findings: there is no disinfection required for bottled water. There is the possibility then, that bottled water can be a threat to people with weakened immune systems, including some infants, the frail elderly, cancer patients and people with HIV/AIDS. The study, "*Bottled Water: Pure Drink or Pure Hype?* can be viewed on their web site at (www.nrdc.org).

Bottom Line: We Do Not Drink Enough Water!

We should drink 8 glasses a day, but, according to a survey, we average only 4.6. A 1999 study by the Center for Science in the Public Interest found that, due in part to aggressive marketing of soft drink companies, the consumption of soft drinks by teenagers has doubled in the past fifteen years.

C. The Three Biggest Threats to the Aquifer (and potentially, your health): LUSTS, Abandoned Wells and the Motor Wheel Plume

1. Leaking Underground Storage Tanks (LUSTS), Most are from former Gas Stations

We zip into the corner gas station for a tank-full, but unbeknownst to many of us is the fact that the 10,000-gallon storage tank buried under the pump may have leaked hundreds of gallons of potentially hazardous petroleum products into the groundwater. The Michigan Department of Environmental Quality lists 33 sites in Ingham County -- including one or more sites owned by Amoco, Total and General Motors -- as Class 1 leaking underground storage tank sites (LUSTS), meaning that they are "an immediate threat to human health, safety, or sensitive environmental receptors." The tanks under most gas stations in the county are not leaking, but the ones that have leaked -- especially the most dangerous ones -- deserve more public scrutiny than they have so far received.

LUSTS Sound Sexy, What are they Exactly?

They are a byproduct of the petroleum age. Ingham County uses hundreds of thousands of gallons of oil and oil byproducts, such as gasoline, each day. A large amount of this material is stored in tanks and an estimated 20 to 40% have leaked. Unchecked, they have the potential to render an area's entire drinking water supply useless. In the U.S. there are well over six million underground storage tanks. Of these about one third are large commercial tanks used by gasoline stations, airports and refineries. Nobody knows how many are leaking but the EPA has estimated that about 300,000 to 500,000 are leaking. That amounts to about 15 to 25 percent.

Like the Y2K problem, there was little thought given to the environmental consequences of placing tanks underground in the 1940s through 1960s. The Michigan Department of Environmental Quality did not seriously confront the issue until 1984 when it established new guidelines that were intended to stop the leaks.

Across the state 37,000 LUSTS have been closed or removed since 1986 and at least 48 municipal well systems have been affected. As of January, 2000, ***Ingham County has more than 1,900 underground storage tank facilities (USTs) of which 499 have been identified as leaking underground storage tank sites (LUSTS), about a 25% leakage rate.*** Of these LUSTS, 281 are "active," meaning that they are currently undertaking remediation of the contamination (but are not yet cleaned up), and 207 are "closed" meaning that the owners or the state completed the required remediated action.

"When I got into this business, back in 1984, LUSTS were given little attention. Since then the state has created an entire division dedicated to nothing else but tanks. I could never have foreseen this. We've spent about $800 million, across the state, to address the problem so far." - *Ben Hall, Storage Tank Division, MDEQ*

How are LUSTS Prioritized for Clean-Up?

In 1995 the Michigan Department of Environmental Quality developed *a four-tiered classification system* for assessing LUSTS. Class 4 sites show no demonstrable long-term threats to human health and include impacted soils greater than 50 feet above the Aquifer. Class 3 sites are considered to be a long-term (will not be a problem for at least 2 years) threat to health, safety or the environment. For example, groundwater might be impacted but it is not expected that contaminants will impact water supply wells for at least 2 years. Class 2 sites are a "short-term threat to human health, safety or the environment. For example, a public water supply may be affected by the contaminants within the next two years.

The greatest attention is paid to *Class 1 sites*, which are designated to be an "immediate threat to human health, safety, or sensitive environmental receptors." For example an active public or private water supply well is impacted or immediately threatened. Ingham County has 44 Class 1 sites (see below). Significantly, the number of sites designated as Class 1 facilities has increased by 25% since 1999 (when it was 35 sites). According to Carol Stuht, a Department of Environmental Quality Official, "it can be safely assumed that many Class 1 sites have impacted the groundwater."

Brian Muench, the DEQ inspector for Ingham County, says that indeed, "Class 1 sites are clearly a serious risk and some have impacted the groundwater, but adds that "in most cases a Class 1 designation is not a serious threat to human health or potable water at all." The impacted groundwater is "most likely a shallow unusable aquifer. . . .It may just be free product that is localized [around the clay]" and traveling very slowly. This is the case with Michigan Bell, an Ingham County site located at 115 West Ionia St. in Lansing. "The leak is contained in a small place, a shallow unusable aquifer, but any site with free product must be labeled a Class 1 and abated."

Then why are sites like Michigan Bell classified as "immediate threats?" "Because anytime there is a leak, there must be an immediate response.

Thus a Class 1 site may not be "an immediate threat to human health or safety," but still be an immediate threat to "sensitive environmental receptors." If there is a threat of explosion or well water, Muench says that "emergency monies are available." If there is an acute problem, "the

Underneath this white walled General Motor's plant at 920 Townsend St. in Lansing there exists, arguably, the worst LUST site in Ingham County. GM's has had more toxic underground LUST releases – fourteen – than any other local corporation. The result? One of the largest LUST plumes in Ingham County. According to the DEQ, it is 'an immediate threat to health, safety or the environment.'

responsible party will do the testing and supply bottled water" to nearby well owners.

Thus, while all Class 1 sites are serious, they are not all of the same level of concern. "They run the gamut from the less serious like Michigan Bell to the sites of greatest concern like *General Motor's BOC Plant 1 (at 920 Townsend St. in Lansing) and Ameritech (at 340 North St. in Mason*). These are the sites with the largest underground plumes. According to Shaw, "the GM LUST is currently being remediated. They have put in deep wells and are recovering free product." Americhem -- which is also being remediated -- is considered by some within the MDEQ to be the most significant site of environmental contamination in the County because of its proximity to three of Mason's six [Erratum # 8: five wells] municipal wells (this is discussed below).

Still, some Class 1 sites are inactive, meaning that nothing is currently being done to address the contamination. Clean up of a site is very expensive, often costing in the hundreds of thousands of dollars. And the responsible party may be long gone. For example, an old abandoned Action Auto site at 2635 S. Williamston Rd. has been classified as an "orphan site" because there is no one available to remediate it. It has been nominated for state monies but there is no guarantee that it will be addressed any time soon. So, despite the best efforts of the DEQ storage tank division, the public is left with a troubling contradiction. On the one hand, we are informed by the State of Michigan that Class 1 sites are an immediate threat to human health or the environment. On the other hand, little is being done at some Class 1 sites to fix the problem.

DEQ officials say that clean up is a very time consuming process, especially when the "responsible party" has failed to do it. They insist that Class 1 tanks get priority attention, "otherwise we can't seek cost recovery which we are mandated to pursue." The DEQ first tries to get the liable parties to do the work, then, if that doesn't work, try other means including placing them on a list for state-funded clean-up, though that could take years. There is still a long-way to go. If the leaker is a wealthy corporation that can afford the clean-up costs, then civic pressure should be mobilized to make them do go forward with the mitigation.

LEAKING UNDERGROUND STORAGE TANKS, BY TYPE
INGHAM COUNTY, APRIL 1999

Total Number of Business Sites with Leaking Underground Storage Tanks (all classes)	**499**
Total Number of Confirmed Releases from Leaking Underground Storage Tanks at the above businesses (a facility may have multiple confirmed releases)	629
Number of Business sites with Class 1 Leaking Underground Storage Tanks ("an immediate threat"); see below for locations. (April 2000 figure)	44
Total Number of Confirmed Releases that resulted in a Class 1 determination. (April 2000 Figure)	74
Total number of Class 1 facilities that are currently being remediated.	To find out, please contact the MDEQ's Shiawassee District Office at (517) 625-4619.

Why Should You Be Concerned?

Your health is one reason. Benzene has been found to be a major contaminant of groundwater as a result of leaching from underground gasoline storage tanks. Still, you must keep in mind that the most common route of benzene exposure occurs at the gas station when you fill your tank. However, if you own a private well close to a LUST, you should be concerned about the quality of your drinking water. There is a small chance that you could be ingesting volatile organic compounds like toluene, xylene, phenol, tetrachloroethylene and MTBE, an additive added to gasoline to reduce carbon monoxide and ozone. A simple VOC test or an organic solvents screen can confirm if one's well has been impacted. They cost more than a regular water test but are important if you are on well water. For information on where to get this test, please contact the Ingham County Health Department.

Economics is another reason. The DEQ has closed a number of municipal wells in Ingham County because of LUST contamination. At a quarter-million dollars per well construction, that's more than pocket change for water consumers. The good news is that if you are on municipal water, your drinking water is not affected. However, some leaks continue to drift close to municipal wells, and are a continuing concern. State and local officials and residents have established six "wellhead protection programs" in Ingham County to protect the most vulnerable municipal wells from contamination of all kinds.

Also, you should be aware that not all USTS are monitored by the DEQ, meaning that Michigan residents do not have to register a wide range of smaller tanks, such as a tank used exclusively for home heating oil for consumptive purposes on the premises where the tank is located.

However some tanks, such as farm and residential tanks holding less than 1,100 gallons of motor fuel, might have impacted shallow drinking wells and caused human health problems. According to a DEQ official, the danger is more in rural areas than in urban areas and in private water supplies. “A tank is a tank is a tank,” said one official. Any spills, no matter what the size of the tank must be reported to the DEQ.

The good news is that in 1987 the EPA put in new guidelines that were intended to stop the leaks. They had three essential elements: 1) new underground tanks needed to be made of non-corrosive materials (such as fiberglass, which degrades more slowly), 2) all new tanks must be equipped with leak detector systems. In addition, owners of commercial tanks must carry at least $1 million in liability insurance to help pay for clean-up efforts (a requirement that caused many small operators to go out of business). Operators were given a decade to comply with the new regulations.

The compliance date was December 22, 1998. Everyone who was out of compliance were subject to a $11,000 fine per day, according to EPA guidelines. In Ingham County there were 93 facilities that did not meet the EPA guidelines by of December 1999. About 30% of these facilities were “red tagged” meaning that that tank essentially was not permitted to be used commercially anymore. Fortunately, through DEQ enforcement action, as of June 7, 2000, only 18 sites remain non-compliant with EPA guidelines. Still, despite the threat of fines, as of April 2000 only two owners have been fined in all of Michigan. The DEQ prefers to seek voluntary compliance and avoid timely court battles. However, with the new guidelines in effect that percentage of leakers should decline substantially from the 25% rate, though some critics still expect a 10-15% leak rate.

But The Number of UST sites (and by implication LUSTS) may be seriously underestimated.

New USTS keep popping up. According to Bill Haun, a former UST inspector, “they are like potatoes, once you dig up one another one appears.” When an assessment was conducted for a new Rite Aid recently, (at Greenlawn and North Cedar in Lansing,) the new owners found a tank that nobody had known was there. Many empty corners in Lansing once harbored a gas station, but records proving their existence are often lost. “Many of these corners have never been assessed,” said Haun. Carol Stuht, a DEQ official, agrees, “every year abandoned tanks are found when property is assessed prior to a sale.”

According to Bob Godbold, Environmental Health Director at the Ingham County Health Department, we do not yet have enough evidence to characterize the scope of the problem at many LUST sites. Godbold says that, in order to properly assess the horizontal and vertical extent of soil and groundwater contamination, the owner must conduct a hydro-geological investigation of the Saginaw Formation aquifer. He said that this is not always done. Ben Shaw, with the DEQ argues that such an assessment is not always required. Muench said that “if it is a small release, we can assess whether the plume extends to the Saginaw Aquifer using other scientific methods.”

Although Ingham is blessed with clay soils (which provide some protection against the movement of these contaminants down from the surface), we have a high water table (of about 10 feet). Thus there is a high potential for water pollution. There are roughly 12,000 drinking wells in the County, 281 active LUST sites, and hundreds of unregulated small tanks, in addition to countless unknown LUST sites that can impact well water.

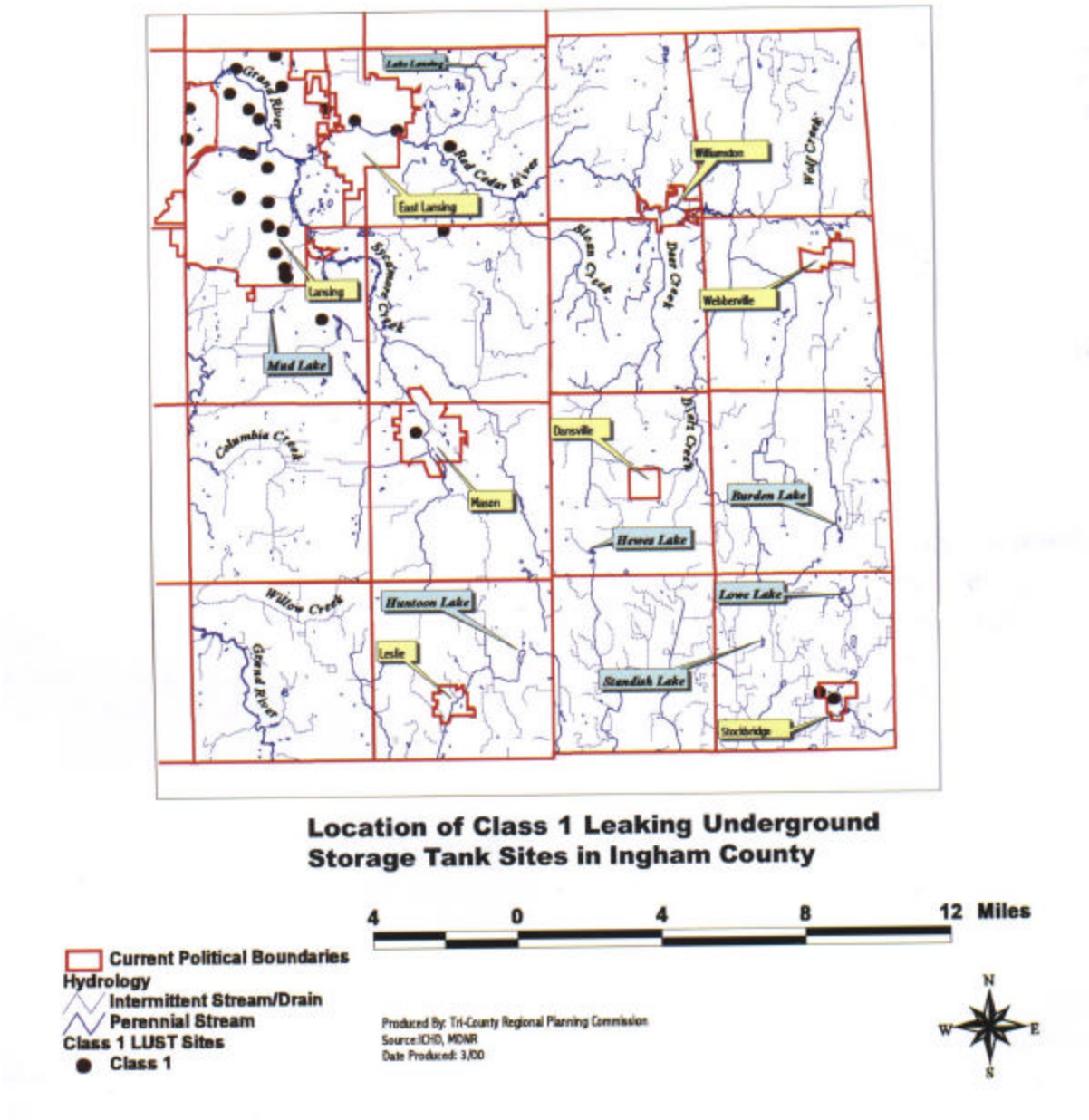
Further, according to Mike Allen, a toxicologist with the Ingham County Health Department, there are thousands of monitoring wells in the county, many associated with LUST sites. "I have not found a LUST site yet that has been required to clean-up monitoring wells as part of its remediation," he said. "It's a growing problem."

Who is Responsible for the Worst Sites?
Businesses that Own (or have Owned) LUST Sites that are an Immediate Threat to Health, Safety or the Environment (Class 1) In Ingham County
Michigan Department of Environmental Quality
April 2000

COMPANY	TYPE OF BUSINESS	TOTAL NUMBER OF FACILITIES	NUMBER OF CONFIRMED RELEASES
General Motors	Car Manufacturer	1	14
Total	Gas Station	7	9
Amoco	Gas Station	4	7
Action Auto	Gas Station	4	6
Shell Oil	Gas Station	2	4
Bay	Gas Station/Petroleum	2	3
Admiral Petroleum	Gas Station	2	2
Americhem Corporation	Chemical Company	1	2
Checker	Gas Station	1	2
Citgo	Gas Station	1	2
Clark	Gas Station	1	2
Muggs & Bopps	Gas Station	1	2
Quality Dairy	Food store	1	2
Waverly Service Building	Service	1	2
Aeroquip Corporation	Aircraft Supplier	1	1
Campus Marathon	Gas Station	1	1
Fresh Up Car Wash	Car Wash	1	1
Lansing Board of Water and Light	Utility	1	1

Michigan Bell	Communications	1	1
Michigan State University	Education	1	1
Miller Oil Company	Petroleum	1	1
Mobil	Gas Station	1	1
MSI	Gas Station	1	1
Paul’s marathon	Gas Station	1	1
Subway (formerly Fuller Service station)	Gas Station	1	1
Superstop	Gas Station	1	1
University Service Center	Service	1	1
Vacant Lot east of Tan Faster	Unknown	1	1
VFW National Home	Cultural Institution	1	1

For a list of the Class1 site locations, please contact us; otherwise, refer to the map below.



We need to have better information about the:

1) extent of residential knowledge about local LUST sites in their communities;
2) number of domestic wells that are within 500 feet of a LUST site;
3) level of remediation at the Class 1 sites; and 4) the number of LUSTS that are close to abandoned wells, particularly if they are in a wellhead protection area.

Priority must be given to the fourth area. Unfortunately, we don't know where most abandoned wells are located. Research is still in its infancy (see below).

What Should Be Done to Address the Problem?

The 1987 EPA guidelines have gone a long way in addressing the problem. However that is not sufficient. According to one observer, we must place tanks into a "secondary containment" (basically a bathtub beneath the tank or a double walled system around the tank) in wellhead protection areas. Wellhead protection is a planning and management program to protect the groundwater from contamination by managing or controlling all potential sources of contamination within an area surrounding a well field.

The EPA does not require secondary containment on new tanks. Secondary containment is, according to the Environmental Defense Fund, the only technical fix that might prevent USTs from leaking directly into soil and water. Instead the new EPA regulations require tanks that are cathodically protected (a corrosion protection method) steel, or fiberglass, or a steel tank clad with fiberglass. According to Liz Browne, a DEQ official, one reason that the EPA did not require secondary containment on all tanks was because of lobbying pressure from petroleum industries.

DEQ officials assert that all new tanks in wellhead protection areas already have secondary containment. However there is dispute by the Ingham County Health Department, about whether the DEQ is even aware of where the wellhead protection areas are located.

The dispute centers around the definition of a "wellhead protection area." Apparently the DEQ does not include a wellhead "delineation" area as a regulated area. But the law says that it must.

Delineation is the first step towards achieving the formal distinction of being a wellhead protection area. If the DEQ properly enforces this law, they must insist upon secondary containment in 6 wellhead delineation regions (East Lansing, Lansing Township, the City of Lansing, Delhi Township, Meridian Township, and Michigan State University). But there is reason to believe that the DEQ is only enforcing the law in two areas of Ingham County, those who have achieved the official status completed a long process of approval as a "wellhead protection area." These are Lansing Township and Delhi Township. We are currently investigating the matter.

If you want to view a map of the delineation areas, and find out whether your home is within a wellhead protection area, go to the DEQ's Surface Water Division web site at: http://www.deq.state.mi.us/dwr/wpu/wpu.html

What you can do

If you live in a rural area, have a shallow well under 150 feet, or your private well is located near a LUST site, by all means get your water tested. Do not worry about the expense. According to Brian Muench, the good news is that the potential responsible party (ex. Americhem in Mason) will usually do this for free, "or their insurance company [will do so] if [your home] is down gradient because they don't want to be sued."

If you live in an urban area -- the most immediate threats are Class 1 sites in urban areas -- learn about the Class 1 LUST sites in your neighborhood and contact your local public official to spur remediation of the site.

Another thing you should do, if you live in a wellhead protection area, is to find out whether or not there is an old abandoned well on your property. If so you can get it quickly plugged at no expense to you. The next section tells you more about the problem.
To find out more about LUSTS in Ingham County visit the MDEQ's web site at:
http://www.deq.state.mi.us/dwr/wpu/wellhead/wellhd.html

2. The Second Threat: Abandoned Water Wells (Empty pipes are direct openings to the deep Groundwater below)

In 1987 the nation was riveted to the story of Baby Jessica, a one-year old child who slipped down an 8 inch-wide, 22-foot-deep abandoned water well in her backyard in Midland, Texas. Fortunately she was rescued. Closer to home, in 1998, firefighters in Leelanau County rescued a woman and a 10 year-old girl who dropped into a well. Wells can indeed be a safety threat. Unfortunately, the media gives far less attention to the more common problems associated with old wells, water pollution.

Like a contaminated needle injecting a disease into a patient's arm during a blood draw, unaware to patient and caregiver, abandoned wells can inject various toxins into the veins of a community's water supply. Wells -- designed to draw water to the earth's surface -- can just as easily conduct contaminants into the ground. And yet, many people, even those who should know better, have no idea about how to identify a well. This can have serious consequences. In 1953 a fuel oil truck operator mistakenly pumped 900 gallons of heating oil down an abandoned well in Holt. This site was once classified as a major contamination zone, but has since been "delisted" by the state, meaning that no efforts were ever made to address this pollution.

