ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION IN URBAN AREAS

CLASSIFICATION ÉCOLOGIQUE (BIOPHYSIQUE) DU TERRITOIRE DANS LES RÉGIONS URBAINES

Ecological Land Classification Series, No. 3

Série de la classification écologique
du territoire, numéro 3

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Proceedings of a Workshop, Canada
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Compiled and Edited by
Compilé et Édité par
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encouragement; Mr. T. Pierce, Lands Directorate, organized the meeting; Mr. G. Ironside, Lands Directorate, edited the Proceedings; and finally, Ms. H. Guindon prepared the Workshop manuscripts.

à la mise en oeuvre de l'atelier: M. D. Crenna, Mme P. Archer et M. D. Noll de la Société centrale d'hypothèque et de logement ainsi que Dr. D. Welch et M. C. Rubec de la Direction générale des terres y ont contribué par leur critique constructive et leur encouragement; M. T. Pierce de la Direction générale des terres a organisé la réunion; M. G. Ironside de la Direction générale des terres a revu le compte rendu; et Mme H. Guindon a tapé les manuscrits de l'atelier.

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TABLE OF CONTENTS

TABLE DES MATIÈRES

* In this section, a paper entitled "Rural to urban land conversion" was presented at the meeting by D.M. Gierman. This paper will be published later under a separate cover.

* Dans cette section, un article entitulé "La conversion des terres rurales à terres urbaines" était présenté à la réunion par D.M. Gierman. Cet article sera publié plus tard sous une couverture séparée.

CONTENTS (CONT'D)

TABLE DES MATIÈRES (CONTINUÉE)

[1] En français

[2] Résumé en français

[3] Disponible seulement en anglais

OPENING REMARKS

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INTRODUCTION

On behalf of the Canada Committee on Ecological Land Classification and the Lands Directorate, I welcome you to this Workshop on Ecological Land Classification in Urban Areas. In these opening remarks, I will briefly describe the purpose of the workshop, review the topical interest in ecological land use planning, enumerate some Canadian experiences in this subject area, and suggest some of the requirements for ecologically sound planning in urban regions.

PURPOSE

The objective of the workshop is to promote the application of ecological concepts and environmental data in the urban and regional planning process. One way to do this is through the development of a more effective dialogue between environmental scientists and planners. Not only must physical and biological scientists appreciate and heed the information requirements and problems of planners, but planners must understand, and sympathize with, scientists' concerns. Both groups must share in the development of planning systems which apply environmental data. We hope that this workshop, through its presentations and discussions, and through the publication of the proceedings, will enhance this dialogue.

TOPICAL INTEREST

Recent Canadian interest in the ecological aspects of land use planning is exemplified by the recommendations of the *1973 Man and Resources Conference*, and the Canadian contribution to the United Nations Conference on Human Settlements (Habitat '76). Both the *Report of the Canadian National Committee for Habitat* and the report of the Canadian Habitat Secretariat, entitled *Human Settlement in Canada*, stress the importance of environmentally sound land use planning. As

ALLOCUTION D'OUVERTURE

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INTRODUCTION

Au nom du Comité canadien de la classification écologique du territoire et de la Direction générale des terres, je vous souhaite la bienvenue à l'atelier sur la classification écologique du territoire dans les zones urbaines. Je vais brièvement décrire le but de l'atelier, exposer le principal intérêt que présente la planification écologique de l'utilisation des terres, faire état de l'expérience canadienne dans ce domaine et proposer quelque-unes des exigences auxquelles doit satisfaire une planification écologiquement sûre des zones urbaines.

BUT

L'atelier a pour but de promouvoir l'application de concepts écologiques et de données environnementales au processus de planification urbaine et régionale. On peut y arriver par un dialogue plus efficace entre les spécialistes de l'environnement et les planificateurs. Les spécialistes dans les domaines de la physique et de la biologie doivent être conscients et tenir compte des besoins en renseignements et des problèmes des planificateurs; à leur tour, ceux-ci doivent comprendre et partager les préoccupations des spécialistes. Les deux groupes doivent collaborer à la mise au point de méthodes de planification qui permettent d'appliquer les données environnementales. Nous espérons que, grâce aux présentations et aux échanges de vues auxquels il donnera lieu et à la publication du compte rendu qui en sera fait, cet atelier favorisera le dialogue.

PRINCIPAL INTÉRÊT

L'intérêt récemment suscité au Canada par les aspects écologiques de l'utilisation des terres se reflète dans les recommandations de la *Conférence de 1973 sur l'homme et les ressources* et dans la contribution canadienne à la Conférence des Nations-Unies sur les établissements humains (Habitat '76). En outre, le *rapport du Comité national canadien de l'habitat* et le rapport du Secrétariat canadien de l'habitat, intitulé *"Les établissements humains du Canada"*, insistent tous deux sur l'importance d'une a consequence of the interest expressed by the Canadian and other national delegations to 'Habitat', the Conference Recommendations make many references to the importance of considering ecological factors in planning development and land use.

These conferences, and other national and regional meetings in Canada have generated numerous recommendations that are pertinent to urban, regional and resource planning and development. The recommendations stress a number of factors of interest in this workshop, including:

- the need to preserve prime agricultural land to meet the food requirements of future generations and to minimize the requirements for energy, fertilizer, and other scarce inputs to the food production;
- the need to recognize and consider the inherent capabilities and constraints of the land resource in development planning;
- the need to extend and up-grade the Canada Land Inventory through 'second generation' land capability and land use inventories;
- the need to address special land use issues such as: recreation and open space needs, shoreline access, landscape aesthetics, the maintenance of unique and fragile ecosystems, and land despoliation and rehabilitation.

In general, the many recommendations reflect a growing awareness of the need for a holistic ecological approach to city and regional planning and resource development, an approach that can maintain an organized and balanced living space, free from hazards and deleterious effects -- whether man-made or natural.

CANADIAN EXPERIENCE

This country has built a considerable body of experience in the development and application of ecological information in planning processes. However, much of this experience relates

planification de l'utilisation des terres sûre au point de vue de l'environnement. En raison de l'intérêt manifesté par la délégation canadienne et par les autres délégations nationales à la Conférence Habitat, les recommandations de la Conférence ont souvent fait allusion à la nécessité de tenir compte des facteurs écologiques lors de la planification des aménagements et des utilisations des terres.

Ces conférences, ainsi que d'autres réunions nationales au Canada, ont été à l'origine de nombreuses recommandations ayant trait à la planification et à l'aménagement urbains et régionaux et à la planification et à la mise en valeur des ressources. Les recommandations soulignent un certain nombre de facteurs qui nous intéressent, dont les suivants:

- la nécessité de préserver les terres agricoles de premier choix afin de répondre aux besoins en denrées des générations futures et de minimiser les besoins en matière d'énergie, de fertilisants et d'autres produits rares qui sont injectés dans les systèmes de production alimentaire;
- la nécessité de reconnaître et de prendre en considération les possibilités et les contraintes inhérentes aux terres lors de la planification de leur aménagement;
- la nécessité d'étendre et d'améliorer l'Inventaire des terres du Canada par une deuxième série d'inventaires des possibilités et des utilisations des terres;
- la nécessité de s'attaquer à des aspects précis de l'utilisation des terres, comme les besoins en aires de loisirs et en espaces libres, l'accès au littoral, l'esthétique paysagère, la conservation des écosystèmes uniques et fragiles, la surexploitation des ressources et l'assainissement des terres.

Dans l'ensemble, les nombreuses recommandations reflètent une sensibilisation croissante à la nécessité d'une méthode écologique globale de planification urbaine et régionale et de mise en valeur des ressources; une méthode qui puisse maintenir un milieu de vie organisé et équilibré, sans danger ni effet nuisible, ni artificiel, ni naturel.

L'EXPÉRIENCE CANADIENNE

Le Canada a acquis une expérience considérable dans le domaine de l'acquisition des données écologiques et dans l'application de celles-ci aux processus de planification. Toutefois, une to rural planning and development. Some of the earliest work in the field was initiated in the 1930s under the Prairie Farm Rehabilitation Act as part of a national response to the disastrous drought conditions on the Prairies. This work, which included an assessment of land capability for grain production, was a forerunner to the Canada Land Inventory (CLI), a nation-wide inventory initiated in 1963 as a cooperative federal-provincial program under the Agricultural Rehabilitation and Development Act of 1961. The CLI is now nearing completion. It has produced reconnaissance-level data on land capability for agricultural, forestry, wildlife, and recreational uses for approximately one million square miles within 'settled Canada'. In addition, the Program has provided a 'one-shot' coverage of land use in the CLI area, has developed a computerized land resource information system (the Canada Geographic Information System), has supported pilot land use planning studies in each province, and has sponsored research, development and evaluation activity for systems of ecological (biophysical) land classification in rural and wilderness areas. The information and systems provided by the CLI have been and are being, used extensively by public and private agencies in land use planning and in environmental impact assessment studies. The use has been so extensive that the CLI classification systems have become 'institutionalized", and are frequently referred to in political and mass-media commentaries on land resources and their uses.

In addition to the CLI, recent years have seen an increasing number of special land inventories being undertaken as part of major resource-development-oriented environmental study programs. Prime examples are the ecological land inventories and assessments conducted under the environmental study programs in the James Bay Region, in the Mackenzie Valley, and in other wilderness areas. The land inventory in the James Bay Region, for example, is providing a systematic ecological land classification and mapping for a 350,000 square kilometer area. The maps being produced integrate data on geomorphology, water bodies, soils and vegetation. This activity is part of a cooperative Canada-Quebec program producing data on climate, wildlife, water quality and quantity, land quality and capability, oceanography and archaeology. The data are being prepared to ensure adequate environmental design in the Region's hydro-power developments. They are also serving as a uniform data base for land use planning by the James Bay Development Corporation.

grande partie de cette expérience a trait à la planification et à l'aménagement en milieu rural. Quelques-uns des premiers travaux dans ce domaine remontent à 1930; ils étaient exécutés en vertu de la Loi sur le rétablissement agricole des Prairies, dans le cadre de la réaction nationale aux désastreuses conditions de sécheresse dans les Prairies. Ce travail, qui comportait une évaluation des possibilités des terres pour la production de grains, était le précursseur de l'Inventaire des terres du Canada, inventaire national lancé en 1963 en tant que programme coopératif fédéral-provincial en vertu de la Loi sur la remise en valeur et l'aménagement des terres agricoles de 1961. L'ITC touche maintenant presque à sa fin. On en a tiré des données de niveau de reconnaissance sur les possibilités des terres pour l'agriculture, les forêts, la faune et les loisirs pour une superficie d'environ un million de milles carrés à l'intérieur du 'Canada urbanisé'. De plus, le Programme a couvert d'un seul coup toutes les utilisations des terres dans le secteur touché par l'Inventaire des terres du Canada; il a permis la mise au point d'un système de renseignements informatisé sur les terres -- le Système d'information géographique du Canada; il a servi a appuyer des études-pilotes de planification de l'utilisation des terres dans chaque province, et il a fourni un cadre à des travaux de recherche, de mise au point et d'évaluation portant sur des méthodes de classification écologique (biophysique) du territoire dans les régions rurales et sauvages. Les renseignements et les systèmes fournis par l'ITC ont été et sont encore beaucoup utilisés par les organismes privés et publics qui s'occupent de planification de l'utilisation des terres et d'études d'évaluation des répercussions sur l'environnement. On les a tellement utilisés que les systèmes de classification mis au point par l'ITC sont maintenant 'institutionnalisés' et sont souvent cités dans les observations politiques et par les médias quand il est question des terres et de leur utilisation.

Outre l'ITC, de plus en plus d'inventaires spéciaux des terres ont été faits ces dernières années aux fins d'importants programmes d'études environnementales axées sur la mise en valeur des ressources. Les principaux exemples en sont les inventaires et les évaluations écologiques des terres, effectués dans le cadre des programmes d'études environnementales dans la région de la baie James, dans la vallée du Mackenzie et dans d'autres régions sauvages. L'inventaire des terres dans la région de la baie James, par exemple, permet de classer et de cartographier systématiquement les terres d'une région de 350,000 kilomètres carrées au

Similar studies have been undertaken in the Mackenzie Valley in response to northern pipeline proposals. Included were investigations of geology, geomorphology, permafrost, hydrology, vegetation, fish and wildlife, archaeology and the socioeconomic circumstances of local populations. One project involved the production of land use information maps based on all available data on resource characteristics, critical environmental areas, and land use. These maps, in addition to providing a basis for decisions on land use permits issued under the territorial land use regulations, are providing an important base for land use and development planning in the North.

The examples cited so far pertain to rural and wilderness areas. However, there are also examples from 'urban Canada' where an 'environmental view' has been explicitly incorporated in urban planning processes. In New Brunswick, for example, the Greater Moncton Metropolitan Plan shows how land can be used to create a desirable physical environment, with a maximum of economy and an adequacy of community facilities. The Plan was devised by using data on variables such as drainage basins, geology, climate, soils, land capability, areas of ecological significance, population density and dwelling types.

In the Ottawa-Hull urban region, the urban fringe lands of the National Capital Commission located in Nepean and Gloucester townships have been mapped at the 1:25,000 scale using an ecological land classification method similar to that applied in the James Bay Study. The land units, based mainly on landforms and soils, have been assessed for land capability using procedures akin to those of the Canada Land Inventory. This data base is useful in planning for housing, playgrounds, effluent disposal, roads, etc. These applications have been enhanced by the storage of the data base in a computer retrieval system that enables rapid recall and manipulation of the data.

Elsewhere in urban Canada, major efforts are being made to incorporate environmental data and considerations in urban planning, for example, in Halifax-Dartmouth, Winnipeg, Calgary, Edmonton, Montreal and Kitchener-Waterloo. New approaches are being tried, sometimes backed by innovative legislation, as in British Columbia under the B.C. Land Commission Act. This Act provides for the preservation of agricultural land greenbelts, parks and land bank operations.

Although there are a few examples of a long-standing interest and experience in considering environmental factors in planning at the

point de vue écologique. Les cartes ainsi produites comportent des données sur la géomorphologie, les étendues d'eau, les sols et la végétation. Ces travaux font partie d'un programme coopératif canado-québécois qui fournit des données sur le climat, la faune, la qualité et la quantité de l'eau, la qualité et les possibilités des terres, l'océanographie et l'archéologie. On établit ces données afin d'assurer une conception environnementale appropriée des aménagements hydroélectriques de la région. Elles servent également de base de données uniforme pour la planification de l'utilisation des terres par la Société de développement de la baie James.

En réponse aux projets de pipeline dans le Nord, on a effectué des études semblables dans la vallée du Mackenzie. Ces études comportaient des recherches sur la géologie, la géomorphologie, le pergélisol, l'hydrologie, la végétation, la faune terrestre et aquatique, l'archéologie et les conditions socioéconomiques des populations locales. L'un des programmes comportait la production de cartes de renseignements sur l'utilisation des terres, établies à partir de toutes les données disponibles sur les caractéristiques des ressources, les régions écologiques fragiles et l'utilisation des terres. En plus de servir de fondement aux décisions relatives aux permis d'utilisation des terres émis en vertu du règlement sur l'utilisation des terres territoriales, ces cartes sont une composante importante de la planification de l'utilisation et de l'aménagement des terres dans le Nord.

Les exemples donnés jusqu'ici ont trait aux régions sauvages et rurales. Il y a cependant des cas dans le 'Canada urbain', où l'on a explicitement intégré un 'point de vue environnemental' dans les processus de planification urbaine. Au Nouveau-Brunswick par exemple, le *Greater Moncton Metropolitan Plan* montre comment on peut utiliser les terres pour créer un environnement physique souhaitable, tout en faisant le plus d'économies possible et en s'assurant les installations communautaires appropriées. On a conçu le Plan en se servant de données sur des variables comme les bassins de drainage, la géologie, le climat, les sols, les possibilités des terres, les zones importantes sur le plan écologique, la densité de la population et les types d'habitation.

Dans la zone urbaine d'Ottawa-Hull, on a cartographié les terres périphériques appartenant à la Commission de la capitale nationale, dans les cantons de Nepean et Gloucester, à une échelle de 1:25,000, selon une méthode de classification écologique des terres semblable à celle que l'on a utilisée lors de l'étude sur la baie James. Les parcelles délimitées principalement selon le relief et les sols, ont été analysées afin d'en déterminer les possibilités.

urban region level, much of the current activity reflects relatively recent interest. There is much to be learned and much to be gained through information exchange and experience-sharing.

REQUIREMENTS

The examples of past and on-going ecological land classification, and evaluation, as reported to the Canada Committee on Ecological Land Classification, have demonstrated the utility of this approach to the collection and application of environmental data in land use and development planning. However, more work is required to 'fine-tune' the approach for meeting planning requirements in urban regions. More detailed information, mapped at larger scales, is required. The data base should be both more comprehensive and specific than is normally provided in ecological land classification. It should also incorporate data on such variables as aquatic resources and risks, sewage disposal capability and geotechnics. Most important, land classification and evaluation programs in urban regions should be conducted as cooperative enterprises of scientists and planners. Data products should be both phased and tailored to the planning requirements of individual urban regions and their constituent parts.

Pour ce faire, on a fait appel à des méthodes semblables à celles qui ont servi lors de l'Inventaire des terres du Canada. Cette base de données est utile pour la planification du logement, des terrains de jeux, des systèmes d'évacuation des effluents, des routes, etc. Ces applications ont été favorisées par le stockage de la base de données dans un système informatique qui permet de rappeler et de manipuler rapidement les données.

Dans les autres zones urbaines du pays, on tente par tous les moyens d'intégrer les données et considérations environnementales à la planification urbaine, par exemple à Halifax-Dartmouth, Winnipeg, Calgary, Edmonton, Montréal et Kitchener-Waterloo. On essaie de nouvelles méthodes qui sont souvent appuyées par des lois innovatrices, comme la *B.C. Land Commission Act*. Cette loi prévoit la préservation des terres agricoles, des ceintures de verdure, des parcs et régit les opérations des banques de terrains.

Quelques cas illustrent un intérêt et une expérience de longue date pour ce qui est de la prise en compte des facteurs environnementaux dans la planification des zones urbaines; l'ensemble des travaux actuels reflètent toutefois un intérêt relativement récent. Il y a beaucoup à apprendre et à gagner des échanges de renseignements et du partage des expériences.

EXIGENCES

Les exemples de classification et d'évaluation écologiques des terres, passées ou actuelles, donnés par le Comité canadien de la classification écologique du territoire, prouvent l'utilité de cette méthode sur le plan de la collecte et de l'application des données environnementales à la planification de l'utilisation et de l'aménagement des terres. Il y a cependant encore beaucoup de travail à faire pour bien arrêter la méthode qui réponde aux exigences de la planification dans les zones urbaines. On a besoin de renseignements plus détaillés à plus grande échelle. La base de données devrait être plus exhaustive et plus précise que celle qui est normalement utilisée dans la classification écologique du territoire. Elle devrait également comporter des données sur des variables dans le cas des ressources aquatiques et des risques, des possibilités d'évacuation des eaux usées et de la géotechnique. Et, point des plus importants, les programmes de classification et d'évaluation des terres dans les zones urbaines devraient être des

CONCLUSIONS

The foregoing has been a very incomplete resumé of ecological planning in Canada. Perhaps the most significant aspect to reiterate is the very rapid growth of both public and professional interest in the subject. The fact that we have so many participants at this workshop indicates a wide-ranging professional interest in the topic. I hope that these two days will sustain and broaden your interest. Finally, on behalf of us all, I wish to thank the Workshop Chairman for his efforts in organizing this meeting. Have a productive session.

entreprises coopératives dirigées par des spécialistes et des planificateurs. Les résultats des données devraient être adaptés aux exigences en matière de planification des zones urbaines et de leurs éléments constituants.

CONCLUSIONS

C'est là un résumé très incomplet de la planification écologique au Canada. L'aspect le plus important, qu'il est bon de souligner à nouveau, est peut-être la croissance très rapide de l'intérêt manifesté par les secteurs privé et professionnel à ce sujet. Le grand nombre de participants à l'atelier indique un intérêt professionnel considérable dans ce domaine. J'espère que ces deux journées maintiendront et élargiront votre intérêt. En dernier lieu, en notre nom à tous, je voudrais remercier le président de l'atelier pour les efforts qu'il a déployés pour organiser cette réunion. Je souhaite que cette séance soit des plus fécondes.

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LAND CONVERSION AND ENVIRONMENTAL PROGRAMS

PROGRAMMES ENVIRONNEMENTAUX ET CONVERSION DES TERRES

A CANADIAN OVERVIEW OF ENVIRONMENTAL PROGRAMS IN URBAN AREAS

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INTRODUCTION

This paper provides an overview of environmental programs concerning urban areas across Canada. Examples of urban environmental programs at municipal, regional, provincial and federal levels of government are given.

MUNICIPAL GOVERNMENT

Winnipeg - Winnipeg was the first Canadian municipality to adopt a formal requirement for an Environmental Impact Assessment of public projects. The City of Winnipeg Act, a set of guidelines for the preparation of environmental impact reviews, was prepared in May 1974 using a seven-stage review process. The environmental impact reviews contain an environmental inventory which includes physical, social, demographic, economic and cultural components. Potential impacts of a proposed work on the quality of the human environment are also considered. Impact studies undertaken since 1974 have included bridges and approach roadways, road extensions, overpasses, and parking structures. However, the adequacy of the environmental review process has not been evaluated.

In March 1976, the Manitoba Government announced that a tri-level technical advisory committee, chaired by the City of Winnipeg, will coordinate the formulation of a comprehensive strategy for the growth and development of Winnipeg. Subject areas to be included in this strategy are housing and land use, growth alternatives, transportation studies, industrial and commercial analyses, the availability of parks, and economic and demographic studies.

REGIONAL GOVERNMENTS

Regional Municipality of Waterloo - This is one of 11 regional municipalities established by Ontario under the *Design for Development* program. It reviews all planning proposals and development controls of the seven area municipalities within its jurisdiction. In 1975, the Council of the Regional Municipality of Waterloo adopted an Official Policies Plan which includes policies to protect *Environmentally Sensitive Areas* and the use of environmental impact studies related to these areas. Seventy Environmentally Sensitive Areas were designated, mainly in urban fringe areas and a few within urban areas. Designation was intended to maintain the natural features to a maximum possible extent. Criteria used in the designation included diversity, extensiveness, ability of the area to accommodate unusual and/or great varieties of wildlife, uniqueness to the Region, indicator species (species whose presence in a system indicate that the system is healthy and therefore satisfies the more demanding habitat requirements of some flora and fauna), hydrological value, location, and educational or aesthetic value and potential.

The Waterloo impact studies are patterned after Ontario's Environmental Assessment Act. However, the effectiveness of Regional Waterloo's actions within the Ontario environmental context has yet to be tested; the legality of the Region's use of impact assessment is being challenged by area municipalities.

Greater Vancouver Regional District (GVRD) - The GVRD's Livable Region Program is an attempt to determine the future population of the region based on the residents' visualization of a *livable region*. A growth of 25% (500,000 people) is projected for the GVRD between 1976 and 1986. A modification of the holding capacity approach is being used in which lower limits are being sought both ecologically and through public dialogue. The Livable Region Program was designed to slow down the population growth rate and simultaneously properly manage and control the region's development. Topics considered in establishing the Official Region Plan included population distribution in GVRD municipalities, housing, transportation, recreation and environment. The environmental objectives considered in establishing the Plan include:

- preserving as much open space, foreshore lands, and farmland as possible;
- controlling all forms of pollution; and

- designing and producing compact residential accommodation.

The official Region Plan sets out adopted objectives and policies to guide urban, rural, industrial and recreation developments in the GVRD.

PROVINCIAL HIGHLIGHTS

British Columbia - Between 1953 and 1973, an estimated 9,750 acres (3,900 ha) of farmland were lost to urban development annually. Most of this land loss occurred in the lower Fraser Valley and the Okanagan Valley, areas of prime agricultural capability. The Land Commission Act was passed in 1973, primarily to inhibit urban sprawl and to protect agricultural lands. It provides for the preservation of four types of land - agricultural, greenbelt, landbank, and parkland.

Details as to the use of biophysical information by the B.C. Land Commission are presented by Runka (these Proceedings).

Alberta - Alberta is experiencing rapid metropolitan growth. In 1973, the province adopted a policy of decentralization to encourage the growth of smaller centres by offering local incentives to industries, lower rates on home mortgages and improved amenities. An energy corridor is planned between Fort McMurray and Hardisty, east of Edmonton.

The provincial government aims to attract people to eastern Alberta and to stabilize the population of numerous small communities. This energy corridor would disperse the petroleum industry and thus avoid serious environmental consequences in metro Edmonton related to dense pockets of odorous compounds in the atmosphere. In Calgary, the provincial government has placed a five mile wide greenbelt land freeze around the city. This 343 mi^2 (892 km^2) greenbelt was instituted by the province to ensure that no suburban satellite communities are constructed unless they meet provincial environmental standards. Such standards include establishing Restricted Development Areas under the Department of the Environment Act. These Areas, when established in urban settings, help to limit residential, industrial or commercial expansion. In Calgary, such a Restricted Development Area is used as an urban park. In Edmonton, a nine mile long Restricted Development Area acts as a buffer zone between the industry of Edmonton and the homes of Sherwood Park.

The Alberta Government is considering changing the tax status of large acreages in Edmonton and Calgary which are assessed and taxed as farmland. This land was given preferred status since it was farmed commercially when the cities expanded through annexation. In Edmonton, for example, the city collects about $40,000 in property taxes on 13,000 acres (5,200 ha) of land assessed as agricultural land. The same land assessed as urban would yield an estimated $3.6 million. Also, this land is not being intensively farmed but is being held for development.

The Edmonton Regional Planning Commission aims to establish a development pattern and thus preserve extensive areas from urban encroachment. These areas would be maintained as natural open space to protect the environmental qualities of the Region. In July 1976, the Commission issued a draft discussion paper entitled *Conserving Our Resources*. One section dealt with regional growth strategies and the effects on wildlife related to urban form. The preservation or enhancement of wildlife habitats within urban areas was also considered, and it was generally concluded that lower density communities offer more opportunities for wildlife to coexist with urban development. Since land values are generally lower in smaller communities, land purchases for habitat conservation purposes will likely focus within these smaller centres. This is in direct support of the Alberta Government's policy to balance growth throughout the province and ensure the vitality of smaller urban centres.

Saskatchewan - As with Alberta, a policy of the Saskatchewan Government is to stabilize the growth of small towns and rural areas. The Urban and Rural Planning and Development Act provides for development control and land use planning in urban areas. Related to urbanization and the growth of urban uses, natural resources such as lakes, rivers, forests and agricultural lands are protected and conserved. The landscape and natural beauty of an area are preserved.

In February 1976, the Saskatchewan Government held a land use workshop to consider the need for a provincial land use policy. Such a policy will develop over the next several years and will be a framework for land use decision-making. It is an aim of the Government to resolve conflicts between urban and urban fringe developments and agriculture, recreation, and wildlife uses.

Nova Scotia - An example of the relationship between environmental planning and urban development in Nova Scotia is the Sackville Lakes Land Assembly which is an 1,800 acre (720 ha) site located 13 mi (21 km) from metropolitan Halifax-Dartmouth. This planned community began in 1976 on virtually untouched lake and forest land. Environmental planning in this project included a reservation of 15% of the area for open space which will be used as public park land. A greenbelt, which borders the shores of two lakes within the project, plus numerous treed areas buffer many homes from the road networks.

The Sackville Lakes Land Assembly has led to the establishment of six land assemblies in the Halifax-Dartmouth area, plus others in Cape Breton and Yarmouth.

Newfoundland - The 1973 Saint John's Urban Region Plan is a statement of policies to guide development in the region. Municipal plans are prepared by local councils, following guidelines in the regional plan. Also begun in 1973 was a ban on the development of agricultural land within the Saint John's Urban Region. Agricultural land use control was accomplished through the designation of land development areas, in effect a land freeze. Any buildings constructed within a land development area must be associated with agriculture or be part of an infilling of an urbanized area.

FEDERAL GOVERNMENT

At the 39th Annual Meeting of the Canadian Federation of Mayors and Municipalities held in Vancouver (June 1976), Mr. Danson, then Minister of Ministry of State for Urban Affairs (MSUA), stated that an objective of the Federal Government is to equalize urban growth across Canada and thereby reduce land costs and urban sprawl. Such an equalization of urban growth would help ease the pressures on Montreal, Toronto, and Vancouver. Mr. Danson also stated that MSUA has an increasing interest in municipal governments related to altering the pattern of urban growth across Canada. However, since municipalities are creatures of the provinces and since not all the provinces wish to discuss a Canadian urban policy at a national tri-level conference, the development of a national urban policy will be difficult. An ideal urban policy would include such factors as transportation, housing, environment and employment.

The Federal Government exercises little direct control of land (other than by expropriation) except on those Crown lands to which it holds title, largely in the Territories, in National Parks, and in the National Capital Region. Elsewhere, the control of land and its use rests with the provinces and through them with municipalities. Nevertheless, the Federal Government is a major landowner in urban Canada, occupying approximately 210,000 acres (84,000 ha) in metropolitan areas (37% of which is in Ottawa-Hull). Included in federal holdings are 43 mi^2 (112 km^2) in the metropolitan cores. The government is committed to a policy of federal urban land management that will contribute to overall urban objectives, such as the improvement of the environment in core areas of cities.

The Federal Government has a responsibility to establish and attempt to achieve national goals and priorities. National goals articulated in past Speeches from the Throne include economic growth, regional balance, proper use and conservation of natural resources, and an adequate standard of living for all Canadians. In seeking to attain these general goals, certain priorities have been established by the Federal Government. These include specific actions such as attempting to control the inflationary spiral, regional development programs, improving foreign trade, and initiatives in energy, transportation and demographic policies.

CONCLUSIONS

The major human settlement issues for Canada in the future will continue to be profoundly influenced by the size, rate of growth, and distribution of population. Improvements in the urban environment should focus on reducing wasteful land use patterns that have typified much of Canada's residential development over the past 30 years. Improvements would include *infill* housing in built-up urban areas, an emphasis on low-rise multiple unit buildings, and more modest land and service requirements for single detached houses. Concerns have been expressed regarding the threat of settlements to Canada's best agricultural land, to recreation and wildlife resources, and the overcrowding of major metropolitan centres.

The emphasis appears to be shifting from land as a *commodity* to land as a *natural resource*. Several provinces are considering the need to establish provincial land use policies of which urban environmental policies will form a major part. The need for a federal land use policy has also been expressed. With this general provincial interest in land use and a specific focus on orderly urban development, there is a wide scope for research in the field of urban ecological planning. Papers contained in these Proceedings should provide an insight into the types of research which would be most beneficial in this urban ecological planning field.

APERÇU GÉNÉRAL DES PROGRAMMES ENVIRONNEMENTAUX DANS LES ZONES URBAINES DU CANADA

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INTRODUCTION

Le présent document donne un aperçu général des programmes environnementaux pour les zones urbaines dans l'ensemble du Canada. On y trouve des exemples de programmes environnementaux en milieu urbain réalisés à l'échelle municipale, régionale, provinciale et fédérale.

AUTORITÉS MUNICIPALES

Winnipeg - Winnipeg est la première ville canadienne à avoir adopté une résolution officielle prévoyant l'évaluation des impacts environnementaux des projets publics. C'est ainsi que la Loi sur la municipalité de Winnipeg (City of Winnipeg Act) (lignes directrices pour l'élaboration des révisions des impacts environnementaux qui ont vu le jour, au mois de mai 1974), prévoient un processus de révision en sept étapes distinctes. Les révisions des impacts environnementaux font l'inventaire des facteurs environnementaux c'est-à-dire physiques, sociaux, démographiques, économiques et culturels. On y examine également les répercussions que pourraient avoir les travaux proposés sur la qualité de l'environnement humain. Les études des impacts environnementaux réalisées depuis 1974 ont notamment porté sur les ponts, les voies d'accès, les prolongements de routes, les viaducs et les parcs de stationnement. Le pertinence du processus de révision environnementale utilisé n'a toutefois pas fait l'objet d'une évaluation.

En mars 1976, le gouvernement du Manitoba a annoncé qu'un comité consultatif technique tripartite, présidé par la ville de Winnipeg, coordonnerait l'élaboration d'un plan global de croissance et d'aménagement de Winnipeg. Le plan concerne notamment l'habitation, l'utilisation des terres, les diverses possibilités d'expansion, les transports, l'aménagement de parcs ainsi que des études économiques et démographiques.

AUTORITÉS RÉGIONALES

La municipalité régionale de Waterloo - Cette municipalité fait partie des 11 municipalités régionales établies par l'Ontario au titre du programme de *conception d'aménagement*. Il incombe à Waterloo de réviser les projets de planification et les mesures de contrôle de l'aménagement des sept municipalités locales qui en relèvent. En 1975, le Conseil de la municipalité régionale de Waterloo a adopté un projet officiel de politiques comportant, entre autres, des politiques destinées à protéger les *secteurs environnementaux menacés* et à surveiller l'utilisation qui est faite des études sur les impacts environnementaux ayant trait à ces secteurs. On a identifié soixante-dix secteurs menacés, la plupart en périphérie des centres urbains et quelques-uns à l'intérieur même des zones urbaines. Ces secteurs ont été désignés en vue de conserver le plus possible les paysages naturels. La désignation s'est faite en fonction de critères tels que la diversité, l'espace, la faculté d'accomodation de la zone à la présence d'animaux inhabituels ou à une grande variété d'espèces, le caractère unique de l'élément dans la région, la présence d'espèces indicatrices (espèces dont la présence dans un système indique que le système se porte bien et peut ainsi répondre aux pressions accrues exercées sur l'habitat de la flore ou de la faune), la valeur hydrologique, l'emplacement, et enfin la valeur et le potentiel éducatif et esthétique.

Les études des impacts environnementaux réalisées par la ville de Waterloo s'inspirent de la loi sur les évaluations environnementales de l'Ontario. Cependant, l'efficacité des mesures prises par la municipalité régionale de Waterloo dans le contexte environnemental de l'Ontario reste encore à vérifier; certaines municipalités locales mettent en doute la légalité de l'utilisation par la municipalité régionale du processus d'évaluation des impacts.

District régional du Vancouver métropolitain - Le programme régional de qualité de la vie mis en oeuvre dans le district régional du Vancouver métropolitain vise à déterminer l'accroissement de la population qui habitera la région dans l'avenir en fonction de l'idée que les résidents actuels se font d'une région où il fait *bon vivre*. Selon les prévisions, la population s'accroîtra de 25 pour cent (500,000 personnes) entre 1976 et 1986. On entend modifier la capacité d'accueil en vertu de laquelle on s'efforce de déterminer une limite inférieure par l'étude de l'écologie et par l'engagement d'un dialogue ouvert avec le public sur la question. Le Programme régional de qualité de la vie a été mis en oeuvre en vue de freiner le taux de croissance démographique et, du coup, d'assurer la gestion et le contrôle efficaces de l'aménagement régional. Au nombre des facteurs examinés au moment de mettre au point le plan régional officiel, notons la répartition de la population dans les municipalités faisant partie du district régional du Vancouver métropolitain, le logement, les transports, les loisirs et l'environnement. Les objectifs environnementaux examinés lors de l'élaboration du Plan sont les suivants:

- préserver le plus possible les espaces libres, les terres riveraines et les terres agricoles;
- lutter contre toute forme de pollution; et
- concevoir et bâtir des habitations résidentielles groupées.

Le Plan régional officiel énonce les objectifs et les politiques qui ont été adoptées pour guider le développement urbain, rural et industriel ainsi que l'aménagement de terrains récréatifs dans le district régional du Vancouver métropolitain.

FAITS SAILLANTS À L'ÉCHELLE PROVINCIALE

Colombie-britannique - Entre 1953 et 1973, on estime qu'environ 9,750 acres (3,900 hectares) de terres agricoles ont été perdues chaque année au profit de l'expansion urbaine. Cela s'est surtout produit dans la vallée du cours inférieur du Fraser et dans la vallée de l'Okanagan, région agricole très fertile. L'adoption de la *Land Commission Act*, en 1973, avait principalement pour but de freiner l'expansion anarchique des villes et de protéger les terres agricoles. Elle prévoit notamment la préservation de quatre types de terres: les terres agricoles, les ceintures de verdure, les réserves foncières et les espaces réservées aux parcs. M. Runka (présent compte-rendu) donne tous les détails précisant de quelle façon la *B.C. Land Commission* a utilisé les données biophysiques recueillies.

Alberta - La croissance métropolitaine en Alberta est particulièrement rapide. En 1973, la province a adopté une politique de décentralisation destinée à favoriser le développement de petits centres par l'offre de primes d'encouragement aux industries et de taux hypothécaires inférieurs et par l'amélioration des commodités offertes. On projette par ailleurs la construction d'un corridor d'exploitation pétrolière entre Fort McMurray et Hardisty, à l'est d'Edmonton.

Le gouvernement provincial entend encourager les gens à venir s'installer dans l'est de l'Alberta et stabiliser la population de nombreuses petites collectivités. Le corridor d'exploitation permettrait de disperser l'industrie pétrolière et d'éviter de la sorte à l'environnement de la région métropolitaine d'Edmonton les graves répercussions qui résulteraient de la présence dans l'atmosphère de poches denses de matières odorantes. À Calgary, le gouvernement provincial a aménagé une ceinture de verdure de cinq milles (huit km) de largeur tout autour de la ville. D'une superficie de 343 mi^2 (892 km^2), la ceinture de verdure vise à assurer qu'aucune banlieue satellite ne sera érigée à moins qu'elle ne réponde aux normes environnementales de la province. Ces normes prévoient entre autres l'établissement de zones interdites à l'aménagement en vertu de la Loi sur le ministère de l'Environnement. De telles zones aménagées en milieu urbain aident à freiner l'expansion résidentielle, industrielle ou commerciale. À Calgary, une zone semblable a été aménagée en parc urbain. À Edmonton, une zone interdit à l'aménagement s'étend sur 9 milles (14 km) de longeur et sert en quelque sorte de zone tampon entre le quartier industriel d'Edmonton et les habitations de Sherwood Park.

Le gouvernement de l'Alberta examine actuellement la possibilité de modifier le régime d'imposition de larges étendues de terrain qui sont évaluées et imposées à titre de terre agricole. Ce type de terre a bénéficié d'un statut privilégié, étant donné qu'il s'agissait de terres agricoles exploitées à des fins commerciales au moment de l'expansion et de l'annexion des villes. Ainsi, à Edmonton, la ville recueille environ $40,000 sous forme d'impôts fonciers pour 13,000 acres (5,200 hectares) de terrain évalué au titre de terre agricole. Or, ces mêmes terrains évalués comme faisant partie du territoire urbain rapporteraient quelque 3.6 millions de dollars. De plus, ils ne font pas l'objet d'une exploitation agricole intensive, mais sont plutôt destinés à l'aménagement.

La Commission de planification régionale d'Edmonton projette de mettre au point un plan d'aménagement et de soustraire ainsi de vastes étendues de terrain à d'envahissement des villes. Ces zones seraient conservées comme des espaces naturels libres, afin de préserver la qualité de l'environnement dans cette région. En juillet 1976, la Commission a publié l'ébauche d'un document de travail intitulé *Conserving our resources* (Protégeons nos ressources). Une partie du document traite des politiques de croissance régionale et des effets de l'urbanisation sur la faune. On y examine également la conservation ou la mise en valeur des habitats de la faune à l'intérieur même des centres urbains et on en arrive en général à la conclusion que les collectivités de faible densité permettent davantage à la faune et à la ville de coexister. Étant donné que la valeur des terres est généralement moins élevée dans les petits localités, il est fort probable que l'on se tournera vers ces petits centres pour y faire l'acquisition de terres destinées à la conservation d'habitats. Cela s'inscrit directement à l'appui de la politique mise de l'avant par le gouvernement de l'Alberta qui vise à équilibrer le niveau de croissance dans l'ensemble de la province et à assurer la vitalité des centres urbains de dimensions modestes.

Saskatchewan - Comme c'est le cas en Alberta, le gouvernement de la Saskatchewan a entre autres comme politique de stabiliser la croissance des petites villes et des régions rurales. L'*Urban Planning and Development Act* prévoit le contrôle de l'aménagement et la planification de l'utilisation des terres dans les zones urbaines. Liées à l'urbanisation et à la croissance des besoins des milieux urbains, les ressources naturelles telles que les lacs, les rivières, les forêts et les terres agricoles sont protégées et conservées. On veille par ailleurs à préserver le paysage et les beautés naturelles d'une région.

En février 1976, le gouvernement de la Saskatchewan a organisé un atelier sur l'utilisation des terres afin d'examiner la nécessité de mettre au point une politique provinciale d'utilisation des terres. Cette politique se précisera au cours des prochaines années et servira de base aux décisions qui seront prises à cet égard. Le gouvernement projette par ailleurs de régler les conflits qui existent entre les projets d'aménagement des centres urbains et de leur périphérie et l'utilisation des terres à des fins agricoles et récréatives et comme habitat de la faune.

Nouvelle-Écosse - L'aménagement de terrain de Sackville Lakes en Nouvelle-Ecosse, qui occupe 1,800 acres (720 hectares) à 13 milles (21 km) de la région métropolitaine d'Halifax-Dartmouth, est un bel exemple du rapport qui existe entre la planification environnementale et l'aménagement urbain. La réalisation de ce projet d'établissement d'une localité a commencé en 1976 dans un cadre de lacs et de forêts encore inviolés. Le plan d'aménagement prévoyait que 15% du secteur serait conservé en espaces libres aménagés en parcs publics. Une ceinture de verdure qui borde les rives de deux lacs faisant partie du projet, ainsi que de nombreux bouquets d'arbres, isolent bon nombre de maisons du réseau routier.

L'aménagement de terrain de Sackville Lakes a été suivi de l'aménagement de six autres terrains dans la région d'Halifax-Dartmouth et d'autres encore dans la région du Cap-Breton et de Yarmouth.

Terre-Neuve - Le Plan de la région urbaine de Saint-Jean, élaboré en 1973, consiste en un exposé de principes qui sert de guide pour l'aménagement de la région. Les plans municipaux sont préparés par des conseils locaux conformément aux lignes directrices énoncées dans le plan régional. Par ailleurs, en 1973 toujours, on a interdit l'aménagement des terres agricoles de la région urbaine de Saint-Jean. Le contrôle de l'utilisation des terres agricoles a été instauré par la désignation de secteurs d'exploitation, qui correspond en fait à un gel des terres. Tout bâtiment construit à l'intérieur d'un secteur d'aménagement des terres doit servir d'une façon ou d'une autre à l'exploitation agricole ou faire partie intégrante d'un plan visant à combler les espaces libres d'une zone urbaine.

GOUVERNEMENT FÉDÉRAL

Lors de la 39^e réunion annuelle de l'Association canadienne des maires et des municipalités à Vancouver (juin 1976), M. Danson, alors ministre d'État aux Affaires urbaines, a affirmé qu'un des objetifs du gouvernement fédéral était d'équilibrer la croissance urbaine dans l'ensemble du Canada, de réduire le coût des terres et de freiner l'expansion anarchique des villes. Le rétablissement de l'équilibre de la croissance des villes permettrait de diminuer les pressions auxquelles Montréal, Toronto et Vancouver sont soumises. M. Danson a également indiqué que son ministère s'intéressait de plus en plus aux municipalités dans l'optique d'un transformation du mode de croissance urbaine dans l'ensemble du Canada. Cependant, comme les municipalités sont sous la tutelle des provinces et que toutes les provinces ne désirent pas discuter d'une politique canadienne en matière d'urbanisation dans le cadre d'une conférence nationale tripartite, la création d'une politique urbaine à l'échelle nationale n'ira pas sans peine. Idéalement, une politique d'urbanisation devrait traiter de divers facteurs tels que les transports, le logement, l'environnement et l'emploi.

Le gourvernement fédéral n'exerce directement que peu de contrôle sur les terres (autrement que par l'expropriation) sauf sur les terres de la Couronne sur lesquelles il possède des droits de propriété, principalement dans les Territoires, dans les parcs nationaux, et dans la région de la capitale nationale. Partout ailleurs, le contrôle des terres et de leur utilisation repose entre les mains de provinces et, par ricochet, des municipalités. Néanmoins, le gouvernement fédéral est un important propriétaire foncier dans les zones urbaines du Canada, occupant environ 210,000 acres (84,000 hectares) dans les régions métropolitaines (37 pour cent dans la région d'Ottawa-Hull). Le gouvernement fédéral possède également 43 mi^2 (112 km^2) au coeur même des centres métropolitains. Il participe actuellement à la mise en oeuvre d'une politique de gestion des terres urbaines qui s'inscrit bien dans le cadre des objectifs globaux pour l'aménagement urbain, par exemple, l'amélioration de l'environnement des centre-villes.

Il incombe au gouvernement fédéral de fixer des objectifs et des priorités à l'echelle nationale et de s'efforcer de les atteindre. Les objectifs nationaux exprimés lors des discours du Trône prononcés jusqu'à présent favorisent la croissance économique, l'équilibre régional, l'utilisation appropriée et la conservation des ressources naturelles ainsi qu'un niveau de vie satisfaisant pour tout les Canadiens. En vue d'atteindre ces objectifs généraux, le gouvernement fédéral a fixé certaines priorités. Il entend à cette fin prendre des mesures particulières pour tenter de contrôler la spirale inflationniste, mettre au point des programmes d'aménagement régional, améliorer le commerce extérieur et mettre de l'avant des politiques dans le domaine de l'énergie, des transports et de la démographie.

CONCLUSION

Toute la question capitale des établissements humains au Canada à l'avenir continuera d'être profondément influencée par la taille, le taux de croissance et la répartition de la population. Les projets d'amélioration de l'environnement urbain devraient se consacrer d'abord à éliminer le gaspillage de terres qui a caractérisé la plupart des projets domiciliaires réalisés au Canada au cours des 30 dernières années. Les projets d'amélioration pourraient favoriser la *concentration* d'habitation dans les secteurs urbains déjà aménagés, mettre l'accent sur la construction d'immeubles de rapports de hauteur restreinte, et offrir des terrains moins grands et des services plus modestes pour les maisons individuelles. On s'inquiète de la menace qui pèse sur les meilleures terres agricoles du Canada, sur les aires récréatives et sur l'habitat de la faune en raison de l'empiètement des villes, ainsi que du surpeuplement qui menace les principaux centres métropolitains.

L'importance accordée à l'utilisation des terres comme *commodité* semble maintenant céder le pas à l'exploitation des terres comme ressources naturelles. Plusieurs provinces examinent actuellement la nécessité de définir des politiques provinciales sur l'utilisation des terres dont une bonne partie porterait sur les politiques relatives à l'environnement urbain. On a par ailleurs exprimé le besoin de mettre au point une politique fédérale concernant l'utilisation des terres. Compte tenu de l'intérêt général que les provinces manifestent à l'égard de l'utilisation des terres et de l'importance particulière accordée à l'aménagement planifié des zones urbaines, il y a largement place pour la recherche dans le domaine de la planification écologique en milieu urbain. Les documents contenus dans le présent mémoire visent justement à offrir un aperçu général des types de recherches les mieux appropriés à la planification écologique en milieu urbain.

THE PRESENT ROLE OF BIOPHYSICAL INFORMATION IN URBAN AND REGIONAL LAND USE PLANNING IN CANADA

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INTRODUCTION

Theoretically, decisions concerning the management and allocation of land are based on a consideration of the social, economic and environmental factors involved. In fact, however, urban and regional planners have tended to concentrate their attentions on economic and social factors, paying little attention to 'environmental' or 'biophysical' factors. Population growth rates, numbers of houses needed, and the location of new subdivisions relative to existing sewer and water line capacities and relative to existing road and transportation patterns are matters which have been of immediate concern to urban and regional planners.

TYPES OF LAND USE PLANS

Land use plans in urban areas are made at many different scales. *Site plans* are concerned with the design and location of single buildings, or small groups of buildings on small pieces of land. *Subdivision plans* involve the coherent development of a larger group of buildings by single developers, a group of buildings large enough to support a local park and one or two local stores. *Community* or *structure plans* consist of a group of four or five subdivisions forming a cohesive community of a size to support a small shopping centre. Only the general location and size of subdivisions, shopping centres and park areas, and the major interconnections among these activities are indicated in such plans. *Municipal plans* of land use are developed for the areas inside the political boundaries of local governments, and generally indicate the location of communities (as defined above), industrial areas, commercial centres, open space, and major transportation and servicing interconnections. *Regional plans* around urban centres usually involve an area approximately coincident with the commutershed. Such plans are concerned with locating and establishing links between municipalities and communities. Political regions of this scale have been established in several provinces, notably Ontario and British Columbia. *Provincial plans* are concerned with the size, location and interconnections among major urban areas and with their relationships to their hinterlands. *National planning*, if it were done in Canada, would be concerned with the distribution of population and economic activities among the provinces. This hierarchy of types of plans - site, subdivision, community, municipal, regional, provincial, and national - differs from place to place.

