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State of the Lakes Ecosystem Conference 1996

Background Paper

IMPACTS OF CHANGING LAND USE

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Notice To Readers

This Background Paper is one of a series of such papers that were prepared to provide a concise overview of the status of the nearshore conditions in the Great Lakes. The information they present has been selected as representative of the much greater volume of data. They therefore do not present all research or monitoring information available. The Papers were prepared with input from many individuals representing diverse sectors of society.

The Papers provided the basis for discussion at SOLEC 96. Participants were encouraged to provide specific information and references for use in preparing the final post-conference versions of the Papers. Together with the information supplied by SOLEC discussants, the Papers have been incorporated into the 1997 State of the Great Lakes report, which provides key information required by managers to make better environmental decisions.

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Impacts of Changing Land Use

1.0 Overview, Findings, and Conclusions

1.1 Introduction

The Great Lakes basin encompasses 762,932 square kilometres (295,710 square miles), with the Great Lakes and their connecting channels making up about a third of this area. As shown in Figure 1, forests account for the largest percentage of total basin area, at about 40 percent. Agriculture accounts for about a quarter of present basin area, and the "built environment"— representing industrial, commercial, residential, institutional, and transportation uses—takes up less than 3 percent of the area of the Great Lakes basin.

The Great Lakes basin is home to 33.5 million people, with about 8.5 million in the Canadian province of Ontario and the other 25 million distributed among the eight Great Lakes states. Population density is highest in the southern part of the basin and around Lakes Michigan, Erie, and Ontario. The Greater Toronto Area (GTA), situated on Lake Ontario, accounts for about half of the Canadian basin population, whereas about 80 percent of the U.S. basin population is located in its 11 largest metropolitan areas.

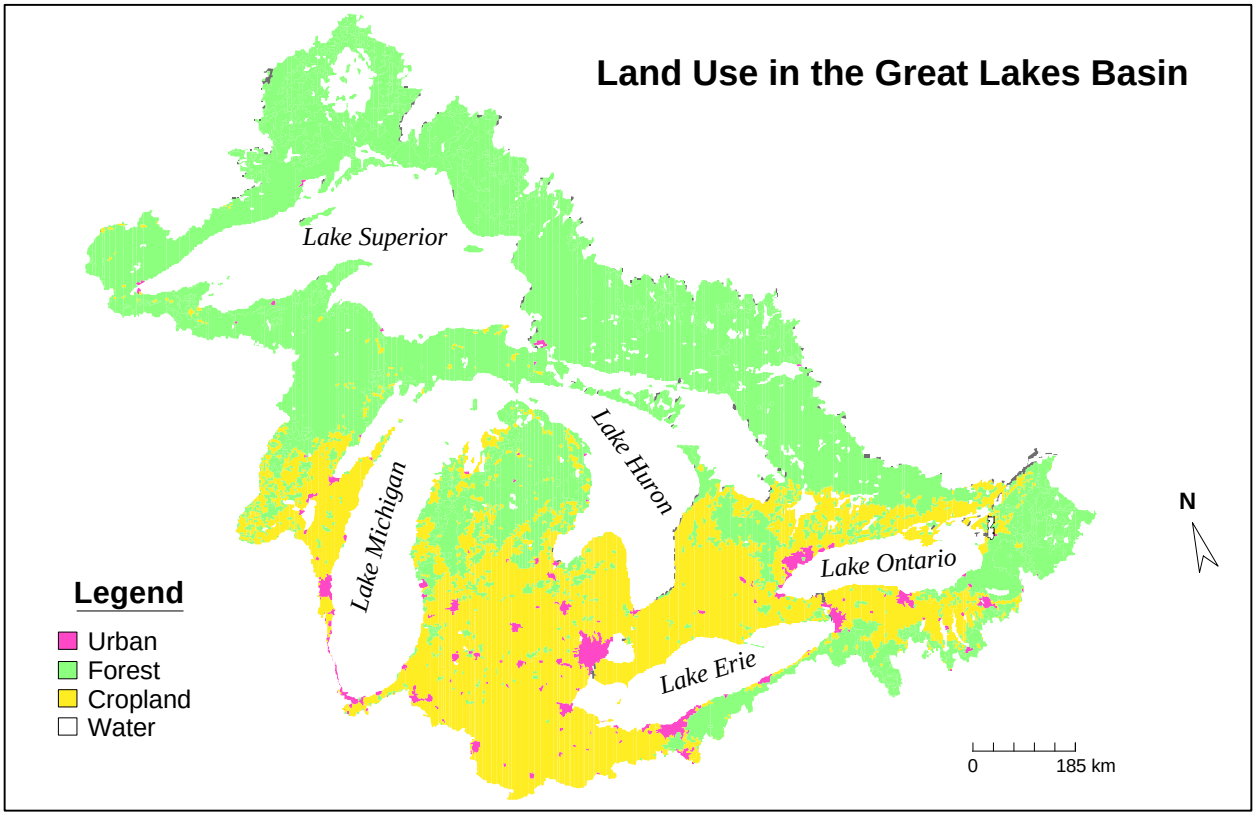

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Figure 1. Land Use in the Great Lakes Basin

Responsibility for land-use decisions that affect the Great Lakes and its basin is fragmented among a very large number of government entities, with the greatest degree of decision-making authority resting with local governments. Government jurisdictions involve two federal governments; one province and eight states, each with a myriad of agencies; 13 regional and 18 county municipalities in Ontario, many substate regional planning commissions and councils of government, and 192 counties in the United States; thousands of U.S. local governments and about 250 Canadian local governments; and more than 100 First Nations and tribal authorities. In addition, significant influence is brought directly to the development approval process by private sector developers and consultants, non-profit organizations such as environmental groups and residents' groups, the media, and the public.

Development is a major ecosystem stressor for the Great Lakes basin and its nearshore areas. The many forms of development—covering industrial, commercial, residential, agricultural, and transportation-related activities—carry specific, significant, and cumulative impacts for the natural world and particularly for Great Lakes water quality. These activities take place throughout the basin, but their most immediate and direct impact on the Great Lakes appears to be on lands proximate to the lakes themselves and their tributary waters. Land use in coastal areas of the Great Lakes is changing in response to the region's evolving economy and industrial restructuring as well as to the relentless forces of urban sprawl. The aesthetic and recreational attraction of the shores is also spurring renewed public appreciation and use of this asset, whether it be an urban waterfront or a remote location.

1.2 Brief History of Land Use

Land use in the Great Lakes basin is subject to continual change. Although natural forces have the greatest potential for altering landscapes and land cover, the current human imprint on the land in the Great Lakes area is obvious and substantial. Human activities ranging from farming to city building are affecting the basin's ecosystem. The nearshore areas of the Great Lakes suffer from a particular and disproportionate environmental burden because of their unique and sensitive environments and proximity to development. The extent and effects of these human impacts have changed over time, corresponding to habitation and technological developments, resulting in both negative and positive trends.

The Great Lakes, as the most prominent physical feature, are not the only vestige of area glaciation. Many of the basin's landforms and distinctive terrains were created during the period of glacier retreat. Climate changes since that time (9,500 years ago) have altered the general vegetation patterns influencing the extent of coniferous and deciduous forests along with open areas of prairies and savannah-type landscapes. Although the number and size of inland wetlands were subject to periodic fluctuation during this prehistoric period, coastal wetlands were generally more stable, being mostly influenced by changes in the levels of the Great Lakes.

The indigenous peoples of the Great Lakes basin, with their hunting and gathering activities, periodic encampments, and use of fire as well as the practice of burning areas for various purposes had no apparent long-term adverse impact on the ecosystem. The next settlement phase, which is continuing through today,

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witnessed successive stages of resource exploitation and landscape alteration. Europe-influenced exploration and the subsequent development of the fur trade diminished particular animal populations and native culture. With both westward domestic migration and immigration, the shores of the Great Lakes became magnets for settlement during the 19th century.

The major settlement period of the Great Lakes region coincided with the rapid development of industrial technologies and processes. Proximity to productive agricultural land and access to important raw materials, coupled with an available labour force, gave the region an unparalleled advantage in domestic and overseas markets. Water transportation was the foundation of shore-based manufacturing and related activities. Water-intensive industrial operations, whether located on the waterfront or nearby, were a natural result of water availability. In many cases, having the option of waterborne shipment for the delivery of raw material and movement of finished goods was a major factor in determining the location of industrial activity.

Economic development created the modern Great Lakes region. Employment opportunities paved the way for population growth and a relatively high standard of living with associated quality of life. But with these good times of ever-increasing prosperity came the seeds of future challenges. The industrial and supporting infrastructure matured, and competition within a developing global economy sharpened. Hundreds of thousands of high-paying jobs disappeared, resulting in severe economic dislocation for some communities and families. Environmental degradation was another outcome of rapid and spontaneous growth in the industrial era. Some of the region's bountiful natural resources that helped sustain economic growth were depleted, in some cases recklessly. The Great Lakes, the region's resource centerpiece and the world's largest system of freshwater, was damaged by basin development and is still threatened.

1.3 Trends in Land Use

1.3.1 Urban and Rural Development Land Uses

The Great Lakes basin is home to more than 33 million people. In addition many more each year visit for business or to enjoy its beauty and amenities. Four-fifths of this largely urban population live in 17 metropolitan areas (11 in the United States and 6 in Canada). The U.S. basin population declined during the 1980s but has now stabilized. By contrast, the Canadian population, however, has increased dramatically in Ontario over the past 20 years. Although the built environment constitutes less than 10 percent of the land area of the basin, most of this development is situated on or near the shores of the Great Lakes or on major tributaries. The Greater Toronto Area on Lake Ontario, for example, concentrates more than 40 percent of Ontario's population on 1 per cent of the province's land base.

Ontario's population is projected to increase by about 2 million people (20 percent) over the next 20 years. Growth in Canada's economic heartland will be in response to the promise of economic opportunity in Ontario's "Golden Horseshoe" and continued immigration into this area, which is known for its cultural and ethnic diversity. In contrast, the U.S. basin will likely see only limited population growth. The long-term trend of redistribution of economic activity and population from the older industrialized regions of the Great Lakes basin to new and expanding regions elsewhere is moderating. Central city areas will continue

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to suffer from under-utilized infrastructure and social problems, whereas coastal areas will continue to grow.

Traditional urban development that was once characterized by high population densities and therefore more efficient city services has virtually disappeared. The modern age of the automobile has facilitated the widespread emergence of urban sprawl over the last half century. Today, urban sprawl is the predominant pattern of development on both sides of the border. Land-use projections for the State of Michigan, for example, indicate that a state population increase of less than 12 percent may result in as much as an 87 percent increase in new developed land by the year 2020. A 6 percent population increase in southeastern Michigan alone is expected to result in a 40 percent increase in land consumption during this same period.

Although urban sprawl, a principal outcome of the post-war economy, has been the dominant form of development, interest is growing in returning to higher-density, mixed-use community planning and redevelopment of under-utilized or brownfields locations that would enhance the efficiency of municipal services such as transportation. Planning systems and approaches that can compensate for the fragmentation of municipal decision-making will be fundamental to curbing urban sprawl.

The high cost and environmental impact of sanitary, stormwater, and combined sewage systems will be restraining factors to new development and constraints to public use of urban beaches and other environment amenities. Groundwater availability may serve to limit new growth in communities not adjacent to the lakes. Those communities will, no doubt, be among those advocating water conservation and higher water prices to reduce the excessive usage and wastage that has characterized North American society, but they will likely also advocate increased access to water from the Great Lakes. Conflicts over water rights and in-basin as well as inter-lake basin transfers of water will be a challenge for municipalities pursuing high growth strategies.

Transportation continues to become more oriented towards the private automobile and trucking, as opposed to more efficient public transit and rail goods systems. Continued urban sprawl will mean heightened awareness of and greater pressure to control urban air pollution from both smog and greenhouse gases. Traffic congestion and commuting delays will further promote work-at-home practices; and the imposition of toll roads by jurisdictions may be needed to assist with the high costs of maintaining roads and highways.

There has also been a significant trend in the basin towards the extensive construction of seasonal “second homes” or recreational cottages. This trend is now shifting towards more permanent, year-round residences in rural areas as the leading edge of the baby boom generation approaches retirement age. The emerging trend towards multiple careers over one’s lifetime and more home-based work for the new “information” generation allows greater workplace mobility, which adds to the desirability of owning these second homes as personal offices, away from home.

Changing demographic and settlement patterns present opportunities to rethink traditional rural development patterns and to develop innovative, efficient, and pleasing alternatives to rural estate lot severances. Local government decision makers will need to consider the service needs of an active but aging population accustomed to the amenities of the city.

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1.3.2 Industrial Land Uses

The Great Lakes basin has been conducive to the development and sustenance of an industrial economy. The lakes themselves have provided transportation links as well as water for industrial processes and opportunities for wastewater release. The close availability of raw materials and natural resources, from lumber to iron ore, and a growing population gave the basin an unparalleled advantage for industrial development in North America for most of the last century.

The evolving change to a global economy and to a North American information-based economy has resulted in a shift away from once-dominant manufacturing activities in the Great Lakes basin. Road and air transportation have increased dramatically, at the expense of shipping and rail, making traditional linkages to ports and rail spur lines less important for manufacturing. Further, many firms faced with modernization are choosing to shut down older and less efficient operations, many of these located on the nearshore, and to relocate manufacturing activities to other areas, including outside the basin. The motivation for relocation rather than re-investment with modern technologies at existing sites can be attributed to a number of factors, including labour costs, taxation levels, and improved access to transportation.

The restructuring of the basin economy has resulted in a surplus of industrial locations that require environmental cleanup before they can once again be put to a productive land-use activity. These "brownfields" (vacant or inactive industrial or commercial properties with known or suspected soil or water contamination problems) pose a unique opportunity and challenge for the development industry, government environmental agencies, and the banking industry, which must weigh the financial rewards of new development against the increased cost and potential environmental liability of providing loans to those undertaking redevelopment of these sites. Mining and forestry activities, on the other hand, which are concentrated in the northern half of the basin, are likely to remain relatively stable into the future.

The retreat of industry from its traditional location along the nearshore presents new opportunities for waterfront and harbour redevelopment as communities become involved in grass-root efforts to "take back the waterfront" for public and commercial uses. Redevelopment of these former industrial sites also presents new opportunities for high-technology manufacturing, commercial service, residential or leisure or some mix of these activities for tomorrow's economy. There are, however, costs and environmental hurdles associated with cleaning up and restoring these sites that pose difficult challenges to governments and interested communities alike.

Public education, awareness, and opinion have made a clean environment a priority for the public over the past 20 years. Almost everyone has accepted the interconnectedness of the environment and the economy and also that sustainable development means discarding the "jobs versus the environment" paradigm. With elementary school children now routinely taught environmental basics such as waste recycling and the importance of conservation in the water cycle, and with widespread public awareness of potential carcinogenic and other public health effects of industrial processes, tolerance for sources of pollution will continue to be low, even considering potential employment possibilities.

Higher environmental standards and improved technologies for reduced vehicle and industrial pollutant releases have been established over the past 20 years. In addition, the adoption of pollution prevention as

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the preferred approach to environmental management is resulting in additional improvement. Voluntary actions are being promoted and utilized to complement regulatory initiatives. Yet, while the basin's transportation system is largely mature, urban sprawl will increase the network of roads and traffic, adversely affecting air quality. Further, the new "just-in-time" delivery system is reducing the need for the traditional warehouse, but is expected to contribute to increased traffic congestion and truck traffic generally.

Current government efforts at fiscal restraint are conflicting with traditional methods of environmental protection, and alternative delivery systems are being explored to ensure environmental protection through industry's meeting or exceeding environmental standards. With governments financially handicapped by the fiscal realities of high public debt, a greater share of the challenge for expanded environmental remediation and restoration will fall to the private sector and local authorities. In general, innovative and more private sector and citizen-based initiatives will be required if the growing public expectations for a healthy ecosystem are to be met.

1.3.3 Agricultural Land Uses

About a third of the land in the Great Lakes basin is used for agriculture, with usage concentrated in the southern half of the basin. Nearly three-quarters of the basin's agricultural land is on the U.S. side. In parts of the basin, agriculture-related sediment, pesticide, and nutrient loading of the Great Lakes tributary rivers is a leading cause of non-point source pollution.

There is a trend towards fewer but larger farms with more intensive crop production, declining livestock numbers, and less land overall in agricultural production. From 1981 to 1992 basin farmland declined by almost 10 percent and cropland by almost 6 percent. The conversion of agricultural land to urban sprawl development, in addition to other global and continental competitive pressures, is causing a shift of agricultural activities to areas with less productive soils, shorter growing seasons, and greater distances to major markets.

An increasing environmental awareness among the public and farmers is resulting in a growing market for pesticide-free agricultural produce. At the same time, farmers are switching to environmentally conserving practices such conservation tillage, integrated pest management, and better manure management techniques. The ramifications of an emerging trend to greater dietary substitution of vegetables and fruit for animal products, in response to the apparent health risks associated with meat products, have yet to be felt to any significant extent. One consequence may be greater truck (produce) farming at the edge of cities as increasingly sophisticated consumers demand more locally grown and fresher vegetables.

Efforts at controlling nutrient and pesticide pollution of tributaries to the Great Lakes have been partially successful, although much more effort will be required to meet public expectations from the agricultural sector. Groundwater contamination, which has been occurring for decades, is now recognized as a serious environmental problem that requires even greater attention to farm pesticide and manure management practices.

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Land-use conflicts, especially the conversion of farmland to urban sprawl, will continue to be perhaps the greatest threat to the long term-viability of the agricultural sector. The greatest challenge to planners and municipal decision makers is to resist pressure for the conversion of viable agricultural land into lots to meet the ongoing demand for residential and other uses. Adequate protection of farmland from the encroachment of rural and urban sprawl is not commonplace throughout the basin, although in some places "demonstration" projects are being implemented. However, the new provincial policy statement on land use (issued May 1996 under section 3 of the Ontario Planning Act) does permit expansion into prime agricultural areas "only where: 1) there are no reasonable alternatives which avoid prime agricultural areas, and 2) there are no reasonable alternatives with lower priority agricultural lands in the prime agricultural area."

1.4 Land-Use Concerns

1.4.1 Nearshore Development

Development in the nearshore areas of the Great lakes has been substantial and is continuing. The nearshore area of the Great Lakes has been a magnet for development since large-scale population settlement first began. The proximity to water for transportation and industrial purposes were initial factors. The shorelines themselves focused and concentrated transportation corridors and related manufacturing areas. The shoreline and the amenities it offers are also attractive for residential use, whether it be in metropolitan areas or in rural places. Construction of second homes (also known as cottage development) near the Great Lakes has been a major trend during the past 50 years.

Four-fifths of the population of the Great Lakes basin resides in the 17 largest metropolitan areas and most of these have coastal locations. The nearshore areas are environmentally sensitive; they represent the interface between land and the lakes, and support special communities of flora and fauna. Development alters land and ecosystem processes, ranging from stream flow to beach sand supply and distribution. It also leads to temporary and long-term contamination of land and water resources. Planning, coordination, and information sharing among levels of government and multiple jurisdictions as well as appropriate regulations are essential to reduce these detrimental consequences. Continuing control and mitigation, pollution prevention, and remedial action for existing contaminated sites are elements of an effective environmental management process. Voluntary as well as regulatory initiatives for implementing land-use policy can be effective when developed in full consultation with the residents concerned.

1.4.2 Urban Sprawl

The most significant development issue in the Great Lakes basin and surrounding region is the continuing growth of major metropolitan areas and the virtually uncontrolled sprawl of low-density residential areas and other development. The detrimental consequences of these trends are well-known. Population-related generation of pollution, higher transportation and residential energy use, increasing encroachment on agricultural lands and natural areas, and burdensome physical infrastructure requirements portend an unsustainable future.

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Development is the connection between the city and the countryside—not only in terms of more houses, but also in terms of industry and service businesses, which have been decentralizing from built-up city locales to suburban-exurban fringe areas and connecting corridors between metropolitan areas. Land and water availability, lower wage scales, transportation access, proximity to new residential markets, and other cost/service factors are propelling this kind of sprawl. The central city anchor for rail transportation, multi-storey factories, and apartment life has given way to interstate truck transport, one-storey industrial buildings, sprawling office parks, and a house and lot of one's own. Natural market forces responding to the escalating cost of extending utilities and other basic urban services to these lower-density regions should ultimately act to retard urban sprawl and stimulate a more efficient and sustainable pattern based on intensification of development within prescribed boundaries and employing existing infrastructure. Unfortunately, an ongoing pattern of tax-based subsidies to developers by municipal governments eager to see growth at any cost has served to constrain these market forces to date.

1.4.3 Brownfields

The economy of the Great Lakes region is completing a transition from heavy manufacturing to a more diverse and increasingly service-oriented economy. Brownfields have been a consequence. The Great Lakes basin contains thousands of former industrial sites or brownfields where once-thriving manufacturing operations have now become blighted areas of neglect and, in many cases, sources of continuing toxic pollution. These problem places, particularly in the central urban areas, have thwarted efforts at redevelopment. New development is rejected for many reasons, including cleanup costs and lingering uncertainty over liability issues, thus encouraging such development to migrate to outlying undeveloped areas or greenfields.

One of the policy issues facing Great Lakes basin states, provinces, and communities is whether and how brownfields redevelopment and greenfields protection can be linked. A potential linkage already exists in that development of a brownfields site may reduce the pressure for a greenfields site to be developed. Redeveloped brownfields represent opportunities to make urban areas more efficient by utilizing existing infrastructure. Impact fees and development charges, by which developers pay for the costs of new infrastructure for development, may also serve as an incentive for the redevelopment of brownfields. A surcharge on these fees could be scaled and put into a brownfields redevelopment fund for that purpose. This approach would forestall sprawl and development in rural areas by encouraging greater use of metropolitan sites. Alternatively, a portion of the "tax increment" from new metropolitan development could be used to purchase open/green space or, in the case of farmland, the purchase of development rights.

1.4.4 Conversion of Farmland

Land classified as "farmland," which includes cropland, woodland, and permanent pasture categories, declined in the Great Lakes basin by more than 1.83 million hectares (4.52 million acres) or 9.6 percent between 1981-82 and 1991-92. Much of this land conversion has taken place near the metropolitan population centres in the basin but the phenomenon is occurring in more remote rural areas where particular residential, commercial, industrial, and transportation development pressures also exist. For example, in Michigan 70 percent of the converted farmland acres between 1982 and 1992 was located near

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three urbanized areas—southeast Michigan, Grand Rapids, and Kalamazoo. On the Canadian side, 96 percent of the land consumed by metropolitan Toronto's tremendous growth between 1966 and 1986 was prime farm land. Land consumption caused by sprawling development has been a dominant postwar trend and, in some places, has eliminated important wildlife habitat and good agricultural land.

The total 345,000 hectare (850,000 acre) decline in Michigan farmland during the decade included 121,500 hectares (300,000 acres) of cropland, much of it with a prime soils classification. A governor's task force estimated that this impact represented a potential loss of $60 to $120 million (U.S.) for each year in gross sales. If significant levels of farmland conversion continue in the Great Lakes basin, the agricultural production base will decline, and with it, the agrifood sector of the economy. With nearly two-thirds of basin cropland located within 50 kilometres of medium-sized cities and large metropolitan areas, efforts to preserve farmland may also help to contain sprawling development patterns and improve sustainability.

1.4.5 Local Land-Use Decisions and Regional Impact

Though the intent of a land-use planning process is to empower local governments to meet the needs of their communities, the result has been highly fragmented decision making, with little or no coordination to consider regional needs or regional consequences of local action or inaction. As cities, suburbs, and rural areas continue to grow, local land-use decisions are no longer autonomous. Increased traffic congestion, pollution, strip commercial development, inability to finance adequate infrastructure, disinvestment in older communities, brownfields, inability to find sites for locally undesirable land uses, and excessive consumption of open space, among other problems, are often the cumulative consequences of independent local land-use decisions on a regional level.

As now practiced, each new development increases the demand for infrastructure such as roads and utilities. It usually adds to negative impacts on the environment, such as discharges to waterways, loss of habitat, and motor vehicle emissions. The effect of each individual land-use decision takes on a new dimension when they are considered cumulatively at the regional level. Another planning concern relates to multijurisdiction agreements and institutions, and their focus on water quality and quantity issues with only limited reference to related land-use activities. Greater coordination among local levels of government is needed to ensure that development takes place in a way that is financially and environmentally sustainable for the region.

Greater participation in regional councils of governments or planning commissions or creation of regional planning authorities, in locations in the basin where this does not already exist, can empower local governments to work together and realize the benefits of considering regional planning needs as part of the local planning process. Also, re-establishing the primacy of the comprehensive land-use plan for land use and related hydrologic resource planning, and using the zoning ordinance as a tool to assist in achieving the goals of the plan, can help curb uncontrolled sprawl and degraded water resources as well as recreate unique and vibrant communities.

1.4.6 "Hardening" of the Landscape and Stream Degradation

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Impervious or “hardened” surfaces such as roads, parking lots, sidewalks, and rooftops block rain from recharging groundwater and drinking water supplies, impair the ability of natural systems to cleanse runoff and protect wetlands and nearshore biota from contaminants, increase the potential for flooding and erosion, and contribute to the degradation of streams and lakes. Stream degradation caused by development is a classic example of both long-term cumulative environmental change and the difficulty of responding to such change. For example, of the more than 63,000 hectares (156,600 acres) that comprise Metropolitan Toronto, only one quarter of that area remains as agricultural, vacant land or open space.

Development is a gradual, continuous process that takes place over a wide region. It is, however, composed of many small-scale, short-term projects that generally transform only a few acres. As a result, the true scope of stream degradation due to imperviousness associated with development may not be fully realized at the watershed level for many years. At first glance, it might seem appropriate to limit impervious cover by restricting development per available area. But on a regional scale, this would spread the same amount of development over a wider area while requiring additional impervious areas in the form of housing and roads to link the far-flung areas together. Paradoxically, the best way to minimize imperviousness and its negative impacts on a regional scale is to concentrate it in higher-density clusters or centres (Schueler 1994). The planning process requires evaluation of the long-term watershed impacts of each individual development proposal.

Another form of hardening takes place along the lake shores and tributaries when shoreline residents act to protect their real estate from wave and flood damage by hardening the shoreline with concrete, gabion and other shoreline covering. Extension of shoreline protection, sometimes coupled with piers and abutments, alters natural functions along the shoreline. This has been the case for much of the north shore of Lake Ontario and has led to the permanent loss of once productive beaches.

1.4.7 Auto and Truck Transportation

High-capacity road systems have not only changed how people and goods move, but have had a significant effect on land use and the environment in the Great Lakes basin. Development requires roads, and roads often spur development. Since the 1950s, much of suburban expansion has been tied to new highway construction. Rural locations for second homes, whether on the Great Lakes or not, have also been made more accessible by new and improved highways. During the last 40-odd years, public transit use has declined, private auto use has skyrocketed, and freight movements have increasingly been undertaken by motor carriers, mainly at the expense of the rail mode.

The land consumption and more energy intensive and polluting aspects of these transportation modes are well known and documented. Dependence on auto and truck transport is so entrenched in current society that significant change in the future will be very difficult. There are, however, a few positive developments. Government policies promote pollution control from mobile sources and encourage fuel efficiency. Design and maintenance of road systems is becoming less destructive to the environment. Emerging technology for moderating congestion and policies geared towards integrating transit use with new development will also provide short-term relief.

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1.4.8 Agricultural Land Management

According to the 1996 Great Lakes Basin Agricultural Profile (coordinated by the Great Lakes Commission), soil erosion and sedimentation, agriculture pesticide use, and manure management are three basin land-use issues with significant implications for water quality and the agricultural economy.

Most of the soil erosion and sedimentation in tributary rivers and streams to the Great Lakes is caused by human activity. Although agricultural practices are the primary cause in many sub-basin areas, construction activity and the relative imperviousness of the built environment also contribute to sediment loads and transport dynamics. Exacerbated by inefficient and conflicting land-management practices and policies, runoff and wind erosion result in substantial economic costs and environmental harm. Agricultural productivity is reduced, resulting in lower yields and/or higher fertilizer requirements. Sediment transport and deposition degrades water quality and aquatic habitat, limits uses of water resources and incurs significant infrastructure costs, including harbour dredging.

Agricultural runoff is also a major vehicle for pesticide and nutrient transport. Herbicides represent about two-thirds of the pesticides used in the Great Lakes Basin. Although usage of pesticides for agriculture is declining—mostly attributed to changes in application rates—the risk to wildlife and human health of pesticide exposure is a matter of increasing public concern. Nutrient transport is a growing problem because of a trend in the basin of fewer farms with livestock but more animals per operation. These farms must wrestle with diverse manure-related issues ranging from storage and odour control to crop nutrient management and implications for water quality. Other problems such as waterborne pathogens connected to manure can raise serious public health concerns. Management of manure and its associated runoff and leaching problems is the focus of much research and solutions will certainly increase the costs of farm operation.

1.5 Indicators

The indicators outlined below are intended to be instructive and to generate discussion on how to measure the impacts of human land-use activities on the nearshore ecosystem. This initial identification of indicators related to land use also demonstrates the extent to which information is available for better understanding of the impacts of land use on the nearshore and other ecosystems.

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Table 1. Land-Use Indicators

Desired Outcome	Indicator	Actual State	Likely Change	Data	Data* Status
Efficient urban development	Urban population density	Poor	Stable	Urban population per area	Good
	Suburban land conversion	Poor	Deteriorate	Land conversion rates	Mixed
	Centre town economy	Mixed	Deteriorate	Fiscal condition/ vacancies/ etc.	Mixed
	Brownfields	Poor	Stable	Number and area	Mixed
	Recreation opportunity	Mixed	Improve	Number and area of parks	Good
	Energy use	Poor	Improve	Energy usage per capita	Good
	Waste created	Poor	Improve	Residential and industrial waste	Good
	Wastewater quality	Mixed	Improve	Loadings of nutrients and toxics	Mixed
	Industrial water use	Mixed	Improve	Volume per facility/ per capita	Good
	Residential water use	Poor	Stable	Volume per household	Good
	Traffic congestion	Poor	Deteriorate	Time spent commuting	Mixed
	Transit use	Poor	Deteriorate	Public transit commuting rates	Good
Human health protection	Air pollution levels	Poor	Improve	Particulates and ozone levels	Mixed
	Beach closings	Mixed	Improve	Days unswimmable	Mixed
	Land fill capacity	Mixed	Stable	Capacity remaining	Mixed
	Stormwater quality	Poor	Stable	Loadings of nutrients and toxics	Poor
	Sewage quality	Mixed	Improve	Loadings of nutrients and toxics	Mixed
	Pollution-prevention programs	Mixed	Improve	Industrial and municipal programs	Poor
	Respiratory illness	Mixed	Stable	Illness and mortality incidences	Mixed
	Fish advisories	Mixed	Stable	Allowable fish consumption	Good
	Outdoor recreation	Mixed	Improve	Opportunities and participation	Mixed
Non-human resource health protection	Wetland habitat	Poor	Deteriorate	Number and area	Mixed
	Agricultural and natural land loss	Poor	Deteriorate	Area lost to rural development	Mixed
	Wildlife populations	Mixed	Stable	Species and population	Mixed
	Forest clearing	Mixed	Stable	Cutting rates	Mixed
	Forest replant and renewal	Mixed	Stable	Successful replant rates	Mixed
	Mineral extraction	Mixed	Stable	Depletion rates	Mixed
	Fisheries pressure	Mixed	Deteriorate	Fishing restrictions	Good
	Hunting pressure	Good	Stable	Hunting restrictions	Good
	Hardening of land surface	Poor	Deteriorate	Area of roads and buildings	Poor
	Municipal pesticide/fertilizer use	Poor	Stable	Application rates	Mixed
	Agricultural pesticide/fertilizer use	Mixed	Improve	Application rates	Good
	Conservation tillage	Mixed	Improve	Area practising no-till	Mixed
	Groundwater quality	Mixed	Deteriorate	Area/number contaminated wells	Poor
	Contaminated sites	Mixed	Improve	Area and number	Poor
	Cottage and second homes	Poor	Deteriorate	Occupation per coastal area	Mixed

*Data status: Good = universally available in a usable form; Mixed = basic data available but needs assembly or varies among different jurisdictions; Poor = not available at all or severely deficient database.

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1.6 Findings and Conclusions

Land use has been destructive to the nearshore ecosystem.

Rapid population growth, intensive industrial and agricultural activity, and sprawling urban development have resulted in significant stress to the nearshore ecosystem. Nearshore waters continue to be polluted, and in some cases have become severely contaminated, from sanitary sewage, industrial toxic substances, and urban and agricultural runoff.

Although there has been some improvement to air pollution from industrial sources, air quality affecting living organisms in the nearshore ecosystem is a major concern, especially for ground level ozone, as urban transportation systems become more energy intensive. Increasing greenhouse gas releases continue to pose a challenge. Wetlands and other natural habitat areas within the nearshore ecosystem are under threat of destruction and alteration by increasing urban sprawl and second-home cottages. Finally, shoreline protection and other shore hardening caused by development have interfered with natural shoreline processes and, in some cases, resulted in the irreversible loss of beaches.

Current land use is not efficient.

Notwithstanding recent attention to more intensive forms of urban development, development throughout the basin continues to be predominantly land-intensive urban sprawl. By contrast, high-density intensive development facilitates the economic viability of public transit as an efficient alternative to the private automobile for commuters. Urban communities with higher population densities typically require less costly municipal infrastructure through sewers and roads, use less water and energy, and create less pollution. As a result, taxation to pay for municipal services may be significantly lower, making higher-density communities more competitive from that perspective.

Economic efficiency resulting from reduced urban sprawl is accompanied by higher environmental efficiency. Urban services, such as transportation, and water and wastewater can be provided at reduced levels of energy and natural resource usage. Reduced use of natural resources generally implies reduced pollution and stress on ecosystems, including the nearshore ecosystem. Urban sprawl has also contributed to the loss of some of the best farmland in the basin, as housing and industrial development replaces agriculture. Farming that shifts to lower productivity soils and at greater distances from final markets is less efficient and more resource-intensive. In addition, urban sprawl promotes the clearing and conversion of natural habitat lands, including wetlands.

Planning and incentives are the keys to sustainability.

Despite increasing levels of awareness about the consequences of urban sprawl among urban officials and planners at all levels of government, urban sprawl continues to be the major pattern of new development. The incentives of relatively low market prices for agricultural and natural lands and the ease of conversion of those lands into other uses continue to favour low-density development. Planning systems that are intended to bring order to and ensure balance in development have not been able to contain urban sprawl.

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Fragmentation of responsibility for planning issues among levels of government has no doubt contributed to this problem. Agricultural land protection through land banking, conservation easements, or specific prohibitions against urban encroachment on agricultural and natural lands are options to this end.

Finally, marketplace incentives that would promote more sustainable development, such as full cost, user-pay development charges or impact fees, are inconsistently applied in different jurisdictions. At the same time many jurisdictions believe they should compete for the short-term jobs and tax revenues that come from new development. Direct and indirect subsidies for new development through the public provision of roads, water, and sewage treatment facilities mask the real long-term economic and environmental consequences of urban sprawl and continue to favour unsustainable development.