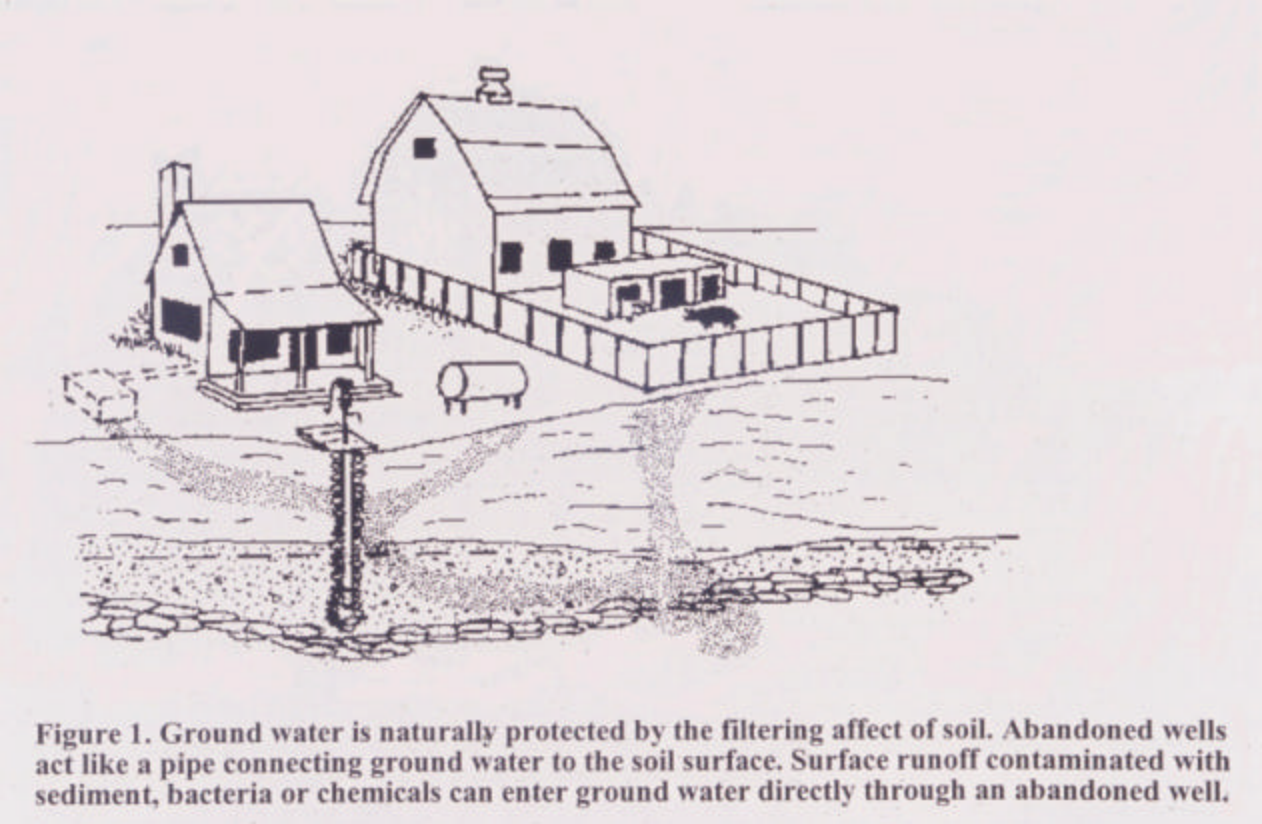


Figure 1. Ground water is naturally protected by the filtering affect of soil. Abandoned wells act like a pipe connecting ground water to the soil surface. Surface runoff contaminated with sediment, bacteria or chemicals can enter ground water directly through an abandoned well.

HOW TO RECOGNIZE AN ABANDONED WELL

- **a pipe sticking out of the ground or the floor of your basement**
- **a depression in the ground that appears to be draining the surrounding area;**
- **a ring of concrete, brick, or stone that could be the remnants of a dug well;**
- **Old sheds, windmills, or structures that may be associated with a well;**
- **a pipe out in the yard that has been capped.**

Abandoned wells are found nearly everywhere. Recently two wells were found just 2 blocks from the State Capitol. One of the wells was filled with waste oil. How did it get there? Years ago, when the dwelling was connected to the Board of Water and Light system, someone decided that the abandoned well would an ideal waste disposal dump. When this misdeed was discovered, the County had to excavate oil out of the entire well and pay thousand of dollars to dispose of the oil.

In some farm areas across the U.S., working wells have been contaminated and cattle have been sickened when fuel oil [Editor's note # 12: the reference to cattle being sickened was anecdotal

data and requires additional fact-checking] seeped into aquifers through abandoned wells. Abandoned wells can also leak pesticides into a drinking well of an adjacent farm.

How Many Abandoned Wells Are there in Ingham County?

We do not know. That is a major problem. Estimates at the State level range from one million to 2.5 million. We only have a good estimate for Meridian Township (just one of 16 Ingham County townships) for which Bob Godbold, the Environmental Health Director of Ingham County, has a list of 8,322 homes likely to at least one unplugged abandoned wells. To date the are no abandoned well maps. Godbold estimates that an estimate of 30,000 may not be too high. "To get a good estimate would require one to count dwellings that existed in Lansing before they got in the water business."

Careless Development Can Cause Groundwater Contamination

As with LUSTS, many abandoned wells are discovered during construction and demolition activities. This can have disastrous results. As recently as January 2000 a construction company demolished a score of homes near Lake Lansing and simultaneously destroyed about 20 abandoned wells before they could be properly sealed. The company refused to seal the wells so the Ingham County Health Department decided to take them court. This was the first time the Health Department has taken someone to court to enforce plugging, underscoring the importance the Department places on insisting that landowners take responsibility for well plugging. The demolition company is under a court order to pay the Ingham County Health Department 125% of the costs that the County incurs in plugging the wells.

What is Being Done? A Census Count for Wells!

Estimating numbers is an abstract exercise. Actually finding the wells takes hard work. Finally, to seal the wells takes a little bit of money (ranging from $50 to $500). Jim McEwen, the director of the Abandoned Well program for Michigan wants to seal all 1 million wells and won't rest 'till he does. The Clean Michigan Initiative has carved out $90 million for surface and groundwater quality. Jim McEwen has asked for about 10 million for the abandoned well program.

Ingham County began its own well identification program in 1999. Eight communities pooled their resources and hired staff from the Ingham County Conservation District to locate and begin sealing abandoned wells. They are using satellites and global positioning systems to track them. As of May, 2000 of the 1,968 homeowners contacted, 175 wells have been found and 146 homeowners have agreed to plug them. Efforts have focused on Meridian township and West Lansing township.

The census efforts are focused upon the most vulnerable areas of the County first. That is, they are focusing on wellhead protection areas around municipal wells in which it would take a contaminant 10 years to travel to a well.

How are they Identified?

Many methods are used: 1) consulting well logs, 2) archival research, 3) interviewing homeowners; 4) visual inspections; 5) metal detectors (more oriented to old farmsteads where there is a thousand acre property); 6) ground penetrating radar; 7) arial photography.

How many wells have actually been plugged in Ingham County?

State law requires the Ingham County Health Department to keep official well abandonment files by law. Every well that is legally and properly plugged has a record in the file. The only wells that may not have a record would be wells that the homeowners did themselves and did not know that they had a legal responsibility to file a report with the Health Department. But, according to officials, there are not many wells plugged by home owners.

The Health Department has records going back to 1996. In 1996 there were 9 wells plugged; in 1997, 65; in 1998, 70; in 1999, 28; and through the first two months of 2000 there were 9. The County has probably sealed less than one percent of abandoned wells.

What Does the Law Say?

State law does not require all abandoned wells to be plugged. After connection to a city water service, state law allows an old well to be kept if it complies with the State Well code. The Well code states that the well water distribution system must be separate from the city water system and the well must be safely maintained. If these conditions are not met the well must be abandoned and plugged.

Few homeowners seal their abandoned well with their own money. Today, if you sell a house, seller disclosure law requires a well owner to inform the buyer about an unplugged well on the property. An unplugged abandoned well can delay the sale of the property. The law also requires owners to plug abandoned wells with impermeable material so that contaminants cannot leak underground. The process is not very costly, ranging from $50 to $500, but many landowners ignore the requirement or are simply unaware of it. There must better education to homeowners about the importance of sealing their wells.

What Needs to Be Done?

According to many observers, we need to establish a relationship with Townships and Cities that would require well plugging as a condition to receiving a demolition permit. The land owner is the responsible party. Unfortunately, the state does not enforce this too strictly. Instead monies have been made available to encourage owners to plug the well. For example, under the Michigan Groundwater Stewardship Program, farmers may qualify for technical and cost-share assistance to plug abandoned wells.

If you identify an abandoned well in your home, you can help out by phoning Jim McEwan at (517) 335-9322. If your home is in a wellhead protection area, the state will pay to have it plugged. That's good for you and good for the water.

3. The Third Major Threat: The Motor Wheel Contamination Site, It Need Never Have Occurred

A Brief History A Brief History

"Waste From Superfund site threatens city water supply," shouted a ***Lansing State Journal*** headline in May, 1997. Indeed, Motor Wheel, a former waste disposal area used by the Motor Wheel Corporation, W.R. Grace, the Lansing Board of Water and Light and other area industries, is responsible for polluting our drinking water with extremely high levels of dangerous chemicals, such as ammonia and vinyl chloride, a known carcinogen. The pollution plume could potentially affect the entire Aquifer, and the drinking water of 230,000 people, if not properly addressed.

Many of the 49 contaminants thus far identified have been under the ground for more than a half-century. Between 1938 and 1978 Motor Wheel and other companies dumped solvents, paints, and waste from wheel making products into the ground. W.R. Grace dumped fertilizers and pesticides into the site. In mid-century, there was little awareness that these materials could hurt human health. But as the 1970s approached, there was increasing consciousness about the dangers.

When water pollution was originally discovered, in 1982, the plume was contained in a small area (in the soils and glacial Aquifer, just under the surface). If addressed at that time, the remedy would have been swift. There would be no story today. However, a 15 year period of legal infighting and debate over who was "the responsible party" has resulted in a scenario few environmental engineers thought possible: the rapid growth of the plume and its entry in the Saginaw Aquifer, the source of our drinking water.

The Motor Wheel contamination site in North Lansing – responsible for the closing of 9 city water wells – is officially off-limits to citizens.

You will recall that there are two Aquifers beneath us: a shallow glacial aquifer and the deeper Saginaw Aquifer, which is our actual drinking water source. The city's drinking water comes from the second Aquifer (Saginaw) below the surface, not the first (glacial) Aquifer.

Some environmentalists recognized the gravity of what might happen as early as 1983. In that year, the Ingham County Health Department cited the company for illegal dumping. At the same time they warned in a report that toxins could leak into the Saginaw Aquifer, the drinking water. But many officials were skeptical of this claim.

By June 1986, the Motor Wheel site was placed on the U.S. EPA's National Priorities List, (the national "Superfund" list of some of the worst environmental sites in the country), but over the next eight years little work was done to research the extent of the contamination.

The penetration of the Saginaw Aquifer was finally discovered in 1994. The plume was traveling at an estimated 50 feet per year and had found openings in the shale that separates the two Aquifers. Some observers believe that the penetration was aided by an old abandoned well, "otherwise it never would have reached the bottom [of the Saginaw Aquifer, about 400 feet down] so quickly." Within weeks of hearing the news, the Board of Water and Light shut down nine of its municipal wells in the area of the plume. They have been out of service ever since. Since its original discovery in 1982, pollution in the groundwater had traveled nearly two miles.

Finally, in 1997, the EPA approved a three step, $30 million plan to place a huge clay cap over the site to prevent further leaching, pump out the contaminated groundwater, and then treat it. Goodyear, owner of the old Motor Wheel site agreed to pay 80%; W.R. Grace and Co., owner of the old Michigan Fertilizer Company would pay 19.5%; the Lansing Board of Water and Light and Textron would pay less that half a percent apiece. The treatment began in November 1997 but soon came to a halt.

Ammonia Pollution is the Most Immediate Problem

In April and May of 2000 water testing revealed that five previously uncontaminated municipal wells now have detectable levels of ammonia. The wells are located northwest and southwest of the disposal site. The confirmed contamination levels ranged from 0.7 to 1.5 parts per million. The EPA had developed a clean-up standard of 1.2 PPM meaning that, with the new developments, W.R. Grace is now required -- by administrative order of the EPA -- to protect the Board of Water and Light Wells, either by drilling new wells or cooperating with the Board on a workable solution.

Bob Franks, the DEQ's project manager for the Motor Wheel site, said,

"W.R. Grace's behavior in Lansing is similar to its conduct in Woburn, Mass, insofar that it often has chosen to litigate rather than work to resolve the pollution problem."

"But rather than comply, the responsible party has been fighting in federal court, trying to get the ruling overturned," said Rob Franks, the MDEQ's project director overseeing the Motor Wheel site. Indeed, W.R. Grace has been resisting both the EPA and the DEQ since 1997, after the government fined it $370,000 for violating its permit by releasing excess levels of ammonia into the Grand River during the Summer. The issue continues to be unresolved.

Why is ammonia pollution important? High ammonia levels in the river can have toxic effects on the plants, fish and animals and cause changes in the balance of species. High levels of ammonia in our drinking water supply could result in nitrates and nitrites, which may cause serious illness in infants, including "blue baby syndrome." And it can cause suffocation in infants. According to the Michigan Public Health Institute, ammonia can be a possible carcinogen when converted to N-nitrosamine. High levels of ammonia can also increase the lead and copper corrosion rates in

the pipes leading to your house, resulting in harmful levels of these two elements in your drinking water.

The Lansing Board of Water and Light is legally required to never permit this to happen (it would break the law). But they are faced with a dilemma. The Board can either shut down the wells permanently or render the ammonia harmless by increasing the levels of chlorine to the drinking water.

Local lads play inside the Motor Wheel site, ambling among the cliffs and ponds, scouting for gold. . . . burying dead turtles and rabbits they find.

But the cure could be worse that the "disease" since high chlorine levels (in the water treatment process) have their own health problems, noted earlier. One must keep in mind that there is about 200 PPB of ammonia in the core of the plume, and the plume is only now beginning its invasion of these 5 municipal wells. The Board can keep the wells closed or decide never to use them again. However, according to a consultant's report, "in the event of a severe drought or, in time, with the addition of new customers, [the Board] may find the need to resume service for these wells."

In a strongly worded statement, the Michigan Environmental Council said in June 2000 that, "the EPA and DEQ are both acting to protect the public health. The company should do the same and fulfill its responsibilities to the community by beginning the cleanup rather than challenging it in court."

A Civil Action in Woburn and a Legal Action in Lansing

Citizens who have followed W.R. Grace's environmental history in Woburn, Massachusetts, (in the 1998 movie "A Civil Action" starring John Travolta, based on the book by Jonathan Harr), may wonder about other similarities and/or differences concerning W.R. Grace's corporate behavior in Woburn compared with its activities in Lansing. In fact, like Woburn, citizens living in the Motor Wheel area of Lansing, have expressed similar fears about cancer clusters and leukemia (see below). In the interests of allying those fears, and/or increasing community right to know, we provide this brief comparison.

In the Woburn case, eight families (each with a leukemia sufferer) brought a civil action lawsuit against W.R. Grace and Beatrice Foods whom they charged had contaminated two nearby municipal wells and made people sick. Between January 1969 and December 1979, twelve cases of childhood leukemia were diagnosed in Woburn. Six of these cases were located in a six-block area served directly by the contaminated wells. The groundwater in the wells was contaminated with industrial solvents, called volatile organic compounds (VOCs), such as trichloroethylene (TCE) and tetrachloroethylene (PCE). Grace argued that the pollutants had probably come from an adjacent river. In July 1986, following a 78-day trial, a six-member federal jury found that Grace had negligently contaminated the wells. But a US District Judge threw out that verdict

arguing that there were inconsistencies as to when the wells had become contaminated. This ruling led to an $8 million settlement with no admittance of wrongdoing on Grace's part.

In 1990, the EPA and the Commonwealth of Massachusetts negotiated a record-breaking $69.45 million Superfund settlement with W.R. Grace and other corporations for cleanup of municipal Wells G & H in Woburn. Shortly thereafter, W.R. Grace began a comprehensive cleanup effort. For more information on EPA activities, see http://www.epa.gov/region01/remed/sfsites/wellsgh.html

In 1997 the Massachusetts Department of Public Health concluded that "the risk of developing childhood leukemia was greater for a child whose mother drank water from contaminated wells while pregnant with the child." To read the 138 page Woburn Childhood Leukemia Follow-up Study see: http://www.magnet.state.ma.us/dph/beha/leukfact.htm

The major differences between the two cases are that the Motor Wheel area has had no reported cancer clusters, nor were there any civil actions taken by local residents against the polluters. Also, unlike Woburn, citizens in the Motor Wheel area have no risk of acquiring leukemia from the local public water supply wells because those wells have been closed.

But the Similarities Are Illuminating

One major similarity in the Lansing case and the Woburn case is that W.R. Grace delayed clean-ups for well over a decade in both instances, denying responsibility and preferring litigation over remediation. A second similarity is that residents of both areas, Woburn and Lansing, are worried about the hazards posed by the nearby Superfund sites. In fact, according to a 1994 government report on Motor Wheel, "*residents of the area are extremely concerned about the hazards* posed by this site as well as other toxic waste contamination sites in the area. [another Superfund site, Barrels, Inc, is located approximately 1 mile southwest of the Motor Wheel disposal site]. They are concerned about air and *groundwater pollution* from the sites, and about their children gaining access to unfenced contaminated areas. In the past, citizens have expressed alarm at what *they believe to be an unusually high incidence of leukemia* and other cancers in the area."

Partially in response to citizen concerns, the U.S. Department of Health and Human Services (with assistance from the Michigan Department of Public Health and the Agency for Toxic Substances and Disease Registry) conducted an environmental assessment of the Motor Wheel area in 1994. As part of their analysis, they compared the incidence and mortality rates of all reported cancers in three zip codes surrounding the Motor Wheel site with the age and sex adjusted rates for all of Michigan. They concluded that the cancer data "do not indicate any consistent pattern of excess cancer incidence or mortality for the residents of the zip code areas in which the Motor Wheel Disposal Area site is located or those adjacent to the site as compared to the rest of Ingham County or to the State." However, they noted, "this does not rule out the possibility that subpopulations in smaller areas near the site experienced excesses. Data do not allow a more localized assessment."

Promised Follow-Up Health Studies Not Conducted at Motor Wheel (another similarity)

The authors noted that one person "living approximately 0.5 mile northeast of the site wrote to MDPH describing a high incidence of various sorts of cancer among the people of her neighborhood. " They replied that "her letter was forwarded to the appropriate section of the MDPH for further investigation." In their concluding statements, the authors delineated a 4 part "Public Health Action Plan." One goal stated that "MDPH, in cooperation with ATSDR, will conduct a health statistics review of cancer incidence in the site area." They said that this would be a follow-up to the cluster analysis and would "determine if an increase in cancer incidence may be associated with site contamination."

But over the ensuing 6 years, there has been no health statistics review. According to one of the study's authors, the letter sent by the resident for further investigation, probably resulted in a return letter explaining that there was not enough evidence to determine more localized environmental cancer causes. In another instance, the researchers never presented data that analyzed leukemia, a major concern of Motor Wheel residents. Moreover, the authors used a relatively crude method of conducting their environmental cancer assessment (for example, they used the entire State of Michigan as a control group rather than a more comparative urban group). A more refined cancer methodology, such as analyzing the region by census tract, might have reached different conclusions.

The lack of a leukemia study was probably a result of the fact that there were no identified paths of exposure (i.e. no contaminants) discovered in the 41 domestic wells and 8 commercial facility wells known to exist within 2 miles of the site. Woburn, in contrast, had high levels of dangerous volatile organic compounds that were discovered in two municipal wells.
But there is one issue that needs to be addressed. According to Mike Allen, the environmental toxicologist at the Ingham County Health Department, "there is no set protocol for analyzing domestic wells around Motor Wheel as there is at other contamination sites, like there is at Americhem (see below), where it is done twice a year." He said that, "seven years ago we [the Health Department] went house to house" to take water samples from the domestic wells [around Motor Wheel] and they found no contaminants. " However, Allen thinks that these wells should be tested regularly. Apparently 1993 was the last time the 41 domestic well homeowners had their water tested.

Though it is doubtful that any of the 41 households draw from the wells for domestic drinking water purposes, in point of fact, the water could be lethal. One of the author's three main conclusions, in 1994, was that

> ***The Motor Wheel Disposal Area site is judged to be an indeterminate public health hazard. The levels of di(2-ethylhexyl)phthalate, 1,2, dichloroethylene, and vinyl chloride in the groundwater at the site would pose significant risks of adverse health effects to anyone drinking the water for long periods, but there is no evidence that the contaminated aquifer is currently being used. The contaminated aquifer does not appear to be connected to a deeper aquifer, which is used as a drinking water source in the site area.***

Unfortunately, a few months after this report was written, it was discovered that the deeper aquifer was, indeed, badly impacted. And, since then, there has been a seven-year time delay in contacting the 41 domestic users of the Aquifer.

In point of fact, vinyl chloride is present in the glacial Aquifer at a concentration of 790 parts per billion. This is an extraordinary number, 395 times higher than the federal health standard (2ppb). In the Saginaw Aquifer vinyl chloride has been measured at 19 parts per billion, amounting in a cancer risk affecting 12 of every 10,000 people, if they habitually ingested the water. But fortunately, no one does.

Quality of Life in the Motor Wheel Area (Emotional Health Effects)

Contaminated drinking water continues to be a concern of some residents, even though they are on municipal water, which is safe. The Lansing State Journal reported on a 32 year old woman that lives near the Motor Wheel site along with her husband and daughter who only drink bottled water.

While this study is limited to water-related concerns, in fact cancer has a number of etiologies, including environmental. In fact, medical anthropologists are conducting increased research in U.S. communities and discovering that community concerns about the environmental etiology of cancer are often met with resistance or silence by medical and public health officials. Martha Balsham, in her groundbreaking 1993 Philadelphia-based study, "Cancer and the Community," found that community concerns about pollution were just as valid an explanation for cancer in their neighborhoods as were the views of medical professionals who regularly insist that personal responsibility over diet and exercise is the main cause.

The Motor Wheel area, like similar industrial areas in the city, needs to be more thoroughly investigated by social scientists using methods such as ethnographic fieldwork and participatory action research. This will uncover hidden concerns and local knowledge that will increase community participation in the resolution of environmental hazards.

D. Capsule Reviews of Nine Other Issues Affecting Groundwater Vulnerability and/or Your Drinking Water.

With the goal of improving community right to know, we present the following stories and data so that you may gain a more well-rounded picture of groundwater issues facing citizens and environmentalists across Ingham County. Vignettes are often the ideal way to communicate complex material. They are also good motivators for action. One of the points in the stories is that citizen action is often essential in uncovering some of these contamination sites in the first place, and for keeping the powers-that-be accountable. Many of the "hot spots" discussed below are well known to water professionals, but ironically, may not be so well known by people living just a few hundred feet away from a pollution site.

The Aurelius Road Landfill has been transformed into a Soccer Complex. Underneath the field, past mistakes continue to do damage.

1. The Mason Esker: An 18-Mile Underground Conduit to the Groundwater Some Mistakes Were Made

Let's go below ground and look at the remains of an old underground stream laid down 10,000 years ago, the Mason Esker. The esker is a an 18 mile long narrow ridge of coarse gravel (stretching from Mason to North Lansing), deposited by an underground stream flowing in an ice-walled valley in a decaying glacial ice sheet. The gravel is a tombstone of sorts. What happened in the Mason esker in the 1960s was enough to send shockwaves into the Aquifer.

Think of the esker as a crack in the armor. In the mid 1960s waste managers used the Mason Esker -- after the gravel was mined and nothing was left but a big hole filled with water – to build the Aurelius Road Landfill. All kinds of waste – residential, commercial and industrial – were disposed of there. The bottom of this landfill consists of sandstone, the top rock layer of the Saginaw Formation! At the time, city planners were not aware of the harm in placing the landfill – poorly regulated at the time – in such a vulnerable spot.

The facility was closed in the late 70's, but not in time to stop the contamination of a number of domestic water wells along Aurelius Road. City water was extended to the areas impacted by the pollution. Worse, is the fact that the plume of contamination will someday, likely reach the City's water supply wells that exists near this site.

Today a new soccer field sits on the spot of the old landfill. This is part of a new wave of "brownfield" reclamation efforts in the city. What once was "brown" (the polluted soils) is today green and vibrant. At least above the ground. Underneath, past mistakes continue to haunt us.