INFORMATION TRADITIONALLY USED

Information of many types and scales is traditionally gathered to develop these plans. Maps of *land use* and discussions of *land use change* are basic planning tools. Information on the *economic base* of a planning area and its future prospects is central to determining land needs for industrial and commercial purposes and to indicate the population the area will support. *Demographic information* used includes analyses and forecasts of population profiles, household sizes and the labour force. *Housing market* analyses and forecasts, when considered in conjunction with forecasts of households, help determine amounts of land needed for particular kinds of housing. Analyses of *patterns of movement* of people and goods and *modes of transportation* used indicate relationships among the parts of the planning area. The planner may understand the importance of the *biophysical environment* for life support or for its aesthetic quality. More likely, he will only consider information on *topography* for sewer placement and costs, and for determining the maximum number of houses into a subdivision with the minimum length of road. The *bearing capacity* of soils is considered when constructing certain buildings.

Different pieces of information assume different degrees of importance depending on the level of the plan. Physical information for engineering purposes is seen to be most important for site planning. Subdivision and community planners pay attention to population forecasts, household size data, housing market information, and existing transportation and servicing networks. Municipal and regional planners are more concerned with land use trends, information and forecasts concerning the economic activity throughout their region, population and household information, and patterns of recreation and open space. Provincial and national planners are more concerned with information on the large scale distribution of population and economic activity, and with functional linkages among activity centres.

Traditionally, planners attribute little significance to biophysical information. There are exceptions, however: 1) Physical information is sometimes gathered for engineering purposes for site plans. 2) Certain crisis situations, such as floods and landslides in populated areas, have directed planners' attention to the biophysical environment. In the latter case, engineering solutions have either been inadequate, have aggravated the problem in the long term, or have been prohibitively expensive, forcing land planning solutions which merely prohibit certain developments in particular areas. This kind of planning is not widespread and is essentially negative and reactive in that it merely stops the worst kind of development in reaction to crisis situations. Nonetheless, it represents incipient attention to biophysical information in urban and regional land planning. More comprehensive attention to the biophysical environment is beginning to be seen in isolated planning areas. However, there are barriers to incorporating such information in urban and regional plans.

BARRIERS TO THE INCLUSION OF BIOPHYSICAL INFORMATION

Three main barriers exist:

1. Information - Biophysical information which is in a form relevant to issues which planners address is lacking.

2. Professional bias - By and large, the professionals developing these plans have little understanding of the biological and physical sciences. Their training tends to be based in architecture or engineering and they therefore treat the biophysical environment as an engineering or design problem. In addition, their clients are only interested in the immediate costs of their proposals.

3. Political and Economic Factors - These may prevent the use of such information. Developers are not pleased to see large tracts of land designated as conservation areas, floods plains, agricultural lands and mineral resource areas. In turn, politicians find it difficult to make such designations because of pressure for development.

Thus, lack of relevant information, professional bias of land planners, and political and economic factors form barriers to the incorporation of biophysical considerations in urban and regional plans.

APPROPRIATE INFORMATION

What biophysical information is relevant to land planning? Biophysical scientists must answer this question, and answer it very thoroughly before launching a program designed to gather biophysical information for use in urban and regional planning. And in designing such a program, it must be remembered that:

1. Biophysical information is only one category of information to be considered by urban and regional planners;

2. The information must be relevant to many types and scales of planning decisions; and

3. The information must be *seen* to be relevant to urban and regional planning decisions by professionals and politicians who are not trained in the subject area, and have traditionally made planning decisions without such information.

Much of the necessary information may already exist, and needs only to be translated into a usable form for planners. Perhaps a land planning manual needs to be devised for the Canada Land Inventory (CLI) in which actual planning problems at several scales are described, and the relevance of the CLI to these situations is outlined. Perhaps similar manuals for various geological maps could be written.

CONCLUSION

We would be naive to expect information on biophysical factors, once made available, to have a major and immediate effect on land planning. Biophysical information is only one kind of information to be taken into account in the formalized planning process, and there are many forces other than information and formal planning recommendations based on that information which determine the outcome of any planning process. But accurate, relevant information which is easily available can be a powerful tool in any planning process. And we must never lose sight of the fact that this information must be of a type to lead to the kind of understanding which will allow wise decisions to be made in the land planning process. We must not find ourselves involved in the kind of information program which would allow some to lament:

> *Where is the wisdom*
> *We have lost in knowledge?*
> *Where is the knowledge*
> *We have lost in information?*
>
> *T.S. Eliot*

LE RÔLE ACTUEL DES CONNAISSANCES EN BIOPHYSIQUE AU SERVICE DE LA PLANIFICATION DE L'UTILISATION DES TERRES EN MILIEU RURAL ET URBAIN AU CANADA

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INTRODUCTION

En théorie, les décisions relatives à la répartition des terres se prennent après examen des facteurs sociaux, économiques et environnementaux. Mais en réalité, les planificateurs urbains et régionaux ont eu tendance à accorder une attention plus particulière aux facteurs économiques et sociaux, sans souci des facteurs environnementaux ou biophysiques. Ils se sont plutôt immédiatement préoccupés du taux de croissance de la population, du nombre d'habitations nécessaires et de l'emplacement des nouvelles subdivisions en fonction des capacités des services d'eau et d'égout, des routes existantes et des modes de transports en vigueur.

TYPES DIVERS DE PLANS D'UTILISATION DES TERRES

Les plans concernant l'utilisation des terres en milieu urbain sont élaborés à divers niveaux. Les *plans par emplacement* s'intéressent à la conception et à l'emplacement des maisons individuelles ou de petits groupes d'habitations sur de petites parcelles de terrain. Les *plans de subdivisions* prévoient l'aménagement cohérent d'un groupe plus important d'habitations par des constructeurs indépendants, groupe suffisamment imposant pour y aménager un parc et un ou deux petits magasins locaux. Les *plans de collectivité* ou *plans structuraux* consistent en un groupe de quatre ou cinq subdivisions formant une collectivité dotée d'une certaine cohésion et suffisamment important pour y bâtir un petit centre commercial. Ces plans n'indiquent que l'emplacement général et les dimensions des subdivisions, des centres commerciaux, des parcs et des principales artères reliant ces différents centres d'activités. Les *plans municipaux* d'utilisation des terres sont destinés à l'aménagement des terres situées à l'intérieur des limites politiques du territoire des autorités locales. En général, ces plans indiquent l'emplacement des collectivités (telles que définies ci-dessus), les quartiers industriels, les centres commerciaux, les espaces libres, ainsi que les principaux moyens de transports et services reliant chacune de ces activités. Les *plans régionaux* visent les régions qui entourent les centres urbains et s'appliquent habituellement à une zone qui correspond à peu près à une distance parcourable chaque jour. Ces plans visent à localiser et à déterminer les réseaux routiers qui relieront les municipalités aux collectivités. Des régions politiques de ce genre ont été établies dans plusieurs provinces, notamment en Ontario et en Colombie-britannique. Les *plans provinciaux* s'attachent aux dimensions, à l'emplacement et au réseau routier reliant les principales zones urbaines et le raccord avec l'arrière-pays. Les *plans nationaux*, s'ils existaient au Canada, concerneraient la répartition de la population et des activités économiques entre les provinces. Cette hiérarchie qui distingue les divers types de plans - emplacement, subdivision, collectivité. municipalité, région, province et pays - varient d'un endroit à l'autre.

RENSEIGNEMENTS GÉNÉRALEMENT UTILISÉS

Des renseignements de divers types et niveaux sont généralement rassemblés afin de mettre au point les plans dont il est ici question. Les cartes de *l'utilisation des terres* et les discussions concernant les *changements apportés à l'utilisation des terres* constituent les outils de base pour entreprendre les travaux de planification. Puis, il incombe de rassembler des données au sujet des *fondements de l'économie* du secteur à l'étude et de ses perspectives d'avenir afin de déterminer les terrains à mettre à la disposition de l'industrie et des commerces et de préciser le nombre d'habitants que la région est en mesure d'accueillir. On se sert également de *données démographiques* comportant des analyses et des prévisions de l'importance de la population, de la dimension des familles et de la main d'oeuvre active. L'analyse et les prévisions du *marché de l'habitation,* lorsqu'examinées avec les prévisions sur la dimension des familles, contribuent à déterminer l'espace qui sera nécessaire pour accueillir les différents types d'habitations. L'analyse des *mouvements* de la population et des biens, et des *modes de transports* utilisés permettent d'établir certains rapports entre les diverses parties de la zone à planifier. Le planificateur peut comprendre l'importance de *l'environnement biophysique* essentiel à la survie ou pour ses qualités esthétiques. Mais il est plus que probable qu'il se contentera d'examiner les *données topographiques* pour l'installation des égouts et les coûts y afférant, et pour fixer le nombre maximal d'habitations qu'il est possible de loger dans une subdivision donnée avec longeur minimale de routes à bâtir. On examine quelquefois la *capacité de charge* des sols au moment de construire certains immeubles.

Les différentes données receuillies varient en importance selon le niveau hiérarchique du plan. Les données physiques pour la réalisation des travaux techniques constituent les renseignements indispensables à la planification par emplacement. Par contre, les planificateurs de subdivision et de collectivité s'intéressent davantage aux prévisions concernant la population, aux données sur les dimensions des familles, au marché du logement et aux réseaux de transports et de communication existants. Quant aux planificateurs municipaux et régionaux, ils se préoccupent avant tout des tendances dans le domaine de l'utilisation des terres, des renseignements et des prévisions concernant l'activité économique dans leur région, des données sur la population et les familles et des modèles d'aires récréatives et d'espaces libres. Les planificateurs provinciaux et nationaux s'intéressent surtout aux données relatives à la répartition de la population et à l'activité économique à une large échelle ainsi qu'aux réseaux qui relient les divers centres d'activités.

De par la tradition, les planificateurs n'accordent que peu d'importance aux données biophysiques. On compte toutefois certaines exceptions: 1) On rassemble parfois des renseignements physiques pour les travaux techniques effectués dans le cadre de plans par emplacement. 2) Certaines situations de crise, par exemple dans le cas d'inondations ou de glissements de terrain dans des zones à forte densité de population, ont amené les planificateurs à s'intéresser davantage à l'environnement biophysique. Dans ce dernier cas, ou les solutions techniques apportées ont été insuffisantes, ou elles ont aggravé le problème dans une perspective à long terme, ou bien elles ont coûté extrêmement cher, de sorte qu'il a fallu interdire l'aménagement de certaines installations dans des secteurs particuliers. Ce type de planification n'est pas répandu et se révèle essentiellement négatif et réactionnaire du fait qu'il se limite à interdire les pires aménagements à la suite de situations de crise. Néanmoins, cela signifie que l'on commence à se préoccuper des données biophysiques dans le cadre de la planification des terres en milieu régional et urbain. D'ailleurs, dans certaines zones de planification isolées, on accorde une plus grande attention au milieu biophysique. Il y a toutefois moult obstacles à l'intégration de tels renseignements dans les plan régionaux et urbains.

OBSTACLES À L'INTÉGRATION DES DONNÉES BIOPHYSIQUES

On compte trois principaux obstacles:

1. Information - Il y a un manque de renseignements biophysiques sous une forme qui répondrait aux questions des planificateurs.

2. Orientation des professionnels - Dans l'ensemble, les professionnels chargés de l'élaboration des plans possèdent peu de connaissances en sciences biologiques et physiques. Il possèdent en général une formation d'architecte ou d'ingénieur et ont par conséquent tendance à traiter le milieu biophysique comme s'il s'agissait d'un problème technique ou de conception. De plus, leurs clients s'intéressent uniquement aux coûts immédiats de leurs projets.

3. Facteurs politiques et économiques - Ces facteurs peuvent faire obstacle à l'utilisation de tels renseignements. Les concepteurs n'apprécient pas de voir de larges étendues de terrain désignées comme aires de conservation, plaines inondables, terres agricoles et zones riches en ressources minérales. Par ailleurs, les personnes politiques considèrent difficile de faire ces désignations en raison des pressions exercées en vue de l'aménagement de terrains.

Par conséquent, le manque de données pertinentes, l'orientation professionnelle des planificateurs, ainsi que les facteurs politiques et économiques font obstacle à l'intégration de facteurs biophysiques aux plans d'aménagement régionaux et urbains.

RENSEIGNEMENTS APPROPRIÉS

Quels sont les renseignements biophysiques appropriés à la planification des terres? Les spécialistes en sciences biophysiques doivent répondre à cette question et y répondre très consciencieusement avant de mettre en branle un programme destiné à rassembler des données biophysiques pour la planification de l'aménagement régional et urbain. Au moment d'élaborer ce programme, il faut bien se rappeler les éléments suivants:

1. Les renseignements biophysiques ne constituent qu'une catégorie au nombre des facteurs examinés par les urbanistes et les planificateurs régionaux;

2. Les renseignements doivent être appropriés à de nombreux types et échelles de décisions de planification; et

3. L'utilité des renseignements relatifs à la planification régionale et urbaine doit sembler évidente aux professionnels et personnes politiques, car ces derniers n'ont aucune formation dans ce domaine et ont toujours décidé du mode de planification à adopter sans tenir compte de ces facteurs.

La plus grande partie des données indispensables existent probablement et n'ont qu'à être traduites de façon à être comprises des planificateurs. Il y aurait peut-être lieu de mettre au point un guide de planification des terres pour l'Inventaire des terres du Canada (ITC) où l'on décrit les problèmes que pose actuellement la planification à divers niveaux et où l'on précise l'utilité de l'ITC en pareilles situations. On pourrait peut-être rédiger divers guides du genre à joindre aux diverses cartes géologiques.

CONCLUSION

Nous serions naïfs de croire qu'aussitôt disponibles, les données biophysiques auront des conséquences importantes et immédiates sur la planification des terres. Elles ne constituent qu'une partie des données à examiner dans le cadre du processus officiel de planification et il y a nombre d'influences autres que les données recueillies et les recommandations officielles sur la planification faites à partir de tels renseignements, qui déterminent les résultats de tout processus de planification. Cependant, des renseignements exacts et appropriés et, par surcroît, facilement disponibles, peuvent être des outils très utiles à tout processus de planification. De plus, nous ne devons jamais perdre de vue le fait que ces données doivent mener à un niveau de connaissances qui permettra de prendre de sages décisions en cours de planification. Nous devons surtout éviter de sombrer dans le piège d'un programme d'information devant lequel certains pourraient s'écrier:

> Où donc est passée la sagesse
> Perdue au profit de l'acquisition des
> connaissances?
> Où donc sont passées les connaissances
> Perdues au profit de l'accumulation
> d'information?
>
> T.S. Eliot, trad.

ECOLOGICAL (BIOPHYSICAL) COMPONENTS AND THEIR SIGNIFICANCE

FACTEURS ÉCOLOGIQUES (BIOPHYSIQUES) ET LEUR IMPORTANCE

THE ROLE OF EARTH SCIENCE IN ECOLOGICAL PLANNING

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ECOLOGICAL PLANNING — WHAT DOES IT MEAN?

In the past, the term *ecology* was used to describe a rigorous scientific approach to studying the relationship between organisms and their environment. The ecologist was therefore generally a biological scientist concerned mainly with the interaction of plants and animals with their surroundings. However, in recent years problems of pollution, energy shortage, etc. have led to the realization that man himself is part of the world ecological system. The philosophy of "multiply... and subdue the earth" (Genesis 1:28) has come under serious scrutiny and attack. A new and broader concept of ecology is being developed, one which includes the study of human activities and how they can be integrated into the natural environment (McHarg, 1969).

The term *planning* denotes a general activity rather than a purely scientific or technological method. Within this activity the planner not only must study, analyze and describe a situation, but must also create, design and offer solutions. The planner, therefore, is not a specialist in any one area but must integrate aspects of many fields.

Thus, *ecological planning* can be defined as planning with an understanding of the natural environment and with a view to integrating human activities into that environment.

This paper examines ecological planning in relation to urban and urban fringe development and growth, and in particular, that aspect of ecological planning concerned with the earth materials and geological processes. The role that earth science information can play in urban planning and what strategies might be developed to promote good ecological planning will be discussed.

INFORMATION — THE BASIS FOR ECOLOGICAL PLANNING

The creating, designing and problem-solving aspects of planning involve numerous decisions and choices. Each decision and choice, if it is to be logical, depends upon the availability of factual data. The rapid growth of urban areas has greatly complicated the decision-making process and has resulted in an increasing need for adequate, accurate information. Urban development can span activities from aggregate mining to high-rise construction, requiring information from bedrock geology to the socioeconomic structure of neighbourhoods.

The necessity for a broad base of information to support sound ecological planning is represented in Figure 1.

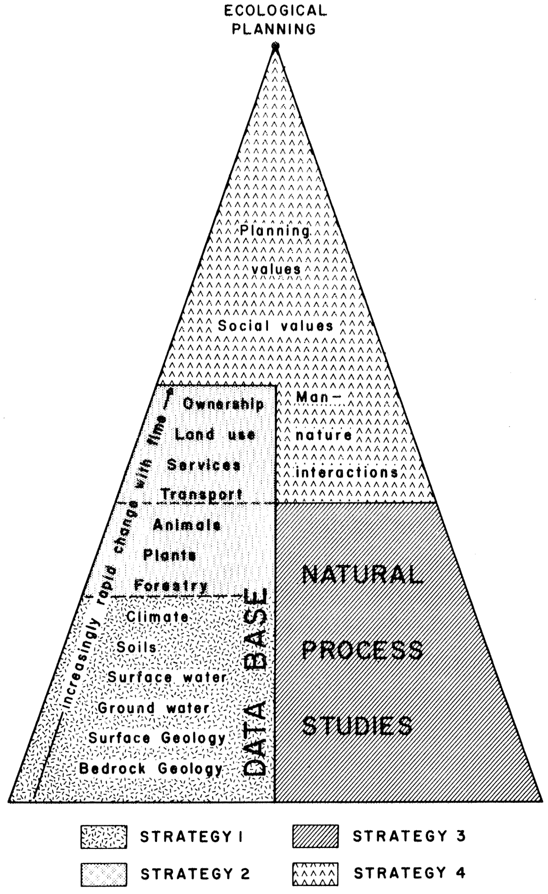


Figure 1: Major information areas which support sound ecological planning. Patterned areas refer to strategies for integrating the information areas into an overall ecological planning program.

Proc. Workshop on Ecol. Land Class. in Urban Areas, Can. Comm. on Ecol. Land Class., 23 & 24 Nov. 1976, Toronto, Ont.

The bottom half of the triangle is divided into two sections; the left side lists roughly the *what's there* information and the right side the *how it works* information. In the case of the *what's there* of bedrock geology, for example, the geological map of Ottawa might indicate that a site is underlain by the Carlsbad shale formation. This information itself has no value to the planner, but when coupled with the knowledge that this rock swells when oxidized, certain precautions can be taken to prevent foundation destruction. The owner of the basement floor in Figure 2 might have found this information very valuable *before* he built the house.

Figure 3, an excellent example of where a good understanding of natural processes has been put to use, shows the shore defences constructed to prevent siltation of the Main Harbour Channel of Toronto harbour and to protect the Toronto Islands from further wave erosion. The Toronto Islands were formed by material eroded from the Scarbourough Bluffs and transported by long shore currents across the harbour mouth. When groins and other devices were installed to halt erosion of the valuable property upon the Bluffs, the source of supply for the Toronto Islands was cut off. The sediment transport system, formerly in a state of equilibrium, was disrupted and the islands began to be eroded. The East Headland shown in Figure 3 protects the islands from wave action. The engineering of this structure shows a remarkable understanding of wave action. Although composed of primarily fine material dug from basement excavations in downtown Toronto, it has been placed so that the waves grade it to a natural slope. Points of coarser material have been constructed to take the brunt of large

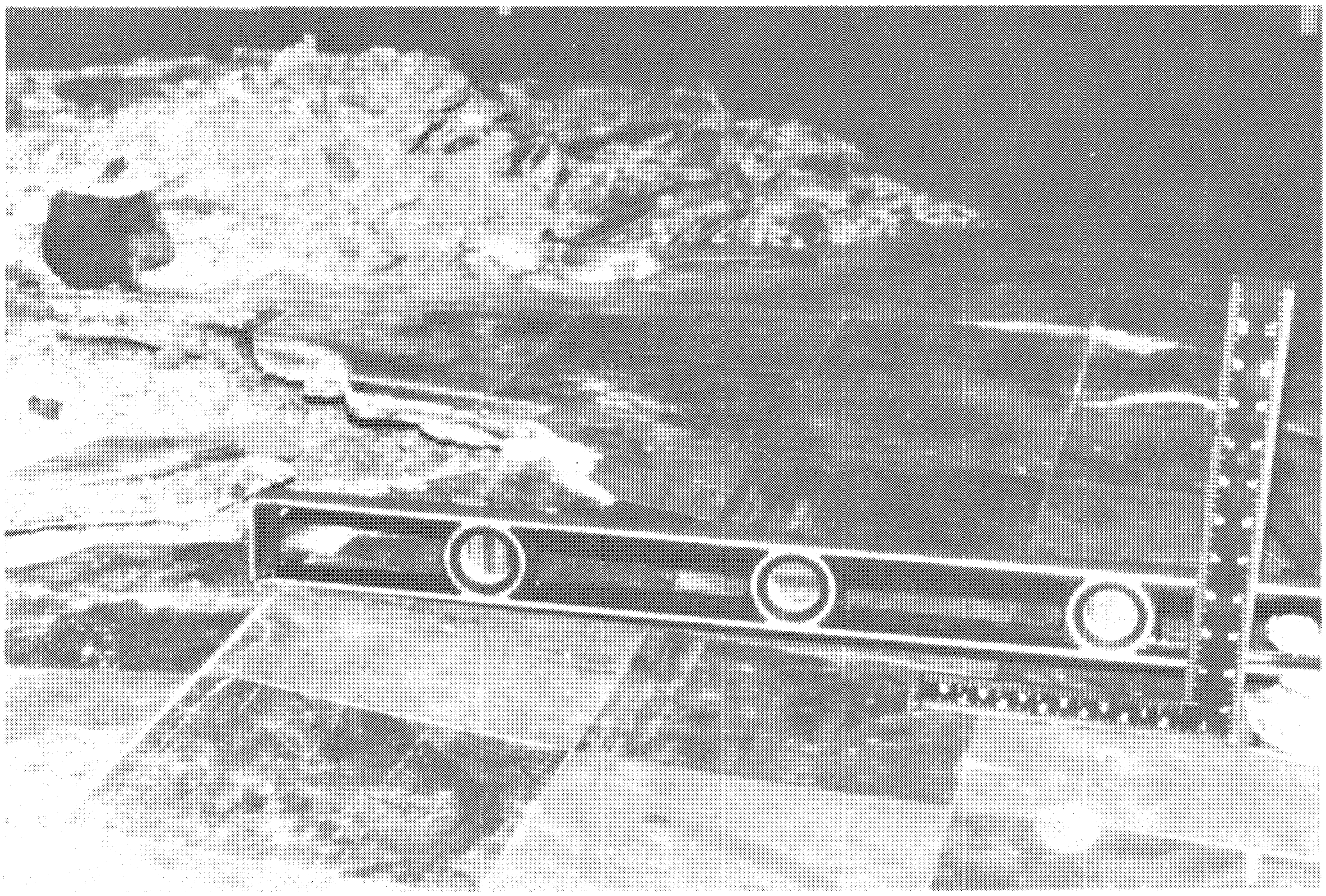


Figure 2: Severe heaving of a basement floor in downtown Ottawa due to biochemical reactions in underlying shale (Penner et al.*, 1973). Photo credit - Division of Building Research, National Research Council of Canada.*

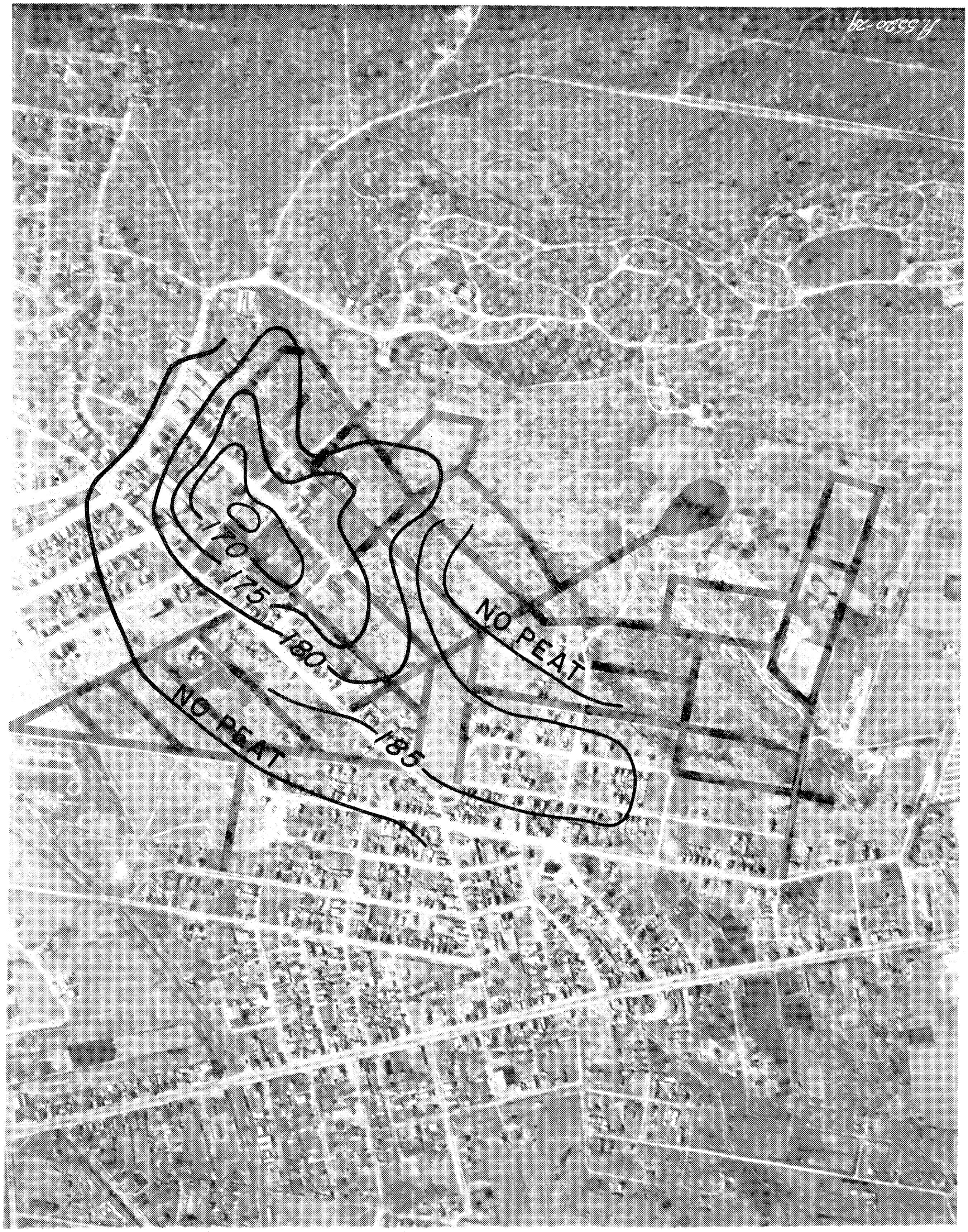
Figure 3: East Headland protecting Toronto Harbour main harbour channel and Toronto Islands as of April 1976. Photo credit - Toronto Harbour Commissioners.

waves. This, allowing the slope of the structure to equilibrate with the waves, has resulted in an effective almost 'natural' structure. A conventional breakwater constructed for the same purpose would have cost over 10 times as much to build and maintain, (Friebergs, 1970).

Lack of knowledge concerning the surface geology has led to serious problems in Vanier City, which abuts Ottawa on the east. Figure 4, an aerial photograph taken in the 1940's, shows that urban expansion had already crept into an area of organic soil, "what was then often referred to as" ... a "quaking bog". Contour lines on the photograph show the depression in which this bog is formed. At its deepest point 5.2 m of organic material has accumulated. The bog was covered with 1.5 m of sand fill and housing lots sold. The dark grey screen lines indicate streets built since the photo was taken. A survey of the area located 20 houses which, from exterior inspection show severe structural damage due to settlement (pers. comm., Neighbourhood Improvement Program (NIP) personnel). Figure 5 shows a two-story house, one side of which is 20 cm lower than the other. Figure 6 shows an apartment house which is so badly twisted that the front door has a five cm gap at the top.

Returning to Figure 1, the left hand side of the triangle lists, under the general heading *DATA BASE*, information from areas other than earth sciences (I leave it to specialists in these fields to present examples of good and bad usage). Man-nature interactions, social values and planning values form the top of the triange and represent perhaps the most transient and difficult part of the information triangle

Figure 4: Vertical air photo of part of the city of Vanier Ontario taken in the 1940's. Superimposed are contours in feet above sea level of the solid ground underlying a bog. The grey grid pattern shows streets built since the photograph was taken.



to characterize. How man interacts with the natural environment depends upon the man and the nature of the environment. Social values include the value system which a group uses to judge the relative merits of a given planning scheme. These values vary from province to province, city to city and neighbourhood to neighbourhood. For example, the value placed on preserving natural stands of trees in dry Calgary is much greater than in humid Ottawa where trees are numerous and easier to replace. Planning values represent the conceptual side of planning and deal with problems such as the form urban growth might take, strip development, satellite communities, etc.

In summary, Figure 1 is an attempt to lay out diagramatically the knowledge base which *must* support sound ecological planning. In my experience, much of the planning done in Canadian cities today concerns primarily the upper half of the triangle. The portion lying below the horizontal line under *Transport* is all but ignored, either because the data base is not available, the processes poorly understood or, in some cases, people have not considered this type of information important. It is *important*, and in some cases *essential*. Figure 7, a view of the remaining part of the town of St-Jean-Vianney, dramatically illustrates how important earth science information can be.

STRATEGIES TO PROMOTE ECOLOGICAL PLANNING

The types of information illustrated in Figure 1 are very diverse and therefore diverse strategies must be used in promoting the use of this information in ecological planning. With the exception of DATA BASE, the areas into which the triangle are divided by the patterns correspond to strategies. DATA BASE is divided into two strategy categories because of the enormous difference in the rate of change of these data with time. Bedrock information once gathered does not change, and while more detailed work may be necessary and some correction

Figure 5: Apartment house, Vanier, Ontario. Building has settled 20 cm on one side.

Figure 6: Apartment house in Vanier, Ontario which has differentially settled causing severe strucutural damage.

warranted, what is actually there does not change. Forestry, on the other hand, can change significantly over a 10 to 20 year period and land ownership can change in a period of days. Therefore, the DATA BASE list has been ordered to show the most stable data (with respect to time) at the bottom and the most variable at the top. The line dividing the list into two strategy categories is rather arbitrarily placed between climate and forestry.

Strategy 1 deals with the least variable portion of the data base. To promote the use of this information, it must be available in a form readily comprehended by planners. An excellent example of the type of information which should be available for every city is the Saskatoon Folio (Christenen, 1970). This handsome collection of maps, diagrams and explanatory text lays out for the planner the earth science and related data needed to make sound planning decisions. Data of the type available in Saskatoon should be provided on a standardized country-wide system. Updating need only occur when significant new data are available. Presently, only five or six cities in Canada have available the data necessary to assemble a compilation of the Saskatoon type. Therefore, in the early stages of any program to promote ecological planning it will be necessary to concentrate on basic data gathering.

Strategy 2 deals with the more changeable nature of the upper part of the data base list. Information in this list should be obtained on a *need to know* basis. Attempts to maintain a current city-wide inventory of these items would be too expensive to justify. However, in some cases such as land ownership, land use, service, etc., existing administrative machinery such as building permit and land registry offices might be tied directly to a computer-operated data base system.

Strategy 3, dealing with natural processes, is perhaps the most difficult because some of this information is obtained with the data base. A large amount of our knowledge of processes

Figure 7: View of part of St-Jean-Vianney following the landslide of 4 May 1971 in which 31 people were killed and 43 buildings destroyed.

comes, however, from site-specific studies rather than regional mapping. As a result, the expertise often resides in the private sector with builders, engineers and people in the geotechnical field. To promote the use of this information by planners, the most important thing is to make them aware that a problem exists. Once this is done, they may obtain specific local expertise by hiring private consultants to answer specific questions. Seminars, workshops and lectures arranged to bring local experts in contact with planners is probably the best way to encourage the incorporation of this type of data in planning.

Strategy 4 must be developed on the local level. Planning values, social values and man-nature interactions are local issues. Each planning unit will have to work out methods of dealing with these issues appropriate to its own conditions.

CONCLUSIONS

Some may think that much of what I have said in this paper is self-evident. This may be particularly true of the section on strategies. However, those not close to the problem tend to expect complex planning problems, particularly those involving earth science information, to be solved by creating integrated maps of predigested information which give clear yes-no answers. In effect, what is desired is a method for bypassing all the messy hard-to-organize data shown in the triangle of Figure 1 and leaping in a single bound to the apex. This naive approach fails to recognize that ecological planning is a method not a product. You can encourage it, but you cannot produce it.

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VEGETATION NEEDS AND CONCERNS IN URBAN AREAS

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INTRODUCTION

A new government approach to the planning of the urban environment has evolved during the past few years. Emphasis has increasingly been put on quality rather than quantity. The socioeconomic and environmental situations of city dwellers, rather than solely the spatial arrangement of man-made structures, have come to the forefront. The management of services and the interaction between services, rather than the mere investment in physical structures, have come into focus. These changes have led to a more complex public participation mechanism in our society and generate an increasing demand for information from the varied professions concerned with specific elements of the urban makeup. The major urban planning concerns can be summarized as:

1. *Housing* - concern for amenities and indoor as well as outdoor space.
2. *Services and Employment* - concerns for health, education and recreational services.
3. *Natural Environment* - concerns for air and water quality, exposure to noise and natural disasters, better conditions and land quality.
4. *Social and Cultural* - concerns for the preservation of typical urban landscapes as part of the national heritage.

Urban forestry has input in all four concerns. It deals with the management of vegetation within the urban area and for the urban population. *Urban forestry* has been defined as: *A specialized branch of forestry which has as its objectives the cultivation and management of trees and forests for their present and potential contributions to the physiological, sociological and economic well-being of urban society*. Expressed in another way, urban forestry can be seen as a medium for transfer of ecological forest management from the forestry setting to the urban environment for the benefit of this and future generations. The term as used here includes all areas in Canada - cities, towns and villages - with a minimum population of 1,000 people and a density above 1,000 people/mi^2. On the basis of this definition, Statistics Canada has forecast that approximately 95% of Canada's total population will be living in urban settlements at the year 2000. According to the 1971 Canada Census, only 75% of the population lived in urban settlements.

VEGETATION FUNCTIONS IN THE URBAN ENVIRONMENT

Urban vegetation occurs in two different settings, namely the *garden* or *horticultural habitat* and the *forest habitat*, both having important environmental functions within the settlement area. Trees, because of their size and longevity, play a dominant role within both types of habitat. Looking at the functions of these two vegetation settings, we find that both offer recreational and aesthetic values important to health (physical and mental) and general well-being of residents, as well as environmental modifications. The main differences between the two settings are to be found in their management requirements, the size of land-use area required for their perpetuation and their environmental impact.

<u>The garden or horticultural habitat</u> - This may vary in size from a small flower bed or rows of trees planted in sidewalks to large city parks requiring intensive (and costly) maintenance and management. The main benefits which urban man can derive from this habitat must be seen in the recreational and aesthetic values created, which are important for community health, and no doubt have an ameliorating effect on the environment of settlements. The requirements for intensive management of this habitat offer the homeowner an opportunity for physical outdoor activity, rare in today's television-oriented society, and for many, a source of regaining physical and mental health. The creation of private spaces and of an aesthetically pleasant community

living environment is another important function.

The presence of the horticultural habitat within the human settlement has many modifying and ameliorating effects on the otherwise barren, man-made human settlement. It helps to conserve energy consumption by modifying temperature and humidity changes. It facilitates recharging of groundwater within built-up areas and the control of soil erosion by runoff. The vegetation also reduces sound and air pollution by serving as a pollution sink. Further, the vegetation makes possible contacts between man and a significant portion of the areas's natural wildlife population.

There can also be detrimental vegetation effects to society. Clogging of drains and problems related to the location of aerial and underground service lines are well-known. Moreover, trees in some areas of the country contribute to the destruction of building foundations. Some plant species are highly toxic to animals and human beings, and some cause allergies. Certain plant societies may also attract unwanted wildlife species close to human habitation.

The forest habitat - The importance of the Canadian forest to society is steadily growing. In addition to its obvious socioeconomic function, more attention is recently being paid to other functions of the forest such as water management, recreation, and conservation of soil, plants and wildlife. Despite this, the role of the forest as an integrated part of our settlement area deserves additional considerations before the ideal living environment can be created for Canadians.

Although the minimum size of a forest ecosystem capable of being managed in perpetuity has not been scientifically established in Canada as such, 50 to 100 ha may be the minimum area required, depending on the forest region. A forest of such a size or larger in the periphery of or within the settled area serves many functions. The first of these is 'renaturalizing', the renovation and reinforcement of natural elements in the built-up landscape. The forest can enhance the biotic value and eliminate the unfavourable influences of technical intervention within the settlement area. The forest ameliorates the climate to a higher degree than other urban vegetation by minimizing temperature and humidity fluctuations and by lowering the wind speed. It can conserve watersheds and their continued production of clean water for human consumption. Further, the forest ecosystem provides an outstanding function in the sanitation of air and water. It provides habitat for wildlife which in turn aids in the control of noxious insects and rodents. The forest has a high capacity for recycling organic human wastes and for the control of pathogenic organisms. It cannot, however, be expected to recycle larger amounts of industrial wastes which, in a sense, constitute a resource waste, often of a nonrenewable resource, a problem which can best be resolved in a modification of the manufacturing process.

Another important function of the forest within the settlement area is that of creating the basis for a stable settlement environment. The rapidly changing modern technology has led to a built-in obsolescence in most man-made structures which in turn, has created an ever-changing cityscape. The use of permanently forested areas for separation of different functional areas within the settlement could conceivably aid in the recreation of a stable urban-dwelling environment. The forest could thus separate the working and transport areas from the residential areas and other areas with different urban qualities. If the forest were used in this manner it would create readily accessible areas for recreation, whether the object of the recreation was the forest itself and its ecosystem or whether the forest was merely to serve as a setting for a non-forest-related recreational activity.

A third major function of forests within settlement areas may be referred to as the 'educational function'. The ecological input in the educational program for Canadians must be at par with that of arts and technology. This goal requires ready and regular access to the forest environment which offers the foremost demonstration of nature's intricate laws. The achievement of a generally high level of understanding of ecology is of prime interest, not least in Canada, which through history and to the present day has benefited greatly from its major natural renewable resource, the forest. Without such an ecological understanding, a proper forest management policy for Canada cannot be expected to be established for the benefit of future generations of Canadians.

In addition to these three major functions of an urban forest, we should remember that a properly managed forest can also be an economic resource for the urban population, in that it can provide high quality raw products close to the market. Other functions of the forest, including those of the forest as a design and ornamental object, shall be left out of this discussion.

URBAN VEGETATION NEEDS

In summarizing the urban vegetation functions, the quality of services which can be achieved from urban vegetation and vegetation management has been sketched. What remains in the discussion of the needs is, therefore, a statement of quantity required, or to put it another way: *How many hectares per* km^2*, or per 100,000 people, is the minimum base requirement for vegetation?* Presently there is no basis for providing a figure as a guideline and it is believed that the answer will vary from location to location. Closeness to the ocean, other major water bodies, or mountains, as well as climate, are factors greatly influencing the vegetation needs of society. To this can be added the urban society standard with regard to 'living within one's natural environment'. From recent development and experimentation by the avant-garde urban planners, one may find the trend of the 60's (the space age) directed toward totally enclosed, climatically controlled living environments 'under the dome', the surface of the soil, or even under the oceans. I have little faith in these kinds of ideas as they, like our present 'disposable society', have a tendency to dehumanize society to a degree that I would hope not to experience. The vegetation needs for urban society must be determined by the philosophy guiding the establishment of urban living policy for other developments' such as nuclear power plants and hydroelectric dams, requiring major capital investments. Where the needs exist for a stable, perpetuating society, the needs for vegetation and trees will be established with little difficulty. What other living landscape element, but the tree, can form a link between the past and the present as well as a projection into the future?

URBAN VEGETATION CONCERNS

Our concerns regarding existing vegetation in or outside the settlement area are many and varied. The conservation of valuable remnants of the natural forest and of urban horticultural plantings must be high on the list. Technology and public apathy both offer threats to this conservation project. The biggest threat is the lack of public understanding of the benefits which ecologically based management can offer. *Only* through management procedures is it possible to secure the continuous flow of benefits from the forest. Left alone, stagnation will occur in the forest; it will become even-aged, uniform and overmature, waiting for a natural disaster (fire, insects or disease) for its rejuvenation. Management alone can secure an uneven-aged, healthy forest with a continuous flow of benefits.

Another concern relates to the permanency of land use required for forestry. Forests, and for that matter individual trees, require long-term unobstructed land tenure for their full development. It obviously takes 100 years of growing to get a 100-year-old tree - - there are no instant trees! Further, these 'youngsters' who may serve for centuries into the future require space for both crown and root development. The competitive land prices and the requirements for service lines are major considerations in the dedication of lands for vegetation use on a long-term basis. However, the most recent trend in housing development is toward a self-contained unit which provides its own energy and water and waste treatment plants, thus only requiring access roads as a service. This is a development of much promise for urban trees and forests of the future.

The selection and availability of tree species for planting is most important and particularly under Canadian conditions. First, there is the problem of obtaining hardy tree species well suited to specific localities. In the nursery industry, there is presently little understanding of the requirements to meet this goal. All our native tree species cover large areas with varied climatic and edaphic conditions which have led to the development of great ecological variance within the species. Yet, nursery catalogues still classify tree species according to hardiness zones and offer no information relating to provenance or seed origin. Secondly, there is the question of where and how exotic species should be used. Our present city vegetation is to a high degree dominated by what we may call an 'international tree cover', where Asiatic and European species dominate over native species. This is not solely a Canadian condition. It is common throughout the western world. It should, however, be of special concern when we also meet these same exotic trees along our highways with a backdrop of native trees, and it may even affect future tourism. Much of the value of the cityscapes is related to the nature of the architecture and the surrounding vegetation. In recent years this architecture has become international, and if we also make and perpetuate the international vegetation used for its landscaping, there will then be very little point in moving from one city to another as a tourist.

The health of city trees under present conditions is a major concern. The most widely distributed cause for decline is the lack of proper space allocation for trees in street planning. Street trees are continuously abused by construction and by road salt, leading to total or partial loss of vegetation which should have served for years to come. Because of the growing conditions, urban trees are also particularly susceptible to attack by otherwise minor pests and disease-causing organisms. Finally, there is the threat of introduced diseases like the Dutch elm disease which has upset the cityscape. A large part of the health problem can no doubt be solved through a change in urban planning, allowing sufficient soil support systems for the root and space for the crown. As a guard against new, introduced, strongly pathogenic diseases and insect pests, a species and genetic variation should be introduced in the urban planning program, as a matter of practice. Only through assuring the widest possible variation will it be possible to guard against future major upsets of the vegetation cityscape.

Trees and other vegetation have, through the times, offered cover and protection for peaceful members of society as well as for the criminal elements. Many people are interested in the relationship between crime and vegetation. In a recent public speech in the U.S., a well-meaning lady suggested that planting of trees in inner city slums would reduce the crime rate. Others have claimed that no vegetation and plenty of light reduces crime. My concern is that this topic is being discussed seriously at all. In my view, crime and slums must be related to human and society shortcomings, rather than to vegetation which by no means is the only cover available to criminals within the cityscape.

One should not underestimate the value of vegetation as a source for local pride. It is this type of pride and the feeling of belonging it creates that, in turn, forms the basis for community existence and is at the root of nationhood.

Another concern related to urban vegetation planning and management is the need for continued and expanded research vis-à-vis the ecologically based management of urban vegetation. This type of research requires the education of researchers who can continue to further develop, in a pragmatically oriented manner, the much needed information gathering and interpretation. It also requires that society be willing to fund this type of activity, both within and outside the government sphere. A first step in achieving this needed support must be obtaining the support of the professions involved in urban planning and government. The second, and not lesser important step, is to back the work with public support.

CONCLUSION

From the review of vegetation functions, needs, and concerns expressed herein, it can be conceived that urban vegetation has a great significance for society as a whole, especially in Canada with an ever increasing rate of urbanization. Problems relating to urban vegetation deserve much greater attention from professionals than has been the case in the past. Foresters, horticulturists, agriculturists, architects, medical doctors, ecologists, geographers and social scientists all have to provide input before the ideal urban vegetation can be created within the Canadian settlements. What is needed for the creation of a proper, ecologically based, urban forest management is a truly interdisciplinary team effort.

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THE SIGNIFICANCE OF THE ATMOSPHERE IN PLANNING HUMAN SETTLEMENTS

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ABSTRACT

The paper outlines the importance of incorporating atmospheric considerations in the design of settlements. It stresses the need to realize that the interaction between the atmosphere and the built environment is characterized by a feedback loop; the regional climate imposes constraints upon the nature of the settlement, and the nature of the settlement evokes a change in the local climate. Some of the fundamental aspects of these interactions are reviewed before consideration is given to how this information can be incorporated into the design of urban areas.

RÉSUMÉ

Le présent document montre l'importance de tenir compte des conditions atmosphériques lors de la conception des établissements humains. Il insiste sur le besoin de se rendre compte des interactions continues entre l'atmosphère et le milieu artificiel; en effet, le climat régional impose des contraintes à ce dernier qui, en retour, entraîne un changement du climat local. Certains des aspects fondamentaux de ces interactions sont examinés, après quoi l'auteur prend en considération la façon d'incorporer ces informations dans la conception des régions urbaines.

INTRODUCTION

The interaction between the atmosphere and human settlements is an example of a *feedback system:*

$$\text{CLIMATE} \rightleftarrows \text{SETTLEMENT}$$

The impact of the climate upon a settlement has long been recognized, and planners, architects and engineers have incorporated these constraints into their respective operations. The reverse impact of the settlement upon the climate is often more subtle and less well appreciated. These feedbacks can be positive or negative (i.e. they can operate to further aggravate a climatic impact, or they can reduce it). Therefore, in planning for amenable biophysical climates in settlements, it is necessary to take account of existing atmospheric conditions *and* to be able to predict what the future climatic characteristics will be after urban development.

This paper reviews elements of both of these impacts with special emphasis upon the less well understood, inadvertent modifications produced by urbanization. It thereby identifies the most pertinent climatic characteristics to be included in any biophysical inventory for urban planning purposes.

IMPACT OF CLIMATE UPON SETTLEMENTS

The 'built' environment satisfies the basic, and almost forgotten, need for shelter. This is required to protect the inhabitants from undesirable weather elements such as high winds and precipitation, and also to provide a comfortable interior climate that imposes the least thermal stress. These primary needs relate to the safety, health and comfort of the occupants, but increasingly we are also aware of the value of optimizing conditions in terms of economic operations, transportation, water resources, recreation, etc.

To a large extent, the primary needs are well understood and are reflected in the traditional building forms which have evolved in different climates on a world-wide basis. In Canada, the essential components are also embodied in the recommendations and requirements of the National Building Code.

The most important climatic elements which enter into building considerations are listed in Table 1 in conjunction with the practical features upon which they have the greatest bearing. Any inventory of climatic characteristics for urban planning should therefore include at least these parameters. Much of the general information required can be obtained from the standard networks operated by the Canadian Atmospheric Environment Service, if a suitable location is available. If not, recourse must be made to techniques of extrapolation between existing stations and/or the installation of new stations.

Table 1: The most important climatic elements having an impact upon the built environment.