2.0 Land Use and Its Impacts

2.1 Development

Land use and its various forms of development has become a key determinant of ecosystem health in the Great Lakes basin and elsewhere. Development, for the purpose of this paper, is defined as human use of land connected with industrial, commercial, residential, agricultural and transportation activities that substantially alters the natural landscape or affects the ecosystem. Development usually conveys progress and prosperity. It is a natural result of economic growth. Jobs are created, buildings are constructed, and human communities are sustained. However, some aspects of development merit continual scrutiny because of their implications for society and the environment. Economic growth-related development should be sustainable. Living “beyond one’s means” is a prescription for trouble. For example, extreme resource depletion such as the clear-cutting of the northern Great Lakes white pine forests and commercial overfishing in the 19th century jeopardized sustained use of these resource products.

How and where development takes place is another issue. For example, the process of preparing land and constructing buildings creates site and off-site environmental problems. Wildlife habitat can be eliminated, and runoff and erosion are usually exacerbated. Mitigation efforts for those problems may or may not take place. Development is a double-edged process—it can be both good and bad.

Development in all its forms is a leading stressor of the Great Lakes basin ecosystem and the nearshore area. Agricultural activities usually entail less substantial changes to the natural landscape compared with more permanent construction projects, but its potential to damage the environment is also great. Development involving construction and occupancy generally disrupts natural vegetative cover and alters the lay of the land. It creates impervious surfaces (roads, rooftops, parking lots, etc.) that reduce areas of water infiltration, thereby increasing volumes of storm water that drain directly into the Great Lakes and their tributaries. During storms, nitrogen, phosphorus, carbon, solids, and trace metals deposited from the atmosphere, plus pet droppings, leaf litter, vehicle leakage, and urban surface decay are delivered to streams. In urban streams, higher pollutant loadings translate into water quality problems such as nutrient enrichment, bacterial contamination, organic matter loadings, toxic compound loadings, trash/debris, and higher temperatures (Schueler 1992). Development also causes soil erosion, which contributes to sediment loading of streams, which in turn decreases stream water quality. For example, a 17-county study in

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northwest Michigan identified commercial and residential development as a primary cause of soil erosion and sedimentation—a major resource-related concern for that region (USDA 1992).

2.1.1 Coastal Population and Development

Much of the Great Lakes basin's population (estimated at 33.2 million in 1991) is concentrated in metropolitan areas. On the Canadian side, only six metropolitan areas, ranging in size from Oshawa to Toronto, represented 66 percent of the 1991 Canadian basin population. The 11 largest U.S. metro areas located completely or partially in the basin accounted for 81 percent of the 1990 U.S. basin population. Most of the basin metropolitan areas have coastal locations. Other coastal areas represent a sizable portion of the remaining basin population. The 85 coastal counties in the Great Lakes states have about 19 million residents, which represents about 17 percent of the U.S. coastal population.

With only 25 percent of the total Great Lakes states' population located in Great Lakes coastal counties, this attribute is not a hallmark of the region compared with other coastal areas, but it is particularly significant for several states. Michigan and Illinois have about half of their states' populations residing in coastal counties, and Wisconsin has more than a third. Nevertheless, the coastal county population is spread quite unevenly. For example, coastal population density ranges from a paltry 22 people per square mile in Minnesota to 4,040 in Illinois, but averages 275 persons throughout the region compared with 183 persons per square mile for the entire eight-state area. Coastal population can also be measured on the basis of shoreline mile, and on that basis, the Great Lakes county shorelines in 1988 had the highest average number of persons per mile (3,835) for a major coastal area in the U.S. Illinois' two coastal counties lead the nation with more than 91,000 persons per mile of shoreline.

The Great Lakes coastal population and areas of concentration reflect the basin's historical connection to its shorelands. The U.S. Great Lakes coastal population declined between 1960 and 1990. The trend masked a dispersal from the large urban counties to suburban and some rural shore counties where "coastal amenities" and growing employment opportunities combined to increase those county populations. Since 1990, some U.S. coastal areas have been growing again. For example, from 1990 to 1995, the total Wisconsin coastal county population along Lake Michigan increased by 2.8 percent, which was about double the rate for the prior decade. These population changes were still below growth rates for the entire state. If, however, coastal population growth is considered without counting Milwaukee County's decline, then the 5.3 percent growth from 1990 to 1995 is higher than for the state. Obviously, with this coastal population growth comes housing and commercial development. During the 1990–95 period, Wisconsin's Lake Michigan counties added 41,584 housing units, and commercial land use on the shore occupied even more space than that for residential use.

A specific effect of development on the nearshore area is the disruption to the natural process of beach creation and replenishment by interference with the process of sand supply and distribution. The construction of harbours, marinas, lakefills, erosion control structures, cottages in dune areas, and other coastal developments that protrude into the lake form barriers to wave-induced littoral drift and cut off the supply of sand. Some major developments in the basin have trapped littoral sand on their updrift sides and caused sand deprivation and severe erosion on their downdrift sides (Chrzastowski 1996). The Illinois shoreline is an example where the long-term and regional effects of extensive shoreline development have become apparent. Construction of marinas, harbours, and erosion control structures along the southern

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Wisconsin and northern Illinois shore has impeded littoral sand from reaching Illinois beaches in the south. In another example, the construction of a navigation channel for shipping to Hamilton Harbour has reduced sediment supply to Burlington Beach, affecting the development of natural fish spawning grounds in the area. In addition to the obvious loss of recreational opportunities and aesthetics, depletion of nearshore sand allows the energy from storm waves to amplify certain erosional forces which, in turn, cause additional beach erosion.

Various remedial and mitigation actions can be taken. Beach nourishment is among the most common practices. Artificial bypass, whereby sand is dredged from an updrift area and placed in the downdrift nearshore, is another more recent remediation tool. In some areas, allowing erosion to reach equilibrium is the most effective, long-term solution to coastal erosion (Chrzastowski 1996). In heavily developed coastal areas, a more practical solution is to integrate structural measures, beach nourishment, and management activities to conserve, enhance, and recycle coastal sand resources.

2.1.2 The Advancing Urban Frontier

The most significant development issue in the Great Lakes basin and surrounding region is the continuing growth of major metropolitan areas and the virtually uncontrolled sprawl of lower-density residential areas and other development. The detrimental consequences of these trends, which range from environmental degradation to burdensome physical infrastructure requirements, portend an unsustainable future. However, the escalating cost of extending utilities and other basic urban services to these lower-density regions may ultimately help slow the process and stimulate a more sustainable pattern. This new land-stewardship ethic would rely more on intensification of development within prescribed boundaries and existing infrastructure capacity.

The migration of development to suburbia and beyond into rural areas continues unabated. The central city anchor for rail transportation, multistorey factories, and apartment life has given way to interstate truck transport, one-storey industrial buildings, sprawling office parks, and a house and lot of one's own. The advancing urban frontier has a voracious appetite for undeveloped land. In northeastern Illinois, the overall population of a six-county area increased only 4.1 percent from 1970 to 1990 but residential land consumption increased by an estimated 46 percent. The picture is no different in the "Great Lakes state," where the Michigan Society of Planning Officials projects a 63 to 87 percent increase in urbanized land between 1990 and 2020 even though the population may increase by only 12 percent during that period. Much of this past, present, and future land consumption has been or will be at the expense of agricultural land. In Michigan, between 1980 and 1990 farmland was converted to some other use at the rate of 4 hectares (10 acres) an hour. Development has become the connection between the city and the countryside— not only in terms of more houses, but also in terms of industry and service businesses, which have been decentralizing from built-up city locales to suburban-exurban fringe areas and connecting corridors between metropolitan areas. Land and water availability, lower wage scales, transportation access, proximity to new residential markets, and other cost/service factors are propelling this kind of sprawl.

The economy of the Great Lakes region is making a transition from heavy manufacturing domination to a more diverse and increasingly service-oriented economy. Brownfields have been a consequence. The Great

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Lakes basin contains thousands of these former industrial sites or brownfields where once-thriving manufacturing operations have now become blighted areas of neglect and, in many cases, sources of continuing toxic pollution. These problem places, particularly in the central urban areas, have thwarted efforts at redevelopment. New development is rejected for many reasons, including cleanup costs and lingering uncertainty over liability issues, thus encouraging such development to migrate to outlying undeveloped areas or greenfields.

Although there is no comprehensive inventory of brownfields sites in the Great Lakes basin, the amount of land categorized as such is significant—tens of thousands of acres is no exaggeration. For example, officials estimate that up to 14 percent of Cuyahoga County land, in Ohio, contains brownfields. About 18 percent of land in Chicago is vacant or inactive, much of it with a former industrial use. Urban redevelopment is not easy and when a parcel has contamination problems, the challenges of cleanup and reuse are even more daunting. Brownfields are associated with high information, transaction, and site-preparation costs. Also, with redevelopment, site suitability is an important consideration. Many brownfields sites are not large enough for a contemplated new use or not viable for such use. For example, a large retail store may need extensive parking space, or a possible residential use would not be appropriate for an existing warehouse area.

A variety of ways exist to reduce development pressure on open space. Through comprehensive plans, zoning ordinances, and subdivision regulations, local governments have the capacity to substantially affect land use. However, the plethora of jurisdictions and multitude of decision makers is not conducive to any consistent pattern of planned development and open space preservation. The resulting hodgepodge is carving up the landscape with interspersed fragments of development. Encroachment on agricultural land and other open space seems relentless. Although the problem defies a simple, quick fix, some approaches are making progress.

One of the policy issues facing Great Lakes basin states, provinces, and communities is whether and how brownfields redevelopment and greenfields protection can be linked. A potential linkage already exists in that development of a brownfields site may mean that a greenfields site remains undeveloped. A more direct connection would be the use of financial incentives to spur brownfields redevelopment if a specific greenfields site is left alone. Another possibility could be something similar to an impact fee that a developer pays to help compensate a jurisdiction for utility and other infrastructure costs. Depending on the nature and location of the land at issue, the fee could be structured to set aside an amount for a brownfields redevelopment fund. This approach would not prevent development but would forestall some redevelopment in rural areas by encouraging greater use of metropolitan sites. The reverse could also work, where part of a “tax increment” from new metropolitan development could be used for open-space protection through outright purchase or, in the case of farmland, the purchase of development rights.

Many combinations are possible. What is needed is a commitment on the part of communities to recognize the many facets of development and support decisions that encourage sustainable development and economic growth based on appropriate land-use policies.

2.2 The Trend to Sprawl

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The predominant post–World War II land-use trend in the U.S. has been a major shift from high-density urban areas to low-density surburban and rural areas, known as "sprawl." Sprawl is characterized by low-density residential development; automobile dependency; scattered rural subdivisions; high cost of utility expansion/extension; strip residential development along country roads; reduced retail shopping opportunities downtown; strip commercial development at the edges of town; loss of unique character; energy inefficiency; high ratio of road surface to development served; and high land consumption (MSPO 1995). For example, since 1980, almost 60 percent of all Greater Toronto Area housing has consisted of low-density urban sprawl. (Metropolitan Toronto Planning Department 1995) Even worse, much of the high-density development was set in sprawl communities that still required use of the private automobile to commute to work, to shop and for recreation—a kind of higher density urban sprawl.

Fragmented decision-making and reliance on zoning are the two main elements of the U.S. planning process contributing to this trend to sprawl. The intent of the U.S. planning process has been to empower local governments to meet the needs of their communities, but this has resulted in little or no coordination to consider regional needs or regional consequences of local action or inaction. This is exacerbated by the primacy of zoning over planning. Zoning is not effective as the primary tool for land use planning because it does not incorporate planning. The zoning process is generally reactive once a zoning ordinance is in place. It can be modified relatively frequently and easily to accommodate proposed development. Zoning specifies *where* development can take place but not *when* and *how* it can take place. The zoning process does not consider the efficiency of development, nor does it adequately take into account the cumulative effects of individual "lot" decisions such as the need for infrastructure and environmental protection.

2.2.1 Land-Use Planning

Increases in population along with demographic shifts and the negative effects of sprawl raise the question: Can land-use planning be done autonomously and independently and still serve the basin's needs effectively? As cities, suburbs, and rural areas continue to grow, local governments can no longer make land-use decisions that are truly autonomous. Increased traffic congestion, pollution, strip commercial development, inability to finance adequate infrastructure, disinvestment in older communities, brownfields, inability to find sites for Locally Undesirable Land Uses (LULUs), loss of unique character and excessive consumption of open space, among other problems, are often the cumulative consequences of independent local land-use decisions on a regional level (Downs 1996).

Several states have responded to these issues by moving comprehensive planning to the state level. At least 13 states have enacted comprehensive planning and growth management schemes—though none of them are Great Lakes states. However, Pennsylvania, Minnesota, and Michigan are among the states currently showing interest in state and/or regional planning schemes. These programs vary widely from state to state, but share several common denominators:

1. consistency—between local, regional, and state plans and state-legislated goals and regulations;
2. concurrency—between infrastructure capacity and new development;
3. compactness—of urban growth, to limit sprawl;
4. affordability—of new housing; and

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5. sustainability—promoting economic development while protecting natural systems (DeGrove 1996).

In a departure from traditional zoning, where plans are not legally binding, the hierarchical consistency requirement gives both the plans and their implementing regulations the force of law.

State growth-management planning is part of a larger trend to counter the sprawl trend and involves a host of innovative planning tools and techniques (see section 5.2.3, "Tools and Techniques"). This counter trend is inspired by a growing consciousness that recognizes that sprawl is neither sustainable nor desirable and that challenges the parochial governance and piecemeal decision-making that characterize the predominant form of American land-use planning. This consciousness includes a new vision for land-use planning whose goal is development, not growth per se, and greater efficiency, not just getting bigger. The vision supports the importance of place—where development takes place is just as important as how and when; job creation over job migration; and the value of rural land for what it is: agricultural land, ecological preserves, and recreational areas that should be protected and enhanced accordingly, not developed.

Converting the new vision for land-use planning from concept to application on a larger scale, however, will require dealing with broader public policy issues. Important among them is the need to rethink the relationship between public and private interests in land-use planning.

An increasingly vocal and powerful property rights movement is also influencing current land-use planning. Those involved in this movement see many environmental and land-use regulations as infringing on property owners' rights to use their property as they desire. In the United States some people are demanding government compensation for the land-use restrictions imposed by such regulations.

The property rights movement is in conflict with, and presents enormous obstacles to, planned growth. It sends a message to state and local governments that planning will require additional resources to deal with potential litigation and increased transaction costs associated with guiding the pattern and pace of development (Libby 1996). Many U.S. states have or are considering property rights protection laws. In the Great Lakes basin, for example, Indiana has a law that requires review of potential impacts on private property value of pending environmental and planning regulations.

These opposing trends in the 1990s—on the one hand, the recognition of the need for new ways to plan for and manage growth and, on the other hand, the growing property rights movement influenced by an antiregulatory political climate—have given rise to a number of innovative non-regulatory or incentive programs that pertain to land use. These are described in detail, along with traditional and innovative regulatory techniques, in Section 5 of this paper. They include purchase of development rights (PDR) and transfer of development rights (TDR) whereby farmland or open space is preserved while the land remains in private ownership; planned unit or cluster developments that allow higher density development in exchange for preservation of open space; tax increment financing whereby increased taxes resulting from development are earmarked for specific purposes, and many others.

Many of the voluntary programs are successful by virtue of their application within the context of regulatory programs, which they complement. For example, voluntary cluster zoning complements regular zoning regulations by allowing higher density development on the most appropriate portion of a parcel in

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order to provide increased open space elsewhere on the parcel. This type of development can protect environmentally sensitive lands, preserve open space, and reduce infrastructure costs associated with new development. The overall density of the development prescribed by zoning regulations remains intact, but is rearranged more efficiently with cluster zoning.

Voluntary or incentive-based programs differ widely in their application, depending on the political climate, the geographic area, and the extent to which they are applied as separate tools or as part of a more comprehensive program. Examples within and outside the Great Lakes basin show promise that innovative planning mechanisms can revitalize urban centres and keep unlimited low-density sprawl in check. Yet these planning tools are only as effective as the context in which they are implemented. Like all planning tools, they require the political will as well as the technical know-how for their effective application. Moreover, the problems created by sprawl are regional in nature and, as such, require regional solutions. Adopting a PDR program will have limited impact on solving growth-related problems if it is not complemented by other strategies, such as revitalizing inner cities.

Two policies at the federal level in the United States have particular implications for land-use planning in the Great Lakes basin. In 1991 the federal Advisory Commission on Regulatory Barriers to Affordable Housing recommended state zoning reform to include comprehensive planning requirements and enactment of statewide land-development ordinances for use by localities. Also, the Intermodal Surface Transportation and Efficiency Act of 1991 (ISTEA) requires a regional transportation planning process (including land-use planning) as a condition for eligibility for federal highway funding. Extending this concept to all public services (housing, open space, sewer, water, solid waste, etc.) would be an important federal step towards instituting comprehensive regional land-use planning (Downs 1996).

There is no single formula or model that can apply effectively to every state, province, region, or municipality—each must consider its own unique natural, political, and cultural circumstances. Yet current success stories in planned growth and growth management reveal some common elements essential for a sustainable land-use planning system that can control unlimited low-density sprawl and provide for economic development, environmental protection, and a high quality of life. Such a planning system requires:

- political will;
- vision—a commitment to long-term well-being over short-term gain;
- recognition of the mutually supporting goals of a healthy environment and a strong economy;
- appreciation for the interdependence between cities, suburbs, and rural areas;
- strategic application of growth management and planned growth tools and techniques; and
- a system of regional governance to ensure coordination among government entities that builds on the existing institutional framework of provincial/state and local or municipal governments.

2.3 Changing Urban Structure and the Benefits of Renewal

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2.3.1 Changing Urban Structure

Urban sprawl has had an impact on the central city areas in the Great Lakes basin. Many U.S. basin cities have seen declining inner city populations and, along with that, a loss of business and residential tax revenue. The industry and commerce that once drove the economies of bustling central city areas have deserted them for the suburbs or other locations.

It has taken longer for Canada's cities to develop and mature and, as a result, Canadian cities have not experienced the same degree of decline as their U.S. counterparts. Metropolitan Toronto (Metro) is made up of six municipalities including the original City of Toronto and is surrounded by four municipal regions of similar physical size. The population of the Greater Toronto Area (GTA) more than doubled over the 30 years from 1961 to 1991, and fully 60 percent of that growth occurred as urban sprawl in the suburbs outside the already expansive Metro boundaries. Even then, much of the development that took place within Metro was urban sprawl on some of the last remaining greenfields in that municipality.

The trend for future development in the GTA is a continuation and magnification of the past. Between 1990 and 1993, while Metropolitan Toronto developed only 26% of all housing as low density single and semi-detached, the figure for the surrounding suburbs was 72% (Metropolitan Toronto Planning Department 1995). According to a 1993 study prepared for the Office of the Greater Toronto Area, the GTA is expected to grow by another 50 percent (to more than 6 million people) over the next 30 years, given current development patterns. Over the 30-year period from 1991 to 2021 Metro is expected grow by less than 6 percent, whereas the suburbs will mushroom by over 117 percent and become almost twice as populated as the existing Metro. A 1990 study of projected development for the GTA identified significant differences between continued urban sprawl and more efficient central development involving the use of brownfields and other opportunities for redevelopment in the central city area (IBI 1990).

Table 2. Land Needed for Sprawl and Central Forms of Development, Greater Toronto Area 2021

Urban Form	Land Needed in 2021	Greenfield Space Lost	% Additional Land Needed	Urban Density
Sprawl	242,000 ha	91,000 ha	60%	39/ha
Central	187,000 ha	36,000 ha	23%	50/ha

Source: IBI Group , *Greater Toronto Urban Structure Concepts Study* (Toronto, 1990).

As is shown in Table 2, the amount of land that would be needed to accommodate an additional 2 million people is perhaps the most telling aspect of the difference between these alternative forms of development and shows the relative inefficiency of urban sprawl. In 1986, the GTA included approximately 152,000 ha (376,000 acres) of urbanized area. Continued urban sprawl would see an increase of some 60 percent in land usage by 2021 to 242,000 ha (600,000 acres). By contrast, a more efficient redevelopment and

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concentrated form of development would result in significantly less land used, with an increase of only 23 percent to 187,000 ha (464,000 acres). The existing population to land ratios of over 15:1 would be maintained with continued urban sprawl, whereas a more concentrated 20:1 would be achieved with the more efficient higher-density alternative.

In the case of urban sprawl, greater land use per capita (lower population densities) involves greater requirements for sanitary and storm sewers, roads, schools and other facilities, and urban infrastructure. In addition to the need for more infrastructure and higher capital costs per capita, it is likely that operating costs will also be higher in the Great Lakes basin. Of course, greater use of cleared land will typically mean greater amounts of stormwater, and more roads will mean greater amounts of road salt being applied and more runoff. Given the inefficiency of public transportation systems in urban sprawl communities, greater use of the private automobile will lead to higher levels of pollution for the nearshore ecosystem.

2.3.2 The Economics of Urban Form

Dr. Pamela Blais conducted an analysis of the economics of alternative forms of development, which was released as part of a review of governance of the GTA in 1996. This work has revealed significant economic differences between the two extremes of urban sprawl and city-centred development for the GTA.

If planned growth targets of 2 million persons over the next 25 years are achieved, urban sprawl will cost an estimated $90 billion in supporting capital investment for new municipal infrastructure. The more compact, re-urbanized, mixed land-use option would reduce those municipal expenditures by as much as $16 billion for infrastructure capital and as much as $4 billion for operating and maintenance over that 25-year period. When external costs, such as health care and policing are added, city-centred development will lead to a net saving of about $1 billion per year. In total, urban sprawl will cost taxpayers 25 percent a year more than they would be faced with by adopting a more compact, city-centred urban form.

Improved municipal competitiveness, with significant savings to home buyers, taxpayers, and businesses could be achieved by shifting development from sprawl to a more compact urban form. Yet, GTA municipalities continue to favour sprawl as a result of standards and economic mechanisms that distort the market against efficient land-use patterns and redevelopment. In spite of the significant economic advantages that would accrue from a city-centred compact urban form, biased development charges and zoning restrictions continue to influence municipal decision-making towards low-density greenfields development.

The adoption of a more compact urban form, in addition to improving the competitiveness of the GTA through reduced capital and maintenance costs for infrastructure, would also reduce the negative consequences of traffic congestion, air pollution, noise pollution, traffic-related accidents (medical costs, highway policing), and the loss of agricultural, recreational, and natural lands.

2.3.3 Industrial Restructuring and Industry Relocation

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Migration of industries out of the city centres of the Great Lakes basin has occurred for a number of reasons. For example, real estate prices are typically lower for greenfields land than for inner city property. Greater land availability in general and reduced restrictions and constraints to building may exist in suburban areas as growing communities compete among themselves to attract new industry. Construction of land-consuming low-profile buildings is more likely in the suburbs than the city. The costs of necessary site environmental remediation and liability exposure from past polluting uses do not usually exist for greenfields.

Since rail and other traditional forms of industry transportation are shifting to road, suburbs offer improved access to highways and (initially) reduced traffic congestion. Since labour may not be as strongly unionized in outlying areas, labour costs may be lower. And since many business owners and managers are more likely to live in the suburbs, firms contemplating a change may be attracted to locating close to home. Direct or indirect subsidies for municipal infrastructure and services may be offered by outlying communities competing to attract new employment. Finally initially low property and business taxes may exist in suburban communities that do not have to support social services to the same degree as established cities.

The experience of Toronto from 1975 to 1985 demonstrates the flight of business and employment from the city centre to the outskirts. Over that 10-year period, while manufacturing employment in the GTA rose by 13 percent, job growth for Metro was virtually static, growing by only one-tenth of a percent. In the inner city of Toronto itself, manufacturing employment fell by almost 18 percent. By contrast, employment in manufacturing industries rose by about 46 percent in the GTA suburbs beyond Metro limits. This migration to the suburbs is similar for office employment, although not as dramatic. Whereas Metro was able to command 84 percent of GTA office employment growth between 1971 and 1981, Peel, York, and the other surrounding suburban communities had reduced that level to just over 50 percent by 1991.

The industrial restructuring that has taken place throughout the basin is both a consequence and a cause of urban sprawl. A major challenge for cities in the basin is to identify opportunities to restore, rebuild, and renew the economies of areas that have been vacated as brownfields or other vacant property. It is important to recognize, however, that the trend away from industrial employment that has been happening in the downtowns of cities is part of a basinwide trend.

For example, between 1984 and 1995 Ontario's total real (adjusted for inflation) gross domestic product rose by 31 percent from $162 billion to $ 213 billion. Yet, manufacturing rose by only 25 percent over the same period, notwithstanding the strong role of the automotive industry in Ontario, which declined from 27 percent to just over a quarter of the Ontario economy. Sectors with significantly greater growth rates included wholesale trades, communications, business services, health, finance and insurance, and transportation sectors. Manufacturing employment has fallen even more in response to advances in labour productivity—from 27 percent of total Ontario employment in 1981 to just 18 percent in 1993. In the U.S. Great Lakes states, manufacturing employment declined from 26 percent to 19 percent of total employment over the same period.

2.3.4 The Benefits of Renewal

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Recent studies by Environment Canada into the potential economic benefits that could result from restoring Great Lakes watersheds are impressive. The studies examined scenarios resulting from restoration of beneficial use at five environmental Areas of Concern that are currently undergoing the process of Remedial Action Planning. Table 3 below illustrates some of the potential economic benefits of restoration and renewal for these communities.

Table 3. Potential Benefits of Restoration and Renewal for Areas of Concern (1991 and 93 values)

Area of Concern	Annual Direct Use Benefits	Annual Local Employment	Annual Local Tax Recovery	Capital Costs for Cleanup	Avoided Future Costs
Thunder Bay	$7.3 million	340 persons	$20 million	$210 million	$250,000
Hamilton Harbour	$43 million	58,000 persons	$18 million	$674 million	$80 million
Metropolitan Toronto	$133 million	860,000 persons	$150 million	$1,515 million	$1,094 million

Source: Environment Canada, *Restoring Great Lakes Watersheds: Adding up the Economic Benefits* (Burlington , ON, 1995).

The benefits of restoring and renewing cities around the basin include those uses associated with having a healthy ecosystem, healthy and productive fisheries, wildlife habitat areas, and general aesthetics. In addition to the qualitative benefits to the ecosystem, Table 3 above indicates that it is also economically advantageous to restore lost and deteriorated beneficial uses at these locations. Restoration and further redevelopment of these areas offer significant potential for spin-off economic activities that can restore employment in depressed centre-city areas.

This new economic activity will assist in returning tax revenues to city coffers for the investments that will need to be made to facilitate and, in some cases, perhaps partner in the renewal of brownfields, contaminated sites, impaired use areas, and vacant downtown opportunities. However, perhaps one of the more significant benefits of environmental restoration is the avoidance of future costs associated with further deterioration of the environment and subsequent measures needed to clean up as a result. Clearly, much analysis must be done before investors will be comfortable with the concept of funding renewal of inner cities and brownfields.

2.4 Industrial and Municipal Activity

Industrial and municipal activities on the land affect the nearshore in a number of ways. This discussion focuses on a major nearshore stressor from municipal and industrial activities—water consumption and discharges into water and air. The release of wastes from facilities and municipal wastewater (sewage) treatment plants has implications for water quality, plant and wildlife populations, and other elements of the Great Lakes basin ecosystem in the nearshore and elsewhere.

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Human population in the Great Lakes basin increased to more than 33 million in 1990 from about 100,000 indigenous people scattered throughout the area in the early 1600s. Today, most of the population is concentrated in major urban centres in coastal areas. The stress imposed on the natural ecosystem results not only from the need to provide water and sewage treatment to support this level of human population, but also from industrial activities. One measure of a community's ability to move towards sustainability is its ability to control its consumption of energy. Unfortunately energy use trends do not indicate increased sustainability. For example, electric energy consumed per capita in Metropolitan Toronto rose from 25 kilowatts in 1981 to over 30 by 1991. This increased use of energy may be partly explained as a consequence of expanded urban sprawl development in the municipality over that time period.

2.4.1 Wastewater and Stormwater Treatment Discharges

Though the upgrading and construction of wastewater treatment plants during the past two decades has reduced the amount of pollution discharged from sewage and wastewater treatment plants, these discharges have had and continue to have an important effect on the Great Lakes nearshore. Municipal wastewater treatment plants treat sewage from residences and businesses, but may also treat wastewater from industrial sources. Discharges from wastewater treatment plants (WWTP), also known as sewage treatment plants (STP), vary around the basin.

The quality of WWTP discharges varies depending on the level of treatment. For example, sewage treatment plants on the largely undeveloped Ontario nearshore of Lake Superior discharged poor quality effluent in 1991, since most plants provided only primary sewage treatment—the most basic level. Many areas in the basin, particularly urbanized areas, have either secondary or tertiary wastewater treatment systems. Nonetheless, large amounts of pollutants are still discharged into Great Lakes waters. In 1991, for example, sewage treatment plants in Ontario alone discharged 5.6 million cubic metres (197.7 cubic feet) of wastewater containing 112 tonnes characterized by biochemical oxygen demand (BOD), a common measure of water pollution, 103.9 metric tonnes of suspended solids, and 4.11 metric tonnes of total phosphorus. Almost 90 percent of this effluent was released into the Great Lakes; nearly all of it went into Lake Erie, Lake Ontario, and the Ottawa River (and eventually the St. Lawrence River).

The Ontario Ministry of Environment and Energy (MOEE) has estimated total loadings from Ontario municipal wastewater treatment works, including lagoons, at 21,000 tonnes per year for BOD, 25,000 tonnes per year for suspended solids, and 1,700 tonnes per year for total phosphorus.

The wastewater discharge problem is exacerbated in many areas that have combined sanitary and storm sewer systems, where storm drains are fed into the same set of pipes that carry household sewage and industrial wastes. Combined systems represent an initial cost saving to municipalities by not requiring the construction of separate sewers. However, the greater volume that the sewers are required to carry during periods of heavy rainfall or snowmelt frequently exceeds the capacity of the combined system, causing overflow that bypasses the treatment plant and discharging raw, untreated sewage to the receiving waters, seriously polluting them. Metropolitan Toronto has 79 combined sewer outfalls of which 74 are designated as priority for pollution abatement action. In addition, the maze of underground piping associated with urban sprawl has led to a major challenge of just maintaining sewer and water supply systems and controlling leakage into and out of the systems. In 1993, the Metropolitan Toronto municipality of

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Scarborough conducted an audit of some 600 km of water supply lines and discovered enough leaks to fill 9000 swimming pools.

Nearly 30 percent of Ontario STPs reported system bypasses in 1991, which resulted in 9.6 million cubic metres (339 million cubic feet) of sewage bypassing secondary treatment and 2.2 million cubic metres (78 million cubic feet) of sewage bypassing primary treatment. For this reason, building combined sewer systems is generally not permitted today, and municipalities are being encouraged to replace them as rapidly as possible. Even without these bypass situations, STPs may exceed effluent guidelines or standards. In Ontario alone, fully one-quarter failed to meet their effluent guidelines or approved release limits in 1991.

2.4.2 Industrial Water Use and Discharges

The abundant water supply of the Great Lakes region is an important resource for industry. Water use in manufacturing operations is concentrated in five major sectors: steel production, food processing, petroleum refining, chemicals/allied products, and paper—all of which are well represented in the regional economy. The intensity of water use in the area is illustrated by the fact that the Great Lakes states account for 40 percent of U.S. industrial water use and much of this demand comes from the Great Lakes basin. Water withdrawn from the Great Lakes satisfies more than three-quarters of total industrial demand in the basin. In Ontario, the degree of dependency is even more pronounced at nearly 85 percent.

Many industries in Ontario manage their own waste treatment facilities and discharge directly into surface waters in the Great Lakes basin. The MOEE assessed 169 industries for compliance with their "certificates of approval" in 1991. Of these, only 84 had been in compliance throughout the year; the other half had not. Following this assessment, 22 companies made physical changes to their treatment systems, 45 implemented best management operational procedures, 5 ceased operations for economic reasons, and 13 were required to take further action or were simply excused by MOEE as one-time exceedances. Of the 169 companies examined, 137 (81 percent) discharged directly into the Great Lakes basin.

Over the four-year period from 1988 to 1991, compliance by those discharging directly into the Great Lakes had improved slightly less than 9 percent. In 1993, direct industrial discharges of wastewater in Ontario amounted to more than 71 million cubic metres (2,506 million cubic feet) per day, including 48 million cubic metres (1,694 million cubic feet) of water used for electrical power generation. Most of the water used in electricity generation is used for cooling, resulting in largely thermal pollution. Nevertheless, 23 million cubic metres (812 million cubic feet) of industrial wastewater is discharged in Ontario, almost five times as much as that discharged by municipal STPs, which also includes indirect industrial discharges to municipal STPs. These 1993 discharge levels are more than twice as great as those from direct industrial dischargers in 1973, some 20 years earlier.

In Ontario, the Municipal-Industrial Strategy for Abatement (MISA) has established regulations for the petroleum, pulp and paper, organic chemical, metal mining, metal casting, industrial minerals, iron and steel manufacturing, and electric power sectors. These regulations are designed to reduce toxic and other pollutants by approximately 11,000 tonnes per year, including an average 18 percent reduction for conventional contaminants and 51 percent for non-conventional and persistent toxic compounds. The

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virtual elimination of persistent toxic substances is a goal of the federal as well as the Ontario government in Canada.

Major industrial plants account for about 80 percent of the U.S. total treated wastewater discharged into the Great Lakes watershed. Over 18 million kg (18,000 tonnes) of heavy metals (copper, lead, zinc, chromium, mercury, cadmium), oil and grease, PCBs, and other important pollutants were discharged between June 1994 and June 1995 through municipal and industrial wastewater treatment plants on the U.S. side of the Great Lakes, according to the U.S. Environmental Protection Agency. Michigan (8 million kg) and Ohio (6.8 million kg) were the leading sources of these pollutants, followed by Indiana at almost 3 million kg. The Detroit wastewater treatment plant, for example, discharged 5.6 million kg of oil and grease, 56,000 kg copper, 10,000 kg chromium, and 47,000 kg zinc into the Detroit River and Lake Erie.

2.4.3 Air Discharges

Many industrial activities release pollutants into the air. Since the 1970s, some of the major industries in the basin such as power plants and steel and paper mills have, as a result of federal regulations, modified their air releases and reduced related pollution significantly. Industrial air pollution, however, remains a significant problem in the basin. Some of the major industrial air pollutants include sulphur oxides, nitrogen oxides, and volatile organic compounds (VOC). Particulates represent a smaller, though important, element of industrial air pollution.

The province of Ontario maintained 387 continuous monitors or high-volume samplers for air quality in 1991. Twenty-year trends in air quality show significant decreases in average levels of lead (99 percent), carbon monoxide (75 percent), sulphur dioxide (75 percent), and total sulphur particles (49 percent), and levels of nitrogen oxides have decreased by 17 percent over the last 17 years. Another air pollutant, ozone, has actually increased over the past 13 years.

Air quality as measured by the provincial air quality index in 1991 indicated that Cornwall on Lake Ontario suffered at least one hour of poor air quality on about 24 percent of the days on which it was monitored, Windsor 21 percent, Toronto 16 percent, and Hamilton 14 percent. The Inco and Falconbridge smelting operations in the Sudbury area are responsible for the large number of air quality exceedences there. Over the last 10 years, there has been only a slight decrease in emissions of VOC in Ontario, a result of improved vehicle emissions and industrial processes.