2. Americhem in Mason: City Wells Are Threatened along the Mason Esker, Some Experts Place Americhem in the County's Top Three Groundwater Pollution Sites

Americhem sits over a LUST pollution plume in which solvents and petroleum products sit six feet thick. One highly informed source within the DEQ believes it is the worst pollution site in the county.

One would not want to locate a potentially hazardous oil and chemical storage facility within a half-mile of three city wells, (60% of a city's municipal supply) and atop the fragile Mason Esker, but that is exactly what happened in Mason, in 1970, when Americhem was permitted to take over a 19-acre site located at 340 North Street in Mason. Thirty years later, in the water table beneath the site, there sit solvents and petroleum products (gasoline and diesel fuel) ***six feet thick***. The plume of contamination -- containing triethylbenzenes (TCE) detected as high as 870,000 parts per billion, which is 170,000 times the health-based drinking water value of 5 PBB -- is just 500 feet away from the city well on Curtis Street.

Mason's Curtis Street well is not currently in use due largely to threats from the Americhem site's underground pollution, now just 500 feet from the well. (Summer 2001)

The DEQ calls the site "an acute public health problem," and is overseeing a clean-up. ***In fact, the municipal water --checked every month at the well -- is free of contamination and very safe to drink.*** But, like the Motor Wheel site, if nobody acted to clean up the site, the plume might eventually spread far and wide, contaminating a huge section of the underground aquifer. Just in case the plume does make contact, the city has contingency plans to build another well far away from the underground pollution.

According to the DEQ, "contamination appears to have been caused by past spills, overfills, leaks from piping and storage tanks, both above and below the ground [the site was a gas station in the 50s and 60s] and general mishandling of products." Originally classified as a LUST site, when serious contamination was discovered from a variety of sources, the primary responsibility of the site was transferred to the DEQ's Environmental Response Division. Like some other heavily polluted sites, Americhem is listed on more than one of the DEQ's priority clean up lists.

3. Top Twenty Sites of Environmental Contamination in Ingham County (according to the DEQ's Environmental Response Division). Most Sites Impact or Threaten the Groundwater

When is a park also a toxic zone? In a May 23, 2000 column, John Schneider, columnist for the Lansing State Journal, pointed out that people entering Crego Park, on the northeast corner of Mt. Hope Avenue and Aurelius Road in Lansing, were greeted with that question, so to speak. One sign greets visitors by announcing, "Ralph W. Crego Nature Park, City of Lansing." But just three feet away an ominous sign warns, "No entry. Hazardous substances, Michigan DNR."

One view of Crego Park.

Schneider's follow-up call to the city's Parks and Recreation department revealed that both signs were true. About one-third section of the 220-acre park is contaminated with PCBs, lead, zinc, xylenes (and chemicals found in gasoline), the remains of the John Bean Company who "used the area to demonstrate fire-fighting equipment and agricultural chemical sprayers." Although 43,000 tons of soil were removed in 1994, it was reported that the cost of remediating the forested flood plain area "would be astronomical."

But how does Crego Park compare with other sites of environmental contamination in Ingham County? If one refers to the DEQ's Environmental Response Division's Priority List (below), we see that Crego ranks 7th of 70 identified sites, making it quite significant.

Another view of the Park, more difficult to see from a passing car.

If fact, there is no single list, within the DEQ, that prioritizes the most dangerous or hazardous environmental sites to the Saginaw Aquifer across all seven divisions for Ingham County. The Surface water division focuses on rivers and lakes; and the air quality division pretty much stays with air. Each division has its own method of prioritizing environmental pollution sites, and comparative criteria are often fraught with controversy or uncertainty. Like the separation of the DEQ itself, individual divisions generally base their priority concerns on a given medium (land, water or air), human impact, or some other distinction, such as the likelihood that a site can become eligible for getting external funds for clean up.

The Underground Storage (UST) division, discussed above, has its own system of ranking sites, but their list has not been integrated with the Environmental Response Division (ERD) list. So, Americhem, for example, is listed as a Class 1 site on the LUST list but is ranked number 13 (of 70) priority sites on the ERD list.

If there is any list, however, that gives a good snapshot of the worst environmental sites in Ingham County (aside from the LUST sites), it is the Environmental Response Division's Priority clean up list. The ERD list (see below) is carefully constructed by assigning a site points based on various indicators such as toxicity of pollutant, mobility of contaminant, and its level of penetration in a given medium such as groundwater (the range is from a low of 17 to a high of 42). For example, in regards to groundwater, a site is given 3 points if a hazardous substance is in contact with he groundwater, and 9 points if a Department of Public Health has recommended nonuse of a potable water supply due to contamination. But all mediums are counted, including soils, surface water and air.

MDEQ Environmental Response Division's
Top Twenty Sites of Environmental Contamination in Ingham County
Priority Ranking (February 2000)

Site	Address	Pollutants (Is Groundwater Impacted or threatened: Yes or No?)	Source	Score
1. Ashland Chemical	1800 Glenrose St.	PCE, TCA, 12DCE, TE, Vinyl Chloride, and Cloroethane	Chemicals and Allied Products	42
2. Consumers Power/Lansing Center	530 W. Willow, Lansing	Benzene Fluoranthen, Benzo(a)pyrene (No)	Gas Production and Distribution	40
3. Foster St. Aband Plating Area	722 S. Foster St., Lansing	As, Cr, Cd, Ni, Zinc, Lead (Yes)	Plating and Polishing	40
4. Motor Wheel	2401 N. High St., Lansing	Vinyl Chloride, Ammonia (Yes)	Nonclassifiable Establishments	40
5. Municipal Well Lansing #25 20	Turner St., Lansing	1,2 Trichloroethene, DCE (Yes)	Unknown	40
6. Municipal Well Lansing #30 07	Ottawa St., Lansing	Trichloroethene, DCE (Yes)	Unknown	40
7. Crego Park	Fidelity Dr., Lansing	PCBs, CR, Lead, Cu, Zinc, Xylenes, PNAs (No)	Non-classifiable Establishments	39
8. Municipal Well Lansing #50 20	750 S. Pennsylvania, Lansing	Perchloroethylene (Yes)	Unknown	39
9. Lindell Drop Forge Co.		N/A	N/A	39
10. Motor Wheel, Saginaw St.	735 East Saginaw St., Lansing	TCE, Ba, Lead, Ni, As, Vinyl Chloride, Xylene (Yes)	Fabricated Metal Products	38
11. Burcham Park	Burcham Drive and Park Lake Rd., East Lansing	Lead, Benzene, Vinyl Chloride (Yes)	Refuse Systems (Dump)	38
12. 1408 Lake Lansing	1408 Lake Lansing	Phenanthren, Lead,	Automotive	38

Rd.	Rd., Lansing	As, Zinc, Benzo(a)pyrene, Ni, Dibenzo(ah)anthra (Yes)	Repair Shops	
13. Americhem	300 North St., Mason	TCE, PERC, BTEX, Vinyl Chloride, Methylene Chloride (Yes, municipal well)	Chemicals and Allied Products	38
14. 1818 Bassett St.	1818 Bassett St., Lansing	TCE, Vinyl Chloride, Lead, DCE, Cr, Cd, Ba, Cu, 2-methylnapthale (Yes)	Plating and Polishing	38
15. Adam's Plating	521 N. Rosemary, Lansing	Chromium, 1,1,1 TCA (Yes)	Plating and Polishing	37
16. Al Serra Ford	3500 S. Martin Luther King Blvd., Lansing	Lead, Benzene (Yes)	Auto Repair Garage	37
17. Lake Lansing Sediments	Meridian St. , Haslett	Arsenic (Yes)	Agricultural Chemicals	37
18. Wohlert Co.	708 East Grand River, Lansing	Methylene, Cl, PERC, TCE, Benzene, Fluorene, Vinyl Chloride (Yes)	Automotive Stamping	36
19. Board Of Water & Light, Dye Plant	149 S. Cedar, Lansing	Benzo(a)pyrene, Acenapthylene, BTEX (Yes)	Petroleum and Coal Products	36
20. General Motors BOC Plant #3 (Former Plating Area)	Between Willow and Saginaw Highway, Lansing	Cyanide, Cr, Ni, Cu, Zn (Yes)	Plating and Polishing	36

Seventeen (85%) of the top twenty sites have either impacted or threatened the groundwater. Eight (40%) sites have pollution sources that are directly related to the automotive industry; two (10%) are chemical and allied products facilities; two (10%) are utilities; and three (15%) are sites whose pollution comes from unknown sources.

Those sites whose pollution comes from unknown sources, are all Lansing municipal wells. In fact, of the seventy sites on the larger Environmental Response Division list, ten of them (14%) are Lansing municipal wells. Curiously, all ten have pollution from unknown sources, according to the DEQ. But further investigation might be able to help identify possible suspects. For example, item #8, (municipal well # 5020) has perc as its only pollutant. Perc is strongly associated with the dry cleaning industry. Further investigation of the dry cleaning establishments near that site might reveal a connection.

Overall the Lansing Board of Water and Light has at least 20 of their 110 municipal wells (18%) that are currently not being utilized because of known or potential environmental contamination. Many of these wells are located in old industrial zones.

Each of these pollution sites has a story to tell. One interesting fact to emerge from Schneider's column on Crego Park is that the site was discovered by a woman walking her dog through the park in 1986. Though the city had purchased the park in 1973, it took 13 years for an alert citizen to help bring 200 drums of toxic waste to the attention of authorities. A little citizen investigation of a neighborhood can reveal much more than meets the eye.

4. The Gunn Road Dump, 3 Miles West of Holt
The Importance of Citizen Participation and Inter-governmental Cooperation
(Gunn is Ranked 51st on the ERD List, but Deserves a Higher Ranking)

In 1985, citizens in the Gunn Road area, about 3 miles west of Holt, brought an old dump, which they suspected of being hazardous, to the attention of the Ingham County Health Department. No governmental agency had known about the old dump until then. That August, the Health Department sampled 7 residential wells near that site and discovered "a pattern of unusually high levels of sulfate, chloride, sodium, hardness, conductivity, and, in one case, arsenic relative to known background levels." In December, a total of 34 wells -- all within a one-mile radius of the site -- confirmed these high levels. The Department called a public meeting, informed the community, and has been closely monitoring the site ever since.

Peering into the Gunn Road Dump. Green overgrowth and rusted metal debris.

Over the years the Health Department tried to acquire funding to conduct a thorough investigation of the contaminant plume (including an expensive horizontal and vertical study of the plume), but was unsuccessful. However, it was successful in drawing the attention of the EPA who completed a "draft screening site inspection report" in April, 1990.

The EPA consultants discovered that the site began operating in the early 1950s and that it became a common practice to dump cans, paint, turpentine, oils, and general rubbish there. They reported that three area corporations --Diamond Reo, Motor Wheel, and Oldsmobile -- disposed of wastes such as cinders and ashes at the site. The site ceased operation in approximately 1965, but the damage had been done.

Significantly, the EPA discovered, in 1990, that elevated levels of trichloroethene, 4,4'-DDT, Aroclor, 4,4'DDD and 4,4' DDE were found in the soil samples and that " a potential does exist for. . .TCL compounds and TAL analytes to migrate from the site to the groundwater in the vicinity of the site." In a confidential report, they wrote,

Approximately 164,276 persons could potentially be affected by the migration of TCL compounds [like trichloroethene, a likely human carcinogen] . . . from the Gunn Road Landfill site to groundwater in the vicinity of the site. This population includes the approximately 163,253

persons served by municipal wells [16 of which are located within a 3-mile radius of the site] and the approximately 1,423 persons who reside within a 3-mile radius of the site and are served by private wells.

Some significant migration of the pollutants finally occurred in 1998. The Health Department discovered that vinyl chloride had penetrated 4 residential wells. One well had to be replaced. Ironically, at just about the same time, it was discovered that the Lansing Board of Water and Light proposed putting new municipal wells adjacent to the site and in the "line of fire" from the suspected pollution plume. The Board had apparently put some effort into securing this location, but apparently did not know the specifics about the pollution plume. When Garry Rowe, the Groundwater specialist at the Health Department, found out about this development, he sent the Board a letter describing the direction of the plume and informing them of the recent detection of vinyl chloride.

The Board subsequently decided not to drill a well in this area for now. But they may do so in the future. Randall Roost, the BWL representative, said that, "we had heard about" the contamination, but they had never seen the EPA report. When read the above excerpt from the EPA, he said that he disagreed with the EPA's assessment. He is skeptical about whether the plume would ever reach the proposed well. At some point the Board may drill an observation well to get a better assessment of the plume. Rowe would like a more thorough, "in-depth hydrogeologic study. . .to actually determine the [vertical or horizontal extent] of this plume." In contrast, Roost said that, if they do drill a new well near Gunn and they do eventually detect contamination, "we'll extract and treat it. We will not dispose of the property until our environmental people [assess it]."

The good news is the fact that there is a wellhead protection program in Delhi Township, where the Gunn Road landfill is located. This intergovernmental program -- which is responsible for creating rules to protect groundwater -- is partially responsible for fostering the communication between the Board of Water and Light and the Health Department which help stop the proposed drilling.

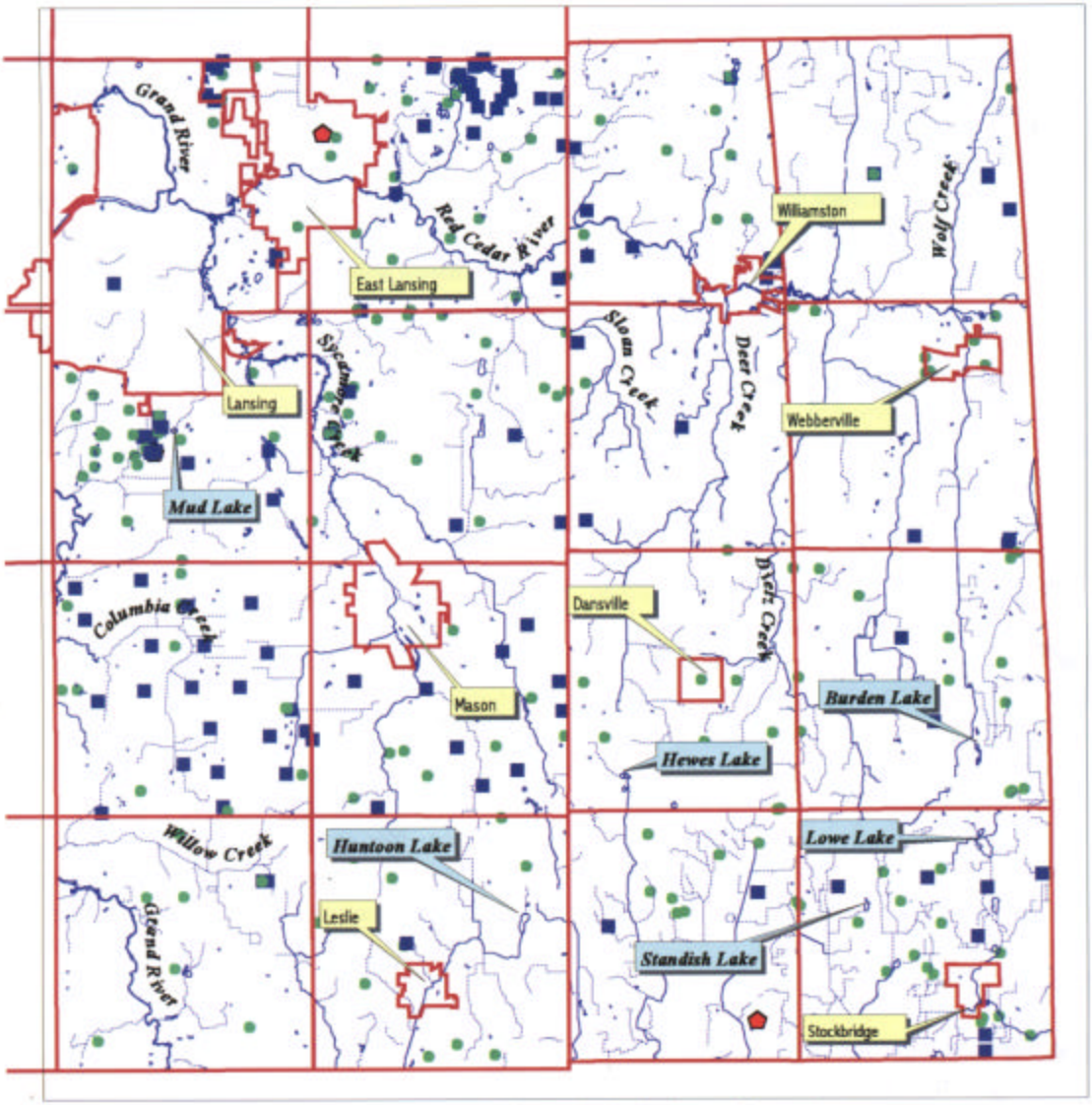
But without citizens bringing the site to the attention the authorities in the first place, things might have been far worse. The Board would likely have drilled the municipal well without any advance warning of a possible problem.

5. Elevated Arsenic in Delhi Township, around Lake Lansing and Elsewhere
New EPA Proposed Standards Place about 10% of Groundwater Beyond the Health Limit

On May 24, 2000, the Environmental Protection Agency proposed that the country reduce the current arsenic standard from 50 parts per billion (ppb) to 5 ppb in drinking water. They said "that this proposal would provide additional protection to at least 22.5 million Americans from cancer and other health problems." The public has 90 days to respond, after which the EPA will most probably make the proposal final.

Arsenic is the twentieth most common element in the Earth's crust and is present in many areas of the soil and rocks of Ingham County. It is widely distributed in low concentrations in groundwater in many places of the country, though there are areas in the U.S. that have been contaminated from arsenic in pesticides and in manufacture, particularly smelting.

In a recent Ingham County Health Department study, there were 422 wells with arsenic levels of 2-110 parts per billion (of 1,819 wells tested). The EPA standard is for concern is currently 50 PPB. There were only three areas that exceeded the EPA's current standard of 50 PPB. However, if the EPA lowers the arsenic standard to just 5 PPB, there will be about 180 sites (10% of all wells tested) that exceed the new standard.



Wells with Documented Arsenic in Ingham County

Current Political Boundaries

Hydrology

Intermittent Stream/Drain

Perennial Stream

Location Of Wells

- **50-110 PPB**
- **10-49 PPB**
- **5-9 PPB**

6 0 6 Miles

Produced By: Tri-County Regional Planning Commission
Source:ICHD, MDNR, MDEQ
Date Produced: 3/00

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Arsenic is classified as a carcinogen by the U.S. EPA. But the health effects of arsenic depend on the concentration of arsenic in the drinking water and the amount of water consumed. Some studies suggest that one would have to consume more than 500 PPB per day for several years before you exhibit certain chronic health problems such as skin abnormalities, anemia or a tingling feeling in you arms or legs (Kosnett, 1997). But other epidemiological studies have suggested that consuming arsenic, even at lower levels, may increase the lifetime risk of lung, bladder, kidney, liver, and skin cancers. Most of the higher concentrations of arsenic were in Aurelius and Meridian townships, near Lake Lansing.

Were some of the arsenic pollution sites human-made? Yes. If you refer to the ERD's Priority Map above, you will see that Lake Lansing sediments are ranked 17th of 70 for priority clean up activities. There are three official arsenic contamination sites near Lake Lansing that so designated because they were used to store the dredged material that was taken from the bottom of Lake Lansing when an arsenic-laden pesticide was applied to the lake decades ago. Currently the Ingham County Health Department is preparing a Request for Proposals to hire a consultant to sample the groundwater down the gradient from these spoils sites to see if the groundwater has been degraded. This will be a complex study. It may be difficult to determine whether the high arsenic levels found around these sites are being caused by the sites or are naturally occurring arsenic.

6. Chloride from Road Salt
Many Major intersections in the County Have Leached Salt into the Groundwater

The road salt used to prevent accidents is getting into the groundwater. Recent studies of chloride contamination in the Saginaw Aquifer have revealed that about 20% of the Aquifer has detectable chloride levels. About 10 areas, constituting only about 2 percent of the Aquifer, exceed the secondary standard for chloride which is 250 PPM. The evidence is that there has been more chloride penetration of the Aquifer than was apparent just 15 years ago.

This is of particular concern, according to Garry Rowe, because these chloride levels may be an indicator that other substances, many unmeasurable, undetectable, or just un researched, may be entering the Aquifer. Naturally there is chloride in the Aquifer; but much of the chloride is also a human byproduct. The contamination results from roadsalt for de-icing street and highways in the winter. Salt reaches the groundwater both from storage stockpiles and from solutions that have been spread on roadways. The Health Department has a map of high chloride area in the County and one of the highest areas sits near Dansville where there is a salt storage facility.

And we do use a lot of salt. Over the past three years the Ingham County Road Commission has applied about 16 to 18 tons per year on its 1200 miles of roads. The Road Commission is experimenting with a new product called Ice-Band, which it adds to salt making it non-corrosive. But this product is very expensive and has its own side effects.

7. Elevated Boron in Williamston Area Groundwater
Are there Any Serious Human Health Effects?
We're Not Sure, But You Should Know About It

There are elevated levels of the element boron in a few pockets of the northeast quadrant of Ingham County's groundwater. Boron is a soft, brown, crystalline substance commonly found in rock formations underground. It is usually found in low proportions in the groundwater and is not a cause for concern. But a 1999 study by Garry Rowe, the groundwater specialist with the Ingham County Health Department, has revealed boron levels that exceed the EPA's health advisory of 0.9 parts per million. The elevated levels may also affect agriculture in the Williamston area.


Surveying Boron and Naturally Soft Groundwater with a Computer Database

Abstract

The risks of boron in drinking water are known by the environmental health community but may not be known by local citizens in Williamston.

Based on the information that we have from the EPA, ATSDR and other sources, it appears that we do not know the actual impact on human health. Boron is currently under review by the EPA, and the health advisory may change.

The EPA's health advisory recommends a limit of 0.9 ppm (per day) for long-term (7 years or more) exposure to boron in drinking water for a 22 pound child. The advisory is 3 ppm, (per day) for long-term (7 years or more) for a 154 pound adult.

What does this mean in English? Well, first you should know that 1 ppm equals 1 milligram per liter. A liter is about 1 quart. Keep in mind that it is recommended that the average adult drinks 8 glasses of water per day, or 2 quarts. This means, that an adult can ingest up to 6 milligrams (3 mg/l x 2 liters) per day and not experience any health effects according to the EPA [Erratum # 9: the previous sentence is mistaken. It should say, "this means that if the drinking water contains just 1 ppm of boron, an adult can ingest 2 quarts of water a day (1 mg/l x 2 liters = 2 ppm boron per day) and not experience any health effects, according to the EPA."] For a child, it is assumed that they drink only a quart of water per day. So children should ingest no more than 0.9 milligrams (0.9 mg/l x 1 liter) per day, according to the EPA.

In his study, Rowe analyzed the water chemistry of 1,509 wells in Ingham County. He discovered that boron was associated with soft-water bedrock wells, which constituted about 15% of his sample. In the 207 soft water wells studied, the median boron level was 1.41 parts per million, in excess of the advisory for children by 0.51 PPM. ***This means that children consuming this water should limit their consumption, and that their parents should learn more about the possible health effects of boron*** **(contact the Health Department).** However, these elevated levels were about half of the long-term health advisory for adults because 1.41 PPM equals 2.82 milligrams per day for an adult drinking 2 quarts of water per day.