ELEMENT	APPLICATION/IMPACT
1. Solar Radiation	Daylighting, external heat loading, solar energy potential.
2. Temperature	Heating/cooling demand (heating or colling degree-days, frost-free days), heat stress on structures and organisms, permafrost alteration, inversion climatology.
3. Wind	Wind loads on structures and organisms, building ventilation, air pollution dispersal, heat loss from structures and organisms (including wind chill), snow drifting and dust transport, impaction of driving rain.
4. Precipitation	Flooding, storm sewer design, snow loading, icing of structures, dampness, water-logging, urban hydrology.
5. Humidity	Fog, interior damp and condensation, comfort, pollutant transformation.

The latter should be allowed to operate for a minimum of three to five years, and analysis of surrounding stations should be conducted to ascertain the representativeness of the observation period compared to normals. Ideally, shorter-period spatial sampling should be conducted to ascertain areal and vertical variability at the site. Such micro- or local-scale surveys are especially important in respect of the temperature and wind fields.

As mentioned, these features are often recognized in historical or legislated building practices at the individual building scale. Unfortunately, it is rare to find such considerations being incorporated into the total settlement planning process.

IMPACT OF SETTLEMENTS UPON CLIMATE

The process of urbanization affects to some extent every climatic element listed in Table 1 (i.e. the construction of a settlement leads to inadvertent modification of the atmosphere).

Alteration of the surface and atmospheric properties leads to a disruption of the natural solar energy and hydrologic cycles which determine the nature of local climates. Urbanization is inevitably associated with changes in the atmospheric pollutant loading (leading to effects upon radiation transfer and cloud droplet growth), the surface fabric (leading to the surface becoming a better heat store and a poorer water store), the surface geometry (making it aerodynamically rougher, and a radiative trap), and the availability of anthropogenic heat and water due to combustion. The average annual magnitude of the climatic changes for a large city are given in Table 2. Although some of these modifications may not appear to be very significant on an annual basis (e.g. only a 1°C increase in air temperature), they can be quite startlingly expressed under certain conditions for shorter periods, and we will consider these in more detail.

Table 2: Weather changes resulting from urbanization (modified after Changnon, 1974). Average changes expressed as percent, or magnitude, or rural conditions.

PARAMETER	TIME PERIOD		
	Annual	Cold Season	Warm Season
Solar radiation	- 22 %	- 34	- 20
Air temperature (°C)	+ 1	+ 2	+ 0.5
Relative humidity	- 6 %	- 2	- 8
Visibility (frequency)	- 25 %	- 34	- 17
Fog (frequency)	+ 60 %	+100	+ 30
Wind speed	- 25 %	- 20	- 30
Cloudiness (frequency)	+ 8 %	+ 5	+ 10
Rainfall (amount)	+ 14 %	+ 13	+ 15
Snowfall (amount)	± 10	± 10	-
Thunderstorms (frequency)	+ 16 %	+ 5	+ 30
Pollution (Vol.)	+1000 %	+2000	+500

Radiation

The presence of an increased amount of air pollutants (gaseous, liquid and solid) in the atmosphere over cities leads to greater absorption, scattering and reflecting of incoming solar radiation. This reduces the overall amount of energy reaching the surface, alters the spectral composition of the radiation and changes its directional characteristics. In heavily polluted districts, the total attenuation can be at least 30% compared with surrounding rural areas over short periods, as shown by

East (1968) for Montreal. The filtering is selective so that the shortest wavelengths are preferentially removed. In Los Angeles, up to 90% of the ultraviolet radiation may be lost by the time it reaches the surface. These wavelengths are important in the production of photochemical smog due to the photodissociation of NO_2 into NO and O in the present of reactive hydrocarbons. The loss is also important to animal and plant life at the surface which at least partially depend on the availability of ultraviolet radiation. Finally, because of the increased scattering and reflection from particles, the incoming and radiation has a greater proportion of diffuse-beam (from all points in the sky hemisphere) rather than direct-beam (parallel rays from the solar disc) compared with a cleaner atmosphere. This is potentially helpful in daylighting considerations, but detrimental in terms of urban visibility.

Temperature

Settlements are characteristically warmer than their surroundings, exhibiting an urban 'heat island' effect. Although this may be small on an annual basis (Table 2), it can be very much more pronounced under certain weather conditions (weak winds and cloudless skies). Vancouver, for example, has a heat island of 1 - 2°C based on annual means, but on individual occasions it can often be greater than 5°C (Figure 1), and under ideal conditions can attain almost 12°C (Figure 2). The exact spatial morphology of the near-surface heat island is directly related to land use, building density, topography and the presence of water bodies for each city. In general, however, the heat island exhibits a 'cliff' (zone of steep temperature change) on the urban/rural boundary, pockets of relatively warm (or cool) air associated with dense buildings (or open space) within the urban area, and a 'peak' (maximum temperature) in the downtown core. Even small settlements show this effect (see the heat island over the University of British Columbia campus which is separated from the city - extreme left of Figure 2). The heat island waxes and wanes on a daily basis, being largest in the early nighttime and smallest near midday.

The heat island discussed to this point relates to that in the *urban 'canopy' layer* (the air below roof level). The effect also extends up into the *urban boundary layer* above the city. The

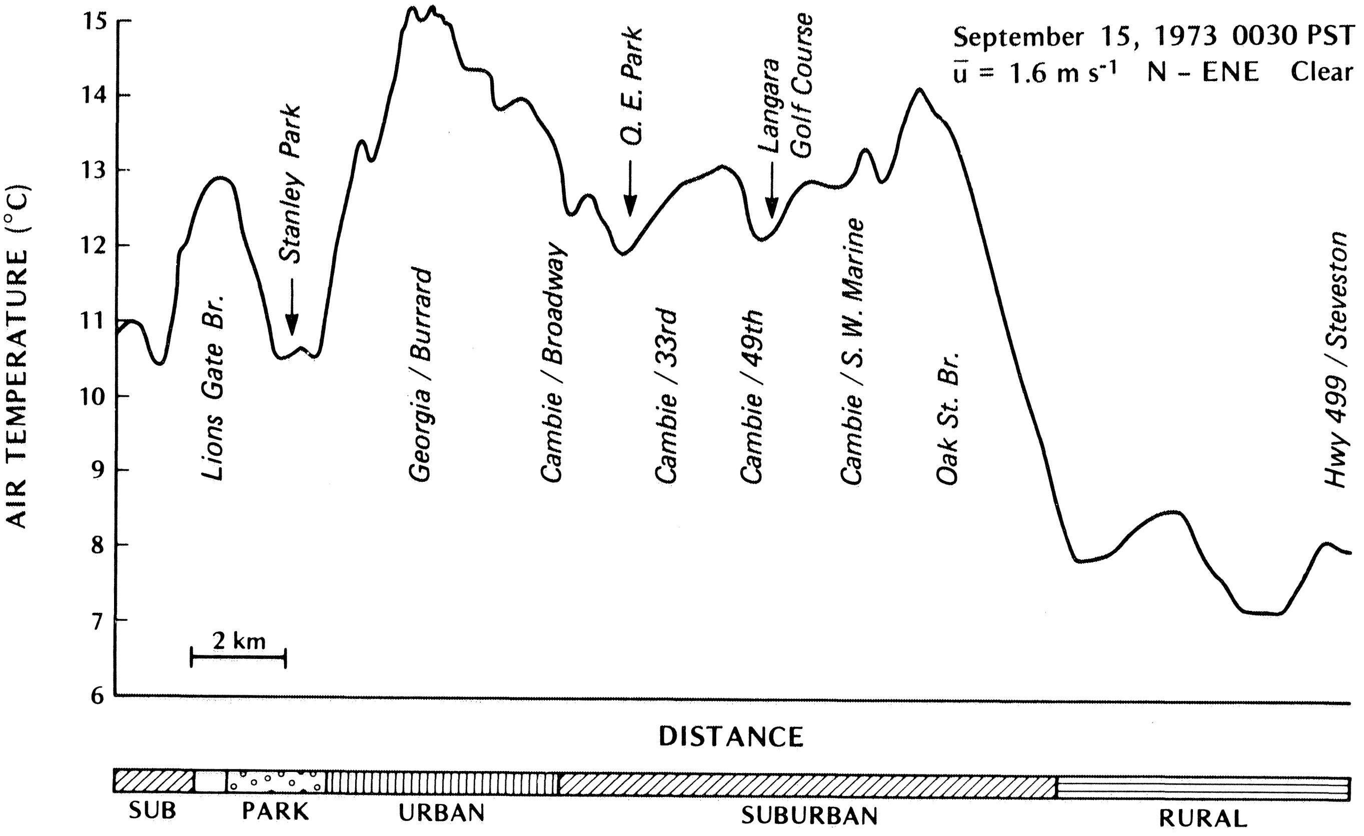


Figure 1: Air temperature cross-section of Vancouver, B.C., obtained by automobile traverse at night with weak airflow and cloudless skies (after Hay and Oke, 1976).

warmer air is advected by the wind giving an urban 'plume' in the downwind region, or in calm conditions it forms an urban 'dome' (Figure 3). Over the centre of the city, the affected layer may be of the order of 0.1 to 0.3 km at night (or in the winter in very stable air masses), and by day it expands to a depth of 0.6 to 1.5 km. Within this layer, the size of the heat island effect decreases with height, becoming zero or even negative at the top. Almost invariably the layer is capped by an elevated inversion. The excess warmth is often traceable to distances of at least 30 km downwind. Because of the urban heat island, heating demands will be decreased (by approximately 10% in most Canadian cities - Summers, 1974), the frost-free period is increased (giving earlier germination and blooming, a longer growing season, and more favourable animal habitats); on the other hand, summer cooling demands are also increased along with human heat stress. The vertical temperature structure leads to the development of an unstable or weakly stable urban boundary layer at all times (i.e. day and night) within which pollutants tend to be almost uniformally mixed. However, the mixed layer is capped by a stable layer, which inhibits further

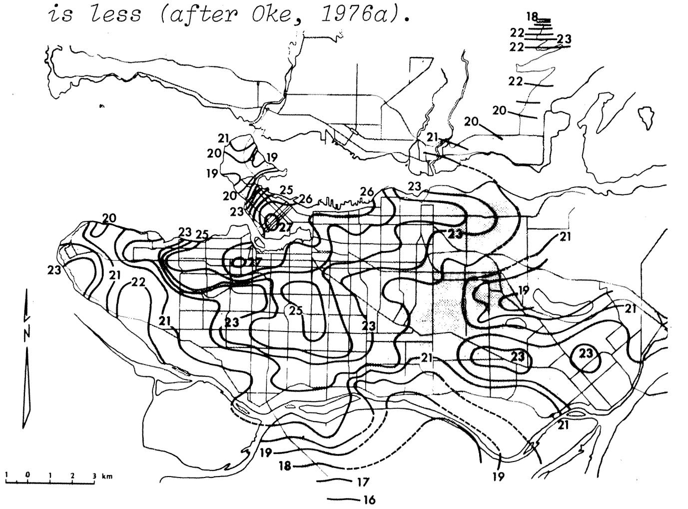


Figure 2: Air temperature distribution ($^{\circ}C$) across metropolitan Vancouver on 4 July 1972 at 2000 PST, with weak winds and cloudless skies. The map is based on the results from six automobiles traversing the area to provide approximately 500 data points. The heat island intensity is the largest yet recorded in this city. It is not 'typical' therefore, but the form of the heat island conforms to that under less ideal conditions when the urban/rural temperature differential is less (after Oke, 1976a).

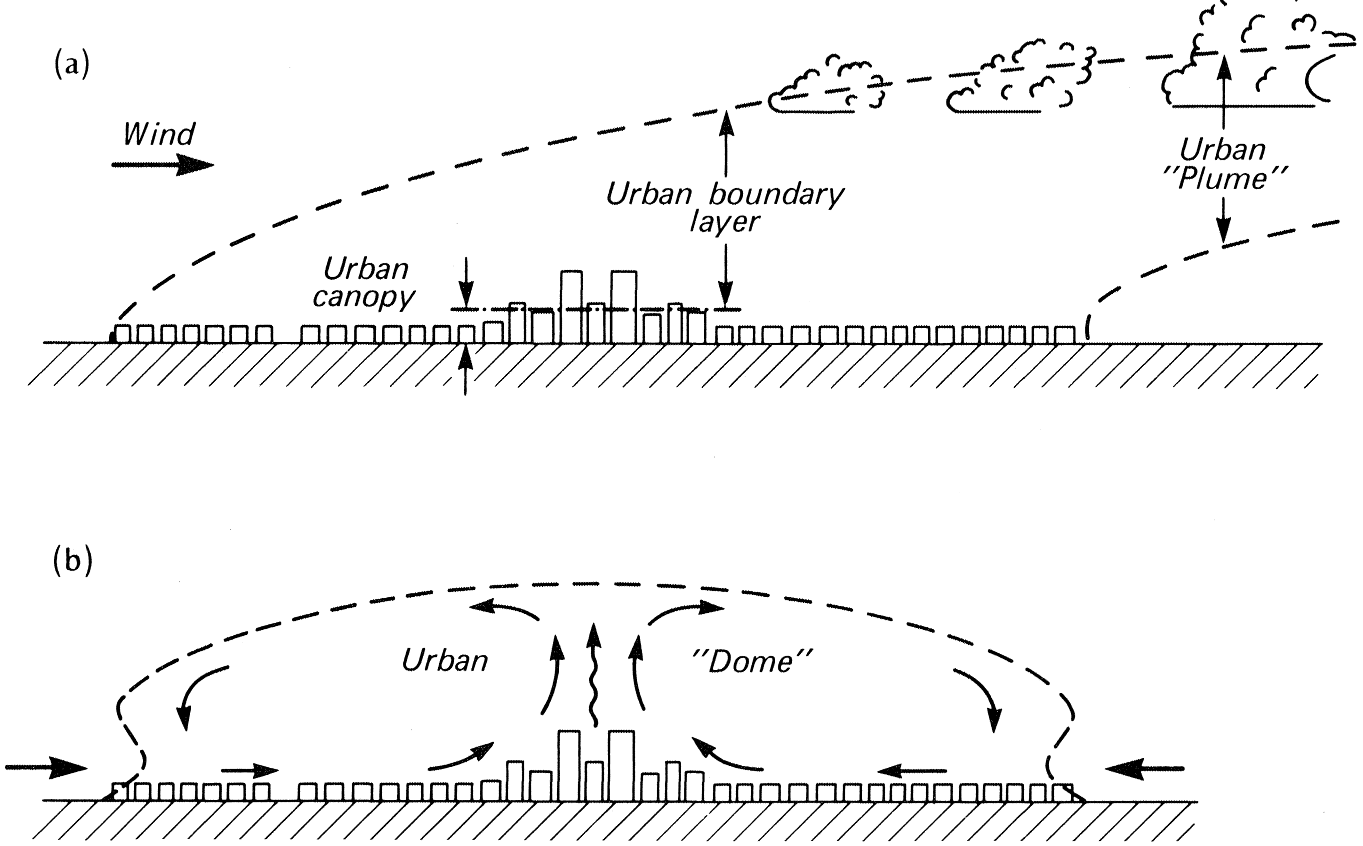


Figure 3: Schematic representation of the form of the air layer modified by a city: (a) with steady regional airflow; (b) in calm conditions (after Oke, 1976b).

upward dispersion.

Wind

Within the canopy layer, wind speeds on the average are reduced (Table 1) due to the greater frictional retardation exerted by the rougher urban surface. There are three significant cases, however, when this general rule is reversed. First, if the wind is blowing parallel to the street orientation, along-street 'jetting' is possible. Second, tall buildings protruding well above the level of the surrounding structures can deflect the faster moving air at higher levels down to the ground (Figure 4). The pressure of the wind produces a stagnation point about three-quarters of the way up the windward wall (where the flow is actually brought to a standstill). Air diverges from this point, with some passing over the top and producing a vortex in the lee of the building with a negative pressure near the top of the leeward face. This can be sufficient to pluck windows and cladding panels off the structure. The rest of the flow streams down the windward face. When it reaches the ground, some escapes around the building edges at the base ('corner-streams'), some joins in a vortex between the building base and the next building upstream, and if passageways are available under the building some will rush through beneath ('through-flow'). In each of these zones, low-level wind speeds are increased compared to those at the same height in the open (see the numbers in Figure 4), and are therefore considerably greater than those in nearby sheltered streets. Since the force exerted by the wind increases as the square of its speed, a threefold increase of speed is associated with a ninefold increase in force. This explains why winds around buildings have been sufficient to knock pedestrians down. The winds are also responsible for increased windchill in cold climates, swirling masses of debris (leaves and litter), and massive snow drifting. Plazas, designed as pleasant meeting places around such buildings, often become the location of the most hostile local environment.

The third example of urban wind enhancement occurs when regional winds are almost calm. Under these conditions, the heat island is usually well developed and the associated pressure distribution induces a circulation system not unlike a land and sea breeze system. Air converges upon the city centre from all directions at low-level. Over the centre there is uplift and aloft the flow diverges to give an upper level counterflow towards the countryside, where it subsides to joint the inflow, thereby completing the circulation. The system is self contained and the circulation of pollutants in conjunction with the heat island takes on a domed appearance (Figure 3(b)).

Taken overall, however, the greater roughness does result in a deceleration of air traversing the city, and increased turbulence. From continuity considerations, if the air slows down the tendency for mass convergence will be re-

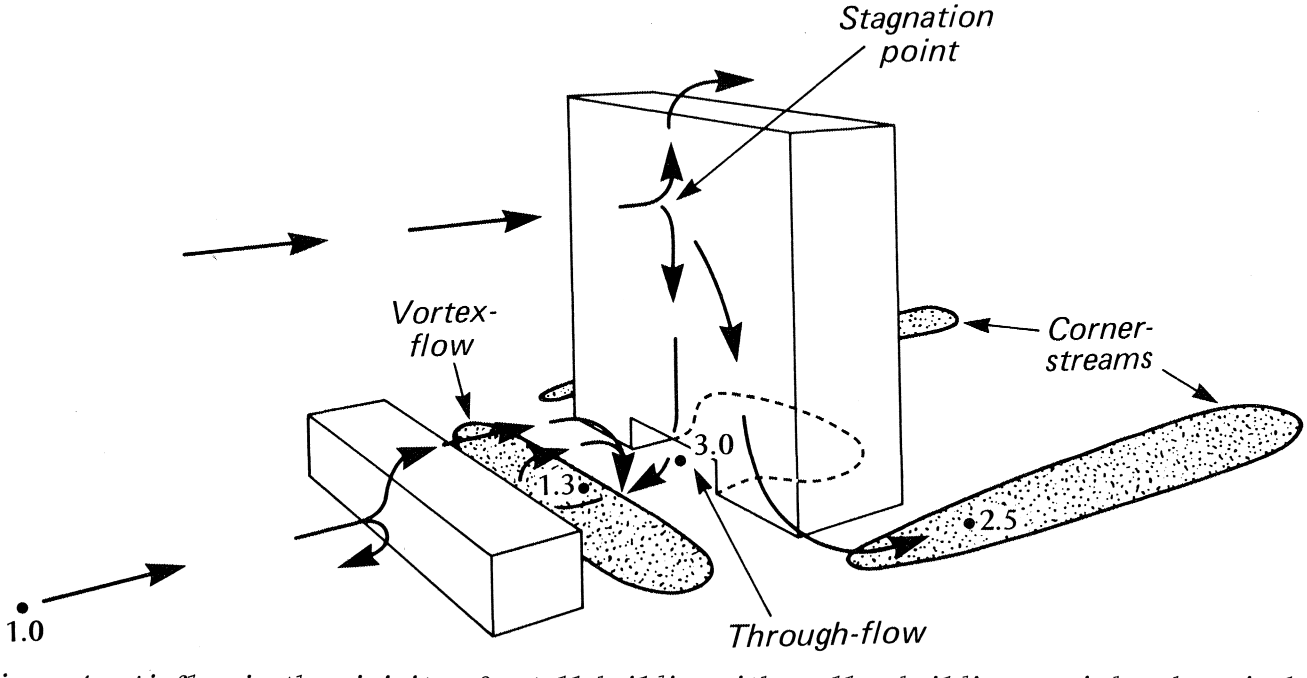


Figure 4: Airflow in the vicinity of a tall building with smaller buildings upwind. The stippled areas delineate areas of substantially increased wind speed at pedestrial level (modified after Penwarden and Wise, 1975).

lieved by uplift. It will also be associated with a turning in the wind direction as the flow adjusts to a new set of forces of motion. All of these changes have a bearing upon the transport and dispersion of pollutants in the urban atmosphere as compared with that over rural terrain.

Precipitation

The growing consensus is that large urban areas can enhance cloudiness and precipitation (Table 2). The increases are usually found in the downwind rural area rather than in the city. The modification seems to be mainly associated with precipitation produced by severe weather. In addition to an increase in amount of rainfall, the quality of it downwind is often changed due to the addition of urban pollutants in solution or suspension (e.g. acid rain). The combined changes can be sufficient to affect crop yields (Changnon, 1973). Within the urban area, the most important water changes are due to the waterproofing of the surface, which accompanies construction. This leads to a reduction in soil moisture storage and a faster hydrologic response time for runoff following a storm.

Humidity

Relative humidity is almost always lowered by urbanization (Table 2). Because this parameter is temperature dependent (decreasing with increasing temperature), the urban heat island effect overshadows any real change in moisture content. A better measure of actual moisture is the *absolute humidity*. Figure 5 shows that during the fine summer weather there is a diurnal reversal of urban/rural humidity differences: the city air is drier by day and moister by night than the environs. The daytime decrease in the city may be due to reduced evapotranspiration, and the nocturnal increase may be due to reduced dewfall, greater moisture from combustion, stagnation of humid air in the canopy layer, and other factors. At high latitudes, the city in winter may remain more humid throughout the day. This may be due to the fact that whereas rural vapour sources are absent (no evapotranspiration from snow or frozen surfaces), the urban area is the site of considerable vapour input as a by-product of combustion for space heating and other needs. However, the low saturation vapour capacity of cold air may lead to extra fog in the city. At temperatures below $-30^{\circ}C$, combustion by-products directly contribute to the formation of ice fog.

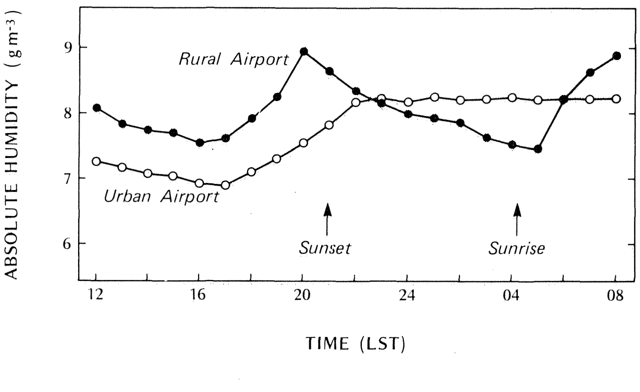
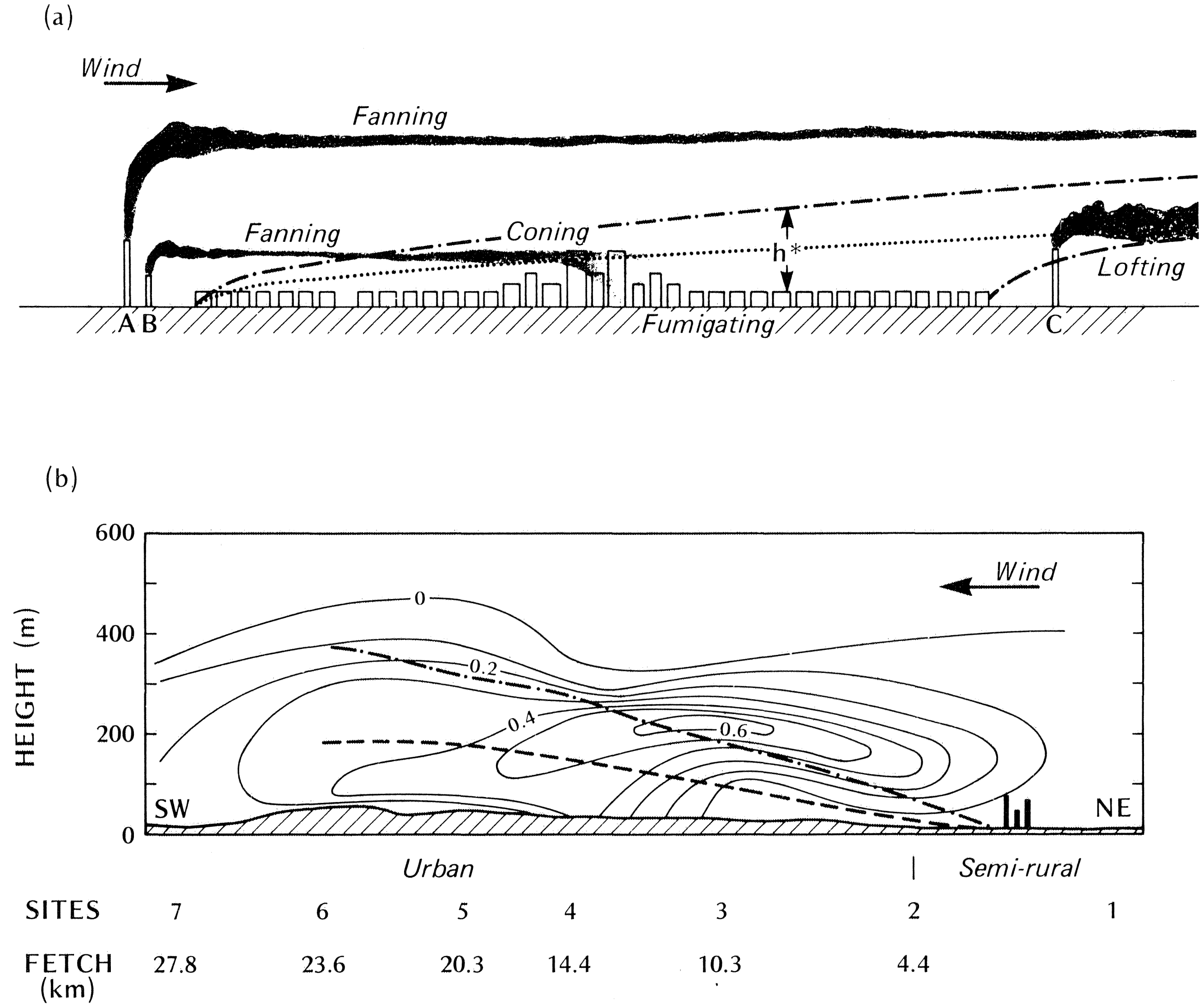


Figure 5: Diurnal variation of urban and rural absolute humidities at Edmonton on 30 fine summer days (after Hage, 1975).

Pollution

Although severe pollution problems can exist near remote industrial processing plants, urban atmospheres are generally more polluted than those of rural areas. Because of the modified urban climate, air pollutants are dispersed, transformed and removed in a manner different from that in a rural location, and this should be appreciated when siting new urban sources. Further, pollution sources placed outside the urban limits may contribute to poor air quality inside the settlement because of the urban heat island effect. For example, consider the plume from rural stack A in Figure 6(a). If the emissions enter a stable atmosphere, they are inhibited from spreading up or down and the lack of turbulence does not break up the plume, so that it 'fans' as a concentrated ribbon travelling with the mean wind. From the point of view of ground-based receptors, the plume is relatively harmless at this time. If the pollutants are emitted at a lower level (e.g. stack B), the plume initially 'fans', but the state of the atmosphere changes when it encounters the urban boundary layer. The greater roughness and reduced stability in the urban atmosphere lead to greater turbulence. This provides a means of diffusing the plume contents, and in the lowest layer, where the heat island causes instability even at night, there is sufficient convective activity to transport it to the ground (i.e. it 'fumigates'). An example of this situation is illustrated in Figure 6(b). It shows conditions in Montreal in the early morning following a cloudless night with light winds. Nocturnal surface cooling produced a stable rural atmosphere, into which the plumes of the oil refineries of east Montreal were emitted. The SO_2 concentrated isopleths show the pollutants to travel with the wind toward the city. Initially they appear to travel upwards, but about 12 km from the upwind urban/rural boundary they intersect the urban-modified layer and the plume axis is turned

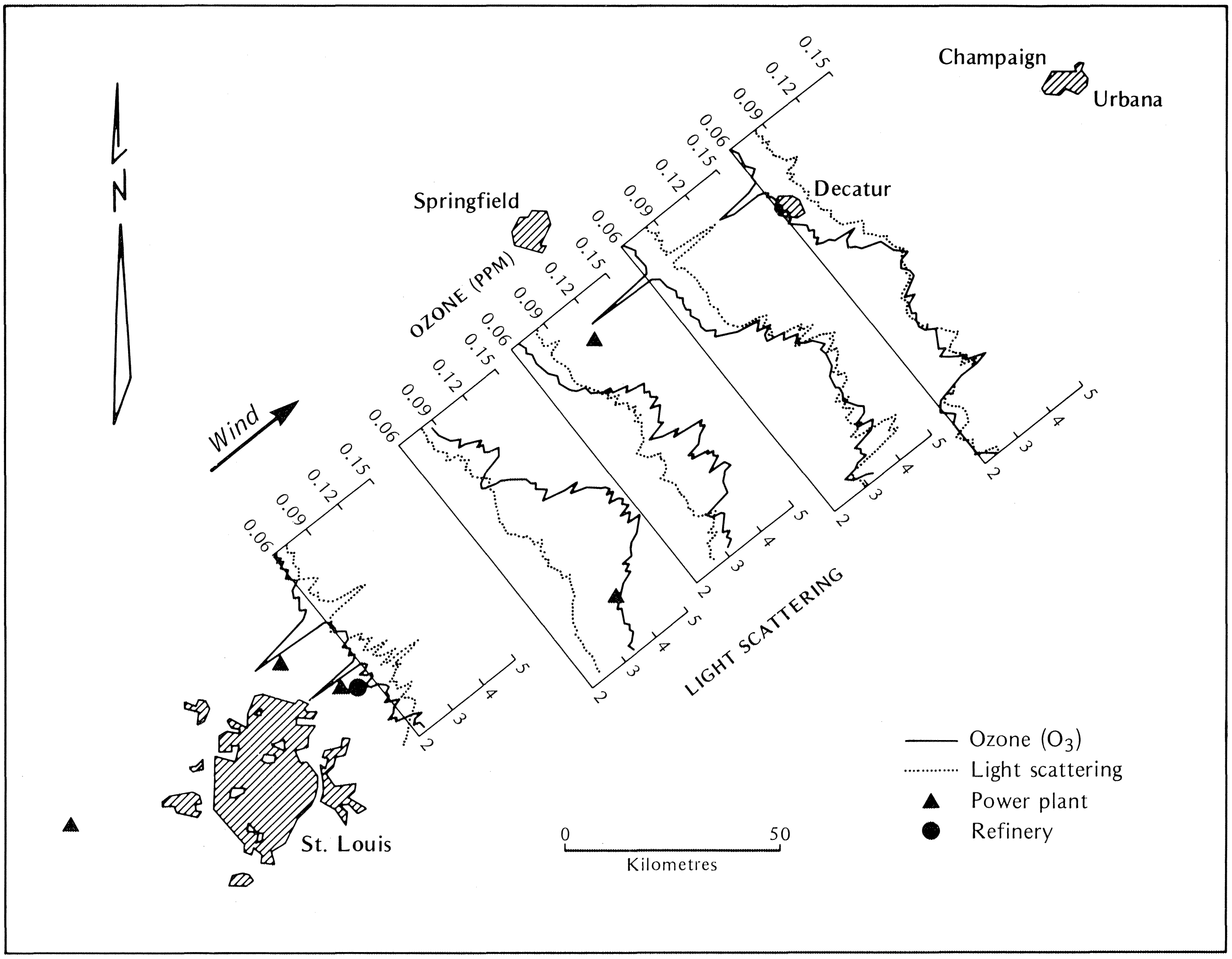
Figure 6: Interaction between plumes from rural pollution sources and the nocturnal urban boundary layer of a large city. (a) Hypothetical cases, (b) observed SO_2 concentrations (ppm vol.) at Montreal on 7 March 1968 at 0700 EST, based on along-wind helicopter profiles. In both (a) and (b) the dash-dot line represents the height of the urban modified layer (h) and the lower layer is the truly unstable portion of the urban heat island (modified from Oke and East, 1971 and Oke, 1977).*



downward, resulting in relatively high SO_2 concentrations in the city centre. Conversely, stack C in Figure 6(a) is downwind of the city and ideally placed to 'loft' its effluents into the unstable urban 'plume'. However, should regional winds become calm and a city wind system form (Figure 3(b)), both stacks B and C would contribute to pollution build-up inside the urban 'dome'.

The contents of the urban plume are also advected to considerable distances downwind. In the example of St. Louis (Figure 7), the plume can be seen to extend to *at least* 175 km. Also, although the plume width expands at greater distances (it is about 50 km wide at Decatur), the peak concentrations of ozone (O_3) and light-scattering aerosol are actually *greater* than near their source. This clearly indicates that these are secondary pollutants formed by photochemical reactions during downwind transport. Therefore, if these substances are brought to ground-level, locations distant from the source region will experience the highest dosages. This has also been demonstrated in the Los Angeles Basin (Pitts, 1969) and the Fraser Valley (Sagert and Tennis, 1975). Long-term planning of developing urban regions

Figure 7: The pollution plume of St. Louis, on 18 July 1975 as defined by the concentrations of ozone (O_3) and by light-scattering (by aerosol). Data gathered by an aircraft traversing the plume as it progressed downwind (modified after White et al., *1972).*



should therefore anticipate downwind changes in climate (especially for precipitation and air quality) for rural areas as well as for the built-up area.

The rational assessment of sites for urban development (either for new towns, for re-development or for extension of existing settlements) must involve a full inventory of present local and microclimatic characteristics, and some attempt to extrapolate into the future to anticipate the affects of inadvertent modification. Although the latter is unfortunately somewhat hampered by the fact that urban climate is not yet a truly predictive science, a number of simple rules-of-thumb are beginning to emerge. For example, Figure 8 shows statistical relationships which allow estimation of the maximum size of the heat island

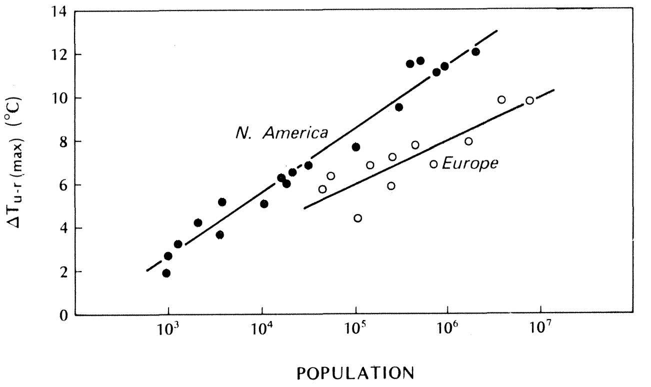


Figure 8: The relationship between the maximum heat island intensity ($\Delta T_{u-r(max.)}$) *and settlement size as measured by population (modified after Oke, 1973).*

effect based on a knowledge of the population of a settlement. Also, the Building Research Establishment in Britain find that complaints about the wind climate around buildings arise if the structure is greater than 25 m in height (approximately six storeys), or if it is more than twice the height of the surrounding structures.

Such practical guidelines are the outcome of a synthesis of past case studies. Much of the present research in urban climatology is aimed at an elucidation of the underlying physical causation of climate modification. This knowledge can then be used as the basis for the construction of *numerical simulation models*. When refined, these hold the promise of mimicking present climates. By the appropriate manipulation of surface or atmospheric characteristics, they can provide estimates of the modification to be expected as the result of undertaking a variety of land use or air pollution management strategies. To some extent this is already possible in the case of urban airflow by using scale models in a wind tunnel (Figure 9).

INCORPORATION OF CLIMATIC INFORMATION INTO URBAN PLANNING

Original Siting

Climatic information *must* enter into the biophysical inventory which should precede the development of detailed plans for completely new settlements. Sensible use of a proper data base should ensure that the most favourable aspects of the atmospheric environment are used and that negative features are avoided. Unfortunately, these features are not always mutually exclusive. For example although a valley location may be favoured on the basis of shelter from winds and a generally warmer thermal climate, in fine (often anticyclonic) weather the valley location is prone to frost and fog, and the air pollution potential is unacceptably high. Coastal locations are plagued by similar dichotomies. The climatic influence of a large water body is usually favourable because it imparts a conservative thermal influence and it maintains a supply of fresh air when flow is from the water to the city. When flow is in the opposite direciton, the water acts as an

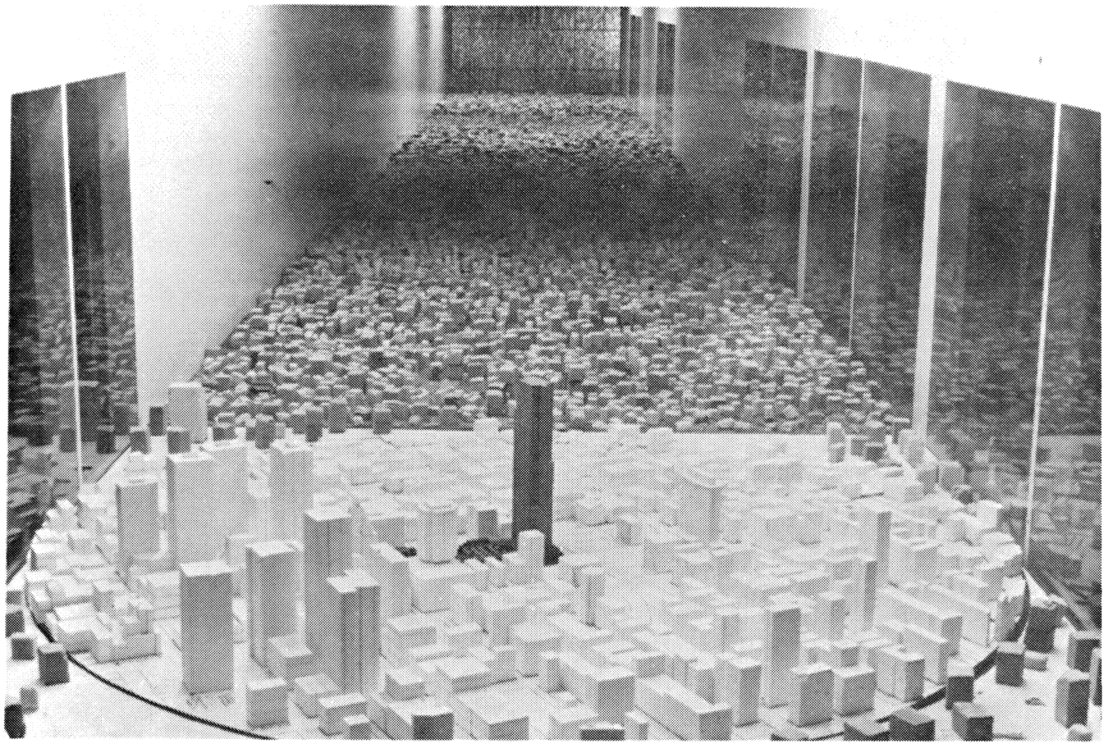


Figure 9: Scale model of central Vancouver in the environmental wind tunnel at the University of Western Ontario. Note that the roughness of the upwind urban terrain is also simulated, and that the area of interest is mounted on a rotatable platform so that different wind directions can be modelled. Flow around the planned tall dark building was being studied (photograph courtesty A.G. Davenport).

uninhabited zone with potential as a pollution sink. With weak synoptic winds, however, coasts are characterized by the development of land and sea breeze systems, with essentially enclosed circulation and poor dispersion conditions (Lyons, 1975).

Settlement location should also consider adjacency to other urban centres (or those projected). Failure to do so may lead to harmful interactions. If the spacing between cities is insufficient, their alignment with the wind may give a cumulative pollution build-up. This is already evident in the megalopitan area of the northeastern United States where the combined emissions from many cities can be traced well out over the North Atlantic Ocean as a giant 'plume'. The plume from one city can also become fumigated into the atmosphere of a second one downstream in the same manner as the stack plume illustrated in Figure 6.

There are a few Canadian examples of new town plans which incorporate some climatic considerations. These include the resource towns of Kitimat, B.C. (Anon., 1954) and Fermont, Quebec (Clunie, 1976; Schoenauer, 1976) and the projected city of Townsend, Ontario (Munn *et al.*, 1972). The Fermont plan identified winds as the most unfavourable aspect of the subarctic climate at this location and designed the settlement to provide shelter for the inhabitants.

Internal Arrangement

Climate should also enter into decisions concerning the morphology, and spatial arrangement of functions, within the settlement. Air pollution is of particular concern, and the siting of urban *and* nearby rural sources should be combined into a regional control strategy. Such a system is greatly aided by the provision of a real-time monitoring and alert network, such as that operated by the Air Management Branch of the Province of Ontario. One innovation which should be investigated in Canada is the use of a single central heating plant for settlements. In Sweden this arrangement has resulted in improvements in both fuel use and air quality. The latter is due to the fact that it is easier to control and filter emissions from one plant than from many domestic furnaces, and because one elevated plume is less likely to contaminate ground-based receptors than are the low-level releases from many low-level chimneys (at least in the local region).

The internal microclimate of the city can also be improved by intelligent use of simple principles. Attention to both the amount and spatial arrangement of green space can be particularly beneficial. Vegetation can provide an air-conditioning role by providing cooling (Figure 10), filtration of pollutants, and noise reduction. There are also a number of reasons why considering the nature of the urban geometry can be beneficial. Street orientation can be utilized to provide increased ventilation of pollutants from low-level sources such as automobiles, or conversely to provide maximum shelter for the inhabitants and to minimize heat loss from buildings. Similarly, the geometric arrangement of building groupings and the height-to-width relationship of streets can be optimized to aid energy conservation, light availability, snow drift accumulation, and the general comfort of pedestrians.

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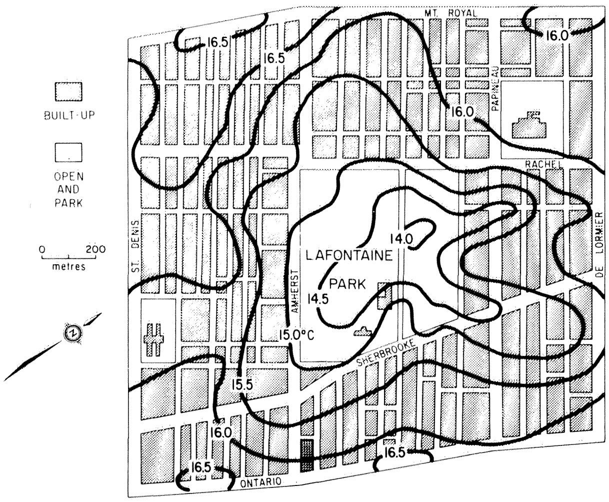

Fgiure 10: Temperature distribution in the vicinity of an urban park in Montreal. Note how the greater evapotranspiration in the park produces a pool of cool air which is advected by the SW wind into adjacent built-up areas at least four blocks downwind (after Oke, 1972).

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WILDLIFE NEEDS AND CONCERNS IN URBAN AREAS

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INTRODUCTION

The number and variety of wildlife species found in any area will depend on the diversity of habitats. The greatest diversity occurs in rural environments where there are small clusters of buildings, cultivated farmland, meadows, regenerating fields, small coppices of woodland, streams, marshes and denser, large wooded areas. That is usually the state before urbanization occurs, and as such, a wide range of wildlife can find suitable habitat. The results of urbanization are clear to everyone - the landscape is simplified and many vegetated areas disappear. As well as the reduction of species from loss of habitat, there are some birds and mammals that cannot tolerate the disturbance from the increased human population. Records over a 140 year period for an area on the outskirts of London, England show that as urbanization grew from 1% to 100%, breeding bird diversity decreased from 72 species to 20 species (Batten, 1972).

To retain a wide variety of wildlife in an urban environment, it is necessary to preserve, or to recreate, as wide a variety of natural habitats as possible. The requirements of wildlife can be stated quite simply as food, shelter and breeding habitat. However, the subject is more complex than is implied and involves a number of underlying principles of ecology and wildlife management. We must bear in mind that wildlife consists of an extremely wide range of species, more so if we include native plants, amphibians and reptiles as well as the usual birds and mammals. Many of the species have their own special requirements. I would like to expose a few management concepts that are inherent in the basic requirements of food, shelter and breeding habitat, and introduce some considerations a biologist must bear in mind when trying to integrate wildlife habitat into an urban environment. Finally, I would also like to touch on some of the concerns for wildlife in urban areas, both the effect people have on wildlife and the effect wildlife and its habitat have on city people.

The basic requirements that any habitat must offer to attract and maintain any wild creature are food at the appropriate time of year, shelter in which to rest and to escape predators and the elements and habitat in which to breed (i.e. carry out courtship activities, nest and raise young). Water is also essential, but in most Canadian cities is seldom a limiting factor. Marshes and rivers are essential habitat for aquatic or semi-aquatic species, but water requirements for most terrestrial species are not a problem.

WILDLIFE NEEDS

1. Food - What are the food requirements of wildlife and how can they be supplied in urban areas? Most foodstuffs are supplied by or related to the vegetation, but that is just the beginning. Many wildlife species are specialized in their food requirements or feeding habitats. Dabbling ducks - those that tip up to feed rather than dive under - require shallow marshy areas for seeds of aquatic plants and bottom-living invertebrates. Diving ducks can feed in deeper waters eating insect larvae, small fish and invertebrates further offshore. Many bird groups have specialized diets such as seed eaters, birds of prey, carrion eaters and wading birds. Urban-adaptable mammals such as squirrels, groundhogs, rabbits, raccoons and skunks are perhaps less specialized in their food requirements than birds, and in fact can become quite adapted to such things as garbage cans and vegetable gardens. Although the foregoing animals offer a wide and frequently abundant food source to their natural predators foxes and wolves, the latter normally lack sufficient shelter and denning habitat where they can escape from human disturbance. Where there are sufficient ravines and large wooded areas, foxes can exist in urban areas but their movements are greatly inhibited, preventing them from exploiting or controlling the prey species that may be in the area.

Although food is an obvious necessity to attract wildlife, the variety of natural foods available in urban areas as a result of present management and cultural norms is greatly altered from the rural conditions:

1) Lawns in parks are kept clipped and weeded, resulting in few grass seeds and a low number of insects. Granted it would not be possible to let fields of weeds take over the parks, but corners and alcoves could be left where the grasses could grow to maturity. Such wild corners with clever designing could even be treated as an attraction.

2) Shrubs and understory vegetation in public lands are frequently trimmed out removing food species and habitat for insects and important cover for nesting and shelter. Highway interchanges and roadside verges in urban areas are particularly sterile areas under present landscaping and management practices.

3) Smog and air pollution may limit the kinds and number of flying insects, in turn affecting the kind and number of hawking birds.

4) Many exotic plants are used in gardens, parks and roadside plantings instead of native species that are adapted to the area and offer berries, nuts, insects or shelter at critical times of the year. A sampling of insects in suburban gardens in Leicester England led the workers to conclude that gardens are collectively the most important, although neglected, nature reserve in that country (Owen and Owen, 1975).

5) Marshes around urban areas are usually filled in or sprayed regularly with chemicals, eliminating many diverse and rich habitats.

Thus, although natural foods for wildlife can be made readily available in urban areas, it requires a positive, conscious effort to supply a wide variety of food for a wide variety of requirements at strategic times of the year.

2. Breeding Habitat - In addition to an adequate supply of food, there must be suitable areas for breeding activities and nesting. Again we must bear in mind the wide range of requirements that are demanded by wildlife. The situation is not unlike designing a subdivision or community housing project. If you build all one design of houses, they will attract one segment of clientele. A variety of designs in different settings will attract a wider range of customers. The same principle holds for wildlife even to the problem of creating ghettos with their inherent social problems, only it is usually the urban dwellers that suffer from the overpopulation of pigeons, starlings, skunks etc. resulting from the stereotype habitats.

Many wildlife species have specific requirements for nesting or raising their young. Hole nesters such as bluebirds, tree swallows and woodpeckers utilize cavities in old or dead trees; however, such natural nesting sites are swiftly eliminated from urban green spaces in the name of safety and good management. There are numerous situations where dead or dying trees could be left to complete their role in the cycle of life and death. Many other species of insects, amphibians, birds and mammals utilize old and decaying trees for part of their life cycle.