Ozone, a by-product of nitrogen oxide pollution, is a powerful lung irritant and has been set at an occupational exposure, eight-hour time weighted concentration limit of 100 parts per billion (ppb) (American Conference of Government Industrial Hygienists measure of threshold limit values). Most exceedances of limits for this pollutant in Ontario occurred at rural shoreline sites, such as Long Point and Tiverton, nearest to U.S. industrial states. During the hot summer of 1988, only six of the monitoring sites in Ontario did not exceed the eight-hour 100 ppb criterion on at least one day.

2.4.4 Opportunities and Challenges

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The continued supply of underpriced water encourages over-consumption of water and high relative levels of water use and wastewater discharge. Continued population growth and urban development will mean increases in levels of wastes from municipal activities. However, another scenario with less pollution and more efficient use of water resources is possible. The current economic shift away from heavy industrial activities to a more service-oriented regional economy may result in reduced discharges from the industrial sector. However, industrial activities are integral to the regional economy and, as such, will likely remain a major pollution source for the Great Lakes basin.

Improved pollution-control systems, such as tertiary treatment for wastewater, offer hope. Renovating and separating obsolete combined sewer systems is another action that can significantly reduce pollution in the nearshore area. The most promising and cost-effective action to reduce municipal and industrial pollution, however, is pollution prevention. Many industries have already reduced the amount of water used for processing. Reducing water usage has been shown to improve the quality of wastewater discharges in addition to reducing the total amount of water needing treatment and discharge. With access to the largest freshwater resource in the world, however, industry and residents have treated the resource much too casually. Whether the focus is at the tap or outfall, we must pay more attention to pollution prevention and conservation.

The production of solid waste poses a major problem for a society that realizes the long term problems associated with such waste. Canada and the United States produce more waste per capita than all other nations on the planet. Although waste recycling has become commonplace in the Great Lakes basin, waste generation continues. Metropolitan Toronto, for example has increased its waste generated per capita continuously from 33 kg/capita in 1971 by almost 40% to 46 kg/capita in 1991 (Metropolitan Toronto Planning Department 1995). Fortunately by 1991, 73 kg/capita were diverted from the limited availability of landfill space in Toronto through a recycling program.

Municipal waste disposal through landfill or incineration poses an ongoing threat to the nearshore ecosystem. Incinerators have acquired a reputation for unreliability. The provincial government of Ontario placed a moratorium on solid waste municipal incinerators in 1991 because of concerns about the effect of air emissions on public health and the potential disincentives for pollution prevention and recycling. Although new design and construction standards aim to prevent contamination of fill material with toxic substances, many older landfills are loaded with toxic contaminants that threaten the surrounding land, ground and surface waters. Metropolitan Toronto, for example has over 80 waste disposal sites that have been closed (Metropolitan Toronto Planning Department 1995). In addition there are the contaminated sites such as the leaking toxic chemical dumps on the US side of the Niagara River that continue to be a major source of persistent and other toxic substances to Lake Ontario.

2.5 Transportation

The development and growth of an extensive transportation system at both the provincial/state and municipal levels has many significant impacts upon the nearshore, nearshore waters, wetlands, and terrestrial biological communities. In the case of the Great Lakes basin, the transportation system is

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approaching maturity, and future trends indicate an emphasis on preserving the system and managing and optimizing the infrastructure, with limited expansion of the system.

Transportation was a pivotal factor in the development of the Great Lakes region. The combination of an in-place water transport infrastructure and a strong natural resource base promoted population settlement, agricultural development, and a manufacturing economy. Over time, an extensive rail, road, and pipeline grid was laid out and eventually a high-capacity air transportation network was built. Freight movements in the binational region serve both domestic markets and international trade. The relatively high level of freight in the region is attributable, in part, to the efficiency of the transport system. Particular modal patterns are evident in commodity movement and route structure. Historically, east-west freight routes have had more capacity and volume compared with north-south links. In recent years, however, cross-border north-south commodity flows have been increasing, and the infrastructure to support this trend is receiving more attention.

Great Lakes commodity movements are dominated by relatively low-value bulk commodities and average about 154–163 million metric tons (170–180 million tons) per year. From a land-use standpoint, shipping facilities and general port infrastructure occupy a small portion of the Great Lakes nearshore area. However, for the principal commercial harbours in urban centres, there are increasing development pressures as well as environmental concerns over dredging and contaminated land (see case study section for more discussion of the dredging issue). Rail and motor carrier freight transportation complement the more energy-efficient and less polluting waterborne mode in the region, but both maintain well-established service profiles while engaging in intermodal operations and head-to-head competition in some instances.

Although annual truck and rail freight tonnages fluctuate in response to business cycles, one trend is significant. The combined modes account for three-fifths of Canadian and two-thirds of U.S. intercity tonnage but highway use is expanding rapidly. For example, U.S. highways carried a third more total tonnage in 1990 than in 1980, whereas U.S. rail movement of manufactured goods declined by about 15 percent during the decade. Timely delivery and broad access throughout the road network has given the trucking sector a strong competitive advantage over rail in the movement of manufactured goods especially within an 800-kilometre (a 500-mile) delivery range. This relatively dense regional road network, encompassing around 1.6 million kilometres (1 million miles) of right-of-way, represents a mobility asset but also a tremendous maintenance and land-use burden.

2.5.1 Pollution Issues and Solutions

Development pressures around the Great Lakes will increase traffic densities and the number of local roadways. Air quality is affected by an increasing number of vehicles on the road. As the number and use of roadways increase, so will vehicle operations and frequency of maintenance, which will likely increase the resulting pollution of the surrounding environment. Commercial traffic is also increasing and associated air pollution, air turbulence, and the increased potential for cargo and fuel spills are some of the effects. Road transportation facilities have the potential to pollute surface water with salt, sediments, operating roadway runoff (oils, heavy metals, etc.) and transportation-related spills because they act as direct pathways for pollutants to receiving water bodies. Traditional design of roadway facilities encouraged the rapid movement of stormwater from the driving surface to the receiving watershed, with potentially

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significant effects on the previous hydrology of watersheds and subwatersheds. The growing recognition of these potential effects and the search for solutions have lessened the likelihood of serious future impacts. Current efforts to solve these problems are focusing on integration of roadway drainage design with the watershed to minimize impacts and, in some cases, mitigate existing hydrologic problems found in the watershed.

Many pollutants are dissolved into stormwater, and effective treatment of such dissolved pollutants, including road salt, is not cost effective. The most effective control for contaminants and pollutants is through the design of roadway drainage. Current efforts are focusing on the removal of suspended particles from roadway runoff. This ranges from construction activities with improved erosion and sediment control to the building of oil/grease separators in parking lots and permanent in-line check dams and sediment ponds to slow runoff and capture contaminants before they enter a drainage system. Techniques in engineering design and the use of artificial wetlands are also being investigated to permit more surface percolation of stormwater. Alternative means to control surface-water drainage on exposed earth slopes, reconstructed drainage channels and road rights-of-ways in general have emphasized quick stabilization with less dependence on hard engineering materials. Research and promotion of various proprietary erosion-control blankets have provided a wider range of products capable of reducing or eliminating sediment-laden runoff during construction. Applying bioengineering such as the use of natural plant materials for stabilizing earth and drainage channel slopes is another proven means of controlling these highly erodible areas.

Transportation infrastructure has been associated with impacts on aquatic fish habitat in nearshore areas. For example, the loss of fish habitat most frequently occurs as a result of

- infilling of nearshore habitat areas
- straightening (and shortening) of tributary streams
- destruction of fish habitat features
- alteration of water quality with loadings of salt and other pollutants
- alteration of runoff temperatures or flow volumes that affect aquatic biota

Transportation agencies employ a number of methods to compensate for, avoid, or mitigate damage to aquatic ecosystems. For example, in Ontario the provincial Ministry of Transportation tries to avoid the infilling of nearshore areas or wetlands where possible. Where this is unavoidable, fish habitat structures are created—for example, artificial reefs or shoals or other habitat features such as rock cribs. A transportation agency should avoid straightening or shortening waterways when spanning these with a bridge or culvert. A better solution would be to use larger bridge spans where possible to avoid having to relocate waterways. In cases where stream straightening is unavoidable, however, compensating measures are undertaken, including replacing in-stream habitat features that were lost. The primary goal in fisheries protection is to prevent damage to fish habitat and minimize direct impacts by avoiding construction during spawning periods or when young fish are present.

Road transportation with its significant ecosystem impacts is an area of public policy and activity where increasing attention is being given to environmental and land-use planning considerations. For example, to meet public expectations in environmental assessments of highway projects, the Ontario Ministry of Transportation plans its construction and major maintenance projects in an environmentally sound manner,

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documenting the effects, developing policies and mitigation techniques to reduce the impacts, and where necessary, compensating for detrimental impacts on natural areas. In the U.S. a landmark transportation law, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), requires that transportation planning on a statewide basis and for metropolitan areas consider the economic, energy, environmental, and social effects of transportation decisions. State and local transportation officials are directed to coordinate their work with land-use planning and development and have been given more flexibility in using federal money to achieve ISTEA's goals.

According to the Transportation Research Board (part of the U.S.-based National Research Council), a major thrust of ISTEA "is to encourage transportation alternatives that mitigate traffic and air quality problems." This new direction in federal transportation policy with its focus on environmental impact planning at the local and regional levels signals a major turning point in public policy. The integration of environmental and transportation issues was necessitated by rising public interest as well as the critical need for viable solutions to transportation and related environmental protection problems.

However, current transportation patterns carried into the future are clearly unsustainable given this sector's energy-intensive, emissions-generating, land-consuming and transit-damaging characteristics. The Toronto situation exemplifies these problems. Transportation in Metropolitan Toronto consumes over one third of all energy used—more energy than from all other individual sources including residential, commercial and industrial sectors. As a result, transportation is the largest source of carbon dioxide emissions for this municipality. In 1987, transportation was also responsible for almost 80% of all nitrous oxide and over 35% of all volatile organic compound emissions in Toronto—two important precursors for the creation of ground level ozone and smog. In recently-created suburbs, "lane -kilometers" per capita are three times what they are in more built-up areas of the central city. While inner city populations are served by public transit, lower density urban sprawl suburbs continue to be heavily reliant on the private automobile for travel. For example, in 1993 more than 60% of person trips in the Greater Toronto area were by public transit in the central area core while in the suburban areas over 80% of person trips were dependent on the private automobile (Metropolitan Toronto Planning Department 1995).

Transportation, whether it be infrastructure or operations, affects the nearshore. Within the Great Lakes basin, many high-volume transportation corridors are in the nearshore area because the lakes and connecting channels can be barriers to particular long-distance routings and often funnel surface routes to, or concentrate them in, the coastal areas. For this reason, the increasing attention given to assessing environmental impacts and coordinating related land-use policy among transportation agencies and communities should be encouraged, if not required.

2.6 Agriculture

Agricultural land constitutes approximately 24 percent of the area of the basin or 35 percent of the terrestrial land base. Much of this farmland is located in the southern half of the basin, with the Lake Erie basin having the highest concentration. The land and water resources of the basin have shaped its agricultural heritage and, over time, are being altered by agricultural activity. The conversion of land to agricultural use in North America has led to a major reduction and restructuring of native ecosystems.

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Through the husbandry of plant and animal communities, with their myriad connections to the natural world, agriculture is a significant part of the basin ecosystem. Certain agricultural practices, though (such as tillage methods, the concentration of livestock, and selected pesticide use), pose a risk to ecosystem health. Agriculture represents a grand experiment in landscape alteration. Its importance to human society has been determined, but its role in the natural world is still being shaped.

Great Lakes basin agriculture is diverse and productive. Commodity sales from all basin farms in 1991 (Canada) and 1992 (U.S.) amounted to $15.2 billion (U.S.). This figure represented 35.7 percent of the total product sales from all eight Great Lakes states and the province of Ontario. With only 29.8 percent of the greater region's cropland, basin production has a relatively large share of higher-valued commodities. Corn, which occupies 35 percent of cropland (1991-92), is the principal crop grown in the basin. Soybeans and hay follow at 22 and 20 percent respectively.

There were 203,993 farms in the Great Lakes basin as defined by the Canadian (1991) and U.S. (1992) agriculture censuses. Within the basin, changes in farm numbers have parallelled regional trends. There are fewer farms and some have grown larger. This is primarily attributed to the conversion of farmland to development and farm consolidation patterns (as farms are sold, existing farms acquire the available acreage). From 1981 to 1992, basin farmland and cropland declined by 1.83 million hectares (4.52 million acres) and 714,000 hectares (1.76 million acres) respectively (for discussion of the farmland conversion issue see "Farmland Conversion: A Major Issue for the Basin"). A reduction in cropland, which represents about 65 percent of total basin farmland, usually reduces particular causes of pollution such as farm chemical and sediment-laden runoff, but if development takes place on former cropland or farmland, another set of environmental consequences usually follow. For example, a developed parcel becomes more impervious, interfering with groundwater recharge and amplifying runoff. The changing of farmland to residential and commercial use leads to the negative impacts of sprawl, such as increased energy use and related pollution. For these and other reasons, the farmland/development balance in the Great Lakes basin has a major effect on natural resources including water quality.

Great Lakes basin agriculture represents an important part of the regional economy. Its complexity, as expressed in its dynamic production cycles, large land area, diversity of management actions, and effect on the environment, makes it a significant land-use issue. One of society's biggest challenges in moving towards sustainable development is to balance food and fibre production with a land and water stewardship ethic.

2.6.1 Soil Erosion and Sedimentation

Of the two major basin crops, corn requires relatively high levels of fertilizer, mainly nitrogen and phosphorus, whereas soybeans, a legume, is more dependent on phosphorus. If land used for these row crops is prepared under conventional tillage practices with extensive ploughing, it is more susceptible to erosion. In parts of the basin, agriculture-related sediment and nutrient loadings of Great Lakes tributary rivers is the leading cause of non-point source pollution. In recent years, more responsible land-use practices in agricultural areas have gained ground, and future prospects are brighter as more demonstration programs and assistance are directed toward the problem. Other measures such as contour ploughing, no-till and conservation tillage, vegetative and woodland cover in erosion-prone areas, filter strips, and

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sediment detention ponds have proved that progress is possible. The marriage of agriculture and conservation is recognized as a complex, long-term undertaking.

The increasing adoption of conservation tillage practices, whereby crop residue is kept on cropland surfaces has, however, resulted in a marked reduction in erosion and related phosphorus loadings. Nearly 50 percent of corn and soybeans in the U.S. portion of the basin is currently grown using conservation tillage. For the portion of the Lake Erie basin that is in Ohio, an annual phosphorus load reduction of 524 metric tons in 1995 has been realized through use of no-till and limited-till methods. On the other hand, nitrogen (nitrate) concentrations in Ohio's Lake Erie tributaries are increasing, possibly as a result of increased water infiltration and leaching of farm fields attributed to crop residue cover (Baker 1996). Other techniques such as soil testing and more precise nutrient application are allowing farmers to carefully manage nutrient levels and prevent overuse of fertilizers.

2.6.2 Pesticide Use

Pesticides are an important part of Great Lakes basin agriculture. These chemical compounds are widely used for the control of weeds, insects, and diseases that can reduce production. The risk to wildlife and human health of pesticide exposure is a matter of public concern, and continued scientific research is necessary to characterize the nature of any risk and help devise effective and safe formulations and methods of use. According to a report prepared by the World Wildlife Fund, agriculture in the Great Lakes basin uses an estimated 26 million kg (58 million lbs) of pesticides annually. Herbicides represent about two-thirds of the pesticides applied, with corn and soybeans receiving much of this amount.

Perennial specialty crops such as tree fruit tend to have more insect and disease problems than field crops grown in rotation and receive higher levels of insecticide and fungicide. Production areas for specialty crops are concentrated in Great Lakes coastal counties and a few inland areas where microclimate factors are conducive to their production. Trends in basin pesticide use for agriculture indicate an overall decline in usage as a result of reduced cropland and changes in application rates. For example, farms in Ontario have decreased their usage of atrazine by two-thirds since 1983. This is significant since atrazine is one of the most common herbicides in use and also has a higher level of persistence (especially in lake water) than many other pesticides. However, some places in the basin such as the northern Lake Ontario basin, reveal higher usage over the past twenty years. Projected declines in pesticide use will be complemented by introductions of "new generation" pesticides that are more target-specific and less persistent.

2.6.3 Manure Management

A trend of fewer farms with livestock but more animals per operation is affecting the basin environment. These farms must wrestle with diverse manure-related issues ranging from storage and odour control to crop nutrient management and implications for water quality. Other problems such as waterborne pathogens connected to manure and feed-contamination can raise serious public health concerns. The basin's relatively large forage base (pasture, hay, and silage) gives the area inherent production advantages for beef and dairy cattle, swine, and sheep; but livestock numbers, except for swine and poultry, have been

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declining. The farm-animal population in the Great Lakes basin produces an estimated 80 million tons of manure each year, which is about 20 times greater than the volume of human excreta in the basin (D'Itri 1996).

The large amounts of manure from livestock concentrations degrade water quality through runoff and related phosphorus loadings as well as nitrate leaching into groundwater. The use of manure as a fertilizer for crops is a long-standing practice, but the increasing amounts have produced nutrient levels well beyond what crops can utilize. More widespread distribution of manure for this purpose has not been economical. Manure management is a topic of intensifying research, and solutions to these problems will likely add substantial expense to farm operations.

3.0 Lake By Lake Perspective

Due to its large size, physical characteristics such as climate, soils, topography and land cover vary throughout the Great Lakes Basin. The northern portion of the basin has a colder climate, poorer soils and is densely forested, primarily with coniferous trees. The southern part of the basin has a warmer climate and more fertile soils that once supported widespread deciduous forests but have been cleared for agriculture and sprawling urban development. Each of the five Great Lakes is also unique. Though they share commonalities and differences based on the characteristics of the larger Great Lakes Basin, each of them also has a unique land use profile that has physical, socio-cultural, economic and environmental quality components. This section describes the unique physical aspects of each Great Lake basin and examines the demographic, social, industrial, agricultural and environmental commonalities and differences of each basin with respect to land use.

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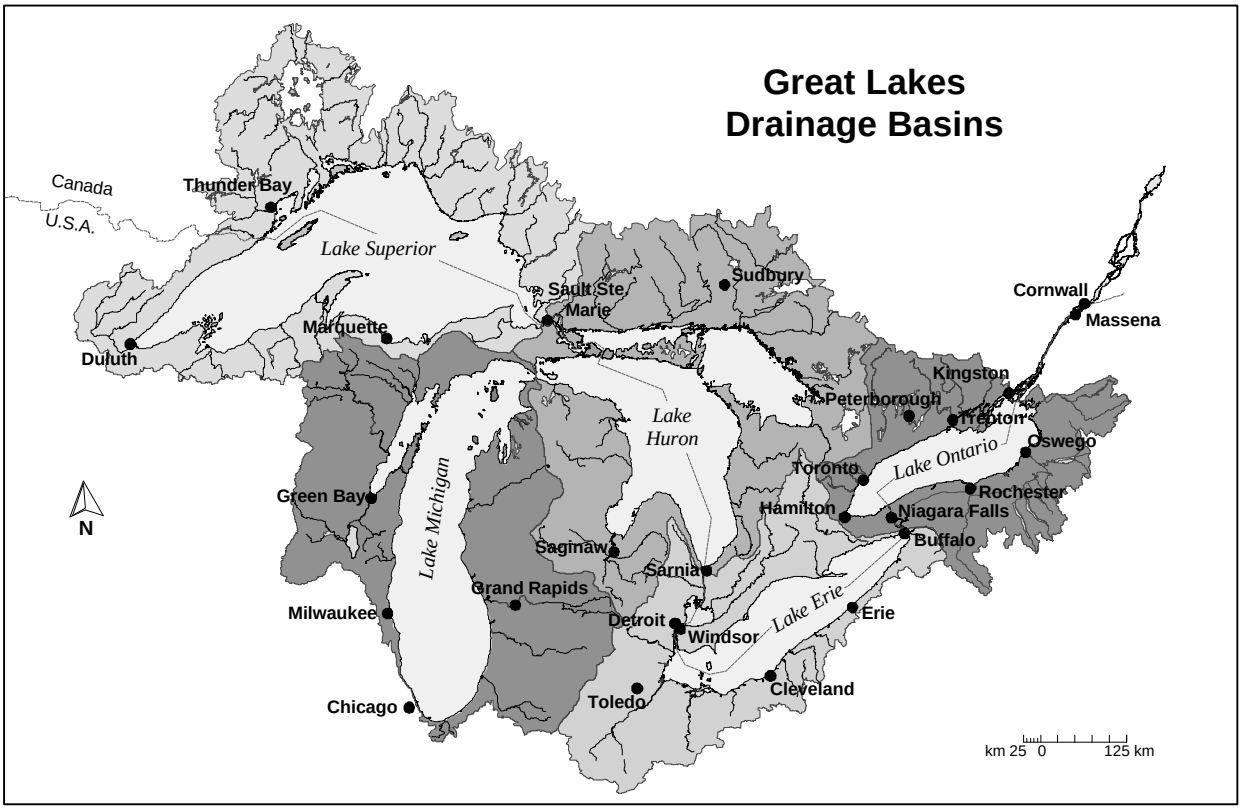

Figure 2. The Five Individual Lake Basins of the Great Lakes Basin

3.1 Hydrologic and Natural Features

Hydrology

Lake Superior is the largest of the five Great Lakes. It holds more water than all the other Great Lakes combined and has the largest surface area of any lake in the world. Lake Superior serves as the headwaters for the other four Great Lakes, receiving its water mostly from precipitation and surface runoff. Lakes Michigan and Huron are one lake hydrologically as they are connected by the Straits of Mackinac and receive water from Lake Superior through the St. Mary's River. However, they are generally viewed as separate lake basins. Lake Huron is the second largest of the Great Lakes and Lake Michigan is the third. The fourth largest Great Lake, Lake Erie, receives ninety-five percent of its water from Lakes Michigan, Huron and Superior, which flows out of Lake Huron via the St. Clair River, Lake St. Clair and the Detroit River. Lake Erie is the shallowest of the Lakes and is especially vulnerable to fluctuating water levels. The smallest of the Great Lakes is Lake Ontario. Lake Ontario receives more than 80 percent of its waters from the other four Great Lakes. For some it has been known as the "last least littlest lost lake" because it is the lowest and smallest in the system of Great Lakes. Nonetheless, Lake Ontario ranks as the twelfth largest lake in the world (Herdendorf 1982).

Diversions and Other Hydrologic Modifications

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Over the past 200 years, the hydrology of each of the five lakes has been altered by human created diversions, regulatory structures, urbanization, dredging and filling and other human activities. Structures at Long Lac and Ogoki divert an average of 5,600 cubic feet per second (158.87 cubic meters) of flow from the James Bay/Hudson Bay watershed into Lake Superior, effectively expanding the functional boundary of the Lake Superior basin. Two major diversions in the Lake Michigan basin—the reversal of the natural flow of the Chicago River through a system of locks and channels and a diversion of the Calumet River—have resulted in the transfer of 1,743 square km (673 square miles) from the Lake Michigan watershed to the Illinois River/Mississippi River drainage basin. As a result, water now leaves Lake Michigan through the Chicago river at a regulated flow of about 3,200 cubic feet (90.71 cubic meters) per second. Other major modifications of the flow of water through the Great Lakes have occurred. For example, the flow out of Lake Huron into Lake Erie has been increased by dredging in the connecting channels between those two lakes. The outflow of Lake Erie into Lake Ontario has been slowed by infill and bridge construction and the Welland Canal system diverts some water around the Niagara River/Falls to provide a means for water transport between Lakes Erie and Ontario. And regulatory structures at Sault Ste. Marie and Lake Ontario that help control lake levels also affect the natural water flow.

Distinctive Features

Each lake basin has common and distinctive nearshore and natural features. A companion paper to this series, "Land By The Lakes: Nearshore and Terrestrial Ecosystems" identifies twelve unique Great Lakes shoreline ecological communities, including: sand beaches, sand dunes, bedrock and cobble beaches, unconsolidated shore bluffs, coastal gneissic rocklands, limestone cliffs and talus slopes, lakeplain prairies, sand barrens, arctic-alpine disjunct communities, atlantic coastal plain disjunct communities, shoreline alvars, and islands (Holland, Reid 1996). That work describes in detail where these unique areas exist in each of the Great Lakes. While some of these communities are found in each of the Great Lakes, several stand out as distinguishing features in only certain lake basins.

The features that distinguish Lake Superior are its relatively pristine character, heavily forested watershed and high water quality. Lake Superior is the only lake that contains stretches of the arctic-alpine disjunct communities—plants and animals adapted to cooler, wetter weather whose primary range is further north, but which are found in isolated areas along Lake Superior's northern shore (Holland, Reid 1996). Though Superior's basin is sparsely populated with less than 2 percent of the entire Great Lakes population, the shoreline has been substantially modified in certain areas; particularly in Michigan's Upper Peninsula where urban areas have replaced wetlands, especially at the mouths of rivers.

Though every Great Lakes Basin has some sand dunes and beaches, the expanse of sand dunes and beaches along Lake Michigan's eastern shore is one of its most impressive features. This extent of sandy beach and dunes is accented by Sleeping Bear Dunes National Lakeshore in the north and the Indiana Dunes National Lakeshore in the south—the latter containing the third highest plant diversity of all U.S. national parks (U.S. Geological Survey 1991). The greatest alteration of the Lake Michigan nearshore has been in the southern part of the basin where intensive urban and industrial development has resulted in filling and "hardening" of the shoreline and discharge of large amounts of pollutants into the air, water and lands of that coastal region.

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A ridge of sedimentary rock forms an arc in the middle of the Great Lakes Basin and is the source of prominent natural features found in several of the Great Lake basins. In the Lake Michigan basin, this ridge is the source of the Door and Garden Peninsulas that separate Green Bay from Lake Michigan. Perhaps the most spectacular part of this ridge, known as the Niagara Escarpment, runs through the Lake Huron and Lake Erie basins in Ontario forming the Bruce Peninsula and Manitoulin Island in the north and extending south and to the east, where the waters of Lake Erie spill over it on their way to Lake Ontario, forming one of North America's single most famous tourist attraction: Niagara Falls (Ashworth 1986).

Lake Huron is renowned for its more than 30,000 islands, one of which—Manitoulin—is the largest freshwater island in the world. When island shorelines are included, Huron boasts the longest shoreline of the Great Lakes. The Michigan side of Lake Huron has nearly 37 percent of all Michigan's coastal wetlands on the Great Lakes, most of which are found in the Saginaw Bay, which is home to 138 endangered or threatened plant and animal species (Michigan DEQ 1996).

The Carolinian forest species found primarily along Lake Erie's sandy-loam north shore and part of Lake Ontario are unique within Canada. Once an important water recharge area, these forests have been almost completely cleared for agricultural use. Lake Erie's nearshore generally has limited sand. However, a succession of sand bars or spits created by littoral drift stand out as unique nearshore features, particularly along the north shore (Herdendorf 1993). The marsh and open waters between the bars provide significant plant and animal habitat and are a popular attraction.

Lake Ontario's most unique nearshore features include the rocky and highly convoluted shoreline of the Kingston basin. This area accounts for more than 50 percent of Lake Ontario's total shoreline. The rocks that form this shoreline are part of a unique ecological community known as coastal gneissic rocklands and are found elsewhere in the Great Lakes Basin only along the island-studded eastern coast of Georgia Bay on Lake Huron (Holland, Reid 1996). Lakes Ontario and Huron share another unique shoreline community: the limestone cliffs and talus slopes associated with the prominent edges of the Niagara Escarpment at the upper portion of the Bruce Peninsula in the Huron basin and along the Niagara Gorge in the Ontario basin (Holland, Reid 1996). Another unique aspect of Lake Ontario's nearshore is that exposure to strong winds and wave action make much of the nearshore zone unsuitable for rooted plant growth, whereas for the other Great Lakes, this zone is generally occupied by rooted aquatic vegetation.

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Table 4. Great Lakes Basin Land and Water Areas and Populations

		Superior	Michigan	Huron	Erie	Ontario
Total Basin Area	mi^2 km^2	81,000 209,800	67,900 175,800	74,700 193,700	40,050 103,700	32,060 82,990
Water Surface Area	mi^2 km^2	31,700 82,100	22,300 57,800	23,000 59,600	9,910 25,700	7,340 18,960
Land Drainage Area	mi^2 km^2	49,300 127,700	45,600 118,000	51,700 143,100	30,140 78,000	24,720 64,030
Basin Population		607,121	10,057,026*	2,694,154	11,682,169	8,150,895

Source: *The Great Lakes: An Environmental Atlas and Resource Book.* Toronto and Chicago. Environment Canada and U.S. Environmental Protection Agency, 3rd ed. 1995.
*Based on the original Lake Michigan basin Boundary, before present Lake Michigan diversions. Lake Michigan basin population based on modern hydrologic boundary is estimated at 7,142,776.

3.2 Land Use

Lake Superior

Over 90 percent of the Lake Superior basin is forested. Agricultural, urban and public/recreational land uses make up the balance. The importance of agricultural lands in the Lake Superior basin is limited due to small cropland acreage and a shorter growing season. The shoreline is relatively undeveloped compared to the other Great Lakes. On the U.S. side, much of the eastern shoreline as well as important tracts in the western basin is under federal or state ownership. Over 90 percent of the northern shoreline is owned by the Canadian Crown. These government-owned lands are generally classified as "public" and recreational lands. Urban land use in the basin is concentrated in the two largest urban areas of Duluth-Superior and Thunder Bay. Residential lands are clustered in these urban areas, but shoreline areas are increasingly being subdivided for potential residential development as demands continue for lake-adjacent second homes.

Lake Michigan

The Lake Michigan basin land use profile varies considerably from north to south. Forested lands dominate the northern portion of the basin. Preliminary data collected in 1993 by the U.S. Forest Service indicate that each of the Lake Michigan-adjacent counties in Michigan's upper peninsula contains more than 202,500 hectares (500,000 acres) of forested land. Historically, the northern basin has also been an important mining area—primarily dolomite (limestone) with some marble, granite and iron ore (Michigan State University 1977). The heavily forested north gradually gives way to predominately agricultural lands in both the eastern and western portions of the basin. In 1991/92, 35.7 percent of the basin's land was

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farmland, most of which was cropland and pasture. The Door Peninsula in the western basin and the "fruit belt" along the coastal counties of the eastern basin are important areas for orchards and specialty crops. Southward, agricultural land is increasingly interspersed with urban areas. The extreme southern portion of the basin— a relatively narrow band of land adjacent to the lake—is heavily urbanized. Between 40 and 46 percent of the land in the Indiana-Illinois portion of the basin is classified as urban.

Lake Huron

The Lake Huron basin has some commonalities with the basins of Lake Superior and Lake Michigan. Like the Lake Superior basin, the Lake Huron basin contains no major metropolitan areas. The largest urban centers in the basin are Sudbury and Sarnia on the Ontario side and Saginaw and Bay City on the Michigan side. With populations under 100,000, these urban areas are relatively small compared to urban areas in the more populous Great Lake basins. Another similarity with Superior is that the Lake Huron basin is heavily forested, particularly in the northern portion. As with the Lake Michigan basin, however, land use in the Lake Huron basin becomes increasingly agricultural from north to south and its urbanized areas are along the southernmost portion of the lake. However, the extent of agricultural and urban lands in the Huron basin is much less than the Michigan basin. Much of southern part of the Huron basin is devoted to intensive cultivated field crops. Beef and dairy farms are also numerous throughout the southern part of the basin, particularly in the "thumb" area of Michigan and along the Bruce Peninsula and extending southward toward Kitchener. Mining of limestone, nickel, uranium, copper, platinum and gold has been an important land use in the northern portion of the Lake Huron basin. Mining of gypsum, limestone, lime and clay occurs in the southern part of the basin (MSU Press 1977). Though residential land use makes up a small percentage of total land use, much rural development has occurred along the shoreline.

Lake Erie

Agriculture is the primary land use in the Lake Erie basin representing 58 percent of the total land use in the basin (Agriculture and Agri-food Canada 1991). Major cash crops (wheat, grain, corn, soybeans and barley) dominate the Erie basin's agricultural land use, particularly in the southwestern basin where in 1991 cropland represented 81 percent of the agricultural land base and cash crops made up more than 80 percent of total cropland. Urban land use on the American side is concentrated in the Detroit, Toledo, Cleveland, and Buffalo metropolitan areas which contain about 86 percent of the Erie basin population. Urban land use on the Canadian side is concentrated in the Windsor area, and along the province's major highway, the 401, which travels in an east-west direction in southernmost Ontario and connects many of Ontario's urban centres. Populated areas along the Canadian Lake Erie shoreline are mainly small "port" towns and villages.

Lake Ontario

The Lake Ontario basin probably has less of a contrast in land use types (i.e., urban, forest, agriculture) than any of the other Great Lakes. In 1992, farmland made up 28.1 percent of the total land use in the Lake Ontario basin, about half of which (48.2 percent) occurred as cropland. Forested and urban lands are equally important land uses in the Lake Ontario basin.. The large stretch of forested land that characterizes much of the northern Great Lakes Basin is also found in the extreme northern reaches of the Lake Ontario basin. Concentrations of forested land are also present in the extreme southern and eastern portions of the

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basin—the latter which extends to the Adirondack mountains. Urban land use in the Lake Ontario basin is most concentrated on the Canadian side, in a band of coastal land along the western portion of the basin known as the "Golden Horseshoe." Toronto is the anchor of this metropolis. By contrast, the U.S. population is dispersed mainly throughout the Rochester, Syracuse and Oswego areas of New York State.

3.3 Land Use Trends and Their Impacts

Land Use and Population/Demographic Trends

With the exception of the Lake Ontario basin, whose population is concentrated in Canada's Golden Horseshoe, population of the individual Great Lakes Basins is greater on the U.S. side, though only slightly so in the Lake Huron basin. The populations of the Lake Michigan, Lake Huron and Lake Ontario basins increased between 1980 and 1990 while populations in the Lake Superior and Lake Erie basins declined. Though the population in the Superior basin overall is declining, population in the basin's two major urban areas, Duluth-Superior and Thunder Bay, is expected to increase. Over the past 10 or more years, population on the U.S. side of the Lake Erie basin has been declining, due in large part to regional industrial restructuring trends away from heavy industry, which has historically dominated the economy of U.S. urban areas in the Lake Erie basin. However, there has been notable growth on the Canadian side in urban areas along and near Highway 401.

The population shift away from central cities coupled with rapid growth in the surrounding metropolitan areas is a significant population trend for Lake Michigan Erie and Ontario basins. The City of Chicago, for example, lost population between 1980 and 1990 while the Chicago metropolitan area experienced continued growth in areas outside the central city. The Milwaukee/Racine area in Wisconsin provides another example of where population decreases in the central city are countered by either lower rates of decrease or population increases at the county level. The cities of Buffalo in the Lake Erie basin and Rochester and Syracuse in the Lake Ontario basin serve as additional examples. Over the past thirty years, their central city populations have declined an average of 44 percent while outlying areas within the metropolitan areas have grown by 39 percent (New York State DEC 1992). In Canada's largest metropolitan region, the Greater Toronto Area, the picture is no different. Low net population growth in the City of Toronto has been replaced by suburban expansion and development of outlying rural areas.

In some places this outlying growth is reflective of an increase in the number of households only, not a real increase in population, while in others, it is a true increase in population. For example, the Rochester metropolitan area's population remained stable through the 1980's, though the central city lost population while the first and second ring of suburban towns around Rochester experienced rapid growth. This suburban population growth is due to two primary demographic trends that have important implications for land use. First is the trend toward lower density households due to the fact that people are having smaller families and more people are living alone. Second is the propensity to have a house and a lot of one's own. Both require more housing, more infrastructure and more land to serve the same number of people.