What are some of the health the risks for those who have private drinking water wells? That is currently under investigation by a number of researchers. Some medical research demonstrates that women with osteoporosis can actually benefit from a supplement of boron. Doctors often prescribe a boron supplement of 3 PPM to reduce the urinary excretion both of calcium and magnesium. However men can experience reproductive difficulties from elevated boron.

Rowe published his findings in the Journal of Environmental Health (December 1999). He recommended that "the county conduct a health survey of the areas in which the population has been drinking the soft groundwater over an extended period of time." He said that, "a lower-than-expected incidence of osteoporosis or a higher than expected level of male reproductive system problems would indicate that high levels of boron in the drinking water may be having health effects on humans."

In summary, since high levels of boron are associated with wells having naturally soft water (with hardness less than 200 ppm as calcium carbonate), it is advised that private well owners with soft water get their water tested. This is particularly true if you live in Williamston and Meridian Townships.

8. Ruptured Underground Gasoline Pipelines, An Emerging Issue
It Happened in Jackson County, Could it Happen Here?

On June 7, 2000 a 16-inch underground pipeline, that brings gasoline from Chicago to Detroit each day, ruptured, spilling about 75,000 gallons of gasoline in Jackson County. The 600-mile pipeline, which sits about 8 feet underground, spewed gasoline in all directions, gushing into a drain that leads into the Grand River and soaking into the underground soil, placing the groundwater at risk. With explosions a possibility, nearly 450 families were evacuated and 400 private well owners were told not to drink their water. Three couples brought a $ 1 billion federal class action lawsuit against the Wolverine Pipeline Company, saying their land was destroyed.

Working round-the clock, crews skimmed about 50,000 gallons of gasoline from the water. Cleanup will run into the millions of dollars. The full impact on waterways and drinking water might not be known for weeks (as of this writing). Mark Griffin, the president of Michigan Petroleum Association/Michigan Association of Convenience Stores was quoted in the Detroit Free Press as saying, "the pipeline break is the unforeseen thing that illustrates how fragile the petroleum distribution system is in this country."

Could a gasoline spill like that happen in Ingham County? Bob Godbold, the Ingham County Environmental Health Director who helped lead the clean-up effort said that, "given the old pipes, the amount of pipes in Ingham County, and the statistics on spills, it's fairly likely."

More Local Control and Citizen Oversight Needed

Ironically, the DEQ, which oversees leaking underground storage tanks does not have regulatory authority over gasoline pipelines. That authority rests with the U.S. Department of Transportation's Office of Pipeline Safety. Indeed, the lack of local control over inspections is

seen as contributing to the problem. Since 1996 the OPS has reduced its inspections of individual segments of pipeline and reduced its reliance on state inspectors to help evaluate pipeline safety. According to the Detroit Free Press (June 16th), the state of Michigan imposed no fines in 1998 and, in 1999, only imposed three fines of $1,000 each.

In a disturbing coincidence, just a month before the Jackson County accident, the U.S. General Accounting Office (GAO) released a comprehensive study which found that the Office of Pipeline Safety has not enforced 22 of 49 safety regulations that were passed by Congress in 1988. At the same time the GAO reported that the number of accidents has increased by 4% a year. GAO found that an average of 22 people died annually from 1988 to 1998. The GAO study was requested by Michigan Representative John Dingell, who said that the report, "paints a picture of an agency that places disturbing amounts of faith in the industry it is supposed to regulate."

Stricter Enforcement and More Citizen Oversight Essential

The Detroit Free Press reports that Rep. Jay Inslee, D-Washington is promoting legislation that calls for regional advisory panels of people who live near the pipelines to make recommendations to OPS. Inslee did so in the wake of a tragic gasoline pipeline fire that killed two boys and a fisherman in Bellingham, Washington last year.

Bob Godbold, the Ingham County environmental health director who served as a consultant to the Jackson cleanup, agreed. "You must give the public the power to mandate safeguards based on risk," he said. "Petroleum products are the number one threat to the groundwater," he added. Wolverine is currently seeking an easement in Meridian Township to replace eight-inch pipes with 12-inch pipes. Some of these pipes pass close to schools and playgrounds and through wetlands.

9. If You Build it, They Will Come, But Urban Sprawl Can Threaten the Groundwater

The mighty trans-continental railroad encouraged settlement along its California route, just as the local highway system encouraged suburbanization. Build a road and people will come. They'll drive on it, even consider living a bit farther from work so that they can enjoy more open spaces. And, today, if a city extends its "urban boundary," -- its publicly financed water and sewer lines -- the value of the land can increase exponentially. Developers of many shades – industry, businesses, realtors, and even speculators -- will be encouraged to buy land or build. And farmers will be tempted to sell.

Newcomers often desire seclusion from their neighbors. Established industries in the city are tempted to leave behind spoiled lands for isolated, green "industrial parks." All desire the city's water. Those underground pipes are like "gold in them thar hills."

But, too often this development is haphazard and spread out. The density of people per square mile might be a fraction of the urban core. If public water and sewer systems follow the new developments, that will add further incentives for more development. Extending urban

boundaries not only comes at great economic cost (as city dwellers ironically help pay for the suburban flight of their, often richer, neighbors); extending these urban boundaries can also result in a serious environmental cost.

Indeed, according to the Ingham County environmental Health Roundtable, "increased residential, commercial, and industrial land uses in formerly agricultural areas can lead to increased chemical accidents, soil contamination, surface and groundwater contamination and surface water runoff."

But the motivation to extend the urban boundary is very strong. For example, the Lansing Board of Water and Light – already operating with excess capacity -- has an interest in generating new markets for its water. It has recently agreed to increase water supplies to Delta Township and plans to extend its water pipeline network to Aleidon Township.

There is always a tension between economic development and environmental protection. But, given the evidence that we've presented about many of the serious environmental impacts of past development practices, there is good reason to be extra cautious today and conduct environmental assessments of new development projects. And, given that we live in a democracy, there is good reason to involve local citizens in the assessment, the debate and the decision making. This new era of "smart growth" demands nothing less.

There are many organizations involved in "smart growth." The Tri-County Regional Planning Commission is currently undertaking a comprehensive "Regional Growth Trends" study that will spur debate on these questions. And the Ingham County Environmental Health Assessment and Improvement Project, which has produced this document, will spur debate on issues such as the environmental impacts of growth.

SUMMARY AND SOLUTIONS: PROTECTING OUR GROUNDWATER—A REGIONAL APPROACH

A glass of Saginaw Aquifer water is good-tasting, good for you (with the qualifications noted above) and, at about 0.2 cents a glass [Erratum # 10: 0.06 cents a glass], still the best deal in town. Based on current projections, the Saginaw Aquifer has plenty of water for many decades to come, for all purposes, industrial, commercial and domestic. However, it is not the quantity of water that is the concern of the present, but the quality of the water.

Ingham County has 499 leaking underground storage tanks; an estimated 30,000 abandoned wells; well more than 70 sites of environmental contamination (including 3 Superfund sites like Motor Wheel); and several old dumps. The Lansing Board of Water and Light has 110 wells, but there are more than 20 wells temporarily out of service due to real or potential pollution issues. Three of Mason's five municipal wells are within a half-mile of a major contaminant plume.

While the total volume of Saginaw Aquifer water that is actually polluted may be just a small fraction of the estimated 4 cubic miles of water, it is clear that if nothing were done to address these problems and prevent future contamination, the Saginaw Aquifer might go the way of the Dead Sea. A great body of water, unavailable for use.

In 1969 the leading water planners of the day were most concerned about the quantity, not the quality, of the water in the Saginaw Formation. They feared that by 1990 the region might not

have enough water to satisfy the region's needs. They speculated about scenarios in which the Great Lakes and even the Grand River might have to be utilized to compensate for inadequate water resources. They recognized that the key impediment to building a pipeline to Lake Michigan was "primarily an economic one." Today, such a scenario would be a logistical nightmare costing tens of millions of dollars in construction and additional millions in eminent domain buy-outs and litigation.

Fortunately, their fears about water depletion never materialized. But the Great Lakes water pipeline scenario might some day ring true, for our children, if we do not continue our vigilance to protect the quality of the groundwater. We have provided evidence that much of Ingham County's current environmental damage to its water supply is due to a variety of inter-related factors:

- The dramatic loss of wetlands which had served as water purifiers and sources of water sources of water for the Saginaw Aquifer;
- Ignorance about the fragility of Ingham County's underground geology (e.g. landfills and chemical companies located on the Mason Esker);

- Old or poorly constructed storage tanks and car-related waste disposal habits;
- Creation of a water and pipeline system that made old water wells obsolete but potentially dangerous;
- Lack of educational outreach to citizens about the dangers of abandoned wells;
- Illegal Dumping on the part of every sector of society;
- Powerful corporations choosing to litigate rather than help fix a contamination problem;

All of the above issues might be placed under an umbrella called the "unanticipated consequences of development."

Solutions

The Tri-County Area has one of the most energetic and successful organizations in the state dedicated to protecting our aquifers, The Groundwater Management Board. Founded in 1983, the GMB is a unique group founded by 13 local townships and units of government. Funding for the group is provided voluntarily from each governmental unit, based on its population. The major focus is groundwater education. Chaired by Christine Spritzley and led by the Tri-County Regional Planning Commission (TCRPC), the group has shaped the agenda for local groundwater protection. Among their many accomplishments are:

- Educating hundreds of local officials, many of whom had never known about aquifers until they got elected;
- Helped create a wellhead protection program for Lansing, with the financial support of the W.K. Kellogg Foundation;
- Conducted a quarter million dollar Water Regionalization Study in 1990 and a $380,000 Regional Aquifer study with the U.S. Geological Survey in 1994, that shaped water policy throughout the decade;
- Created a Groundwater Resource Center and regional groundwater library, housed at the TCRPC;

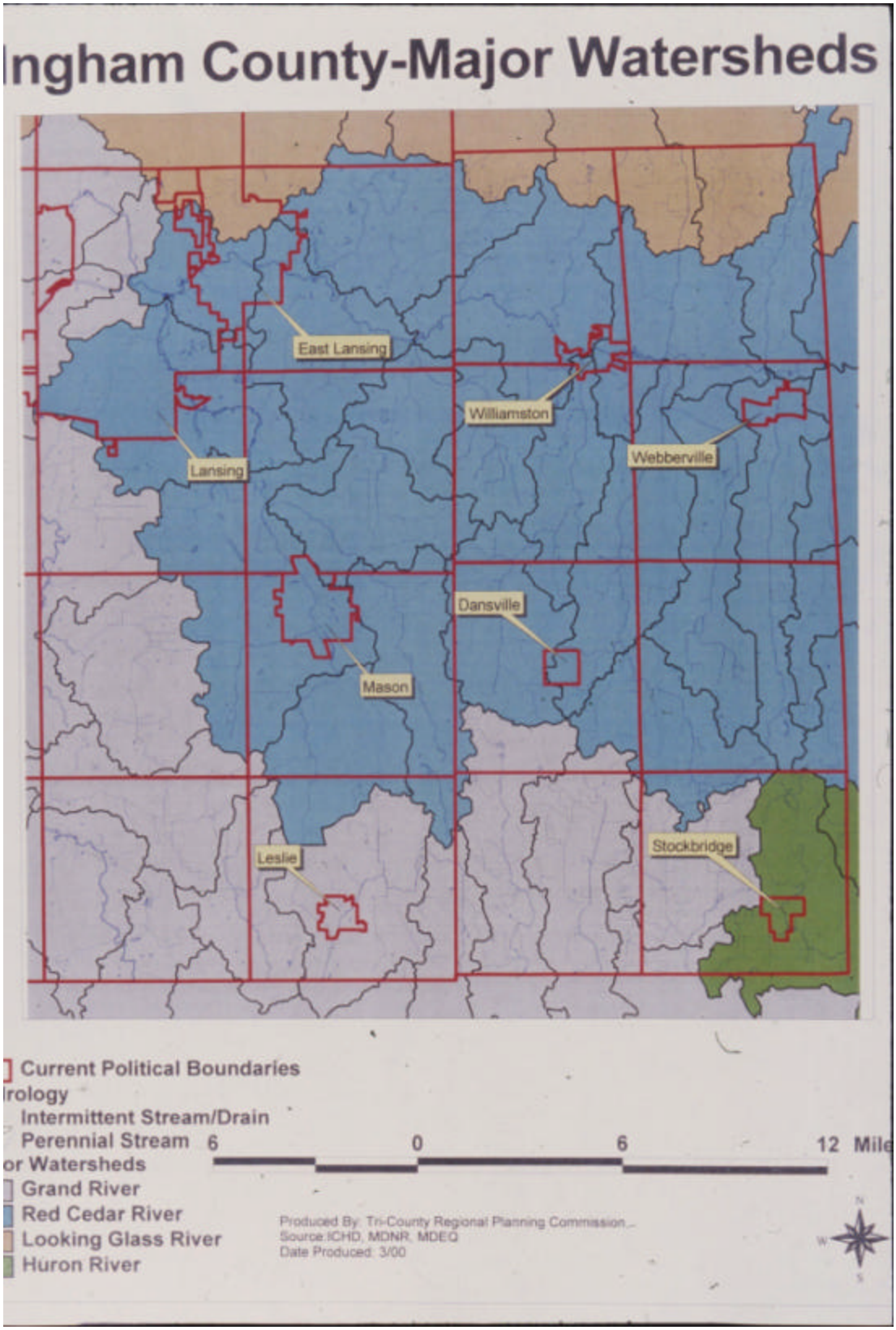
- Organized the First Children's Water Festival in 1995, attended by 1,000 children from the Tri-County Region.

The Groundwater Management Board is the local center of gravity and catalyst for change in Ingham, Clinton and Eaton counties. For more information and to learn how you can become involved, call Ms. Spritzley at 393-0342.

In general, here are some of the activities that will help preserve the Saginaw Aquifer:

- Truthful description of the immense scope of groundwater issues to catalyze action;
- Wetland Preservation and restoration;
- Wellhead Protection Programs;
- Environmental Impact assessments on proposed developments with strong citizen involvement (these are rarely done, but should be required.);
- Abandoned well identification and plugging program;
- Citizen reportage of suspicious dumping activity, or improper waste disposal;
- More resources for governmental education and enforcement;
- Create "smart growth" land use policies;
- Drink more Saginaw Aquifer water!

Ultimately, the only thing that can keep the drinking water clean is awareness and vigilance on the part of everyone.


ngham County-Major Watersheds
East Lansing
Williamston
Webberville
Lansing
Dansville
Mason
Leslie
Stockbridge
Current Political Boundaries
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Intermittent Stream/Drain
Perennial Stream
or Watersheds
Grand River
Red Cedar River
Looking Glass River
Huron River
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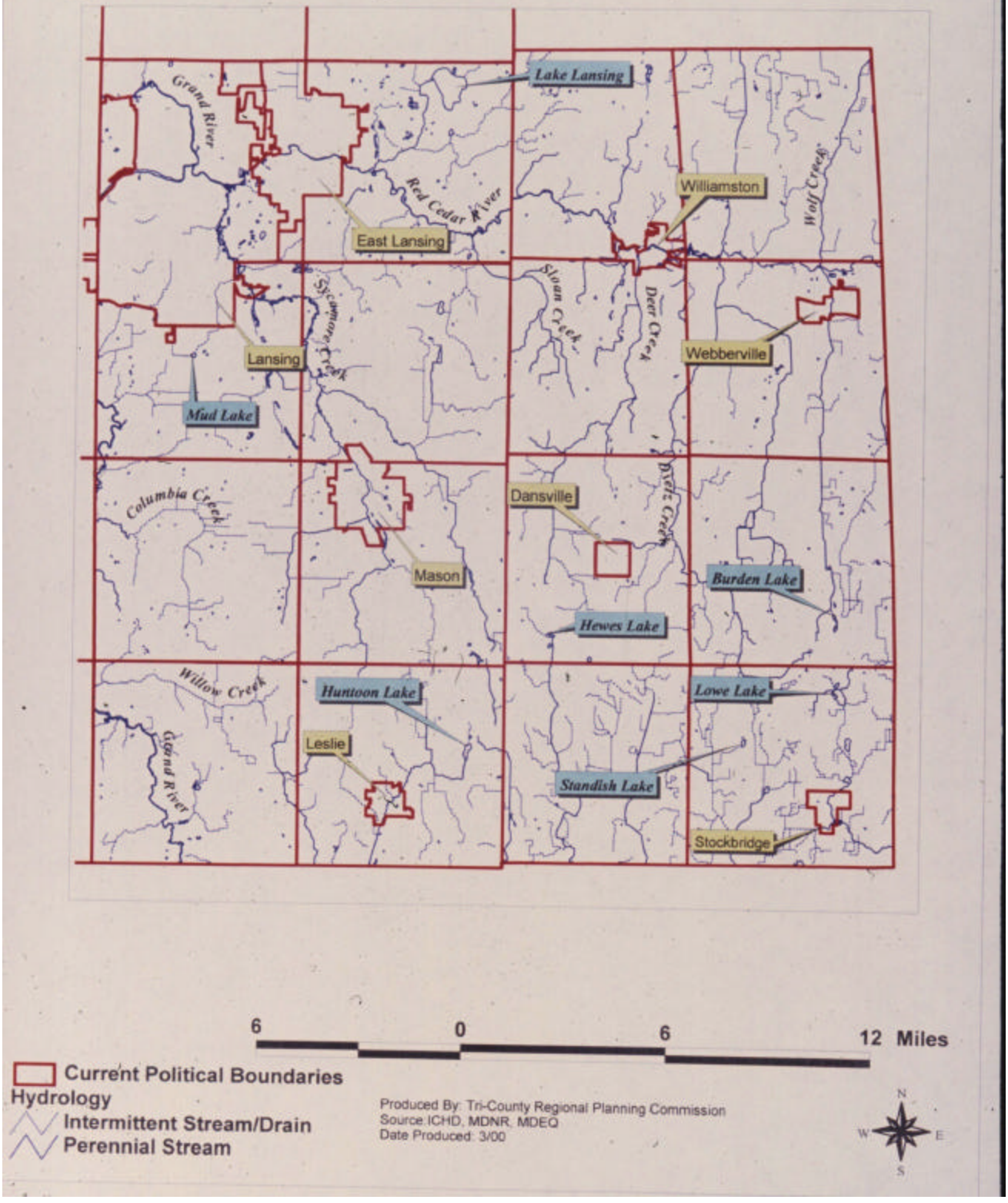
Source:ICHD, MDNR, MDEQ
Date Produced: 3/00

Ingham County-Surface Water Bodies



PART 2: SURFACE WATER

A. Basic Facts

In Search of Burden Lake and Mud Creek

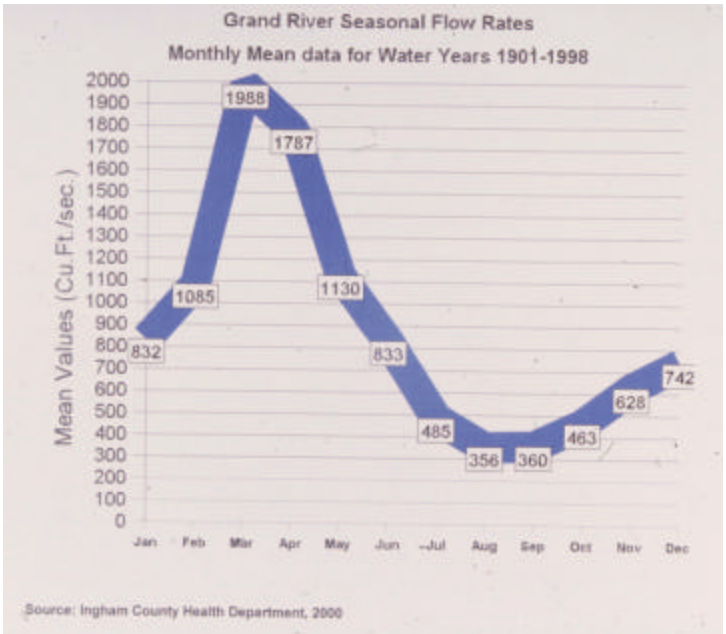
We know the names of our roads better than our streams. And we know them by numbers like 96, 69, and 52, rather than by their earthly descriptors like Hull and Grand, an ancient Indian trail that became a road named a river! We catch glimpses of fall colors as we stream down the interstate, but we don't often stop to look beyond.

Glance at the above Ingham County map and carefully note the tiny blue lines. You'll discover scores of creeks all about. They have names like Dietz, Deer, Doan, Columbia, Willow and Mud (which empties into the Sycamore Creek in Alaiedon Township). There are lakes with handles like Standish, Lyons, Lowe, Lanes, Huntoon and Burden (which sits in Whiteoak Township). There are streams within a few miles of every citizen's home.

Let's briefly look at some known and not-so-well-known natural features of our rivers and streams, taking the well-studied Grand River as our point of departure.

Rivers, Creeks Lakes and Wetlands Do Not Stand Alone

Like all river bodies, the Grand River flows in a natural cycle, reaching its high peak flow in the Spring, when the rain and snow melts, and falling to its lowest level in late Summer. Over the 20th century, the Grand River's highest average flow rate (in ft^3/second) of 1,988 occurs in March (that's about 53.5 million gallons an hour) and the lowest average flow rate (in ft^3/second) of 356 occurs in August (about 9.6 million gallons an hour).



Why then, if there is a long drought, (there have been 2 this century in Ingham County) hasn't the Grand River ever run dry? If fact, why don't all rivers and streams just disappear more frequently than not? During the slow flow periods in August and September where is that water coming from?

It's coming from aquifers! Many citizens are unaware of this fact. River ecologists are only now beginning to look more carefully at this relationship. In a 1998 study by the U.S. Geological Survey, 54 streams across the U.S. were analyzed to determine the amount of groundwater flow into the streams. The analysis indicated that during a 30-year period, a median of 52 % of streamflow was contributed by groundwater! The contributions ranged from 14 % to 90%. One

of the highest groundwater contributions occurred in Northern Michigan, at the Sturgeon River. The Sturgeon River Basin is underlain by highly permeable sand and gravel, and nearly 90 percent of its average annual flow is contributed by groundwater.

In August, most of the water flowing down the Red Cedar River comes from underground Aquifers!

So what about the Grand River? According to Jon Bartholic, director of the Institute of Water Research at Michigan State University, ***about 40 percent of the flow of the Grand River comes from glacial Aquifer contribution.*** In general, the amount of water that you see in late summer, (when the river is at its lowest flow because precipitation rapidly evaporates in the hot weather) is a good indicator of groundwater contribution. That's 356 cubic feet per second (in August) which we then divide into the average yearly flow (880 cubic feet per second) to get the rough estimate of 40 percent. So next time you're feeding ducks on the Red Cedar in August, take a moment to reflect on the water underground.

Still, some Ingham County creeks do run dry because of limited groundwater contribution. Sloan Creek, a tributary of the Red Cedar near Williamston, has virtually run dry in 1954, '57 and '88 when its recorded flow was 1/100th cubic feet per second. That's about 4 and a half gallons a minute, an indicator of drought conditions.

But these are the exceptions. The fact is that some of the groundwater near the very top of the deep Aquifer comes to the surface and is a major contributor to our rivers and streams.

So you CAN see the Aquifer, in a Sense! Why is this important?