Urban environments for species that build nests on cliffs or flat ledges such as swallows, pigeons and nighthawks offer a number of opportunities and problems. The pigeon was quick to adapt to the many window ledges and cornices of city architecture and quickly became a pest. That problem has largely been overcome by modern architecture through the use of almost flat, vertical surfaces on new highrise buildings. Nighthawks take advantage of the flat roofs in cities for nest sites. In a study done in Detroit, one of the main factors affecting the population of nighthawks was the number of flat roofs for nesting. After that, territorial requirements began to influence population numbers (Armstrong, 1965).

The availability of marshland determines the presence of the many wildlife species that are dependent on that type of ecosystem. Many birds can nest in marsh vegetation (e.g. redwinged blackbird, grebe and marsh wrens), but others such as dabbling ducks, although utilizing the marsh for food, frequently nest a considerable distance from the water in grassy or shrubby areas. An urban community may make the effort to preserve a marsh within its confines, but without sufficient surrounding habitat its attraction to certain wildlife species will be minimized.

Aquatic vegetation, both emergent and submergent, supplies essential food, cover and building materials for wildlife. Many urban communities consider the presence of 'waterweeds' unsightly and would prefer to have their waterways cleared of all vegetation. It is essential to strike a balance.

Height above the ground and density of vegetation are factors that influence the nesting of certain birds and mammals. Rabbits and hares locate their nests in dense underbrush so that they are protected from their many predators. A series of runways through the undergrowth allows the adults to come and go undetected. Certain bird species frequently nest within a band of vegetation at certain heights from ground level while others locate their nests on the ground.

For example, MacArthur (1958) studied five species of warblers that appeared to have similar feeding and nesting requirements. Upon closer examination it was found that two of the species habitually nested in the uppermost cluster of branches of spruce trees, two nested in the median level of branches and the fifth chose the lower portion of the same species of tree. The zones of the tree in which the five species fed corresponded closely to their nesting habits. Those subtle differences need to be taken into account when planning and managing urban habitats for wildlife. The species of warblers under consideration above required stands of spruce and fir for feeding and nesting. Parkland clearing of conifers by cutting out the lower levels of branches and thinning out young trees could possibly exclude one or more species of birds by removing that particular aspect of the habitat that supplies their specific requirements. Likewise, the clearing of underbrush and leaf litter from urban green spaces removes essential cover for ground nesting birds.

Dense, unmanaged plots or corners of vegetation in urban green space systems will offer sanctuaries that may attract some of the shyer species that cannot tolerate too much disturbance during periods of nesting and rearing.

3. Shelter and Escape Habitat - Shelter is less critical than food and nesting habitat since the feeding and nesting areas frequently provide adequate protection from the elements. Shelter is of particular importance during the winter and during periods of dirnal and seasonal movements. Habitat for wildlife in urban areas should be planned as a network rather than in isolated patches. In that way, shelter (from predators) is available when the young are dispersing from parental care, for movements between feeding and nesting areas and for other daily and seasonal activities. In addition to shelter, a network system increases the edge effect of the habitat allowing more interaction for both people and wildlife.

SOME MANAGEMENT AND ECOLOGICAL PRINCIPLES

In addition to the necessities discussed above, there are a number of management and ecological factors that influence wildlife populations. Although urban planners need not know the detailed application of the principles, an understanding of their existence and mode of operation would be of value. Many of the principles may have some relevance, in modified form, to *Homo sapiens* as well.

1. Home Range and Territorial Requirements - Many species of mammals and birds require, and establish, specific areas over which individuals attempt to maintain exclusive control. Such areas have been divided into *home range* and *territory*, of which there are a variety of variations depending on many factors such as time of year, species, population density, habitat features, etc. Home range may be defined as *that area traversed by the individual in its normal activities of food gathering, mating and caring for young*. Territory may be defined as *any defended area*, and is normally part of a home range. Home ranges can overlap to a certain extent but territories do not. The effects of those phenomena on wildlife populations have been postulated as:

1) ensuring an adequate food supply for raising young;

2) a selective process for the survival of the strongest individuals, and thus the survival of the species;

3) a necessity, in some cases, to have a certain amount of conflict to synchronize breeding; and

4) preventing the undue increase of the species.

The number of individuals of a species that an urban habitat will support (*the carrying capacity*) will be affected by territorial requirements as well as the availability of essentials such as food. It is well-known that as competition increases as a result of increased population, territories can shrink but will reach a minimum size (Tompa, 1962). The decreased territory size and increased competition lead to increased aggressive interaction amongst individuals that in turn has a variety of effects on individuals and populations. Robert Ardrey, in his book *The Territorial Imperative*, draws some interesting parallels between *Homo sapiens* and other animal species. Perhaps the drive for single family dwellings and the reaction of people to high-rise apartments are related to territorial requirements.

2. Predator-Prey Relationship - Predators play a natural role in regulating populations of prey species. However, an urban environment is artificial and traditional predator-prey relationships are altered. Foxes, owls, hawks and coyotes are natural predators of many of the urban birds and mammals. However, because it is difficult for predators to range and hunt in a city, their populations are smaller than normal and their influence is decreased. On the other hand, the high incidence of cats and dogs has an unknown affect on wildlife populations. The one reference I was able to locate on the subject noted that feral dogs frequently chased cats, squirrels and birds, although a

capture was never observed (Beck, 1974). Another major predator of wildlife in urban areas is the automobile. Numerous animals are accidentally killed while trying to cross streets. The numbers of hawks and owls that prey on passerine bird populations decrease as urbanization increases. Experiments are in progress to study the reintroduction of peregrine falcons to some urban centres. Many of the birds that inhabit urban areas are insectivorous, but the effect of predation on urban insect populations is unknown. Since urban dwellers tend to get particularly upset by mosquitos, an analysis of the effect of birds on mosquito populations may be interesting. The relationships between predators and prey populations in urban areas is one field that requires considerably more research.

3. Edge Effect - The largest variety of wildlife species is associated with zones of transition from one vegetation type to another. The transition from field to woodland and from water to upland are the primary examples. The greater variety of plants in the ecotone provides more cover and food and thus a greater number of birds and animals can be supported. That is an important principle in developing or preserving green space in urban areas. The greater the length of edge that can be created, the larger the variety of birds and mammals the area may support. It is important to bear in mind, however, that solid stands of mature woodland or open grassland attract species that are unique to that habitat as well. An irregular, wavey border along an urban green space will allow a greater length of edge than a square, straightsided park area.

The needs of wildlife in urban areas can be summarized in the term 'diversity'. The greatest diversity of habitat types available ranging from marshland to quiet, mature woodlands will supply the basic requirements of life for a wide variety of species. At the same time, the natural environment imparts a unique character to its city environs while offering urban dwellers access to a wide range of outdoor experiences.

WILDLIFE CONCERNS IN URBAN AREAS

Concerns relating to urban wildlife issues may be divided into: (1) the influence of urban dwellers on wildlife, and (2) the influence of wildlife on urban dwellers.

One indication of the surge of interest in urban wildlife is the large number of people putting out bird feeders during the winter months. The sale of birdseed has become a multimillion dollar business. The practice of feeding wildlife populations is not limited to backyard feeders, but extends to municipalities distributing hay for deer and corn along river fronts or harbours for waterfowl. Artificial feeding can induce migratory birds to delay migration, or to overwinter in an area in which they would not normally stop. It may also play a part in altering traditional migration routes. Delaying migration may mean that many birds are caught by a sudden onslaught of bad weather or birds may starve if they become dependent on artificial feeding and the source is suddenly removed. In the case of artificial feeding of deer, it can lead to higher than normal survival rates resulting in over-population problems as the number of animals exceeds the carrying capacity of the habitat.

The keeping of exotic mammals, birds, reptiles and amphibians as pets poses the threat of introducing an exotic species into an environment in which there are no biological controls. The examples of the starling and Engligh sparrow are classical.

The presence of wildlife, or its habitat, in urban areas has a variety of direct or indirect influences on urban dwellers. It is the source of a number of passive recreational activities that may be enjoyed through a picture window with the aid of a pair of binoculars and a comfortable armchair or by a short walk in a nearby park. Attracting birds to bird feeders and bird watching are relaxing, educational pastimes of many people in today's cities.

Some of the habits of skunks, raccoons and mosquitos have a considerable influence on some people, frequently out of all proportion to the perceived problem. A large percentage of people in the Canadian urban population become quite upset if mosquitos invade their garden or share the barbecue. If a marsh or stream happens to be nearby, the mosquitos are usually attributed to that source with subsequent political pressure to remove the source or spray with chemicals. The point here is that city people have been isolated from contact with nature and when it does intrude into their routine they may overreact.

The possibility of wildlife acting as a reservoir for disease or health problems in cities is frequently advanced during discussions of urban wildlife. Man is probably in more danger from domestic pets than from wildlife populations in urban areas.

Urban wildlife can be a positive advantage to our educational systems, offering outdoor laboratories and living exhibits for nature study. The teaching of ecology is enhanced with the use of living examples.

There appears to be a correlation between the presence of certain wildlife species and the age and structural composition of various parts of a city (Erskine, 1975). That relationship may be one of the factors that could aid planners in defining or identifying urban environmental quality. Certain plant species such as lichens and some trees can be used as environmental indicators because of their intolerance to certain air pollutants. Biological organisms are similarly used as indicators in water pollution.

Planning for urban wildlife requires establishing and maintaining habitat. The presence of that habitat creates ecological diversity in our cities, creates neighbourhood character, aesthetically enhances an area, frequently increases the value of adjacent properties, helps combat pollution and encourages an ecological awareness amongst city inhabitants.

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SOIL SURVEY CONCERNS IN URBAN AREAS

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These remarks are my interpretation of the experience of the Canada Soil Survey in urban areas, which has been quite considerable in recent years. Some of the views may be taken as those of the Soil Research Institute, others are purely personal opinions, all are from the standpoint of a soil survey correlator.

WHAT IS AN URBAN AREA?

Urban area has different connotations for different people. For many, it is probably the visibly built-up area of towns exceeding a certain size. Others would add the less densely built-up fringe, occluded open space, and idle land in the immediate path of urban expansion. A minority might follow urban influences outward still further to the limit of where they affect land prices and the ratio of farm to nonfarm residences. Indeed, it is doubtful if there is any longer a perceptible urban/rural boundary. The one-time physical entities called *cities*, decaying, reforming and spreading out, have become the more diffuse *urban fields* of Friedmann and Miller (1965), a more useful image of urbanism that would have all of Southern Ontario for example, falling into two or three urban fields. The implication for the Canada Soil Survey is that this entire area be treated as urban surveys, in respect of the information they seek to provide. Defined either in this way, or more narrowly, such surveys do have a few special requirements.

SURVEY ORGANIZATION

Clearly, several kinds of survey organization might serve the purpose equally well. I do not propose to dwell on this subject here except to endorse the need for a team approach. The value of tackling surveys with teams of specialists is well established, although the degree of agency cooperation still leaves much to be desired. The makeup of the team has to be adjusted to the objectives of the survey, whether it be a general- or special-purpose survey. It might include expertise in soils, geomorphology, climatology, hydrology, various aspects of ecology, geotechnical engineering, land economics, and probably more. Ideally, this 'expertise' should be something more than a smattering of on-the-job experience, such as the geomorphology picked up along the way by many soil surveyors. Proper training in the subject makes some difference. Actual involvement in field operations would be heavier for the soil surveyor, geomorphologist and ecologist, lighter for the engineer (depending upon the amount of deep drilling and investigations of performance of existing structures), and still lighter for the climatologist and economist.

The project-planning process in its early stages should involve this wide spectrum of expertise, plus selected information users, such as planners and highway engineers. Too often, these individuals are called upon only late in the game to assist with evaluation of mapping units already set up by the soil surveyor working alone. It will, of course, always be necessary to resist recurrent demands from planners for more detailed work, by pointing out that 1:10,000 scale surveys usually require five times the inputs at 1:20,000.

Streamlined consultative machinery is required to expedite the team approach, to minimize misunderstanding as to individual responsibilities, to minimize bureaucratic hang-ups, and above all to minimize the interminable succession of planning meetings that presently tend to enmesh such endeavors. More flexible coordinated funding arrangements need to be worked out, that would secure continuity of funding from diverse sources for the life of the project, and at the same time would allow a rapid response to needs that are perceived only during the course of the project (such as additional computer hardware, or the need to contract out a special field of the work). These needs seem inevitable no matter how well thought-out the plan.

MAPPING PHILOSOPHY AND MAPPING UNITS

Traditionally, soil scientists could be grouped into three main categories (or hybrids thereof) according to their concepts of soil, whether edaphic, pedological or geographical. To the *edaphic* fraternity, soils were primarily materials for supporting plant growth, and could be separated and rated according to their capacity in this respect. The *pedological* model, on the other hand, was the synthesis of interacting processes into unique objects of intrinsic interest, all crying out for classification. The *geographical* concept (geomorphic plus climatic) while touching on the other two, and acknowledging a great internal diversity, attempts to set soils into useful spatial patterns, keyed to segments of landscape, and climate.

The *soil geographical model* guides virtually all soil surveyors, implicitly if not explicitly. It has been more explicit in Western than Eastern Canada, roughly speaking, and for Fourth and Fifth Order surveys (scales generally less than 1:100,000) as opposed to more detailed surveys. At scales of 1:25,000 and larger, an appropriate scale for general-purpose surveys in urban areas, it is sometimes thought that this geographical approach is in conflict with a pedological (or so-called soil taxonomic) approach, and that a choice must be made. It has further been supposed that at large scales fairly pure delineations of soil material and taxonomic entities can be made, so why worry too much about aggregation into landscape units? In fact, most soil surveyors who give the impression of relying very heavily on soil taxonomy, implicitly relate their mapping units to geographical or landscape units. The pure pedological model, unrelated to landscape, has rarely if ever been practised. Any distinction between the geographical and pedological models, valid perhaps for soil science in general, is actually quite blurred among mappers.

The geographical model has just as much application at large scales as at small scales; it has been found that at scales as large as 1:10,000, 'pure' units remain very elusive, and treatment of soils in their geographical setting materially assists interpretive and evaluation work. It remains true that many subdued or unpatterned landscapes, especially under forest, cannot be consistently subdivided into self-defining units by different surveyors; each will aggregate components and place boundaries differently (and thereby will require close local correlation).

Even with a geographical approach, the surveyor will and should map soil differences that find no expression in landscape changes, and they occur frequently.

In the majority of cases, vegetation characterization need not be included in the definitive criteria for map units - at least, in general-purpose surveys. Indeed, it should be handled descriptively for each of the map units defined by other criteria - soil, landform and sometimes climate. This is not to underrate the significance of urban ecology but rather to avoid making the mapping system, legend construction and map symbolization unnecessarily cumbersome. The widespread transformation of plant communities by human impact and the predominance of agriculture and idle land around most Canadian cities reduce the value of vegetation for differentiating map units on basic land resource maps. It may be as important to map the ephemeral land features as the permanent ones, but the best vehicle would seem to be separate compilations classifying sensitivity, hazard and unique resources.

Complex symbols should be discouraged, especially on maps destined for relatively uninformed users. Twelve characters or more in a map symbol begin to offend cartographic principles of clarity, and some maps prepared in recent years are hopelessly unintelligible even for specialist users.

It is difficult enough within a single agency such as the Canada Soil Survey, to formulate a single, consistent, unified mapping approach that would be acceptable to most mappers, applicable over a range of scales and intensities, and accommodate existing formal classifications for soil, landforms and vegetation and that are amenable to 'ecological' (biophysical) integration. How much more difficult is it to arrive at a neat uniform system for inter-agency co-operation? In fact, at present the level of agreement on general philosophy and principles of a geographical approach is quite remarkable, and perhaps greater than many realize. This is evident in the latest urban area survey by the Soil Research Institute, in the Ottawa fringe at a scale of 1:25,000, now in later stages of preparation (Marshall and Dumanski, 1977). Mapping units are based on soil landscape units that are subdivisions of landforms and material types, that are in turn subdivisions of soil climatic zones. The soil components of the soil geomorphic unit are identified and made the vehicle for descriptive and analytical data, and computer storage of the same. The mode of aggregation of soil components in soil geomorphic units provides a sound base for repeated subsequent interpretations, including computer-plotted single-purpose maps, for a full spectrum of land uses.

The system has many similarities to ecological (biophysical) land classifications, indeed being one kind of ecological survey. It seems to meet most requirements of surveys in urban areas. The maps have already been used, quite effectively and hopefully not too late, to show that much of the planned urban expansion of

Ottawa may be quite misdirected in view of the choices available. The major deficiency of this and other surveys are those which still await development of more quantitative methods of land evaluation.

WHAT KINDS OF INTERPRETATIONS?

The most necessary types of soil survey interpretations are now fairly well known, and once established, define the attributes of soil and land that must be investigated and properly differentiated in mapping. Traditionally soil surveys have rated soils as to their suitability for crops and other uses, and itemized the limitations holding them back, in a rather subjective, qualitative way. The modern soil survey should endeavour to make the ratings much more specific and if possible quantitative, by differentiating levels of productive potential for different uses. Economists will be involved to assist in the calculation of economic indicators, such as input-output ratios and comparative net margins in relation to benefits to the community. The soil mapping units are a basis for these evaluations. The evaluations should produce a suitability statement with some index that relates each mapping unit to the other, and gives at least a rough idea of the costs of meeting adverse land attributes. There is some uncertainty as to how far soil surveyors should go down the road of economic and social suitability rating, as opposed to physical capabilities; we presently think of going far enough to narrow down the *a priori* list of alternative uses of land to an easily comprehended but realistic package for the planner.

In contrast, a recent trend in the United States surveys is the concept of *Soil Potential*, which aims to avoid an excessively negative approach couched in terms of *limitations*. But this approach stops at the physical aspects, leaving evaluation incomplete according to our concepts. The U.S. approach appears to shy away from indicating economic choices and perhaps even the wider environmental implications of land suitability rating. This situation may be temporary.

Many interpretive sessions with municipal planners have left me with the impression that by-and-large they can accept the ratings *highly suitable* or *unsuitable*, but are perplexed by *moderately suitable* or *moderate limitations*. This is especially true of situations such as housing development dependent on septic tanks, where a site is either suitable or unsuitable. These kinds of ratings should be discouraged and replaced by evaluations grouping all the soils and land types in a single two-category table or map for each individual use. Within the *suitable* category a number of subclasses would be differentiated on the basis of costs of necessary site modifications, relative to the best sites in the survey area (amelioration costs).

Most interpretations will eventually be in the form of quantitative or semi-quantitative land evaluations (also known as land appraisal). However, the methodology of doing this for rural uses is only now becoming the subject of basic research thrusts, so that it may be some time before all uses are incorporated. In the meantime, Soil Surveys should pool efforts with anyone who can help add productivity measurements (in the widest sense) and environmental protection costs, so that possible changes in land use are placed in their proper perspective in relation to broader issues such as the quality of life.

A basic checklist of suitability ratings to be included in general purpose soil surveys of urban areas is given below. There would be additions and subtractions for specific cases. The ratings should show relative suitability of all map units, or map unit components as the case may be, pinpointing sources of problems and where possible indicating costs of amelioration.

Agriculture	- general physical capability - capability for special crops - indicative suitability relative to other uses
Forestry	- general physical capability - multiple use potential - special protection needs
Horticulture	- suitability for crop groups, fruit - suitability for key ornamentals - suitability for lawn mixtures, ground cover
Urbanization	- general suitability and difficulty of development (e.g. Hoffman method in Ontario).
Building site development	- ease of excavations, cut-and-fill - suitability for dwelling construction - rating of residential desirability - road location - reservoirs, ponds and embankments
Construction materials	- suitability as source of fill and sand - source of gravel, and aggre-

	gate stability - source of topsoil
Sanitary	- suitability for effluent disposal in the soil - sanitary landfills - settling ponds etc.
Recreational uses	- parkland suitability - camp areas - picnic areas - playgrounds - pathways - ski areas
Wildlife ecology	- special preservation and unique areas - outstanding features - erosion hazard

Little explanation of the list is necessary. Suitability for gardening is an important field to cover in the suburbs of most cities; it is a widespread activity supporting a booming industry. Suitability ratings for gardening should take account of effects of pollution and the incorporation of construction materials into soils, in addition to the usual soil fertility and physical factors.

The maps must be made useful for the preliminary selection of alternative sites for potential residential, commercial and recreational areas, communications lines (including roads, pipelines, underground cables), sanitary landfills and industrial settling ponds, sources of gravel, sand, and fill, reservoirs and several other use categories. Ideally, it should provide a framework for engineering site investigations and thereby ensure continuity and compatibility of data. A valuable and generally neglected facet of the work would be the monitoring of performance of existing structures correlated with the map units.

Above all, the surveys must accurately pinpoint sensitive or unique areas needing special development controls, such as the forested erodible drumlin slopes overlooking lakes in Dartmouth N.S., or the oak-arbutus communities of Victoria B.C.

The relative values and priorities of these individual ratings, and the questions of dropping some and adding others for particular areas, should be partly determined locally, with the help of the information users. Planners and engineers have their own biases and these should not be allowed to detract too much from a degree of uniformity and consistency of evaluations between different survey areas.

This raises the question of local user input in the process of deciding on what evaluations ought to be made, and therefore what data are to be collected. Most local needs become well-known as a function of the team approach, but beyond that there is evidence to suggest that a large proportion of users of soil information do not know what they want until they are given it (or given an inferior substitute that illuminates further possibilities of what they could have). On the other hand, there are other users who know what they want, and wrongly assume that it cannot be found in an *agricultural soil survey*. Some have repeatedly complained of the Soil Survey not mapping criteria of importance to forestry, and yet have not been a rich source of constructive suggestions on these criteria. Public participation in determining kinds of survey interpretations, like public participation in planning, is useful but only up to a point, sometimes reached rather soon.

Suitability is rated from selected attributes of land that in turn function as combinations of basic soil and land properties (Table 1). Some elements could be labelled equally well either as attributes or as properties, but in general the properties are directly measurable and readily available from raw data compilations, whereas the attributes are usually the expression of particular combinations of properties and their values are frequently generated for specific needs.

Attributes as used here, the link between basic properties and evaluation, have been called *derived land factors* (Dumanski, pers. comm.) *qualities* (Brinkman and Smyth, 1973) and factors of *soil behaviour* (Smith, 1976). *Properties* are similar to *characteristics* as used elsewhere (Brinkman and Smyth, 1973) and most of the *basic land factors* of Dumanski (pers. comm.). There is room for two or even three categories of attributes according to the degree of generalization, where one is given here. The list in Table 1 is fairly complete from the modern soil survey standpoint, but might be considerably augmented for some other ecological surveys.

The design of mapping units and selection of phase variations within them, must facilitate the separation of significant value rankings of those land attributes relevant to the intended suitability rating. This is self-evident, yet there is a persistent tendency for map delineations to be quite arbitrary, reflecting unimportant separations. "It must not be assumed that, because a terrain classification exists as an apparently logical subdivision in Nature, it must necessarily have any significance to an engineer" (Aitchison and Grant, 1968).

Table 1: Land attributes for rating land suitability, and contributory properties.

Land attributes

Landform type
Mode of origin of materials
Slope stability
Flood risk
Erosion hazard
Sediment yield potential
Conditions for germination
Trafficability
Corrosion potential
Compactness
Wetness
Moisture availability to plants
Moisture regime
Availability of water-drinking
Availability of water-irrigation
Aeration of root zone
Droughtiness
Temperature regime
Frost susceptibility
Radiation energy
Climatic exposure
Snow cover
Fertility level
Organic matter levels
Toxicity to plants
Accessibility
Pest and disease susceptibility
Land tenure
Fragmentation of fields
Plant communities
Plant succession paths
Land utilization types
Shoreline fragility
Water body characteristics
Unique endowments
etc.

Land properties - soil

Particle-size distribution
Atterberg Limits (plasticity)
Fibre content (peat)
Structure
Consistence
Density
Quality of gravel
Depth
Moisture content
Water transmissivity
Available water capacity
Porosity
Shrink-swell potential
Clay and sand mineralogy
Compressibility
Shear strength
Stoniness
Micromorphology
Soil temperature

pH
Salinity
Exchangeable cations & capacity
Carbonate content
Mobile Fe, Al and Mn
Total C and N
Available P

Soil colour
Horizon depth & thickness

Land properties - nonsoil

Depth of unconsolidated material
Hardness of bedrock
Depth to zones of saturation

Slope and pattern
Rockiness

Plant species and communities
Forest height
Forest density
Forest age and condition
Numbers and condition of valuable plant species
Numbers and condition of wildlife species

Atmospheric temperature
Accumulated heat
Precipitation
Frost-free period
Wind occurrence
Fog occurrence
Hail occurrence
Snow thickness, persistence, type

Aircraft noise levels
Socioeconomic tangibles
Socioeconomic intangibles
etc.

Knowledge of the land attributes permits the initial evaluation of feasible land use alternatives; this does not define best use, but does materially assist the planner and manager to weigh the economically and socially appropriate alternatives.

SOME PARTICULAR NEEDS

1. Archive Research

Urban areas have generally been the subject of many investigations and studies over the years, and the amount of information of use to a land resource survey is quite surprising. Compared to the average soil survey a much greater effort is required in probing into consultant's studies, well-drilling logs, records of highway contractor's borings, individual building site investigations, and many other sources. Their value has already been demonstrated in Soil Survey.

2. Define Limits of Responsibility

Most changes in urban land use involve high investments. Since the cost of thorough individual site investigations may be a small proportion of the total development cost, the site investigation will always supplant the general survey in establishing suitabilities, alternative possibilities and costs. Therefore, to avoid wasted efforts it is important to define quite precisely the cut-off point of land evaluations; this point should be a forward position, in order to display viable alternatives realistically, but not so forward as to allow the ratings to be invalidated by changeable economic factors, or discredited as trespassing beyond their bounds into the field of planning. Perhaps the economic factors should be treated as multipliers that can be updated *en masse* and plugged back into the inventory every few years - a modular evaluation package.

3. Technical Improvements

There are technical deficiencies in our mapping procedures apart from the more philosophical matters already touched upon. Two areas are singled out:

a) *Soil Erosion* - The Soil Survey is not doing a good job of mapping soil erosion, either past erosion or erosion susceptibility. This is a much more serious problem in the east as well as the west of Canada than is generally apparent from survey maps, or even in published reports. We need to develop a methodology of mapping erosion and costing out the ramifications of non-conservation. This is extremely important in urban areas, where disturbance of the surface during construction can have devastating effects on slope stability and quality of streams and lakes.

b) *Moisture Regime and Drainage* - Soil moisture regimes are differentiated qualitatively in soil mapping, only in terms of the apparent persistence of excess water in a profile, and termed *well-drained, imperfectly drained,* etc. The actual moisture conditions of any of the seven classes vary enormously according to the climatic area, and there is little possibility of national consistency at present.

Soil surveys require a new system to describe the soil moisture regime based upon a more quantitative rating of persistence of certain moisture contents, the duration, depths and type of water tables, transmissivity of soil and extent of seepage. This is a very important aspect for urban surveys, being the basis of map unit separations, evaluations for building sites, recreational uses, waste disposal, excavation of gravel and fill, to mention only a few.

c) *Greater Depth of Investigations* - The depth of soil used to classify and characterize it extends up to two metres - the maximum control section. Inferences are made about deeper material, supported by investigation of chance excavations. In the absence of such excavations, and where the probes of a surveyor encounter stones, dense material such as fragipan or a zone of saturation, or when he simply does not have time, investigation gives way to inference well within two m. There is no doubt that survey quality would be materially enhanced by substitution of more twentieth century power tools for the time-honoured and time-wasting shovel and auger.

d) *Land Use Typology* - When surveys rate the suitability of areas for different uses a weak link that emerges is the identification of uses. Categories commonly used may be general (field crops, urbanization) or specific (corn growing, construction of foundations). Land evaluation programs such as that of the Soil Research Institute expose the need for more refined rural land use typologies than have hitherto been available (e.g. the Canada Land Inventory present land use classification). The same need is felt for urban uses. For agricultural uses, Vink (1975) proposed characterization of *land utilization types* in terms of type of product, size of farms, level of management, land tenure, adequacy of infrastructure, level of capital inputs required, and level of annual production inputs. The suggestion here is that evaluation should go beyond suitability for a crop or a particular engineering activity, or the need to preserve a single species. It should encompass suitability for the whole land utilization type, be it a type of farming enterprise, a whole residential development or preservation of a whole ecosystem.

As a simple example, while an area in the urban fringe may be highly rated for growing silage corn, the rating for a beef enterprise using that corn might be quite different. Such an enterprise may involve too much under-utilization of valuable land as pasture, pollution hazards in recreational waterways, conflict with residential development (by way of odours, pilfering, crop trampling, animal worrying, garbage dumping) and adverse pressures exerted by urban-inflated land values. It should be possible to assess the suitability of the land not only for the crop, but for this farming system, an alternative fresh milk dairy system (where access to market is important), or a low density residential housing system.

The ecological land classification of Dansereau (1973), a hierarchical scheme incorporating notions of degree of human dominance in the environment, processes of exploitation, detailed types of use and energy levels, might be adapted for our purpose. However, it is by no means clear how the categories in the scheme can be aggregated into use systems or land utilization types whose relative potential can be rated.

4. Systematic Data Collection

Recent urban area surveys, such as that in the Ottawa area, have amply demonstrated the advantages of systematic coding of observations and computerized storage and manipulation of data. It is the only way to cope with the exceptionally high density of observations in urban surveys, large number of mappers with a high turn-over rate, the great variety of data sources, and the recurrent requests for a variety of single-use interpretive maps for special purposes.

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BIOPHYSICAL AND CULTURAL-HISTORIC LAND CLASSIFICATION AND MAPPING FOR CANADIAN URBAN AND URBANIZING LAND

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ABSTRACT

A methodology for the mapping and classification of the cultural-historic, abiotic and biotic land features at scales of 1:500 to 1:25,000 is proposed. It is oriented toward encouraging a land-use planning process which addresses issues of environmental quality and environmental assessment. Opportunities and constraints are identified as well as ecological processes. The biotic mapping uses a three-tier system based on description, function and value of the resource area mapped.

RÉSUMÉ

Une méthodologie est proposée pour la cartographie à une échelle comprise entre 1:500 et 1:25,000 et pour la classification des lieux culturels et historiques, abiotiques et biotiques. Elle vise à encourager une planification de l'utilisation des terres qui tient compte des questions relatives à la qualité et à l'évaluation de l'environnement. Les circonstances favorables et contraires, ainsi que les processus écologiques sont indiqués. La cartographie biotique s'intéresse à trois aspects: la description, la fonction et la valeur de la région cartographiée.

INTRODUCTION

Land classification and mapping for resource management purposes has become a well-accepted procedure throughout the world, whether for multiple resource uses or for specific single resources (see Christian and Stewart, 1964). Appropriately, land classification oriented toward capability to produce food and fibre has been a central or key approach. For primarily social and economic purposes, cities have been mapped and described from a land-use and zoning point of view; here land capability to produce food and fibre has no significance. Cultural-historic, geological, and biological mapping of cities is uncommon; in fact, very few methodologies for carrying this out have even been put forward.

Urban fringe[1] areas designated for urban development, including supporting urban infrastructure, have also received limited attention by natural scientists and agricultural scientists considering the potential financial implications of building on unsuitable terrain. When broader perspectives of environmental quality and environmental assessment are added, it becomes useful to examine whether better mapping of this landscape 'battle zone', where competing uses are intense and where public and private rights continually collide, could assist in resolving land-use conflicts, and better identifying where public rights may have precedence over private rights, and vice versa. This means bringing the expertise of the natural and agricultural sciences together with the expertise of the professions involved in urbanization: planning, civil engineering, architecture, landscape architecture, economics and law.

This paper proposes a methodology for classification and mapping of cultural-historic, abiotic, and biotic features, and their associated ecosystem properties, for land already urbanized and land to be urbanized. The resource management problems which underlie the need or rationale for such a mapping system, the objectives of the system, issues of scale and cost, personnel needed, the mapping format, and an example of the proposed product are presented, along with suggested methods for implementation (programming and budgeting). It builds from the vegetation classification of Dansereau (1957) and Kuchler (1967), the biogeographic concepts of Crowley *et al.* (1970) and Tivy (1971), and some 90 practical planning problems of land use and resource management encountered in Ontario

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[1] "Urban fringe" is later defined in the footnote for Table 1.

by the author and many colleagues during a ten-year period. The philosophical basis for the classification is the ecological triad: reverence for life, land, and diversity (Dorney, 1976b).

RESOURCE MANAGEMENT PROBLEMS IN URBAN/URBANIZING LAND

Although one may be accused of too simplistic an approach in trying to examine environmental (resource) management problems in the context of various urban/rural land zones, it has been presented this way (Table 1) to demonstrate the effect of five urban zones and one rural zone as related to scale of mapping utilized; the entries are not meant to be comprehensive but only representative of the types of issues and problems likely to be encountered. The land zones run from the central business district (CBD) to the rural area. The 'break point' between *new subdivisions* and *old subdivisions* (20-25 years of age) is based on bird population data and biomass data for Southern Ontario cities. It may require later refinement as more quantitative urban biome[1] studies are done.

Table 1 demonstrates that many crucial resource management decision 'points' occur in the urban fringe land zone at the time rural land is being committed to urbanization. At this time land values dramatically change, and with them a shift in human perceptual values attributed to the different cultural-historic, abiotic and biotic resources. A second (but lesser), decision point is when old suburbs and the central business district come up for rezoning (urban renewal) consideration. The resources in Table 1 are broken into cultural-historic, abiotic and biotic components or subsystems; this approach is also followed in Tables 3-6. Aesthetics and the existing social structure and economic base are additional areas of concern which could be added to Table 1, but which are outside my perceived frame of reference for this paper which focuses on the biophysical environment.

Agricultural capability and associated physical and social agricultural infrastructure is an additional and emerging concern in the urban fringe; it requires special analytical techniques which also are perceived to be outside the boundaries of this paper.

The increased intensity of planning and land-use decision-making outlined in Table 1 demonstrates that the urban fringe requires particular attention by environmental managers, and by scientists having varying technical expertise. Planners and other design professionals, economists, engineers and lawyers have traditionally been the prime actors in decisions in this zone, with minimal attention to resource issues viewed in an ecosystem frame of reference. The recent requirement for environmental assessment at Federal and Provincial levels will require more involvement by environmental managers, and will require increasing inter-professional teamwork.

OBJECTIVES FOR AN URBAN/URBANIZING LAND CLASSIFICATION SYSTEM

In all, 24 objectives were identified. These can be segregated into three levels of significance, which can then be used to test the suggested methodology.

First Order Objectives

1. Creating of new "social norms" (Fabos, 1971), by explicit description of land features, their functions, and their values.

2. Integrating of cultural-historic, abiotic and biotic land attributes or features in an ecosystem framework.

3. Facilitating the preparation of the environmental component of Official Plans.

4. Identifying areas having potential conflict in land-uses.

5. Mapping costs should not exceed $7.50/acre ($19.00/ha) at a scale of 1:10,000 and $3.00/acre ($7.50/ha) at a scale of 1:25,000 (assuming adequate 1:50,000 scale resource data are available).

6. Mapping formation should facilitate communication between resource specialists, designers, engineers, lawyers, educators, the private sector, the public sector, and elected officials by use of appropriate symbols and nomenclature designed specifically with the broadest definition of the user in mind.

7. The methodology should provide information capable of replication as the quality of the work will be tested continually by other teams of scientists and in the courts and hearing boards.

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[1] The term urban biome is felt to be appropriate for describing a biological complex in which buildings and their associated infrastructure and 'managed' landscape are the major determinants of ecosystem dynamics, as opposed to climatological determinants which control ecosystem properities in the more classicial biome definition.

Table 1: Environmental management problems or issues related to landscape zone, scale of mapping and planning approach utilized.

			CULTURAL-HISTORIC COMPONENT (SUBSYSTEM)	ABIOTIC COMPONENT (SUBSYSTEM)					BIOTIC COMPONENT (SUBSYSTEM)		
Land Zone	Scale of Mapping Available/Utilized	Planning Approach Utilized		Climatology, Air Quality,	Sub-Surface Geological	Surficial Geology/Soils	Hydrological	Noise	Aquatic Habitat	Terrestrial Habitat	
										Vegetation	Wildlife
Rural (Agriculture, forestry & recreation)	1:1,000,000 1:250,000 1:50,000	Fed./Prov. policy planning and/or strategic planning, rural official plans, reconnaissance level environmental impact for defining transmission study areas, feasibility studies, etc.	Special sites: cemeteries, archaeological sites, special rural ethnicity, etc.	Air pollution effects on susceptible crops, forest areas, heat units, frostfree periods, etc.[3]	Hard-rock mining, mine drainage pollution, dereliction and rehabilitation.	Capability for production of crops, forest products, wildlife and recreation	Major recharge/discharge zones need protection, lake/ocean shoreline erosion, water uses for energy generation, navigation, irrigation, flood control requires control.	Limited problem.	Commercial and recreational fishery, wildfowl production, water quality/pollution issues.	Production of wood products, mapping protective forest zones, fire control, recreational areas.	Hunting and wildlife production, some viewing.
Urban Fringe[1]	1:25,000 to 1:5,000	Regional, metro, or city official plans, conceptual design, secondary level plans for separate parcels for housing or for recreational development.	Same as above but in more refined fashion.[2]	Same as above, also livestock odours, inversion zones,[4] fog prone areas.	Aggregate utilization, dereliction & rehabilitation, land-fill sites, potential hazardous zones for construction.	Engineering capability.	Development potable urban water supplies, trunk sewer and flood control systems are developed.	Airport, freeway noise generators.	Same as above plus amenity value of aquatic resources.	Same as above including aesthetics and increased recreational uses.	Same, plus viewing becoming major value.
Urban Construction Zone	1:5,000 to 1:500	City official plans, registered plans of subdivision, zoning control and by-law control	Salvage required where site cannot be integrated or protected.	Dust/soil erosion from land clearing or stripping operations.[5]	Conversion of derelict land to urban uses, mitigation subsurface (hazardous) problems.	Same as above, also erosion control.	Hydrological models or calculation required for storm water management including zero runoff, dewatering trenches causing stream pollution.	Construction Noise (7a.m. - 7 p.m.)	Sediment and temperature control to protect water quality, development of ponds for variety of uses, stocking for recreational fisheries, nuisance aquatic and insect control, amenity value protection.	Fencing, and site control to prevent damage to trees, prairie, etc.	N/A
New Subdivisions*	1:5,000 to 1:500	City official plan, zoning and by-law control.	N/A	High degree of exposure to wind, sun.[5]	N/A	N/A	N/A	Minor nuisance due to traffic	Same as above	New planting.	Viewing, bird feeders emerge.
Old Subdivisions**	1:5,000 to 1:500	Same as above plus rezoning/redevelopment pressures resulting in specially commissioned planning studies for urban renewal, or neighbourhood improvement (NIP).	Preservation of old buildings; salvage if excavation uncovers interesting historic or archaeological material.	Moderation in microclimate due to maturation of trees.	N/A	N/A	Runoff coefficients generally lowered due to large trees decreasing runoff through evapotranspiration, old housing built in flood hazardous zones.	Same as above, some problem streets.	Same as above and redredging of ponds and lakes.	Urban forest management, replacement mature stock.	Same.
Central Business District	1:5,000 to 1:500	Same as above.	Same as above.	Heat island effects.[4 5]	Subway construction, footings for tall buildings.	Sediment deposition in storm sewer cleanouts or harbours need to be collected or dredged, excavated materials & rubble requires disposal.	Insufficient capacity to pass storm peaks due to incremental suburban growth.	Some severe problems due to noise from demolition & heavy traffic, generated by incremental growth.	Same as above.	Limited replanting, urban forest management.	Nuisance birds, rodents require control.

[1] For convenience, 'urban fringe' is defined as the zone outside designated urban boundaries where market value of the land exceeds its economic potential to produce crops and forestry products (e.g. high-priced recreational lake and river frontage, strips along roads, canals and waterways, etc.).

[2] This component is further examined in Table 3.

[3] This level of concern is generally macrometeorological in scale.

[4] This level of concern is generally mesometeorological in scale.

[5] This level of concern is generally micrometeorological in scale.

* Up to 20-25 years old.

** Older than 20-25 years.

8. Mapping should be computer convertible.

9. Mapping should be useful for tax assessment purposes.

10. The mapping should assist in identifying areas where unskilled/unemployed manpower could be utilized for conservation projects.

Second Order Objectives

1. Updating information should be performable at one-fifth that of original cost.

2. Mapping should facilitate preliminary or reconnaissance level environmental assessment by mapping and describing the resource and identifying its functions and values, but should not try to include assessment *per se* since full environmental assessment requires knowledge of a specific action or impact of which there are potentially dozens (e.g. hydro line, high-rise, airport, etc.).

3. The mapping should facilitate an independent environmental impact review by agency staff.

4. Mapping should tie into smaller scale (Canada Land Inventory (CLI)) and other rural or forestland Canadian mapping systems.

5. The mapping should facilitate land-use policy, planning, decision-making, and zoning.

6. Mapping system should be capable of being seen as a continuum of scales, including downtown core (CBD), shorefront, industrial, commercial and suburbs.

Third Order Objectives

1. Identifying land-use trends should be facilitated through examination of sequential changes in resource features over time.

2. Mapping of sensitive resources likely to be of government concern should reduce or adjust speculative pressure on these features or areas.

3. Identifying secondary impacts should be feasible through sequential analysis (over time).

4. Research should be facilitated on the phenomenon of urbanization.

5. Identifying both mutable and immutable land attributes should be accommodated by the methodology.

6. Expanding data base to include mapping of the social 'fabric' should be feasible.

7. The mapping should facilitate environmental impact analysis by reducing the time and cost to do the work.

8. The mapping should provide school teachers with laboratory material on local natural resources.

The system proposed in this paper was devised to address many of these 24 objectives; any evaluation, however, will need to be done by field-testing the approach in various regions, gaining experience with the strengths and weaknesses of the system, and possibly contrasting it with the universal ecological land-use classification under development by Dr. P. Dansereau (personal communication).

SCALE AND COST

Scale and related cost are central to any attempt to map urban and urbanizing areas. Unless the scale is appropriate to the problem, any mapping will be of limited value. Too large a scale (too detailed) means higher than necessary costs.

The logical place to enter the urban (urbanizing) land classification system is by using 4" to the mile air photos for the field mapping of cultural-historic, abiotic and biotic features. The base map should thence be either 1:25,000, 1:10,000 or 1:5,000. The comparative advantages of the varying scales, and the costs for the mapping are shown in Table 2 related to the urban issue under study.

In my judgement, a scale of 1:50,000 for urban land classification will be of no value; it may even be of negative value as maps at this scale will be enlarged four to ten times by private consultants and by public agencies to save money. Fisheries and Environment Canada will then be put in the position to point out the inappropriateness of its mapping, or worse yet the waste of money, time and resources that such "urban" mapping entailed. Should Fisheries and Environment Canada for budgetary reasons decide it can only do 1:50,000 scale mapping, the money would, in my judgement, be better spent on regularly updating the 1:25,000 scale topographic maps and leave the urban biophysical mapping to local governments, the private sector, or the project proponent.

PERSONNEL NEEDED

The urban mapping would best be done by a two-person field team: an earth scientist and a forester or plant ecologist. The cultural-historic map would be done independently by

Table 2: Comparison of scale, minimum size unit to be mapped, contour interval, cost and application

Scale	Mimimum Size of Mapping Unit	Contour Interval	Cost/Acre* (cost/hectare)	Application
1:25,000	10 acres (4 ha)	10 ft (3.0 m)	\$4.00 (\$10.00)	Rural areas to be protected or modified in urbanizing region; regional municipality official planning; new town envelope location, environmental assessment at macro-level.
1:10,000	2 acres (0.8 ha)	5 ft (1.5 m)	\$7.50 (\$19.00)	Corridor feasibility studies, conceptual planning neighbourhoods or new town, secondary planning for subdivisions.
1:5,000	¼ to ½ acre (0.1 - 0.2 ha)	2½ ft (0.8 m)	\$35.00 (\$88.00)	Existing urban areas, registered subdivision working drawings.
1:500	single trees on lot	1 ft (0.3 m)	<\$100** (<\$250)	Checking single trees for livability, checking service lines, and lot grading plans.

* Assumes 1" to mile soils and geological mapping are available. Costs derived from consulting work in Southern Ontario include field checking forest areas, stream systems. The cost figures assume no intermediate scale mapping is available for sequential refinement, that is at 1:5,000 no 1:10,000 scale maps are available (only 1:50,000 scale). This cost does not include synthesis of data and development of alternative planning strategies. (See Dorney, 1976a for discussion of these additional costs).

** Assumes 5 trees/acre average.

checking archives and by limited field checking by archaeologists and historians. Senior supervisory personnel familiar with the regional history, geology, biology would check the work and train the field crews. The amount of academic and field experience for the field team to do the mapping would be a Master's degree and one year experience or a Bachelor's degree and two years experience.

FORMAT FOR THE MAPS

The features to be mapped (Table 3) for the cultural-historic map will produce a constraint map including Pre-Caucasian, Caucasian, and Native Peoples or Ethnic groups. The latter category would be a present (existing) characteristic or "feature". Should the social complexity in an urban area need to be depicted, a separate map may need preparation. However, such intricate social mapping has not been done in urban areas for planning purposes to my knowledge[1], although some single ethnic maps have been prepared for planning purposes for rural urbanizing areas (Dorney and George, 1970).

The abiotic components map (Table 4) includes air, water, land and noise components. Obviously for any one area only a small number of the total components listed would be significant and would be depicted.

The aquatic biotic component (Table 5) would be put on the same map as the terrestrial biotic component (Table 6) unless the map would become too clut-

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[1] Some social mapping for research purposes has been done and is being done with increasing frequency; such mapping may eventually be used or be useful for planning purposes.

*Table 3: Proposed urban/rural fringe land unit classification system cultural-historic components**

Pre-Caucasian

Village sites permanent
  transient
Burial grounds
Quarry sites
Historic places (battles, symbolic land features, pictographs, trails)

Caucasian

Historic places (battlefields, signing treaties, locks, old roads, etc.)
Historic buildings (homes, barns, industries)
Cemeteries
Scenic/historic roads
Abandoned rail lines
Adandoned docks
Abandoned shipwrecks (above, under water)
Churches

Native Peoples/Special Ethnic Groups

Reserves, neighbourhoods, special needs (e.g. old-order Mennonites using horse-drawn vehicles)

* A compilation of these features will result in a constraint map for development; no functions or values are ascribed to each feature; rather these aspects will need to be handled on a case by case basis.

tered. As the four Tables show, the features would be described for all three subsystems; the functions and values of the biotic subsystems would be included. The values are much more difficult to replicate; here senior staff would be needed using local expertise through some public participation process, to get a feel for the values of the community vis-à-vis regional biological systems.

Preparation of a regional field manual would need to be done to assure uniformity in mapping such attributes as P=R, resiliency, and in mapping the 'functions'. For example, as consultants we '*calibrate*' our detailed resource mapping by examining historical land survey notes to give us an understanding of the probable original or climax ecosystem (P=R), including any anomalies which relate to regional uniqueness of an ecosystem (e.g. an oak plain or savannah relict) or to a relict P=R situation. For example, in Table 6 the height of trees might be broken into 8 height classes from .1 meter to 35 meters (see Kuchler, 1967, p. 188). These field manuals by title and date would need to be cross-referenced with each map produced so that the users could better understand and evaluate the results depicted.

EXAMPLES OF MAPPING

At this point, skeptics would say such cultural-historic, abiotic and biotic mapping can't be done on 3 pieces of paper, and I must agree I would have felt this way myself three years ago. However, for the new town of Townsend (Llewelyn-Davies Weeks, 1976) such mapping was prepared and used in the conceptual design planning process. (An additional agricultural suitability map was also prepared but is not shown here).

The time to prepare them[1] was 60 days, the cost about $40,000[2]; the scale was 1:25,000 (Figures 1, 2, 3). The biotic constraints map (Figure 3) has actually gone one step beyond information which I have proposed in Tables 4 & 5, and has been interpreted for a specific impact-housing. In the system proposed in this paper, this interpretation step would not be done because the proposed mapping would serve as a base map for many possible impacts, in addition to housing. Each biotic feature would have its description, its functions and its values listed on the map in symbolic form, in a 'balloon' alongside the feature. The use of these three maps in defining the urban envelope (Figure 4) by an overlay process including group discussion on systems interactions is reasonably apparent; major constraints are avoided, and certain development opportunities accommodated.