A second important demographic shift is the remarkable population decrease related to job loss in several of the lake basin's highly-urbanized areas. For example, the hub of North America's steel production in

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Northwest Indiana has been influenced by the downsizing of steel mills. As a consequence, population decline for the tri-city area of East Chicago, Hammond and Gary between 1980 and 1990 was 14.8%, 10.1% and 23.2%, respectively. The Buffalo metropolitan area has experienced similar demographic shifts, due in part to the virtual loss of its steel-making and other heavy industries (New York DEC 1992). This trend has been occurring since the 1970s and is expected to continue, though at a slower pace.

Land Use and Society

The latter half of the twentieth century has witnessed a renewed societal appreciation for coastal amenities and water-related recreational opportunities. Significant land use implications have manifested from this societal shift. The desire to reap the benefits of nature (physical, spiritual and psychological) has resulted in a booming increase in second home or "cottage" development along the shorelines of many of the Great Lakes. Coupled with increased societal awareness of the benefits of physical fitness, it has also spurred the demand for shoreline access and recreational opportunities in and around the Great Lakes, be it swimming at a public beach or jogging in an urban waterfront park.

COTTAGE DEVELOPMENT

The trend toward second home or cottage development is particularly important for several of the Great Lake basins. A substantial nearshore trend toward second home development is apparent on the U.S. side of the Lake Superior basin. For example, over fifty percent of the homes in Keweenaw county on Michigan's Upper Peninsula are classified as second homes. Second home use is less common in the Canadian Lake Superior basin mainly because of its remoteness. The overall population decline in the Superior basin, discussed above, masks this significant trend of increasing number of second home residents. This is because census population figures, based on the number of permanent residents in an area, do not account for the seasonal population. In the Lake Michigan basin, a study of a ten-county area of in the northeastern basin (northwest Michigan), concluded that one person in six (about 16 percent) staying in the region in 1995 was not part of the permanent population. Two-fifths of those were people staying in second homes (Becker et al. 1996). Trends indicate continued high rates of second home development (41% to more than 80%) in this region between 1990 and 2020 (MSPO 1995) where during summer months in coastal counties there is almost one "visitor" for every two permanent residents (Becker et al. 1996). Seasonal cottages are also found along most of the Lake Huron shoreline, with the heaviest concentration (over five units per square kilometer) located along the Bruce Peninsula and Georgian Bay shores and the "thumb" area of Michigan. The significance of the second home population is that it constitutes an important element of overall land use, but it does not necessarily contribute to tourism-related economic benefits, which are generally associated with seasonal visitors.

Implications for the nearshore are magnified as many of these cottages are being converted to year-round use or built and equipped to permanent use standards. This trend is particularly apparent in the Lake Huron and Erie basins. In many cases, upgrading cottages also necessitates improvements to, or installation of septic systems. The cumulative impact of individual septic systems on groundwater and natural areas poses a serious long-term threat to the ecosystem. Shoreline erosion is also an issue. The nearshore area of shoreline-adjacent seasonal cottages has considerable time during the year to replenish itself, re-establish or maintain natural communities and generally exist without human impact. Nearshore residences that are occupied year-round do not provide such relief from human impacts.

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WATERFRONT REDEVELOPMENT

Today, many manufacturing plants originally located on or near the lakeshore are closing or relocating and modernizing at different locations. Increasingly diversified economies around the Great Lakes and increased societal appreciation of and demand for access to coastal areas has led to a wave of waterfront revitalization efforts in many areas. These efforts are most notable in the Lake Michigan, Erie and Ontario basins where heavy industry has been an important part of the lakefront heritage. In the Lake Ontario basin, Toronto's waterfront has become valued as a civic focal point with lakeshore access geared for diverse uses other than industrial activity. Other former waterfront industrial areas on Lake Ontario such as Port Credit and Cobourg are also being redeveloped. Waterfront revitalization has been significant in the Lake Michigan basin. Almost all of the coastal communities along the lake's western shore have had some degree of waterfront revitalization (Wisconsin Department of Administration, per. comm. 1996). Some Lake Michigan shoreline communities have undergone remarkable redevelopment in the form of waterfront residential complexes (Racine) and extensive lakeshore park systems (Manitowoc), while other revitalization efforts (such as at Ludington and Sheboygan) are proceeding much more slowly due to environmental contamination problems (Davidson 1996). Waterfront revitalization has been less significant in the Lake Superior and Huron basins because of their remoteness and historically lower levels of industrial development. More public access and attractively designed waterfront facilities are common to waterfront revitalization efforts. With revitalization, once old and deteriorated waterfronts are becoming the focal points of communities. Waterfront revitalization is one of the trends that has positive implications for land use. It is an efficient use of land as it provides new economic and recreational opportunities by renovating already developed areas where infrastructure is already in place.

Land Use and Industry

Proximity to the Great Lakes was a key factor in the establishment of the economy of the Great Lakes region as well as for the individual Great Lake basins. Historically, many areas around the Great Lakes areas were settled on or near the lakes themselves because of access to waterborne transportation and water for industrial processes. However, economic shifts away from heavy and waterborne-dependent industries toward a more service-oriented economy have altered the economic makeup of several Great Lakes Basins.

The Lake Superior basin has had a rich mining history particularly for copper and iron ore. Mining has also been important in the northern portions of the Lake Michigan and Lake Huron basins, as noted earlier. The U.S. mining industry has experienced substantial layoffs and mine closings for decades and the trend continues today. On the Canadian side of the Lake Superior basin, however, the mining industry continues to prosper. Surface mining substantially alters the local landscape and contributes to soil erosion and sedimentation problems for nearby waterways. The environmental impacts of mining are complicated by the presence of mill tailings, which can be toxic to plant and animal life, particularly in the case of copper, and can leach or erode toxic minerals or substances into surface and groundwater.

The abundant forests of the Lake Superior and northern Lake Michigan basins support a leading forest and paper products industry, despite some plant closings and corporate restructuring in the forest products industry on both sides of the Lake Superior border. The northern Lake Michigan basin serves as one of the nation's foremost Christmas tree growing regions. The Fox River-Green Bay area of the Lake Michigan basin is recognized as the world's largest concentration of pulp and paper mills. Pulp and paper mills have contributed to huge pollution problems, but, improvements over the last two decades have been significant.

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Mill effluents containing dioxin and other chlorinated organic compounds are toxic contaminants posing a serious to human health and the environment. New production and treatment technologies are reducing and, for particular facilities, eliminating these pollutants. Contamination from past practices, however, remains a significant concern.

Shipping is an important industry in several of the Great Lakes Basins, but its importance is probably most pronounced in the Lake Superior basin which boasts the largest tonnage port in the Great Lakes-St. Lawrence system in Duluth. Shipping is also important in the economy of the Lake Erie basin. Ohio's water ports are a boon for commercial activity with eight ports along the shore from which nearly $18 billion in goods is annually shipped. Shipping does not directly impact the land, but the ports and harbours that serve navigable waters have made their mark in Great Lakes nearshore areas. Construction and maintenance of ports and harbours alters the natural dynamic of the nearshore land/water interface and can degrade or destroy local nearshore terrestrial and aquatic habitat. Dredging to maintain navigable waterways becomes an important land use issue when contaminated sediments are involved, which is the case for many older ports and harbours around the Great Lakes. These issues are basinwide rather than lake-specific and are discussed in more detail in Section 4.3 ("Dredging and Confined Disposal Facilities") and elsewhere in this paper.

Steel is uniquely important to the Lake Erie and Lake Michigan basins. The largest concentration of steel production in North America is located near the southern tip of Lake Michigan. There, five large integrated mills with blast furnaces and three minimills dependent on iron/steel scrap produce about a quarter of U.S. steel. Steel was once an important economic base for Buffalo, which lost its steel industry between 1970 and 1988 (New York DEC 1992). However, Cleveland and Detroit still have substantial steel production. The steel industry has had a major impact on land use and the nearshore environment. Its sprawling scale, including fabricating and warehouse facilities occupies thousands of nearshore acres and, in southern Lake Michigan, unique dune ecosystems. Steel making has been a notorious polluter of water and soil. As a result, the industry's legacy has generated tons of pollutants, some of which are still present in contaminated sediments in nearshore waters and soil within plant boundaries. Much improvement in air emissions and water effluent has occurred in recent years. For example, water use for process purposes has been substantially reduced with the incorporation of recycling and closed-loop systems. As with the pulp and paper industry, however, contamination from past practices remains a significant concern.

Recreation and tourism are important economic factors in all of the Great Lakes Basins, but not necessarily for the same reasons. Due to extensive dunes and beaches, the Lake Michigan basin offers more recreational and tourist opportunities associated with beach activities. Rugged shorelines make recreational boating, marinas and fishing areas more economically important in the Lake Erie and Huron basins. Despite these differences, most of these recreation and tourist activities spur the same types of spin-off services in the form of hotels, restaurants and parking. Perhaps the greatest economic difference in tourism and recreation among the Great Lakes is seen when comparing the northernmost lake basins with the more southern basins. In the northern Lake Michigan basin and in many areas throughout the Lake Superior basin, tourism is no longer a one-season industry. Skiing, snowmobiling, and conventions have extended the tourist season beyond the traditional warmer weather activity base. Though tourism and outdoor recreation can take a toll on the nearshore environment when activities such as second home construction and automobile usage often overwhelm once-unpopulated areas and sensitive habitats, the industry stands out as a sector of the economy that can also contribute to environmental quality. Public access, outdoor

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recreation and exposure to these natural areas increase appreciation for their special qualities and support for conservation measures. Fees from fishing and hunting permits and park entrance fees are used to restore and maintain nearshore habitat, wildlife populations, and the other natural features of the nearshore that attract visitors/users in the first place.

Sport fishing and recreational boating anchor an important part of the recreation and tourism economies for several Great Lakes Basins. The most biologically productive of the Great Lakes, Lake Erie's fishing industry is worth approximately $141 million Canadian ($101 million U.S.). According to the 1991 U.S. national fishing and hunting survey, 34 percent of all Great Lakes anglers fished in Lake Michigan, a close second to Lake Erie's 35 percent. Sport fishing is also important economically in the Lake Huron basin where the sport fishing industry (bass, trout, salmon, perch) in Canadian waters is estimated to be over $100 million (CAN.) per year. The number of recreational boats operated on Lake Michigan each year is estimated at 400,000, or nearly half the number for all the Great Lakes. Although boating has a strong connection to fishing, which relies on clean water and productive fish stocks, much of the boating activity is tied to marina and new nearshore residential development, which degrades nearshore habitat and water quality in localized areas. Along Indiana's Lake Michigan shoreline, for example, boat slips increased from 1,100 in 1985 to 2,700 in 1991, though many new marina developments in Indiana are occurring on previously-developed sites.

Commercial fishing is a particularly important industry in the Lake Erie basin. Port Dover and Wheatley harbour are the largest commercial freshwater fishing ports in the world.

Land Use and Agriculture

Agriculture represents a significant portion of the economies and overall land use in all the Great Lakes Basins except Superior. Following the time of early settlement, the economies of the Lake Michigan, Huron, Erie and Ontario basins were strongly dependent on agriculture. Though agriculture now plays more of a supporting role in the economies of these four Great Lake basins, it remains a major force affecting land use in these basins.

Table 5. Farming Intensity in the Great Lakes Basin

Percentage of Total Basin Land In Farmland for 1991/92*					
Superior	**Michigan**	**Huron**	**Erie**	**Ontario**	**Total**
2.27	35.70	17.00	57.54	28.14	22.83

*Source: Agriculture and Agri-Food Canada

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Although many major cropping and livestock systems are present in the Great Lakes Basin overall, each of the individual Great Lake basins has a distinct agricultural profile. The Lake Erie basin, for example, has the largest percentage (nearly 58 percent) of farmland of all the Great Lakes Basins. An important agricultural trend in the Lake Erie basin has been an increase in cropland and decrease in improved pasture. The conversion of improved pasture to cropland likely accounts for most of the increase in cropland area. These trends indicate a shift to more intensive field crop production—primarily soybeans. Indeed, cropland used for soybean production in the Ontario portion of the Lake Erie basin has increased more than 100 percent since 1981. The trend to more intensive field crop production increases the risks of soil erosion, agricultural runoff and other environmental problems related to agricultural land use.

The Lake Michigan and Lake Ontario basins have regions characterized by particular soil types and climatic conditions that make them conducive for orchards and specialty crop production. In these areas, the moderating influence of the lake reduces the risk of spring freezes and helps lengthen the growing season. The eastern Lake Michigan basin, particularly in the coastal counties, is one such area. Orchards are common in this area, which is the leading Great Lakes Basinwide source of cherries and apples for processing. The Lake Michigan basin accounts for 45 percent of total Great Lakes Basin specialty crop (fruits and vegetables) acreage. Door County, Wisconsin in the western Lake Michigan basin is also known for its favorable growing conditions and is an important area for cherry and apple production as well. The Niagara "fruit belt," which lies between Lake Ontario and the Niagara Escarpment and runs from the outskirts of Hamilton to the Niagara River, is one of the most significant areas for tender fruit production in Canada. Yield and product quality concerns for these and other specialty crops also translates into relatively high use of pesticides, which constitute an important element of nonpoint source pollution in the basin as they are leached into groundwater or runoff into Great Lakes tributaries and nearshore waters.

Dairy production is strongly represented through much of the central western Lake Michigan basin, the southern Lake Huron basin and the Rochester Embayment and more interior areas of the Lake Ontario basin (though agricultural land uses in the Rochester Embayment has declined in recent decades). The Lake Michigan basin alone accounts for 40 percent of the dairy cows in the entire Great Lakes Basin. A-well established trend is fewer but larger dairy farms with more milk from each cow. This trend in the dairy industry is reflective of a larger trend in agriculture towards consolidation and large-scale farming operations. Thus, while there may be a decrease in the actual number of acres used as farmland, those acres are used more intensively than before. This decline and intensification of the agricultural land base means that stresses to the ecosystem are more concentrated, placing these lands and the waters that flow through and around them at greater risk of pollution and degradation.

The flip side of this problem is that in some areas where marginal agricultural lands are being taken out of production, those lands are being allowed to regenerate, reducing the risks to land and water associated with agricultural land use. In the Lake Huron basin, for example, a declining agricultural land base has led to increased forest cover in the interior areas of Ontario counties within the basin, which are predominantly rural/agricultural. This alone will have a positive impact on water quality within the local rural watersheds and, ultimately, in the larger basin as well.

Pork production is significant within the Lake Michigan basin—the only lake basin experiencing an increase (9.4 percent) in hog and pig numbers since 1982.

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Table 6. Percent Changes in Agricultural Land Use Between 1981/82 and 1991/92*

	Superior	Michigan	Huron	Erie	Ontario	Great Lakes Basin
Cropland	-17.9	-6.0	-4.1	-4.1	-12.0	-6.0
Pasture †	-16.1	-17.0	-23.9	-28.0	-27.5	-23.8
Farmland ‡	-15.0	-8.6	-8.1	-7.0	-15.6	-9.6

*Source: Census of Agriculture-1981/91, Statistics Canada, CA
Census of Agriculture-1982/92, Bureau of Statistics, USA
† includes improved (without inputs or maintenance) and unimproved (permanent) pasture
‡ includes cropland and pastureland as well as woodland and other grazing areas

Though cropland has declined in each of the individual Great Lake basins, the percentage of farmland that is in cropland has increased for all the lake basins except Superior. That is because the rate of overall farmland loss has exceeded that of cropland.

Over the past twenty years, agricultural lands in virtually all of the Lake basins have been reduced and fragmented by urban expansion and scattered residential development. This loss of farmland, or farmland conversion is an important land use issue for all the Lake basins where agriculture is a significant part of the land use base and the economy (Michigan, Huron, Erie and Ontario). (See "Farmland Conversion: A Major Issue for the basin," Section 4.1).

Land Use and Water Quality

Water quality in the Great Lakes is directly related to the type, extent and location of human land uses. Water quality problems arise when the type and extent of human land uses exceeds the natural ability of the watersheds to accommodate land use related stresses. Though water quality is an issue for all of the individual Great Lakes, its seriousness varies among as well as within the lakes.

Though there may be water quality degradation in localized areas, water quality of both ground and surface waters in Lake Superior is high, reflecting the relatively pristine environment of the Lake Superior watershed. Lake Superior is considered oligotrophic: deep and cold, with low levels of available nutrients, little plant life, high levels of dissolved oxygen, and important populations of cold water fish.

The other four Lakes experience water quality problems of varying degrees. Water quality problems are attributable to a variety of land uses that contribute both point source pollution, via direct discharges into the water (e.g., from industrial discharges and sewage treatment plants), and nonpoint source pollution, via indirect sources such as atmospheric deposition, groundwater infiltration or surface (urban and

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agricultural) runoff. Many improvements have been made in the control of point source pollution throughout the Great Lakes. Nonpoint source pollution control, however, still has a long way to go.

Nonpoint source pollution is now the largest contributor to water quality problems in the Lake Michigan basin. This statement is likely true for Lakes Huron, Erie and Ontario as well for several reasons. The Lake Huron basin has relatively less urban and industrial development. All three basins have a high percentage of farmland, especially Erie, which brings with it agricultural runoff. Also, cottage development and the conversion of seasonal to year-round residences increases nonpoint source pollution related to construction and maintenance of buildings and roads and, perhaps more importantly, private septic systems. Because of the few widely scattered sewage treatment plants within the Lake Huron watershed, much of water in need of treatment does not get "treated."

The sources of nonpoint source pollution are numerous and complex. The loading of sediments and nutrients (e.g., phosphorous) from agriculture and urban development is the largest and most widespread nonpoint source pollution problem in Lake Michigan surface water. This statement is probably true for the Lake Huron, Erie and Ontario basins as well, given the prominence of agriculture in those basins and the fact that agriculture is the largest source of surface water contamination in the United States (World Resources Institute 1995). In addition to sediments and nutrients, however, agricultural practices and urban development contribute other nonpoint source pollutants. Urban development contributes toxic compounds through residential and commercial application of lawn chemicals, heavy metals from oil/grease and gasoline deposits on surface roads and parking lots, and bacterial contamination from pet droppings, combined sewer overflows and treatment plant malfunctions, while agricultural activities contribute bacterial contamination through manure runoff and toxic compounds through application of pesticides, herbicides and fungicides.

The open waters of Lake Michigan are considered oligotrophic. Many nearshore waters at the mouth of major tributaries, however, are considered mesotrophic (intermediate in character between oligotrophic, defined above, and eutrophic, which are shallow and warm with high levels of available nutrients, abundant plant life and low levels of dissolved oxygen). With the exception of the few industrialized and urbanized harbors and bays, the sparsely populated, heavily forested regions of the northern portion of the Lake Michigan basin generally have better water quality than those in the southern portion of the basin. In the open waters of Lake Michigan, phosphorous and chlorophyll concentrations have decreased significantly since the late 1970s, primarily due to improved municipal sewage treatment and laws requiring reduction or elimination of their use in certain products such as soaps and detergents. However, chloride concentrations continue to increase and the rate of increase is accelerating. The primary source of chloride seems to be municipal waste water discharges (a point source) and salt from road deicing (a nonpoint source) (Michigan Office of the Great Lakes 1996). In the heavily-populated and industrial southern part of the basin, water quality is severely diminished. The leading stressors are almost entirely urban in nature, including occasional backflows induced by combined sewer overflows, direct stormwater runoff, and industrial discharges. A recent evaluation of the Northwest Indiana watershed revealed that of 210 stream miles assessed, 186 were considered non-supportive for aquatic life.

Although massive investment in municipal and industrial waste treatment along with programs to control agricultural runoff have achieved excellent results in the Lake Erie basin, large-scale displacement of native vegetation in the watershed and the severe exploitation of fisheries followed by exotic species invasions

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have devastated the original aquatic community of the Lake. While Lake Erie's basin may be the most intensively populated and farmed, pollution loading has been mitigated mostly by productive algae and fine soil particles from soil erosion which tend to absorb pollutants in the water. Accordingly, Lake Erie has shown the lowest concentration of toxic contaminants among the Great Lakes. However, because of its shallow depth, relative warmth and high fertility of the surrounding basin's soils, Lake Erie is naturally more eutrophic than the other Great Lakes.

Bacterial contamination is a significant problem for Lake Ontario. Public beaches on Lake Ontario's north shore are often closed to swimmers because of high bacterial counts that exceed health standards. Combined storm and sanitary sewers is a major contributor to the problem and Ontario continues to lag behind U.S. states in terms of wastewater treatment. U.S. states, by contrast, rarely require beach closures for excessive pollution since methods of sewage treatment were improved in the 1970s.

AREAS OF CONCERN

Each of the Great Lakes has Areas of Concern (AOC) as identified by the U.S. and Canadian Governments under the 1978 Great Lakes Water Quality Agreement and the 1987 Protocol. AOCs are severely degraded geographic areas where beneficial uses—activities that are dependent on the chemical, physical and biological integrity of the water—are threatened or impaired. Restrictions on fish and wildlife consumption, loss of fish and wildlife habitat and beach closings are examples of the 14 beneficial use impairments identified under the Water Quality Agreement.

Pollution sources in AOCs vary widely, but are associated predominately with urban, industrial and agricultural land uses in the sub-watersheds that contain the AOCs and those immediately surrounding them. Land uses and their associated activities which have degraded these particular areas reflect land use patterns in the individual basins. For example, nearly all of the northernmost AOCs have the forest products or mining industry as a primary cause of degradation. AOCs around major metropolitan areas, such as the Milwaukee Estuary, the Buffalo River, the Cuyahoga River and Metro Toronto have numerous and complex sources of degradation including: industrial and municipal (sewage treatment plant) point source discharges, combined sewer overflows, urban runoff, improper hazardous waste disposal and leaky landfills.

The Lake Superior basin has seven AOCs: four Canadian and 3 U.S. The Lake Michigan basin has 10 AOCs (all U.S.). The Lake Huron basin has 4 AOCs: three Canadian and one U.S., though Collingwood Harbour in Ontario was the first AOC to be delisted in 1994. The Lake Erie basin also has 10 AOCs: one Canadian and nine U.S. The Lake Ontario basin has seven AOCs: four Canadian and three U.S. There are also five AOCs on connecting channels of the Great Lakes. Three of them are binational: the Detroit River, the St. Clair River and the St. Marys River. These AOCs present a special challenge as the two governments must collaborate on remedial efforts using different planning and environmental restoration and cleanup standards and processes. The remaining two AOCs—the Niagara River and the St. Lawrence River—are addressed separately by the U.S. and Canada on either side of the border. Progress to restore beneficial uses in AOCs through Remedial Action Plans (RAPs) varies widely in each of the individual Great Lake basins.

3.4 Key Future Issues

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Urban Sprawl/Inefficient Development

Trends indicate that population will continue to grow in all of the five individual lake basins. Most future development will be low-density, particularly residential, development in suburban areas. The development of housing often far removed from employment opportunities results in increasing dependence on auto and truck transport and enormous infrastructure requirements that chop up the landscape and segregate communities. Addressing urban sprawl and its attendant negative impacts will continue to be a critical policy issue for state and local governments in all five lake basins. Future policies must address the negative economic and social as well as ecological impacts of sprawl and encourage efficient and affordable urban development, including brownfields redevelopment. The goal is to make urban areas desirable places to live and work and reduce the impact on the environment.

Loss of Farmland

One key sprawl-related issue in the Michigan, Huron, Erie and Ontario basins is the extensive loss of farmland to residential and commercial development. The proliferation of non-farm rural settlement can undermine the agricultural economy and eventually lead to a loss of local food base. Large influxes of rural residents inflates land prices, and conflicts with farm uses, creating incentives for farmers to sell lands to speculators for land development, removing land from food production. As urbanites move to the country, they bring urban values and expectations that are in conflict with rural lifestyles and place additional stresses on the rural environment. Farmland protection and preservation will continue to be of critical importance from cultural, economic and ecological standpoints.

Continuation of a strong agricultural industry in the individual lake basins, as in the Great Lakes Basin, demands comprehensive policies that recognize the interdependence between a viable agricultural industry and a healthy environment. On the one hand, policies are needed to ensure that farming remains a livelihood and agricultural products are competitive in national and international markets. Policies are also needed to institutionalize agricultural practices that are ecologically sustainable over the long-term, such as integrated pest management to reduce the use of agricultural chemical inputs, and pollution prevention measures (i.e., best management practices) to keep nutrients and sediments out of surface waters and avoid the high costs of fixing resulting downstream problems.

Wastewater/Stormwater Management

Wastewater/stormwater management problems are common to all of the five individual Great Lakes, though the severity and extent of the problem varies for individual basins. Increased appreciation for Lake Superior's relatively pristine condition has lowered tolerance for pollution in its basin. In 1991 the governments of the U.S., Canada, Minnesota, Wisconsin, Michigan, and Ontario established a Binational Program to Restore and Protect the Lake Superior basin whereby the governments committed to making Lake Superior a "zero discharge" demonstration zone to eliminate the use and discharge of nine of the most harmful and long-lived chemicals. With such standards, managing chemical-carrying stormwater discharges for the modest amount of urban growth that is expected in the Lake Superior basin will remain a key issue.

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Stormwater management continues to be a particularly important issue in the Lake Ontario basin, primarily due to problems associated with combined storm and sanitary sewers and lower water treatment standards in the Province of Ontario.

Cottage Development

A related and key wastewater management problem in the Lake Huron and Erie basins is the continuing increase in seasonal cottages and conversion of cottages to year-round residences. This trend raises the issue of whether and how to allow continued cottage development and conversion of seasonal dwellings to permanent use on private sewage (septic tank) systems. Particularly in the Province of Ontario, there is a problem with the location and number of water treatment facilities. Many municipalities do not have the ability to extend treatment facilities to these areas, and servicing scattered development and cottage conversions is not cost effective. Septic system failures have definite impacts on surface and ground water quality and aquatic ecosystems. Addressing septic failure is a key issue that the Province of Ontario will continue to grapple with.

Loss of Critical Habitat/Shoreline Access

Cottage development, along with other forms of development, is also associated with loss of critical habitat and reduced shoreline access. Though sprawl is not a big problem in the Lake Superior basin, increased subdivision of land is occurring, especially in areas on or near lakes, including the Lake Superior shoreline. As this trend continues, cultural rights-to-use will be impacted as local residents who are accustomed to free access to Lake Superior through undeveloped private tracts find these recreational opportunities reduced and eliminated (except for formally protected First Nation rights). Also, with development, the already few unprotected and unique communities that provide numerous freshwater species and filtering mechanisms will become less common in Lake Superior and in the lower lakes as well. Loss and degradation of critical habitat is also a problem in the Lake Huron basin. Much of Lake Erie's few beaches are privately owned, which has implications for shoreline access and protection of nearshore terrestrial and aquatic communities. Strategic, long-term management is essential to protect critical nearshore habitat and ensure continued public access to the shores of these lakes.

Nonpoint Source Pollution—Urban and Agricultural Runoff

In the past two decades, implementation of pollution control policies have dramatically reduced the amount of pollution being discharged from point sources. Nonpoint pollution sources, which can be as widespread as the population, are now a very significant, if not primary cause of degraded water and air quality in all of the Great Lake basins. Continued trends of intensification of the agricultural land base and increased sprawl development will exacerbate the nonpoint source pollution problem. On the agricultural side, impacts from nonpoint source pollution will be more concentrated and severe. On the urban sprawl side, nonpoint source pollution will grow disproportionate to the population given the increase in roads and other impervious surfaces and greater land (hence hydrologic) modification as a result of greater land consumption. Control of nonpoint source pollution from agricultural and urban sources is essential to the future health of the basin. Urban and agricultural nonpoint source pollution will need to be addressed in a comprehensive strategic manner that promotes efficient development that includes farmland and open space protection and revitalization of older urban areas. It will require policies that address the complexity of

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nonpoint sources (e.g., urban/suburban development, agricultural land use practices) as well as related issues such as pollution prevention, product design, and consumer behavior.

Waterfront Revitalization

Waterfront reuse/revitalization will continue to be important to the future of all of the individual Great Lake basins, but particularly for Lakes Michigan, Erie and Ontario whose economies have been historically heavily dependent on waterfront-based industries. Waterfront revitalization has shown much promise in many of the larger coastal metropolitan areas, such as Chicago, Milwaukee and Cleveland that have a more diversified economic base and can commit to investment in waterfront redevelopment. However, waterfront revitalization remains particularly challenging for many medium and smaller industrial coastal communities with less diversified economies and thus fewer resources to sustain the trend of industrial restructuring. The challenge for these areas will be to create policies and forge multi-sector partnerships to encourage waterfront revitalization that provides increased coastal access and waterfront development to support recreational, cultural and commercial activities.

Areas of Concern/Remedial Action Plans

Though there is no discernable geographic pattern to the AOCs within or among the Great Lakes, there is a hydrologic pattern to their location. Areas of Concern are concentrated among the lower reaches of the major tributaries to the individual Great Lakes. What this means is that a major portion of the lifeblood of the Great Lakes is contaminated, largely as a result of past land use decisions in and around the AOCs. Achievement of the goals set forth in the Remedial Action Plans for the present 42 Areas of Concern is imperative to maintain the ecological integrity of the basin. Contamination from past uses will require long-term cleanup and, in some cases, restrictions on the future use of those lands and waters. Successful remediation of AOCs will require greater resource commitments—money, time and personnel—from the public and private sectors. The costs of continued impairment of beneficial uses and the use of tax dollars in the most cost-effective manner are two critical issues facing local land use decisionmakers involved in remediation and planning efforts. Future land use decisions should be based on lessons learned from these problems to avoid future AOCs. This will require local land use planning that considers the local and regional impacts of future development, and its long-term ecological sustainability locally, regionally and within the Great Lakes Basin at large.

4.0 Case Studies of Best Practices, Trends, and Issues

4.1 Farmland Conversion: A Major Issue for the Basin

In the Great Lakes basin, the continuing growth of major metropolitan areas and the virtually uncontrolled sprawl of residential areas and other development is eating away at farmland and natural areas. This relentless process of encroachment carries with it a particular set of determental consequences. Farmland and open-space preservation issues and policies are rapidly coming to the forefront in the Great Lakes basin. Conversion of farmland to non-farm use, particularly in places around metropolitan areas in the basin, is taking place at a worrisome rate. In many of these places, good cropland is being replaced—taken

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out of production for the foreseeable future. If significant levels of farmland conversion continue in the Great Lakes Basin, the agricultural production base will decline, and with it, the agrifood sector of the economy.

The Great Lakes basin contained 17.3 million hectares (42.7 million acres) of land defined as "farmland" in 1991-92 according to data derived from the Canadian (1991) and U.S. (1992) agricultural censuses. This large area is equivalent to 172,988 square kilometres (66,791 square miles). Basin farm acreage represents 31.3 percent of such acreage in the greater region comprising all eight Great Lakes states and Ontario. The definition of farmland or land in farms has changed over the course of census taking and now refers to the area of an agricultural holding that generates annual sales of crops, livestock, or other agricultural products in excess of $1,000 for U.S. farms or $250 (Cdn) for Canadian farms. Farmland entails more than just cropland; it includes woodland as well as permanent pasture and other grazing areas. Nearly 75 percent of basin farmland is in the U.S.; the remainder is in Canada. Basin land classified as farmland has been diminishing. From 1981-82 to 1991-92, basin farmland declined by 1.83 million hectares (4.52 million acres), or 9.6 percent.

Farmland in the basin includes a large amount of land that can be used to grow crops. Basin cropland acreage in 1991-92 totalled 11.2 million hectares (27.7 million acres), or 65 percent of all land in farms. Cropland is defined as the total area of land sown or to be sown for harvest of agricultural commodities, including hay, orchards, nursery and greenhouse products but not including woodlands, permanent pasture, grazing land, and idle cropland. The total amount of cropland in the basin declined by 714,000 hectares (1.76 million acres), or 6 percent during the 1981-82 to 1991-92 period.

For the state and provincial jurisdictions, the percentage "loss" of basin farmland for the 10-year period ranged between 6 percent in Ohio to 19.5 percent in Illinois. Fifty-seven percent of the 4.5 million acres of farmland converted during this period came from three states: Michigan, New York, and Wisconsin. New York's loss of more than a million acres was the greatest amount of loss among jurisdictions, representing a sixth of all its basin farmland. However, the 18.8 percent loss of farmland for all of New York exceeded its basin rate. Several basin areas had farmland conversion rates that significantly exceeded the rates for their respective states: Indiana, Minnesota, and Pennsylvania. In Ontario, which has the largest amount of farmland among basin jurisdictions, the number of hectares converted to non-farm use was more than 456,416 (1.12 million acres), representing a net decline of 9.1 percent from 1981 to 1991.

In Michigan, which is almost entirely within the Great Lakes basin, the substantial loss of farmland to development prompted the governor to establish a task force in 1994 to address the issue and provide recommendations for "maintaining land for agricultural production." The extent of the problem, as identified by the task force, is sobering. From 1954 to 1992, 2.59 million hectares (6.4 million acres) of farmland were converted to other uses. This 39 percent decrease was one and a half to five and half times greater than that for its three neighbouring Great Lakes states. During the most recent decade period for which trend data is available (1982–1992), farmland loss in the state amounted to 345,000 hectares (850,000 acres), or a 7.8 percent reduction, which translates into an average of 4 hectares (10 acres) an hour.

Even though the rate of conversion has slowed from the rate of previous decades, the critical issues are where the farmland loss is occurring and what the long-term impact is on productive cropland. Seventy

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percent of the converted farmland acres was located near three urbanized areas—southeast Michigan, Grand Rapids, and Kalamazoo. The other area that experienced significant farmland loss was in northwest Lower Peninsula where resort and second-home development are key factors. The Michigan acreage loss for the decade included 121,500 hectares (300,000 acres) of cropland, much of it with a prime soils classification. The task force estimated that this impact represented a potential loss in gross farm sales of $60 to $120 (U.S.) million for each year. Many factors are contribute to Michigan farmland loss. Residential development, particularly that at low density levels, is a chief one. Increasing land values and taxes are having an effect by inducing farmstead sales, as is an aging farmer population with associated retirements.

The basin is particularly vulnerable to farmland loss resulting from urban sprawl trends. Much of the basin's population (currently estimated at 33.5 million) reside in relatively few metropolitan areas that exemplify the growing sprawl pattern. On the Canadian side, only six metropolitan areas, ranging in size from Oshawa to Toronto represented two-thirds of the 1991 Canadian basin population. Urban sprawl has spread more than 100 kilometres from central Toronto, making surrounding counties the fastest growing in the province. This settlement pattern just in the Greater Toronto Area alone has resulted in a substantial cumulative loss of productive agricultural land, now estimated at 5,000 hectares per year. The famed Niagara "fruit belt" between Lakes Ontario and Erie has also felt the squeeze from urbanization. There is no question that the displacement of farming activity near Ontario's metropolitan areas has pushed some farming operations into marginal areas where growing conditions are less favorable.

The 11 largest U.S. metro areas located completely or partially in the basin accounted for 81 percent of the 1990 U.S. basin population. A seven-county eastern Wisconsin area, which includes metropolitan Milwaukee, where population increased by less than 1 percent from 1970 to 1980 and by about 3 percent from 1980 to 1990, illustrates the trend. From 1970 to 1985 urban land uses in this area increased by 20 percent, totalling an additional 258 square kilometres (100 square miles). Much of this land consumption has been at the expense of prime agricultural land. In fact, most of the basin's urban population is located near cropland and continued area growth of cities and suburban areas will encroach upon this valuable agricultural resource. Figure 3, which is based on Advanced Very High Resolution Radiometer imaging, shows the proximity of basin urban areas to cropland, with hypothetical "growth circles" extending into cropland. Sixty-four percent of all basin cropland is within a 50-kilometre (31-mile) zone of influence of identified urban areas.