Because contaminated aquifers that discharge into streams can result in long-term contamination of surface water. Conversely, rivers and streams can be a major source of contamination to aquifers. According to the USGS, "whether the initial contamination is present in groundwater or surface water is somewhat immaterial because the close interaction of the two sometimes results in both being contaminated." ***Water planners are beginning to spread the message that surface water and groundwater are a single resource.*** This means, for example, that the motor oil that someone secretly pours down a back road can diffuse into a stream and enter an aquifer decades hence.

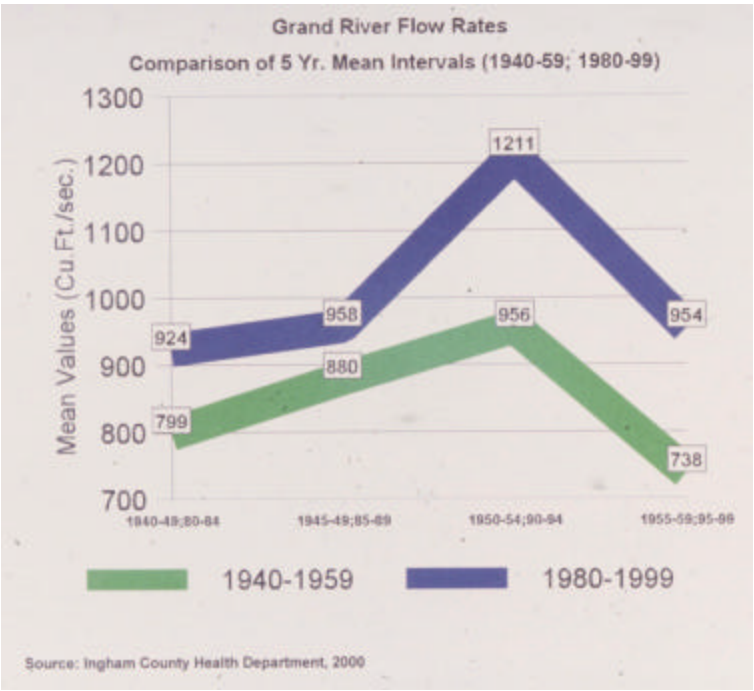
Some rivers, streams, lakes and wetlands contribute to the groundwater in what is called "recharge." Like a battery recharger, surface waters help to re-energize (replenish) the groundwater. This does not mean that the Saginaw Aquifer is an extension of the Grand River, a common misconception. Remember that pumps are drawing water from about 400 feet below the surface, where it may have been underground for a hundred years or more. By the time that river water reaches these levels any contaminants have usually become greatly diluted. However, for

those of you on shallow wells less than 150 feet that are close to a river, you should get your water tested annually.

In the Past 65 Years, the Grand River has Ballooned in Size by 25%. Is this "Un-Natural" or a Normal Cycle?

Lake Michigan is shrinking. In the past 2 years its water level has declined 2.9 feet, the greatest fall since measurements were first recorded in the 1860s. Locally, this Spring, Lake Lansing dropped as well, an estimated 2 feet to a 20 year low (fortunately, it fully recovered by summer). The Grand River is slowing down too. In 1999 its average flow rate was 703 cubic feet per second, its lowest since 1979. The decline in rain and snowfall has contributed to the low levels. This has affected shipping in Lake Michigan -- many boats cannot unload their cargo. And it temporarily threatened recreation in shallow Lake Lansing -- boaters feared hitting bottom – though thankfully it's back to normal as of this writing.

On the other hand, from the long view of history, the Grand River is actually rising! To be more precise, the river is gaining more flow, but with faster flow there are often higher water levels as well. In the last 20 years the yearly flow averaged 1,012 cubic feet per second, which surpassed the 1935 to 1954 flow rate by 25% (809 cubic feet/second). ***In essence, the Grand River has increased its volume enough to absorb a river the size of the Red Cedar*** (whose average flow rate of 215 cubic feet per second nearly matches the increased 202 cubic feet growth). There are alternate explanations for this phenomenon, one possibility is natural causes, the other is "unnatural" or human made causes.



Since 1971 the Grand River's fifteen-year running average has been well over the overall average (1935-1999) of 850 cubic feet. Each data point in a fifteen year running average is nothing more or less than the average of the given year combined with the average for the 14 years previous years to it. This technique helps to more easily recognize trends as it corrects for anomalous years like 1999, in which the average was 703 cubic feet, although the fifteen-year running average was 900 cubic feet.

Is this natural or human made? According to Steve Blummer, the chief of network operations for the U.S. Geological Survey in Michigan, this ebb and flow is probably part of a natural cycle. "A lot of things have to do with loading in the river," he said, "but precipitation is the most significant." He noted that effluent and runoff are contributors to river flow rates but cautioned against assuming that runoff was that important. Droughts are of greater importance. He noted that there were two big droughts, one in the 1930s and the other in the

1960s and suggested that a fifty year time period may not be sufficient to recognize natural trends that may take a few hundred years to complete. In other words the recent increase may be an anomaly. “Given the absence of a good trend analysis,” it might be caused by something else.

Pat Lindemann, the Ingham County Drain Commissioner, offers a different interpretation. “With deforestation, the dramatic increases in housing starts since the 1950s, and the growth of compact soils (e.g. compressed dirt in lawns and soccer fields) “the number of impervious surfaces has skyrocketed, ” he said. “Urban sprawl and river flow pattern are closely linked,” he said. Indeed, flows are increasing on nearly all Southern Michigan rivers where sprawl is a problem.

Urban sprawl concerns Blummer too. The next extended drought – which could occur as early as this decade if droughts follow any kind of cyclical pattern -- could affect Red Cedar river quality like never before. With the great growth in population since the 1930s and the modern problem of combined sewage overflows into the river, a drought situation could arise after an August rain storm (when the river is at its lowest ebb) in which there is more sewage overflow in the river than river water! Not a welcome thought.

A Chance of More Severe Floods in Ingham County?

Wetlands act as nature’s kidneys. They also reduce flooding. They do this by acting as a hydrologic sponge, temporarily storing floodwaters and then slowly releasing them. This reduces flood peaks and helps protect downtown property owners from damage.

The Great Lansing flood of April 18-24, 1975 severely crippled the city and surrounding areas. In Williamston and Lansing 4 to 5 inches of rain fell in 7 hours on April 18. The Red Cedar River reached 12 feet, (five feet above the flood stage), its highest level since 1904. About 4,700 homes were damaged. The total estimated loss in Ingham County was $50 million.

Did earlier wetland loss in Ingham County contribute to the severity of the flood? According to Blummer, “probably, but I do not know of any work that has measured the effect of wetland reduction. You would hope that much of the zoning and planning that has occurred in the past couple decades will aid in reducing damage associated with floods.” But proactive environmental zoning to address water quantity and quality has been rare in past decades, though current initiatives seek to change that.

According to Kris Olson, Co-Chair of the Huron Land Use Alliance and Water Resources Specialist for the Huron River Watershed Council, “flood volumes have increased up to 5 times in developed watersheds. The frequency of high flows in developed watersheds increases from 1 or 2 times/decade to several times a year. Streams in developed areas experience higher spring floods and lower summer flows. These more frequent, larger floods erode stream channels.”

Two centuries ago river flow was different than we see now. More of the precipitation entered the shallow ground water system prior to reaching the river (as opposed to running off quickly). So rivers had higher base flows and lower storm peaks. So floods were less common.

Jerry Lee Crawl enjoys a day's fishing by the Brenke Fish Ladder. Being a sports fisherman, he throws all the fish back into the river. His take this Spring day: 7 blue gill, a walleye, a bull head and 3 rock bass (average 1 ½ pounds).

B. From Wilderness to Agriculture to Sprawl: Wilderness and the Big Fish

In 1790, when Hugh Heward came to Ingham County as an explorer and clerk for the Askin and Robertson Fur Company at Fort Detroit, he wrote in his diary of Chippewa Indians spearing sturgeon -- a mighty fish that sometimes reaches a length of 7 feet and weight of 350 pounds -- along the Washtenong River. Washtenong was the Chippewa name for the Grand River. "Washtun" was a spirit who acted as a guardian of the River.

Two centuries later, John Hesse acts as a modern day guardian of the Red Cedar and Grand Rivers as he saunters along the banks – more than a hundred days a year -- pulling in dozens of steelhead, salmon and small mouth bass. But unlike the Chippewa, he'll probably never catch a sturgeon. "It would be an extremely rare event," he said. "I doubt if there are any upstream of Grand Rapids. They likely would be coming in from Lake Michigan and wouldn't likely be able to pass the fish ladders."

Hesse, a former environmental health specialist for the Michigan Department of Community Health, is angry at those who abuse the Red Cedar River. "Shopping carts, bicycles, parking cones, and trash of all types can be seen littering the river bottom and shoreline," he says.

Indeed, on April 15, Earth Day 2000, about 30 MSU students conducted a Red Cedar River clean-up. Among the debris were 21 bikes, 6 parking cones, 5 shopping carts, 4 manhole covers, 4 hubcaps, 4 police barrels, a giant metal sculpture, an old tire, a mattress, a rug, a couch and a no parking sign.

Hesse is also concerned about other forms of human impact on the Grand River watershed, particularly housing developments. In the 60s he used to steal away to several fishing holes on the Red Cedar, between East Lansing and Williamston, but he laments, "much of what seemed like wilderness then in the stretches between the bridges is now filled with housing developments Access to the river now is much more difficult."

You Can Travel Anywhere in Local Rivers!

According to the MDEQ, property owners along the banks of Ingham County rivers and streams may prohibit trespassing onto their property but not within the river itself. Therefore, if someone can find legitimate access to the river they may go upstream or downstream as long as they stay within the banks.

The Brenke fish ladder gives salmon and other fish a chance to spawn further upstream.

Dams are another problem. They prevent fish like steelhead and salmon from reaching spawning areas upstream. "We want to return the waters to their natural state. Letting fish go as far as they need to find good spawning habitat." Fish ladders have been installed to allow fish passage over 5 dams on the Grand River already, he said. "Currently the Moores River Dam, one at Diamondale, and one at Eaton Rapids are the only remaining barriers to opening up many more miles of river for migratory and resident fish species to utilize freely." The Moores dam captures water for the needs of the Lansing Board of Water and Light. Hesse said that the state of Michigan is moving towards more dam removals but more work needs to be done.

Hesse's enthusiasm for the local waters has spread to his son, Jay, whose 1994 Master's thesis at MSU demonstrated that chinook salmon, a fish introduced to the Grand River in the 1960s, can reproduce in many streams flowing into the Great Lakes! His son's research showed that about a third of adult chinook caught by anglers in the Grand Haven area of Lake Michigan were from natural reproduction, not from hatcheries. Hesse was surprised a few years ago to catch an 11-inch non-hatchery rainbow trout from the Red Cedar in August. Now it's not uncommon to see Lake Michigan salmon (both chinook and coho) spawning in the Red Cedar River each fall and to see large rainbow trout (steelhead) spawning in the spring. For Hesse, it's like old times.

Despite Hesse's enthusiasm for the fishing, it must be noted that the Michigan Department of Environmental Quality recently reported that fish kills in a section of the Grand River (from Moores River Dam to downstream of Lansing) and the Red Cedar (in East Lansing downstream to the Grand River confluence). Sewage from combined sewer overflows (see below) was the main culprit, resulting in higher pathogens and lower dissolved oxygen (so the fish can't breath) in these areas. The Red Cedar River in the vicinity of Williamston has also experienced the above problems, though no fish kills have been reported. The data for the Sycamore Creek watershed indicates that fish and macroinvertebrate communities are poor, and dissolved oxygen low.

In summary, while the wilderness continues to disappear in Ingham County (in the form of lost wetlands, lower water quality, or decreased access to lakes, rivers and streams), the fishing can be very good. Many fish are simply caught and released, others, however, are eaten. This presents another problem that wasn't there in the Era of Pre-European Settlement.

Today, Eating Certain Quantities of a Given Fish Can Make You or Your Child Sick, Unless You Take Certain Precautions

There are plenty of fish to catch in Ingham County. In general, we need to eat more fish. Fish provide a good source of protein and some species, like salmon, provide Omega 3 fatty acids, a terrific health booster. But unlike the Presettlement era, today's Ingham County fish are frequently contaminated with chemicals such as PCBs, mercury, chlordane, DDT, and dioxins. The good news is that, for most locations, the level of PCBs has been declining. But the Michigan Fish Consumption Advisory (Michigan Department of Community Health) lists the Red Cedar River and the Grand River as bodies of water in which women and children should limit their consumption of certain fish. Fish consumption in the Grand River is limited for carp, channel catfish, northern pike and walleye. For the Red Cedar River, PCB levels are high enough than women of childbearing age and children should not consume carp larger than 18 inches in length more often than one meal per month. Women and children should not eat northern pike over 26 inches more often than 1 meal per week.

PCBs Are Declining but are still a Risk

Many Ingham County residents are familiar with the term PCB without knowing much about it. PCB is the acronym for Polychlorinated Biphenyl. Virtually all PCBs are human-made and have come into industrial scale production only within the last 70 years. PCBs represent a large variety of compounds, with the most common historical use as heat stabilizing agents for high temperature oils. PCB compounds were developed and marketed before extensive environmental testing was required.

Studies have shown that PCBs accumulating in mothers' fat tissues and consumed in her diet will pass through the umbilical cord, which supplies the developing fetus with nutrients. There are some studies reporting the potential risk of loss of cognitive function. Prenatal exposure (indicated by umbilical cord serum PCB level) predicted poorer short-term memory function on both verbal and quantitative tests in a dose-dependent fashion, in children at 4 years of age.

Mercury is Rising: There Can be Serious Harm from Tiny Amounts

Mercury in fish is also an increasing public health concern. All inland lakes in Michigan, including Lake Lansing, are under mercury advisories. Mercury is a potent neurotoxin, meaning that, even at very low levels it can cause subtle but permanent damage to the brain and central nervous system. The most common pathway of exposure is by eating fish contaminated with mercury. The EPA estimates that as many as 85,000 U.S. women of childbearing age are exposed to mercury levels sufficient to affect the in-utero brains of their babies, and as many as 3 million U.S. children have elevated blood mercury levels.

Where does it come from? According to the EPA, the largest sources of mercury emissions on a national level are coal-fired power plants (33%), municipal waste incinerators (18%), and medical waste incinerators (10%). Ingham County's largest mercury emitter is the Lansing Board of Water and Light. ***The DEQ estimates that the BWL emitted 145 pounds of mercury in 1993 (the last time that estimates were made). That may not sound like much until one considers that "it could take only .002 pounds of mercury – 1/70th of a teaspoon – to contaminate a 25 acre lake to the point that the fish in that lake are unsafe to eat. (Raloff, Science News, 1991)."*** Another potent source is Michigan State University's coal-fired plant.

Much of the air emissions gather in the atmosphere and are deposited to the ground and surface waters through the rain. Scientists from the EPA and major universities have discovered that the concentrations of mercury in urban centers like Detroit are as high as 65 times the EPA safe level. Even a remote location like Michigan's Sleepy Bear Dunes had as high as 35 times the EPA safe level.

Ironically, hospitals are also significant mercury emitters, through medical waste incineration or simply by dumping mercury down the drain. Lansing's wastewater treatment plant has 232 waste pre-treatment programs in industries across the city to regulate or prevent toxins that are sent to the sewage plant. Significantly, in 1999, despite their best efforts, there were three chronic violators of sewage discharge limits: Litho-Color Services (for silver), Ingham Regional Medical Center (for mercury) and Sparrow Hospital (for mercury).

Educational Outreach at the Riverbank Needed

Fishing for sport or subsistence is popular for many anglers along the Grand River who fish for and eat pan fish, carp, and catfish. For some individuals or their families it is possible that the fish may contribute a meal per week or more during certain times of the year (thus exceeding the fish advisory). For those who consume carp and catfish, which feed among bottom sediments where PCBs have settled out and which have more fat where toxins accumulate, pollutants may be ingested in higher concentrations. We do not have a good count of how many families may be eating above the recommended levels of these fish, in part because many of the fisherfolk do not possess fishing licenses. About 10,000 Ingham County residents do purchase fishing licenses every year, but we do not know how many of these residents fish locally. Direct educational outreach at the river banks is necessary to properly address this issue.

It is necessary to note that Michigan's Fish Consumption Advisories have lower standards for the general population than some other Mid-western States such as Wisconsin (For Michigan's advisory see: www.mdch.state.mi.us/pha/fishadvi.htm). Instead, Michigan has two standards, a lesser standard for the general population and another, more stringent one for women of childbearing age and children (who are more vulnerable to contaminants). A state like Wisconsin has only one standard, the more stringent one, for the entire population.

For Ingham County, the implications of this policy decision are that a man is advised to have "unlimited consumption" of Red Cedar River carp (which have certain levels of PCBs) while women and children are advised against eating more than one meal per month. In Wisconsin, men would be held to the same once- per- month advisory as women and children.

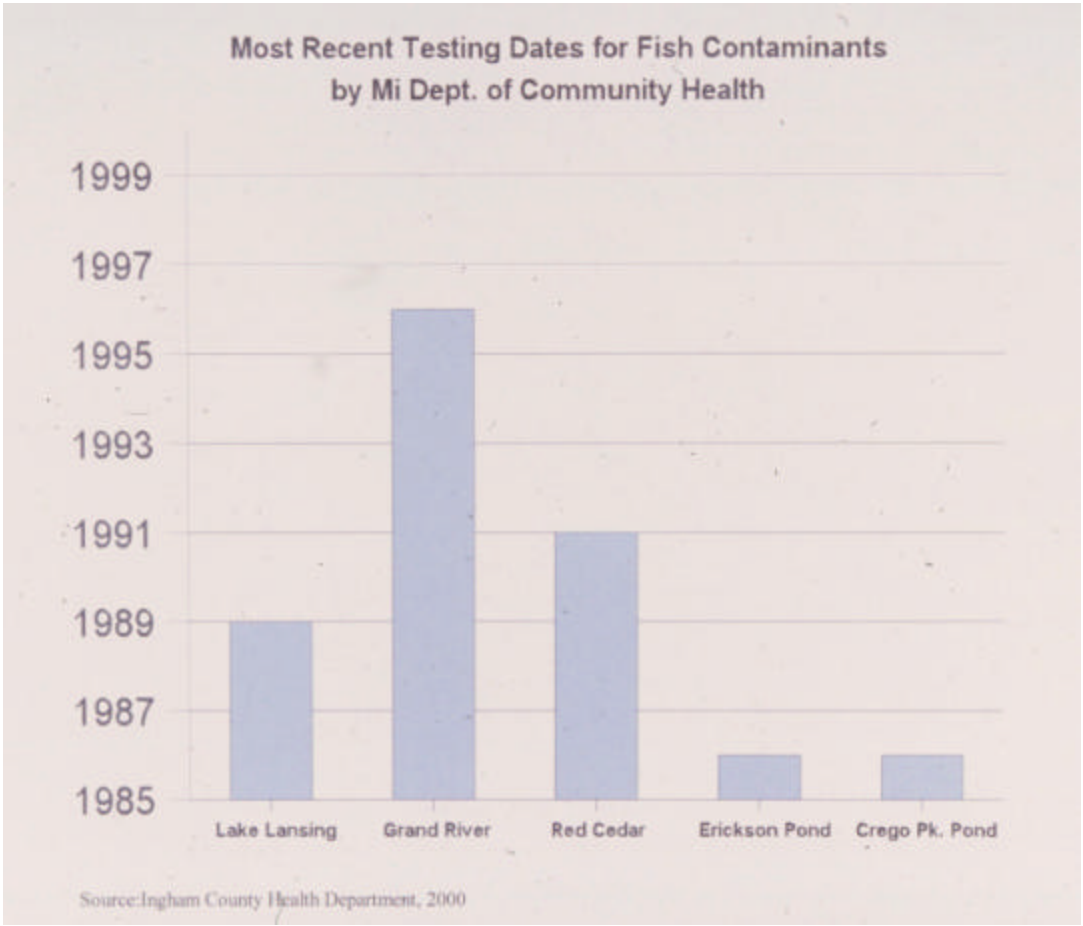
Testing Ingham County fish for PCBs, Mercury and Other Toxins is Intermittent

The Michigan Department of Community Health issues a fish advisory brochure every year telling you, "important facts to know if you eat Michigan fish." One thing it doesn't tell you (besides the information above) is that over the past 15 years only five Ingham County water bodies have been tested. You might have the mistaken impression that since the booklet is reissued every year, the state is updating its research. Not so. See the graph below.

The last time Red Cedar Fish were tested was 1991. And it's been nearly 11 years since fish were tested in Lake Lansing.

According to the DEQ, the average mercury concentration in largemouth bass in the Grand River doubled from 0.21 PPM in 1989 (four fish tested; range was 0.19 to 0.25) to 0.41 in 1996 (six fish tested; range was 0.22 to 0.83). The maximum contaminant level is 0.5 ppm, and one of the 6 fish tested most recently was over that limit. While this might appear significant at first glance, the DEQ said that given the small sample sizes and the differential weights and lengths of the fish, there is no statistical relationship. In other words, the mercury levels didn't really double. But one wonders why the DEQ does not sample the right number and size of fish so that statistical comparisons can be properly assessed? Also, why was the channel catfish tested in 1991 (average mercury level was 0.18ppm, within the safe limit) but not again in 1996 even though it is commonly consumed by local fisherfolk?

Why doesn't the state test more frequently? It costs about $400 to test a fish and the entire testing budget for the state is about $350,000 per year. This restricts the numbers and frequency of testing.



Fish testing can be requested from the Michigan Department of Environmental Quality. They will consider the request, but their prioritization is based on data needs not phone calls. If the state is unwilling or unable to spend the money for testing, perhaps other revenue sources can be found.

Destroying Wildness: The Loss of Ingham County's Wetlands

Many folks think of wetlands as mosquito infested areas, but in fact they are quite diverse natural phenomena, and mosquitoes are often exaggerated as a problem. In the Midwest there are various varieties of wetlands: bogs, fens, sloughs, wet meadows. Many are without standing water for a good part of the year, while others frequently evidence no standing water of note. It is important to keep in mind that most Ingham County wetlands were not destroyed because of the mosquitoes (which were troublesome in many areas), but because of farming.

Destroying our Wetlands. This wetland is up for sale (plot # 16 off Jolly Road, near Belle Chase Way). Note that the owners, Du Charme Developers, are against the 'Rain Tax,' a term used by the Lansing State Journal and others to describe a method of financing the cost of repairing combined sewer overflows.

To many a farmer over this century a wetland was considered "too thick to drink and too thin to plow." Once considered as having little or no value, wetlands are today recognized as important for wildlife habitat, floodwater retention, protection of the land from erosion, the filtering of contaminants and river flow. Over the past 200 years wetlands have declined in Ingham County from about 25% of total surface area [Erratum # 11: about 20%] to just over 3%. This is a wetland loss rate of 90 percent, much higher than Michigan's overall loss rate (an estimated 50%).

Though historically the majority of wetland loss was due to farming, much of the more recent loss -- in areas like East Lansing, Okemos and Haslett -- has been due to new home construction and stores. Urban sprawl is a big part of the problem. Unlike the pre-World War Two era, when communities were compact and people often walked to work or the store, new residential development is very low density and car dependent. The total number of housing units in Ingham County more than doubled, from 49,693 in 1950 to 108,542 in 1990. In 1960 there were 3.27 people per household; by 1990 that dropped to 2.55. And we own more cars per household in the county. In 1970 the number was 1.22, by 1990 it was 1.66, an increase of 36 percent in just twenty years.