OTHER POSSIBLE ADDITIONS TO PROPOSED SYSTEM

Landscape personality maps emphasizing landscape aesthetics may be useful adjuncts to the 3 map system proposed. Fabos (1971) recently has described various approaches for doing this.

Agricultural capability/feasibility maps may also be useful in determining leasing programs, odour problems, protection of special crop areas and development phasing in the urban fringe.

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[1] Preparation done by Ecoplans Ltd. under a subcontract to Llewelyn-Davies Weeks. The study are was about 15,000 acres.

[2] This cost does not include a wealth of existing inventory data hence it was actually only about $2.75/acre; the figure of $4.00/acre in Table 2 is a more typical estimate for this scale of mapping.

Table 4: Proposed components for urban/rural fringe land classificaton

ABIOTIC COMPONENT*

Minimum unit size at 1:10,00 scale - 2 acres or 1 hectare, 5 ft. or 2 meter contour; at 1:5,000 - $\frac{1}{4}$ to $\frac{1}{2}$ acre or 1/8 to $\frac{1}{4}$ hectare, 2$\frac{1}{2}$ ft. or 1 meter contour.

Air System Component

- Inversion potential zones
- Pollution zones (SO_2, particulates, CO) of significance.
- Cold air drainage channels
- River valleys where lake air intrusion occurs

Sub-Surface Geological Component

- Economic minerals/aggregate
- Fault zones
- Karst
- Depth to bedrock
- Marine clays
- Buried valleys

Surficial Geological Systems/Soils Component

- Description of feature (e.g. esker, spillway, old shorelines, scarps)
- Permafrost
- Viewpoints
- Slippage areas (overburden)
- Soil drainage (surface)
- Waterfalls
- Slopes (by classes A-E)
- Subsidence
- Derelict areas (landfill, pits, quarries, mining sites, slag heaps)
- Dunes

Hydrological Systems Component

- Morphometry of lakes, coastal shorelines, large rivers
- Piezometric surfaces (well water, gradients)
- Chemical impurities in water affecting use
- Recharge zones/areas
- Shoreline erosion control (shoals, marshes and dunes)
- Discharge zones/areas
- Streambank erosion zones (mapped at finer scale where significant)
- Heavy metal sediment zones (deltas, channels, harbours, etc.)
- Flood/fill lines
- Salt water intrusion zones
- Permanent streams and intermittent streams
- Water level fluctuations
- Irrigation uses
- CFS streams, rivers
- Littoral drift

Noise

- NEF zones (airports)
- Freeway decibel zones
- Arterial highway decibel zones
- Railway noise zones

* A compilation of these features will result in production of combined or separate constraint maps for separate activities, such as housing, industry, airport location, major highway location, harbour dredging/blasting feasibility, location pipelines, subways, etc.

The social 'fabric' map for built urban areas already discussed earlier could depict ethnicity, demography, turnover rate in housing, rental-ownership patterns, etc.; such social maps could demonstrate potential compatibility or incompatibility between existing or proposed adjacent uses. Such social maps would begin to bridge the gap between the human ecology (sociological and anthropological phenomenon of man) in the sense of the Chicago School of Park, and ecology as a natural science (organisms and their environment); in my judgement[1] such a bridging is conceptually possible and potentially profound in its implications, adding to the value of the cultural-historic and biophysical mapping system proposed.

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[1] I believe Mr. W. Michelson at the University of Toronto has made similar comments but can find no specific reference to quote at this time.

Table 5: Proposed urban/rural fringe land unit classification system: Aquatic biotic component

DESCRIPTION AND ANALYSIS OF EXISTING BIOTIC RESOURCES

1 3 5 7 9 11 13
2 4 6 8 10 12

1. Lake, stream, river, marsh, estuary
2. Major fishery components, amphibian or shellfishery components
3. Historical trophic status of lake
4. Present trophic status of lake
5. Biochemical quality of river/stream (H, M, L)
6. Spawning grounds, location, by species or family
7. Migratory fish run by species
8. Staging areas for waterfowl
9. Breeding areas for aquatic birds; trophic levels present identified (I, I&II, I to III)
10. Water level fluctuations in feet or meters
11. Size lake or marsh areas in acres, or sectional length/width of river
12. Plant species
13. Indicator invertebrates seen

CAPABILITY

Not applicable in urban area

FUNCTIONS PROVIDED BY BIOTIC RESOURCES OF IMPORTANCE TO MAN

1 2 3

1. Sewage assimilative capacity: degrades organic pollutants entering zone (biochemical sink)
2. Traps sediment (marshes)
3. Importance to terrestrial wildlife

VALUES/PROBLEMS OF BIOTIC RESOURCES

1 3 5 7 9
2 4 6 8

1. Overall aesthetic appeal H/M/L
2. Major wildlife viewing resources YES/NO
3. Major recreational gathering or fishing (food) resource YES/NO
4. Hunting resource (ducks) YES/NO
5. Provides outdoor education or research/scientific potential YES/NO
6. Major swimming resource YES/NO
7. Major boating resource YES/NO
8. Biological Nuisances - insect hatches, algal blooms, dead alewives, algal rotting PRESENT/ABSENT
9. Hazardous area locations (Engineered ditch), disease potential bacterial and industrial pollution location.

Table 6: Proposed urban/rural fringe land unit classification system: Terrestrial biotic component. Minimum unit size at 1:10,000 scale - two acres or one hectare, five foot or two meter contours; at 1:5,000 - ¼-½ acre or 1/8-¼ hectare, 2½ foot or 1 meter contours.

❶ Site Region

❷ Ecoclimate (from Hills: normal, hot, cold)

❸ Drainage D, DM, M, MW, W

❹ Soil texture or organic, its depth

❺ Physiognomy: Pasture mowed, mowed lawn, rough, pasture, cropland by type, etc. savannah by dominant species, woodland by dominant species (overstory, understory, etc.)

❻ Average diameter, woodland overstory (6-10", 10-18", 18")

❼ Age of overstory

❽ Height of overstory

❾ Percent crown closure

❿ Production/respiration ratio

⓫ Resiliency (H, M, L) to drainage; to 50% crown opening; to compaction by man; to ground fire

⓬ History veg. management: logging, grazing, fire, maple sugaring, etc.

⓭ Wildlife use by order of birds, mammals

⓮ Acreage

DESCRIPTION AND ANALYSIS OF EXISTING BIOTIC RESOURCES

1 3 5 7 9 11 13
2 4 6 8 10 12 14

CAPABILITY

Not applicable in urban area

FUNCTIONS PROVIDED BY BIOTIC RESOURCES OF IMPORTANCE TO MAN

1 3 5 7 9
2 4 6 8 10

❶ Ability to control wind erosion H/M/L

❷ Ability to control water erosion H/M/L

❸ Contributes to bank stability (water, freeze/thaw)

❹ Recharges ground water

❺ Protects discharge zone (springs)

❻ Buffers/protects adjacent wooded unit from wind/sun

❼ Microclimatic protection

❽ Runoff coefficient (fractional number)

❾ Energy buffer (noise, wind, water)

❿ Filters air

VALUES/PROBLEMS OF BIOTIC RESOURCES

1 3 5 7 9 11
2 4 6 8 10 12

❶ Overall aesthetic rating H/M/L

❷ Uniqueness of biotic community in area H/M

❸ Endangered/rare plant species list, or N/A

❹ Endangered/rare animal species list, or N/A (vertebrates, all classes)

❺ Buffers incompatible land uses

❻ Provides open space linkage H/M/L

❼ Potential for activie recreation use H/M/L

❽ Potential for passive recreation use H/M/L

❾ Potential for nature education or research H/M/L

❿ Production nuisance insects by type (e.g. mosquitoes H/M/L)

⓫ Damaged by pollution (explain)

⓬ IBP sites or equivalents.

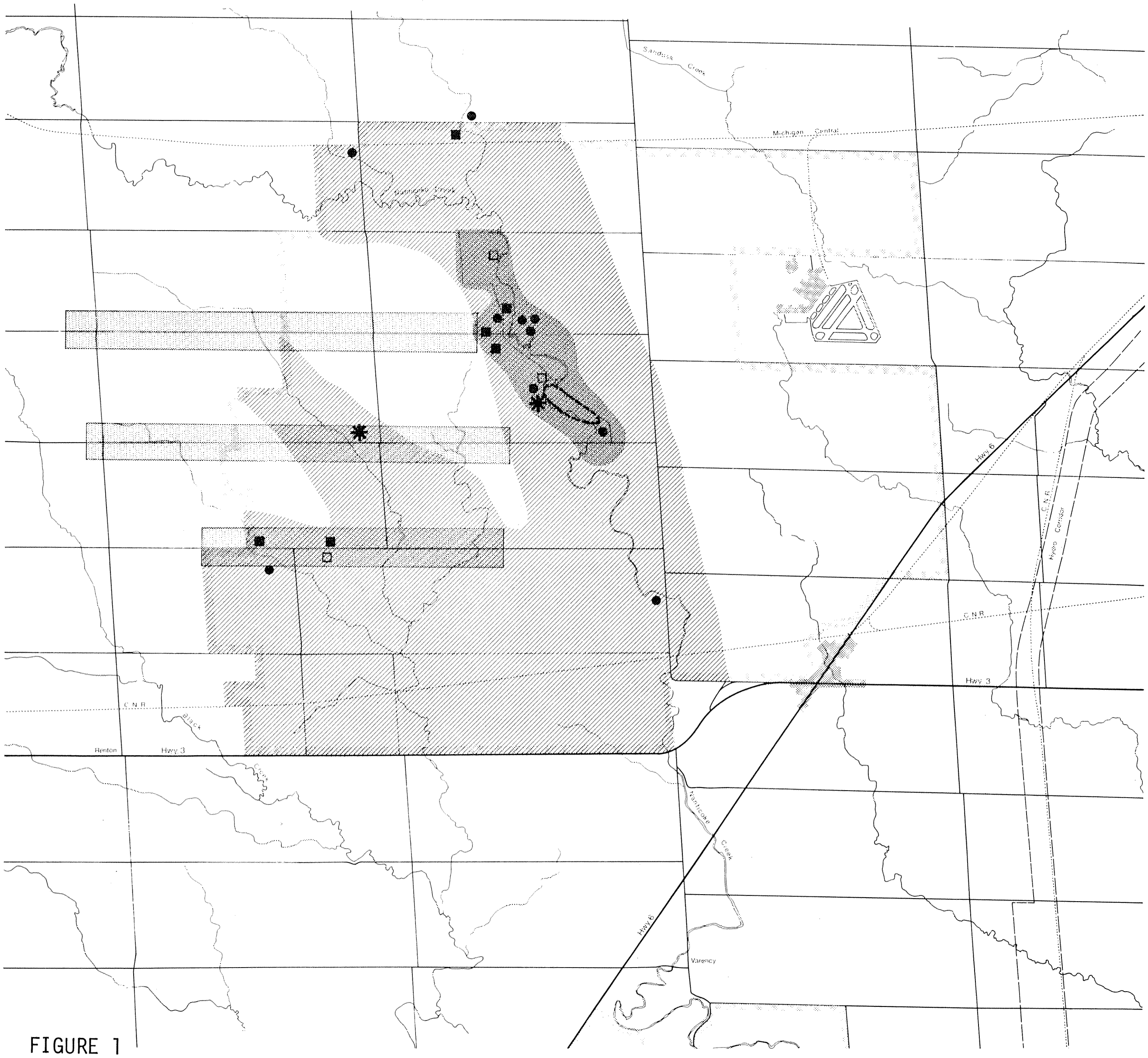

FIGURE 1

Cultural and Historical Constraints for Development

100 Hectares

100 Acres

1 KM

1 MI

Date April 76

✱ Known Archaeological Sites

▨ Study Area for Other Possible Sites

● Former Saw Mill Site

■ Significant Historic/Architectural Buildings

□ Important Historic/Architectural Buildings

▩ Major Grouping of Historic/Architectural Buildings

░ Other Grouping of Historic/Architectural Buildings

⬭ Former Mill Pond

TOWNSEND

COMMUNITY DEVELOPMENT PROGRAM

Source: Llewelyn-Davies Weeks Ltd.et al., 1976

Source:T.C.P.T., U. Women's Club of Norfolk, Big Creek C.A., Dr. P. Ramsden & Historic Atlas of H.N.C.

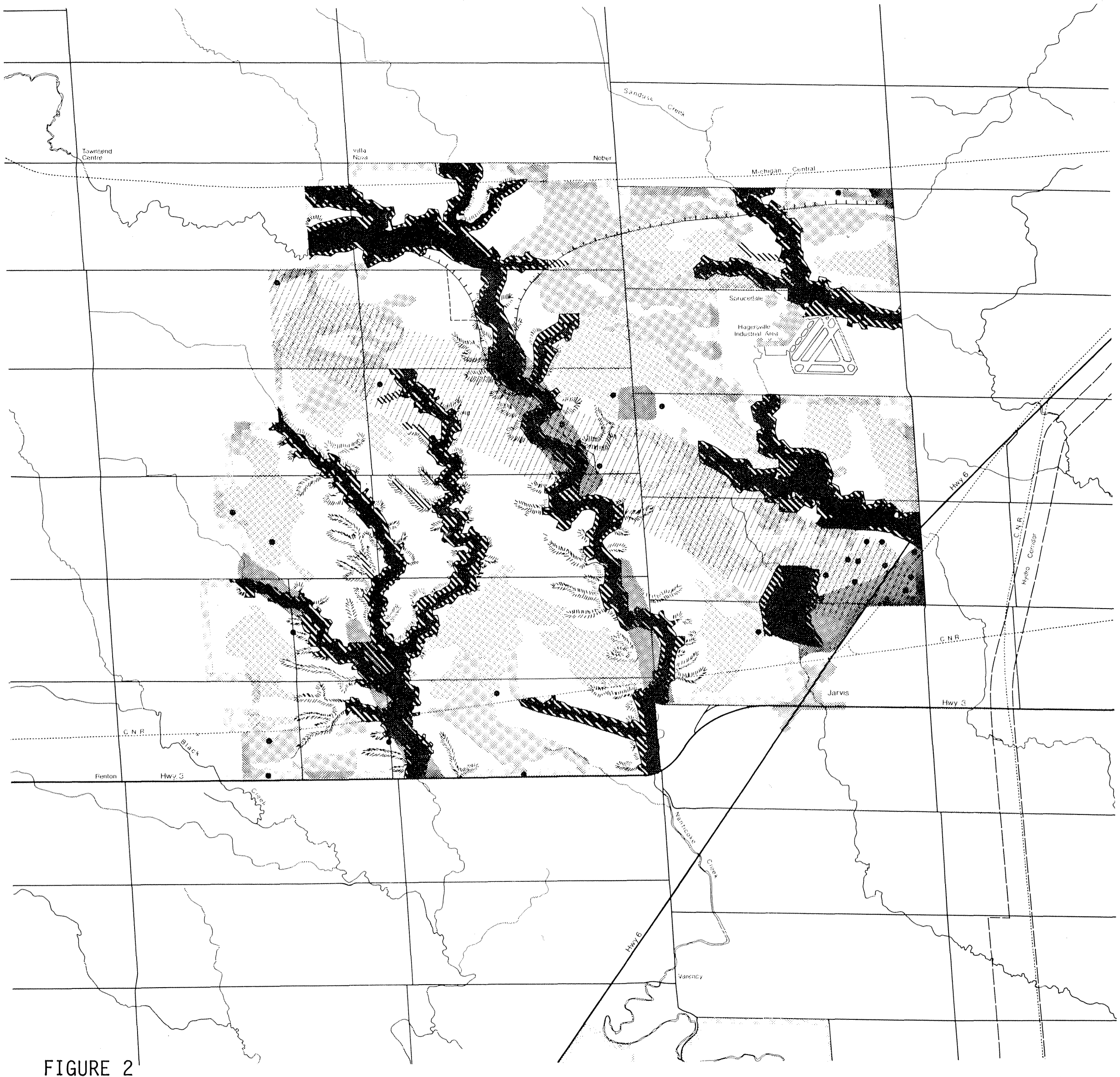

FIGURE 2

Abiotic Constraints for Development

- ■ Flood Plain (Incomplete Data)
- ▨ Fill Line (Incomplete Data)
- ▦ Shallow Overburden (Less than 5m. to Bedrock)
- ▒ Poorly Drained Soils (>50% of Area)
- ☐ Steep Slopes (More than 9%)
- ▨ Other Areas Liable to Seasonal Flooding
- ▨ Zone of Possible Bedrock Sinks
- ☐ Gypsum Bearing Formation<30m. from Surface
- ● Gas Wells
- ░ Poorly Drained Soils (20% to 50% of Area)

Source: Dillon, MNR, ESP and Dr. Chesworth

100 Hectares

100 Acres

1KM

1MI

Date Sept. 76

TOWNSEND

COMMUNITY DEVELOPMENT PROGRAM

Ministry of Housing

Ontario

Source: Llewelyn-Davies Weeks Ltd. et al., 1976

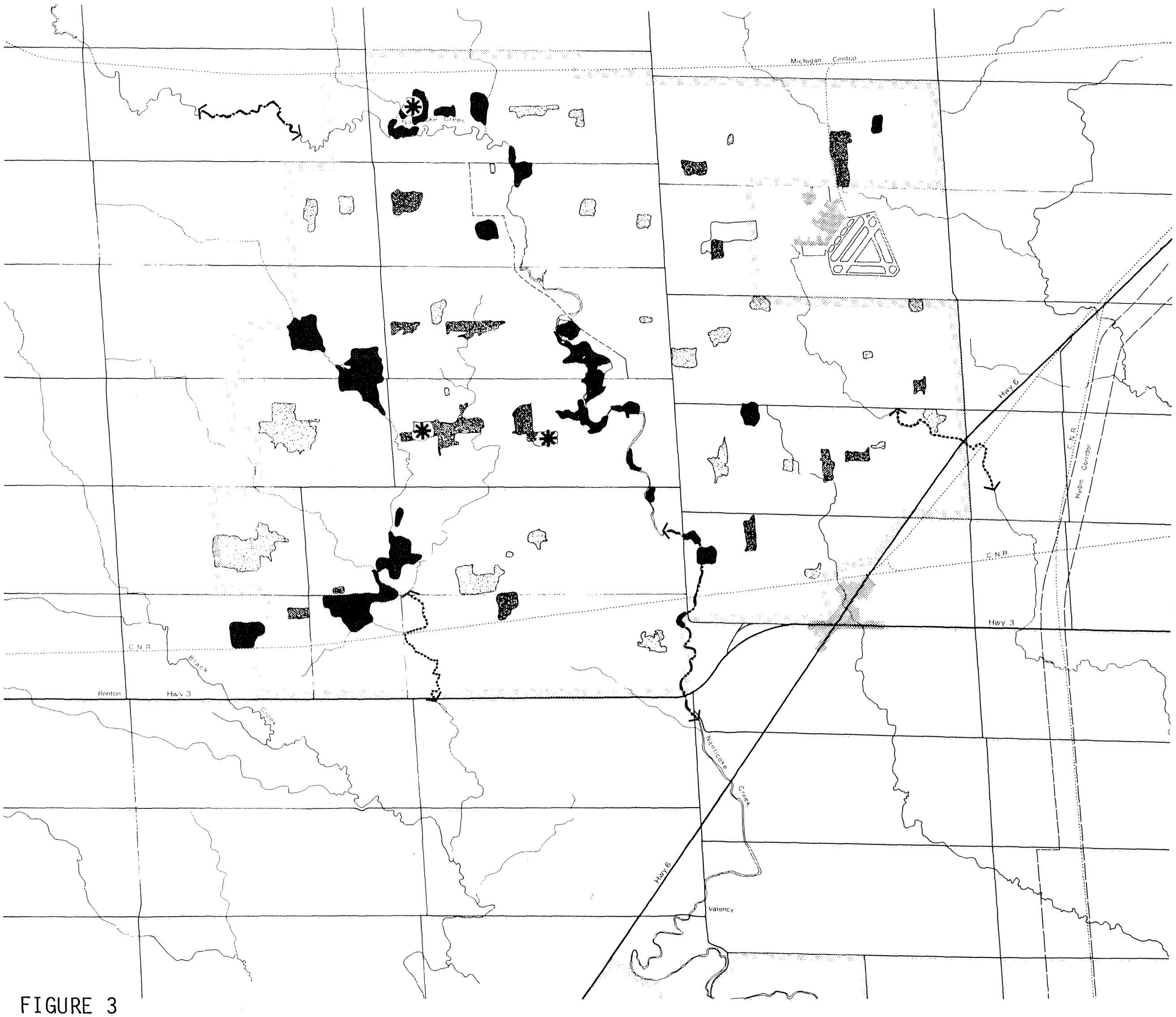

FIGURE 3
Biotic Constraints to Development

■ Woodlots: Low Acceptability for Urbanization
▩ Medium Acceptability for Urbanization
░ High Acceptability for Urbanization

⋰ Water Quality: Medium
⋰ Medium to Low
⋰ Low

✱ Suggested International Biological Program Sites

Source: MoE and Ecoplans

100 Hectares
100 Acres
1KM
1MI

Date April 76

TOWNSEND
COMMUNITY DEVELOPMENT PROGRAM

Source: Llewelyn-Davies Weeks Ltd. et al.,1976

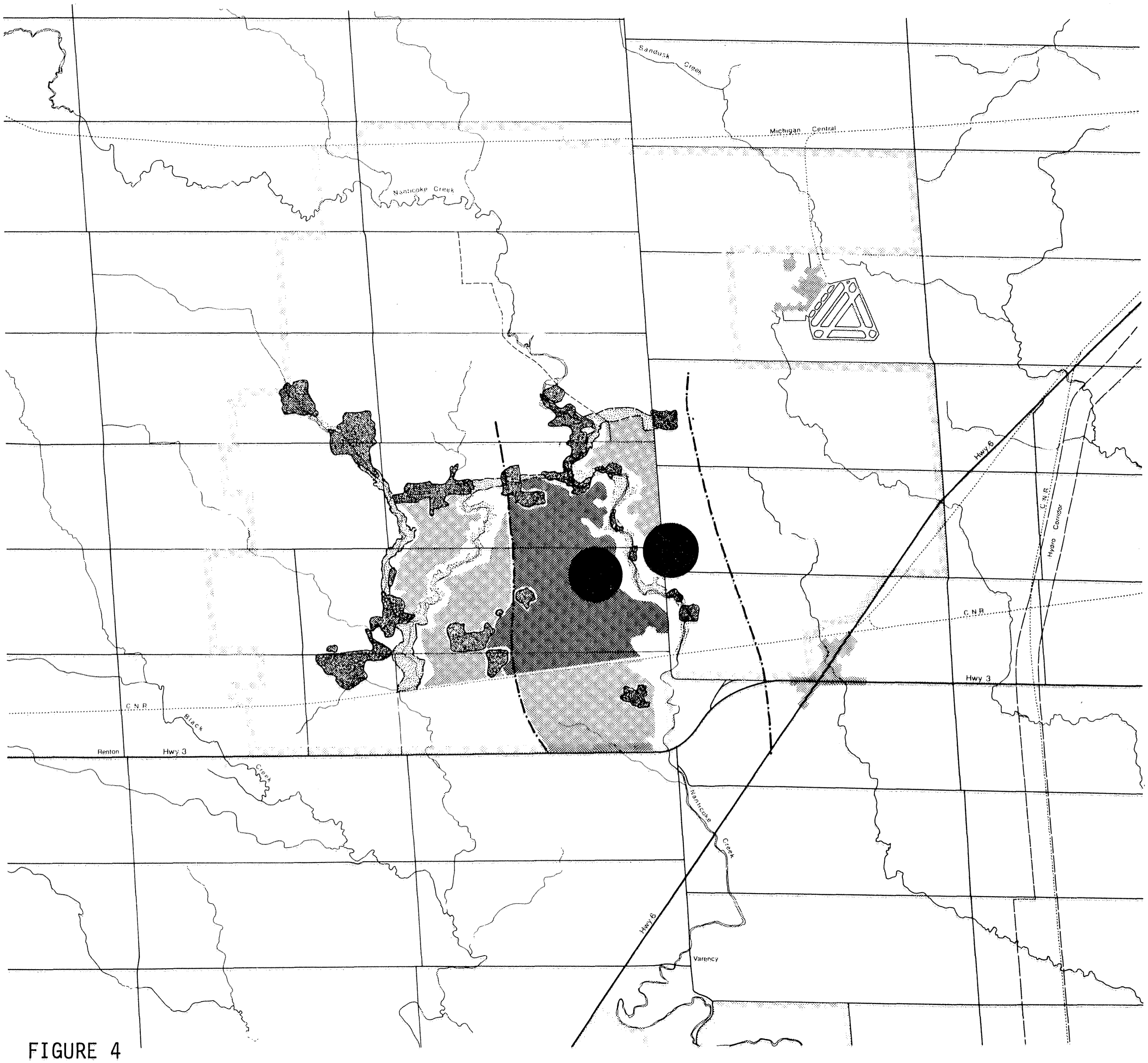

FIGURE 4

Recommended Development Envelope

Phase1: 20000 Population (1986)

▩ Confirmed Areas for Development
▒ Possible Areas Requiring Study

● Possible Locations for Regional Centre

▧ Flood Plain with Fill Line
▩ Woodlots
⧄ Watershed Boundary

100 Hectares
100 Acres
1KM
1MI

Date April 76

TOWNSEND
COMMUNITY DEVELOPMENT PROGRAM

Source: Llewelyn-Davies Weeks
Ltd. et al.,1976

SUGGESTIONS FOR IMPLEMENTATION

To implement a nationwide urban mapping program as proposed would be foolhardy and potentially wasteful without a series of pilot projects. The following steps are proposed which could determine the viability of the proposed mapping scheme:

1. Select representative urban study areas having major climatological, and major biophysical differences. Some suggestions based on quality of existing baseline information with which I am familiar would be: Waterloo Regional Municipality, Ontario, 500 square miles; Townsend or North Pickering New Towns, Ontario; City of Saskatoon, Sask.; Fredericton, N.B.; City of Calgary, Alberta; Part of City of Vancouver, B.C.; Gillam, Manitoba; Halifax, N.S. I am not familiar with urban information systems in Quebec, Newfoundland, P.E.I., and the Territories and for this reason can make no comment on the availability of existing biophysical information systems; no doubt reasonably complete baseline biophysical data systems also could be found in these Provinces.

2. Select areas having major growth pressure.

3. Develop handbook for each study area, and undertake mapping with suitable supervisory control. This could be done by consultants, by Universities, by government teams, or combinations of all three.

4. Define users; bring users on board project at the inception.

5. Locate offices of the project in office of major public agency (user) to become recipient and custodian of the maps to facilitate communication between mappers, one user group, the development sector and various community groups.

6. Have independent review of users' perception of the value of the mapping at completion of mapping, 1 year later, and 5 years later..

7. Review the impact the mapping will have had on land-use planning, economic adjustments of private sector (especially speculators) on designated sensitive parcels, private owners perception of property values on designated sensitive parcels 5 years after completion.

8. Compare on one or more areas this proposed method with the Dansereau land classification system (personal communication), and any other systems which may be put forward.

9. Involve local Universities in the work to facilitate a two-way technology transfer, thereby facilitating diffusion of ideas to students by professorial staff who would be familiar with the evolving approach. A number of these would thereby be generated testing the methodology or inventing new methodologies for refinement. Students graduating would thence generate demand for such mapping in the agency where they work.

COST FOR IMPLEMENTATION OF PILOT PROGRAM

An approximation of cost for the Waterloo Regional Municipality can be made because the area already has much of the base data needed in computer form, and soils (1:20,000), geology (1:50,000) and unique natural attributes are already classified. In addition, the City of Waterloo is already mapped at 1" to 200' for many biophysical features (Dorney and Priddle, 1973). Assuming the availability of 1" to 800' mapping for Kitchener, Waterloo and Cambridge, a 1:25,000 scale mapping[1] for an area 4 miles deep around the cities, and a 1:50,000 for the remainder of the Municipality[2], the entire area could be mapped for approximately $500,000. Budgeted over a 3-year mapping program this total would cost approximately $175,000 per year. If the 1:50,000 scale mapping portion were deleted then the cost would be slightly less than half. Off-setting these costs would be savings to both the private and governmental sectors from not having to do such base mapping for environmental assessment purposes (procedures already approved in the Regional Official Plan in addition to Provincial and Federal requirements); such savings are not possible to quantify but could be on the order of $30,000 to $50,000 over the 3-year period. With servicing costs of urban land running at $35,000/acre plus the market value of the land itself, these mapping costs are minimal investments to facilitate the approval agencies response to development options.

Areas in other provinces would have to be examined from the point of view of available forestry, geology, soils mapping before budgets

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[1] Soils are already mapped at 1:20,000; these costs assume 110 square miles at $3.00/acre deducting one dollar/acre for soils survey.

[2] Data already near complete except for forest, stream and lake classification; for this additional mapping I have assumed $2.00/acre for 450 square miles.

could be prepared. I am not sufficiently conversant with the data availability to hazard a guess as to the cost for such work but certainly Saskatoon has a good urban geology base, Calgary a good geological hazards and natural environment base, and Fredericton floodplain mapping, all of which would facilitate the work, thereby reducing the cost.

CONCLUSION

Canada, like many industrialized-urban countries is trying to reconcile economic development with environmental quality. New legislative directions, of which environmental assessment is one of the more visible, new hearing processes which attempt to involve the affected parties (of which the Berger Commission is one of the more notable recent examples), all suggest tangible directions which this public concern over environmental quality, environmental impact issues will take. Having up-to-date biophysical and cultural-historic mapping should facilitate more reasoned discussion, facilitate more rapid and precise planning, minimize the inevitable litigation arising over competitive land uses, and raise public awareness of the location, nature, function and value of these resources.

As space and time shrink, as human populations increase, and as our potential for environmental disruption increases with more sophisticated technology, the availability of improved maps describing these irreplacable natural and cultural resources should improve our management capability, our ability to respond to crisis, and ultimately our survival at a reasonable standard of living.

ACKNOWLEDGEMENTS

In review the approach presented here, the critical comments of Dr. L. Russwarm, Messrs. C. Kitchen, V. Moore and J. Dorney, and my Colleagues in Ecoplans are greatly appreciated.

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APPLICATIONS OF ECOLOGICAL (BIOPHYSICAL) COMPONENTS IN URBAN AREAS

APPLICATION DES CONNAISSANCES ÉCOLOGIQUES (BIOPHYSIQUES) AU MILIEU URBAIN

A MODERN AND FUTURISTIC APPROACH TO HYDROGEOLOGY AND RURAL RESIDENTIAL DEVELOPMENT IN EASTERN ONTARIO

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Geo-Analysis Ltd.
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INTRODUCTION

Existing and future residential development in rural areas is almost exclusively dependent on groundwater and the suitability of the soil for sewage disposal by conventional septic tank and drain tile field systems. The lack of a true appreciation of these two critical resource conditions has led to numerous polluted water supplies in many country villages and to a fundamental failure in planning wherein rural subdivision layout is modelled after typical metropolitan residential plans. There is a big difference between planning a rural subdivision on earth resources where Mother Nature calls the shot, and in the city where engineering assures us of a treated water supply and some form of sewage treatment and disposal.

Country residential planning and development is a highly topical item with respect to the recent *Habitat* Conference. Hopefully this presentation can be used as a framework for planning rural development, not only in Canada but throughout the world. First, we will examine the major items of importance - groundwater resources, terrain types, stratigraphy and geologic processes, in short - *terrain suitability* or *capability*. As well, I will point out the difficulty of defining these resources in graphic and written form to a largely layman political administration (the client) who collectively must in turn justify the expenditures for such a study to their ratepayers. This will be followed by a description of how this information is put to practical use - i.e. the manner in which we decide where and how to develop residences and how large the lots should be along with other basic planning items. Representation difficulties of this aspect of the work will be described.

I am indebted to March Township (Figure 1) for their kind permission to present this paper. However, I would like to emphasize that the conclusions and planning guidelines presented are the sole responsibility of the author.

TERRAIN MAPPING

Accurate topographic maps showing the distribution of surficial (Figures 2 and 3) and bedrock deposits (Figures 4 and 5) are fundamental to any type of planning. Diagrammatic cross-sections, sketches or perspectives show the relationships between the various terrain units in detail (because planning decisions are based on this) *and* in general (so that a layman can understand). Photos greatly assist illustration of terrain types (Plates 1 to 11).

This information is obtained by field mapping, photo interpretation, analysis of water well data and previous work. The problems really begin here. First, it is essential that a geologist with surficial, geomorphic, bedrock, hydrogeologic and some engineering experience undertake the bulk of this work. This person

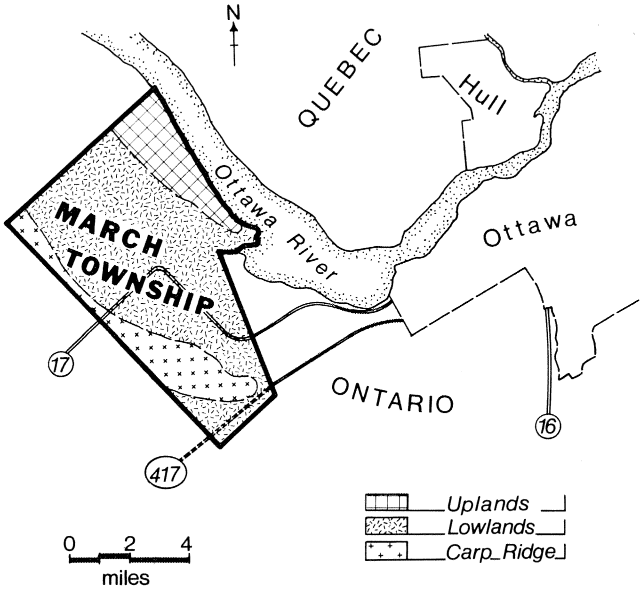
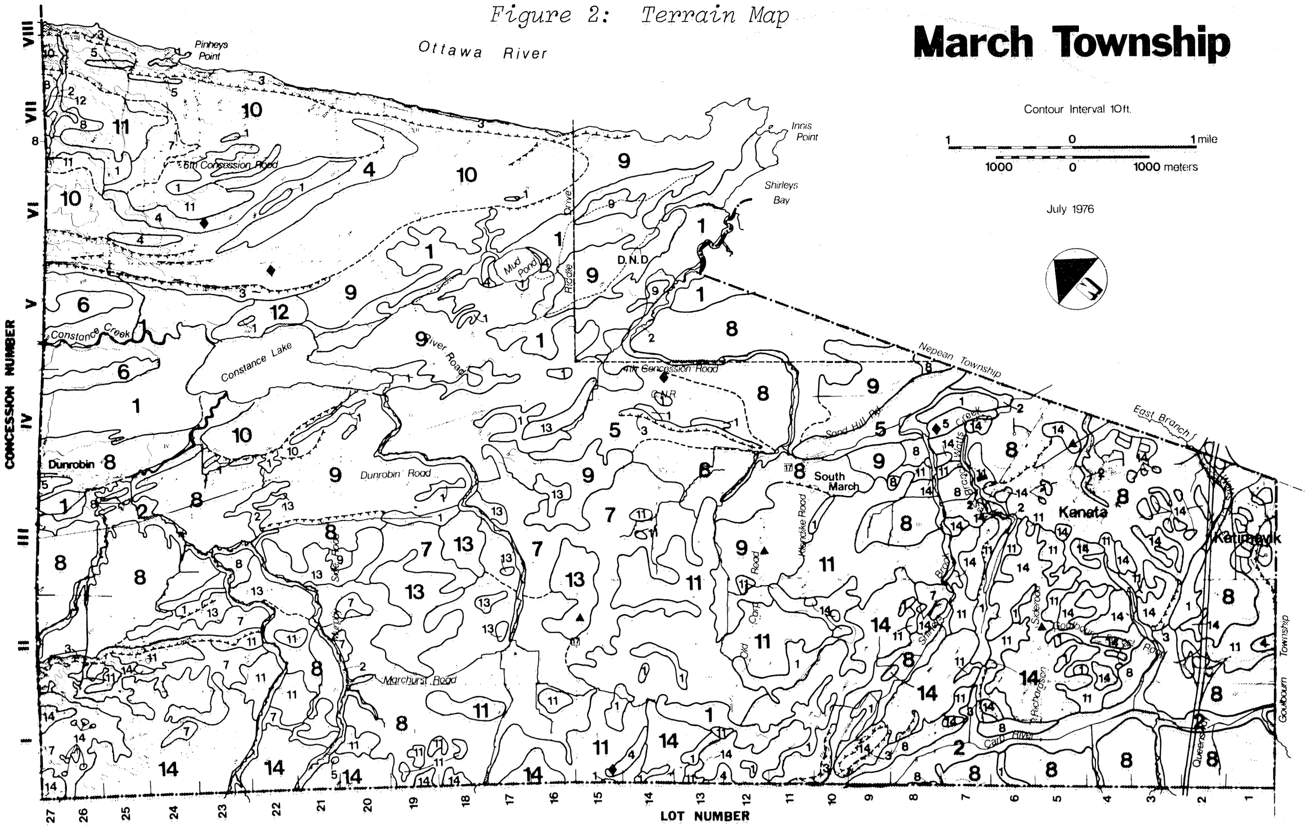


Figure 1: Location of March Township

Proc. Workshop on Ecol. Land Class. in Urban Areas, Can. Comm. on Ecol. Land Class., 23 & 24 Nov. 1976, Toronto, Ont.

Figure 2: Terrain Map



◆ GRAVEL PIT

▲ QUARRY

┴┴┴┴ SCARP

—— TERRAIN CONTACTS (APPROX.)

1 ORGANIC: Mud, peat, poorly drained, free water, includes some alluvium; beaver dams, marsh; depressional.

2 ALLUVIUM: Silt and sand, some clay, organic mud; channel and flood plain deposits, poorly drained.

3 COLLUVIUM: Steep slopes, poorly sorted gravel in places, talus, soil creep material, bare bedrock or soil cut banks.

4 BEACH: Gravel, silty, sandy, fossiliferous in places; low well-drained ridges along or adjacent to bedrock; 1 to 3 m thick; poorly stratified; pebble composition reflects underlying bedrock; includes abandoned beach at Mud Pond.

5 FLUVIAL SAND: Sand, mainly very fine to fine grained, wavy parallel stratification, layers of silt and clayey silt, well-drained; >0.5 m thick; includes local aeolian sand layer at Dunrobin.

6 DELTAIC SAND: Sand, medium grained, well-sorted, cross-stratification, buff; >0.5 m thick; upper part aeolian (wind blown); hummocky to gently rolling; treed; well-drained.

7 THIN CLAY: Silty and sandy in places; <1.5 m thick; low relief, planar and depressional to gently rolling; often poorly drained; bare bedrock outcrop; pasture land; may include thin layer of till; overlies Paleozoic or Precambrian bedrock mainly, but may overlie till in central part of Map Area.

8 THICK CLAY: Dense, plastic, hard when dry; silty, >1.5 m thick; low relief, planar to gently rolling; poorly drained; agricultural land; includes local layers of sand.

9 VENEERED LOWLANDS: Thin layer of silt, clay, clayey gravel, or modified till; commonly <0.3 m thick up to 1.5 m, overlies Paleozoic bedrock; tabular bare patches of bedrock, flat boulders and low ridges of bedrock common; gently rolling; poorly drained.

10 VENEERED UPLANDS: Thin layer of silty, clayey gravel or modified till, overlies Paleozoic bedrock, gently rolling, low bedrock scarps and bare bedrock patches; poorly drained; scattered low ridges of aeolian sand.

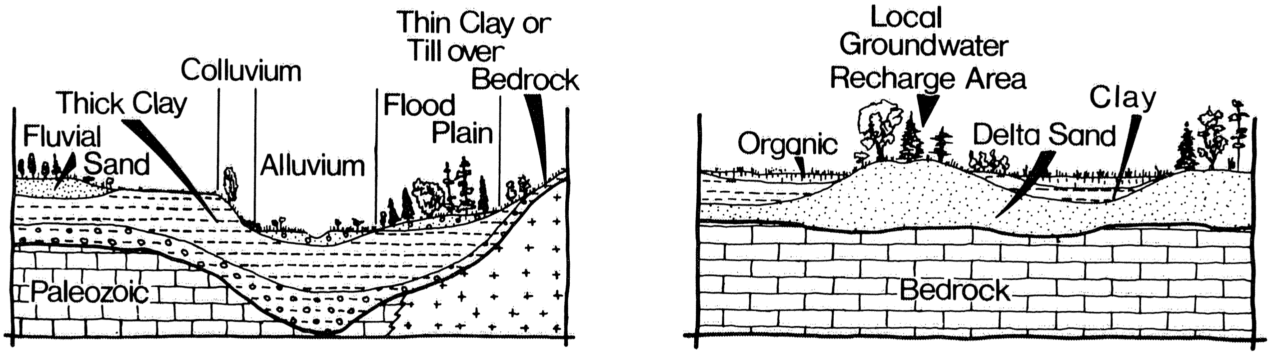
11 MODIFIED THIN TILL: Thin layer of till over bedrock, numerous boulders, sandy clay matrix, coarse gravel in places, includes local patches of sand and clay; rolling topography, well-drained, mainly treed; includes bare patches of bedrock; low scarps, Paleozoic and Precambrian bedrock.

12 THICK TILL: Till, sandy clay matrix, >0.5 m thick; large boulders, gently rolling, upper part modified by wave action into beaches on northeast foreshore of Constance Lake; moderately well-drained.

13 PALEOZOIC BEDROCK: Low but rugged relief, gently rolling, bare bedrock plains and erosional remnants, mantled with clay or till deposits up to 3 m thick in places; numerous boulders; often treed.

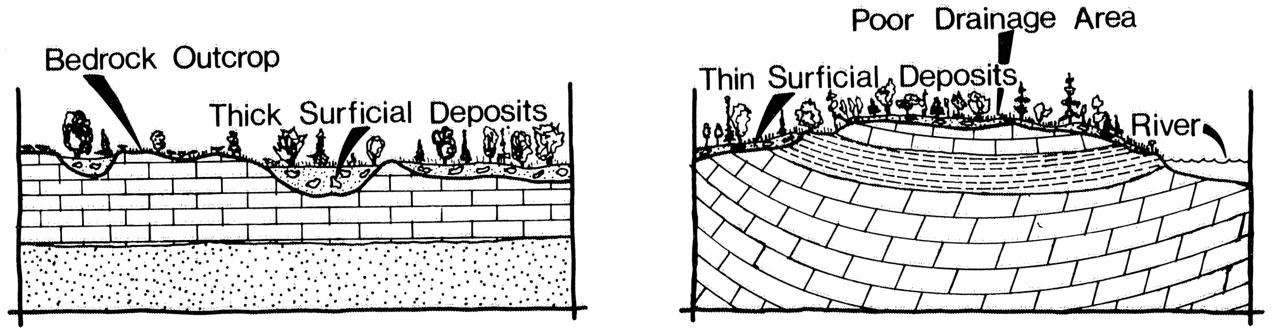
14 PRECAMBRIAN BEDROCK: Knolls and scarps of igneous or metamorphic rock, rugged relief; includes local patches of till, sand, clay and gravel, poorly drained, organic depressions.

Figure 3: Terrain sketches of March Township



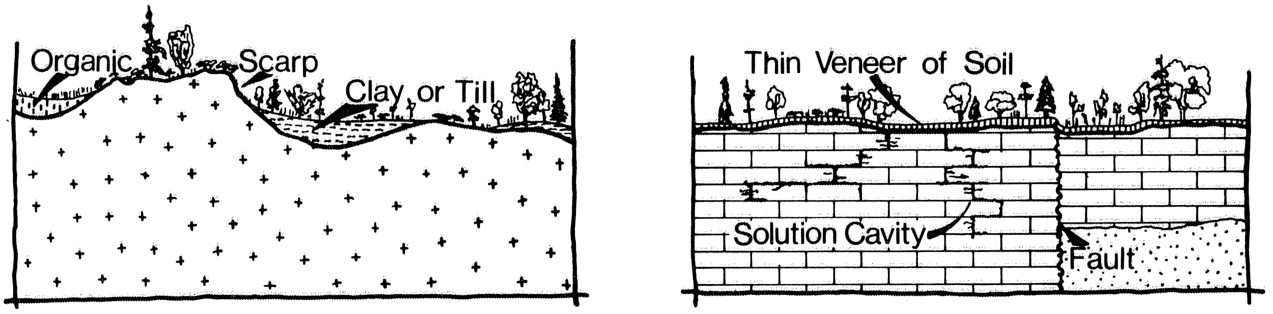
A: Terrain Units 2,3,5,7,8 & 11

B: Terrain Units 1 & 6



C: Terrain Units 12 & 13

D: Terrain Unit 10

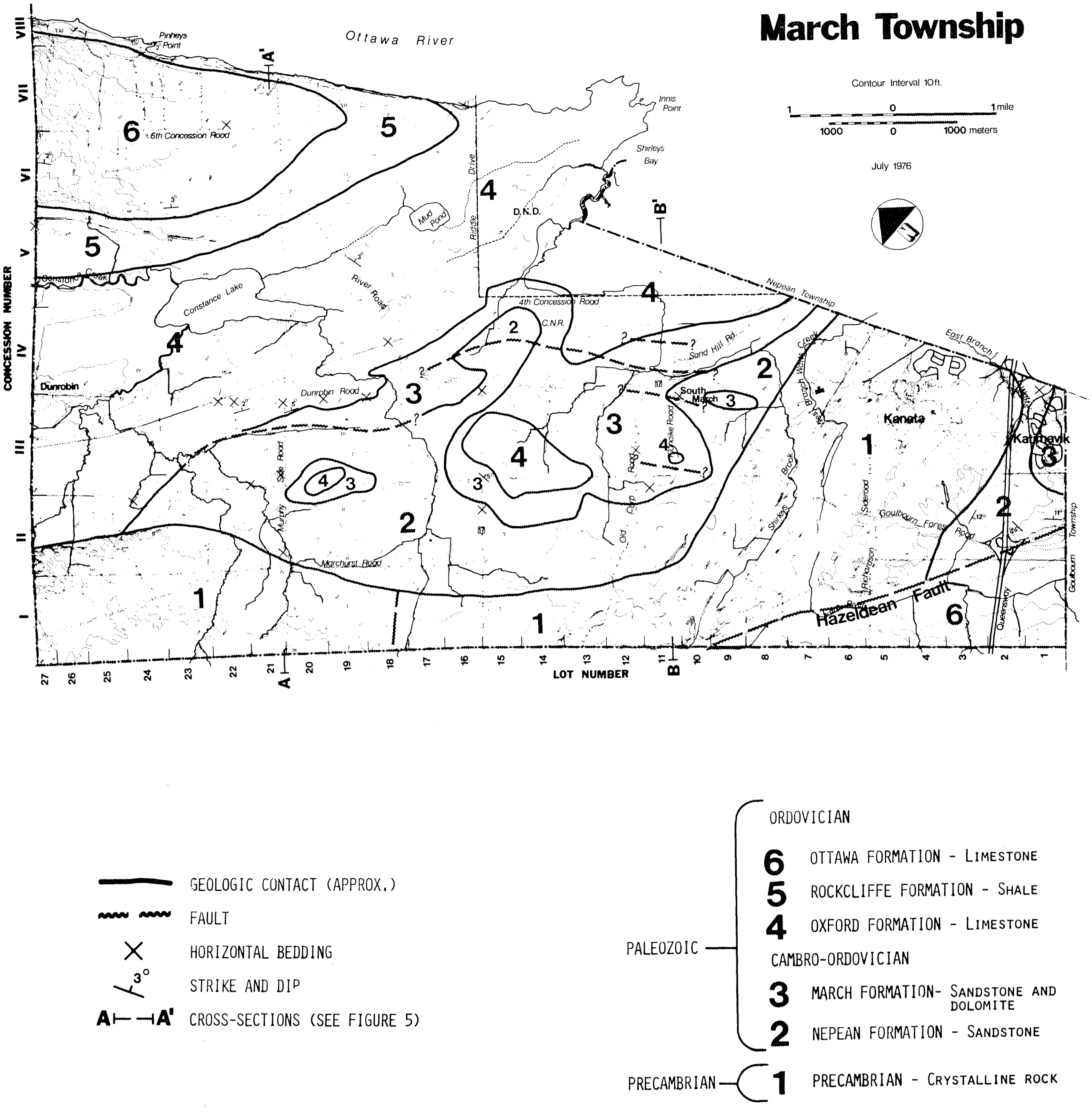


E: Terrain Units 11 & 14

F: Terrain Unit 9

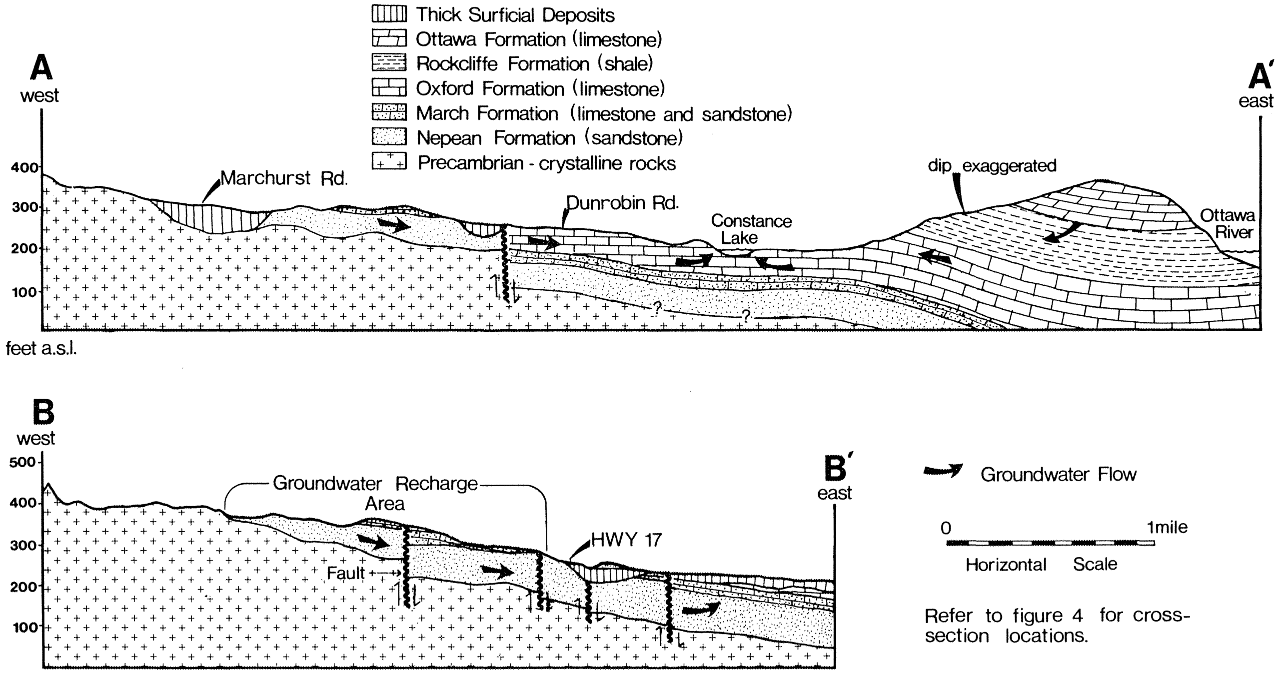
For "terrain units", see Figure 2 and Table 1.