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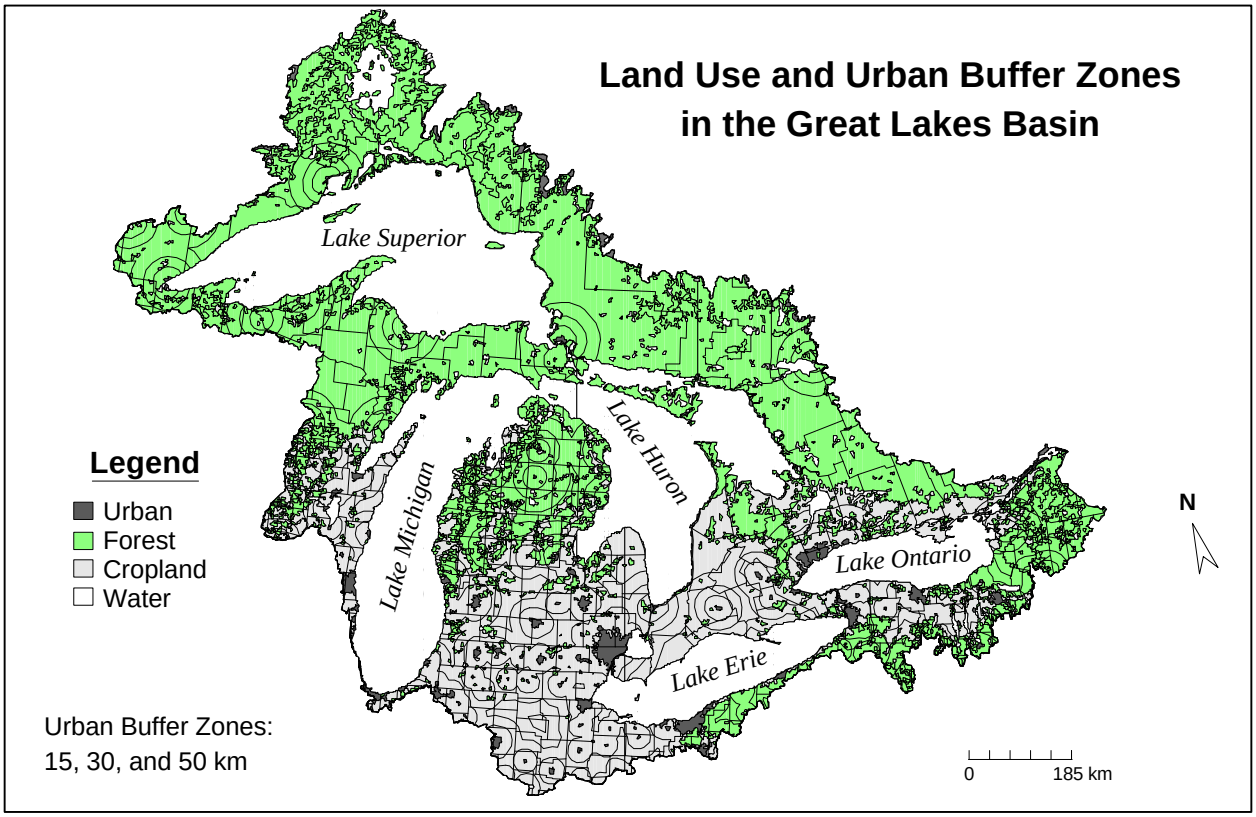

Figure 3. Land Use and Urban Buffer Zones in the Great Lakes Basin

4.2 Planning for Sustainable Growth in Cottage Country: Tay Township

Introduction

The Township of Tay in the County of Simcoe provides an excellent example of the kind of pressures that have been felt in waterfront municipalities throughout much of the Great Lakes. We briefly examine this municipality in terms of historical development pressures of both cottage and year-round development; the effect of this development on Severn Sound, Georgian Bay, and Lake Huron; and the responses that the township has taken and is taking to resolve past and present problems and to plan for future growth and development.

Context

The Township of Tay has been the beneficiary of considerable cottage development over the past four decades and the recipient of the effect of that development. Tay is located on the southern shore of Severn Sound of Georgian Bay, only 120 kilometres (74 miles) from the Greater Toronto metropolis; its 48 kilometres (30 miles) of shoreline and natural setting have been an attractive magnet for cottage development.

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The population of the township is currently 10,200, having grown from approximately 2,300 in 1930. An estimated 4,500 seasonal residents, not included in the permanent population of the community, are added to the community during the summer months. Historically an agricultural community with a lumber mill and grain elevator, the township has undergone significant economic changes in the past 30 years. It now functions as a series of bedroom communities, stretching along the shoreline of Severn Sound, for the larger urban centres of Midland, Orillia, and Barrie, which are located about 60 kilometres (37 miles) to the south. Significant changes have also been made to the traditional cottage areas of the township, with more and more seasonal waterfront and back lot homes being converted to year-round residences. This trend is expected to increase as the baby boom generation moves into its early retirement years and begins to cash out its homes in the GTA and look for retirement homes in cottage country.

Environmental concerns for Severn Sound first became readily apparent in the early 1970s with the occurrence of large algae blooms and floating weed beds in portions of the sound. Public concern about excessive algae growth lead to Severn Sound being examined by the International Joint Commission (IJC). The IJC concluded, on the basis of the information and recommendations of the Canadian and Ontario governments, that the beneficial uses of the Severn Sound ecosystem were sufficiently impaired to require recognition of the sound as one of the 43 AOCs in the Great Lakes and one of 17 in Ontario.

Severn Sound is the source of drinking water for five communities within the township as well as the receiving body for the sewage effluent from two water pollution control plants currently discharging 2,500 cubic metres (88,250 cubic feet) per day into the sound. Sport fishing has also suffered as a result of the changes in the water quality in Severn Sound, which has changed from a primarily large predator sport fishery to one now mainly producing a variety of pan fish species. Other uses of the sound, such as swimming and other water sports, have also suffered from the algae and weed growth, although no formal beach closures have occurred in the recent past.

The growth in residential and cottage development in the township has had a number of direct environmental impacts on Severn Sound. Shoreline septic systems, cumulative shoreline alterations, and property maintenance activities—including the application of pesticides and fertilizers adjacent to the shoreline—have all affected the water quality of the sound.

Perhaps the biggest impact of urbanization on Severn Sound has been the loss of natural lands and the habitat they have provided. An estimated 40 kilometres (25 miles) of nearshore habitat have been lost to cottage development along the shoreline of the sound in Tay, leaving only a limited distance (8 to 9 kilometres/5 to 6 miles) of undisturbed shoreline today. The planning challenge is to maintain the natural features of the area and improve the water quality of Severn Sound, which are the very characteristics that make the Township of Tay and Severn Sound an attractive destination.

History of Shoreline Cottage Development

Figure 4 shows the shoreline of Severn Sound within the Township of Tay and the historic development of the shoreline cottage areas of the township. In the pre-1930s era, little cottage development existed in the area, with Port McNicoll, Victoria Harbour, and Waubaushene being the focus of community life. With the first wave in the early 1930s through to the late 1970s, the shoreline of Tay Township became ribboned with cottage developments as residents of the Toronto area took advantage of increased disposable income

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and improved road networks to look north for summer cottage areas. By the mid-1980s most of the available and easily developed shoreline of the township had been developed for seasonal cottages. While some shoreline remains, these areas are associated with provincially significant wetlands or with railway lands that have only recently become available. Tay's challenge is to plan effectively for the remaining areas of the Severn Sound shoreline and to develop policies and programs to rehabilitate and mitigate the impacts from the existing cottage areas on the quality of Severn Sound.

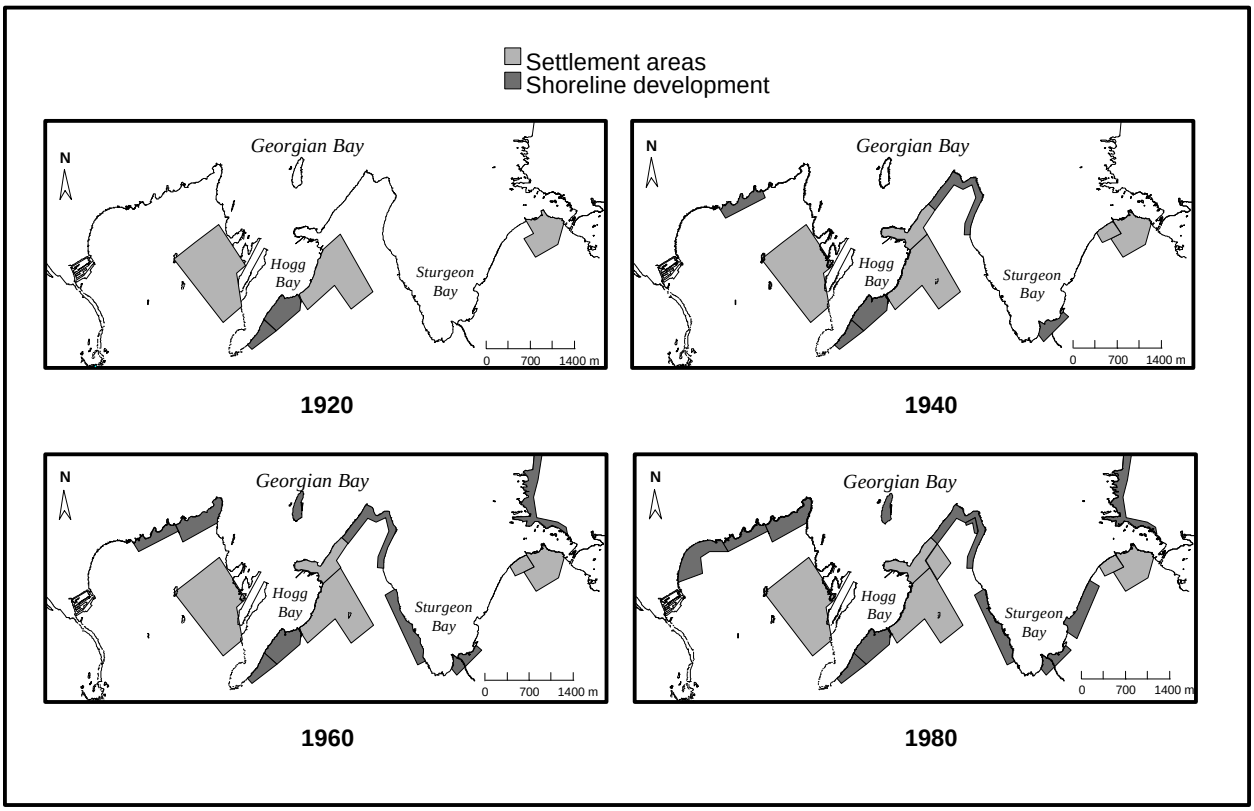

Figure 4. Township of Tay Shoreline Cottage Growth

Planning for the Future

Tay, Simcoe County, and the Severn Sound Remedial Action Plan (RAP) are all undertaking programs to alleviate the impacts from the existing cottage areas and to plan in a more sustainable way for the future growth and development of the area. In addition to a comprehensive list of actions identified in the RAP Stage 2 document, the Severn Sound RAP has a number of initiatives that specifically focus on shoreline areas and restoring shoreline habitat. The Shoreline Owners Advisory Program (SOAP) is a program that assists shoreline property owners in reducing fertilizer and pesticide use (which affect shoreline habitat) adjacent to the waters of the sound, restoring a portion of the owner's shoreline to a more natural habitat condition, and reducing the locations for direct impacts to Severn Sound. Furthermore, a program has begun this year to reconstruct shoreline wetlands and habitat in areas of the sound where habitat loss has been the highest.

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Tay Township is also tackling the following issues: first, a program to connect existing shoreline communities (currently serviced by private septic) to one of the two water pollution control plants. This has already started, with the township's long-term goal to connect all unserviced shoreline communities to the sewage treatment plants. Second, Tay has already included Severn Sound RAP objectives within its planning control documents and is undertaking a review and consolidation of its Official Plan to ensure that, in addition to other items, a natural heritage system is identified and protected within the township. This "greening" of Tay's planning approach is also reflected in its cooperation with Environment Canada and the Severn Sound RAP in participating in and managing a pilot project to develop a restoration strategy for the Hogg Creek subwatershed in the Severn Sound watershed in order to achieve the terrestrial and habitat objectives of the RAP.

Simcoe County, currently in the process of developing its first Official Plan, has also committed itself to dealing with major environmental issues at the regional level. A main building block of the plan is the identification of a "greenlands" system. Using a functional approach, the consultant has mapped green land units and inventoried the features and functions of those units. The application of appropriate constraints to development in those units can minimize the negative impact of such development.

Summary

Tay township is one of many predominantly recreational areas along the Great Lakes nearshore that has been under increasing pressure of urban development. What were once relatively rustic recreational cottages along the shoreline are rapidly being converted into second homes in a form of nearshore urban sprawl. In addition to the destruction of natural habitat that occurs when these second homes are constructed, the use of pesticides and fertilizers, the introduction of exotic plants, and the concentration of wastes through inadequate sewage and septic treatment continue to stress the nearshore ecosystem of the Great Lakes.

4.3 Dredging and Confined Disposal Facilities

For more than 150 years, dredging for navigation purposes has taken place in the Great Lakes. Dredging, involving the removal of accumulated bottom sediments, is necessary to maintain channel depths for safe and efficient vessel operations. In U.S. waters, the U.S. Army Corps of Engineers (the corps) is authorized to maintain 131 navigation-related projects, nearly all of them commercial and recreational harbours and navigation channels. Many of these projects require periodic dredging. The other commercial and recreational harbours are either privately owned and maintained or under the responsibility of local jurisdictions. The appropriate disposal of material dredged from navigation projects is a nationwide issue but has important implications for the use, management, and protection of waters in the Great Lakes basin. Federal policy dictates that contaminated dredged material, which has been determined as posing an unacceptable risk to the environment, must be confined; the necessity of such confinement is also recognized by state and local governments.

Many facilities for placement of these polluted sediments have been built in the Great Lakes nearshore area, some in water and others at upland locations. Concern over environmental effects of dredging and

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disposal of dredged material, the increasing scarcity of suitable disposal sites, and the role of dredging in supporting waterborne commerce have combined to elevate the issue on the region's public policy agenda.

The history of dredging in the Great Lakes is one of incremental development, responding to both political and environmental considerations, as well as changes in vessel design. Early efforts aimed at improving U.S. harbours, such as the construction of piers and breakwaters and limited dredging, were often undertaken by private and local interests with some federal involvement. Many of these harbours were located in the lower reaches or mouths of tributaries to the lakes. As vessel size and draft increased over time, harbour sediments needed to be regularly removed and adjacent shore lands modified to widen harbour areas and also to accommodate waterfront development. Federal funding for some of this work ebbed and flowed prior to the Civil War, reflecting congressional opinion on "internal improvements."

By the middle of the 19th century and under the direction of the Board of Works, Canadian navigation improvements such as enlargement of the Welland Canal (first opened in 1829 as a way around Niagara Falls) were well under way. When congressional appropriations for Great Lakes harbours became more regular in support of national infrastructure development and in response to Canadian competition, a pattern emerged that would sustain harbour and channel development up to the present time.

As Great Lakes commodity movement increased, the corps undertook a more system-wide approach to navigation improvements. Connecting channels became a top priority, with incremental depth improvements as well as new locks at Sault Ste. Marie, Michigan. The River and Harbor Act of 1892 authorized a minimum navigation depth of 6.1 metres (20 feet) in connecting channels, and eventually major commercial harbours were also dredged. Vessel drafts and navigation depth continued to increase and, in 1956, U.S. legislation set the stage for the current 8.2-metre (27-foot) vessel draft. This congressional action was related to St. Lawrence Seaway legislation in both Canada and U.S. that culminated with the modern Seaway lock and channel system in 1959.

These channel and related harbour deepening activities created an initial increase in dredged material quantities, and subsequent maintenance of authorized depths for U.S. projects has continued to generate relatively large volumes—from 2.3 to 3.8 million cubic metres (3 to 5 million cubic yards per year). Another 0.76 to 2.3 million cubic metres (1 to 3 million cubic yards) are removed annually at other sites controlled by private interests and state and local jurisdictions. Until the mid-1960s, much of the dredged material was redeposited offshore away from navigation channels. But some of it was used for nearby land filling and to replenish beach sand lost to littoral drift and wave action. Rising concern about Great Lakes water quality and possible connection to polluted sediments resulted in a shift of policy on disposal of dredged material.

During the latter half of the 1960s, the corps, in cooperation with the Federal Water Pollution Control Administration (predecessor of USEPA), began to study its Great Lakes dredging activities and related in-water disposal of dredged material. This investigation also included the construction of the first confined disposal facilities (CDFs) for the Great Lakes. A Corps of Engineers Buffalo District report released in 1969 concluded that in-water disposal of polluted dredged material was "presumptively" undesirable for the Great Lakes. The corps investigation, coupled with growing concern about water quality in the Great Lakes and elsewhere, spurred Congress to take action. With passage of the River and Harbor Act of 1970 (P.L. 91-611), the current era in U.S. disposal of contaminated dredged material from the Great Lakes was

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launched. Section 123 of this legislation authorized the construction of diked disposal facilities for the Great Lakes. The legislation also authorized the corps to undertake "a comprehensive program of research, study and experimentation relating to dredged spoil" for all U.S. waters. From 1973 to 1978, the Dredged Material Research Program managed by the Corps Waterways Experiment Station was the principal follow-up program, but the study has continued through additional coordination with government agencies and other researchers. For example, due to speculation over the effectiveness of Great Lakes CDFs in containing contaminants, an interagency CDF Work Group was formed in 1986, consisting of representatives from the Corps Buffalo, Chicago, and Detroit Districts, the U.S. EPA Region 5, and Great Lakes offices of the U.S. Fish and Wildlife Service. These as well as other agencies have conducted a number of studies and monitoring efforts.

Since the 1960s, the corps has constructed 40 CDFs around the Great Lakes. Of the total number of U.S. Great Lakes CDFs, 14 were constructed on land and 26 were built as in-water facilities, often adjacent to the shore or at nearshore locations. The CDFs built in the water average 45 hectares (112 acres) in size, whereas the upland sites are considerably smaller, averaging 14.5 hectares (36 acres). In Canada 12 CDFs have been constructed. Figure 5 shows locations of the U.S. Great Lakes CDFs.

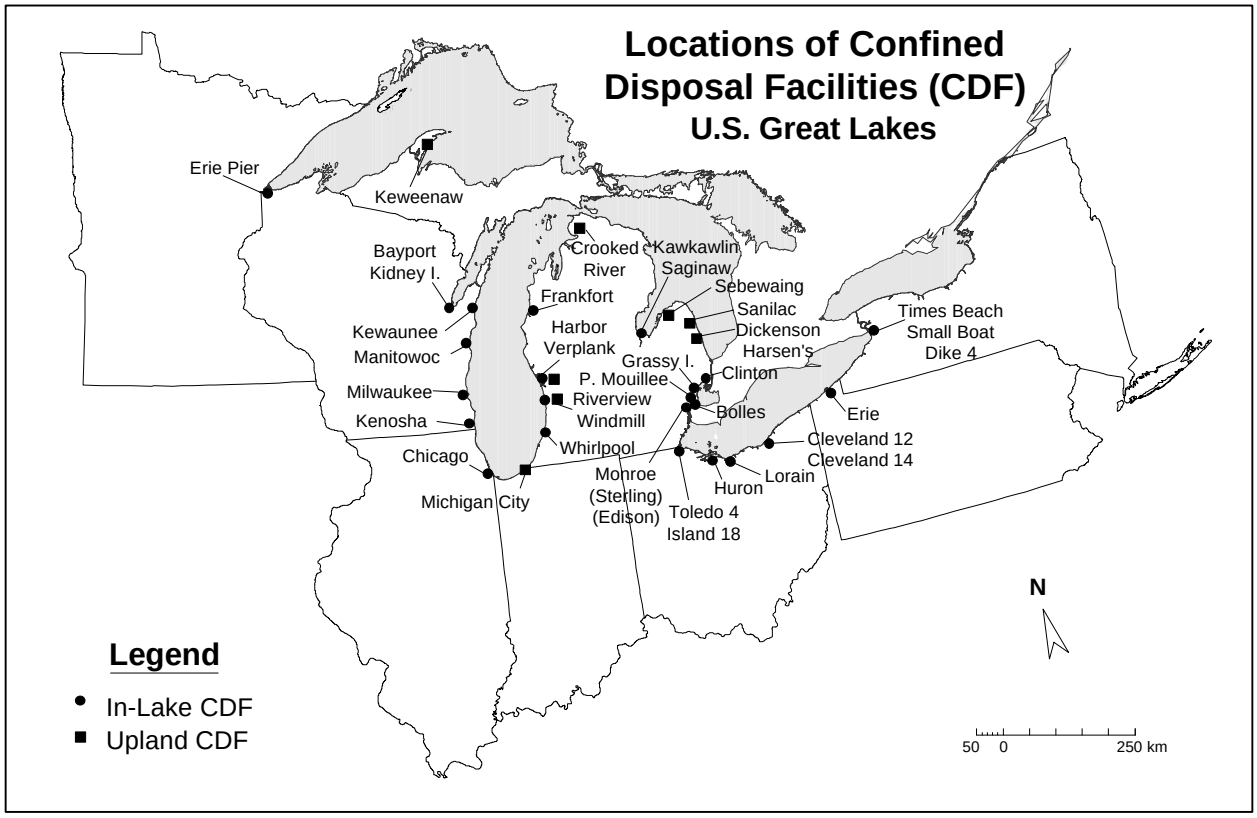

Figure 5. Location of Confined Disposal Facilities (CDF) US Great Lakes

Under current dredged material evaluation procedures, about half of the material removed each year is considered polluted or otherwise not suitable for open water disposal and placed in confined disposal facilities. This amount, averaging around 2.5 million cubic yards (1.92 million cubic metres) would fill

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500,000 standard dump trucks and if parked end-to-end, the line of trucks would stretch from Windsor (Ontario) to Spokane (Washington). The size and design of each facility is site-specific, depending on the location, the nature and potential amount of sediments, and how it will be used or function once it is full or no longer receiving dredged material. Dikes for in-water CDFs are usually constructed in layers with heavy, protective stone on the outside and progressively smaller stones to sand on the inside. Some CDFs incorporate liners or steel sheet pile in the dike walls. As dredged material is pumped or placed in a CDF, the sediments fall to the bottom and the accompanying water evaporates or percolates through the walls or into the ground. When permeability is reduced over time because of sediment sealing, a variety of water-release mechanisms, including overflow weirs and filter cells, are used.

The regulation of dredged material disposal activities in U.S. waters is governed by the Clean Water Act of 1972 and its subsequent amendments (CWA). Corps district offices handle permitting under section 404 except in Michigan, where relevant authority has been transferred to the state. The corps conducts an evaluation of all the disposal activities managed by the corps; the guidelines for this evaluation were developed in cooperation with U.S. EPA and must comply with respective state regulations. In addition to this level of regulation, state review of dredge-and-fill disposal activities under section 401 is required to certify that such activities will not violate state water-quality standards or criteria.

Another regulatory issue is whether contaminated dredged material is also subject to hazardous waste regulation and how that complicates the review and permitting process. Pennsylvania is one of the states with this concern. For various dredging projects around the Great Lakes, the evaluation process, particularly as it relates to open water disposal of dredged material and CDF expansion or location, has become publicly contentious and administratively protracted. Part of the problem rested with national testing guidelines and evaluation criteria used under section 404 that were deemed to be inadequate for the Great Lakes. As a result, the corps' North Central Division and the EPA regions having some Great Lakes jurisdiction have prepared a draft "Great Lakes Dredged Material Testing and Evaluation Manual" (released for public review and comment October 1994). Dredged material will be evaluated through a tiered approach, starting with a "reason-to-know" that sediments are contaminated and, if necessary, progressing to more rigorous chemical, physical, and biological assessments. If a contaminant determination is made, confinement and/or remediation of the polluted material triggers another set of issues, some of which pose formidable future challenges.

Great Lakes ecosystem health depends, among other things, on the elimination of contaminants or, where necessary, a high level of isolation of contaminants. A major concern is how effective CDFs are in keeping the material from recontaminating the surrounding environment. Contaminants often bind with fine sediments such as silt and clay. If this form of pollution is confined to the CDF and bioaccumulation of pollutants by plants and animals in or near CDFs is not significant, CDFs are presumed to be relatively efficient. There is no system-wide, continual monitoring program for Great Lakes CDFs. However, the monitoring of CDF water quality generally occurs during dredging and disposal operations, and 12 CDFs do have monitoring wells in dike walls.

Furthermore, many environmental studies have been conducted at selected CDFs around the Great Lakes with interesting results. A 1993 CDF report prepared by the corps' North Central Division summarized the overall environmental status of CDFs as reported in studies to date: "The results of water quality monitoring [have] confirmed that CDFs are highly efficient at retaining the sediment solids and attached

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contaminants." CDF influent typically has suspended solids levels around 100 mg/1 whereas effluents are normally around 1 mg/l. With respect to contaminant losses from in-water CDFs, detailed studies at several facilities show a high level of efficiency at keeping pollution within the CDF itself. For example, computer modelling of PCB loss at the Saginaw Bay CDF indicates a 99.82 to 99.93 percent efficiency. Biomonitoring studies there did not detect any contaminant transfer. At the Chicago Area CDF, tissues from organisms near the CDF were shown to be no different (with respect to contaminant levels) than those taken from remote locations. But fish and invertebrates collected from within the CDF did reveal some elevated contaminant levels. The Times Beach CDF at Buffalo has had more biological studies than any other Great Lakes CDF. This 18.6 hectare (46-acre) facility was used for only four years before being designated a nature preserve in 1976. Dozens of studies since have shown some mobility of heavy metals through the plant community into soil invertebrates in an upland area.

Contaminant mobility within wetland and aquatic communities has been detected but not yet fully quantified. Studies have been undertaken for all Canadian CDFs and the results indicate that plant and animal life that inhabit CDFs are bioaccumulating contaminants. Canadian researchers have suggested that waterfowl that inhabit or visit CDFs may be good biomonitors of bioaccumulation of contaminants. Even though CDFs appear to be efficient in retaining contaminants, more research is needed to describe the potential contaminant exposure pathways associated with CDFs and to test mitigation strategies such as capping or otherwise eliminating or neutralizing sediment exposure.

The continued use of confined disposal facilities in the Great Lakes is necessary. Originally, the main CDF program authorized by P.L. 91-611 envisioned use of such facilities for a 10-year period. It was believed that progress in pollution control, particularly from municipal and industrial point sources, would sufficiently reduce the contamination of sediments and thereby eliminate (or reduce) the need to use CDFs. However, the extensive accumulation of contaminated bottom sediments, particularly in industrial harbour areas and tributary river reaches, and continuing land-use practices that create erosion, sedimentation, and related pollution require ongoing confinement of large quantities of polluted dredged material.

Contaminated sediments in the Great Lakes represent an acknowledged threat to the health of the basin's ecosystem. Human health is also threatened, particularly through fish consumption and related PCB contamination from polluted sediments. Long-term use of CDFs is the principal means of resolving the overall problem of disposal of contaminated sediments derived from dredging for navigation purposes. But other strategies exist. Remediation or cleanup of polluted material from a CDF or elsewhere is technologically feasible through various means, but is relatively expensive compared with placement and storage in a CDF. Sediment reduction at the source, though, offers much promise as a means to both reduce polluted sediment transport and, where possible, lessen navigation-related dredging requirements.

Most of the sedimentation in tributary rivers and streams to the Great Lakes is caused by human activity. Although agricultural practices are the primary culprit in many sub-basin areas, construction activity and the relative imperviousness of the built environment also contribute to sediment loads and transport dynamics. Littoral drift is a natural process that contributes to some sedimentation in navigation channels exposed to or near the open lake. Also, siltation levels are high for many Great Lakes harbours, particularly those that contain river flows and areas where the basin has substantial agricultural activity. For example, the largest tributary of Lake Erie, the Maumee River, with a 17,483 square kilometre (6,750 square mile) watershed, transports huge quantities of silt and clay sediment that cause shoaling in parts of the river and

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at the Port of Toledo. It was estimated that the mean annual sediment load for the Maumee River during the 1980s was 1.1 million metric tons, representing about 10 percent of annual gross erosion in the Maumee watershed. In addition to the physical movement of sediment and the effects of associated dredging, sediment-produced turbidity reduces light penetration, which affects aquatic plant growth. Agricultural runoff is also a primary source of phosphorus loading for streams and rivers and especially for lakes. The infusion of phosphorus into receiving waters, in both its soluble and particulate (in association with sediments) forms, acts as a plant nutrient resulting in eutrophication problems.

The control of erosion is recognized as a key component in reducing sedimentation in streams, rivers, and Great Lakes harbours as well as reducing associated chemical pollution. In a recent initiative of the U.S. Natural Resources Conservation Service in the Maumee River basin, erosion control projects for the three-state, 25-county area are aiming at a 15 percent annual reduction in the volume of sediment dredged at Toledo for several successive years. The increasing adoption of conservation tillage (reduced till and no-till) has made significant progress in parts of the basin in reducing erosion rates as well as phosphorus and pesticide loads for tributary waters and the Great Lakes. Other measures and programs such as acreage set-asides embodied in the Conservation Reserve Program and Ontario's Conservation and Environment Protection Assistance Program, along with contour ploughing, vegetative and woodland cover efforts in erosion-prone areas, filter strips, and sediment detention ponds have proved that progress is possible on this difficult issue where land meets water.

Additional CDF capacity beyond that which exists now, or alternatives, will be needed. Some CDFs have been filled to capacity and are no longer being used. And all but 2 of the 26 CDFs built and used under P.L. 91-611 will be full or at design capacity by the year 2006. There are added concerns among states and communities that certain CDFs could be used for material originating far away from their localities as other CDFs fill up, despite the high cost of transporting the material. Without more CDF capacity, much of the maintenance dredging for navigation purposes could come to an end, causing serious consequences for commercial navigation and the regional economy. The Lake Carriers' Association indicates that even slight decreases in available depth significantly reduces a vessel's carrying capacity. For example, the workhorse vessel of the Great Lakes fleet, the 1,000-footer, loses 245 metric tons (270 tons) of cargo for each 2.54 cm (inch) reduction in draft. Low-cost, efficient transport of raw materials on the Great Lakes is necessary for steel production that is dependent on waterborne commerce and the connection to the region's durable-goods manufacturing sector.

New construction of CDFs or expansions of existing ones are subject to non-federal cost sharing. With a CDF potentially costing several million dollars to develop, non-federal sponsors have been understandably reluctant to build new CDFs. Another serious problem is the siting of new CDFs. The Great Lakes have the most in-water CDFs in the country and this apparent bias in favour of water locations is partly explained by the relatively high cost of upland sites, which are often in highly urbanized areas. An alternative to a water site that is being closely at is using an existing contaminated site and incorporating a cleanup as part of the CDF construction process. Contaminated sediments from Indiana Harbor are likely to end up at such a nearby site.

Several communities around the Great Lakes are taking a "conservation-of-space" approach to the problem of future CDF capacity as well as planning for new facilities if they become necessary. For example, in the shared harbour at Duluth (Minnesota) and Superior (Wisconsin), the CDF known as the Erie Pier Dredged

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Materials Placement Facility has been the site of a successful sediment cleaning and sorting activity. Coarser-grained material (clean) is separated from the finer particles and reused off-site for construction, road maintenance, and other purposes. This process, supported by the local Remedial Action Plan Citizens Advisory Committee, will increase the lifespan of the CDF. In Cleveland, an option to raise dike walls on a CDF that is close to capacity has been ruled out in favour of building a new CDF adjacent to a waterfront airport. In this case, land-use considerations were very important because the city planned to add the existing CDF to its park space and the new CDF needed to be compatible with airfield operations.

In Ashtabula, Ohio, the lack of a plan to dispose of highly polluted sediments from a portion of the lower Ashtabula River prevented any dredging from 1979 until 1993, when a limited amount of recreational dredging took place with temporary disposal at a river-adjacent confinement site. Eventually, this polluted material, along with a greater volume of dredged material, will be moved to a permanent upland site. Two sites are now under active consideration by the Ashtabula River Partnership, a public/private group of stakeholders.

In Toledo, Ohio, a Harbor Planning Group made up of local, state, and federal officials has developed a long-term management strategy for its dredged material disposal problems. With an average of 649,910 cubic metres (850,000 cubic yards) of sediment needed to be dredged each year, this large volume has spawned a three-pronged approach: (1) continued short-term use of the harbour CDF for nearly three-quarters of the sediment, with the rest having been determined suitable for open lake disposal; (2) concerted effort to continue reusing dredged material, subject to cleaning and combining with sewage sludge to create top soil material along with efforts to better manage CDF sediments through dewatering to facilitate compaction (to create additional capacity); and (3) planning for a new CDF-type facility that would function as a shoreline protection structure and also create wildlife habitat and eliminate the need for future open lake disposal. These three activities, combined with the effort to substantially reduce erosion and sediment transport in the Maumee River basin, has created a plan to not only protect the waters of Lake Erie, but also maintain the port as a valuable economic development asset for the region.

Now that many CDFs have been built, with several closed for disposal operations, there is an interest in converting them to another use. The only CDF built under P.L. 91-611 that has been released from Corps of Engineers jurisdiction is the small facility at Kenosha, Wisconsin. Part of the CDF (1 hectare/2.5 acres) is now city parkland. A marina has also been developed adjacent to it, utilizing some of its structure. Various other CDFs are being contemplated as part of parkland areas or specially developed for wildlife habitat or to function as shoreline protection structures. The Pointe Mouillee Diked Disposal Project on Lake Erie south of the Detroit River illustrates this multiple purpose approach to CDF development and use. The 283-hectare (700-acre) diked island was needed to hold polluted dredged material from the Detroit and Rouge Rivers when other containment areas were nearing capacity. Its location and crescent shape were designed as a barrier island to protect the Pointe Mouillee State Game Area and associated marsh from wave action. This game area is the largest in the Detroit area.

Dredging and fill operations in the Great Lakes have modified the shoreline and nearshore waters in many places. Thousands of acres have been added to urban waterfronts, including harbour areas. Some of this “created” land is occupied by parks and buildings, and other land has been used for industrial and port development. Confined disposal facilities, many with their unique undevelopable status, encompass hundreds of nearshore acres throughout the Great Lakes. They serve an important environmental purpose.

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And possibly, with appropriate planning and remediation, existing and future CDFs can also support more direct human uses.

4.4 Redevelopment of Cobourg Harbourfront

A recurring theme along the shores of Lake Ontario, as with other waterfronts around the world, is the transformation of former industrial and transportation lands to a new generation of uses—residential, commercial, tourist, and recreational. These are dramatic changes in land use, providing equally dramatic challenges and opportunities for planning, environmental cleanup, design, and economic revitalization.