All Around the Mulberry Bush? Species Depletion in Ingham County

With the loss of wetlands there has been a parallel assault on many lovely plant and animal species in the County. There are 17 threatened species, 15 plants including goldenseal and ginseng, and two animals, the spotted turtle and the least shrew. There are also two federally endangered species, the Indiana bat and the King Rail, a bird.

The sweet berrylike fruit of the red mulberry tree, the gentle swaying of the Cat-tail sedge, the baying Bog bluegrass. Nearly gone.

It is not merely the loss of habitat that is the culprit, a common refrain. Sometimes it's just the carving up of a wetland that does the deed. For example, according to Pat Lederle, a wildlife specialist with the DNR, the King Rail rattlesnake [Erratum # 12: the King Rail is, of course, a bird, as noted above. Mr. Lederle was referring to a Michigan rattlesnake whose species must be fact-checked.] needs a highland area to reproduce before it travels back down to the lowland part of a wetland. Unfortunately developers frequently take the high ground to build housing.

Housing developers near Jolly road and Dunkle in Lansing take the highland part of the wetland, leaving the lowland for what species remain.

The Drain Commissioner: Historic Foe of Wetlands

Since at least 1819, when Michigan enacted it earliest drainage law to clear wetlands for highways, local drain agents have interfered with the natural wetland landscape of the county. By mid-nineteenth century, most local Ingham County townships were appointing their own drain commissioners, and by 1899 Ingham County elected its first Drain Commissioner. For most of their tenure, local drain commissioners spent a good deal of time emptying the landscape of wetlands. In some areas they helped to make an impassable swamp passable, and thus were an aid to farmers and other developers. A chief concern of the time was clearing "swamp and overflow" areas that were "too wet to profitable cultivate." But they also destroyed thousands of

acres of “clayey” soils that were “usually rich in available plant foods but too wet to farm” in the Spring. At the time it was thought that destroying, ditching and draining were the only ways to make a region habitable or cultivatable. In hindsight the commissioners of the time were throwing the baby out with the bathwater. Many designated "drains" were creeks and streams that were transformed into barren ditches.

This, of course, still happens today. One reason that so many wetlands, farms and open spaces are disappearing is because state law contains many subsidies and incentives for developing them. One of the most troublesome statutes is the Michigan drain code. The current code dispenses many powers to county drain commissioners, who can independently decide where to ditch and dredge, with little public oversight. If a developer’s drainage request to the Department of Environmental Quality is denied, they can often ask and receive permission from a local drain commissioner.

The good news is that Pat Lindemann, the current Ingham County Drain Commissioner, has done much to reinvent the role of the Drain Office. His current efforts reverse decades of destruction as Lindemann and his staff work to preserve, protect and defend the wetland. In fact, they have actually created a new wetland!

The Tollgate Wetlands are a great asset to the Groesbeck community in Lansing. Joggers, walkers and painters abound along its paths.

A Major Success: The Tollgate Wetlands

If you head over to the Groesbeck golf course, off Grand River Avenue in Lansing, keep your eyes peeled for one of the human-made wonders of Mid-Michigan, the Tollgate Wetlands. In the early 1990s Pat Lindemann and his staff at the Drain Office completed work on this wetland ecosystem designed to naturally clean and recharge the neighborhood’s storm water. It’s a unique solution to the problem of cleaning water pollution that is both environmentally conscious and cost effective. It’s also a great place to take a walk or enjoy the wildlife, as many Groesbeck residents do.

When it rains the Tollgate wetlands spring into operation, capturing -- through an intricate web of storm sewers and lilly laden holding ponds -- a good portion of the non-point source pollution of the Groesbeck neighborhood. This includes fertilizer, herbicide and pesticide runoff from lawn care, oil drippings from cars, pet waste, and road salt. Citizens are advised to reduce or remove their use of all these pollutants around their homes, but for those who ignore the warnings, the ecologically sustainable ecosystem is there to exact its Toll. The wetland needs regular maintenance since wetlands cannot remove oil, salt, or herbicides meant to kill plants.

Various native plants were landscaped into the area. And all have a special role to play in protecting water quality or quantity. For example an acre of broad-leafed arrowhead (or “duck potato”) evapotranspirates thousands of gallons of water into the air in a single day. Native

wildflowers like Cat-tail sedge have been planted to provide wildlife habitat and absorb water runoff. The wetland water is also used to irrigate the Groesbeck golf course, having been brought to within water quality standards after filtering.

Other Wetland Recovery?

The news is not as fortunate for the rest of Ingham County. In October 1980 the State of Michigan enacted a landmark wetland statute that changed the rules for developers. Certain wetlands were regulated, including all those that were contiguous with (connected to in some manner) a permanent inland lake system. For counties with a population greater than 100,000 (like Ingham County) all non-contiguous (or isolated) wetlands greater than 5 acres in size were also regulated. Everything smaller than 5 acres was unregulated, meaning that anyone could do whatever they wanted with them.

Regulation did not mean protection, however. Developers -- of a housing project, industrial park, a road etc. -- and homeowners could apply for a permit to develop property. If they were granted permission to destroy a wetland they were required to replace it by building another wetland in another place. They had to build a bigger wetland, at a ratio of 1 ½ new wetland acres to 1 old wetland acre.

How has the program gone? Not very well. Unfortunately, the wetland mitigation rule has been poorly enforced. First of all, for most of the program's history, the DEQ never kept records of the permitted sites. Moreover, DEQ representatives rarely, if ever follow-up with a developer to check whether or not that had actually created a new wetland as they were required to do by law.

In the past three years, the DEQ has placed more effort into getting its house in order, and record keeping has improved. As of June 1999, the DEQ only had records of 23 permitted acres lost to 35.5 mitigated acres (replaced) for Ingham County. But the DEQ does not know whether those 35.5 acres (listed on paper) were indeed replaced, in reality. According to Rob Zbciak, a surface water quality specialist for the DEQ, wetland mitigation did not begin in earnest until the mid-1980s, and even then, many people didn't know about it. Even today the wetland overseers have "a limited staff stretched too thin."

Zbciak said that the number of 23 wetland acres lost to development was "probably low." He said that a better indicator of sprawl was wetland lost illegally; however he admitted that this number is hard to ascertain.

The Grand River is "Seriously Impaired" A Closer Look

We have already indicated the unhealthy nature of the Grand River. Now it's time to discuss this assessment in more detail.

There are, in fact, a host of organizations that have assessed (or report on) one or more aspects of the Grand River. Chief among these is the Michigan Department of Environmental Quality Surface Water Quality Division which -- in addition to numerous special investigations -- conducts a routine assessment of surface water bodies every five years and reports on those

bodies that are in "non-attainment" every two years. Others include the EPA, the Lansing Wastewater Treatment division, Michigan State University, and the Ingham County Health Department.

If you have Internet access, you yourself can go to the EPA's "Surf Your Watershed" web site (http://www.epa.gov/surf3/hucs/04050004/) and look at the data for the Upper Grand River. That data includes information on both Ingham and Livingston counties since this EPA database does not distinguish between county boundaries. However, given that the all waters flow though Ingham County, it is appropriate to discuss the overall health of the entire watershed. Most of the description that follows is based on data gathered by the MDEQ, Shiawassee District Office. However, the EPA has integrated data from a number of sources, so the MDEQ is not responsible for the assertions which follow (though DEQ representatives have reviewed this material and many of their comments have been integrated). Also, the MDEQ does not yet have web-based graphic depiction on the scale or quality of the EPA, and that is why you are being directed to the EPA web site.

You will note 16 indicators of river quality and that the river is doing "better" in five categories (like contaminated sediments.), moderate in 6 areas (like population change) and "more serious: in three areas (discussed below in four sections). There are insufficient data for two areas (sources of drinking water), but as you know by now there will always be insufficient data there because we do not drink water from the Grand River. Let's look at the reasons why the EPA says that the Grand River is "seriously impaired." Note that most of the concerns are agricultural-related phenomenon.

IMPORTANT NOTE: Data on agriculture is provided, due, in part, to the fact that data is easier to identify in this area and so is more available. URBAN, SUBURBAN AND INDUSTRIAL POLLUTION -- FROM LAWN PESTICIDES AND FERTILIZERS, -- MOTOR OIL, ROAD SALT, SEPTIC TANKS AND ILLEGAL DUMPING -- IS ALSO SIGNIFICANT, BUT DIFFICULT TO ASSESS. Many homeowners who live along a river or stream do not know that they need to plant shrubs and long grass to soak up runoff water to help keep the rivers clean.

1. *Wetland loss.* The EPA reports that there has been "a high level of wetland loss in the Upper Grand River Watershed during 1982 and 1992." The loss of wetlands -- which are natural storm water buffers -- has come at the same time that the Grand was continuing to discharge tons of raw sewage into the Grand River after a storm event. In 1997 there were 713 million gallons of raw sewage that swept into the Grand River due to combined sewer overflows. More about this below.

2. *High Levels of Phosphorous pollution:* Reporting by the EPA for the years between 1990 and 1998 found that 43% of 643 observations exceeded their criteria (>0.1 milligrams per liter).

Agricultural fertilizers on farms are a major source of phosphorous. Excessive amounts cause excessive plant growth in lakes and streams.

3. *High Levels of Ammonia Pollution.* Reporting by the EPA for the years between 1990 and 1998 found that 63% of 312 observations exceeded their criteria. Ammonia adds nitrogen to the soil. In areas where the ecosystem cannot handle excessive nitrogen, toxic effects to plants, fish, and animals and changes in the balance of species will result indirectly. It also stimulates the growth of unwanted species and can be converted to nitrate (NO_3) which if it gets into farmer's drinking wells at high enough levels, can cause methemoglobinemia ("blue baby" syndrome) in infants. This is an extremely unlikely situation.

4. *High Level of Potential Impact of Agricultural Runoff, particularly for Pesticides and Nitrogen.* Out of 2,110 watersheds where data are available, (with 1 being the lowest level of impact and 2,110 being the highest level of impact), the Upper Grand ranked 1,772, or in the 84th percentile. This means that the Grand River watershed performs worse than 84% of all watersheds in its agricultural runoff potential.

The potential for ***nitrogen runoff*** was in the 88th percentile. Out of 2,110 watersheds where data are available it ranked 1,854. Recall the nitrogen is related to ammonia pollution (see above). In presence of sufficient phosphorous it can stimulate the growth of plants, bacteria and fungi.

The potential for ***pesticide runoff*** from farm fields was in the 85th percentile. Out of 1,577 watersheds where data were available the Upper Grand River ranked 1,344, a "high potential." The key word here is "potential." Unfortunately, there is no routine monitoring of the Grand River and the Red Cedar Rivers for pesticides, so we do not have hard data on the actual levels. More on pesticides below.

These four EPA indicators are only one data set monitoring Grand River quality. In fact, there are a number of data sets that point to other issues of concern. One of the most serious is the amount of raw sewage that is drained into the river each year after a rain event as a result of combined sewer overflows (see below). Let's continue the story by looking at agricultural pollution, given that the EPA highlighted it.

Ingham County Agricultural Development and Water Quality

Agriculture is a big part of Ingham County. Acre by acre, it consumes 54% of the land. Therefore, what occurs on this land potentially has a big impact on water quality. ***Troubling is the assessment by the Ingham County Soil Conservation District, that roughly 65% of agricultural acres in the Red Cedar River watershed (which encompasses Ingham and Livingston counties) do not use of best management practices (BMPs) such as conservation tillage, nutrient management, grade stabilization structures, pest management and buffer strips (to prevent runoff from going into streams).*** The lack of the BMPs contribute to the siltation (the loading of sedimentary material composed of fine mineral particles), pesticide and nutrient loading discussed above.

One cannot simply blame farmers, anymore than we can simply blame citizens for applying fertilizers to their lawns and gardens. To understand agricultural pollution one must have a better understanding of the larger cultural context: 1) the economic pressures on local farmers; 2) the desire of farmers (both family farmers and agribusiness) to make a profit and 3) the lack of environmental awareness on the part of many farmers.

Let's begin with some basic facts about local farming.

What Our Farmers Produce

Ingham County farmers are a source of local pride. Farmers work long hours, often under potentially hazardous conditions. As of 1997, 53 percent of Ingham County land (190,405 acres) were devoted to farming (crops and livestock).

THE MAJOR CROPS, IN ORDER OF ACRES DEVOTED TO THEIR GROWTH, (IN 1997) WERE:

- Corn for grain (49,300 acres)
- Soybeans (48,705 acres),
- Wheat for grain (18,481 acres)
- Hay (18,466 acres).

THE MAJOR LIVESTOCK, IN ORDER OF THEIR NUMBERS (IN 1997) WERE:

- Hogs and pigs sold (15,761 animals on 37 farms, an average of 426 per farm; there were four farms with 1,000 or more hogs and pigs sold)
- Milk cows (6,097 animals on 80 farms, an average of 76 per farm)
- Poultry 20 weeks old and older (2,317 on 61 farms, an average of 38 per farm)
- Beef cows (2,203 animals on 132 farms, an average of 17 per farm)
- Sheep and Lambs (2,105 animals on 48 farms, an average of 44 per farm)

Many of these production activities affect the groundwater and surface water in Ingham County, but data collection in many areas is still in its infancy.

Farmers Are in Retreat

They have been since 1790 or so, when 90 percent of the U.S. population lived on farms. Today that's just over 3 percent. In Ingham County this trend is quite evident. The amount of acres devoted to farming has shrunk appreciably in 15 years, from 222,742 acres in 1982 to 190,405 in 1997, a drop of 15 percent. Moreover the number of farmers has fallen from 1,105 in 1982 to 827 in 1997, a drop of 25 percent in just fifteen years. And, a telling statistic, the average age of an Ingham County farmer is rising, from 49 in 1982 to 54 in 1997, indicating the difficulty in attracting youth to farming.

One reason is the poor return on investment. According to the 1997 Census of Agriculture, fifty-seven percent of Ingham County farms suffered net losses in 1997 with the average loss per farm of $18,649. At the same time government payments per farm have dropped significantly, from $5,545 in 1987 to $1,711 in 1997. That is part of the reason why about 55% of farm operators do not list farming as their primary occupation in Ingham County. Indeed 44% of all Ingham County farmers worked off the farm 200 days or more.

Another reason that we are losing farms is the tax structure. Right now farmers are taxed according to development value (a higher tax rate based on the potential for building housing, malls and other forms of development). There is an initiative in the state legislature to change this and tax working farms at a lower tax rate.

Moreover, there is a trend towards larger farms. On average, farms have grown from 202 acres in 1982 to 230 in 1997. Moreover the number of farms over 1000 acres in Ingham County has grown from 29 in 1987 to 36 in 1997, an increase of 24 percent. Conversely, the percentage of rental farms has more than doubled advancing from 5 percent of all farms (51 farms) in 1987 to 13 percent of all farms (109 farms) in 1997. If a farmer cannot afford the capital equipment and operating expenses to run the fields, but still wants the farming life, there is often little choice but to rent from corporate agribusiness.

Farming as a principal occupation has always been a risky enterprise, but the economics associated with it has had a dramatic effect on farmers' livelihoods. Impelled to keep inputs (like costs of fertilizer, pesticides etc.) down, farmers do what they can to stay in business, like soil tests to provide information on the proper amount of inputs needed on the farm, or the use of satellite technology (global positioning systems) to identify the precise amount of input to a specific piece of land.

Pesticides are one area of concern. Over the past 50 years most Ingham County farmers have adapted to the pesticide revolution (though there is a growing movement of organic farmers in the county). Farmers in general desire cheap and effective pesticides. Many farmers express skepticism of EPA guidelines that remove certain pesticides from the market. In fact the MSU Extension has an information sheet, "Pesticides at Risk," which alerts farmers to those pesticides likely to be taken off the market in the near future.

Types of Pesticides Used on Ingham County Farms

There are four main types of pesticides (including fungicides and herbicides) used on Ingham County farms. Two have fallen in the past 10 years (insecticides and nematodes), and the use of the other two has risen (disease-related applications and herbicides). Here is a breakdown:

Two have diminished:
1. Pesticides for insects (used on 34,561 acres in 1987 and fell to 19,065 in 1997)
2. Pesticides for nematodes (used on 10,804 acres in 1987 and fell to 2,779 in 1997)

Two have increased:
1. Pesticides for diseases (used on 2,216 acres in 1987 and increased to 3,353 in 1997)
2. Pesticides for weeds (used on 82,784 acres in 1987 and increased to 102,413 in 1997)
Most (about 60%) of Ingham County pesticides are herbicides (or weed killers).

Some pesticides are "restricted use, " which require a necessary certification course for the applicator. The leading restricted use pesticides applied to area farms (as of 1997) are:

PESTICIDE	TYPE	TONS	% OF TOTAL
Atrazine	a weed killer	59 tons	47%
Acetochlor	an insecticide	27 tons	21%
Alachlor	an insecticide	15 tons	12%
Cyanazine	a weed killer	12.5 tons	10%

Note that Cyanazine is a pesticide that was in use on 12.5 percent [Erratum # 13: this should read 10 %.] of all Ingham County crops in 1997 (mostly for feed corn). However in 1995 the manufacturer of Cyanazine voluntarily agreed to phase out production over a four-year period in response to concerns about the herbicide's carcinogenic potential as a contaminant of food and drinking water.

In 1993, the U.S. Department of Agriculture (USDA), the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) pledged to have **75% of the U.S. agricultural acreage under IPM by the year 2000** and to reduce the use of pesticides. Local data are difficult to acquire, but as noted above, the Ingham County Conservation District estimates that only about 35% of farmers have reached that goal.

Atrazine: Ingham County's Number 1 Restricted Use Pesticide: Controversy Surrounds its Use

According to a 1998 publication by the U.S. Geological Services, "pesticide contamination of groundwater and surface water has become a major environmental issue." One pesticide of concern, for both the USGS and the EPA, is Atrazine.

Atrazine is classified as a possible human carcinogen by the EPA. In animal studies it causes damage to liver, kidneys, and heart. It also causes tremors and changes organ weights. The health standard is 3 parts per billion. The EPA reports that Midwestern corn farmers have a 1 in 863 lifetime risk of cancer from Atrazine if they mix and apply it on their own, eat a typical diet or

get their water from the surface. Atrazine is also under scrutiny for its possible role in breast and ovarian cancers. According to the Michigan Public Health Institute, atrazine is long-lived in soil and moves quickly to the groundwater. It has a low toxicity to mammals, birds, fish but aquatic organisms are susceptible at levels less than 10,000 parts per billion. And it "tends to bioaccumulate." The mounting evidence of atrazine's dangers was enough to prompt countries around the world to ban it, including Italy, Germany, Sweden, Hungary, Austria, Norway and the Netherlands. It is not banned in the U.S., its biggest market. Ciba-Geigy, a chief manufacturer of Atrazine (and which has a plastic production facility in East Lansing), has successfully resisted moves by the EPA to take a more aggressive stance. In fact, the EPA's 1992 changes, which helped insure that there would be no ban in the immediate future, were actually proposed by Ciba-Geigy.

A counterpoint, put forward by the University of Nebraska's Cooperative Extension office, argues that atrazine should not be banned, but its use better managed. In their 7 page guide "Questions and Answers about Atrazine, " they say,

> ***Banning atrazine would reduce the contamination problem, but could also increase other health and environmental risks. Corn and sorghum producers would likely compensate for the loss of this weed control tool by increasing reliance on cultivation and/or alternative herbicides. Increased reliance on tillage for weed control increases soil erosion by wind and water. Alternative herbicides generally provide less weed control and are more likely to cause sorghum or corn injury. Furthermore, increased use of alternative herbicides may create a different set of environmental and health concerns. Atrazine, which has been in use for over 30 years, is much better understood than newer herbicides that show promise as atrazine alternatives. Zero risk sounds appealing, but does not reflect reality.***

The good news is that no Atrazine has been detected in any of the municipal water supplies (the drinking water for almost 90% of us) as it leaves the treatment plant, according to the MDEQ. But the area of potential concern is the surface water. The DEQ does not measure pesticides like Atrazine in our surface waters. The news is not good in areas where the pesticide has been studied.

In the largest study to date, the USGS found Atrazine in 990 of 1,604 water samples from Midwestern streams, rivers, and aquifers from 1989 to 1994. During the Spring planting season, enough of the weed killer vaporized off Midwestern farms that it could be detected in 23 state[s] as far away as Maine. In a separate study by the Iowa Department of Natural Resources, Atrazine was sometimes found in concentrations exceeding 10 parts per billion in Iowa raindrops.

According to the Center for Public Integrity (1999), many Midwestern reservoirs and rivers routinely violate the safety standard during the spring growing season, when rains wash atrazine off fields and into water supplies. They point out that,

> ***But water suppliers have been slow to install the costly filtration equipment that is needed to comply with the safety standard, which did not take full effect until 1996. It is easy to understand why: the potential price tag is staggering. Nationwide, the cost of complying with all of the EPA's standards for pesticides in drinking water could cost from $152***

million to $465 million per year, with much of the cost attributable to atrazine, according to a study by the American Water Works Association.

Given the amount of Atrazine on Ingham County farms, 59 tons in 1997, the issue deserves better study locally.

*Farm *A*Syst*

There is a program actively involved in outreach to local farmers in Ingham County, *Farm *a* Syst.* Since 1996 the organization, based at the Ingham County Conservation District, has provided services to about 10 to 15 percent of Ingham County farmers. FAS is a voluntary and confidential assessment tool which helps farmers identify risks to groundwater protection. Since it is confidential, there are no data available.

The program provides technical assistance on pesticide handling, well protection, and hazardous waste disposal. “We check for nitrates and bacteria in their well water and advise them to install anti-back-flow devices for their hoses.” Farmers in Ingham County tend to use their drinking wells for irrigation, which potentially can put their health at risk in the event of a back flow episode. “We advise every farmer to get their water tested regularly, said Cynda Beach, the local agent.

C. Much of our Human Sewage Ends Up as Fertilizer on Area Farms: A Recent Development with Environmental Implications

Most of our urine and feces is converted into sewage sludge and trucked to local farms in Ingham, Clinton and Eaton Counties. In the trade it's referred to as "land application of sewage sludge," though federal and state officials prefer the term "biosolids," a term nestled somewhere between euphemism and science. Before the 1980s most of our excrement eventually was dumped into our rivers, land filled or incinerated.

Sewage sludges contain nutrient and organic matter that fertilizes crops; they also contain biological pathogens (bacteria, viruses and protozoa) as well as contaminants from home and industry. The goal of sewage treatment (and pre-sewage treatment before industrial waste reaches the wastewater treatment plant) is to remove or diminish the biological pathogens and to lower the amounts of nine heavy metals like lead and mercury in the sludge (see below). These heavy metals are the "chemical solids" and "physical solids" lurking in "biosolids".

We can contrast today's black, mud-like sewage sludge with the excreta of past civilizations. For much of human history many Asian societies recycled human waste into cropland, recognizing its high nutrient value. "Night soil," as it was called, was an excellent way of managing human waste. Unlike today's modern sewage effluent, it was relatively pure. It did not contain PCBs, cadmium, arsenic and the 60,000 human-made chemicals that today's sludge contains (most in negligible amounts, yet still unmeasured), owing to the contributions of household and industrial contaminants dumped down the drain.