Figure 4: Bedrock geology



Geology after Wilson(1946).
Additional features from present work.

Figure 5: Structural cross-sections of March Township



must identify relationships between till, outwash, alluvium and other surficial deposits, not only from the standpoint of spatial relationships but also for detailed stratigraphy. At some point he will have to give an opinion on the advisability of dumping 'sewage' on a specific deposit. He needs bedrock geology experience because many groundwater aquifers occur in the bedrock, and it is the detailed characteristics like porosity, permeability, structure and stratification that determine the aquifer potential. He needs hydrogeology experience so that he is able to efficiently view the various terrain units within the perspectives of a realistic hydrogeologic spectrum. Geomorphic experience is required for accurate interpretation of the significance of landforms and their ultimate capability and inherent constraints (e.g. flood plains). It helps finally to have knowledge of engineering for he will have to provide basic earth science data to guide engineering activities as well (e.g. to avoid landslide localities and soils of low bearing capacity, etc.). Persons with such expertise are rare in Canada.

The second problem arises in actually carrying out the work. To properly map an area, you must traverse the land at various spots. However, the land is almost exclusively privately owned. To provide landowners with an explanation of the nature of the work is impractical and offers no guarantee of admission. To complete the work on schedule, it is therefore necessary to handle difficult situations as well as possible and to circumvent those that are impossible.

The third problem is that to obtain subsurface data you must analyze the water well records (Figure 6). These records are far from complete and are certainly not up-to-date. The reliability of water well records data are also incredibly suspect, and the descriptive terms used in the records really test the interpretative rationale of even the most highly trained geologist.

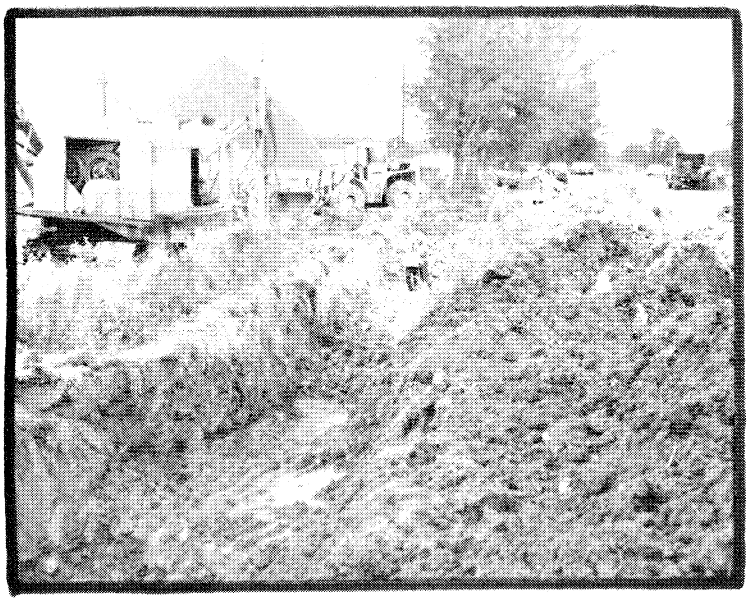
HYDROGEOLOGY

The next major exercise is to analyse the hydrogeologic regime or the groundwater system. Firstly, this involves definition of the various aquifers and a relative rating of their potential (Figure 7). Water quantity and depth to the aquifer must be considered. Secondly, we must define areas of groundwater discharge and areas of recharge. This is because we strongly suggest that either no development or only light development be allowed in recharge areas so that the long-term integrity of an aquifer is protected. On the other hand, groundwater discharge areas are usually poorly drained but do have a wide variety of potential land uses other than for residential development. Usually, the best area for residential development is in

EXPLANATION OF PLATES

PLATE 1:	Thin bedded siltstone strata of the Rockcliffe Formation form the tip of Pinhey's Point shown here. The view is to the NE and bedrock strata dip gently to the left (West).
PLATE 2:	Thick clay (Unit #8) surrounding a buried bedrock knob is shown in the excavation for the Queensway extension in the SW part of March Township.
PLATE 3:	Paleozoic bedrock of terrain unit #13 is exposed at this location west of the railway track on Riddell Drive. One good residential site with sufficient soil in one to two ha should occur in such terrain.
PLATE 4:	A view to the SE showing the western part of Pinhey's Point.
PLATE 5:	Spectacular deltaic cross stratification can be observed in this sand deposit of unit #6 at the Younghusband Pit.

1



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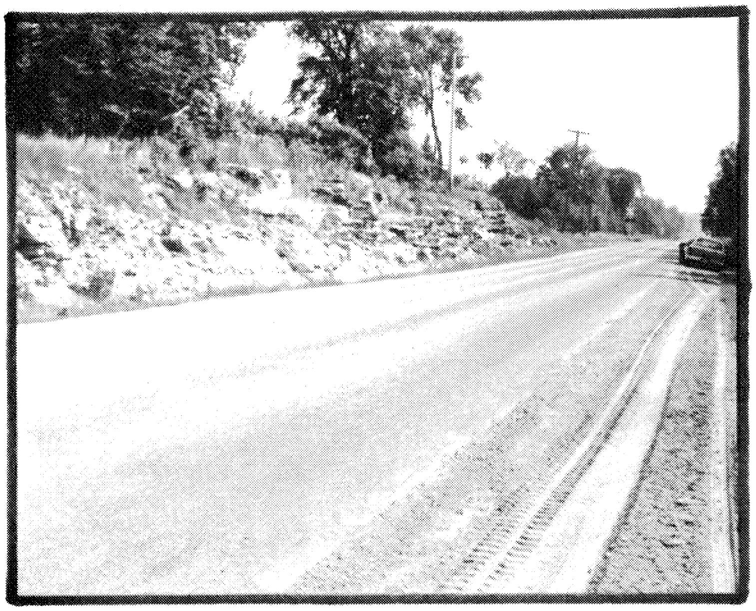

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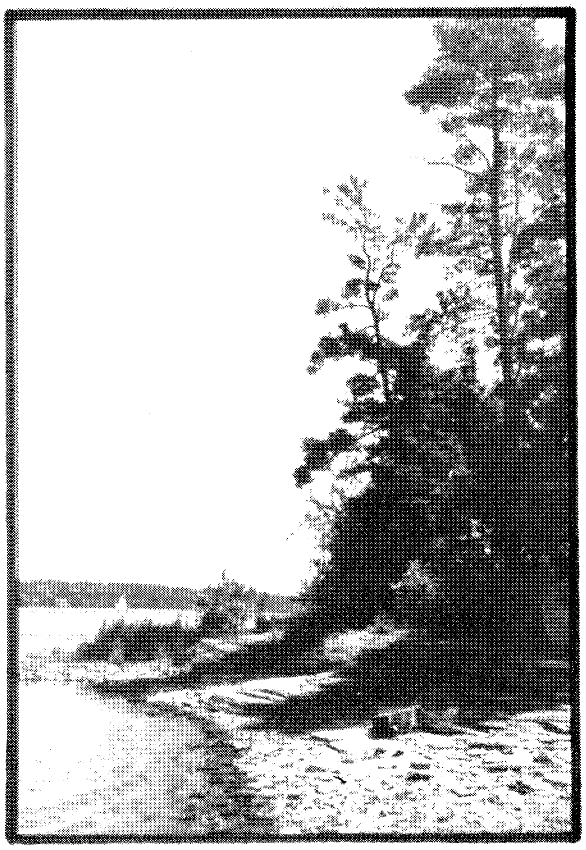

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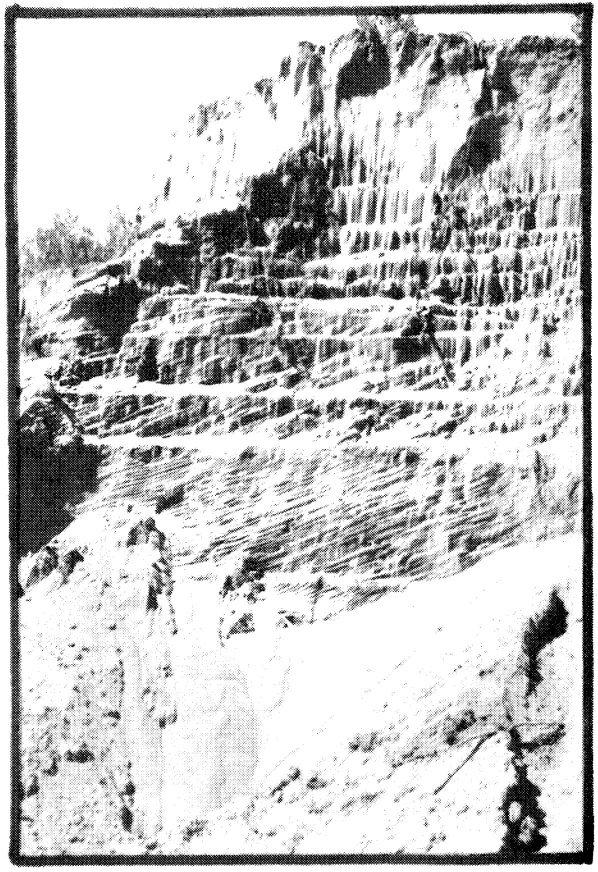

EXPLANATION OF PLATES (CON'T)

PLATE 6:	The high groundwater table and near-surface bedrock in the veneered lowland unit (#9) is apparent at many localities, especially at quarry sites like this one near South March. Bacterial contamination may present major health hazards at such unregulated sites despite the indisputable natural beauty of quarry lakes.
PLATE 7:	Pinhey's Farm in the veneered upland unit (#10) is the subject of a recommended biophysical study and master plan development. The slope in the background is part of the colluvium unit (#12).
PLATE 8:	Terrain type in raised beaches along the northern shore of Constance Lake. Thick till is suspected at the locality.
PLATE 9:	Constance Lake is an ideal float plane base, but is not suitable for cottage development because of near-surface bedrock and high groundwater levels. The lake water quality is deteriorating seriously; its integrity *must* be insured.
PLATE 10:	Horizontal bedding in the sand unit (#5) near Sand Hill Road reveals that it is a fluvial deposit probably formed by the Ottawa River perhaps 10,000 years ago after the Champlain Sea had retreated.
PLATE 11:	Near-surface bedrock is common in the Uplands as shown by this shale pit developed in the Rockcliffe Formation.

6

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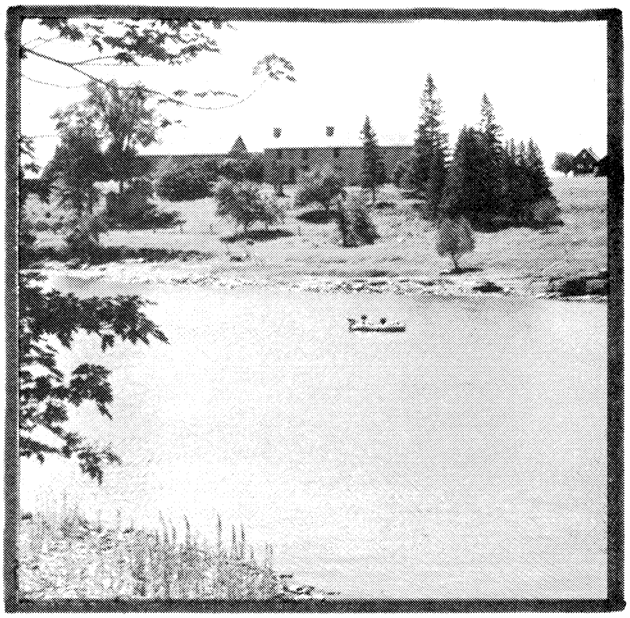

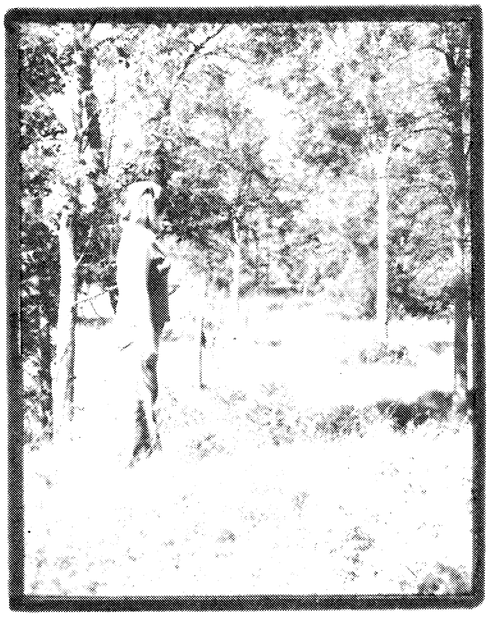

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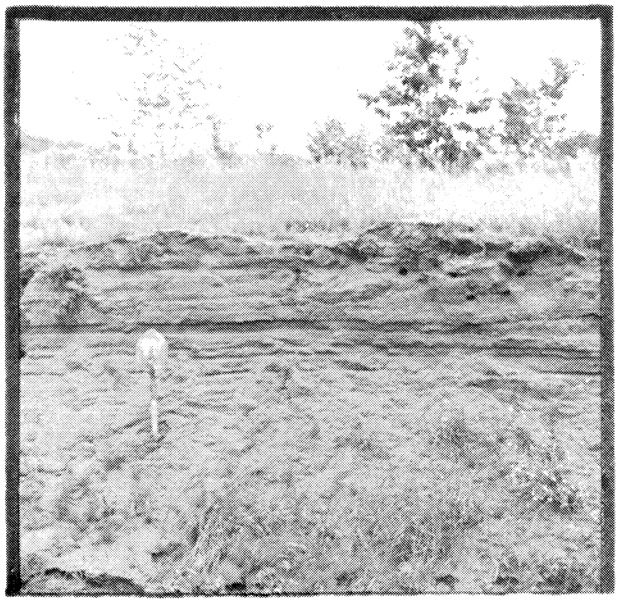

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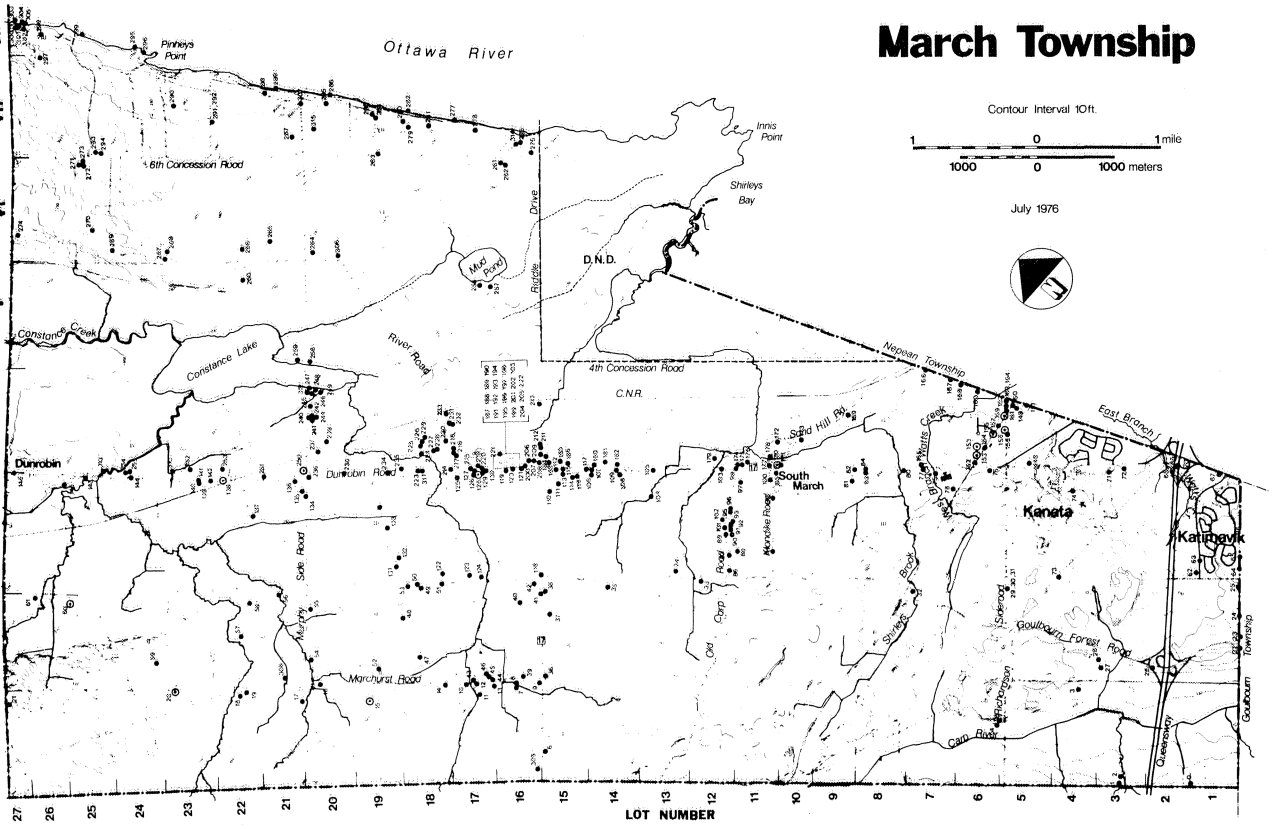
11

Figure 6: Water well locations.



●71 WATER WELL LOCATION AND NUMBER

⊙20 FLOWING WATER WELL LOCATION AND NUMBER

ALL WELLS REGISTERED WITH THE ONTARIO MINISTRY OF ENVIRONMENT BETWEEN DECEMBER, 1946 AND MARCH, 1974. COMPLETE RECORDS WERE UNAVAILABLE BETWEEN APRIL, 1974 AND APRIL, 1976.

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the transitional groundwater flow area. The problems in defining these important zones depend on the topography of the area, the amount of surface geologic data available, and the amount of reliable water well information. For example, in an area of low relief from 0 to 15 m and with limited outcrops, the definition of groundwater recharge and discharge zones is very difficult. In more rugged terrain where there are more geologic data, the definition of groundwater zones is much easier and the conclusions are therefore much more reliable. Well completion techniques in various terrain types are illustrated in Figure 8.

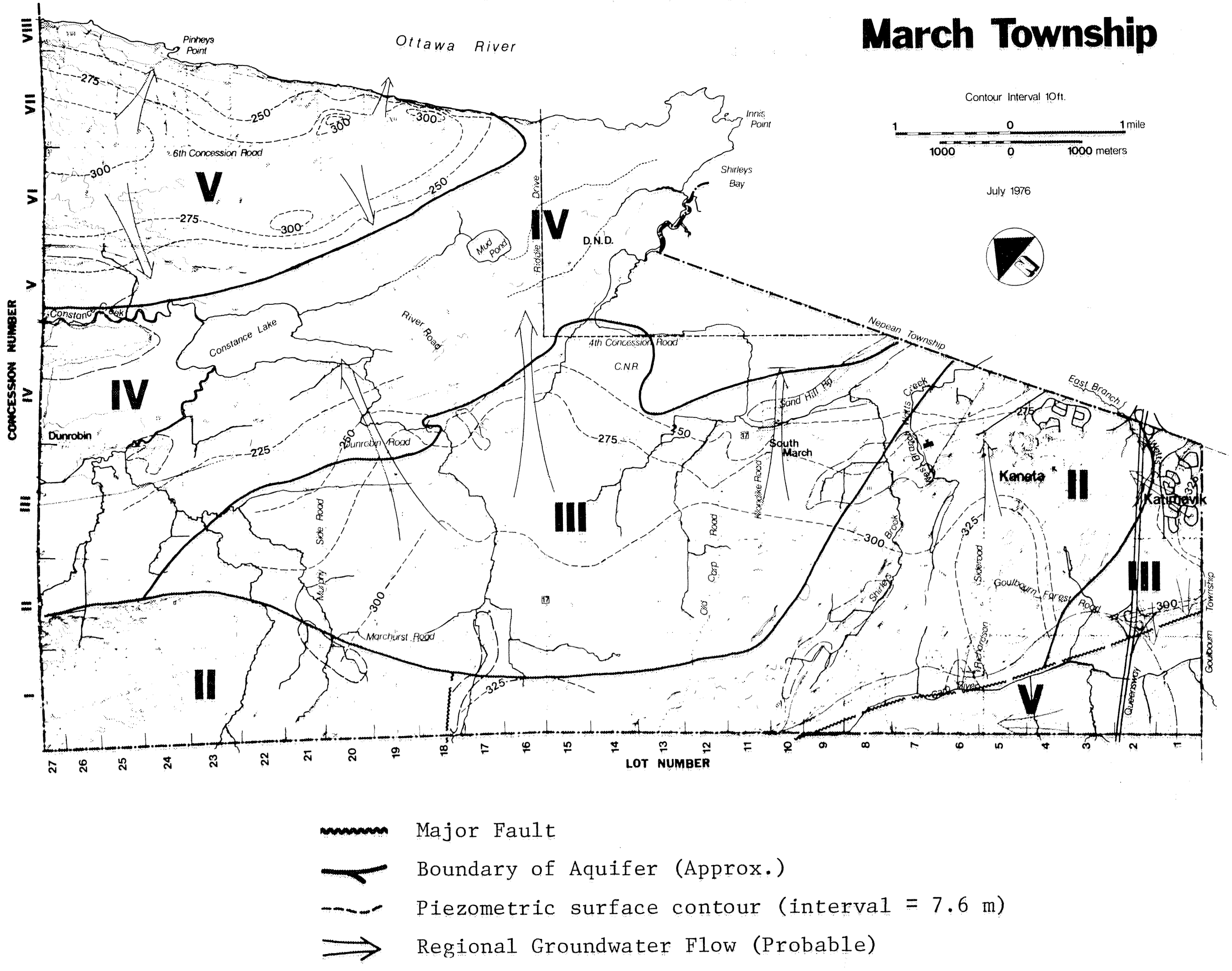
DATA SYNTHESIS

Evaluation of the hydrogeological resources is carried out on small parcels of land equally as well as on large parcels of land such as townships. Once these resources are defined, it is possible to synthesize the various components and to determine the suitability of the terrain itself for development of septic drain tile fields and individual wells. Certain natural elements must exist, however, before the site can be considered for the installation of drain tile fields. Modified somewhat from the regulations of the Ministry of the Environment, these include: the groundwater table must be a minimum of 1.5 m below the surface; the depth to any relatively impervious barrier such as bedrock must be at least 1.5 m below the surface; and the slope of the terrain ideally should be within 1-3%. These elements coupled with a semipermeable surficial deposit (e.g. a sandy till with a percolation rate of around 30 minutes) would constitute an ideal model.

DETERMINATION OF LOT SIZES

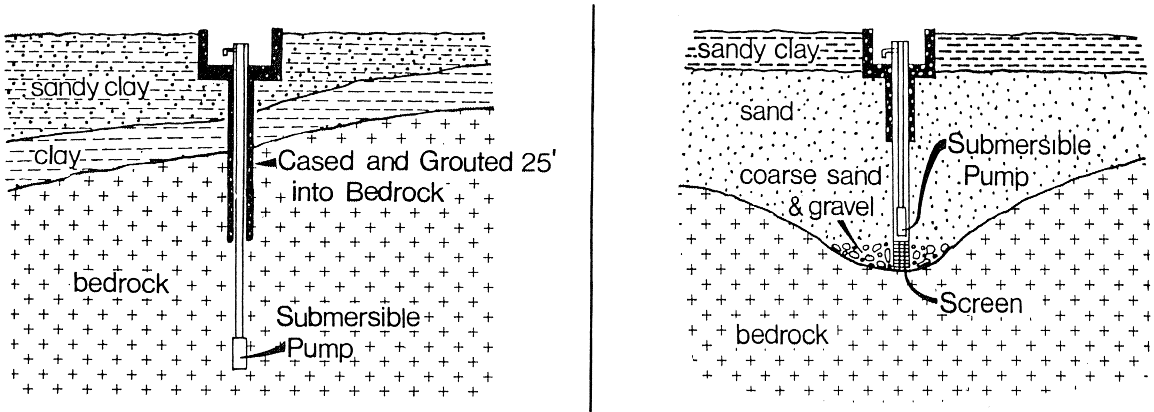
The attenuation capacity for dissolved minerals in a glacial till is high compared to that in sand. In one specific case for example, the concentration of chloride moving through a silty clay till decreased from 1967 ppm to 7 ppm within a distance of 5.2 m. In contrast, in a sand material, a concentration of chloride of 287 ppm

Figure 7: Hydrogeology



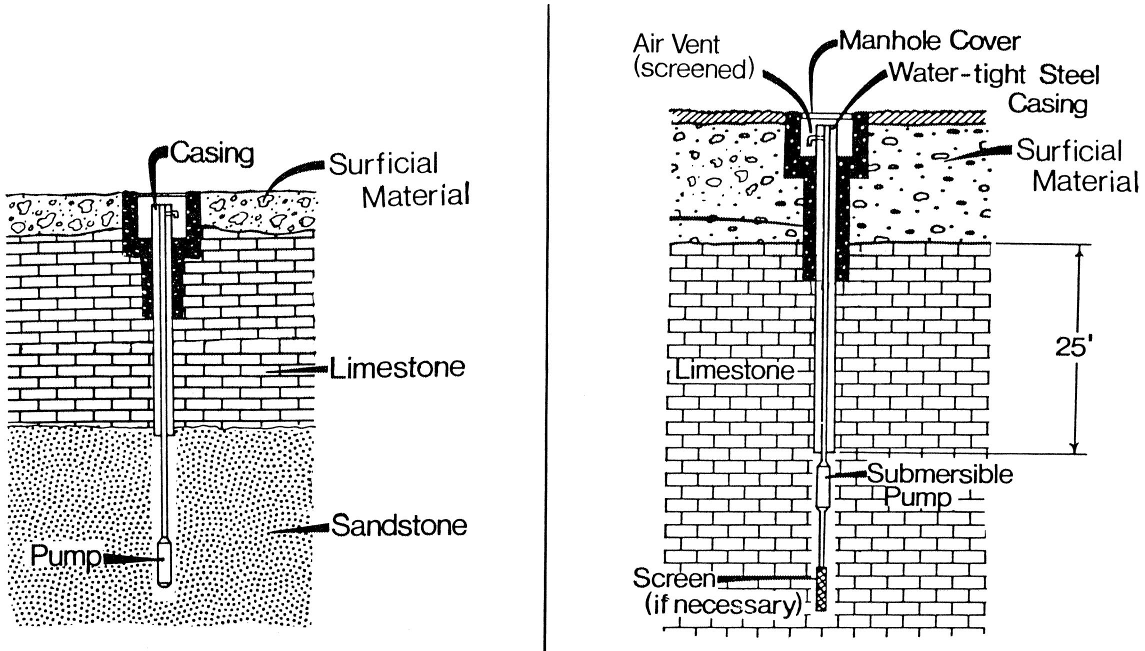
	GROUNDWATER POTENTIAL	DETAILS OF AQUIFER
0	Fair to Good	SURFICIAL - Sand or till gravel aquifers, high possibility of high-yield buried valley aquifers where indicated. Usually within 30 m of the surface.
II	Poor to Fair	PRECAMBRIAN - Crystalline rocks; yields a function of fracture permeability. Wells in excess of 60 m required.
III	Good to Excellent	NEPEAN SANDSTONE and MARCH FORMATION within 45 m of surface; best potential aquifers.
IV	Fair to Good	OXFORD FORMATION and underlying MARCH FORMATION - wells 15 - 60 m deep.
V	Fair	OTTAWA FORMATION - Limestone in SW within 45 m of surface, also Uplands area in the NE but wells in order of 60 m deep required here.

Figure 8: Water well completion



Precambrian bedrock

Surficial aquifer



Paleozoic bedrock with thin overburden

Paleozoic bedrock with thick overburden

decreased to 64 ppm *only* after a distance of 180 m. Total dissolved solids moving through the till went from 19,810 ppm to 372 ppm in 5.2 m whereas moving through the sand the concentration goes from 7024 ppm to 622 ppm in about 180 m[1]. Clearly there are major differences in the attenuation capacity of different surficial materials.

These facts present a basis on which to judge the size of lots that would be necessary for long-term environmental safety with respect to water quality. Given an ideal combination of certain terrain conditions, a lot size of 1400 to 1850 m^2 (0.14 to 0.185 ha) would, therefore, be sufficient for a well-drained glacial till where the till is at least 1.5 m thick and the groundwater table is at least 1.5 m deep. On the other hand, lots on sand terrain under similar conditions may have to be 8,000 to 16,000 m^2 (0.8 to 1.6 ha) to provide the same measure of long-term environment safety, depending on near-surface stratigraphic details.

The first problem in this activity is that to properly make this judgement, the professional must have extensive experience. This is a most difficult part of the job. The evaluation of rural areas for development on private services is of far-reaching significance. The method of determination of suitable lot sizes is in turn the most difficult to explain and one of the most poorly understood (with regard to hypothesis or *modus operandi*) by rate-payers or the general public. They cannot understand the reasoning behind this method. Their mystification is mainly due to the fact that there is a big difference between a half acre (0.2 ha) lot and a three acre (1.2 ha) lot in terms of economics. The more lots that they can obtain from their various parcels of land, the more money they can make. In our experience, what usually happens is that the price of the lot goes up with the size, and in the end a country lot usually becomes accessible only to very rich people.

Further economic problems revolve around these basic issues. The municipality's income is tied to the number of rate-payers, and it therefore welcomes more tax-payers generated by new residential projects. Municipalities are also concerned that the homeowner will not be able to aesthetically maintain such large lots. Road maintenance and snow clearing are further economic factors of municipal concern as relative costs are related to the ratio of homes per road km.

The additional problem for the consultant is the presentation of the data in a format that is easily understood not only to a layman, but also to officers of the Ministry of Environment. Most officials have considerable experience in site evaluation for drain tile fields but do not have a formal training in the important aspects of geology, groundwater flow, leachate-attenuation capacity, cation-exchange potential of different soils, and other aspects of geologic processes. The consultant must present the data so that a health inspector, for example, can evaluate a site efficiently and within the context of the whole geologic picture.

THE FINAL PRODUCT

The final product of an evaluation of this type is a *terrain suitability map*. For March Township, we were able to define a variety of terrain types with more or less common topographic, stratigraphic, surface and sub-surface drainage characteristics. Using our model for a base and our geologic experience and work in this area, we asked ourselves "For each terrain unit, what would be the minimum amount of land wherein it would be reasonable to expect the occurrence of at least one locality suitable in all respects for a drain tile field?" On this basis, we rated all the terrain units for development on various lot sizes.

For March Township, our basic criterion was that we were to evaluate the area for country estate lot development potential - i.e. lots ranging in size from 0.8 ha up to say 20 ha. Also, the terrain had to be reasonably well-vegetated and gently to moderately rolling. Terrain suitability and lot sizes for the various map units are shown in Figure 9. This map also shows the land that is completely undevelopable such as steep slopes, flood plains, muskeg and bedrock terrain types.

We carried this synthesis one step further and combined the areas that were best suited with respect to groundwater supplies with the areas that were best suited with respect to septic tank suitability. The result is shown in a stippled pattern on Figure 9. The stippled localities therefore are the ones that should be given priority for development, and this information forms the basis for a policy state-

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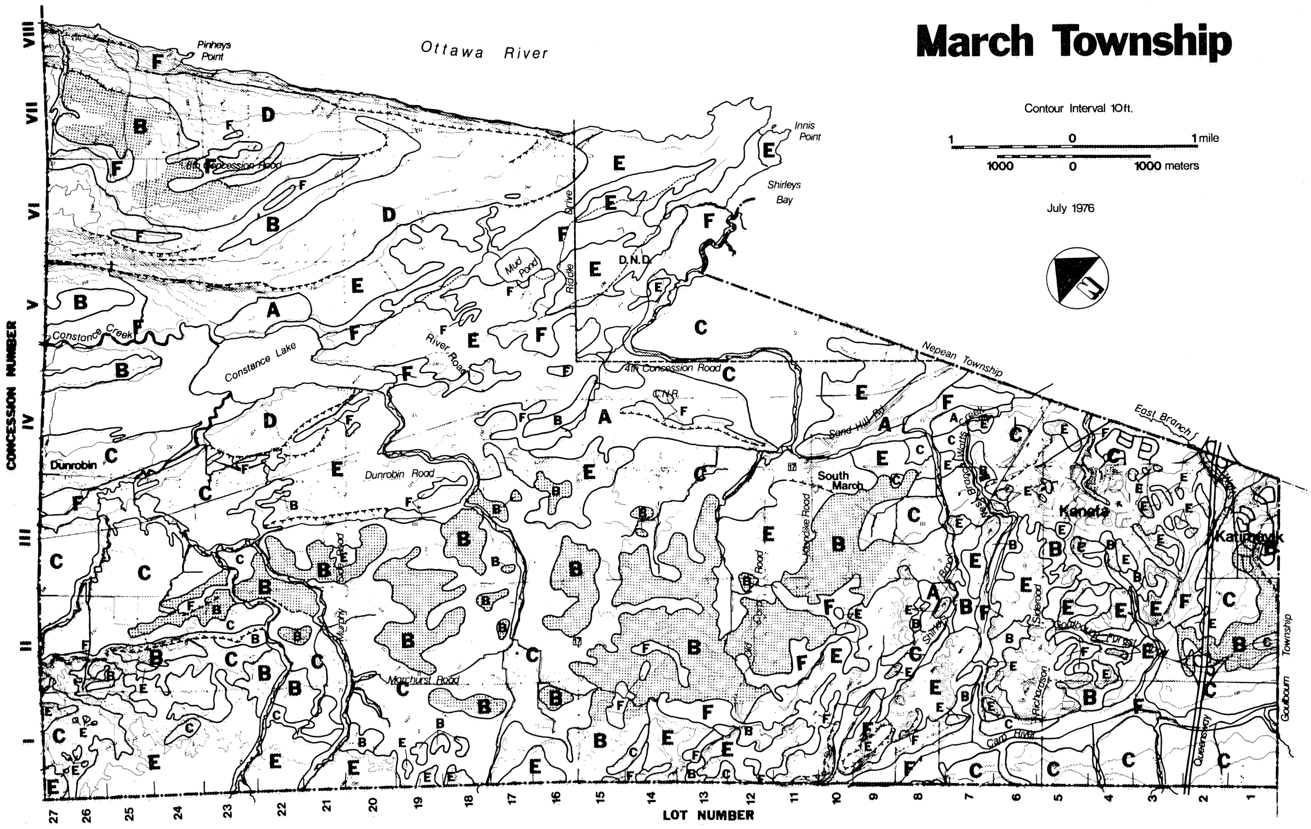
[1] Hughes, G.M. *et al.* 1971. Hydrogeology of solid waste disposal sites in northeastern Illinois; U.S. Environmental Protection Agency; Report SW-12D.

Figure 9: Terrain suitability and lot sizes.



A: 1 - 3 acres (0.4 - 1.2 ha)
B: 3 - 5 acres (1.2 - 2.0 ha)
C: 5 - 10 acres (2 - 4 ha)
D: 5 - 25 acres (2 - 10 ha)
E: 10 - 25 acres (4 - 10 ha)
F: Undevelopable
— Unit Contact Approx.
⌃⌃⌃ Scarp
▨ Very Best Suitability

EXPLANATION OF THE RATING SYSTEM

Lot sizes are based on hydrogeologic and terrain characteristics discussed in the report. For example, for any particular lot size the chances of finding at least one suitable site for one single family residence development is excellent. Further, "A" and "B" areas can be considered the best terrain for this type of development, and of these the "B" areas are the preferred location of country estate lot development. Various parts of the land, "C" areas for example, are of agricultural value, thus presenting a resource conflict that influences its suitability for development. These and other constraints such as a high groundwater table are shown in Table 1 and discussed in the text for the various lot size units.

The most suitable terrain in "A" and "B" localities is that which is also underlain by a good aquifer. These are shown in stipple pattern and should be given priority for development.

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ment.

Clearly this type of study is of practical value to planners. However, many problems arise. Firstly, the best areas are usually not the ones that the developers want to develop. Secondly, in many townships an official plan has already been devised, and in our experience it is almost always at odds with the results of such environmental studies. Thirdly, if there is a regional plan, there is a distinct possibility that the ideal sites are located in or near conservation zones or on agricultural land.

In summary, the wealth of resource information presented in terrain and hydrogeologic studies not only serves the ultimate purpose of environmental planning, but also provides a client with a great source of land use data (Table 1).

Table 1: Terrain suitability for septic drain tile field and development implications.

TERRAIN UNIT	LITHOLOGY	STRATIGRAPHY AND THICKNESS	TOPOGRAPHY	ORIGIN	DRAINAGE	SINGLE FAMILY RESIDENCE CONSTRAINTS	LOT SIZES ON PRIVATE SERVICE	DOMESTIC WATER SUPPLY POTENTIAL (SEE TABLE 1 AND FIGURES 6 AND 7)	VEGETATION	DEVELOPMENT RECOMENDATIONS
1 ORGANIC	MUD, PEAT, MARSH, SILT AND CLAY; BEAVER DAMS	LAYERED IN PLACES, LESS THAN 5 FEET THICK	DEPRESSIONAL, LOWLANDS, 0 TO5 FEET RELIEF	RECENT DEPOSITS	POORLY DRAINED, FREE WATER; WATER TABLE AT OR NEAR SURFACE	DRAINAGE, LOW BEARING CAPACITY	NOT APPLIC-ABLE	NOT APPLICABLE	CATTAIL MARSH, WILLOW - ALDER, WET CEDAR, MUSKEG, LIGHT TO DENSE	NO DEVELOPMENT
2 ALLUVIUM	SILT, SAND, CLAY	LAYERED, 0 TO 10 FEET THICK	STREAM VALLEYS, LOW GRADIENT, 5 TO 20 FEET RELIEF	FLUVIAL, FLOOD PLAIN AND CHANNEL DEPOSITS	POORLY DRAINED, HIGH WATER TABLE	EROSION AND FLOOD HAZARD	NOT APPLIC-ABLE	NOT APPLICABLE	LOW WATER SEASON- CATTAIL REED, WILLOW-ALDER, LIGHT TO DENSE	NO DEVELOPMENT
3 COLLUVIUM	BARE BEDROCK ALONG SCARPS, TALUS GRAVEL, SILT AND SAND	SCATTERED POCKETS, LESS THAN 5 FEET THICK	STEEP SLOPES, SCARPS, 10 TO 100 FEET RELIEF	SOIL CREEP, ROCK FALL, SLUMPS	WELL DRAINED; SPRINGS IN PLACES	STEEP SLOPES, SURFACE BEDROCK	NOT APPLIC-ABLE	NOT APPLICABLE	CONIFEROUS PINE (DOMINANT), SPRUCE (DOMIN-ANT), CEDAR, JUNIPER, DENSE	NO DEVELOPMENT
4 BEACH	GRAVEL, SILTY AND SANDY, FOSSILIFEROUS IN PLACES, PEBBLE COMPOSITION REFLECTS UNDERLYING BEDROCK IN PLACES	POORLY DRAINED, 0 TO 10 FEET THICK; OVER-LIES BEDROCK	LOW LINEAR RIDGES UP TO 5 FEET HIGH	CHAMPLAIN SEA BEACHES AND PRESENT LAKES	WELL DRAINED, WATER TABLE VARIABLE	NEAR-SURFACE BEDROCK IN PLACES; SPECIAL WELL COM-PLETION TECH-NIQUES; AGGREGATE POTENTIAL	5 TO 10 ACRES	ADEQUATE IN BEDROCK AQUIFER	DECIDUOUS MAPLE (DOMINANT), ELM BIRCH, HEMLOCK, DENSE	OF GEOMORPHIC SIG-NIFICANCE, POSSIBLE PRESERVATION; AGGRE-GATE POTENTIAL SHOULD BE EVALUATED BEFORE DEVELOPMENT
5 FLUVIAL SAND	VERY FINE TO FINE GRAINED SAND, SILTY AND CLAYEY LENSES AND LAYERS	WAVEY PARALLEL STRA-TIFICATION, LAYERS OF VARIABLE COMPOSI-TION; 0 TO 15 FEET THICK	ROUNDED RIDGES AND LOW PLAINS, GENTLE SLOPES	HIGH LEVEL DEPOSITS OF EARLY OTTAWA RIVER DRAIN-AGE	WELL DRAINED; WATER TABLE AT LEAST 5 FEET BELOW SURFACE	SPECIAL WELL COMPLETION TECH-NIQUES; GRANULAR DEPOSIT POTENTIAL	1 TO 3 ACRES	ADEQUATE IN BEDROCK AQUIFER	CLEARED, DOMES-TIC GROWTH (MAN. MAPLES) LIGHT	POTENTIAL AS GRANULAR DEPOSIT SHOULD BE EVALUATED BEFORE DEVELOPMENT; POSSIBLE LANDFILL SITE
6 DELTAIC SAND	MEDIUM TO COARSE GRAINED QUARTZ - FELDSPATHIC SAND, AEOLIAN SAND	GREATER THAN 15 FEET THICK, PROMINENT CROSS-STRATA, POSSIBLE GRAVEL LENSES	GENTLY SLOPED, ROLLING, HUMMOCKY IN PLACES, 10 TO 15 FEET RELIEF	GLACIO-FLUVIAL(?) DELTAIC	WATER TABLE AT LEAST 5 FEET BELOW THE SURFACE	SPECIAL WELL COM-PLETION TECHNIQUES; AGGREGATE POTENTIAL	3 TO 5 ACRES	ADEQUATE IN BEDROCK AQUIFER	DRY, MIXED CONIFEROUS SPRUCE(DOMIN-ANT) PLANTED PINE SPREADING DENSE	PRESENTLY USED AS GRANULAR SOURCE; LOCAL GROUNDWATER RECHARGE; UNSUIT-ABLE FOR SANITARY LANDFILL
7 THIN CLAY	CLAY, SILTY OR SANDY IN PLACES, INCLUDES RESIDUAL BOULDERS AND THIN REWORKED TILL; OVERLIES BEDROCK	BASAL BOULDERY GRAVEL COMMON; LESS THAN 5 FEET THICK; SOME BED-ROCK OUTCROP	GENTLY ROLLING, BARE BEDROCK KNOLLS, 5 TO 15 FEET RELIEF	CHAMPLAIN SEA DEPOSITS OVER BED-ROCK "HIGHS", SHALLOW WATER	FAIR DRAINAGE ON KNOLLS, POORLY DRAINED DEPRES-SIONS LOCALLY; WATER TABLE USU-ALLY HIGH, WITHIN 5 FEET OF SURFACE	RAISED TILES AND BASEMENTS REQUIRED; ROCK BLASTING POSSIBLE	5 TO 10 ACRES	ADEQUATE IN BEDROCK AQUIFER	HERBACEOUS PASTURE CLEARED AND CULTIVATED, BLUE WEED, VERY LIGHT	MAINLY PASTURE LAND; SOME AGRICULTURE; NOT IDEAL FOR COUNTRY LOTS
8 THICK CLAY	CLAY, SILTY IN PLACES, DENSE, UP-PER PART FRACTURED OR WEATHERED	COMMONLY DENSE MASSIVE BLUE GRAY CLAY, RARE OVERLYING SAND LAYER, UP TO FEET THICK	LOWLANDS, PLANAR TO DEPRESSIONAL, 5 TO 15 FEET RELIEF LOCALLY	CHAMPLAIN SEA DEPOSITS, DEEP WATER	POORLY DRAINED, HIGH GROUNDWATER TABLE	RAISED TILE BEDS REQUIRED, FILL REQUIRED; LOW BEAR-ING CAPACITY; DRAINAGE PROBLEMS	5 TO 10 ACRES	ADEQUATE IN BEDROCK AQUIFER BUT MAY BE SALTY AND SULPHUROUS	CLEARED AND CULTIVATED	MAINLY AGRICULTURAL LAND; UNSUITABLE FOR COUNTRY LOT DEVELOP-MENT
9 VENEERED LOWLANDS	PEBBLEY CLAY OR CLAYEY GRAVEL, NUM-EROUS BOULDERS, BARE PALEOZOIC BEDROCK COMMON, LOW BEDROCK RIDGES	POORLY STRATIFIED; OFTEN LESS THAN 1 FOOT THICK, RARELY 5 FEET THICK	LOW, PLANAR TO VERY GENTLY ROLLING, 5 TO 15 FEET RELIEF LOCALLY	EROSION AND DEPOSITION DURING CHAMPLAIN SEA AND PRE-VIOUS GEOLOG-IC TIME	POORLY DRAINED, HIGH GROUNDWATER TABLE	RAISED TILE BEDS, BASEMENTS AND FILL REQUIRED; ROCK BLASTING POSSIBILITY, DRAINAGE PROBLEMS	10 TO 25 ACRES	ADEQUATE IN BEDROCK AQUIFER	CONIFEROUS PINE, SPRUCE ON RIDGES, CEDAR IN WET AREAS, DECID-UOUS IN THICK-ER SOIL AREAS, MEDIUM TO SCATTERED	NATURAL TERRAIN SETTING UNSUITABLE FOR DEVELOPMENT ALTHOUGH OFTEN TREED. THIN SOIL LAYER OVER BEDROCK DOES NOT FAVOUR ADEQUATE EFF-LUENT TREATMENT
10 VENEERED UPLANDS	SILTY CLAYEY GRAVEL, OR MODIFIED TILL; BEDROCK PATCHES COMMON; BOULDERS COMMON, LOCAL SAND RIDGES AND PATCHES OF CLAY OR GRAVEL	COMMONLY LESS THAN 3 FEET OF SOIL OVER BEDROCK; POORLY STRATIFIED	UPLANDS, ROLLING TO GENTLY SLOPING 10 TO 20 FEET RELIEF LOCALLY	EROSION AND DEPOSITION DURING CHAMPLAIN SEA, REWORK-ING OF OLDER DEPOSITS	POOR DRAINAGE; WATER TABLE NEAR SURFACE; SPRINGS AT BASE OF SLOPES	RAISED TILE AND BASEMENT REQUIRED; FILL FOR TILE BEDS; BLASTING POSSIBILITY	25 TO 50 ACRES	ADEQUATE IN BEDROCK AQUIFER	DECIDUOUS MAPLE (DOMINANT) CON-IFEROUS PINE IN THIN SOIL AREA, LIGHT TO MEDIUM	AS FOR #9; DETAIL REQUIRED FOR HOUSE LOCATION; MORE SUIT-ABLE FOR COUNTRY LOTS
11 THIN TILL	SANDY TILL, CLAYEY GRAVEL IN PLACES, LOCAL PATCHES OF SAND AND CLAY, SOME BARE BEDROCK PATCHES; NUMEROUS BOULDERS	OVERLIES BEDROCK, LESS THAN 5 FEET THICK, RARE THICKER POCKET	ROLLING, 10 TO 20 FEET RELIEF, MINOR RUGGED SCARPS	GLACIAL DEPOSITION AND LATER REWORKING BY CHAMPLAIN SEA	WELL DRAINED EXCEPT IN LOCAL DEPRESSIONS; WATER TABLE 5 FEET BELOW SURFACE EX-CEPT IN DEPRESSIONS	NEAR-SURFACE BEDROCK IN SOME LOCALITIES; RAISED TILE BEDS MAY BE REQUIRED IN PLACES; DEEP WELLS REQUIRED IN TERRAIN UNDERLAIN BY PRECAMBRIAN ROCKS	3 TO 5 ACRES	ADEQUATE IN BEDROCK AQUIFER	DECIDUOUS ELM AND MAPLE (DOM-INANT), DENSE	WHERE TILL UNIT IS THICK, THIS TERRAIN IS IDEAL FOR COUNTRY LOT RESIDENTIAL DEVELOPMENT
12 THICK TILL	SANDY CLAYEY TILL, NUMEROUS BOULDERS, DISTRIBUTION POORLY KNOWN	GREATER THAN 5 FEET THICK; UNDERLIES FORESHORE NORTHEAST OF CONSTANCE LAKE	GENTLY ROLLING, 5 TO 10 FEET LOCAL RELIEF	GLACIAL DEPOSITION; UPPER PART REWORKED BY CHAMPLAIN SEA	MODERATELY WELL DRAINED, LOCAL POORLY DRAINED DE-PRESSIONS; WATER TABLE MAY BE CLOSE TO SURFACE	GROUNDWATER TABLE MAY BE NEAR-SURFACE; LARGE BOULDERS OCCUR; POOR DRAINAGE ON UPLAND AREA	1 TO 3 ACRES	ADEQUATE IN BEDROCK AQUIFER	MESIC MIXED CONIFEROUS WOODLOT, NO DOMINANT SPECIES, DENSE	IDEAL TERRAIN FOR COUNTRY LOT RES-IDENTIAL DEVELOP-MENT. BEST DE-POSIT ALONG NORTH-EAST FORESHORE OF CONSTANCE LAKE; LAND-USE CONFLICT APPARENT
13 PALEOZOIC BEDROCK	NEAR-SURFACE AND SURFACE OUTCROPS OF PALEOZOIC BEDROCK WITH POCKETS AND PATCHES OF SILTY CLAY, SAND AND/OR TILL; NUMEROUS BOULDERS; LOW SCARPS	POCKETS OF SURFICIAL MATERIAL COMMONLY CLAY, UNDERLAIN BY SAND OR GRAVEL, UNDER-LAIN BY TILL; UP TO 10 FEET THICK OBSERVED	TOPOGRAPHICALLY PRO-MINENT BUT LOW RUGGED KNOLLS; OFTEN TREED; LOCAL RELIEF 5 TO 15 FEET	EROSIONAL REMNANTS OF HORIZONTALLY BEDDED PAL-EOZOIC ROCK, LATER POORLY BURIED BY SURFICIAL DEPOSITS	VARIABLE DRAINAGE CONDITIONS, POOR TO WELL DRAINED; GROUNDWATER TABLE COMMONLY WITHIN 5 FEET OF SURFACE	REQUIRES CAREFUL SITE SELECTION AND DE-TAILED DRAINAGE CON-SIDERATIONS; NEAR-SURFACE BEDROCK AND BOULDERS; RAISED TILES MAY BE NECESSARY BE-CAUSE OF DRAINAGE	3 TO 5 ACRES	ADEQUATE IN BEDROCK AQUIFER	MIXED CONIFER-OUS (PINE, SPRUCE), DECID-UOUS MAPLE, ELM, BIRCH, MEDIUM TO DENSE	IDEAL FOR COUNTRY ESTATE LOT DEVELOP-MENT AT LOCALITIES WITH SUFFICIENT SOIL THICKNESS
14 PRECAMBRIAN BEDROCK	BARE CRYSTALLINE ROCK OUTCROPS, THIN PATCHES OF BOULDERY TILL OR SANDY CLAY. NUMEROUS LOCAL ORGANIC DEPOSITS IN DEPRES-SIONS, SCARPS COMMON	FLANKS OF BEDROCK HILLS MAY BE UNDERLAIN BY UP TO 10 FEET OF SURFICIAL DEPOSITS LOCALLY	STRONGLY TO MODER-ATELY ROLLING, ABRUPT SCARPS AND DEPRES-SIONS; 15 TO 25 FEET LOCAL RELIEF	EROSIONAL REMNANTS OF PRECAMBRIAN ROCKS, DEEP-LY SCOURED BY GLACIER; EXHUMED PALEOPENE-PLAIN	POOR TO MODERATELY WELL DRAINED; LOW GROUNDWATER TABLE MAY BE AT SURFACE IN DEPRESSIONS	BEDROCK COMMON; DRAINAGE PROBLEMS LOCALLY; DETAIL RE-QUIRED FOR BUILDING SITE; WELL IN EXCESS OF 200 FEET DEEP RE-QUIRED	10 TO 25 ACRES	USUALLY ADEQUATE IN BEDROCK AQUIFER	NORTH HALF EARLY SUCCESSION WITH POPULAR AND ASPEN AND SOUTH-ERN HALF MORE ADVANCED SUCCES-SION, DENSE	IDEAL FOR COUNTRY LOT DEVELOPMENT IN AREAS WHERE WELL DEFINED THICK LAYERS OF TILL OR SIMILAR SURFICIAL MATERIAL OCCURS; DETAIL SITE ANALYSIS REQUIRED