The Royal Commission on the Future of the Toronto Waterfront (1988–1992) concluded that to meet these challenges and opportunities effectively, we needed to shift to a more integrated decision-making approach. This approach, based on an understanding of the interrelated nature of ecosystems, would attempt to balance environmental, social, and economic conditions and objectives. After public consultation, the commission also developed a set of principles to guide regeneration of the waterfront. They state that the waterfront should be:

- clean
- green
- accessible
- affordable
- diverse
- attractive
- open
- connected
- usable

These principles are now being applied by municipalities, conservation authorities, developers, and other landowners along the Lake Ontario waterfront for many different kinds of projects and plans. Examples of the scope of activity include an official plan for the Town of Whitby, the renovation of Marie Curtis Park in Etobicoke, a waterfront plan for Metropolitan Toronto, a renaissance program for the Trenton waterfront, and the cleanup of Shell Canada's lands in the Port of Toronto.

The revitalization of the West Harbour Lands in Cobourg provides a case study that demonstrates many of these kinds of plans and actions. Cobourg is located on the north shore of Lake Ontario, between Oshawa and Brighton.

Cobourg was founded in 1798 and by the mid-1800s it was a thriving regional centre with a population of about 1,000 people. Construction of a harbour in the 1840s on Cobourg's beach stimulated the town's growth and the harbour soon became a busy port from which iron ore and other products were exported. In 1860 the magnificent Victoria Hall, designed by internationally renowned architect Kivas Tully, was completed, with the expectation that Cobourg would become the centre of government for Canada West. Later of course, the colony became Ontario, and Toronto was selected its capital city.

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After World War II industry expanded again and Cobourg became the home of several international businesses, including General Foods and Curtis Products. Rail lines served passengers travelling to and from Cobourg as well as the needs of industry in the region. Several rail spur lines and bulk gasoline and furnace oil storage operations were located in the west harbour area.

Today, Cobourg's population numbers 15,000 people. The harbour-related industries that helped create the local economy have moved out, making room for new land uses on the waterfront. Thanks to a strong framework established in a secondary plan adopted by the Town of Cobourg in 1989, these changes are taking place in an integrated manner. Cobourg's downtown is only one block from the lake, creating opportunities to integrate the new development with the heritage and businesses of the commercial district.

The eastern part of the harbour area has already been renewed, creating a significant asset for the town and the region. Attractions include Victoria Beach and Park, a campground, a marina, and the Waterfront Promenade (part of the Lake Ontario Waterfront Trail, which stretches from Stoney Creek to Trenton).

The west harbour lands present more significant challenges, due to a legacy of soil and groundwater contamination resulting from decades of industrial and transportation uses. ***The pollutants left behind by these activities can have a range of effects on the nearshore ecosystem, including impacts on plant growth, wildlife diversity and health, and human health. These contaminated sites must be cleaned up before redevelopment takes place.***

Undeterred by these obstacles, the Cobourg Harbour Development Corporation was quick off the mark to start the process of cleanup and redevelopment, with the early construction of 40 attractive, low-rise condominiums, and plans for more housing.

These actions stimulated adjacent landowners—Ultramar Canada Ltd., Imperial Oil, and Canadian National Railways—to evaluate their own properties to determine how best to restore them for new uses. The Waterfront Regeneration Trust assisted these landowners in coordinating their efforts and working with the Cobourg Harbour Development Corporation, the Town of Cobourg, the Ontario Ministry of Environment and Energy, and the general public. This involved sharing information about site conditions and developing remediation plans that would be cost-effective, employ innovative techniques, protect human health and the environment, and avoid re-contamination of clean sites.

Each remediation plan was carefully developed to take into account the specific characteristics of the site, making costs lower than would be the case with the traditional approach of excavation and off-site disposal. For example, Ultramar Canada Ltd. used air sparging to treat the hydrocarbon contamination in groundwater and soil by using pipes to inject air below the water table. Imperial Oil's property, being contaminated with diesel fuel and furnace oil, was found to be suitable for bioremediation techniques (similar to composting). The affected soil was excavated; mounded into large piles on the site; treated with fertilizer, moisture, and oxygen; and covered to help retain heat and moisture. Canadian National Railways is considering a combination of air sparging with excavation and off-site disposal for its property. And the Town of Cobourg and Cobourg Harbour Development Corporation (CHDC) are cooperating to develop a remediation program for a small parcel of municipally owned land that will be sold to the CHDC.

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With remediation under way or complete on all these properties in the West Harbour Lands, they will be available to contribute to Cobourg's vision for its waterfront, combining a mix of residential, commercial, and parkland uses.

A *West Harbour Waterfront Development Plan* was prepared for the Town of Cobourg in 1994/95 to guide the provision of recreational opportunities. The plan provides for a marina centre, a mooring basin, heritage landscape treatments, a new headland incorporating natural habitats, a wetland, a picnic area, and a trail system connecting to the Lake Ontario Waterfront Trail.

The revitalization of Cobourg Harbour is reconnecting Cobourg's business district, with its rich heritage, to the waterfront. This is changing the way Cobourg's residents and visitors view the town, making it an increasingly attractive place to live, work, and visit. Canada Day celebrations bring thousands of visitors each year, including many from the United States who make the trip across the lake by boat and enjoy Cobourg's renovated harbour. This year, an additional feather in Cobourg's cap was the selection of Cobourg's waterfront by the Mariposa Festival as the location for its 1996 event.

Cobourg's successful efforts to renew its waterfront exemplify the value of taking an integrated approach to planning and development in the nearshore ecosystem. They show how Great Lakes communities can build on their existing character, landscapes, and history to solve problems and take advantage of new opportunities.

4.5 Watershed-based Planning and Innovative Land Use in Northwest Michigan

Characterized by rolling hills and valleys, more than 100 inland lakes and 132 miles of Lake Michigan shoreline, the Grand Traverse Bay watershed is the centerpiece of Michigan's northwest lower peninsula. Soil-rich coastal areas and a temperature-moderating "lake effect" create favorable growing conditions for specialty crops, mainly fruit trees, making this area the tart "cherry capital of the world." Collectively, these features create not only a picturesque landscape, but also a diverse regional economy with strong representation from the manufacturing, retail trade, finance and real estate and service sectors.

This combination of natural features and a thriving economy has become a magnet for businesses and residents migrating from across the Great Lakes Basin. Grand Traverse County, for example, experienced a 17.1 percent population increase between 1980 and 1990. Development pressure is high. At the current rate of growth, in the next 25 years the population of the five-county area surrounding Traverse City will reach 140,000—a 41 percent increase from 1995. This popularity has a price. Tributaries to the Bay are showing signs of nutrient enrichment and sediment loadings; cherry orchards are being replaced with subdivisions and second homes; roads are being constructed and widened. All of these factors are altering the character of the region that attracted people in the first place.

In the interest of maintaining the special character of the area and its quality of life, many diverse interests in the region have come together to protect and restore the Grand Traverse Bay watershed and plan for sustainable community development. Two complementary, collaborative efforts stand out in making this

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region a success story in watershed protection and innovative land use: The **Grand Traverse Bay Watershed Initiative** and **New Designs For Growth**. The successes of each of these initiatives can be measured by process as well as product.

Creative Partnerships

The Grand Traverse Bay Watershed Initiative and New Designs for Growth are examples of successful multi-sectoral organizational cooperative efforts. The Grand Traverse Bay Watershed Initiative is a long-term collaborative program among many agencies and organizations dedicated to managing resources in the five-county area surrounding Grand Traverse Bay, located off the northwest corner of Michigan's lower peninsula. A partnership agreement provides a decentralized, noncontractual, yet coordinated management framework for public and private stakeholders to collaborate on watershed protection projects. The partnership agreement is based on a common belief in three fundamental principles that emphasize: 1) locally based, locally managed projects; 2) responsible behavior on part of all residents and visitors to the region; and 3) pollution prevention and resource protection now rather than costly cleanup in the future. Today, the partnership consists of more than 120 agencies and organizations. These include business and civic associations, environmental groups, land conservancies, educational institutions, local, state and federal units of government, and many more. Some partners of the Watershed Initiative share information and technology on an informal basis while others collaborate extensively on projects. Since 1990, partners have undertaken approximately 55 projects relating to land use, wildlife, rivers, creeks and lakes that balance economic growth and environmental protection.

New Designs for Growth is a novel coalition of twenty businesses and business associations, educational and environmental organizations, and local units of government responding to surging population growth and unchecked development in the five Lake Michigan coastal counties surrounding Traverse City.[1] What is novel about New Designs is that it is one of only five such business-led growth management initiatives nationwide. Newly-established in March of 1996, their mission is "to formulate new patterns for land use that enhances northwest Michigan's natural features, regional economy and cultural heritage by joining with communities to establish innovative tools to prepare for change." The primary instrument for carrying out this mission is the *Grand Traverse Bay Region Development Guidebook* developed in 1992 with support from the Grand Traverse Area Chamber of Commerce. The *Guidebook* provides model ordinances and land use design concepts, as well as guidelines for growth management. Coalition stakeholders agree that managing growth has been and continues to be the biggest issue facing the Grand Traverse Bay region. Stakeholders in New Designs have defined a set of six goals to fulfill their mission: 1) enhancing the quality of life by strengthening the regional economy and expanding locally-driven business opportunities; 2) safeguarding key natural features by increasing the use of model land use principles; 3) broadening the civic discussion about growth; 4) establishing orderly commercial street design; 5) preserving the region's working rural character; and 6) minimizing pollution by promoting energy and resource conservation. New Designs pursues these goals by providing public education and land use planning services for free or at a nominal charge to ninety three local governments in the five counties.

[1] The Grand Traverse Bay Watershed Initiative and New Designs for Growth cover slightly different geographic areas. Both cover Antrim, Grand Traverse, Kalkaska, and Leelanau counties. The Watershed Initiative covers a small portion of Charlevoix county to the northeast of the Bay, consistent with the watershed boundaries, and New Designs covers Benzie county to the west.

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Though they have somewhat different principles and goals, both New Designs and the Watershed Initiative share the collective knowledge that growth is inevitable and necessary, but if not managed, everyone will lose the very things that have made the region a high quality place to live and visit. The two efforts have a symbiotic relationship. Technically, the Watershed Initiative (with its more than 120 partners) is a partner in New Designs, yet many members of New Designs are also signatory to the Watershed Initiative's partnership agreement. Both provide unique structural models for different interests to build trust among themselves and work together to address issues of common concern.

Northwest Michigan is more than a success story in organizational collaboration. Many tangible and critical ecological restoration, environmental protection, watershed-based planning and land use initiatives have been adopted or implemented in the region. Though well over fifty such efforts have been completed or are underway in the region, the following are a few examples that illustrate why this is a region of success.

Chain of Lakes-Watershed-Based Planning

Watershed-based planning activities are occurring in at least four of the major sub-basins in the Grand Traverse Bay watershed. The Chain of Lakes/Elk Lake watershed is a remarkable example of established watershed-based planning in the region. The Chain of Lakes is the largest of the subwatersheds, comprising about 500 square miles—more than half of the Grand Traverse Bay watershed. With assistance from the Conservation Resource Alliance (formerly the Northwest Michigan Resource Development and Conservation Council, Inc.), dozens of local groups from the watershed coalesced to develop a strategic plan for the Chain of Lakes watershed. The strategic plan contains six overarching goals including traditional water quality and habitat protection goals. These goals also include provisions for such things such as viewsheds and "cultural character"—concepts that have been relatively absent from traditional watershed planning in part because they do not fit in with watershed planning grant programs that focus on scientifically-measurable environmental attributes. More than eighty strategies and activities are planned or underway to achieve the six goals. Implementation of the plan is ongoing by numerous local stakeholders, including local units of government, educational institutions, business, environmental and citizen group interests and others. The plan was completed in 1995. Already a landowner's guidebook has been completed and watershed boundary road signs have been erected. A budget over a half a million dollars continues to support inventories, analyses and education and outreach efforts. Committed stakeholders in the plan try to find funding sources that meet their goals rather than trying to meld their goals to fit those of the funding sources. This high level of stakeholder commitment and involvement is an inspiration for other watershed planning efforts.

Boardman River Watershed Restoration

The Boardman River Watershed, the second largest subwatershed, comprises about 30 percent of the Grand Traverse Bay watershed. In 1990, Kalkaska and Grand Traverse Conservation Districts collaborated with the state of Michigan to identify over 600 active erosion sites, 85 percent of which were the result of human activities. Restoration efforts began in the fall of 1992. Since then, nearly 90 erosion sites have been restored, preventing an estimated 1,500 tons of sand from washing into the River. In addition, four sand traps are now in place on the River system, each with a long-term privately funded maintenance contract. Engaging local volunteers to perform some of the restoration work has been highly

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successful in getting local stakeholders to become active stewards of the River. Increased grassroots involvement holds promise for addressing the more than 500 remaining sites that still require attention, particularly at a time when initial funding sources are close to expiring. Recently, the Conservation Districts have teamed up with the Grand Traverse Regional Land Conservancy to develop a restoration and protection fund that will provide long-term protection of the Boardman River system.

Miller and Jack's Creek Watershed Planning

Miller and Jack's Creek Watersheds are subwatersheds to the Boardman River watershed. The area is under some of the most intense urban development pressure in the region, but a number of large undeveloped parcels still remain. With leadership from New Designs for Growth, local officials have received a $25,000 grant under the state's Coastal Zone Management Program with an equal match from the local township and business interests to develop a comprehensive plan and implementation strategy for these watersheds. The project includes conducting ecological surveys and inventories, common to watershed planning, and integrates them within a broader, stewardship-based community planning context. This context includes provisions for developing a model conservation easement to protect water quality and the prospect of creating a "village center." Efforts to curb non-point source pollution within these watersheds will be viewed as a demonstration site to showcase innovative land-use planning approaches.

Soil Erosion/Stormwater Management Ordinance

Nonpoint source pollution is now the most significant contributor to water quality problems in the Lake Michigan Basin. The loading of sediments and nutrients is the largest and most widespread nonpoint source pollution problem in Lake Michigan's water. Northwest Michigan has been at the forefront in addressing this issue through promotion and adoption of an integrated ordinance to control soil erosion and resulting nonpoint stormwater runoff. Developed under the leadership of the Grand Traverse County Drain Commissioner, a Grand Traverse County soil erosion and stormwater ordinance has provided a model for the region to protect wetlands, waterways and groundwater recharge areas in the Grand Traverse Bay Watershed. Based on the Grand Traverse County model, a soil erosion and stormwater ordinance has also been adopted by Antrim County and three more counties in the watershed are considering similar ordinances. The Homebuilders Association of Grand Traverse County and several major contractors are in support of an ordinance that is consistent throughout the watershed. The Northwest Michigan Council of Governments is helping to promote the adoption of such an ordinance within and beyond the watershed and has reproduced a soil erosion and stormwater control brochure for use by homebuilders.

Long-term Stewardship Through Land Conservancies

More than one hundred long-term stewardship activities are underway in the five-county area around Grand Traverse Bay with the support and assistance of two land conservancies.[2] Since its inception in 1991, the Grand Traverse Regional Land Conservancy has completed eighty projects, including thirty-five

[2] Two other conservancies are important to note. The Old Mission Conservancy focuses on land protection in the Old Mission Peninsula and operates primarily through the Grand Traverse Regional Land Conservancy. The Little Traverse Conservancy, is a well-established and very active conservancy whose efforts include protecting lands in Emmet, Charlevoix, Cheboygan, Mackinac, and Chippewa counties—primarily outside the Grand Traverse Bay region.

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conservation easements, sixteen nature preserves, twenty-two preserve additions and seven projects assisting with property acquisition or transfer. As of early December, 1996, the Grand Traverse Regional Land Conservancy, which covers Antrim, Benzie, Grand Traverse and Kalkaska counties, has protected a total of 3,051 acres, including over 15.3 miles of water frontage. The Conservancy is also working with local businesses to establish a Grand Traverse Regional Land Use Protection Fund to support projects that will strengthen local government's ability to effectively plan for growth in the region.

The Leelanau Conservancy, which operates in Leelanau County, has protected 1,500 acres of land, through 50 different projects. Forty of those projects are conservation easements that protect about 800 acres of land which remains in private ownership. The remaining 700 acres are protected through 10 different preserves around the county that include nearly 5 miles of shoreline.

Together, these two conservancies have protected more than 4,500 acres of land, including more than 20 miles of water frontage on rivers and lakes in the area. These areas include dunes, wetlands, habitat for endangered and threatened species, scenic views, recreation areas and even a village center open space. While much of these protected areas are still owned by private landowners, hundreds of acres are now available for public use.

Purchase of Development Rights (PDR)

Purchase of development rights is a particular kind of conservation easement whereby the development rights to a piece of property are purchased through a tax and a governmental entity takes ownership of those rights. Both the Leelanau Conservancy and the Grand Traverse Regional Land Conservancy have nominated parcels to participate in a purchase of development rights program under the state's farmland and open space protection law. Two conservation easements have been completed and six more parcels are under negotiation.

The first parcel to participate in the state PDR program is located on the Old Mission Peninsula—a 17 mile long strip of land which juts out into Grand Traverse Bay. Since then, the Old Mission Peninsula has become a laboratory for agricultural and open space protection using the PDR approach. In 1994, Peninsula Township residents passed a 15-year millage to finance its own local PDR program to protect a selection of the township's most scenic farmland. The first actual purchase under the township's program—a 49 acre parcel—was completed in October, 1996. Township officials hope to enroll about 1,500 acres by the end of the year and a total of about 2,000 acres through the life of the millage. Peninsula Township's PDR program is the first of its kind in the Great Lakes Basin and is a model for other townships that wish to preserve important agricultural, open space and scenic characteristics.

Greenways

The Northwest Michigan Greenways project hold promise for connecting the many recreational open space lands and ecological preserves protected through the conservancies. Under the leadership of the Northwest Michigan Council of Governments (NWMCOG), stakeholders in Northwest Michigan have undertaken an inventory and assessment of the area's resources for the purpose of developing greenways in the five-county area around Grand Traverse Bay. A greenway is a system of publicly and privately-owned interconnected river, trail and wildlife corridors. The Council was recently awarded a three-year $90,000 Intermodal

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Surface Transportation Efficiency Act grant to apply the inventory and assessment to identify and promote the creation of non-motorized corridors. Simultaneously the Conservation Resource Alliance, with support from the state Coastal Zone Management Program, is actively developing greenways program for the area that focuses solely on ecological corridors for wildlife. The NWMCOG and the Conservation Resource Alliance, both partners under the Watershed Initiative, are working very closely to coordinate their complementary efforts. Though the greenways have not yet been created, formal partnerships have been established, much public support has been garnered, and monies have been secured to move these efforts forward.

Growth Management Planning

The approach of New Designs for Growth is to provide professional advice and services to counties and townships on strengthening land use management and planning. One of the hottest growth management activities they sponsor is a team of trained professionals that offers community education workshops upon formal request by townships and counties. The workshop program recognizes the unique interests of each jurisdiction and includes a needs assessment to establish specific local requirements. Specific features of the municipality are used to gauge the effectiveness of new and existing land use planning tools. Participants are able to see what happens to traffic, home building, village centers and the landscape by adopting various planning approaches. The workshop helps local decisionmakers develop a planning strategy that will meet their objectives and those of the *Development Guidebook*. Since March of 1996, three workshops have been scheduled, six are planned for the fall of 1996 and eleven municipalities are on the waiting list.

In addition to their innovative workshops, New Designs also has a number of other activities that support growth management. An annual awards of excellence program recognizes outstanding examples of development that reflect the goals of the *Development Guidebook*. A Peer Site Review Committee supports growth management by reviewing, upon request, developers' plans to evaluate consistency with the *Development Guidebook*. A Model Projects effort applies *Guidebook* principles to specific sites for landowners considering development. Thus far, the principles have been applied on four separate properties in the area. Professional planning services and advice are offered at a nominal fee to follow up on workshop outcomes, while a Direct Services program subsidizes professional services to directly implement guidelines in the *Development Guidebook*, such as conducting surveys or writing an ordinance.

Conclusions: What Constitutes "Success?"

Each of these efforts is part of a larger web of conservation, environmental protection and community planning initiatives that make Northwest Michigan the success story it is. The organizational structure and the individual projects and initiatives make up the patterns and strands of the web, but what sustains the web must not be overlooked.

Northwest Michigan has dared to create a vision for itself and preempt the potential demise of the natural beauty and resources that sustain the area's quality of life. People seem to have a sense of place over a sense of politics. Consider the village center concept embodied in the Leelanau Conservancy's village center open space easement and the Miller and Jack's creek watershed planning effort. This progressive approach

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is also apparent in the Chain of Lakes Watershed Plan and the Old Mission Peninsula PDR program's attention to community character and aesthetics on par with conservation goals.

The theme of integrating community development with environmental quality goals is inherent throughout many of the Northwest Michigan initiatives. The old way of thinking that says environmental and economic goals are in conflict has buckled under the truth that the two are inextricably linked and interdependent. Stakeholders in Northwest Michigan realize this truth. The local home builders association, for example, used to view environmental initiatives with a skeptical eye. Now they are a leader in New Designs for Growth and participate in a number of the local planning and watershed protection efforts. The same is true for the many other businesses that actively participate in the numerous watershed planning and protection efforts underway in Northwest Michigan.

That both the Grand Traverse Bay Watershed Initiative and New Designs for Growth are locally-based and consensus-driven has been critically important to their success. No agency or organization from above dictated their problems or solutions and no one entity controls the program or agenda. Instead, their driving principles and goals were arrived at through the efforts of numerous committed groups and individuals at the local level who defined their own problems and proposed their own solutions. By defining their own goals and guiding principles and solutions, the many diverse partners have a personal stake in the projects to protect the watershed and guide future development.

In Northwest Michigan, community leaders realize the importance of education and outreach. Each initiative is premised on the recognition that education and outreach to improve community leaders' and residents' understanding of the challenges facing them is central to success. Like the problems they address, these projects are not undertaken overnight. Community leaders are taking the necessary steps slowly to ensure that stakeholders have an understanding of the issues and options and that there is a commitment to action. For example, in the New Designs workshops, a series of initial meetings and the formation of a steering committee builds a team of stakeholders and defines expectations and roles of the workshop. A lot of work is done planning for the workshop so that when it does take place, it has been a community-led initiative and residents and community leaders have a clear idea of the purpose and program.

Northwest Michigan stakeholders have made many important strides to change practices and behaviors that are destructive to the land and other natural resources, remediate past abuses, overcome the environment versus economy myth and create sustainable, livable communities. Theirs is a success story in steps toward sustainable development from which many other areas around the Great Lakes Basin have much to learn.

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4.6 Planning North Aldershot Development

Introduction

Regional government and changes to municipal planning introduced in the early 1970's in Ontario were instituted partly as a response to growing concern over urban sprawl and the loss of agriculture and natural lands to development. The provincial government, at the time, sought to control the accelerating outward movement of people and jobs from Ontario cities to the suburbs to avoid the kind of inner city problems that had become evident in large cities in the United States.

Two other provincial measures that were introduced included the designation of the Niagara Escarpment planning area and creation of the Niagara Escarpment Commission and the establishment of the Parkway Belt West Plan. The Parkway Belt West Plan limited development within a band of land surrounding existing and future development across what is now the Greater Toronto Area starting most predominantly in the City of Burlington and Region of Halton. This limitation was intended to separate urban areas, to preserve areas for potential use as hydro-electricity and highway corridors, and to ensuing preservation of the ecologically sensitive lands within the Belt.

North Aldershot Development Planning

The North Aldershot area is an ecologically important part of the City of Burlington and one of the last areas that has not been extensively developed in the City south of Highway #5. Comprising some 1,530 hectares (3,780 acres) with over half designated for environmental protection, North Aldershot is geographically within the “Escarpment Link” of the Parkway Belt West Plan that has limited development to preserve the prominent natural features of the area. The Grindstone Creek, its tributaries and the surrounding valleys form the central sector of North Aldershot and make up about a third of its land area. This ecologically unique area is an important part of the Hamilton Harbour ecosystem. Grindstone Creek features a sustainable salmon run and the valley is home to deer and other wildlife. It is blessed with numerous nature trails and is well-used by naturalists.

Land in the Grindstone area of North Aldershot was partially cleared for farming during the current century as farm land near the emerging centres of Hamilton and Burlington was being developed for housing, industrial and commercial purposes. This central sector of North Aldershot currently contains 135 homes, most built since 1945, and includes two subdivisions. Water supply is available to some of the residents from an older trunk line although the area is otherwise not serviced. Groundwater supply in North Aldershot is scarce and some residents have to truck water. The early 1970's had seen some land speculation, partly in response to the 1971 Burlington Official Plan that had indicated a community population of 3000 for North Aldershot (Taylor, et al, 1994).

In 1978 the Province enacted the Parkway Belt West Plan which essentially restricted the area to in-fill development. However, by the early nineties landholders in the area decided to challenge the status quo and filed ambitious plans for subdivision development with the City. The City and Region rejected these plans and the developers appealed to the Ontario Municipal Board (OMB), prompting the City into new action.

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Although the Parkway Belt West Plan essentially limits development to in-fill, section 6.3.2. allows for a comprehensive study before further significant development can be undertaken.

In preparation for a defence against the developers' appeal to the OMB, the City together with the Regional Municipality of Halton, the Halton Conservation Authority, the Niagara Escarpment Commission, and provincial Ministries including Environment, Natural Resources and Municipal Affairs participated in a study to meet that requirement—the North Aldershot Inter-Agency Review of 1994. The review, performed by land use consultants, recommended in excess of 500 new homes for the central sector of North Aldershot and removal of this area from the regulations of the Parkway Belt West Plan. The review, which was ultimately accepted by the City and Region, further identified a theoretical maximum for all of North Aldershot of 1425 residences.

The public, who had been consulted during the Inter-Agency Review, largely expressed the view that new development should be prohibited or at least limited to in-fill on existing services. This view was re-iterated at the Development Committee hearings on the issue. The City largely rejected the public's view arguing that the case to limit development in the area would be stronger if the City had a plan of its own. In a somewhat unusual action, the City then prepared an official plan amendment that included a suburban design for 232 fully serviced homes.

The Grindstone Creek Settlement Area developers, who had initially set their plans for development at more than a thousand, came to the OMB hearing with a plan for just less than 600. During a recess in the OMB hearings, the developers and the City negotiated to around 500 homes and the ensuing OMB decision ratified that agreement. In fact, the OMB further noted that other landowners in the area might now also seek higher development rights, which could result in as many as 2000 homes being developed across North Aldershot.

Conclusions

The City's plan to limit development in North Aldershot failed to protect the area from urban sprawl. Ecologically sensitive North Aldershot is now be open to suburban development. Although only about 500 units have so far been approved, it is likely that the number could soon rise to as many as 2000 homes. Many ecosystem features that require integration between the valley and the table lands, including the deer herd, will be likely be destroyed. There will be negative impacts on the Grindstone Creek and Hamilton Harbour, especially during the construction phase of the development. Air pollution and traffic congestion on roads leading from the development to adjacent communities and the major highway to Toronto will increase, since the private automobile is the only viable means of transportation for this type of development in North Aldershot.

Sprawl development is costly (Blais 1995) and has typically been subsidized, through taxes or service rates, by residents in the rest of a community (Troyak and Muir 1993). Thus financial considerations are a key qut initiatives are proposed. Both the City and the developers performed financial impact analyses which partially identified the extra costs associated with this type of development. Many potential costs were not considered, however, including the costs of expanding Burlington's existing sewage treatment facility, which is currently operating at or above its physical capacity and well below the requirements of the Hamilton Harbour Remedial Action Plan (RAP). Halton Region, which manages the facility is now

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planning to move the sewage outlet pipe from Hamilton Harbour into Lake Ontario because it cannot meet these RAP water quality goals without substantially more cost which would have to come from higher development charges.

Both of these fiscal impact studies assumed that the existing level of development charges would be sufficient to address the potential costs of such high risk development in an environmentally sensitive area. However, both the City of Burlington and Halton Region have been reducing development charges for the nonresidential sector and are under considerable pressure to do the same for residential development. In addition, neither study considered the social or environmental costs associated with this development project.

The City chose its strategy to go to the OMB from among a number of options. In 1988 the City of Burlington had passed a motion that would have, essentially, turned planning of the North Aldershot area over to the Niagara Escarpment Commission. However, that motion was never implemented. The Commission has a clear role and track record in restricting development for environmental reasons and might have been in a stronger position than the City to face the OMB. The City also could have defended the status quo for the area, based on the views of the majority of residents and resisted undertaking further actions, such as the inter-agency review, that ultimately would take it on the road to approving new urban development.

Two other considerations are of note. First, the Ontario planning and development legislation, while serving to constrain and restrict some land uses, is primarily aimed at promoting development. Indeed the Parkway Belt was also structured to allow further development in the Aldershot area, requiring only a special study before development could proceed. Second, the OMB, by using its decision authority to deliver detailed requirements, diminishes the role of community based planning and local political responsibility and accountability. Since matters referred to it are heard and treated as ‘de novo’ without a history or a past, the Board sometimes renders decisions that seem in conflict with the local public will and opinion. Further, community concerns are sometimes viewed as less important, by the Board, than the advice of lawyers and technical witnesses, many of whom have no stake or connection with the community. The Board is, thus, seen as biased to giving more weight to the evidence of professional experts rather than to the affected and concerned residents in the community.

Although the extensive consultations the City had undertaken with area residents demonstrated wide-spread public opposition to the kind of development that ultimately has been approved, the City seemed helpless to use that public will in its fight to limit the development. The results of this case study are to some extent telling for how development issues, and especially urban sprawl, are still viewed in Halton Region and Burlington. Moreover, this case study illustrates how difficult it is to stop urban sprawl even with the well developed professional planning system and the relatively progressive land use designations and policies that exist in Ontario.

5.0 Land-Use Planning Across the Border

5.1 Binational

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The **International Joint Commission (IJC)** is a binational body created under the Boundary Waters Treaty of 1909 to prevent and settle disputes between the United States and Canada regarding the use of boundary waters. Specifically, the commission was designed to resolve questions relating to water and air pollution and the regulation of water levels and flows. Geographically, this mandate includes the boundary waters themselves as well as their upstream tributaries and downstream boundary waters. The IJC is comprised of six commissioners, three U.S.-appointed and three Canadian-appointed, and is supported by a complex organizational structure of boards and reference groups that deal with the diverse issues in which the IJC is involved. The IJC functions in an advisory capacity to the federal governments of the United States and Canada. Upon request of the governments, the IJC performs three primary functions. First, it serves as a quasi-judicial body in approving or disapproving applications for obstructions, uses, or diversions that affect the natural level or flow of water. Second, it investigates questions or matters of difference along the shared U.S.-Canadian frontier. Third, it monitors and coordinates the implementation of recommendations accepted by both governments. The IJC's two main offices in Ottawa and Washington D.C. are devoted to handling issues that arise along all the boundary waters of the U.S. and Canada, including the Great Lakes. The IJC also has but one regional office in Windsor, Ontario created under the U.S.-Canada Great Lakes Water Quality Agreement of 1972 (the Agreement) which is devoted solely to Great Lakes issues.

In the 1990s much of the IJC's activity involves undertaking studies of water quality and quantity at the request of the two governments pursuant to the Great Lakes Water Quality Agreement of 1972 and its 1987 Protocol, which calls for the U.S. and Canada, as parties to the IJC, to "restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes basin Ecosystem." The IJC's Water Quality Board and its Science Advisory Board were both formed pursuant to the 1972 Agreement. The 1987 Protocol commits the two governments to Remedial Action Plans for 43 areas that have been designated Areas of Concern within the Great Lakes.

Though the IJC has not traditionally been involved in land-use planning in the region, it has engaged in activities dealing indirectly with land-use issues. A first example is the establishment of the Pollution from Land Use Activities Reference Group (PLUARG) pursuant to the signing of the 1972 Great Lakes Water Quality Agreement to investigate and develop recommendations addressing pollution of the Great Lakes system from agriculture, silviculture, urban development and other land-use activities. A second and more recent example is the final report of the IJC Levels Reference Study Board in 1993. The report contains a series of 42 specific recommendations for regulating Great Lakes lake levels, many of which involve land use and shoreline management. What is important is that the report concludes that coordinated land use and shoreline management programs must be instituted at the local level to curb current trends that damage shoreline properties, public infrastructure, and water-dependent businesses.

The 1955 U.S.-Canada Convention on Great Lakes Fisheries established the **Great Lakes Fishery Commission** to advise the two federal governments on ways to improve the then-devastated Great Lakes fisheries, to develop and coordinate fishery research programs, to develop measures and implement programs to manage sea lamprey, and to improve and perpetuate fishery resources. Though not directly involved in land-use issues, the Fishery Commission's Strategic Vision for the 1990s advocates an ecosystem approach to fisheries management, which necessarily includes land use. The Fishery Commission has also been active in promoting the integration of remedial action and fishery management for the basin's Areas of Concern.

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5.2 United States

5.2.1 The Framework

U.S. local government is remarkably decentralized compared with that of Canada, whose planning system is hierarchical in structure, with local planning agencies accountable to higher levels of government. U.S. states all have their own planning and zoning laws based on federal law and have delegated responsibility for land-use controls to local governments (i.e., counties and municipalities). State planning laws authorize local governments to develop and adopt comprehensive plans, and state zoning laws enable local governments to develop zoning regulations.

The distinction between plans and regulations is an important one. The comprehensive plan is concerned with the long-term use, development, and conservation of land and the relationship between local objectives and overall community and regional goals. Zoning ordinances include both a map that divides a local jurisdiction into districts and a set of regulations that determines the use of the land and the type of buildings allowed on the land in each district or zone. In other words, plans set forth goals to be achieved, whereas regulations are a means by which to reach these goals.

Theoretically, zoning is an important tool for achieving the goals set forth in planning. In the U.S., however, much—if not most—of land-use planning is not planning but zoning. Some states require zoning to be consistent with a comprehensive plan, but most do not. It is important to note that the zoning ordinance carries the force of law, not the comprehensive plan. Although local governments have the authority to do so, they are not required to operate any system of land-use control. And though most do have a zoning system, some with small populations have no land-use controls at all.

Local governments may also use subdivision regulations to determine the details of land development. These regulations determine how a larger piece of land will be divided into smaller units or lots, including lot locations and shapes, street patterns, location of parks, and infrastructure needs of the proposed development (streets, water and sewer lines, utilities, storm drainage, etc.).

The courts constitute a higher level of authority for land-use planning, but only to ensure that local governments operate in a legal and constitutional manner, not to coordinate policy. Federal and state constitutions limit local land-use controls to protect constitutional rights and principles. Three amendments to the U.S. Constitution have important land-use implications. First is the First Amendment, which protects individuals' right to free speech and which has implications for ordinances dealing with signs and billboards. Second is the Fifth Amendment, known as the "takings clause," which protects private property from being severely restricted by public action without just compensation. Third is the Fourteenth Amendment, which directs public officials to adhere to procedures and to apply them equally to all people in all circumstances. Though the state and federal constitutions provide a unifying structure for land-use law, they do so only where there is an opportunity for appeal against a local decision.

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With more than 3,100 counties and more than 19,000 municipalities in the U.S., most of which are not accountable to any higher level of government for land-use controls, land-use planning is a fragmented and, above all, complex activity.

The environmental movement of the late 1960s provided the impetus for a host of U.S. federal laws concerning environmental protection needs, which directly affect the nearshore. Among these Acts are the Clean Water Act, the Safe Drinking Water Act, the Clean Air Act, and most important for the nearshore area, the Coastal Zone Management Act. Today, there are literally hundreds of U.S. local, state, and federal programs that have some impact on planning in the nearshore. Two primary types of programs deal with environmental problems associated with uncontrolled land use: (1) laws that restrict the types of uses permitted in certain sensitive or critical lands, such as national parks, wetlands, or the coastal zone, or establish specifications for size, location, and density of development on those lands; or (2) laws that establish performance standards defining maximum permissible impacts on specific resources, such as drinking water supplies or discharges into waterways.