It's important to stress that farm application of sewage sludge is a relatively new historical phenomenon and that its long-range impacts are controversial in some quarters (see below). Indeed, industrial societies have changed their approach to managing human sewage numerous times over the past two centuries. In the 19th century much of this sewage was pumped to open sewer ditches running on streets. Cholera outbreaks were one result. By 1920 most sewage was piped instead into our rivers and streams. But by the 1950s most of the country's waterways were badly polluted. Demands were made for treatment of waste prior to disposal. With the growth of the underground sewage pipe infrastructure, (achieved at public expense), corporations began to dump a wide variety of toxicants into the sewage stream. But it proved impossible to separate the sewage nutrients from all of the toxic waste in the pipes. When some of the toxins were removed (or pre-treated), it was often at a high expense.

Finally, in the 1980s, the EPA evaluated different methods of disposal to determine the environmental health effects of each. They determined that land filling and incineration each had health and environmental drawbacks and offered none of the benefits of applying sewage sludge to farms, forests, and golf links. Soon the EPA expressed a preference for land application, thus signaling a return to an age-old remedy. Or was it?

What the EPA and DEQ Say: The Case for Land Application of Sewage Sludge

In 1993 the U.S. Environmental Protection Agency implemented Part 503 of the Clean Water Act to improve both the quality of recycled sludge and its safe application. The EPA asserted that, when properly managed, land application of sludge is an excellent disposal option. Indeed, sludge contains many nutrients necessary for plant growth as noted earlier but it also contains much else. There are two types of potential health hazards to be considered: pathogens including bacteria, viruses, protozoa and helminthes; and toxic substances including organics, trace elements, heavy metals and nitrates. The EPA said that it is important that some of these contaminants be reduced to a level judged as safe for application to agricultural land.

In fact, in all the years that properly treated biosolids have been applied to the land, we have been unable to find one documented case of illness or disease that resulted.
Martha Prothro, Former Assistant Administrator for Water
U.S. Environmental Protection Agency

The Details! Sewage Sludge Creation is an involved process. The EPA established two categories of sludge: the excellent quality sludge (Class A), and the lesser quality sludge (Class B). To achieve Class A, pathogens must be below detectable levels. Treatment plants use methods such as heating or increasing the alkalinity to kill all the bugs that can be detected. But most large treatment plants, like the Lansing Wastewater Treatment plant, produce Class B sludge. For this lesser quality sludge, indicator organisms must be reduced to below 2 million colony forming units of fecal coliform per gram of dry weight. To achieve this rating treatments include aerobic or anaerobic digestion, composting, heat treatment, and drying. Another concern for Class B sludge is that the eggs of parasitic worms (helminthes) survive sewage treatment and soil processes that other pathogens do not. As a result, farmers must wait before harvesting crops on land that had received Class B sludge, allowing time for the organisms to die in the soil.

Impact on groundwater, air and soil quality, and surface runoff are part of the new EPA guidelines. There are strict limits for some trace metals, steps to minimize odor, restriction of access to sites with certain quality biosolids, and requirements that the biosolids be applied only at a rate that can be used by the crop being grown (agronomic rate). Evaluation of the land includes soil type, topography, water table level and environmental suitability. In addition, the nutrient composition and the farmer's plans for growing crops are considered prior to issuing the permit to apply the biosolids to land.

The farmer receives the sludge free of charge!

How Much Sewage Sludge Are we Talking About in Ingham County?

In 1999 Ingham County generated 6,345 tons of sewage sludge and an estimated 4,323 tons were trucked to more than 20 farm fields in Clinton, Eaton and Ingham County (see map below) [Note # x: see the map on page x.]. The largest generator was the Lansing Wastewater Treatment plant which created 5,777 tons of sludge. Lansing only land applies about 65% of its sludge, the rest is land-filled.

Ingham County currently has 5 municipal waste water treatment plants that generate sewage sludge: Lansing, Williamston, Delhi Township, Mason and Leslie. Williamston began its operation in 1999. East Lansing plans to convert from incineration to sewage sludge in the near future. Private contractors are paid to pick up, deliver and apply the sewage sludge to area farms.

AMOUNT OF SEWAGE SLUDGE GENERATED IN INGHAM COUNTY
1997-1999

CITY/TOWNSHIP	1997	1998	1999
Delhi Township	290 tons	117.5 tons	362 tons
City of Lansing	5,776.9 tons	4,769 tons	4,638.6 tons
Leslie	82.3 tons	48.94 tons	107.8 tons
Mason	196 tons	142 tons	159 tons
Williamston	did not apply	did not apply	119 tons
Total amount of sewage sludge created	6,345.2 tons	5077.4 tons	5386.4 tons
Estimated amount of sludge applied to area farms	4,323.2 tons	3,408.4 tons	3762 tons

For rural dwellers who rely on septic tanks and drainfields on their property for waste disposal, not the municipal pipes, the sewage is eventually trucked to a large septic waste field, never farmland, since it is an untreated human waste. These sites need to be better monitored. As of 1997 there were 11 septic waste sites in Ingham County (see map).

Following the Money: Some of the Economic, Political and Health Incentives to Generate Sludge:

As noted earlier, farmers in Ingham County get the sludge for free, a tremendous incentive that can save them thousands of dollars in fertilizer costs. The Farm Bureau is a big supporter of land application. Scott Everett, a former Farm Bureau spokesperson, said that they are particularly interested in the issue as it relates to urban sprawl as they view it helping to retain farmland.

As noted above, East Lansing incinerates its sludge, but there are environmental and health risks associated with that practice. That is one reason that they are considering other options.

Is it Cheaper for cities to Send Sludge to Farms or to the Landfill? The Lansing waste water treatment plant stores their sewage sludge (18% solids content) in tanks after the required treatment. Lansing pays a private contractor (Enviroland, currently) $64.83/dry ton to transport

and apply the sludge by subsurface injection to approved land sites. The plant must also stabilize the sludge with lime prior to land application at a cost of $87.25/dry ton. The sludge is tested for content whenever the contractor collects the material, which is usually 2-3 times per year. Lansing will send some sludge to the landfill when conditions are not good for land application (about 35% of the time). They will then dry their sludge to 25% solids content and pay $16/cubic yard for disposal in the landfill. The opinion of the plant superintendent is that the two methods are about equal in cost to them. The Cities of Mason and Leslie and Delhi Township pay the contractor Synagro to transport and apply sewage sludge within Ingham County.

Enforcement. In Michigan, the Department of Environmental Quality (DEQ) Surface Water Quality Division is responsible for the licensing and monitoring of the sewage sludge generators, the transportation of the waste as well as all land application sites. The land sludge that is applied must be evaluated and tested at least every 2 years. Every year the DEQ is required to review records from the plant and the application contractor. Sludge sample test results are sent to the DEQ prior to each application for approval. Spot inspections are done on both the application sites and the plant frequently.

Some Concerns on the Local Level: the Possibility of Water Pollution

Bob Godbold, the Environmental Health Director of Ingham County, is concerned about the levels of metals that might be leaching into the surface water, and the relatively few resources that are spent on enforcement in Ingham County (the DEQ has only one inspector for the eight County Shiawassee District). One concern is that Ingham County farms have drainage tiles buried beneath the crops which, he believes, can serve as ready conduits for sewage sludge to drain into surface waters after a storm event.

Some DEQ water specialists disputed Godbold's concerns. "Tiling is not the equivalent of a direct conduit from soil to water; more is involved," said one specialist who works with the surface water quality division. "The data collected so far is very lacking. The inputs from residential septic systems are probably more likely [to pollute water] than biosolids sites," she said. Septage disposal is viewed as a more significant environmental hazard by the DEQ's surface water quality division. Septage includes waste and excrement removed from septic tanks, portable toilets and other sites. According to one DEQ official, septage haulers get away with a lot because they know that no one is watching them. The DEQ hired a new person in May to oversee septage practices in eight mid-Michigan counties. Refer to the map [Note # 14 the groundwater pollution map, above] for a listing of some of the septage sites in Ingham County. In any case, a new Red Cedar River Watershed Initiative (discussed below) will investigate the issue of metal leaching more thoroughly by taking solid samples from a number of sewage sludge sites in the Red Cedar River watershed.

Is the Sewage Sludge Safe? Critics of EPA Sludge Guidelines

In their 1999 report, "The Case for Caution," (www.cfe.cornell.edu/wmi/) researchers at the Cornell Waste Management Institute identified 14 "non-protective aspects" of the EPA guidelines. Two criticisms presented evidence that said that groundwater and surface water could be threatened. The Cornell researchers did not suggest a prohibition of land application, "but rather significantly more restrictive use."

Current U S federal regulations governing the land application of sewage sludges do not appear adequately protective of human health, agricultural productivity or ecological health. [EPA's risk assessment] contains many gaps and non-conservative assumptions in establishing contaminant levels which are far less protective than those of many other nations.
Cornell Waste Management Institute, 1999

Unlike Europe, the U.S. EPA used only a 100 year site life in its risk estimates for sewage sludge.

In contrast, in Europe the view of time and land is different since one can see lands that have been farmed for thousands of years. Vineyards that grew grapes for Roman wines are still growing grapes today and lead used by Romans persists in the soil two millennia later. That makes the concepts of sustainable practices that can be carried out in perpetuity much more salient in Europe.

Sustainability is the key word for the many European countries that land apply their sewage sludge, they note.

Evidence Cited for Groundwater and Surface Water Pollution

Echoing Godbold's concerns, the Cornell researchers noted that, "recent research indicates the potential for metals to leach from sludges. . .and the possibility of violating drinking water standards." Channels created by worms, roots and other processes were shown to provide rapid downward water movement that can limit metal absorption (and other protective chemical processes) into the soil. Examination of field research data over the years typically finds up to half of some metals applied in sludges appear to be "missing" from the soil and may have leached. In a 1998 study, concentrations of cadmium, nickel and zinc exceeded drinking water standards in leachate collected immediately below soils receiving sludge 20 years after a large quantity of sludge had been applied to agricultural soils.

Cornell researchers also said that small surface water bodies were at risk as well as shallow percolating water that reaches tile drains under agricultural fields. They said that the EPA assumed that only a tin[y] percentage (about 0.24%) of a watershed receives sludge. But by making that assumption, the EPA failed to assess impacts on smaller bodies of water.

Like Godbold, the Cornell group also found that there "is inadequate enforcement and oversight," of sewage sludge operations. They pointed out that the EPA views the new regulations as largely "self-implementing," and note that there have been federal budget cuts

forcing a reduction in environmental staff. Cornell researchers also worry about lost records, and improper setback distances from watercourses that may lead to water pollution.

Here are the 12 other Cornell Waste Management Institute Criticisms of current sewage sludge practices:

- Allows pollution to reach the maximum "acceptable" level. For example sludge application would be allowed to raise groundwater contaminant levels up to the drinking water standard, but no safety factor is applied, leaving no margin for error. And there is no consideration for the hormone disrupting effects of synthetic organic chemicals which is likely to have its MCL decreased in the future.
- Safety or uncertainty factors (many risk-assessment based standards divide calculated numbers by 2 or even 100 depending on the level of uncertainty).
- Evaluates each exposure pathway separately not accounting for multiple pathways of exposure or synergy.
- Calculates cancer risk of 1-in-10,000 vs. 1-in-1,000,000.
- Soil Ingestion Rate is conservative.
- Underestimates pollutant intake through food.
- Reference dose for Arsenic is 0.0008 mg/kg/day (a higher limit) versus 0.0003 or less (a lower and presumably safer limit, which the EPA uses in other programs).
- Many pollutants not regulated or monitored (ex. synthetic organic chemicals like PCBs and dioxins; also boron is not regulated despite having critical pathways; this is a noteworthy concern given it's slightly elevated levels in northeast Ingham County).
- Not protective of agricultural productivity.
- Inadequate assessment of pathogen risks.
- Ecological impacts inadequately assessed.
- No labeling of sludges or sludge products.

Based on their research, the Cornell researchers developed tougher standards for each of the nine metals that the EPA chooses to regulate. The table below compares standards from the EPA and Cornell with the actual metal levels reported for Michigan as a whole. While Michigan easily passes the EPA standards, it fails eight of the nine standards set forth by the Cornell researchers.

Comparison of Michigan 1997 Sewage Sludge Contaminant Levels with Alternate Standards (In Parts Per Million)

	EPA Regulatory Limits (1993 standards)	Michigan Sewage Sludge Contaminant Average (in 1997)	Cornell Waste Management Institute Standards (1999). (Bold is where Michigan exceeds recommendations)
Arsenic	75	8	**1-10**
Cadmium	85	4	**2**
Copper	4300	459	**40-100**
Lead	840	61	**0**
Mercury	57	2	**1**
Molybdenum	75	13	**4**
Nickel	420	46	**25-50**
Selemium	100	8	**5**
Zinc	7500	831	**75-200**
PCBs	No Standard	Not measured	1

Other countries have far stricter standards for some of these metals. For example, the maximum allowable soil concentrations in the U.S. for zinc is 1,400 ppm; while for Denmark it is 100 ppm, and for the European Union it is 300 ppm. For cadmium the U.S. ceiling is 19.5 ppm, in contrast the Netherlands where it is 0.8 ppm.

What Needs to Be Done?

We forwarded our table to representatives from the Michigan Department of Environmental Quality and asked them about their thoughts on Cornell's sludge research Two DEQ representatives responded. Both indicated some support for Cornell's efforts. One person, a former sewage sludge specialist, said that he had heard Dr. McBride (one of the Cornell authors) speak and felt "they had some good rationale behind their concerns." The other individual, a soil scientist and groundwater specialist, said,

> ***I don't think I've seen the Cornell article. . .however, we reviewed the Part 503 regulations for the use and disposal of sewage sludges and concurred with a number of the comments made by Dr. M. McBride of Cornell University in a paper written for the Journal of Environmental Quality, (Volume 24, 1995, No.1), "Toxic Metal Accumulation from Agricultural Use of Sludge, Are USEPA Regulations Protective?" The DEQ sent a letter to Ms. Browner [director of the EPA] expressing the department's concerns. The EPA's***

response was to thank us for our letter, and in a nutshell, indicated that in the unlikely event the sludge regulation were ever revisited they would keep our comments in mind.

Clearly there is dispute and concern from a number of quarters within state and local government about current sludge practices. Some want it banned altogether. In his 1995 book, "Toxic Sludge is Good For You," John Stauber details the EPA's educational campaign to convince the public sludge is safe. Stauber, who is against land application of sewage sludge, described Seattle's "name change task force," which in 1991 reviewed over 250 names for the product such as biolife and black gold before settling on biosolids, a term, he argues, masks more than it reveals.

The Ingham County community should become more educated on this issue as it promises to receive more attention in the future.

Industrial and Commercial Pollution and Water Quality

To simplify matters, the accompanying graphic illustrates the pathways for the estimated or recorded amounts of toxic and hazardous wastes in Ingham County in 1997. Notice that the greatest amount of pollution, by weight, goes into the air (94.8% of all pollution). Comparatively very little industrial waste is piped directly into our rivers. Rather, it is first sent to the wastewater treatment plant, which creates sewage sludge and deposits it to area farms (or the landfill). The wastewater that is eventually returned to the river contains many chemicals that the plant cannot fully eliminate, but it is an advance over direct industrial discharge into the river.

Industrial and Commercial Pollution Generated in Ingham County, 1997
Where Does it all Go?

1.6% of Total WASTE (558 TONS) Goes to Recycled Energy Recovery (or treated waste)
#1 Xylene (41%)
#2 copper cmp. (17%)

All inland lakes are under a fish consumption advisory due to high mercury levels, much of it coming from coal-fired utilities.

94.8 % of Total Waste (33,917 TONS) Goes to Air Pollution
#1 Sulfer Dioxide (18, 521 TONS)
#2 Nitrogen Dioxide (11,521 TONS)
3 Volatile Organic Compounds (2,122 TONS)

The Lansing Board of Water and Light is the top emitter of SO2 and NO2. It has an older coal-fired utility that is legally permitted to pollute our air at rates 3 to 7 times higher than modern plants. SO2 is a major source of acid rain in Northeast U.S. The Lansing Board of Water and Light emitted an estimated 145 pounds of mercury in 1993 according to the MDEQ. This is considered to be a very high amount.

3.2% of Total Waste (1,130 TONS) was sent to Hazardous Waste Landfills or Incinerators.

#1 GM's wastewater treatment sludge from aluminum coating
#2 Tetrachloroethylene
#3 Lead

FACTORY / UTILITY and/or HAZARDOUS WASTE GENERATOR
(ex. car maker or electricity maker)

TOTAL POLLUTION CREATED IN 1997: 35,769 TONS (100%)

HERE'S WHERE IT ALL GOES.

Farms: About 65% of all sewage sludge was applied to local farmland in 1997. That was 4,124 tons. Farmers receive it free. Critics like the National Research Council (1996) question many aspects of its use. Until the 1980s most treated sewage was simply dumped into rivers. Now it is used as fertilizer. The EPA sets limits on bacteria and metals in the sludge. Still, some critics want the practice stopped altogether.

0.1% of Total Waste (28TONS) was sent to Local Landfills.
#1 zinc
#2 lead
#3 copper

0.4% of Total Waste (135 TONS) to Wastewater (Sewage) Treatment Plant
The plant effectively treats "anti-freeze" and "certain glycol ethers" which break down under oxygen and biomass (bacteria that eat those things). Metals and other toxins gather in sewage sludge. Lansing has 232 waste pre-treatment programs that regulate toxins sent to the sewage plant (down the drain).

Electrical Cooling: The Lansing Board of Water & Light withdrew 62.3 billion gallons of water from the Grand River in 1999 for cooling its electrical equipment. That's seven times more water than it withdrew from the Saginaw Aquifer that year! Though technically not a pollutant, the water is returned to the Grand warmer (up to 5 degrees warmer). This has effects

GRAND RIVER & other Ingham rivers &streams

0.004% of Total Waste (1.4 TONS) was Discharged directly into rivers & Streams

Most nitrates from the wastewater treatment plant (above, purple) pass through the facility. Nitrates contribute to increased aquatic growth.

PCBs: the Grand River has fish advisories for PCBs. PCBs were a constituent of electrical equipment.

Note the astounding amount of water (63.3 billion gallons in 1999) that is extracted from the Grand River by the Board of Water and Light for cooling its electrical equipment. This amount is seven times greater than all the water it withdrew from the Saginaw Aquifer that year.

The Board of Water and Light generates electricity at its Eckert complex on the Grand River. It used 63.3 billion gallons of river water to do so in 1999 – seven times all the water it withdrew from the Saginaw Aquifer that year.

When discharged back into the Grand River after cooling, output water is often up to 5 degrees warmer than surrounding river waters. Also, the water contains chlorine and small amounts of other pollutants, from interaction with the electrical equipment or from BWL treatment. The ecological impacts of this practice are monitored by the DEQ. We did not have sufficient time to critically assess this practice, but encourage others to do so.

D. But Turtles Poop in the River, Why Can't We? (asked a local public official in 1998)

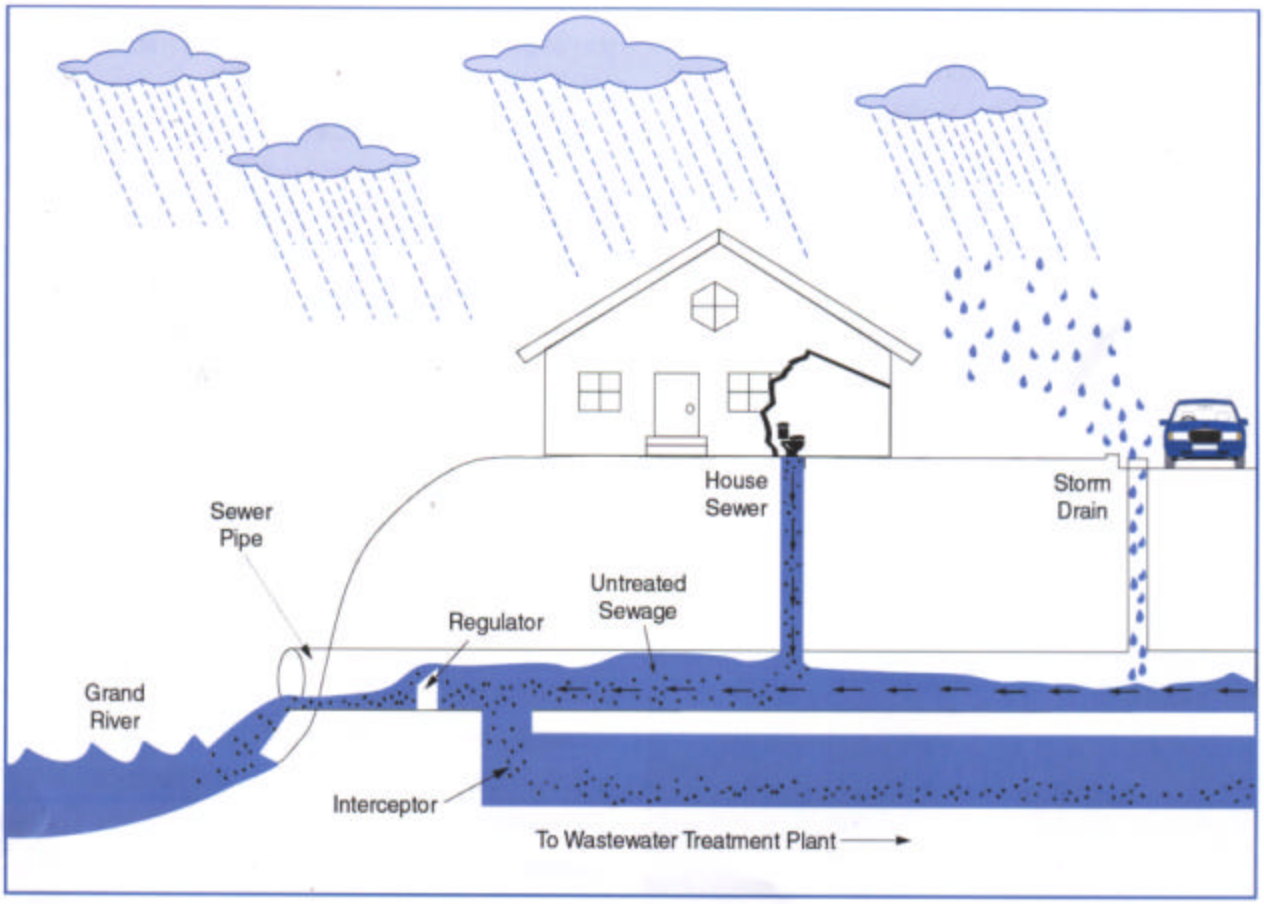
Combined Sewer Overflows

Wood turtles are, in fact, disappearing along the Grand River. As indicated above, the wood turtle is on the endangered species list. So if turtles are pooping in the river, it's probably in much lesser quantities than before. Were that true for human sewage. Since 1992 there have been

more than 5 billion gallons of raw sewage dumped into the Grand River in Lansing. That's the equivalent of 20 million tons, or 3.4% of a square mile. Each year about 634 million gallons, on average, is dumped into the river.

Why Does It Happen?