For example, gravel deposits are outlined, new townsites may be located, in some cases ideal landfill sites emerge from the synthesis, potential transportation corridors can be identified or perhaps new recreational resources are discovered. In spite of these benefits, there is always a battery of problems, many of which are predictable as discussed in this presentation. Also, there is still a great reluctance on the part of established municipal bodies to fund studies of this nature. It is up to all concerned professionals to continually demonstrate the desirability to conduct these fundamental studies. This information and the ability to properly utilize it is critical to the future well-being of the people and management of rural land in all parts of the world.

FLOOD DAMAGE REDUCTION PROGRAM — FREDERICTON PILOT PROJECT

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ABSTRACT

This paper presents an overview of the National Flood Damage Reduction Program and a more detailed discussion of the Fredericton pilot flood risk mapping project. Prior to the formulation of the national program, six urban areas were selected for pilot projects: Sault Ste. Marie, Ontario; Oshawa, Ontario; Montreal, Quebec; Moose Jaw, Saskatchewan; Carman, Manitoba; and Fredericton, New Brunswick (the first project to be completed).

The success of the Fredericton pilot mapping project was somewhat influential in shaping the national program. The two bilingual maps and the brochure produced have become a model on which future mapping will take place. The project provided the opportunity to test and develop methodology and to estimate future costs. Flood risk mapping, the key element in the national program, is intended to reduce flood damages over the long-term by discouraging development in designated flood risk areas, while at the same time encouraging zoning.

Agreements have been negotiated and/or signed with New Brunswick, Quebec and Manitoba, and negotiations are continuing with other provinces.

RÉSUMÉ

Le présent document donne une vue d'ensemble du Programme national de réduction des dommages causés par les inondations. On y trouve également une discussion plus détaillée sur le projet pilote visant à cartographier le risque des crues dans la région de Frédéricton, Nouveau-Brunswick. Avant de mettre sur pied le programme national, on a décidé de réaliser des projets pilotes dans six régions urbaines, à savoir celles de Sault Ste.-Marie (Ontario), d'Oshawa (Ontario), de Montréal (Québec), de Moose Jaw (Saskatchewan), de Carman (Manitoba) et de Frédéricton (Nouveau-Brunswick) (le premier projet à être réalisé).

Dans une certaine mesure, les succès obtenus à Frédéricton ont grandement influé sur la conception du programme national. Les deux cartes bilingues et la brochure produites constituent maintenant un modèle auquel on se référera lorsqu'on dressera d'autres cartes dans l'avenir. Grâce au projet de Frédéricton, on a pu éprouver et élaborer des méthodes, et estimer les coûts des futurs travaux. L'établissement de cartes des régions exposées aux crues est un important élément du programme national qui vise à réduire, à long terme, les dommages occasionnés par les crues en décourageant l'expansion dans des régions menacées par les inondations tout en favorisant le zonage.

Des accords on été négociés et/ou conclus avec le Nouveau-Brunswick, le Québec et le Manitoba, et des négociations se poursuivent actuellement avec les autres provinces.

INTRODUCTION

Flooding occurs every year in some locations in Canada, and major floods were recorded during the 1940's and 1950's on the Lower Fraser and Red Rivers, and in Metro Toronto. In recent years, the Saint John River (N.B.), the St. Lawrence River (Montreal area), the Grand River (Ontario) and several Prairie rivers have caused much damage to property, and in the case of the Toronto flood there was also loss of life. Governments have responded with both long-term and emergency measures. Assistance from federal-provincial governments totaled more than $100 million from 1948 to 1970, with approximately a $40 million federal government

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contribution. Furthermore, flood compensation for the country amounted to over $50 million in 1974 alone (Environment Canada, 1975). Damages would have been greater except for protective works already in place, such as the Red River Floodway. These structures have been expensive to build and to maintain, and costs continue to escalate; for example, dyking under the Lower Fraser Flood Control Agreement was budgeted at $36 million, but has increased to $120 million (Spargo and Watt, 1969, p.13). The federal government has entered into other agreements with the provinces for flood control which demand additional resources.

Unfortunately, past emphasis on structural solutions, and income transfers from both federal and provincial treasuries to those who claim flood damages, have tended to encourage rather than deter development in flood-prone areas. The presence of flood control and protection structures generally produces a false sense of security, and results in further encroachment of the flood plain, thereby increasing the potential for more damages. In addition, increasing urbanization will result in expanding development and rising densities in cities and towns, many of which are located within or near flood plains. Inflationary trends also contribute to increasing costs of damages and of flood control structures.

As a result of such trends, the federal government conducted a reassessment of its past policies on flood damage assistance. This reexamination, which included interdepartmental and federal-provincial consultation, recommendations from basin study reports, experiences in the U.S. and results from pilot flood-risk mapping projects, produced a new national strategy for flood damage reduction.

NATIONAL FLOOD DAMAGE REDUCTION PROGRAM

Alternative strategies which were considered included the construction of more flood control structures, a combination of flood insurance and flood risk mapping, and continuation of the present courses of action. The program which was eventually formulated is patterned after the cooperative federal-provincial approach to the Canada Water Act, and depends on adherence to certain principles discussed below. Public announcement of this program was made by the Minister of Environment Canada (now Fisheries and Environment Canada) in April 1975.

The first and foremost principle requires a clear understanding by governments and agencies of the interrelationships of their specific responsibilities. In this way, jurisdictional problems are minimized and a more comprehensive federal-provincial program can be carried out. It is also important to ensure that the new national program does not duplicate or negate provincial efforts already in progress. General agreements provided under the program serve the purpose of defining intergovernmental goals and levels of participation.

Related to federal-provincial cooperation is interdepartmental consultation and coordination within the federal government itself. In other words, agencies such as the Department of Regional and Economic Expansion (DREE) which provides incentives to industries locating in economically disadvantaged areas, Central Mortgage and Housing Corporation (CMHC) which administers the National Housing Act, and the Department of Public Works (DPW) which manages and provides federal facilities across Canada, have been directed by Cabinet to cooperate with the federal Department of Fisheries and the Environment (DFE) which is administering the flood damage reduction program. Two important vehicles for interdepartmental participation are the Interdepartmental Committee on Water and its Subcommittee on Flooding. Agencies such as DREE and CMHC integrate their activities with DFE by not locating or supporting development in areas designated as flood risk zones, thereby discouraging undesirable developments and reducing future flood disaster assistance. While the federal government can only carry out its role under the Flood Damage Reduction Program in relation to areas within its jurisdiction, provincial governments undertake not to make or encourage flood vulnerable investments in identified flood hazard areas, and also to encourage appropriate zoning. However, this does not preclude the construction of flood control structures should they be considered necessary under the *Basic Approach for Reducing Potential Food Damage*[1] specified in the General Agreements.

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[1] For example, in the General Agreement between Canada and New Brunswick, the principle of this approach is stated as follows:

> *(a) consideration is given, in each case where measures are proposed, to all practicable structural and non-structural alternatives, including the alternative of allowing some flooding to occur, so that the best choice on the basis of effectiveness, cost, corollary benefits and environmental impact is made; and*
>
> *(b) preference is given, subject to paragraph (a), in areas determined to be flood risk areas, to measures that prevent or make subject to requirements for flood proofing all undertakings vulnerable to flood damage.*

The key to this program lies in the identification of flood-prone lands and in mapping these areas as a first step. The resulting maps would be utilized by government agencies, and serve to inform and alert industry and the general public of areas which can suffer from flooding, and are therefore subject to the Flood Damage Reduction Program requirements. Furthermore, public awareness is of vital importance to a program of this nature, and to this end, the Flood Damage Reduction Program makes provisions for information dissemination.

CANADA-NEW BRUNSWICK AGREEMENTS

The federal government responded quickly to preliminary interest by the New Brunswick government to participate in the National Flood Damage Reduction Program. On 31 March 1976, the two governments signed a *General Agreement* and two subsidiary agreements on flood risk mapping and special studies, while the agreement on flood forecasting is still under negotiation. Costs of the programs undertaken will be shared equally by Canada and New Brunswick.

a. General Agreement - This established the *Basic Approach for Reducing Flood Damage* and the policies agreed to by both the federal and provincial governments. The General Agreement, which lasts at least ten years, stipulates that there must be intensive consideration of all structural and non-structural alternatives for flood damage reduction in terms of costs, benefits, effectiveness and environmental impact. It also designates two types of flood hazard areas which include the *floodway* and the *flood risk area*. The *floodway* (or *inner high risk area*) where no development is to take place, lies within the zone of the 1 in 20-year flood. The *flood risk area* on the other hand, is an outer zone within the 100-year flood line (or greater) which permits developments provided they are adequately flood-proofed. Participation of other departments such as CMHC and DREE would be important in terms of refusing support for unwise undertakings, after the flood risk areas have been designated and widely publicized. This Agreement also provides for the negotiations of other subsidiary agreements related to flood damage reduction, such as flood forecasting and warning, flood-proofing techniques, land use planning and structural works.

The General Agreement established a Steering Committee which includes two appointees from the federal government and two from the New Brunswick government. This Steering Committee reports directly to the federal and provincial ministers concerned and maintains coordination between the signatories of the Agreement. The Committee is also charged with the responsibility of carrying out a public information program.

b. Flood Risk Mapping Agreement - This Agreement, which has a term of five years compared to ten years for the General Agreement, provides for a program of mapping 24 flood-prone areas in New Brunswick and establishes guidelines for hydrologic and cartographic specifications. The additional five years in the term of the General Agreement permit observation of the implementation of its policies developed after flood zones have been designated. The Flood Risk Mapping Agreement provides for a Technical Committee which ensures that maps conform to hydrologic and cartographic standards agreed upon. Two federal and provincial members have been named to the Technical Committee which reports to the Steering Committee.

c. Special Studies Agreement - Under the *Agreement Respecting Studies for Flood Damage Reduction*, projects are to be directed toward the determination of the best measures to reduce or prevent future flooding by the Saint John River at Fredericton, by Marsh Creek at the city of Saint John, and by Walter Brook and the Restigouche River at Campbellton. Studies of other areas may be undertaken if considered necessary during the term of the Agreement. The Steering Committee is also responsible for administering this Agreement.

d. Flood Forecasting Agreement - Negotiations are continuing between the federal and New Brunswick governments as a result of the latter's initial proposal for flood forecasting in the province. The Agreement is presently being drafted, but is likely to be confined to the Saint John River Basin.

AGREEMENTS WITH OTHER PROVINCES

On 4 October 1976, Canada and Quebec signed a General Agreement dealing with Flood Risk Mapping and Flood Damage Reduction, and an Agreement concerning dyking and flow regulation in the Montreal region. Selection of members for the committees is under way.

Manitoba took part in the pilot mapping project (Carman) and agreements under the Flood Damage Reduction Program are in the final negotiating and approval stages.

For the Northwest Territories and Yukon, the Department of Indian and Northern Affairs and DFE signed a Memorandum of Understanding, which would provide the basis for general and mapping agreements to be formulated later. The Memorandum authorizes flood risk mapping at Hay River, N.W.T. to commence immediately.

Agreements with other provinces, where flood damage reduction is a major issue, are in the negotiating and drafting stages.

PILOT FLOOD RISK MAPPING PROJECTS

The experimental mapping of flood hazard areas at several locations across the country was undertaken while the National Flood Damage Reduction Program was being formulated. Severe floods in various parts of the country in 1974 provided the added incentive to establish the program earlier than was anticipated.

Six locations were selected for the flood risk mapping pilot projects. Maps for Fredericton, Moose Jaw and Carman have been published, while maps for Sault Ste. Marie, Oshawa and Montreal are in varying stages of completion.

Provinces such as Ontario and British Columbia have established flood hazard mapping programs which are suited to their own requirements. Pilot flood risk mapping projects under the national program were undertaken to obtain some knowledge of costs and problems of mapping in different parts of the country, to experiment with varying map scales and specifications, and to assist in the design of the full program. They proved useful in the development of a national standard of flood risk maps which provide enough flexibility for local conditions.

Fredericton Pilot Project (1973-75)[1]

Fredericton was the first location to be mapped under the pilot program. New Brunswick suggested that this area should receive priority because of the extensive damages sustained during the flood in 1973, the intensive hydrologic investigations carried out during and immediately following this flood, as well as the long history of inundation by the Saint John River at Fredericton. This pilot project, undertaken as a joint federal-provincial effort by Environment Canada and the New Brunswick Department of Fisheries and Environment, was designed to provide information for government agencies or individuals who may plan to use lands in the Fredericton area which are subject to flooding. Specifically, it can help to:

a) prevent unsuitable land development in flood plain areas, thereby averting flood damage claims;

b) protect prospective home buyers and commercial and industrial concerns from the consequences of locating in areas of flood risk;

c) establish guidelines for the purchase of open space areas for public agencies; and

d) aid both federal and provincial emergency organizations in planning emergency procedures in the event of floods.

Flooding in the Fredericton Area - Historical records indicate that flooding has occurred on the Saint John River for at least 300 years, and the cost of damages has increased over the years. During this century, five floods have each caused over $1 million worth of damage. The 1973 spring flood, the most severe in recorded history, damaged property totalling some $11 million in the Saint John River Basin with $5.2 million located in the vicinity of Fredericton. A major reason for increased flood damage in this area is gradual urban encroachment into the flood plain resulting from rising demands for more residential, industrial and business property.

The Saint John River floods in several places along its mainstream and its tributaries (the Aroostook, Nashwaak and Oromocto) due to a combination of rapid snowmelt and intense rainfall during April or May. The most serious flooding occurs from Fredericton to the Reversing Falls. These falls, at the mouth of the river, have worsened the flood situation by acting as a control for outflows and retarding discharge into the Bay of Fundy. Ice jams often also caused serious flooding in the Fredericton area, but construction of the Mactaquac Dam on the Saint John River has significantly reduced that threat.

Unfortunately, sections of Fredericton can still be subject to floods from ice jams in the Nashwaak River, a tributary of the Saint John.

Mapping Area - A 12.5 mi. reach of the Saint John River, from about 2.5 mi. above the mouth of Nashwaaksis Stream to the upstream tip of Oromocto Island, was chosen for mapping, and zones at the confluences of tributary streams and the mainstem were also included. This particular area was chosen because large scale topographic maps (1" = 400 ft. with 5 ft. contour intervals) were available. It was suitable for a pilot project, and it contained locations which have high damage potential. The availability of these maps enabled savings in time and money.

Flood Risk Maps - Two map sheets were produced for the area chosen, using the scale of 1:12,500 (approximately 1" = 1,040 ft.). The maps were

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[1] Based on Bailey, 1974, and on Envir. Can. and New Brunswick Dept. of Fisheries and Environment, 1975.

printed following the style of the National Topographic System sheets with flood risk zones depicted in bright colours. Lines representing hypothetical floods based on present channel conditions, and the actual 1973 flood, are marked for the Saint John and its tributaries, Nashwaak River, Nashwaaksis Stream and Baker Brook. To give a range of possible flood conditions, 20- and 100- (5% and 1% probability respectively) year recurrence intervals were chosen. These flood lines were calculated from different flood elevation frequencies for the mainstem using stage data. Although flood elevations are often related to discharge and volume, the complexity of the hydraulics of the lower Saint John has made it necessary to ignore these two factors. Using records for the period 1929-1974, derived from the only river gauge in the project area at the Fredericton Pump House, a bar graph was charted for the maximum daily mean stage (Figure 1). Flood heights have varied from 12 to 28 ft. in the past with the maximum recorded in 1973. From these records, a frequency curve of the annual maximum daily flood stage was determined (Figure 2). Starting points for water surface profiles of the hypothetical floods can then be derived from this curve. Stage records at Oromocto (two mi. downstream from the lower end of the study area) were used to derive the second starting point. The actual shape of these profiles was drawn using the well-defined profile from the 1973 flood (Figure 3). These profiles provided the basis for determining elevations for the flood lines of the 20- and 100-year floods depicted on the maps. The extent of the 1973 flood was delineated on the maps, because it is the maximum recorded flood and its recent occurrence provides a useful reference point for inhabitants.

Flood profiles for the tributaries had to be calculated differently, because of the unavailability of flow or stage data. For the lower reaches of these rivers, discharge values from

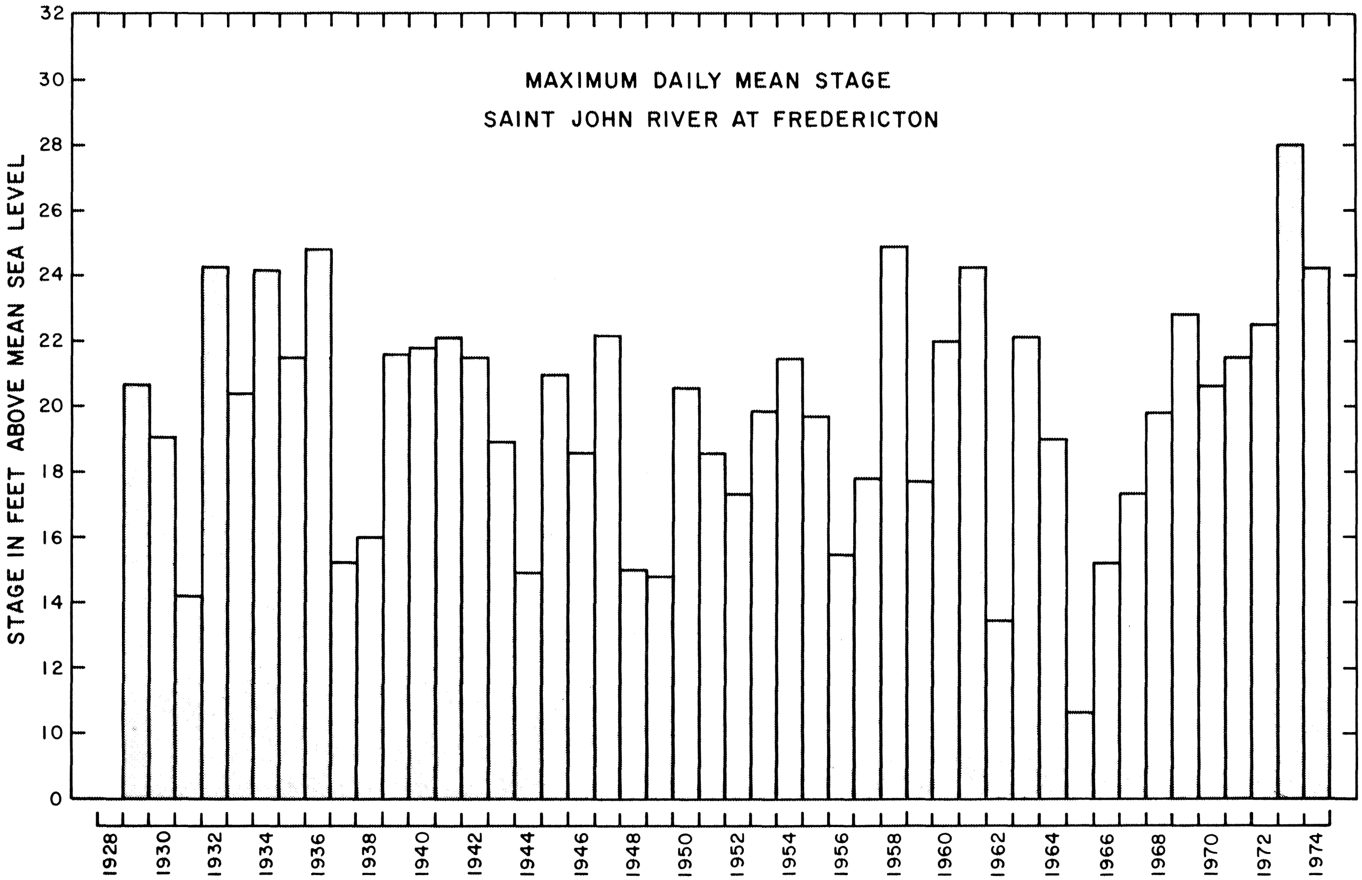


Figure 1

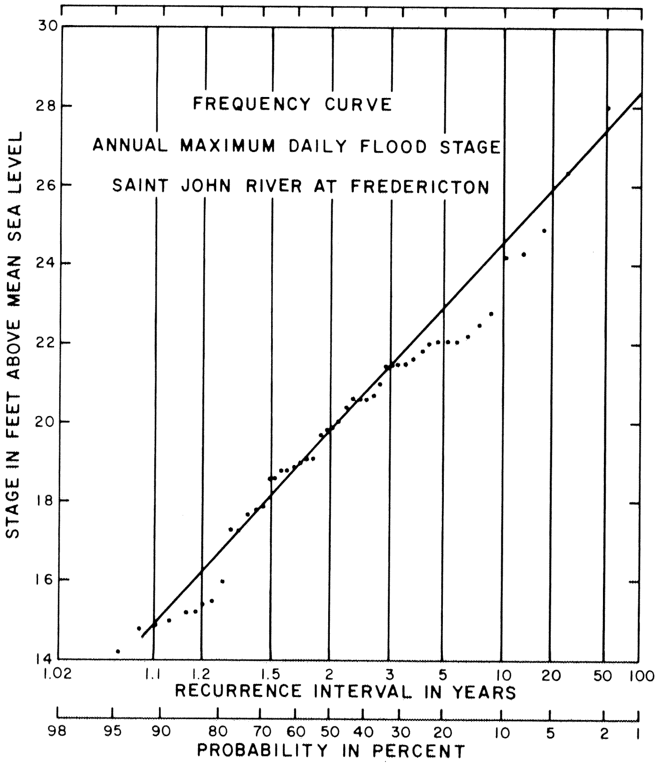


Figure 2

regional flood regression equations and backwater computations were used to develop surface water profiles which in turn were employed in delineating flood lines.

One must bear in mind that the limits drawn on these maps depict estimated levels based on existing channel conditions, and changes such as new bridges, roads, etc. could affect the pattern. Furthermore, floods from other causes such as ice jams and sudden torrential downpours were not considered. A maximum error of five ft. can also be attributed to the flood zone demarcation because of the inherent inaccuracy of the base maps used.

As part of the Fredericton pilot project, two map sheets were produced in bilingual format. A small booklet containing text and diagrams explaining appropriate hydrologic terms related to flooding, methods used in drawing the zones, and an explanation on how to use these maps properly is attached to each map sheet. Two general information brochures (published separately in French and English) with a discussion of the flooding problem in Fredericton, explanations of the causes and amelioration of floods, and a map showing the parts of the project area which were inundated in the 1973 flood, were also produced.

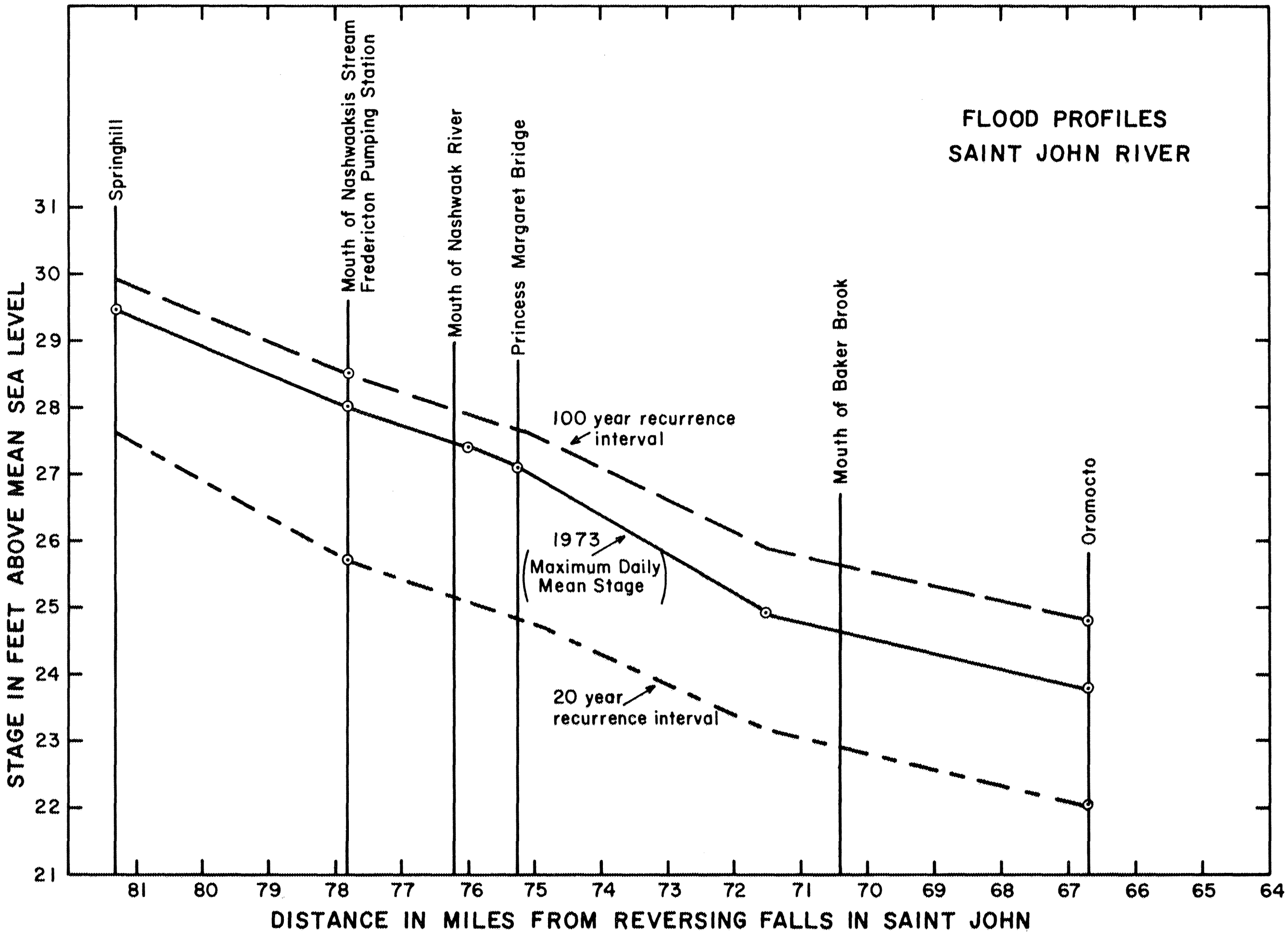
Environment Canada and Energy, Mines and Resources were responsible for the preparation and printing of these maps, but actual distribution was undertaken by the various provincial, municipal and federal agencies in the region involved in the project. The maps and the brochures were made public and were distributed in the spring of 1975. Approximately 3,000 maps were released to the public, business and government agencies. Although there has been no direct feedback, it appears that the maps were well-received and there have been further requests from agencies such as realty companies.

CONCLUSIONS

The National Flood Damage Reduction Program represents a change from the use of structural measures as the only means of reducing flood damages. The program is designed to minimize flood damages by discouraging vulnerable developments from the areas of risk, while providing the best combination of structural and non-structural controls. Of major importance are the flood risk maps which define the areas to be considered; the maps from the Fredericton pilot project have demonstrated their importance and usefulness within the overall program. The subsequent Agreements negotiated and/or signed with New Brunswick, Quebec, Manitoba and other provinces are evidence of this. Furthermore, the New Brunswick government is in the process of drafting the Flood Plain Bill, which would allow for zoning of land in the flood plain, in order to control new developments in flood risk areas similar to those specified in the Canada-New Brunswick General Agreement.

Under the Constitution, Canada has a history of divided responsibilities in the area of resource management, and the principle of cooperation between the federal and provincial governments involved is strongly emphasized through the various agreements established under the program.

Figure 3



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N.B. All three Figures are derived from the booklets attached to the Flood Hazard Maps, Fredericton Area, New Brunswick 1975.

LEGISLATION TO ENHANCE AND PROTECT CANADA'S URBAN TREES AND FORESTS

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ABSTRACT

Canada's urban trees and forests lack comprehensive protection under contemporary legislation and regulation. As an example, the Ontario Municipal Act enables any municipality to compose and enforce tree bylaws, but only the larger municipal governments have enacted tree protection legislation. In general, municipal trees are more subject to removal than conservation. If violations of legislation do occur, the culprits are seldom prosecuted and punished. Increased civic activism, however, has alerted municipal officials to investigate more adequate tree protection legislation. In response to this need, a model tree bylaw and urban tree information brochure are discussed.

RÉSUMÉ

Les lois et les règlements actuels ne protègent pas beaucoup les arbres et les boisés des villes canadiennes. Par exemple, la loi municipale de l'Ontario permet à toute municipalité de rédiger et de mettre en application des arrêtés municipaux concernant la protection des arbres, mais seules les grandes administrations municipales ont décrété des lois à cet effet. En général, les arbres des billes font plus souvent l'objet d'abattage que de conservation. Si des infractions à la bois se produisent, les coupables sont rarement poursuivis en justice et punis. Une intensification de l'activisme civique a toutefois poussé les hauts fonctionnaires municipaux à étudier les possibilités de légiférer pour une protection des arbres plus appropriée. En réponse à ce besoin, un projet d'arrêté municipal concernant les arbres et une brochure informative sur les arbres des villes sont à l'étude.

CONSERVING URBAN VEGETATION

Canadian townscapes, once dominated by trees, are now characterized by the angular silhouettes of massive commercial and residential buildings. Arborescent vegetation that has managed to survive the onslaughts of urbanization continues to lose ground and in most instances is declining in quality of stature and quantity of species (Andresen, 1975b). Recent visits by the author to Edmonton, Montreal, Ottawa and Vancouver coupled with interviews of their respective urban Foresters indicated that urban woody vegetation is disappearing faster than it is being replaced.

The horizons of Southern Ontario have lost their sylvan character through a series of castastrophies. Land exploitation and Dutch elm disease have wreaked havoc. Suburban roadsides, guarded earlier by magnificent sugar maples, now offer the motorist stumps, utility poles and steel barriers (Goodwin, 1970); housing areas, in city and hamlet, once shaded by elm cathedrals are sun-baked in summer and stark naked in winter; and our precious ravines and other wooded greenspaces are now identified by the grey skeletons of white pine and hemlock (Juhola *et al.*, 1976).

Fortunately, there is still time and opportunity to halt the destruction of native and planted greenery in Ontario and the other provinces, reverse the trend of deforestation and replant and conserve the green heritage that environmentally and morally belong to every Canadian. Conservation of this urbanized greenspace, depends upon the empathy as well as the physical and legislative support of municipal decision and policy makers. They must be convinced of the ecological, economic and political values of arboricultural programming.

In an enlightened society, conservation or urban-dominated natural resources can be accomplished through several endeavours or alternatives. The ideal would incorporate maximum civic participation and support with minimum bureaucratic control; least desirable would be rigid municipal control backed by punitive legislation. This latter alternative would probably inhibit or stifle rational resource development and dis-

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courage or exclude interest. Realistically, in our contemporary Canadian context, an approach to conserving our urban trees seems to thread a compromise path between the two extremes. This paper reviews the legislative options attendant to the mid-course. The review is supported by an analysis of municipal forestry legislative needs and an examination of British tree protection laws.

CANADIAN LAW AND THE URBAN FOREST

At the Humber College public forum on *Trees in the City*, Swaigen (1973) discussed Ontario legislation that affects the status of cultivated and naturally established trees. His general conclusions were that:

(1) existing legislation offers little to place a high priority on the preservation of trees and greenspace; and

(2) contemporary legislation provides broad discretion to all levels of government to cut trees and exploit greenspace with little or no accountability to the citizenry.

Further, he stated "While there is an abundance of legislation aimed at punishing the person who defaces individual trees, there is little duty imposed on developers, either private or public, to conserve trees and greenspace or to account for them in their planning procedures".

During a panel discussion on *The Case for Urban Vegetation* held at the 1974 International Public Works Congress, Andresen (1975a) noted that archaic or inflexible shade tree protection bylaws discourage or hamper cooperation by contractors and builders. He also indicated that when bylaw violations do occur, there is a lack of, or extended delay in, prosecution of offenders by the courts.

Managers of urban vegetation are confronted by a serious legislative dilemma. On one hand, as requested by Municipal Council, the urban forester or arborist is obliged to adjust the landscape to accommodate to increasing housing demands. On the other, and responding to the same Council, he is expected to maintain the quality, quantity and integrity of municipal green space. Both endeavours, so essential to the urbanites' well-being, are supported by legislation that can be contradictory in intent and application.

With the recognition of the ecological movement, which gained international momentum at the close of the 1960's, a new body of environmental law rapdily emerged (Baldwin and Page, 1970). This legal concern, coupled with earlier (and continuing) programs in urbanology, regional planning, resource conservation and the analysis of man's impact on his environment, is directly applicable to the conservation and preservation of the urbanized treescape.

Jurisdiction over urban trees was given primarily to the provinces at the time of Confederation. Upon that occasion, the British North America Act of 1867 distributed legislative and regulatory powers between the Canadian and the provincial governments. Specific powers were given to the provincial governments to pass provincial laws to be administered by the provincial government and its various ministries, boards, commissions and agencies. Further rights were given to allow passage of legislation permitting municipal and local councils within the province to pass their own bylaws.

Generally, the federal government has jurisdiction over matters considered to be of national scope and interest at the time of Confederation, such as interprovincial railways, territorial natural resources, and marine fisheries. Matters which were thought to be of a sub-regional, local or private nature, such as property and civil rights, fall within provincial legislative competence. As a result, there are few federal statutes that apply directly to the conservation and protection of urban trees. The *Forestry Research Act* (Revised Statutes of Canada 1970, Chapter F-30) enables the Canadian Forestry Service to provide advisory and research assistance to agencies or individuals to encourage better municipal tree management. The *Railway Act* (Revised Statues of Canada 1970, Chapter R-2) gives the nation's railroad carriers authority to manage trees and forests along specified rights-of-way whether on rural or urban land. The provinces and their municipal governments may enact tree-protection and related land development statutes and bylaws.

At the Ontario Provincial level a number of statutes specifically apply to the regulation of tree management practices or permit local control of tree resources. The *Trees Act* (Revised Statutes of Ontario 1970, Chapter 468) as written and usually interpreted, protects trees from trespass and illegal cutting on wooded sites of 0.8 or more hectares. This Act would be of interest and value to the increasing number of resident owners of suburban woodlots and the absentee urban owner of a rural wooded site. The majority of the trees on the small residential lots of Ontario's 8.8 million urbanites, however, are not protected by the Act. Litigation involving trees on privately owned urban land seldom takes the form of prosecutions against those who injure trees or civil actions for injunctions against destruction of trees. Most cases are civil suits for compensation for property damage or physical injuries caused by trees or large branches falling on objects such as vehicles, dwellings and utility wires.

Section 457 of the *Ontario Muncipal Act* (Revised Statutes of Ontario 1970, Chapter 284) is more urban-oriented than the Trees Act but still offers little to conserve or protect privately owned trees. As implied by the title of the Act, trees under consideration would have to be municipally controlled or owned. Municipal Councils are authorized to pass bylaws to preserve and protect municipal trees, plant trees along municipal roads, enter private property to prune or remove hazard trees and otherwise manage trees for the public good. Other Ontario laws and Acts such as the *Environmental Protection Act*, the new *Environmental Assessment Act*, and the *Planning Act* (now under review) have general reference to land development but are ill-defined regarding conservation of trees, either public or private. The primary defect in the Ontario legislative scheme, especially in relation to tree conservation in and near metropolitan areas, is that "The Acts (described above) give municipalities and expropriating authorities broad discretion to destroy trees, with no corresponding duty to plant, replant, or relocate. While municipalities are empowered to pass tree-protection-bylaws, they have no duty to pass such bylaws or to enforce the ones they have" (Swaigen, 1973).

Further to Swaigen's lament, municipal tree bylaws and municipal departmental regulations have not been catalogued or inventoried, nor has a comprehensive assessment been made of legislative effectiveness. To gain a better understanding of existing bylaw legislation in Ontario and to determine what corrective measures or reforms are needed to enhance the legal standing of trees (Stone, 1975), the Ontario Shade Tree Council (OSTC) requested specific tree law data from municipal officials. Results of the survey follow.

MUNICIPAL TREE BYLAW SURVEY

Under the sponsorship of the Association of the Munciipalities of Ontario (AMO) and the OSTC, 670 of the 832 upper[1] and lower tier Ontario municipalities were asked some 90 questions to establish a profile of municipal, tree management policies and practices. Eight of the questions were specifically designed to analyze tree bylaw comprehension and use. The sample size of 670 coincided with the dues-paying membership (mailing labels available) of AMO (municipalities not affiliated with AMO are primarily county governments, villages under 1,000 in population and township governments with fewer than 1,000 people/mi^2).

Responses to the tree bylaw questions came from 399 different municipal governments. Their answers provided a reasonable estimate of tree bylaw presence, need and related data.

Results - Of those governmental representatives responding to the questionnaire, those of Ontario's cities and boroughs were the most active and interested in tree bylaw application (Table 1). Tree inventories, upon which tree management and ultimately tree bylaw legislation are based, for all classes of government were few or lacking especially for towns, villages and townships. Most municipalities incorporated tree removal policies within their operational programs, but in contrast, policies to protect trees were usually lacking except for some 4% of the cities and boroughs. Allocation of specific funds for tree planting and maintenance work was closely related to the interest in tree protection. Finally, the majority of the officials of town, city, borough and upper tier governments were prepared to initiate new tree programs if provincial or federal funds became available. Correspondingly, the same groups were interested in receiving tree bylaw and related information. Between 30 and 43% of the villages and townships were also concerned with aid programs and information.

Interpretation: A diagnosis of the data in Table 1 leads one to conclude that the 56 villages and 207 townships that responded (and probably those who did not reply) require immediate fiscal and educational help to conserve and protect their urban tree resources. As indicated, tree-related bylaws of these two levels of government were few in number and tree inventories were nonexistent. Lack of concern in current tree protection programs is also reflected in the passive interest to gain additional funding and extension assistance. It should be recalled, though, that most village and township public trees are located on through roads and not on residential streets. Well-treed village parks are few and far between.

Tree removal policies vis-a-vis tree protection policies further reinforce Swaigen's (1973) observation that tree removal programs are of much more municipal concern than tree conserva-

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[1] Upper tier governments include metropolitan, district and regional muncipalities, established and restructured counties and districts. Lower tier governments include those listed on Table 1. There is considerable overlap in population numbers in moving down the demographic scale from city to improvement district.

Table 1: Tree bylaw and related data derived from Ontario municipal forestry survey (Andresen, 1976).

Response Category	Municipal Level				
	City or Borough	Town[1]	Village	Township[2]	Upper Tier Municipality
Total population	5,179,040[3]	1,161,162	129,189	1,398,451	--[4]
Total number of governments	44	142	121	486	39
No. of govts. responding	34	80	56	207	22
Current tree bylaws in force	29.4[5]	10.0	0.0	2.9	9.1
Other bylaws that apply to trees	47.1	15.0	7.1	16.0	22.7
Public trees inventoried	26.5	2.5	0.0	0.5	13.6
Tree removal policy	76.5	47.5	26.8	19.3	50.0
Tree protection policy	47.1	10.0	1.8	2.9	18.2
Specific funds for tree work	50.0	11.3	1.8	2.9	9.1
New programs of provincial funds available	70.6	68.8	42.9	29.5	45.5
Want tree bylaw and related information	88.2	67.5	39.3	38.2	63.6

[1] Includes separate towns.

[2] Includes improvement districts.

[3] Demographic source: Ministry of Treasury, Economics and Intergovernmental Affairs (1975).

[4] Includes all lower tier populations.

[5] Following percentages indicated a "yes" response.

tion endeavours. It was encouraging, however, to learn that the larger municipalities that include most of Ontario's citizenry are responsive to programs and information that would enhance their public tree programs.

In general, tree conservation and protection bylaws are either needed or require updating; ways and means to fund municipal forestry programs must be found; and one or more provincial agencies or professional organizations should take the lead to provide guidance and assistance to those municipalities in need.

BRITISH EXAMPLES

Since we often look to Britian for legal precedents, England's *Tree Preservation Order* legislation (Hall 1970) is worth noting. Regulations attendant to this legislation are probably the most environmentally enlightened and comprehensive of any tree and forest conservation measures in the Western World. In his review of Tree Preservation Orders, Hardy (1972) reminded his readers that the Orders had their origin in the *Town Planning Act* of 1909 and the later *Model Clauses* of the 1929-1932 Acts. At that time, a Municipal Council had the jurisdiction to deny destruction of trees by either public bodies or private individuals if the trees were registered as having amenity value to the community at large. Improvements and revisions to Tree Preservation Order legislation were introduced through the *Civic Amenities Act* of 1967, the *Town and County Planning Act* of 1968, and the *Tree Act* of 1970 (Arboricultural Association, 1970). Further, issuance of the Orders was given to Local Planning Authorities rather than Municipal Councils (Wilson, 1971).

In spite of this relatively sophisticated tree protection legislation, abuses to trees still occur. Decline and death of trees registered for protection does not usually result from malicious intent but rather from ignorance of biological processes and lack of Order enforcement. A number of trees that I observed during a 1976 study tour of Southern England were legally posted (sign *nailed* to tree) with numbered Tree Protection Orders, but in virtually every case the tree's root system had been disturbed. Trenching for utility conduits within 1.5 m of the trunk, lowering or raising soil grade close to the tree, spilling of petrol and oil beneath the shade of the crown, and incorporation of detrimental building debris within the root zone were common occurrences. All of these careless practices create conditions that lead to early mortality of both young and old trees.

As a further complication, and because of worsening budgetary deficiences, Arboriculture Officers who normally would enforce the Orders simply could not keep ahead of the building and the construction crews, nor could they monitor the tree sites to determine or prevent damage.

Hopefully we can employ enough municipal, urban personnel to avoid the British malaise. Reform of our own Canadian tree preservation legislation without enforcement would be a frightful waste.