The Clean Water Act and the Safe Drinking Water Act impose strict regulations on local governments to ensure that drinking water is safe and sewage is properly treated prior to discharge. The Clean Water Act requires states to engage in comprehensive water-quality management planning to accomplish specific statutory water-quality goals. The Safe Drinking Water Act sets national drinking-water standards to which local governments must adhere and which are enforced by the states. The Clean Air Act does not require a comprehensive planning program, but does require states to develop a transportation control planning process to achieve national air-quality standards.

Another, more recent development in land-use planning is the 1992 Intermodal Surface Transportation and Efficiency Act of 1991 (ISTEA), which requires a regional transportation planning process (including land-use planning) as a condition for eligibility for federal highway funding.

Coastal Zone Management Act

Perhaps the most significant land-use planning program for the U.S. nearshore area, and a core example of planning in the nearshore, is the federal coastal zone management program developed and implemented pursuant to the federal Coastal Zone Management Act of 1972 (CZMA). The CZMA authorizes the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) to provide financial assistance for state planning and implementation of comprehensive plans to control land use in the coastal zone. Under the program, which is voluntary, the U.S. federal government provides financial assistance for the state planning and implementation of coastal zone management plans (CZMPs) to control land use in the coastal zone. To receive financial assistance to administer their programs, participating states are required to prepare CZMPs, which must be approved by NOAA.

Most U.S. coastal states participate in the CZM program. In the Great Lakes region, four of the eight Great Lakes states have federally approved CZMPs: Michigan, New York, Pennsylvania, and Wisconsin. Indiana and Minnesota have made some progress towards developing their plans. Ohio is very close to completing its plan, which is expected to be approved by the end of 1996. Illinois is the only Great Lakes state that does not participate or plan to participate in the program.

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CZMPs usually contain an elaborate set of state coastal policies that govern land and water uses in the coastal zone as well as planning for coastal resource protection, energy facilities, and shoreline erosion. The CZMA establishes national policies to provide guidance for state coastal programs, but gives the states considerable latitude in developing their coastal plans. The national policies that must be contained in each state plan include the protection of significant natural systems such as wetlands and beaches; priority consideration for coastal-dependent uses; and orderly processes for siting energy and other major facilities. CZMA funds have helped local and state governments to establish setback lines and erosion protection measures, protect marshes, clean up beaches, rebuild fishing piers, revitalize waterfronts, improve public access, and increase tourism benefits to local communities.

The federal program allows each state to define its "coastal zone." Most use the highwater (mean high tide) mark as the shoreline boundary of the coastal zone, with the upland or landward boundary varying considerably from state to state. Some states include all their coastal counties, whereas others include only a narrow strip of land adjacent to the sea. The definition of a coastal zone reflects political realities and the need to establish mappable and measurable boundaries rather than ecological criteria. For example, in Michigan and Wisconsin, the coastal zone includes only that area 1,000 feet landward of the highwater mark, whereas in Pennsylvania the coastal zone ranges from 1,000 feet in some areas to 3 miles in others.

State coastal programs take a number of forms. While some coastal states have passed a single coastal management law, others have several laws governing land use in the coastal zone, which are then "networked" into their CZMP. Michigan's is an example of a networked program, which brings together a number of state laws applicable to coastal areas. Michigan passed its Shorelands Protection Act in 1970, which established criteria for shoreline modifications and setbacks for erosion-prone areas. Five other Michigan laws passed between 1929 and 1976 also regulate land use in the coastal zone and are part of the CZMP.

The coastal zone management program alters the traditional structure of U.S. land-use planning by creating a hierarchical structure whereby local governments must coordinate with state requirements for land-use control in the coastal zone. Under the CZMA, states are required to use one or any combination of three means of control for implementing the state CZMP: (1) direct state regulation of coastal lands; (2) local regulation in accordance with state standards; and (3) local regulations subject to state review.

The management program also alters traditional state-federal relations. The CZMA contains a "federal consistency" provision that modifies the traditional supremacy of federal legislation and programs by requiring federal activities in the coastal zone to be consistent with the state CZMP "to the maximum extent practicable." Federal activities include financial assistance programs to states and local governments, as well as programs that "directly affect" the coastal zone.

Federal financial assistance programs cover a plethora of activities from highway construction to housing development. Any federally funded program that is reasonably likely to affect any land or water use or natural resource of the coastal zone is subject to state consistency requirements. Local governments must certify that activities conducted with federal funds are consistent with the state CZMP before the federal government will grant the assistance. Activities "directly affecting" the coastal zone include activities funded in whole or in part by federal agencies, (e.g., highway construction) as well as those conducted by state and local governments, private businesses, or individuals who apply to the federal government for a

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required permit or licence or any other type of approval or authorization. The determining factor is not whether the activities occur in the coastal zone, but whether they affect any land or water use or natural resource of the coastal zone. Cumulative and secondary effects are included in all consistency determinations.

Although the federal coastal zone management program theoretically gives states considerable control over land-use planning in the coastal zone, deference to state authority has been uneven among the states. Nonetheless, federal monies for local projects have helped protect and restore shoreline habitat, water quality and other nearshore features.

Many states and local governments have established programs for sensitive lands such as inland lakes and stream shores, floodplains, and wetlands. Additional land-use controls are in place for nearshore areas that contain these features.

Wetlands Protection Programs

Section 404 of the Clean Water Act establishes a federal "dredge and fill" permit program that regulates the discharge of dredged or fill material into wetlands and other federal waters of the United States. This program is administered by the U.S. Army Corps of Engineers (the corps) in cooperation with the U.S. Environmental Protection Agency (USEPA). The corps, through its 37 district offices (four in the Great Lakes region), is responsible for the day-to-day administration of the 404 permit program. Anyone wanting to discharge dredged or fill material into wetlands or other U.S. waters must first receive authorization from the corps, either through issuance of an individual permit or under a general permit.

Under the 404 program, the corps must evaluate permit applications according to USEPA guidelines. The USEPA guidelines provide the environmental criteria designed to help maintain the physical, chemical, and biological integrity of the nation's waters and these criteria must be met before a section 404 permit can be issued. USEPA has the authority to veto a corps decision to issue a permit or to otherwise prohibit or restrict the discharge of dredged or fill material to wetlands or other waters of the United States. Generally, USEPA restricts the use of this authority to the more significant and controversial permit applications.

As the federal agency responsible for maintaining navigation channels in U.S. waters, the corps conducts its own dredge and fill operations. Before proceeding with a dredge and fill activity, the corps engages in a review process analogous to the regulatory permit process; only instead of issuing a permit to itself, the corps issues a "Finding Of No Significant Impact."

The corps also operates, in consultation with USEPA, an environmental dredging program whereby contaminated sediments can be dredged from U.S. waters, including wetlands, as part of the operation and maintenance of a navigation project or for the purpose of environmental enhancement and water-quality improvement to meet the requirements of the Clean Water Act. Such work must be cost-shared with a non-federal entity. Contaminated sediments are disposed of in confined disposal facilities designed specially to contain such contaminated sediments.

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The corps' dredge and fill permits and navigation maintenance operations are a federal activity and as such they must be consistent with state CZMPs. If a state has a wetlands program as well, it is often networked with the state coastal program.

State regulatory programs also exist for both coastal and inland wetlands. These programs vary, but follow a common model. There is no formal planning program, but state law usually defines wetlands and authorizes a state agency to map wetland areas. The state agency either regulates wetland uses directly through a permit program or delegates the program to local governments. Programs either require a permit to be approved by the regulatory agency prior to development in a wetland area or they may prohibit wetland development altogether in some areas.

Floodplain Programs

Most floodplain regulation occurs at the local level, though many Great Lakes states have adopted floodplain programs. As with wetlands, some state programs regulate floodplain development directly whereas others delegate it to local governments, with state supervision. Floodplain programs are supported by the National Flood Insurance Program, which requires local floodplain regulation before development in the floodplain can be eligible for federal flood insurance. The insurance program also advocates land-use controls to regulate floodplain development. Usually, state and local programs prohibit permanent buildings and fills in the floodplain, which is based on the "100-year flood" (a flood of the magnitude likely to occur once each 100 years).

Lake and Stream Shore Protection Programs

The National Park Service administers national lakeshores and national seashores that preserve the unique natural values of the areas while providing water-oriented recreation opportunities. Although national lakeshores can be established on any natural freshwater lake, the four national lakeshores are located in the Great Lakes and cover 92,034 hectares (227,244 acres) in the Great Lakes basin. They are the Indiana Dunes National Lakeshore (Indiana), Sleeping Bear Dunes National Lakeshore (Michigan), Pictured Rocks National Lakeshore (Michigan), and Apostle Islands National Lakeshore (Wisconsin). National lakeshore lands are federally owned and are managed and protected by the Park Service.

Several states have adopted special legislation for the protection of inland lake and stream shores. Like the coastal zone program, the definition of shoreline varies widely from state to state and reflects political and administrative considerations rather than precise resource characteristics. For example, Wisconsin and Minnesota regulate river as well as lake shorelands up to 300 feet from the highwater mark or to the landward side of the floodplain, whereas Michigan regulates inland lake shores to within 1,000 feet of the highwater mark. Shoreland regulatory programs establish state standards for local adoption of zoning, subdivision controls, and, in some cases, sanitary codes. State standards allow low density residential and recreational uses in shoreland areas through a permit program. However, they place tight restrictions on wetland areas and floodplains.

There are literally hundreds of additional local, state, and federal programs that have some impact on planning in the nearshore. More than 130 federal programs alone have a direct impact on land use in the United States. There are programs that control land use of forested areas, agricultural lands, and mineral

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and energy resource lands, to name just a few. To the extent that these lands exist within or near the nearshore area, programs that govern their use also influence land-use planning in the nearshore area.

5.2.2 Planning Roles and Responsibilities

Federal

Within the U.S. federal government there are at least six major federal agencies and more subagencies with a direct interest in land use in the basin that administer at least several dozen programs. Notwithstanding the federal coastal zone management program, these are not land-use planning programs per se, but they do affect land use to the extent that most restrict or place certain conditions upon how land is used. The federal role includes regulating and permitting, standard-setting, giving financial and technical assistance to states and local governments, and directly managing federal lands.

The **U.S. Environmental Protection Agency** is an independent agency that reports directly to the president. This agency is responsible for administering dozens of federal environmental protection laws, primarily dealing with pollution control and cleanup of air, hazardous wastes, surface water and groundwater. USEPA either administers its programs directly or delegates this task to the states. USEPA operates, in addition to its headquarters, 10 regional offices and a separate Great Lakes National Program Office for the Great Lakes basin.

Three USEPA offices have jurisdictions entirely or partly in the basin. The Region 5 office has jurisdiction over six Great Lakes states: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. Region 2's jurisdiction includes the Great Lakes states of New York and Pennsylvania. Regional offices are responsible for administering the federal programs within their jurisdiction.

The **Great Lakes National Program Office** is a unique part of USEPA in that it was created for the sole purpose of monitoring, facilitating, and reporting on the progress of U.S. programs in meeting the terms of the U.S./Canada Water Quality Agreement.

The U.S. Department of Agriculture's primary influence on land use in nearshore areas of the basin is through its **Natural Resource Conservation Service (NRCS).** The NRCS operates hundreds of local conservation districts around the basin that provide technical and educational assistance to local governments as well as to urban and rural residents on watershed projects, flood protection, water supply/management, recreation, and wildlife habitat.

The U.S. Department of Defense includes the **Army Corps of Engineers,** which is the principal federal water resource development agency. The corps' most notable influence on land use in the nearshore is through its federal dredge and fill program and its environmental dredging program discussed above.

The U.S. Department of Commerce houses the **National Oceanic and Atmospheric Administration (NOAA),** which administers the federal coastal zone management program and is discussed above.

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The U.S. Department of the Interior plays an important role in regulating land use in the nearshore through programs administered by its subagency, the **Fish and Wildlife Service.** The Service is the lead federal agency in the conservation of the nation's migratory birds, threatened and endangered species, certain marine mammals, and sport fish. Its activities include management of national wildlife refuges and fish hatcheries, management of migratory birds through habitat conservation and hunting regulations, recovery actions for endangered species, conservation and enhancement of wetlands, biological review of environmental impacts of some development projects, and the enforcement of federal wildlife laws.

The Interior Department's **National Park Service** also has an important role in land use in the basin. The Park Service administers national parks, monuments, and other areas of national significance, such as national lakeshores, for their recreational, natural, and historical properties. The lands managed by the Park Service are federally owned, yet, particularly in the case of national parks and lakeshores, often require extensive coordination and cooperation with surrounding jurisdictions to maintain the desired land use. For the Indiana Dunes National Lakeshore on Lake Michigan, for example, the Park Service has engaged in extensive land-use planning in the area to improve compatibility between the goals of the national lakeshore and surrounding land uses, which include a mix of residential, open space, and heavy industrial uses. In addition to the four national lakeshores, the Great Lakes basin has one National Park—Isle Royale—and numerous National Memorials and National Historic Sites.

The U.S. Department of Transportation has two primary subagencies with an influence on land use. The **Federal Highway Administration** has the primary mission of ensuring that the nation's highways are safe, economic, and efficient with respect to the movement of people and goods, while giving full consideration to the highway's impact on the environment (i.e., land) as well as social and economic conditions. The **Federal Transit Administration** seeks to improve the environmental standards of U.S. cities through grant programs that extend and modernize existing urban mass transit systems. The U.S. Department of Transportation (1990) specifically addresses land use by making it federal transportation policy to "encourage development of local tools for ensuring compatible land use around airports"; to "ensure that measures are taken to minimize the adverse environmental effects of transportation construction activities, for example, through the 'no net loss' goals for wetlands," and to "encourage the design and building of transportation facilities that fit harmoniously into communities and the natural environment ." The U.S. Department of Transportation is responsible for administering the Intermodal Surface Transportation Efficiency Act of 1991, which establishes a framework for intermodal regional surface transportation planning.

Collectively, these federal agencies administer more than 130 federal programs that have a direct impact on land use in the nearshore—from protecting agricultural lands, wetlands, and drinking water supplies to ensuring safe and efficient highways. Where these lands or resources exist within or near the nearshore area, programs that govern their use also influence land-use planning in the nearshore area.

Basinwide in United States

Established by joint legislative action of the Great Lakes states in 1955 and granted congressional consent in 1968, the **Great Lakes Commission** is an interstate compact agency that guides, protects, and advances the common interests of the eight Great Lakes states in the areas of regional environmental quality, resource management, transportation, and economic development. The Commission comprises state

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officials, legislators, and governors' appointees from Illinois, Indiana, Michigan, Minnesota, Ohio, Pennsylvania, New York, and Wisconsin. Though technically an advisory body, the Great Lakes Commission is the only regional organization with a statutory mandate to represent the collective views of the eight Great Lakes states and carries significant weight as the voice of the Great Lakes states, both within the region and nationally.

The Commission's mission, as defined in the 1955 compact is to "promote the orderly, integrated and comprehensive development, use and conservation of the Great Lakes Basin's water resources," which include the lakes themselves, their tributaries, and the land within the watershed. Comprehensive management of Great Lakes water resources necessitates consideration of all activities affecting the basin's water resources, whether in the water or on land, in the basin or out of the basin. The Commission's *Strategic Plan*, adopted in October 1995, explicitly recognizes that the broad mandate contained in the compact requires the Commission to be dedicated to the "use, management and protection of the water, land, and other natural resources of the Great Lakes basin." To this end, the Great Lakes Commission is involved in a plethora of land-use activities in the region, from administering a regional grant program for the prevention of soil erosion and sedimentation in the basin to coordinating the compilation of the first comprehensive profile of agricultural land use in the basin.

The **Council of Great Lakes Governors** is a private, non-profit organization devoted to working cooperatively on public policy issues common to its eight member states: Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. The council was formed in 1983 to coordinate stewardship of the region's economy and environment. In particular, the governors wanted a forum to discuss their common economic problems during the recession that hit the Great Lakes states in the early 1980s and to build upon the successful cleanup of the Great Lakes begun a decade and a half earlier.

The goal of the council is to "stimulate economic, community and environmental development within its member states." The council has a regional agenda based on the fulfilment of this goal, which it pursues through joint consultation among the governors. Though the council's mandate is a broad one, which potentially includes many land-use issues, its agenda to date has been more project-specific. Current projects focus on recycling, water quality, tourism, technology, and education. Like other councils of government, the effectiveness of the Council of Great Lakes Governors is directly related to the extent of the governors' collective commitment to regional action.

States

Each of the eight Great Lakes states has several agencies with some authority over land use in the state. Usually there is a Department of Natural Resources or equivalent agency that is responsible for administering natural resource conservation and management programs. Each state also has an agency responsible for environmental protection programs—for example, air, waste, and water—that largely parallels USEPA or administers its delegated programs. Some states combine their natural resources and pollution-control agencies. All Great Lakes states have a Department of Agriculture and a Department of Transportation or their equivalents. Each state also has other agencies, commissions, and/or extension services with special responsibilities that influence land use, which might include energy planning and development, natural or open space and recreational lands, fish and wildlife management, soil conservation,

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and agricultural preservation. All in all, the eight Great Lakes states collectively have more than 50 state agencies with some responsibility regarding land use in the Great Lakes basin.

Some Great Lakes states use zoning ordinances and subdivision controls alone, whereas others coordinate with well-developed comprehensive plans. Several U.S. states have adopted a more hierarchical land-use planning structure, such as enacting comprehensive state planning and growth management laws—though none of them are Great Lakes states. Pennsylvania, Minnesota, and Michigan are among the states currently showing interest in state and/or regional planning schemes.

Local

Local governments include county and municipal governments (cities, townships, and special districts). There are 192 counties wholly (131) or partly (61) in the Great Lakes basin, 83 of which are coastal counties. There are thousands of municipal governments that have populations from a few dozen to over a million people. They vary almost as widely in land area, from small townships with a six square mile jurisdiction to large urban cities whose jurisdiction covers dozens of miles. The special districts have a wide variety of functions, from regulating the impacts of development on streams (drain commissioners) to developing and maintaining local parks (park districts). Both special districts and general purpose local governments are faced with different land-use issues based on their size, location, economic base, environmental resources, and demographic attributes. And they respond differently to those problems, using any combination of tools and techniques noted earlier, within the limits imposed by state and federal land-use restrictions. Which types of local governments have land-use decision-making authority varies from state to state; however, local governments all have in common the authority to determine how land is used within their jurisdictions—which lots will be developed, when they will be developed, and how. Some use zoning ordinances and subdivision controls alone, whereas others coordinate with well-developed comprehensive plans.

Local governments in all the metropolitan regions and many rural areas of the U.S. portion of the basin are organized into regional councils of governments or planning commissions. These entities are typically established by intergovernmental agreement under general state enabling legislation, although some are created directly by state law. Their services include research on regional issues, preparation of long-range plans, and provision of technical assistance to their member jurisdictions. Their areas of concern relevant to the ecosystem of the Great Lakes include demographic forecasting, land-use planning, stormwater management, wetlands protection, and brownfields redevelopment. They are generally repositories of socio-economic and environmental data for their regions. Most are not granted direct authority to implement their recommendations, but function in an advisory and coordinating capacity to local governments.

5.2.3 Tools and Techniques

Regulatory and Incentive-based Land-Use Controls

Purchase of development rights (PDR): Also known as a conservation easement purchase program, this program to purchase development rights provides an opportunity to retain agricultural or open space land as such and requires the involvement of an outside funding source, usually a public body. Under a PDR

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arrangement, the landowner voluntarily sells the development rights to the land and receives compensation for the development restrictions placed on the land. It works as follows. State or local government (or a private entity, such as a land conservancy) raises money to purchase the development rights on specific farms and open lands. The entity owning the development rights ensures that those rights are not used. The farm or open space remains in private ownership and can be sold or passed along to others, but the landowner has sold the right to develop the property. Once the development rights are sold, use of the property is limited to farming or open space. The conservation easement runs with the land either in perpetuity or for a period of time specified in the easement document.

A PDR system allows the original landowner to ultimately receive the highest value for the land—collected in two instalments. The difference between what a farmer could pay and what a developer could pay is received when the development rights are sold. Then when the land is sold, the landowner receives the lower price because the land can only be used as farmland or open space. The landowner has, however, already received the money for the development rights so the total amount received is equal to what a developer would have paid. In this way, the landowner can continue to farm and keep the land as farmland until he or she is ready to sell, without losing money on the value of the land. This makes the land affordable for young farmers who cannot compete with the high prices developers can offer. Those interested in preserving the farm or open space also benefit since purchasing the development rights is considerably less expensive than purchasing the land outright.

Conservation easements: In addition to easements to restrict development under a PDR program, conservation easements can be purchased for a number of other property interests, including retaining the natural conditions of the land, creating public access, or preserving historical or architectural character.

Transfer of Development Rights (TDR): This is a non-regulatory approach within the context of a regulatory (zoning) program. It allows the right to develop to be transferred from one zoning district to another. Under a typical TDR program, a local government awards development rights to each parcel of developable land in the community or in selected districts, on the basis of the land's acreage or value. Persons can then sell their rights on the open market if they do not want to develop their property or are prohibited by regulation from developing the property at a desired density. For example, a district zoned for low-density development might be used as open space, which does not develop the property to the extent that is allowable. In essence, there is a reserve of development rights that is not being used. Another district may be zoned for moderately high development, but a developer wants to build apartments that would exceed that allowable density. Using the TDR approach, the owner of the open space land can sell his/her development rights to the developer, transferring the right to develop land from one area to another. Henceforth, the open space cannot be developed, while the developer has acquired the right to exceed the density for that particular site. Unlike the PDR approach, the TDR involves no public monies and requires no third party—the transaction is between two private parties. Much like the PDR approach, by selling development rights, TDR allows the property owner to receive profit from property appreciation without developing the parcel.

TDR can reduce substantially the value shifts and economic inequities of restrictive zoning. For example, it can allow the market to compensate owners whose land cannot be developed because of environmental, historic, or scenic significance.

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Right to farm or nuisance lawsuit protection: While more a tool for protecting farming practices than a land protection or growth management technique, this type of law represents an effort to mitigate conflicts engendered by newcomers to rural areas. All states have some right to farm legislation and some have two or three different laws using alternative forms of protection for agriculture. Just how useful these laws are in protecting agricultural lands has been difficult to determine. Some experts believe improvements to "right to farm" laws, such as equating sound agricultural practices with complying with federal, state, and local laws and regulations for environmental protection, may improve the ability of the laws to protect farmers and their land. In the Great Lakes basin, such laws exist in Michigan, New York, and Ohio.

Cluster zoning and planned unit development: Cluster zoning (also known as "open space zoning") and the planned unit development describe land-use control devices that allow development in higher densities on the most appropriate portion of a parcel in order to provide increased open space elsewhere on the parcel. Cluster development techniques typically do not allow increased overall development density, but simply rearrange development to preserve open land and improve site design. For example, a developer owns 100 acres in an area zoned for half-acre residential lots, which could be developed into 200 buildable lots using the entire 100 acres. Under a cluster zoning program, the developer could cluster the 200 units on 50 acres, for example, and permanently dedicate 50 acres of open space for public use. Cluster zoning and planned unit development techniques exist in many forms and offer several benefits over conventional zoning, including protection of environmentally sensitive lands, preservation of open space, and reduction in infrastructure needs and costs associated with new development (i.e., roads and utility lines), which can also reduce the cost of housing and public services. Cluster zoning and planned unit development are voluntary programs that operate within an existing regulatory program (zoning ordinance).

Bonus or incentive zoning: Whereas cluster zoning allows a developer to exceed density limits in exchange for open space protection, bonus or incentive zoning allows a developer to exceed dimensional limits if the developer agrees to provide another public benefit. The classic example is permitting a developer to exceed height limits by a specified amount in exchange for providing open spaces or plazas.

Agricultural zoning/exclusive agricultural zoning: Traditional zoning entails the separation of a city or county into districts (agricultural, residential, commercial, etc.) Exclusive agricultural zoning involves the deliberate establishment of agricultural zones as a tool to moderate farmland or open space conversion. Like many other tools, the effectiveness of agricultural zoning depends on the context in which it is implemented: agricultural zoning is likely to be more effective when it is just one part of a larger local program that includes community plans, urban boundary agreements, or other state farmland protection programs. Indeed, experts note that states with more comprehensive programs, including Wisconsin, have more success than those whose programs are not integrated or are voluntary, such as in Pennsylvania and Minnesota.

Agricultural districts: Agricultural districts are areas of farmland set aside from non-farm development for a fixed period of time. Local agricultural landowners initiate the establishment of such voluntary districts. Willing landowners participate by agreeing to not develop their land in exchange for a variety of benefits that encourage and protect their agricultural operations. The benefits can include any combination of the following techniques and tools, some of which are listed in this section: use-value assessment; protection against nuisance suits (right to farm); protection against eminent domain; protection against annexation; protection against extension of public facilities that would encourage urban development and

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related taxes; eligibility or priority for state PDR programs. Although this technique is widely used, experts indicate that existing programs need improvement to slow farmland conversion.

State farmland protection policies: These are statutes that discourage the expenditure of state or local funds in public projects that will result in the destruction of farmland. In the Great Lakes basin, Illinois, Pennsylvania, and Wisconsin have such laws in place. These laws typically call for an examination of alternatives to any government plan that proposes to take agricultural land out of production.

Development exactions and impact fees: "Development exaction" is a generic term that describes a variety of mechanisms by which communities require developers to dedicate land or facilities (i.e., roads, parks, sewer lines) or to pay a fee in lieu of land or facilities. Also referred to as "dedications," "linkage requirements," and "mitigation requirements," exactions can be explicitly mandated in development regulations or imposed informally on a case-by-case basis in rezoning or special permit negotiations. Impact fees require a developer to pay a certain amount of money determined by a pre-established formula rather than by negotiation or tradition, as is the case with exactions.

Adequate public facilities ordinances: This land-use planning tool is akin to the concurrency requirement set forth in state growth management schemes. It requires that adequate public facilities be available to serve a proposed development prior to development approval. In other words, it requires that infrastructure to support the effects of growth be in place concurrently with those effects. An adequate public facilities ordinance sets quantitative standards and uses those standards to determine the public service levels necessary for proposed developments. In this respect, the adequate public facilities ordinance and the concurrency requirement can be compared to strict implementation of a capital improvements program, which is discussed below. Funding to support infrastructure concurrency can be provided by local and/or state governments as well as through impact fees, improvement districts (also discussed below), and other innovative funding mechanisms.

Urban growth boundaries: Not widely used, yet a potentially significant growth management technique, urban growth boundaries limit long-term growth to land within designated boundaries. Although many communities have short-term boundaries beyond which they are unlikely to encourage or permit expansion, the boundaries are generally flexible in the long-term. Urban growth boundaries distinguish urban lands (cities) where growth is anticipated and planned from rural lands, which are areas with sparse settlement where urban growth is not expected. The states of Hawaii and Oregon and the city of Boulder, in Colorado, use urban growth boundaries to plan for and direct growth. Although urban growth boundaries deal with the issue of where growth will occur, they do not address the issue of timing or fiscal impacts of growth. The application of urban growth boundaries is most effective when coordinated with programs that plan for the orderly and timely expansion of public facilities (i.e., an adequate public facilities ordinance and/or a capital improvements program).

Overlay zones: An overlay zone, or overlay district, is an area in which a set of special regulations apply in addition to the regulations of the "underlying zone" or pre-existing zoning district. Thus, the area covered by the overlay zoning is subject to conventional zoning regulations as well as special overlay zone regulations. This technique is applied most frequently to achieve various public objectives in sensitive environments, such as floodplains, wetlands, and shoreline areas. The existing permitted land uses are not

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disturbed by the overlay zone. Where the overlay zone contains a more restrictive standard, however, it supersedes the standard in the underlying zone.

Moratoria and interim development regulations: Moratoria and interim development regulations are designed to restrict development for a limited, specified period of time. They can prohibit all development during that time or just specific types of development. Interim development regulations allow development based on certain conditions, pending the outcome of other actions, which generally include the development of a plan or growth management scheme, or the adequate funding and/or development of public facilities to service the development.

Conditional zoning and development agreements: Sometimes a developer may seek rezoning, but the local government is unwilling to allow the whole range of uses or densities that the proposed rezoning classification would permit. Instead of denying the rezoning, the locality may impose conditions on the prospective rezoning. With conditional zoning, a local government may make rezoning conditional on the developer's providing certain concessions or conditions that are not otherwise imposed in the proposed zoning district. The applicant must commit unilaterally to provide those concessions in exchange for the rezoning; however, the local government makes no reciprocal commitment to rezone the property. Development agreements differ from conditional zoning in that, typically, they are enforceable agreements that lay out precisely the land uses and densities a developer may place on a large parcel and the public benefits that the developer must provide as a condition of approval. Development agreements also give developers and lending institutions, early in the process, certainty as to the amount and type of development authorized—an element lacking in conditional zoning, which is binding only for the developer.

Local Taxing and Spending Policies

Property tax incentives—preferential or use-value assessment: Established through state law, this is a taxing system whereby land is taxed according to its use rather than a value that reflects the possibility of future development. Most states have enacted use-value property tax assessment programs for farmland and open space lands. These programs are designed to reduce taxes for farmers (or proprietors of other open space lands) and to lower the rate of conversion of farmland or open space to non-farmland or development use by reducing the number of tax-motivated sales. For example, instead of a farm being taxed at its development potential, it is subject to a lower tax rate as farmland. The lower tax rate can help reduce the pressure to sell or develop, which is sometimes caused by high property taxes. There is little evidence, however, that special tax laws alone alter land-use patterns. Experts agree that tax incentive programs must operate in concert with other land-use measures to reduce the rate of farmland or open space conversion.

Special assessments: Special assessments are a local taxation technique that has a great potential impact on controlling land use. Technically more a surcharge than a tax, special assessments raise revenue and create disincentives for development by charging landowners who derive special benefits from a municipal facility. These assessments are often used for road improvement, street lighting, off-street parking, sewers, and water systems. Special assessments can be compared to impact fees in that both techniques require the developers to pay for public services that specifically benefit their development.

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Improvement districts: Landowners within a specified district are levied a special tax or assessment (i.e., through tax increment financing) that is used to make public improvements to benefit that district. The special assessment or impact fee is applied to an entire district, not to a single development project.

Tax increment financing: This is a system whereby the tax differential between an undeveloped or unimproved parcel or site and a developed or improved one is used to make public improvements in that district. The landowner still pays the normal required taxes according to the value of the land, but the municipality uses the taxes generated from the difference between the former value of the land (undeveloped or unimproved) and the new value of the land (developed or improved)—the new tax increment—to finance public improvements. The money can be used either for general public improvements or earmarked for specific activities such as brownfields cleanup and redevelopment.

Capital improvements programming (CIP): The provision of municipal services is generally governed by a city's capital improvements program, a timetable that indicates the timing and level of municipal services the city intends to provide over a specific period of time (usually five to ten years). Since the feasibility of development projects often depends on the availability of municipal infrastructure such as water and sewer lines, the CIP can control development by rendering unfeasible any development plan that exceeds the CIP schedule. For example, if a proposed development project requires water and sewer services that exceed the CIP schedule, the project is unlikely to proceed.

Land acquisition: Land acquisition is an important supplement to land-use regulations and voluntary programs as a means of managing growth and protecting critical resources. Local governments enjoy broad authority under state enabling legislation to acquire real property interests, either through voluntary sale or condemnation, for any legitimate public purpose. Federal, state, and local governments can purchase the land outright and all the rights associated with it (called "fee simple acquisition") or they can purchase select rights, such as development rights, otherwise known as "easements." Easements can be either affirmative—granting special rights—or negative—limiting rights to specific uses of the land. An affirmative easement might authorize a utility company to place electric lines across someone's property or authorize the public to pass through private property to obtain access to a shoreline. Examples of negative easements include prohibitions on development (such as the PDR program described above) or on construction that would obstruct a neighbouring view. Governments generally acquire fee simple ownership for parkland, shorelands, and other recreation areas.

Private Voluntary Land Protection

Private land trusts/land conservancies: Land conservancies are private, non-profit organizations, whereas land trusts can be either private non-profit or quasi-municipal entities. They both acquire land or rights to land in the interest of protecting and or preserving the land. Quasi-public land trusts allow local governments to meet their conservation and growth management goals and objectives by participating in the private real estate market as representatives of the public interest. In so doing, they are able to use the range of voluntary land-conservation techniques available to private land trusts. The two most important land-protection techniques used by land trusts and land conservancies are fee simple acquisition and acquisition of easements.

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Land trusts, land conservancies, and any other private party can, in addition to purchasing land at its full fair market value and purchasing conservation easements, employ the tools and techniques described below to preserve, protect, or otherwise control land use.

Donation or bargain sale: Donation is the option of choice for the land trust or conservancy, since it eliminates expenses associated with purchasing the land while providing maximum tax benefits to the landowner. A bargain sale involves a combination of a donation and a purchase, whereby a landowner transfers the property at a price below fair market value.

Right of first refusal: A right of first refusal is an agreement between a landowner and a second party whereby the landowner agrees that if he or she receives an offer from a third party to buy the property, the landowner will notify and give the second party a certain amount of time to match the third party offer prior to accepting the offer from the third party.

Leases and management agreements: These tools, which exist in many forms, allow for temporary control over a parcel without the expense of acquisition. Leases generally give a land trust the right to manage and occupy the land for a certain period; management agreements specify the terms under which the landowner continues to manage the property.

Preacquisition: Land trusts may acquire property to hold and manage in perpetuity or they may serve as an intermediary for a public land management agency. Preacquisition takes place when a public agency works with a private land trust so that the land trust acquires the property from the landowner first and then transfers it to the public agency. Preacquisition is appealing to public agencies because the private land trusts can often negotiate and undertake other necessary steps for acquisition faster and more adeptly than the public agency. The next step of transferring the land to a public agency furthers conservation goals since public agencies can often manage additional adjacent land more economically and can confer more protection against other public agencies (e.g., a state highway department) than can private land trusts.

Limited or controlled development: This technique typically entails clustered development or other limited development of a portion of a parcel in order to finance acquisition and preservation of the remaining portion. Development is generally limited to non-sensitive or previously disturbed portions of a parcel. Limited development (also called controlled development) can permit land stewardship and substantial resource protection when donation is not possible and acquisition for full preservation is not financially feasible. Limited development is often feasible because building lots or houses next to restricted open space frequently increases their value. This tool is appropriate only for parcels of sufficient size and with conditions that allow creative partial development without endangering the resources that are worthy of protection.

Conservation investment: Many real estate ventures are financed partnerships in which numerous individuals or entities pool their resources to finance a project. In return, they receive some combination of benefits, such as tax breaks, dividends, etc. In some cases, a trust may sell property subject to appropriate deed restrictions or conservation easement to a buyer looking for an aesthetically pleasing place to live or a vacation home. In other cases, charitable investors may be persuaded to invest in a working farm, nature preserve, or other open space land with deed restrictions.

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Examples of Successful Regional Planning in the United States

Oregon

In 1973 Oregon passed state legislation creating the Oregon Land Conservation and Development Commission (LCDC) and charged it with the adoption, administration, and enforcement of mandatory state planning goals. All Oregon counties and cities are required to adopt comprehensive plans that conform with statewide planning goals established by LCDC and to enact appropriate ordinances to implement those plans.