In short, it happens because nobody worried much about land use planning in the early part of the century. And few thought about the unintended consequences of development. Sewers that were built before 1953 only used a single pipe to transport both raw sanitary sewage and stormwater. Lansing's wastewater treatment plant could accept and treat all of this material until the early 1950s. But around that time the system began having trouble absorbing all of the sewage waste during a rain storm. Due to the dramatic growth of population and business, and the increased usage of the single pipe, the pipe began to discharge excess sewage overflow into the Grand River.



Combined Sewer Overflows

The Good News

As a result of the country's new environmental awareness, and the regulatory authority of the EPA, Lansing and 30 other municipalities in Michigan were required to develop plans to eliminate sewage discharge into the river. Lansing's Combined Sewer Overflow Control Project, begun in 1992, involves separating 203 miles of combined sewer pipes by constructing a second parallel pipe so raw swage can be carried separately. The raw sewage (human waste) will only go to Lansing's wastewater treatment plant and the stormwater (after a rain), will go to the river.

Amount of Raw Sewage Released into Grand River

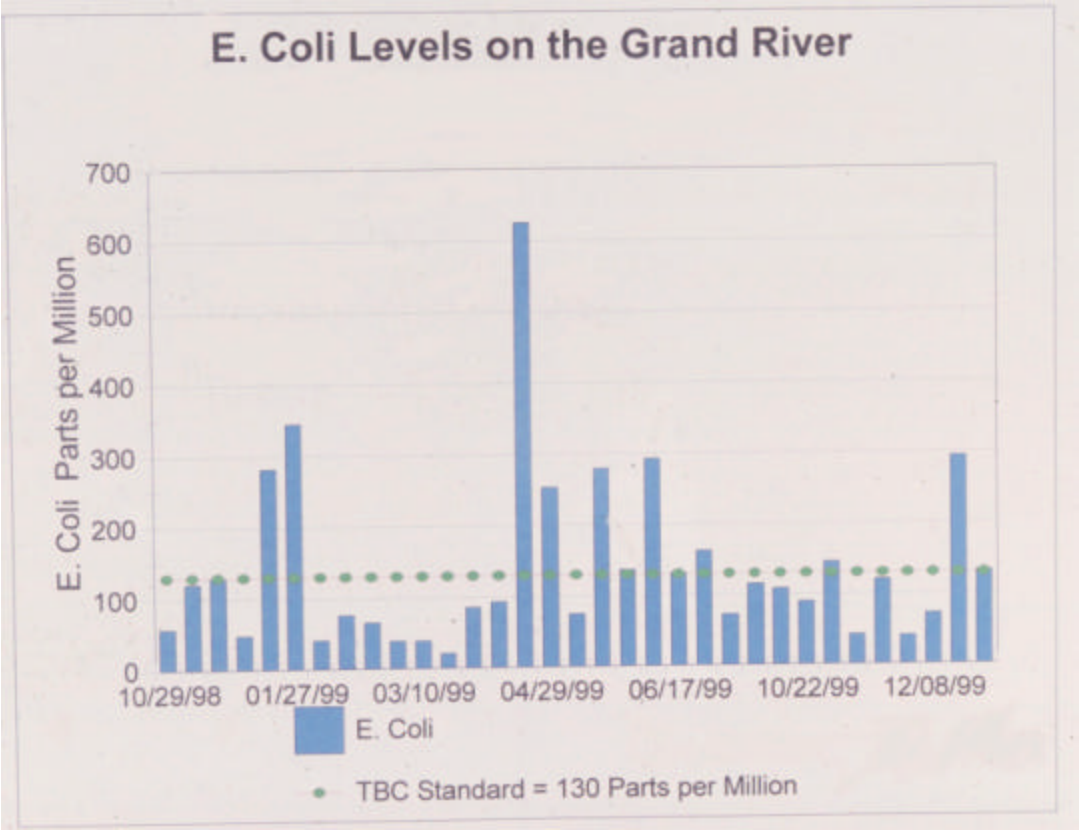
Year	Yearly Total of Sewage Released into Grand River, in Millions of Gallons	Total Amount of Rain that Year, in inches	Sewage Overflow Per Inch of Rain in Millions of Gallons.	Amount of Sewage Saved from the River in Millions of Gallons	Percentage Reduction of sewage dumped into Grand River
1992	604	33	18.1	0	0%
1993	621	36	17.5	0.4	< 0.1%
1994	909	38	24.1	26.9	2.8%
1995	343	22	15.4	10.6	3%
1996	901	32	28.3	30.7	3.3%
1997	713	22	32.3	32.4	4.3%
1998	476	26	18.0	17.6	3.6%
1999	502	26	19.6	17.9	3.4%
TOTAL	5,069 (634avg.)	29 inches (average)	21.7 MG/inch (average)	137 MG (17MG average)	2.6% average

Just a little bit of rain has a giant impact. In 1998, after receiving only .05 inches of rain, 1,727,000 gallons of sewage waste was dumped into the Grand River [Errata # 14: the correct calculation is the following: "In 1997, after receiving only .05 inches of rain, 1,615,000 gallons of raw sewage waste was dumped into the Grand River."] On average, one inch of rain results in 21.7 million gallons of sewage.

E. Coli Rates in the River Are High When it Rains

In an effort to measure the effect that Lansing's sewage overflows were having on river quality, a water-sampling program was established in February 1998. The program consists of collecting 24 surface-water samples at eight locations in the Grand River every week. One important measure of surface water quality is the bacteria, E. Coli. Michigan's recreational standards are based on the number of E. Coli that are found in a 100-millimeter sample of water (about a cup).

If the sample results exceed 130 E. Coli per sample, then no one should swim in the river. As the graph below illustrates, there were exceedences on 9 occasions in the period between November 1998 and December 1999.



The Bad News: Only 10% of Ingham County Citizens Can Describe a CSO.

CSOs will continue to be a problem with Lansing until 2020. Meanwhile few citizens truly understand the repair project. Scott Witter, the chair of the Ingham County Environmental Health Roundtable, argues that local government needs a better method of communicating with the public:

> ***I feel strongly that the public hearing process is not working. Only those most impacted or special interest groups tend to participate. The City of Lansing CSO project is a perfect example. After a series of public hearings from 1994-97 only 10% of the thirty-five stakeholder groups we interviewed knew what the project was about. Ninety percent of these told us that the first time they had heard about the almost $200 million project was when they received a bill. Of these less than 10% knew what a CSO is or why they should be concerned.***

A New Age of River Pollutants: Antibiotics, caffeine and other Drugs:

Even with the separation of CSOs in our urban areas there will be a number of pollutants being funneled directly into our rivers, streams, lakes, ponds, and drains through a large number of

catchment basins. Salt, oil, gasoline brake fluid, fertilizers, animal waste, and sedimentation will be mobilized during rain and snow melt occurrences and flow into catchment basins where it will be directed into the nearest river or drain.

Moreover, according to preliminary findings by the U.S. Geological Survey (USGS) in 1999 a number of drugs and medicinal compounds -- caffeine, codeine, antacids, cholesterol-lowering agents, estrogen compounds, anti-depressants, heart medications and chemotherapy drugs -- have been found in lake, rivers and wastewater streams across the U.S. These pollutants are entering our surface water bodies via our normal human waste treatment plant's discharge. Unfortunately there has been no research on the human impacts of these low doses if non-conventional pollutants. But birth control pills are reported to have a feminizing effect on the reproductive organs of fish. There is no definitive information about the impact of these pollutants, but we can expect that they are in the Red Cedar, Grand, Looking Glass and Sycamore Rivers.

With the reauthorization of the Clean Water Act, CSOs will be a focal point for MSU, East Lansing, Okemos, and other smaller cities in the county, as they are required to have a watershed management plan before they receive a NPDES (water pollution) permit.

How's the Swimming?

There are three beaches in the County open to bathing [Lake Lansing South, Burchfield Park and Valhalla). The Ingham County Health Department monitors the raw E. Coli results from 3 samples per week from at all three of these public beaches. These bodies are safe for swimming (according to official parameters).

THERE WERE ONLY A FEW INSTANCES OF BEACH CLOSINGS IN RECENT HISTORY:
Lake Lansing South on July 1, 2, & 3, 1994
Lake Lansing South on July 22 & 23, 1994.
Burchfield Park on September 1, 2, & 3 1995.
Valhalla has not been closed for water quality problems at least as far back as 1988.

E. Lake Lansing: A Beach Closing in 1994 that Became a Local Wake-Up Call

"A marsh that became a lake that wants to be a marsh again."
Pat Lindemann the Ingham County Drain Commissioner.

The Fourth of July weekend is not the time to close Ingham County's number one bathing beach, Lake Lansing park, but that is what happened on July 4, 1994, after the weekly fecal coliform sample results came back high. Three weeks later it happened again.

Enjoying Lake Lansing, Spring 2001.

The media descended on the story. Meetings were called. The Lake Lansing Property Association wanted answers. What was causing the high bacteria numbers? Was there human sewage in the lake? Was it geese? Local government agencies responded. The Drain Commissioner's Office and the Ingham County Health Department investigated and issued a comprehensive report that December. It was the first time that anybody had ever taken a thorough look at the lake. The findings surprised everyone.

Ninety Percent of the Lake's Water Comes from Storm Water Runoff; Meaning that the Riparian Property Owners (those who live on the banks) and Developers were Causing a lot of Pollution

Before we discuss the high bacteria events, we take a brief tour around the lake, as did the authors. As a prelude to discussing the findings, county officials revealed many interesting facts about Lake Lansing. It's a good guess that few Ingham County citizens know about them, even today. But without a proper understanding of the lake's physical features, one cannot appreciate the factors that contributed to the beach closings.

Lake Lansing receives about 90% of its water from storm runoff. That's right. The same rain that causes combined sewer overflows in the Grand River actually ***becomes*** Lake Lansing (though there is no municipal sewage draining into the lake). Unlike the Grand River which gets about 40% of it flow from aquifers,

Lake Lansing is intimately connected to the community that surrounds it.

(relatively purer and less contaminated sources) the lake is made up of the water that runs across surface areas around the lake. That includes the wetlands to the North, but it also includes everything on parking lots, streets, and lawns (such as fertilizers herbicides, salt and automobile byproducts.

What Nobody Knew: The Major Findings

What nobody knew until that August, was that there were <u>*twelve unknown drainage inlets*</u> feeding runoff material into the lake. Storm water runoff into the lake flows through many types of mechanisms such as buried pipe, ditches, sheet feed and swales (a low tract of marshy land). The origin of these 12 inlets were unknown.

The authors highlighted 14 "summary findings and conclusions," including "the most evident and urgent problems." Six findings were "good news," (e.g. there were normal dissolved oxygen levels, and algae plumes were not a problem, in their estimation). But eight findings were troubling. Here they are, synthesized into the four major points:

- ***Housing development had destroyed much of the shore line vegetation, and was thus significant contributor to pollution.*** The authors noted "a large percentage of shore line has been constructed to accommodate lush lawns and beach and boating activities." As a result, there was a lack of shoreline vegetation (on the land and in the water) that can act as a buffer strip to absorb many of the pollutants. They noted that there were high phosphorous levels in the Lake, and said that these were associated with lawn care and bird feces. There were 3 "hot spots" of high pollution (sediment load) in Lake Lansing's bottom: the northeast corner of the lake had a phosphorous load five times higher than the rest of the lake; there were above normal phosphorous levels found on the northern shore, near a condominium development and nitrate; and nitrate levels were about 4 times higher at the southern tip. All these areas were near drainage inlets.

- ***Birds, dogs and other animals were significant contributors to the fecal pollution***. The number of geese had increased 4-fold between 1990 and 1994, increasing the amount of excrement (and nutrients like phosphorous) in the lake. The authors reported that nutrient loading by water fowl (particularly Canadian geese) can promote lake eutrophication, that is, a process in which increased nutrients decrease the dissolved oxygen in the lake, favoring plant over animal life. Geese also contribute to "swimmers itch." It was also noted that the dog population had grown and that "uncontrolled deposits of their fecal material" could be a problem.

- ***The lake was "infested" with high levels of a "harmful" exotic weed, called Eurasian Milfoil.*** A nonindigenous aquatic plant, Milfoil reached Midwestern states between the 1950s and 1980s. It forms thick underwater stands of tangled stems and vast mats of vegetation at the water's edge. It can disrupt recreation like boating and kill off native plants. "Milfoil was a contributing factor to the lake's high bacterial counts in the Summer of 1994."

- ***The high bacteria counts of 1994 were caused by "a combination of weather, weeds and animal population and behavior."*** More specifically the scenario looked like this. A period of low rain in June was followed by a similar period of heavy rain, creating a flushing effect. The animal waste and bacteria which had accumulated over time on the sidewalks, lawns and streets was dumped into the lake all at one time. This combines with bird feces from the surface (geese defecating on the water). The added nutrients accelerated weed growth, which provided a safe environment for coliform bacteria.

Despite these "urgent problems," the authors concluded that, "the general health of the lake is good." This assertion could be seen as a declaration that the waters were safe for swimming and recreation (indeed there have been no beach closings there since '94), but it didn't mesh with some of their other findings, where the indicators were poor.

Recommendations for Action: A Watershed Management Plan

Indeed, the authors made 15 recommendations "related to the issues facing Lake Lansing's health and viability." At heart, the authors called for an overall "watershed management plan" linking all 15 issues. Among their many recommendations: eradicate the Milfoil; install catch basins in approximately 17 locations (costs ranged from $800 to $1,500); forbid composting by area property owners; manage the bird population; and install buffer strip landscapes around the lake. We are currently following up with the authors to determine the successes of lake management efforts to date.

In short, over the course of the twentieth century, Lake Lansing was transformed from a local fishing spot to a recreational wonderland (with the help of a spectacular dredging operation in the 1970s), vastly improving property values but placing the water body at greater risk of pollution from non-point sources. In 1994, citizens began to better realize that the lake was vulnerable. Lake Lansing continues to be a popular recreational resource, used by about a quarter million people per year. But it needs to be properly managed.

Red Cedar River Being Studied

The Red Cedar River has recently come under the scrutiny of a number of regional actors. In 1998 the City of Williamston received state funding to create a white water park for public use. The Health Department, concerned about possible contaminants decided to conduct an investigation of the river. Water samples were collected from the Putman Street bridge just upstream from the white water rapids every week and tested for E. Coli bacteria, an indicator organism used to measure surface water quality. Surface water is considered to be safe for swimming if the E. Coli levels are less than 130 per 100 milliliters of water. In 1998, the water rarely met this quality.

In 1999, in a landmark collaborative between six governmental bodies and MSU, the Red Cedar River Coordinating Committee, was formed to form a watershed management plan for the region. As part of this initiative, researchers in the coming months will begin to collect baseline data on a host of factors (including survey data on farmer knowledge of BMPs) so that they can target intervention efforts among local citizens, especially farmers.

One Small Example of What a Watershed Management Plan Means in Practice: Golf Courses

In June 1998 an effort was begun to improve the environmental practices of Michigan's golf industry, a notorious water polluter in years past. In a cooperative project between MSU, MDEQ, MDA and environmental advocacy groups, the Michigan Turfgrass Environmental Stewardship Program was founded. It seeks to increase compliance with environmental laws, educate owners about pollution prevention practices and enhance the habitat for fish and wildlife. As of April 2000 more than 150 Michigan golf courses (of the estimated 900) have participated in one of the programs.

To date only 5 of the 21 Ingham County Golf courses have participated in a training. These include: MSU Forest Acres, Royal Scott, Timber Ridge, Groesbeck and Walnut Hills. The

program provides training on leaking underground storage tanks, pesticide and fertilizer storage, pesticide handling application and mixing and loading pads. “Abandoned wells are voluntarily being sealed,” reported Debra Swartz, the program director, “though we do not have hard numbers” about pollution prevention successes.

OVERALL SUMMARY AND CONCLUSION (IN PROGRESS)

The reader has been taken on a long journey over the pages of this water report. We hope that you have made margin notes, questioned all the answers, and are now better prepared to become environmental researchers and activists in your own communities.

…

The Red Cedar River runs through it.

We must preserve our precious water resources. . .they replenish our bodies and stir our imaginations. . .

Entering the Harrison Meadows in East Lansing.

The Butterfly garden in Harrison Meadows.

APPENDICES

A. IS THAT YOUR FINAL ANSWER?

A Millionaire Quiz
(Increased Ecological Knowledge Could be Worth Millions to the Environment)

Match the Statements in Column A with the Questions in Column B	
A	B
1. About 60% of your feces is condensed into sewage sludge (what the MDEQ call biosolids) and applied here.	1. What is Lake Lansing?
2. It takes about 38,000 gallons of water to make one of these.	2. What is a local farm?
3. In 1969 the Lansing branch of the United States Geological Survey thought we'd run out of drinking water and speculated that we'd have to get water from this place.	3. What is a wetland?
4. They are tearing up 1,100 parking spaces and returning them back to green space.	4. What is a sturgeon?
5. They once covered 25% of Ingham County, but today only 3%	5. What is Michigan State University?
6. If it were above ground, it would stand 70 above your head and we'd all drown.	6. What is Lansing's urban sprawl?
7. It weighed 350 pounds and was up to 7 feet long but no longer swims in the Upper reaches of the Grand River.	7. What is the rain?
8. It keeps growing and growing with deleterious effects on water quality.	8. What is the Saginaw Aquifer?
9. It is the ultimate source of water for the Saginaw Aquifer	9. What is Lake Michigan?
10. A marsh that became a lake that wants to be a marsh again.	10. What is a car?

B. Help Us Make this Better!

Issue	What we kind of know	What we Don't Know
Abandoned Wells		

C. Local Resources Involved in Water Quality Issues [COMING! STILL BEING GATHERED]

(e.g. MEC, MUCC, DEQ, Mid-MEAC, and so on.....)

D. Web Resources [COMING! STILL BEING GATHERED]

Come join the Ingham County Environmental Health Assessment and Improvement Project

E. Bibliography …… [COMING! STILL BEING PREPARED]

F. **********Who We Are********** [COMING!]

G. List of Roundtable Members and their affiliations (there are 12 of us)

Scott Witter, Chair
Elizabeth Browne
Bill Cooper
Dave Dempsey
Bob Glandon
Bob Godbold.
John Hoehn
Michael Kamrin
Ed Larkin
Brian McKenna
Suzanne Miel-Uken
Bill Rustem

Principle Author: Brian McKenna, Ph.D.,
Research: Brian McKenna, Garry Rowe, Diane Gorch and Susan McIntosh
Graphic Design: Tracy Brummel, Toby Koenig,
Maps: Craig Anderson
Cover: Jan Larkin
Date:

H. Acknowledgements [COMING!]

We would like to thanks a number of other individuals without whose efforts, this publication would never have been completed.....

I. For Additional Information: [COMING!]

J. Editorial Notes and Errata for PEER Publication

We have faithfully provided the reader with the precise text as it existed on August 28, 2000 -- the day, nearly an entire year ago, that all production was ordered halted on this work. Thus the author, at that time, did not have sufficient time to conduct last-minute fact checking on the document, a normal course of action in the final days of creating such a far-ranging and thorough analysis.

In this PEER production we have made fourteen minor editorial notations in the text. We also made 14 minor corrections (errata) as well. All editorial insertions are referenced in the text. We now summarize these additions below.

K. Editorial Notations:

Note # 1 (page 5): The Centerfold graphic was not available for this publication.

Note #2 (page 6): We note that the Centerfold graphic was not available for this publication. It is available (albeit in incomplete form) at the Ingham County Health Department.

Note # 3 (page 13): Please read the more complete analysis of Consumer Confidence Reports for a critical interpretation.

Note # 4 (page 22): The amount of water that evapo-transpires in Ingham County averages 24 inches per year, or about 231 billion gallons.

Note # 5 (page 27): The text notes that “there are no such studies on the relationship between turbidity and gastrointestinal illness in Ingham County.” We note that this is primarily due to the fact that Ingham County draws its water from the groundwater, not surface waters; though we consider this further below.

Note # 6 (page 30): The 1985 Groundwater survey found no human-made organic chemicals in 50 water wells tested. We note that these results are now nearly 20 years old and do not reflect the more sophisticated water sampling techniques available today. In the final analysis, domestic well owners are advised to get their water tested. A recent CDC study found high coliform bacteria levels in 41% of wells tested, as well as detectable herbicide levels in many wells.

Note # 7 (page 34): Turbidity at MSU sometimes exceeds 5 NTUs when a well is flushed.

Note # 8 (page 34): According to some sources, there is no turbidity rule for groundwater-based systems. According to other sources groundwater turbidity should not exceed 5 NTUs.

Note # 9 (page 34): This evaluation is true for some sources, not for others.

Note # 10 (page 37): According to some sources, there is no turbidity rule for groundwater-based systems. According to other sources groundwater turbidity should not exceed 5 NTUs.

Note # 11 (page 37): Since MSU is a groundwater-based system, the turbidity rule does not seem to apply to it. Still, given that MSU turbidity sometimes exceeds 5 NTUs, which according to some sources exceeds the groundwater MCL, one can speculate on possible concerns.]

Note # 12: (page 50): The reference to cattle being sickened was anecdotal data and required more fact-checking before publication.

Note # 13 (page 24 of surface water section): See map, page 20 of the groundwater section.]

Note # 14 (page 26 of the surface water section): See map page 20 of the groundwater section.]

L. ERRATA:

Erratum # 1: (page 9). The average cost of a gallon of water, for the nation, is $0.005. That amounts to $0.0006 for a 16oz. glass or 0.06 of a penny per glass of water.]

Erratum # 2 (page 12): Regarding the amount of water pumped from the Saginaw Aquifer that is actually used for drinking, the text reads “0.003%” It should read “0.3%.”

Erratum # 3 (page 14): Regarding the increase in pounds of household hazardous waste collected by the Ingham County Health Department between 1986 and 1997, the text reads “320%.” It should read “230%.”

Erratum # 4 (page 24): Regarding the amount of water pumped from the Saginaw Aquifer that is actually used for drinking, the text reads “0.003%” It should read “0.3%.”

Erratum # 5 (page 29): “where” should be “were.”

Erratum # 6 (page 29): “was” should be “were.”

Erratum # 7 (page 38): The Michigan Public Health Institute correctly reports that the turbidity rule applies only to surface water systems.

Erratum # 8 (page 43): Mason has only five municipal water wells.

Erratum # 9 (page 69): The text tells the reader to “keep in mind that it is recommended that the average adult drinks 8 glasses of water per day, or 2 quarts. This means, that an adult can ingest up to 6 milligrams (3 mg/l x 2 liters) per day and not experience any health effects according to the EPA.” However the previous sentence is mistaken. It should say, “this means that if the drinking water contains just 1 ppm of boron, an adult can ingest 2 quarts of water a day (1 mg/l x 2 liters = 2 ppm boron per day) and not experience any health effects, according to the EPA.”

Erratum # 10: (page 73). The average cost of a gallon of water, for the nation, is $0.005. That amounts to $0.0006 for a 16oz. glass or 0.06 of a penny per glass of water.]

Erratum # 11 (page 11): Wetlands once constituted about 20% of surface area in Ingham County, not 25%.

Erratum # 12 (page 12 of surface water section): The King Rail is, of course, a bird, as noted earlier in the text. Mr. Lederle was referring to a Michigan rattlesnake of undetermined species.

Erratum # 13 (page 20): Cyanazine was in use on 10% of Ingham County crops.

Erratum # 14 (page 33): The correct calculation is the following: “In 1997, after receiving only .05 inches of rain, 1,615,000 gallons of raw sewage waste was dumped into the Grand River.”