The Oregon program is founded on policies that favour conservation of natural and agricultural lands. Tools such as purchase or transfer of development rights are not necessary to protect these lands since they are zoned for agricultural use and they stay that way. Strong protection of natural and agricultural areas is complemented by the establishment of Urban Growth Boundaries around every city in Oregon. Urban growth boundaries distinguish urban lands, where growth is anticipated and planned, from rural lands, which have sparse settlement and where urban growth is not expected or wanted. Local governments must identify housing needs and formulate a means for providing density and types of dwellings sufficient to meet those needs. Infrastructure required within urban areas must also be determined.

Each county is responsible for coordinating all planning activities affecting land use within the county—including county, cities, special districts, and state agencies activities—to assure an integrated comprehensive plan for the entire county. Though the structure of the Oregon land-use program is regional in nature, local governments, including counties, cities and special districts, are the primary units for effecting land-use planning. The LCDC may adopt goals and review local plans and regulations for conformity with the state goals, but local governments are the medium for expressing that policy.

Portland Metro

The Portland Metropolitan Region is a particularly well-regarded model for regional metropolitan governance.

The 1973 Oregon state statute established a regional planning authority—Portland Metro, which encompasses most of the three counties in the Portland area—to plan and regulate land use within the metropolitan area. Portland Metro is the United States' only directly elected regional government. Complementing the establishment of a regional urban growth boundary as required under state law, Portland Metro balances highway expansion with a high quality light-rail system; suburban growth is balanced with significant development downtown. The region has adopted a 2040 plan, which will guide its development well into the next century. The plan places a strong emphasis on adding light rail lines linking cities and designated growth centres, while at the same time is committed to reducing residential lot sizes to preserve downtown Portland's share of the regional job pool. Portland still experiences many maladies characteristic of modern urban life, but the sense of a coherent regional approach and a vision leading the region into the 21st century is an important model for other metropolitan regions across the continent.

Twin Cities

The Metropolitan Council of the Twin Cities Area of Minnesota is not a regional government, per se, but rather a hybrid regional agency comprising metropolitan agencies, local governments and the state

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legislature itself. The Metropolitan Council was established in 1973 to coordinate the development of the seven counties containing Minneapolis and St. Paul and their surrounding suburbs.

The major tool for coordinating regional growth in the Twin Cities Area is the comprehensive development guide, an integrated policy, plan, and program provided for in the state statute establishing the Metropolitan Council. The guide reflects regionally agreed-upon strategies to accomplish regionally agreed-upon goals. These goals include protection of the regional environment, protection of the regional economy, management of public conflict, fairness to all members of the metropolitan community, efficiency in the delivery of public services, and minimum intrusion into individual liberties in carrying out these goals. The guide consists of separate functional planning chapters covering sewers, solid waste, open space, transportation, and other public services, which are complemented by a comprehensive regional growth strategy. Accordingly, the council does not have direct control over the delivery of public services; rather the state legislature created a system of single-purpose metropolitan agencies (i.e., sewer, transit, highway, airports, parks, housing) to provide these services throughout the metropolitan region. Though the council has the authority to enforce the long-range goals and plans set forth in the guide, each metropolitan agency operates relatively independently.

Local governments within the seven-county area are required to develop plans for their respective jurisdictions. Comprehensive regional planning takes place through the council's authority to review and require modification of those local plans to meet regional goals. The council also approves capital improvement programs for sewers and transportation and has the power to review proposed developments of "metropolitan significance."

The council is one of the few regional agencies in the nation to have substantial independent powers. Its success is based to a large degree on its recognition of the delicate balance between providing a mechanism for addressing complex regional problems and limiting interference in the local control of smaller communities.

5.3 Canada

5.3.1 The Framework

Federal

Canada is a federation of ten provinces and two northern territories. Although there is general constitutional division of authority between the federal and provincial governments, many areas requiring governmental management, such as the environment, are a shared responsibility. Both levels of government have environmental legislation governing their own activities that affect the environment as well as activities that they are empowered to manage. Thus, for example, Ontario and Canada both enforce their own environmental protection and environmental assessment legislation.

To the extent that duplication and other difficulties exist between these different governments applying and implementing similar legislation, the federal and provincial governments are attempting to address

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harmonization through the Canadian Council of Ministers of the Environment. One of the most powerful pieces of federal environmental legislation is the Fisheries Act. Provisions that restrict the release of deleterious substances into water bodies and that ensure the "no net loss" of fisheries habitat can serve to curb urban land activities that affect the nearshore ecosystem. The federal governments of Canada and the United States—through the International Joint Commission—manage the flow of water through control structures on the Great Lakes, thereby indirectly affecting the production of hydroelectric power, navigation, and water levels.

The federal government may intervene in areas of provincial influence through funding programs. Federal activities in housing include the creation of the Canadian Housing and Mortgage Corporation to facilitate home ownership through housing standards and credit availability. The federal government also contributed to a number of infrastructure programs, including those largely responsible for the creation of municipal sewage works that discharge sewage destined for the Great Lakes. The federal government has contributed extensively to the building of the provincial road and public transit infrastructure through grants and partnership funding programs. The federal government has jointly managed a number of environmental programs with the province, such as the contaminated orphan site program or the flood damage reduction program.

The federal government owns extensive property directly within or that can affect the nearshore ecosystem. The federal government manages federal parks at locations such as Pelee Island and Five Fathoms Park. In addition, the Canadian Wildlife Service manages wildlife preservation at various locations, such as Long Point. The federal government is also responsible for aboriginal issues and lands, such as Walpole Island. Although privatization is affecting its responsibilities, the federal government has been active in land management issues related to railway operations, airports, and some industrial lands, such as the Toronto waterfront. Further, federal legislation governs the operations of harbours and ports throughout the basin, including Toronto, Hamilton, Thunder Bay, and numerous small craft operations and the canal systems in Ontario.

The federal government has played a leadership role in developing and implementing remedial action planning for Areas of Concern on the Ontario side of the basin, contributing both human and economic resources and sponsoring public involvement. The Canada Centre for Inland Waters, in Burlington, has provided research and analysis for provincial as well as federal programs. The federal government has played an important role in connecting Ontario to such broad international activities as the world biosphere program for Long Point and the Niagara Escarpment, North American waterfowl management, and the United Nations Environmental University.

Provincial

The provincial government is responsible for most matters that affect the planning and use of land in Ontario, including the management of Ontario public lands and management of the province's natural resources. The provincial government can establish local governments, regulate property rights, and manage urban planning within the province. Thus, Ontario has the primary responsibility for land planning on the Canadian side of the Great Lakes basin.

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Ontario has taken a pro-active and interventionist position to land-use planning by establishing policies that affect settlement and the management of growth within which municipal planning and development can proceed.

Municipal

There are almost 4,500 municipalities in Canada, including 811 local government bodies in Ontario. Municipal structures throughout Ontario vary, depending on the degree of planned urbanization. In the more heavily populated southern part of the province, two-tiered regional government was established in the 1970s to assist municipalities with planning for development. These include the regional municipalities of Durham, Metropolitan Toronto, Peel, Halton, Hamilton-Wentworth, Haldimand-Norfolk and Niagara, which border on the Great Lakes. Within each of these regions, local municipalities operate and share responsibility, to variable extents, for planning, water, waste and wastewater, roads, social services, and parks services.

In other areas of the province, a combination of county, city, township, town, and village predominate in multi- or single-level form, depending on the size and complexity of the municipality and the issues facing it. For example, the unsettled northern part of Ontario makes do with a minimum of governance.

The Legislative Framework for Municipal Planning

Ontario's municipalities are created and guided in their essential operations by the Municipal Act. The Planning Act is the key piece of legislation governing growth and settlement within the Province. Among major elements, the Act

- establishes the role and interest of the province in planning matters;
- sets the framework for establishing local planning administration;
- sets the framework for planning instruments and controls that can be employed by local governments, including official plans, zoning, and subdivision control;
- establishes public consultation requirements;
- defines the role of the Ontario Municipal Board with respect to the planning approval process.

Land uses and the planning and development process are regulated by a large number of other laws and regulations pertaining to construction standards, environmental standards for infrastructure, uses of watercourses and shorelines, etc. Environmental assessment and protection, resource management, and aspects of flood control planning in watersheds are controlled through various federal and provincial laws, regulations, and policies. Key among these are Ontario's Environmental Protection Act, which protects air, land, and water, and the Environmental Assessment Act, which requires an environmental assessment process for major public works.

Many other controls are in place to regulate land uses affecting valleys, watercourses, fish habitat, tree cutting, aggregate extraction, and other activities; but it is the municipal planning process mandated under the Planning Act and the strategies and limits on local land use set out in local plans that govern growth and settlement. Although environmental interests are expressed as important principles in the Planning Act, land-use planning and official plans are more concerned with the developed landscape rather than the

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natural environment. For example, terminology such as “hazard land” and “open space,” which reflect more dated frontier attitudes, are still used to characterize natural landscapes, as if they are best defined by either their openness or their hazard. In Ontario, at least, land-use planning based on the primacy of natural ecosystems is still some way off, both in principle and reality.

Education matters are largely governed by schools boards throughout the province, which levy property taxes separate from municipalities, under the mandate of the Education Act and in cooperation with the Ministry of Education. In a similar vein, but to a lesser extent, the Ministry of Municipal Affairs and Housing serves to assist and review the activities of municipalities. The province is currently considering alternative ways to fund and disentangle responsibilities for municipally delivered services, including education. Greater devolution of responsibility for municipal planning and development to the local level is one option being considered as a trade off against greater provincial control over school education and health programs.

5.3.2 Planning Roles and Responsibilities

Matters of Provincial Interest

The first section of Ontario’s Planning Act states that the matters of provincial interest to be “had regard to” in carrying out provincial approval responsibilities include the following:

- protection of the natural environment, including agricultural lands, and management of natural resources;
- protection of features of significant natural, architectural, historical, or archaeological interest;
- supply, efficient use, and conservation of energy;
- provision of major communication, servicing, and transportation facilities;
- orderly development of safe and healthy communities;
- equitable distribution of educational, health, and other social facilities;
- coordination of planning activities of municipalities and other public bodies;
- resolution of planning conflicts involving municipalities and other public bodies;
- health and safety of the population;
- protection of the financial and economic well-being of the province and its municipalities.

Provincial Policy Statements

Under the Planning Act, there is a cabinet-approved statement—the Provincial Policy Statement (PPS)—dealing with municipal planning matters that are deemed to be of provincial interest. A new set of PPSs came into effect in May 1996, which dealt with issues such as municipal infrastructure, housing, agricultural policies, mineral resources, natural heritage, water quality and quantity, cultural heritage and archaeological resources, natural hazards, and human-made hazards.

All of Ontario’s local government bodies must implement and plan within the framework of this legislated system. Provincial ministries, agencies, and local governments must “have regard to” the land-use policies established by the province, although not necessarily rigidly conform to them, when making planning

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decisions. This builds in some flexibility to allow for local circumstances to be considered in local planning decisions. Where local planning decisions vary from provincial policies, decision makers are expected to explain the discrepancies.

Official Plan Approvals

The focus of planning legislation in every Canadian province is some form of local policy plan, which is intended to enable a municipality to formally set down its goals, objectives, and policies on how it wants to develop in the future. In defining what a municipal plan should contain, the Ontario Planning Act states:

> "An 'Official Plan' shall contain goals, objectives and policies established primarily to manage and direct physical change and the effects on the social, economic and natural environment of the municipality or part of it, or an area that is without municipal organization."

Official plans must be formally adopted by the respective regional or local municipal councils in Ontario before being forwarded to the provincial government for approval. Provincial approval involves the circulation of the plan to a broad range of provincial and other public agencies to ensure that any relevant concerns are addressed. Over the years the time needed to complete this review and approval procedure has become longer as the nature of issues to be considered becomes more complex. In a few instances the provincial approval authority for lower tier municipalities has been delegated to the regional level of government, where that exists.

In Ontario, a municipal plan is not binding on the province, although any ministry is required to "consult with, and have regard for, the established planning policies of the municipality" before carrying out any activity. Authority for most land-use planning decisions has been delegated by the province to one or both levels of municipal government. Exceptions are found for some northern areas lacking municipal incorporation. For a number of local municipalities within counties lacking effective planning capability, the province continues to approve the required municipal official plans that set out a municipality's future land-use and development policies.

As the focus of the local planning process, this provincial sanction of the municipal policy plan is considered in most provinces to be essential. Generally the legislation indicates that once a plan has been finally approved, no local controls or public works may be carried out that do not conform to the plan.

Provincial Plans

Ontario also has legislation enabling the provincial government to prepare its own plan for any part of the province. Such provincial plans take precedence over the plans of municipalities, which are required to amend their own documents to conform to the provincial plan.

Only two such plans have been passed since the legislation was introduced in 1973. The Niagara Escarpment Plan oversees the management of escarpment lands for a distinctive linear landscape feature with high recreational potential that cuts across several counties and dozens of local municipalities. The effect of the plan is to suspend local land-use controls and replace them with special development control powers exercised by an appointed commission. The second plan, the Parkway Belt West Plan, restricts

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urban development on a corridor around the rapidly growing Greater Toronto Area (GTA), thus allowing for the future provision of utilities, roads, and green space.

The Ontario Municipal Board

The Ontario Municipal Board (OMB) is a quasi-judicial body of last resort and has broad powers to resolve disputes on planning matters. Since it is a court of last appeal and resort and since it can rule on land use, including overturning council decisions, as well as matters of process, the OMB is a powerful entity in planning and is regarded as the final planning authority in Ontario. The Planning Act lays out the framework describing who can refer planning matters to the OMB and when they can do so in the planning process. Matters that typically end up before the board can relate to official plans, official plan amendments, zoning, plans of subdivision, and even minor variances from zoning provisions.

Expropriation and Compensation

In Canada, private property rights imply the reasonable use of one's land. For example, a municipality cannot arbitrarily zone private land for public purposes. As a result, we have no tradition of compensating individuals for the so-called injurious effects of planning decisions or, on the other hand, the sharing of profits from advantageous planning decisions. However, the high cost of constructing major public infrastructure in urban areas, such as major extensions of water supply and sewage collection facilities, has prompted measures to share these costs with the private landowners who stand to gain large benefits from their construction.

If an action by any level of government means the removal of reasonable use of private property, the land in question must be acquired by the public authority intending to use the land. For example, private land may be needed to acquire the route for a new highway. Many landowners will be affected. Depending on the amount of an individual's property that is needed, it may be acquired in whole or in part. In Ontario, if only part of a property is required, then the landowner may seek compensation for "injurious affection" because of the limited use of the remaining land.

The compensation to be paid for land acquired in this manner must be market value (i.e., the price a willing buyer would pay to a willing seller) plus any disturbance considerations. Some landowners may come to an amicable agreement on the value of their property, whereas others may prefer to take the chance of seeking higher compensation through an expropriation process. This brings arbitration measures into play and a public hearing may be held. In Ontario the Land Compensation Board may determine the value of compensation if the parties cannot agree. An appeal to the Ontario Court of Appeal is also possible.

Tiered Municipal Governments

Under the two-tier system of local governance, functions are divided between the two levels. Exact responsibilities vary from place to place, but generally the upper tier—regional governments—take on functions such as regional planning, sewer and water infrastructure planning, major roads, transit, policing, and some social services. The local governments deal with local planning, parks, garbage collection, etc. There is often duplication between the two levels—with respect to economic development initiatives, for instance. The recent report of the GTA Task Force (January 1996) noted, for example, that in the Greater

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Toronto Area, 4 out of 5 regional governments and 25 of 30 local governments engaged in economic development activities.

When it was first established in 1954, the Municipality of Metropolitan Toronto was regarded across North America as a progressive model for urban governance. Now, however, development has long since spread beyond the Metro Toronto boundaries into the surrounding four regional municipalities. In order to better coordinate issues related to the governance of the GTA, Canada's largest urban region, the province created a provincial agency to bring the many local and regional governments together. A joint provincial/municipal process has been set in motion to achieve greater coordination in planning the form of future growth and the infrastructure needed to serve it. No special legislation has been passed to date.

Official Plans

Ontario legislation requires the mandatory preparation of official plans for the 13 regional municipalities created through a reorganization of local government in the most populous parts of the province. Once the regional plan has been approved, local municipalities are required to amend their own official plans to bring them into conformity with the regional plan. Ontario takes the approach of requiring municipal councils to review their plans at least every five years to ensure that their basic principles and goals are still valid.

Legislation enables the regional municipality to amend the local plan directly if the local municipality fails to do so itself. In practice, this rarely happens, in spite of discrepancies between the two levels of plan. One reason for this may be because many of the same people serve on both councils since many regional governments are elected indirectly; that is, they are elected to the lower-tier municipality but also serve on the regional council. One of the difficulties of Ontario's two-tier municipal system is the almost constant tension between the two levels, particularly where there is direct election to regional council, as in Metropolitan Toronto.

An approved municipal plan has little effect by itself and must be implemented by various control devices. Most legislation does not state that policy plans must be implemented, but there are exceptions. The effect of this approach is to make the implementation of policy a somewhat negative exercise. Implementation takes the form of ensuring that no uses of land are allowed that do not conform with approved planning policies, but nothing is legislated to actually seek the achievement of specific planning objectives. Similarly, the subdivision and servicing of raw land for development purposes may not take place in contravention of municipal planning policies.

However, official plans can be and are frequently amended to allow for changes in designated land uses to accommodate growth and other changes that municipal politicians may deem appropriate. In growing municipalities, pressure for amendments from politicians wishing for development growth and from developers can significantly alter the original goals of the official plan for a municipality. Finally, official plans require periodic renewal as mandated by the province.

Zoning

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A common characteristic of Canadian planning legislation is to provide fairly detailed provisions on how planning policies are to be implemented at the local level. Most implementation measures involve the control of privately initiated development. The forms of development control vary from one jurisdiction to another, but are generally centred on municipal zoning bylaws. Municipal planning legislation often indicates the permitted scope of zoning bylaws and generally limits the ability to zone to local municipalities.

Zoning bylaws are precise documents adopted by local municipalities to regulate the use of land. They must be consistent with the municipal policy plan and state exactly what uses are permitted in different parts of the community. Maps are included to show the precise boundaries between different zones. Detail is provided on where buildings may be located, the types of uses and dwellings permitted, standards for lot size, parking requirements, building height and setback distances from the street. Bylaws usually establish several types of residential, commercial, industrial, and other zones according to density or character of development. This gives a municipal council a precise context within which to make decisions on development applications. If a development application submitted by an individual or company does not conform to the bylaw, it is rejected or an amendment to the bylaw is considered—as long as it is consistent with the policy plan.

The zoning system, developed originally to protect neighbourhoods from undesirable uses, provides a measure of certainty and predictability, but has drawbacks as a development control device. In growing municipalities, zoning bylaws tend to be frequently amended simply because zoning is often not flexible or creative enough to regulate new development. Zoning that is frequently changed may be attacked for apparently betraying the expectations of original residents about the future use of land. However, in small, rural municipalities, where the only permanent employee may be the municipal clerk, the pre-set rules of the zoning bylaw and the zones set out on maps provide landowners with a reasonably clear indication of what they can and cannot do with their land and facilitate land-use management.

Many larger municipalities across the country have evolved variations on the basic zoning system. Some use broad, generalized zoning categories and grant development permits on the fulfilment of specified conditions. A more discretionary development permit system, in the absence of local professional planning advice, has more potential for misuse and arbitrary decision-making. In the absence of local government, at one level or another, the control of land-use is the direct responsibility of the provincial government. Ontario legislation, for example, gives the province authority to impose “zoning orders” on any area. These orders effectively freeze development to existing uses and any change requires an amendment of the order. For example, a new mining operation may result in residential facilities for employees, which should be regulated in terms of location, access, and other factors.

Subdivision Control

Another aspect of plan implementation in Canada is control over the division of land for sale as building parcels. This control has been delegated to most regional municipal governments where they exist in Ontario. Subdivision control ensures that land is suitable for its proposed use and that it conforms to municipal planning policies. It also serves to protect the community from inappropriate development that may be premature or may put undue strain on community finances or services (e.g., water supply or sewage treatment facilities).

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Public Consultation

Public involvement in the planning process has long been taken for granted in all Canadian provinces. The effectiveness of at least some of that involvement, however, is increasingly being called into question. There seems to be a direct relationship between the nature of the planning issue under review and the degree of public interest. If the planning matter is a broad-scale policy plan, public involvement and interest tends to be sporadic. Clearly, more effort is needed to actively involve the community at this stage. However, if the issue involves a specific building application that directly affects the nature of a neighbourhood, public interest will be lively, intense, and often emotional.

Ontario legislation provides for the public to be involved at key stages in the planning process and in the development of official plans and zoning bylaws, in particular the following:

a) Official plans: A proposed official plan (or amendment to an existing plan) must be circulated within a municipality for public comment and at least one public meeting must be held to receive comments. Only then may the plan be forwarded to the province for approval, together with copies of public comments. Any person who still objects to the official plan after it has been adopted and forwarded for approval may ask that the plan be referred to the Ontario Municipal Board for review. This appointed board operates in a quasi-judicial manner with the authority to adjudicate and decide upon planning appeals throughout the province.

b) Zoning bylaws: Before passing a municipal zoning bylaw, or bylaw amendment, the local council must ensure that sufficient information is made available to enable the public to understand the proposal and must hold at least one public meeting to receive comments. After the bylaw has been passed by council, the public must be advised. Any person then has 20 days to appeal any of the bylaw's provisions to the municipality. Objections received must be forwarded to the Ontario Municipal Board.

If objections are put forward, the legislation requires the Ontario Municipal Board to hold a public hearing following the expiry of the required notice period. At the hearing the municipality states why the bylaw has been proposed and the appellants may state their objections. The board then decides the issue and whether the bylaw can come into effect. If there are no objections to the bylaw, it becomes effective upon receiving final reading by the municipal council. Concern has been expressed about the role of the Ontario Municipal Board, as an appointed tribunal, in undermining the authority of elected officials in what has at times become a time-consuming adversarial process.

The Waterfront Regeneration Trust

The Waterfront Regeneration Trust (WRT) was created by the province of Ontario on June 25, 1992 and reports to the Minister of Municipal Affairs and Housing. A successor to the Royal Commission on the Future of the Toronto Waterfront, only the second-ever combined federal and provincial royal commission, the WRT sets an example of nearshore planning that blends land-use concerns relating to many different issues, from site remediation to agricultural practices. Though not a planning agency and having no decision-making authority, the work of the WRT demonstrates an integrated ecosystem planning approach

designed to protect, modify, and remediate both built and natural environments. Its success is due in large part to the use of influence and consensus among stakeholders.

The WRT's mandate, based on legislation, is the following:

- To ensure coordination of provincial policy and programs, and advise on waterfront issues.
- To facilitate the establishment of a waterfront trail and associated green or open spaces.
- To create partnerships and alliances, and resolve jurisdictional conflicts to promote investments in waterfront projects.
- To maintain a Waterfront Resource Centre for educational, community, and commercial use to promote an integrated approach to solving economic, environmental, and community waterfront issues.
- To hold land, generate revenues, and administer funds for purposes of waterfront regeneration.

The Act defines "waterfront lands" as "the land, including land covered with water, that is related to the shore of Lake Ontario extending from Hamilton Harbour in the west to the Trent River in the east; with a provision for possible extension." During 1996, the WRT was invited to extend its work to Niagara-on-the-Lake and Kingston.

The WRT reports to the legislature through the Minister of Municipal Affairs and Housing. The minister is responsible for the administration of the WRT's legislation. Some activities under way include the following:

Implementing the Lake Ontario Greenway Strategy through partnerships with municipalities, conservation authorities, provincial and federal ministries, and community groups.
Continuing the transition of Toronto's Central Waterfront to a greater mix of uses—for residences, commerce, tourism and entertainment, parks and modern industry—based on an integrated transport system and low-cost reliable energy supply.
Promoting awareness, understanding, and participation in the regeneration of the waterfront among people, communities, business, and public agencies.

Conservation Authorities

In Ontario the conservation authorities, constituted on the basis of one or more watersheds, play a significant role in land management and environmental protection. The Ontario Conservation Authorities Act, enacted in 1946, sets out the formal roles and responsibilities for conservation authorities. The conservation authorities are funded in part by the province, their municipal clients, and users of the parks and other resources they provide. They were established to approach resource management on a comprehensive basis, which includes not only flood control, but also land-use impacts, soil conservation, forestry, wildlife, recreation, and public education. Conservation authorities are the only public bodies in Ontario organized on the basis of a physiographic unit (watershed boundary) that is superimposed over the boundaries of local and regional municipalities (political boundary).

Currently, the activities of conservation authorities are focused on the following areas:

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water management and flood control;
outdoor recreation areas and facilities;
development review;
input into municipal planning documents (official plans, zoning bylaws);
forest management;
fish and wildlife management, including wetland acquisition and management.

5.3.3 Tools and Techniques

Planning and the Nearshore

Traditional land use and development planning within the basin profoundly affects the nearshore. Canadian provincial and local governments have, therefore, established special zoning by-laws, permit schemes, and other development control instruments for sensitive lands in the nearshore. These fall into a number of categories, including

watershed planning;
floodplain protection;
lake and stream shore protection;
agricultural zoning and practices;
extractive resources planning;
infrastructure planning;
environmental protection;
site remediation planning;
parks and waterfront recreational planning;
wetland preservation;
hazard zoning.

Site Remediation Guidelines and Brownfields Development Approaches

In Ontario, soil contamination varies within municipalities and from site to site, depending on past and present land uses, type of activities and the environmental protection measures taken. Certain pollutants such as organic compounds and heavy metals can persist in the ground for years after industrial activities have ceased. “Brownfields” (vacant or inactive industrial or commercial properties with known or suspected soil or water contamination problems) are a problem in central cities, older inner-ring suburbs, and some rural areas. In the Greater Toronto Area, some areas such as the Port Industrial Lands in Toronto have been recognized as contaminated due to former industrial land uses.

Contaminated soils can preclude the reuse of the land by rendering properties unfit for human use and development. Cleanup costs to remediate a site can be very high, especially when earlier regulatory practices required a high level of cleanup, discouraging recycling of industrial land. Brownfields influence the location of residential and business activities, shaping regional development patterns and raising barriers to potential urban revitalization. To address these and other issues, in 1993 the Ministry of

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Environment and Energy initiated consultation with government and non-government participants to revise its "Guideline for Use at Contaminated Sites in Ontario."

Under the new contaminant guideline released in June 1996, the level of soil cleanup is dependent on the intended use of the land. For example, property to be used for housing or schools will need a higher degree of cleanup that other activities, such as roads and parks. By requiring registration on title for contaminated property, the guideline will assist the members of the public, the real state industry and lending institutions in making informed investments decisions. The new guideline provides advice and information to property owners and consultants to use when they are assessing the environmental condition of a property and determining whether or not restoration is required and the kind of restoration needed to allow continued use or reuse of the site.

The new guideline describes three approaches that can be used when a decision has been made to remediate or restore a contaminated property: background, generic, and site risk assessment. The property owner and those undertaking the work are responsible for ensuring that the site restoration work is completed in a manner consistent with the information provided in the guideline and that the site is suitable for the intended use or reuse. Although there is no inventory of potentially contaminated lands available for the whole GTA, several initiatives are under way to identify contaminated sites. One such initiative, led by the Waterfront Regeneration Trust, in Toronto's central waterfront, brings together the province and the private sector to find ways to expedite development approvals on specific brownfields sites, depending on their level of contamination and the proposed use.

Property Tax Reform

Although assessment information is managed provincially, the determination of actual assessment varies by year and valuation methodology among municipalities across the province. Part of the reason for the flight of industry from the City of Toronto is that assessment rates are more favourable in the suburbs where municipalities try to attract new employment opportunities for their planned industrial lands as part of their municipal growth strategies.

An initiative is currently under way to reform property tax in Ontario. The present system is extremely complicated, with assessment systems varying from place to place within the province. The intention to implement a single, province-wide property tax system based on "actual value assessment" (AVA) has recently been announced. An important proposal associated with the new system is the basing of assessed value on the current, actual use of a property, not on its speculative value.

Transit-Supportive Land-Use Planning Guidelines

The province of Ontario issued guidelines for transit-supportive land-use planning several years ago. They present a comprehensive package of measures to be taken into account in the land development process to make new development transit-supportive. The guidelines deal with matters such as land-use, density, and urban design.

Urban Growth Boundaries

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Many local and regional plans, particularly those undergoing greenfields development or anticipating future growth, identify a long-term urban growth boundary. These are generally not intended as permanent urban boundaries, but urban growth boundaries for a planning time frame of 20 to 30 years. In the Region of Peel Official Plan, for example, an urban growth boundary is established to the year 2021.

Parkland Conveyances

The Planning Act allows for parkland to be conveyed to a municipality in conjunction with approvals for the subdivision of land. Up to 2 percent of the total land area to be subdivided can be required for parks if the land use is commercial or industrial, or up to 5 percent for residential uses. In certain cases, the Act also allows a dedication standard of 1 hectare of parkland for every 300 residential units.

Density and Height Bonuses

The Planning Act allows municipalities to grant bonuses in height or density above and beyond what would ordinarily be allowed on a particular site, in return for a landowner's providing certain "facilities, services or matters." These can include, for example, affordable housing, daycares, or other public facilities such as cultural or exhibition space. The landowner and municipality enter into a legal agreement defining issues and responsibilities.

Holding Zoning

The Planning Act provides for a holding zoning designation to be granted to a site or area, in which the zoning permissions are in place but are essentially withheld subject to the landowner's fulfilling certain conditions or obligations with respect to the property. The holding designation (usually depicted as an H symbol on a map) is lifted when the conditions are met. This approach might be used, for example, with respect to ensuring cleanup of contaminated lands prior to permitting development to proceed.

Development Charges

A Development Charges Act was introduced in Ontario in 1990. The Act sets out a province-wide framework that permits local and regional municipalities and school boards to charge fees to developers and builders to pay for the costs of growth-related infrastructure. Individual municipalities then adopt development charge bylaws, setting out infrastructure items that the charge will finance and the charges to be applied to different types of development (e.g., single detached dwellings, townhouses, apartments, and commercial development).

Development charges vary considerably from one municipality to another, which encourages industrial and other developers to shop around. Municipalities that do not recover the full costs of municipal infrastructure, including "hard" services, such as roads and sewers, and "soft services," such as schools, parks, and libraries, in fact subsidize the developers for locating development in their community. The burden for this subsidy falls on the general ratepayers through increased municipal debt or, more immediately, higher taxes and increased service charge rates. The Development Charges Act is currently under review by the province, and a new Act is expected in the fall of 1996.

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5.4 Conclusions

5.4.1 Background

Growth and development in the Great Lakes basin is a complex issue with many participants and one very obvious trend—urban sprawl. Economic growth, which has lead to the standard of living that residents in the Great Lakes basin enjoy, has been partly based on the very factors that now serve to strangle its continued progress. The automobile, highways, efficient agriculture, and high population growth rates over the years have encouraged and facilitated a development culture based on continued greenfield development and urban sprawl. Highly desirable as a lifestyle in a relatively unpopulated community, low-density development (sprawl)—now extending across the Great Lakes states and Ontario—is a major stressor for the nearshore ecosystem. Urban sprawl has a number of implications for social interaction and the provision of social and community support. Unique community character and the sense of "place" that fosters collective community pride is sadly lacking in many sprawl communities.

Ways of dealing with development pressures on each side of the Great Lakes have been as different as the institutions, political and legislative systems, and cultures of the two countries that share the basin. Canadians have tended towards reliance on provincial authority to require municipalities to undertake complex and comprehensive longer-term planning systems followed by comprehensive zoning. U.S. municipalities have operated in a less centralized fashion and with more of a *laissez-faire* attitude to development, relying more heavily on restrictive zoning to meet the needs of their communities in response to the development demands.

In the end, there is little observable difference in the results of urban sprawl on either side of the border. Differences in the extent of inner city decay between Canadian and U.S. cities have more to do with factors such as the overall growth rate of the U.S. and Canadian populations over time and consequent relative maturity of their cities than with planning systems. Given current rates of urban sprawl in Ontario, 20 years of comprehensive municipal planning, does not appear to have made a difference in this regard. Urban sprawl continues virtually unabated on either side of the border.

5.4.2 Extending the Tool Kit

Tools and techniques are available to planners and decision makers throughout the basin to promote more sustainable development. This tool kit of planning instruments has evolved over time and it will need to continue evolving if we are to move toward a planning system that ensures more efficient and environmentally compatible communities. A more sustainable development over time will result in reduced pollution in the nearshore ecosystem, less stress caused by development on the rest of the ecosystem, and a greater sense of belonging and connection to one's community.

Making environmental protection a priority objective for urban development is critical. Current approaches that treat the environment as just another factor clearly have not been effective. Prohibitions against sprawl—where it is already creating environmental and social problems— would provide much needed breathing space and send clear messages to the development industry and the residential and commercial

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markets that it serves. Strong protection against farmland conversion, through agricultural land banking and the greater use of conservation easements, has not been embraced on either side of the Great Lakes. Removal of hidden financial and economic biases in favour of sprawl and against inner city redevelopment and more compact urban development, as well as the adoption of a full cost-pricing approach for different types of development, is especially important.

There is need for public education! The environmental and social impacts of suburban lifestyle are, obviously, not well understood and appreciated by the public. Education of the public by state and provincial agencies could help to reduce the demand for sprawl housing—for example, by undertaking a public education campaign to advertise the environmental, social, and long-term economic costs associated with sprawl. Banking and mortgage companies have an evolving role to play in demonstrating, through their commercial and residential lending policies, the importance, value, and relative benefits of longer-term sustainable development. In fact, developers and real estate agents, made aware of the effects of continued urban sprawl, could be perhaps the most appropriate agents of communication for this message.

Finally, if it is the economics of cheap agricultural land and subsidized municipal services that have made sprawl so popular, it will take economic disincentives to discourage even greater sprawl. Development charges and impact fees are perhaps the most powerful tool for bringing the real cost of sprawl into the market for homes and new industrial and commercial locations. That these fees are not applied evenly and universally across the basin is a factor that continues to favour sprawl.

Taxation rates that more closely reflected the higher annual municipal operating and maintenance costs associated with urban sprawl would dissuade potential buyers who examined the long-term costs of their investment. There is, perhaps, an emerging trend by some municipalities to impose user fees instead of general property taxation for specific services, such as the removal of solid waste. Fees for specific sprawl-related services such as roads and education, for example, would provide residents with clear economic signals. Road tolls would also provide incentives for greater use of environmentally friendly public transit.

5.4.3 The Challenge for the Future

Clearly, the United States and Canada face many common pressures related to growth and change in the Great Lakes basin. This is not surprising given the nature of the political, legislative, cultural, and economic factors that must be accommodated. Yet maintaining and restoring natural ecosystems, which do not respect political boundaries, in the face of the pressures of a continental and global economy, technological change, and continuing urban sprawl are issues that complicate the role of planners and land-use planning. The problems of urban sprawl have been evident for at least the last 20 years. And the fact that urban sprawl, a major stressor for the Great Lakes ecosystem, is continuing and perhaps even accelerating rather than slowing down is an important message for decision makers to consider in relation to planning systems across the border. This is true in spite of tools and techniques that are available to planners and decision makers to promote more sustainable development, which in turn will reduce both pollution in the nearshore ecosystem and stress caused by development on the rest of the ecosystem.

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