ASSISTANCE AND REFORM

Two major endeavours are now underway to meet the tree bylaw needs and the information requirements of Ontario's municipal governments (the other provinces are invited to share in the results). The first is a project sponsored by the Canadian Forestry Service and performed by the Canadian Environmental Law Association and the University of Toronto Urban Forestry Studies Programme. The objectives are to review all relevant legislation applicable to urban tree management, to recommend reform of tree legislation to bring older laws into current reality, and to compose a model tree bylaw that can be adapted for local use by the several classes of government listed in Table 1. Several versions of the model bylaw are now under review. A formal, public report should be ready for distribution in the autumn of 1977.

As the second major program, the Ontario Shade Tree Council will soon release a comprehensive urban tree information brochure. The brochure will include a summary listing of agencies, organizations and references available to individual citizens and municipalities concerned with the conservation and management of Ontario's trees and forests.

In closing, the reader is reminded that adequate tree bylaw legislation and regulation are essential components of an urban forestry program of any level of government. Further, there seems to be an upwelling of civic interest to better manage urban tree resources and greenspaces of Ontario's (and Canada's) metropolitan centres. With these thoughts in mind, it behooves all professional foresters to become better acquainted with the problems of municipal forest management and to assist in solving urban forestry problems.

ACKNOWLEDGEMENTS

Messrs. J. Swaigen and P. Lewis-Watts reviewed and contributed to this paper.

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CLIMATOLOGICAL STUDIES IN URBAN AREAS

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INTRODUCTION

Over the past few years, climatologists have been studying the weather within cities in considerable detail. This has been a natural response to generally greater environmental awareness of the population. Moreover, most Canadians are urban dwellers and seek a pleasant living environment to offset the crowding and rush associated with many aspects of modern life.

City climate may be readily contrasted with that of the countryside. The major factor to be identified is the *heat island*, which grows and becomes more intense with city size and industrialization. At night or under a very stable atmosphere, the structure of the heat island may be antagonistic toward the dispersion of pollutants. Daytime heating, however, may induce convection and the upward dispersion of noxious wastes to be transported away by upper winds. The heat island may also reduce the cost of artificial heating in winter. Climate *control* is not economically feasible on a major scale, but management of land-use based on a knowledge of the effects of meteorological processes can lead to a healthy, yet financially viable, urban living space.

This paper notes the chief characteristics of the city climate, along with the means by which climatological surveys, documentation and analysis are carried out. The use of such data in the planning process is explored.

SITE AND CLIMATE

Climate is a long-term study of meteorological conditions affecting an area. The weather is influenced to a varying extent by the nature of the earth's surface. Under stormy conditions, the effect of the immediate surface on wind, temperature and precipitation may be difficult to discern but under calm, stable weather, the terrain can be seen to bring about local differences in heat energy, atmospheric moisture (including cloudiness) and air flow. Even the climate of leaf surfaces has been described in comparable detail to that of whole countries.

The city may be considered in this light as a collection of man-made topographic units having distinctive heat and moisture balances with the atmosphere, creating specific wind patterns and chemical characteristics. These properties may be measured at a number of points and generalized, but the degree of complexity of exchanges of solar energy quantities over a multisurfaced city with attendant effects on humidity and momentum has to be appreciated. The details are the subject of treatises; only some broad examples are allowable here. Absorbed solar radiation depends on the effective transmissivity of the solar beam through the atmosphere to earth, and the reflectivity of the contact surface. This is the solar contribution to atmospheric and soil heating and evapotranspiration. In cities, it is less in quantity annually than that available in the country (Oke, 1974). However, heat energy is also made available by horizontal advection and radiative exchanges, energy conversion, the combustion of fossil fuels, and the heat given off by people and domestic animals. The latter *anthropogenic* sources are much larger than the solar source in many mid-latitude cities during winter.

In basic terms, solar heating and cooling of landforms is variable and winds are established to nullify horizontal air density differences. Thus, lake breezes that form on spring days move dense air formed over the cold water inland to replace uplifted air over the warm land. Similarly cold air flows downslope at night from higher plateaux or ice-fields which are the first areas to cool off at sunset, and which readily emit radiant energy gained during the day to a more dust-free atmosphere. The sub-canopy level of forested regions loses less heat under such conditions than open, and snow-covered areas. Cities are kept even warmer as water vapour and pollutants aloft absorb long-wave radiation attempting to escape to space.

Roughness of the surface affects the wind speed and direction. The details of turbulent flow are too complex for much comment here. Terrain or buildings may block natural currents or promote acceleration through narrow passages. The generally observed increase in wind speed above the surface has been approximated by the power law:

$$\bar{u}_z = \bar{u}_1(\frac{z}{z_1})^a$$

where: $\bar{u}_z$ is the mean horizontal wind speed at height z
$\bar{u}_1$ is the mean horizontal wind speed at height $_1$ (known)
a is an empirically derived exponent which is approximately 0.4 for the City (Chandler, 1976)

Unfortunately, the law yields only approximate answers and cannot be used below roof level in the city where airflow is in turbulent eddies rather than sublaminar.

Another topoclimatic variable is the water balance. Whether precipitation is absorbed by the soil, becomes overland flow, or is evaporated depends on the permeability and temperature of the surface. When evaporation is taking place, heat is removed from the air or ground to vaporize the water. Free evaporation is most effective from moist, vegetated surfaces.

Heat conductivity, retention, permeability, colour, roughness, and moisture content of natural and man-made materials are important determinants of near-ground atmospheric conditions, each different component tending to shape its own microclimate. Contrasts between climatic parameters over urban and rural landscapes are notable, and important to appreciate since data from a meteorological station in one environment sometimes have to be used to resolve problems in another.

URBANIZATION AND CLIMATIC MODIFICATION

Factors such as surface geometry and physical properties of materials, combined with a concentrated population burning enormous quantities of fuel for space heating and vehicle traffic, explain many of the climatic differences from the city to country. The relationships are complex, and despite a voluminous recent literature, many areas still require considerable research.

On the average, during the year the city is warmer than nearby rural areas having similar terrain by 1-2°C. The urban heat island is a dome-like mass of warm air which displaces cooler air above it in a rhythmic pattern from day to night, and season-to-season. At about 400 m above the surface, a stable air layer is often encountered which may be characterized by a temperature inversion. Below the stable layer is an accumulation of pollutants. With strong winds, the top of the heat dome may be displaced downwind in the form of a plume.

At ground level, a conglomerate of separate hot zones over industrial and commercial areas may coalesce to form the centre of the heat island. The boundary of the island is strongly marked by steep temperature gradients at the edge of continuous urban land-use.

The production of anthropogenic heat through the combustion of certain fossil fuels is associated with a copious release of moisture. In spite of drastically reduced transpiration surfaces within cities, the urban atmosphere contains greater absolute quantities of moisture than that of the country. The watering of lawns and gardens may be a contributing factor. However, higher temperatures mean lower relative humidities, at least near the ground. Cooling of the air by evapotranspiration is confined to parks and residential areas. Precipitation water is quickly drained underground or absorbed in porous building materials, which render it not readily available for cooling the city air.

Cities are said to decrease wind speeds at ground level by up to 75%. However, under light wind circulations, speeds are somewhat higher in the city responding to pressure gradients established by the heat island, and some channelling between buildings. Johnson and Bornstein (1976) found that the critical regional wind speed for New York City was 8-9 mph. These authors also noticed a cyclonic (counter-clockwise) motion on airstreams decelerating on entry into the city and either an anticyclonic or cyclonic bending during acceleration over the city depending on stability. It is very difficult to predict wind speed at street level, but direction may be estimated by reference to upwind building and street orientation. A stroll along a street with a hand anemometer is a very interesting experience.

Cloudiness and the incidence of fog increase over the city as augmented water vapour finds abundant condensation nuclei in the form of dust and smoke particles. The city may enhance precipitation. In fair weather, cumulus clouds may be fed moisture by ascending air currents and pollutants from the heat island convective cell resulting in showers. Sometimes slowly moving frontal-type storms capable of producing precipitation may be strengthened to deliver thundershowers over and downwind from the city.

These are only some of the known urban-induced modifications to climate.

DETECTING THE URBAN CLIMATE

Identification and documentation of the climatic characteristics of the city is dependent on the instrumentation, its type and network size, plus the facilities for data analysis including the construction of physical models.

Familiarity with previous work carried out in cities having similar size and terrain is useful in evaluating preliminary research results. The instrumentation and siting is of course dependent on the nature of the problem or results required. Local air pollution regulation has a different set of procedures from development of an overall climatic survey for a city plan. The broader type of study, however, has greater relevance to this paper.

In the latter part of the last century, major Canadian cities had meteorological stations as part of geophysical observatories located in the older part of town. The advent of commercial aviation became the growth stimulus of meteorology as a science entailing a move of the principal meteorological station to the airport. At the same time, however, there was some growth of the climatological station network in the city which included temperature, precipitation and occasionally wind measurements at places where volunteer observers could be obtained (usually in residential areas). While much useful information is obtained from such observations, particularly when a very conscientious observer continues over a number of years and the neighbourhood does not change greatly, a more systematic approach is needed for comprehensive inventories and planning. Meteorological networks are expensive to purchase and install, and considerably more expensive to maintain, especially when volunteer observers are unavailable. Although the network size and location of stations is in practice a compromise to what may be ideal, a few well-placed stations can usually yield enough data for the simpler models needed for most planning and administrative purposes.

For design purposes, the city needs to be divided intitially into districts of similar climate. This may be done with the aid of infrared thermal-band imagery obtained by aircraft overflights (Lewis *et al.*, 1975) and/or ground automobile surveys with sensitive portable instrumentation. In the former case, the temperature sensed is the blackbody temperature of the skin layer of the surface. The air temperature at the normal measurement level above is different, but absolute values are less important than the identification of warmer and cool areas and the gradients between them. The mobile automobile survey was developed almost 50 years ago as a means of distinguishing frostprone zones in agricultural districts, but its utility in the city was shown in Toronto by Middleton and Millar (1936). Here, electrical sensors are mounted on a motor-vehicle at an extended point from the area affected by engine heat. The power supply may be the automobile battery and the circuit is wired to a recorder where the dry bulb and wet bulb temperatures are traced on a chart. The recording chart units are proportional to the air temperature and the humidity may be easily computed from psychrometric tables. The electrical sensors have a fast response to changes in the ambient air so that even with a rapidly moving vehicle, steep gradients and boundaries are distinguishable. The controlling factors over such boundaries are terrain and land-use, as these are primary influences on the factors of the radiation, heat and water balances.

Following the delimitation of zones, sampling and monitoring takes place. Often it is not easy to find a suitable location for the siting of instruments. Basically, it is necessary to select an area having good exposure for an anemometer, as well as a surface typical of large areas so that intercomparisons of station data may be achieved. The international standard surface is close-cut grass, typical enough of suburban areas, but rare in the central business district. Some compromise is usually necessary. Once a suitable station environment has been chosen, the installation must then be protected from vandalism. Necessary structures may entail some interference with an otherwise acceptable site. Vertical atmospheric measurements have been successfully carried out using helicopters, tethered balloons and towers.

The time needed for the data-collection phase varies. Some key stations should be permanent so that planning may be updated as land-use evolves and regional climates fluctuate. The others may be terminated after development of a physical model based on the laws governing heat and moisture transfer accurate to the map scale required. The model predicts to an operational level of accuracy the temperature, humidity and wind field for a given area under specified synoptic weather situations. The model is verified by mobile surveys and remote sensing.

MANAGING THE URBAN CLIMATE

The title of this section is somewhat misleading. Once the climatic processes and quantities have been understood, it is very worthwhile to adapt land-use and building design to make the best of the favourable aspects and to minimize the unpleasant features. For example, stagnant air zones in denser parts of the city may often be because the area is a topographic depression.

Ventilation may be impeded if the streets are narrow or oriented at an oblique angle to winds bringing clean air. Sometimes buildings are sited in the path of natural air streams, forming dams. Some cities having air pollution problems may not recognize natural advantages of their sites which could be developed to improve ventilation, and the overall climate. Lakeside or seaside cities receive refreshing afternoon breezes from over the water during spring and summer. The entry of this invigorating air to the city core is often impeded by tall blocks of buildings lining the shore to serve the port. Cities in valleys or plains with higher land nearby may profit from *flushing* of pollutants or hot, dry air by night-time gravity (katabatic) winds or, in accentuated relief, upslope (anabatic) winds responding to differential surface heating. These winds are channelled into topographic valleys and gullies; thus, building permits should not be issued in these natural air passageways which may be flood-prone areas as well. For the winds to disperse pollutants, industries producing noxious gases should be located on the downstream side of town.

Evaporation of water removes considerable heat from the atmosphere. The maximum rate of evaporation at a given temperature occurs as long as free water is available, and light to moderate winds can accelerate the rate. In the city, rainwater drains rapidly from the surface, thus leaving dry concrete and asphalt during ensuing hot periods. The addition of green space, trees, grass, and shrubs promotes cooling through evapotranspiration, and also aids in the absorption of dust and some pollutants, as well as the decrease of noise. Unfortunately, vegetation may be difficult to cultivate in the shade of tall buildings and where the air is habitually foul. Radial treed boulevards, roof gardens, flat roofs to collect rainwater, and the recent European idea of planting grass between paving stones of parking lots are other aids to abstract benefits from the *latent heat of evaporation.*

Other urban design improvements include: wide street passages to ventilate neighbourhoods (automobile traffic corridors should not be increased proportionally); avoidance of high-rise clusters where wind is accelerated or deflected between narrow corridors creating hazards for motorists and considerable discomfort of pedestrians; heat shields and sunshields on buildings to avoid excessive *greenhouse* heat buildup in summer, (costing fuel for air conditioning), and at the same time to reduce heat loss during winter; and avoidance of the shading of choice recreational or leisure areas by large buildings.

Larger cities have pollution monitoring and control mechanisms and regulations, including mandatory fuel types, factory chimney heights and land-use zoning to prevent unfavourable situations arising in the first place. A decided improvement, however, would be to consult meteorological specialists on a regular basis when town plans are to be introduced or altered.

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TERRAIN ANALYSIS FOR URBAN SUITABILITY: A COMPARISON OF ALTERNATE TOWNSITE LOCATIONS USING EARTH SCIENCE INFORMATION

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INTRODUCTION

This paper illustrates the application of earth science-oriented data in determining the suitability of land for urban-related land uses. The philosophy of the approach taken is discussed to point out shortcomings and rationale as they exist today in British Columbia.

The case study used, part of an overall environmental study program currently being undertaken in the northeastern part of the Province, was precipitated by the impending development of large coal fields in the area. As part of the overall study, terrain analysis concentrated on three potential townsites and two existing urban centres with potential for expansion. This paper discusses the terrain analysis prepared for one of the areas examined for a new townsite. It illustrates the manner in which the technical information is communicated to the landuse planners.

The paper is not an exhaustive study as to how the planning process should ultimately be structured. Instead, it discusses the way in which earth science data have been handled in one particular area in British Columbia.

RATIONALE

When he is interacting with a landuse planner, the earth scientist is often faced with the questions of conservation of natural resources, the health and safety of the public, and the orderly growth and development of urban areas. These issues are not new to human settlement, since historically the land has influenced the location and design of urban areas. This is particularly true of communities in British Columbia. Figure 1 illustrates constraints imposed on the City of Vancouver simply by topography. What has changed is the degree of recognition given to the biophysical, sociological and economic complexities inherent in planning for development in these areas. From the physical point of view, it is possible to reduce the complexity if we understand the climate and the features of the land which make up those parts of the earth scientist's domain (geology, hydrology, soil sciences). Through an application of these sciences, we may categorize and hope to understand the natural characteristics of the land, the processes that shape it, its resource potential and its natural hazards. The application of these sciences defines a terrain analysis.

It is a consequence of history that these sciences mentioned have not oriented their data collection or presentation toward solving some of the urban development questions. Simply because information exists for a particular area on geology or soils does not mean that the planner can use it in decision-making. For example, the use of a general bedrock geology map can become a nightmare for someone not trained in the concepts. The general public, and in some instances the landuse planner, often lack the experience or training required to recognize the significance of such information. The onus then falls on the earth scientist to provide the best way of communicating his information so that it is understandable to the planer and the public.

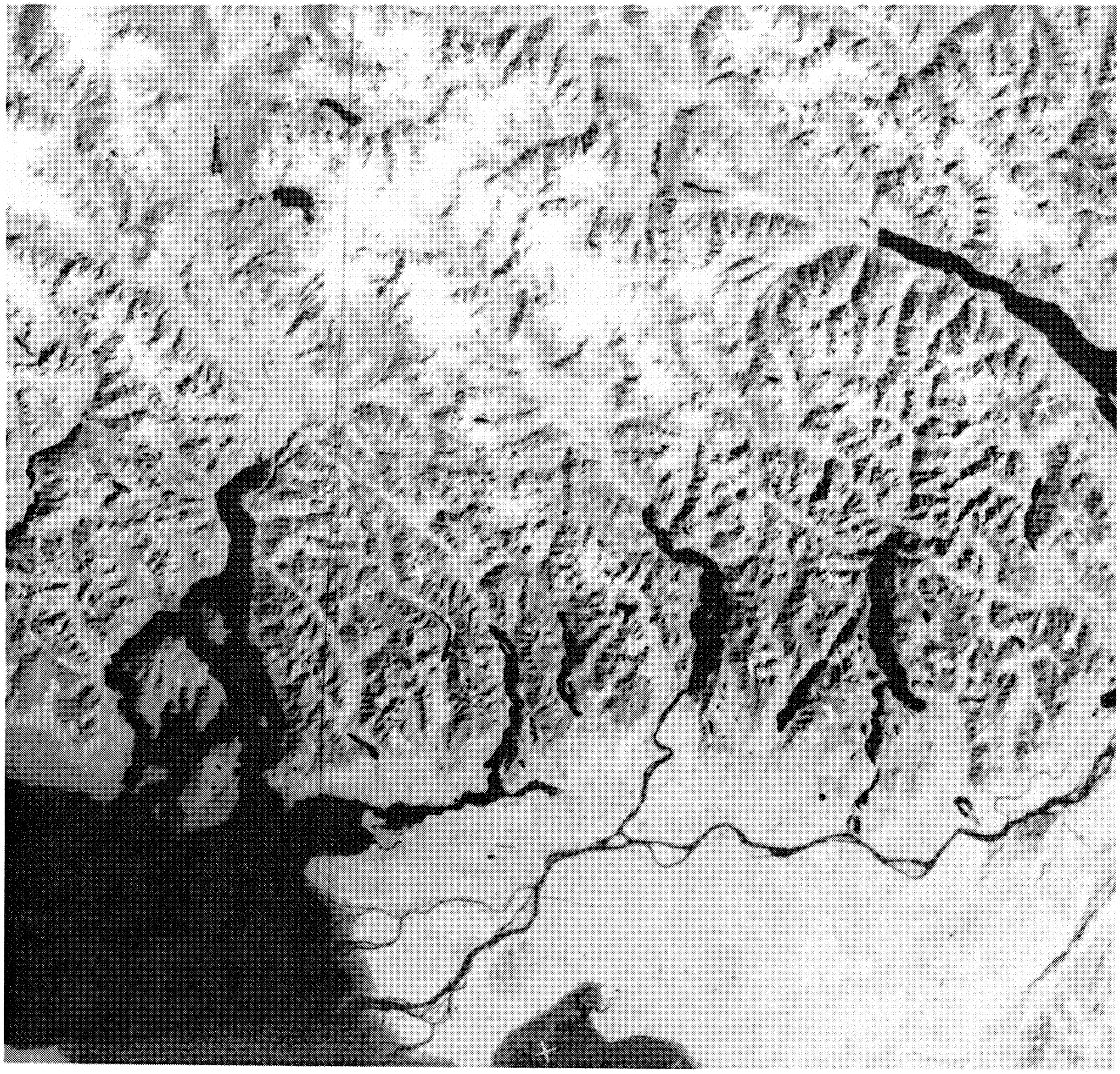
Since the availability of resource data is important, it is necessary to be aware of those agencies or departments which deal with the particular aspects required for a terrain analysis. Table 1 shows examples of some agencies which in British Columbia provide base information and analysis of physical and biological conditions that contribute not just to a terrain analysis but also to an overall biophysical study.

As a result of the many agencies involved, in both data collection and interpretation, there is a massive coordinative task involved in bringing the data to bear on a particular urban problem. Following this, the problem is one not of a lack of information, but rather a difficulty in communicating particular themes to a user.

To-date the Resource Analysis Unit of the Environment and Land Use Committee (ELUC) Secre-

Proc. Workshop on Ecol. Land Class. in Urban Areas, Can. Comm. on Ecol. Land Class., 23 & 24 Nov. 1976, Toronto, Ont.

Figure 1: LANDSAT view of the City of Vancouver. Urban development is concentrated on the delta, hemmed in by the mountainous topography.



tariat, has been the principal group involved in urban terrain analysis. The steps followed in these projects are simplistically logical and similar to those followed by other groups across Canada. This is best explained by referring to Figure 2. The diagram is intentionally brief, designed to show the steps followed and the various planning agencies involved in the process. It should be noted here that physical landuse planning is but one part required for totally planning development in a particular area. Landuse planning is also concerned with the economic, political and social characteristics of the study area.

What follows is an example of the application of these concepts for assessing the physical attributes of the land from the point of view of urban landuses. Although the treatment of some concepts will have to be brief, I will point out one method for communicating earth science information to landuse planners. To

Table 1

Ministry of Environment - Provincial

Resource Analysis Unit
- soils
- terrain
- hydrology (aquatics)
- climate
- vegetation
- recreation capability
- wildlife capability
- forestry capability
- agriculture capability
- present landuse

Water Resources Services
- hydrology
- hydraulics

Land Service
- administrative maps
- planimetric maps
- topographic maps
- air photos
- composite maps

Ministry of Mines & Petroleum Resources - Provincial
- bedrock geology
- engineering
- mineral potential
- existing mining use

Ministry of Highways - Provincial
- geotechnical
- engineering
- avalanche coordination

Ministry of Recreation & Conservation - Provincial

Parks Branch

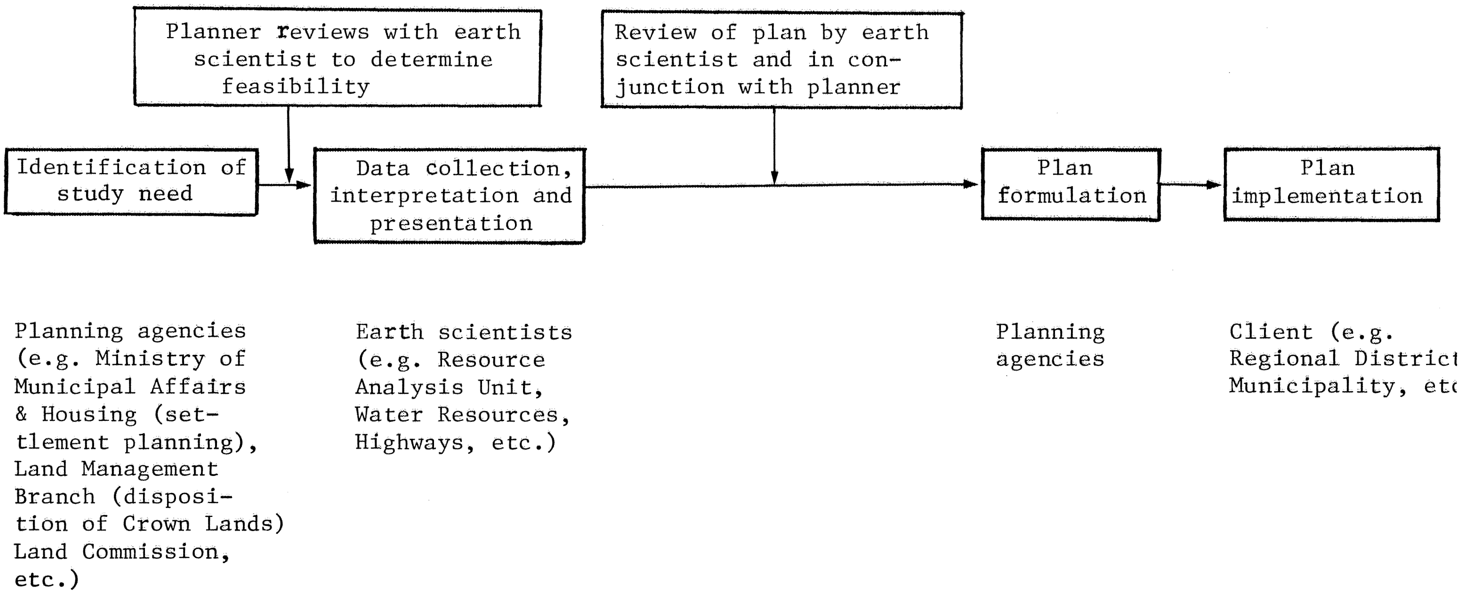
Fish & Wildlife Branch
- fish and game

Ministry of Forests

Forest inventory

Geological Survey of Canada - Federal
- bedrock
- surficial geology
- topography
- air photos

Figure 2: Schematic of planning process to illustrate the inclusion of earth science data.



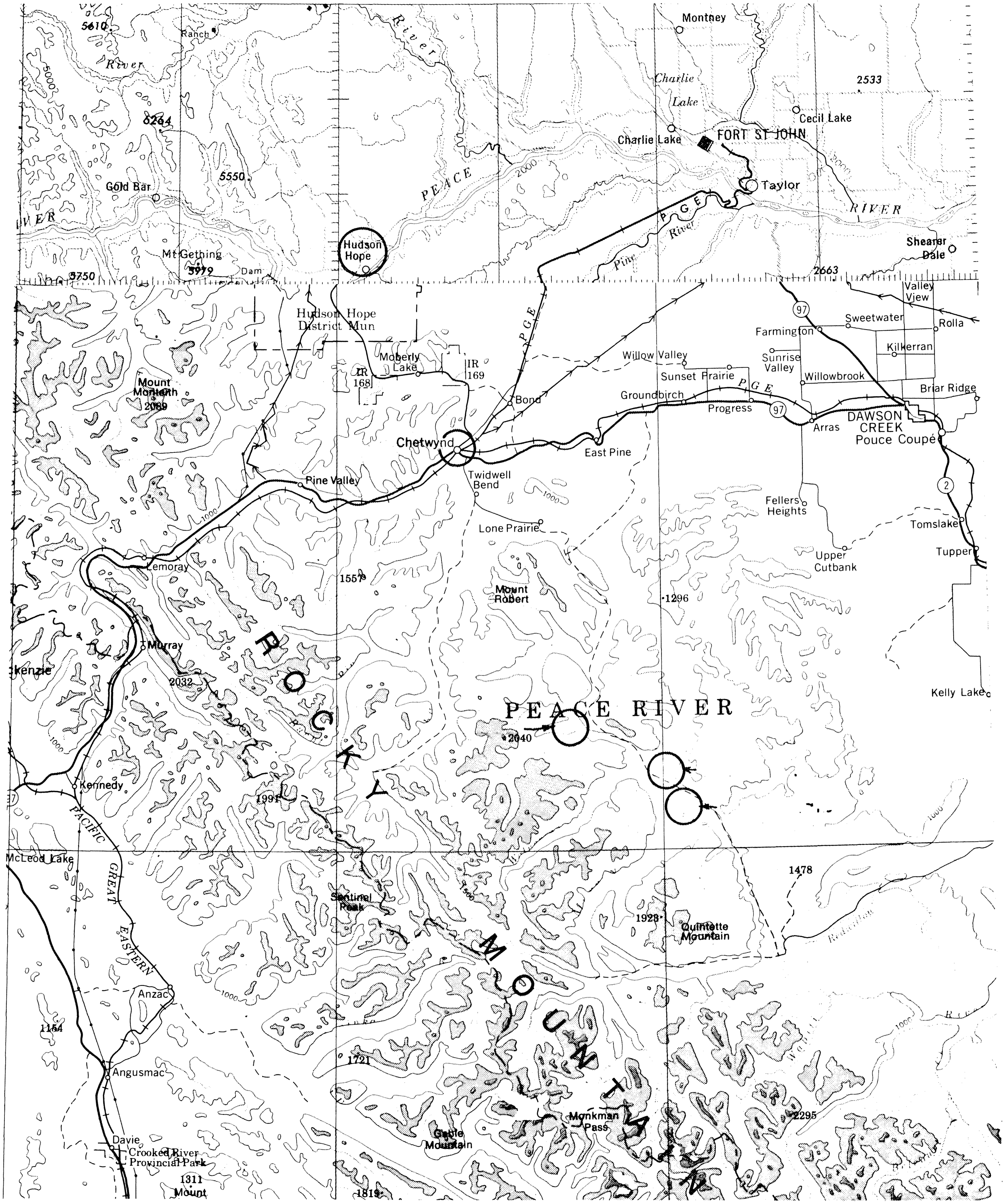


Figure 3: Location of areas studied.

show the continuance of this type of study in British Columbia, and the research into improved techniques for data collection and presentation, Appendix 1 contains examples of other studies currently taking place. The first section shows the type of hydrologic and aquatic data being collected by E. Karanka (personal communication) as part of a study in the southeastern section of the Province. The legend and portion of map illustrate those features considered for these types of study. The second section of Appendix 1 contains an example of the climate information being supplied by R. Bennett (personal communication) for a study in the vicinity of Vancouver. Although it is not possible to show the breadth of this information, the three graphs do illustrate some of those features considered important.

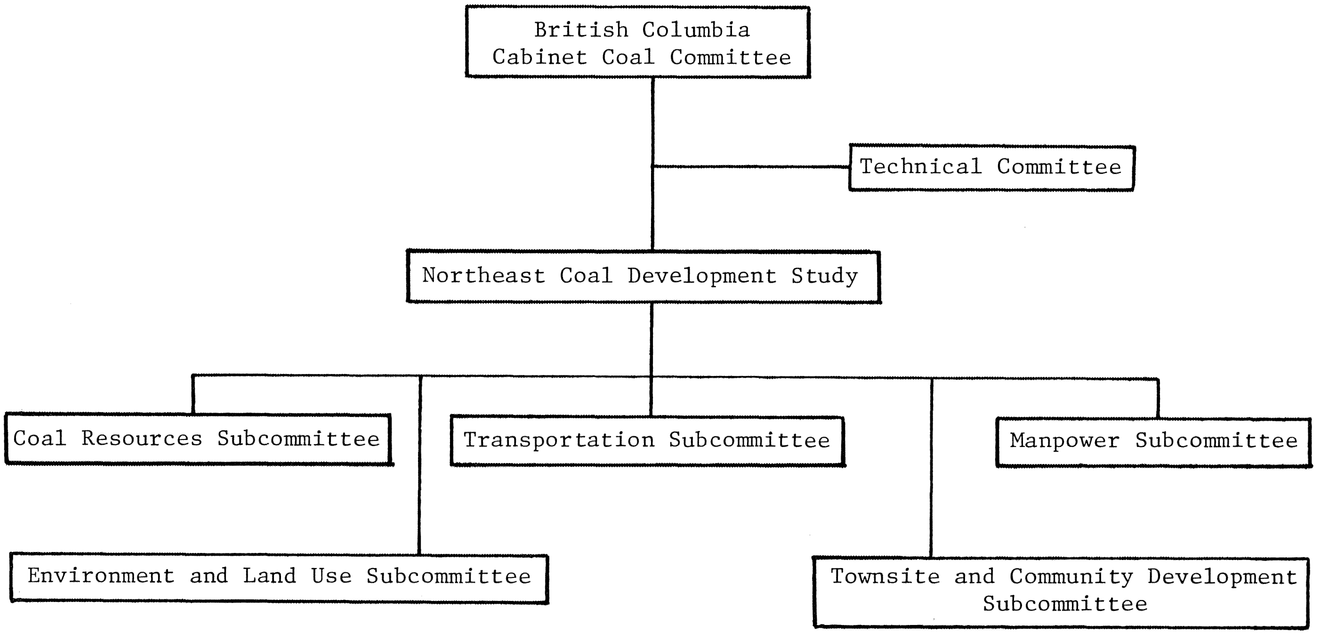
CASE EXAMPLE — THE NORTHEAST BRITISH COLUMBIA STUDY AREA

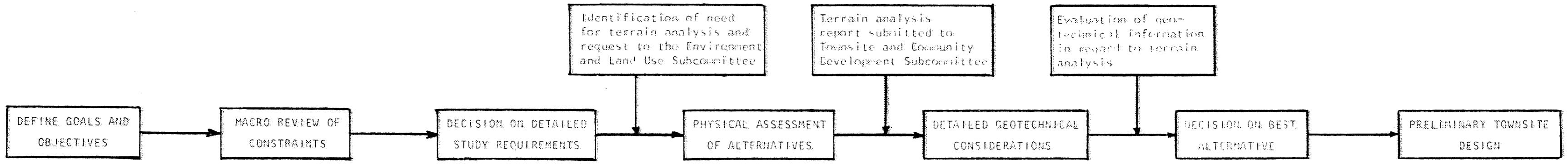
The example to be discussed here involves the terrain analysis of a potential townsite location. Analyses were completed on several areas as part of an environmental study program in northeastern British Columbia (see Figure 3). This program is part of the Northeast Coal Development Study and is administered under the Environment and Land Use Subcommittee on Northeast Coal Development. Figure 4 illustrates the organizational structure of the Northeast Coal Development Study, and shows the linkage between the Environment and Land Use Subcommittee which contains the terrain analysis component, and the Townsite and Community Development Subcommittee which coordinates all of the various economic, social and biophysical studies required for both townsite selection and initial planning. The latter subcommittee requested that a terrain analysis be undertaken, and it is they who will be using the data and interpretations in the initial planning stages.

Figure 5 schematically portrays the various steps followed in this part of the environment program. It shows how this procedure follows the more conceptual one outlined in Figure 2. The program is now at the stage of deciding on the best alternatives arising from environmental, economic and social considerations. As indicated, this is the most crucial part of the study, and requires good communication between the earth scientist and the planner. The techniques used by the earth scientist to portray (explain) the information base are very important as poor presentation techniques may result in poorly understood data and hence poor decisions.

Table 2 lists the various parameters which form

Figure 4: Organizational structure of the Northeast Coal Development Study





Set up subcommittee structure

Initial review of entire region for potential sites employing the following criteria on a macro scale

: climate
: elevation
: location
: access
: overall topography
: amount of potentially usable land (minimum 2000 acres)

Those nine acreas identified previously reduced to three ,as a consequence of severe restrictions

Terrain analysis performed on three locations; scale 1:20,000; interpretation of data provided to enable comparisons of alternatives to be made; other environmental studies taking place concurrently.

: climate
: vegetation
: wildlife resources
: recreation
: visual analysis
: heritage resources
: aquatic resources

Geotechnical studies performed on those portions of the three potential townsites indicated by the terrain analysis as being highly suitable for development; drilling specific locations to provide necessary engineering data as well as ground-water potential

Entire array of information (terrain analysis being one part) used to decide on most suitable site; decision made by consultation between earth scientist and planner

Townsite design studies undertaken; continued liaison with individuals responsible for various environmental themes.

Figure 5: Schematic representation of the townsite selection process, terrain analysis component, Northeast Study Program.

Table 2: Field characteristics recorded during sampling.

1. Terrain classification (ELUC Secretariat, 1976).
2. Soil Classification (Can. Soil Surv. Comm., 1974).
    i) horizon depth, pH, colour, texture, etc.
3. Major vegetation
    i) dominant trees
    ii) dominant shrubs
    iii) dominant herbs
    iv) regenerating tree species.
4. Slope
5. Coarse fragment content (by volume).
    i) % 3-10" in diameter.
    ii) % >10" in diameter.
6. Estimated flood frequencies.*
7. Depth to apparent water table.
8. Soil moisture status
    i) regime
    ii) drainage class
    iii) perviousness class
9. Depth to impermeable layer.
10. Rockiness and stoniness classes (Can. Soil Surv. Comm., 1974).

* Floodplain mapping performed by the Water Resources Service is used when available

the structure of the terrain analysis. The Terrain Classification System (ELUC Secretariat, 1976) is an important part of the analysis since it describes only the surficial geologic material in terms of genetic type, but also describes features such as texture, surface expression, and those processes which are modifying or have modified the landscape. Figure 6 is a legend for a terrain map drawn by J. Ryder (personal communication). It explains in more detail those features which are inherent to the Terrain Classification System. Pedological characteristics are described by classifying the type of soil to the subgroup level and noting field and laboratory data required for the interpretations.

Each map unit defined by this process and depicted on the air photos employed was sampled to provide the laboratory data required for specific landuse interpretations. The sampling and description of the map units employed standard soil survey techniques and as such was concerned with the surface two or three meters of material. Geotechnical studies are employed to study the characteristics of the materials at depth. Table 3 portrays the parameters measured in the laboratory. Most are required for the more engineering-related interpretations, but some (e.g. conductivity, organic matter content) are needed for biological interpretations such as topsoil suitability.

Table 3: Laboratory analyses performed on sampled soil material.

1. Liquid and plastic limit
2. Coarse fragment content (2mm to 7.3 cm)
3. Particle size and textural classifications (Can. Soil Surv. Comm., 1974).
4. pH
5. Electrical conductivity
6. Calcium Carbonate equivalent
7. Sieve analysis required for UNIFIED classification
8. Organic matter content.

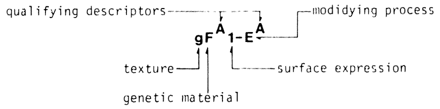
The finalized boundaries of the map units were portrayed on a 1:50,000 topographic map enlarged to 1:20,000 (1:50,000 maps are the largest scale available in this region), and on a 1:60,000 air photo enlarged to 1:20,000. The topographic map is required for the contour information as well as the legal and cultural data. The air photo provides an excellent visual impression of the landscape and facilitates communication about specific features. A current air photo will also indicate present landuse and access. Field mapping was done on 1:15,000 black and white air photos, from which the lines were transferred to these two forms of presentation.

Although a multitude of interpretations could be made from the field and laboratory data collected for each map unit, specific ones were selected to satisfy the needs of the study. Table 4 provides the interpretations for each map unit. Due to lack of climate data, these interpretations are made irrespective of climate considerations, which may alter the interpretation of some cases. Methods used to make these interpretations are a combination of those defined by the U.S. Dept. of Agriculture (1974) as modified to suit particular needs in British Columbia and those defined by various

Figure 6: Legend - surficial geology

Explanation of Letter Notation

A combination of letters is used to designate each map unit. The relative position of letters within the symbol indicates the characteristic that they represent.



Units consisting of two or more types of terrain are designated by two or more groups of letters separated by dots and slashes:-

eg. **gFt/dCf** (See Composite Units below)

Material underlying the surface unit is shown by a symbol that is written beneath the surface unit symbol and separated from it by a horizontal line:-

eg. $\frac{\mathbf{sEv}}{\mathbf{gFt}}$

Genetic Materials

letter symbol	name (process status*)	
A	anthropogenic (A)	man-made or -modified materials including those associated with mineral exploitation and waste disposal.
C	colluvial (A)	products of mass wastage; includes rubbly bedrock-derived material and material derived from unconsolidated Quaternary sediments; includes earthflow, mudflow and landslide deposits and talus material. - generally consists of massive to moderately well-stratified sediments with a great range of particle sizes.
E	eolian (A)	materials transported and deposited by wind; includes dunes, loess and sheets of sand and silt. - generally consists of medium to fine sand and coarse silt that is well sorted and poorly compacted.
F	fluvial (I)	material transported and deposited by streams and rivers; alluvial materials. - generally consists of moderately to well-bedded and moderately to well-sorted gravels and/or silt.
F^G	fluvio-glacial (I)	fluvial materials that were deposited either in contact with or directly in front of glaciér ice. - generally consists of non-bedded to poorly-bedded and non-sorted to poorly-sorted gravels with minor amounts of sand; evidence of collapse associated with melting ice (slump structures, kettles, irregular topography) is commonly present; includes kames, kame terraces, eskers and pitted outwash.
I	ice (A)	permanent snow and ice; glaciers.
L	lacustrine (I)	sediments that have accumulated in lakes. - generally consists of stratified and sorted sand, silt and clay, and moderately to well-sorted, rounded gravels that are the products of lakeshore wave action.
L^G	glacio-lacustrine (I)	lacustrine materials that were deposited in contact with, or directly from melting glacier ice. - typically consists of stratified silt and sand with slump and settling structures and with scattered (ice-rafted) stones; surface is irregular and/or kettled.
M	morainal (I)	material deposited directly by glaciers; till. - generally consists of compact, non-sorted and non-stratified material that contains a wide range of particle sizes and a matrix of silt or clay.
0	organic (A)	material resulting from the accumulation and decay of vegetative matter. - generally consists of peat, unstratified and locally containing minor amounts of marl and inorganic detritus.
0^B	organic (bog) (A)	peat material consisting of undecomposed to moderately decomposed sphagnum mosses; water-table is generally high; dominant vegetation is black spruce, feathermosses, sphagnum spp. and ledum spp.
0^F	organic (fen) (A)	peat material consisting of well to moderately decomposed sedges (carex spp.); watertable is commonly at the surface; vegetation dominantly consists of sedges, grasses and reeds with some shrub cover.
0^S	organic (swamp) (A)	peat material consisting of decomposed sedge or feathermoss species; water-table is generally at or above the surface; vegetation is most commonly a tree cover of cedar and spruce.
R	bedrock (I)	outcrops and rock covered by less than 10 cms of unconsolidated material.
U	undifferentiated (I)	used where more than three types of genetic material occur in close proximity and cannot be separated at the scale of mapping.

* See Qualifying Descriptors below for definition of Process Status

Modifying Processes

letter symbol	name (process status*)	description
A	avalanched (A)	slopes modified by frequent snow avalanches and by the deposition of rock debris transported by snow avalanches.
C	cryoturbated (A)	unconsolidated sediments or colluvium modified by frost heaving and churning; includes patterned ground.
D	deflated (A)	areas modified due to the removal of sand and finer particles by wind action.
E	channelled (I)	surfaces crossed by channels formed by running water; includes channels of braided streams, meander scars, and scroll patterns; channels are broad, shallow, and generally not incised.
E^G	channelled by glacial melt-water (I)	surfaces crossed by glacial meltwater channels; channels on former outwash plains are generally broad and shallow; other meltwater channels are typically narrow, flat-floored, steep-sided troughs
F	failing (A)	slopes where slow downslope movement of masses of unconsolidated material or bedrock is occurring; slopes may be crossed by tension fractures, slump scarps, or show other evidence of slow failure; also includes slopes where relatively rapid soil creep is occurring.
G	frost shattered (A)	rock surfaces covered with angular fragments derived *in situ* by frost shattering.
H	kettled (I)	surfaces marked by depressions formed due to melting of ice blocks in fluvioglacial, glacio-lacustrine or morainal sediments.
K	karst (A)	bedrock (chiefly limestone) modified by solution resulting in surface features such as sinkholes and limestone pavement, and subsurface caverns and underground drainage.
N	nivated (A)	surface modified by shallow depressions that result from frost action, meltwater erosion and mass wasting around and under snow patches.
P	piping (A)	surface modified by small, steep-sided depressions, commonly aligned along routes of subsurface drainage; results from collapse of underground conduits formed by removal of particulate matter; ("pseudokarst").
S	soliflucted (A)	surface modified by the slow downslope movement of saturated overburden across a frozen or otherwise impermeable substrate.
V	gullied (A)	surface crossed by deep, steep-sided ravines that are parallel or subparallel and result from fluvial erosion.

* See Qualifying Descriptors below for definition of Process Status

Composite Units

Composite units are employed where two or three types of terrain are intermixed or occupy such small areas that they cannot be designated as separate units at the scale of mapping. Symbols (defined below) are used to indicate the relative amounts of each terrain type, and the components are always written in decreasing order of importance.

.	the components on either side of this symbol are approximately equal
/	the component in front of the symbol is more extensive than the one that follows
//	the component in front of the symbol is considerably more extensive than the one that follows

eg.	Mb//R	Mb is considerably more extensive than R
	Mb//R.Cv	Mb is considerably more extensive than R; R and Cv are of roughly equal extent
	Mb/R//Cv	R is less extensive than Mb; Cv is considerably less than R

Figure 6: Legend - surficial geology (continued)

Surface Expression

letter symbol	name	description
a	apron	a relatively gently sloping surface that is at the foot of a steeper slope and underlain by material derived from that steeper slope.
b	blanket	a mantle of unconsolidated material which has no constructional form of its own, but derives its general surface expression from the topography of the unit which it overlies; it masks minor topographic irregularities in the underlying unit and is more than 1 m thick. - if the underlying unit consists of unconsolidated materials, it is shown in the unit symbol; if no underlying unit is shown, it may be assumed to be bedrock.
f	fan	a surface that is the sector of a cone.
h	hummocky	steep-sided hillocks and hollows that are rounded or irregular in plan; slopes of 15 to 35^{0} predominate on unconsolidated materials, and slopes of 15 to 90^{0} predominate on bedrock; local relief is greater than 1 m.
l	level	a flat or gently inclined (less than 5^{0}) surface with uniform slope and local relief of less than 1 m.
m	rolling	elongate or linear, parallel or subparallel hills or ridges with slopes generally less than 15^{0} and local relief of more than 1 m.
r	ridged	elongate or linear, parallel or subparallel hills or ridges with slopes predominantly between 15 and 35^{0} on unconsolidated materials and between 15 and 90^{0} on bedrock.
s	steep	steeply inclined erosional slopes (scarps) with gradients commonly greater than 35^{0} on unconsolidated materials and greater than 35^{0} on bedrock.
t	terraced	step-like topography; includes both scarp face and the horizontal or gently inclined surface above it.
u	undulating	low hills and depressions with slopes generally less than 15^{0} and rounded or irregular in plan; local relief greater than 1 m.
v	veneer	a mantle of unconsolidated materials which has no constructional form of its own, but derives its surface expression from the topography of the underlying unit; it reflects minor irregularities of the underlying surface, is generally between 10 cms and 1 m in thickness, and outcrops of the underlying unit are common. - if the underlying material is unconsolidated, it is included in the unit symbol; if no underlying unit is indicated, it is assumed to be bedrock.

Texture

letter symbol	name	particle size (mm.)	other characteristics
b	bouldery	256	rounded & subrounded particles
g	gravelly	>2-256	rounded & subrounded particles (includes interstitial sand)
s	sandy	0.625-2	
s̸	silty	0.0039-0.0625	
c	clayey	<0.0039	
d	diamicton		heterogeneous mixture of particles of any size, roundness or angularity in silt and clay matrix
r	rubbly	2-256	angular and subangular particles with finer interstitial material
a	blocky	>256	angular and subangular particles

Notes:- (1) The absence of a textural term from a unit symbol indicates that texture of the material was not observed in the field and cannot be reliably interpreted from air photos. The reader is referred to the general textural descriptions under the heading Genetic Materials (below).

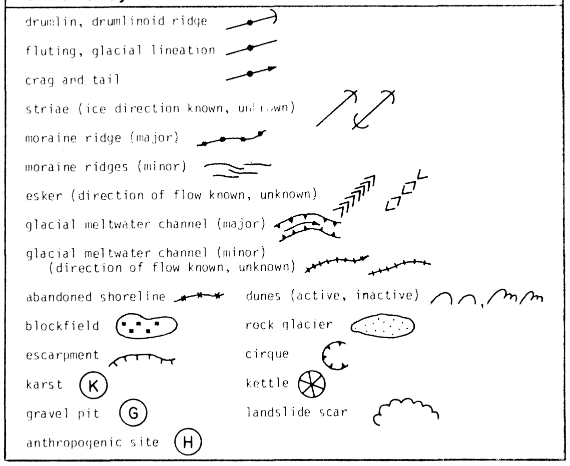
(2) Where two textural terms are used together, they are written in order of increasing importance. eg. s̸s is silty sand, sg is sandy gravel.

(3) A diamicton texture is always implied in the case of morainal (M) materials. Any textural term written in the symbol merely modifies this basic texture. eg. s̸M indicates till consisting of silty diamicton, not silt alone.

Qualifying Descriptors

letter symbol	name	description
G	glacial	- used to qualify non-glacial genetic materials or process modifiers where there is evidence that glacier ice affected the mode of deposition of materials or the mode of operation of a process. (See F^{G}, L^{G} and E^{G} above).
B, F, S	bog, fen, swamp	- used where possible to supply additional information about units of organic material. (See 0^{B}, 0^{F} and 0^{S} above).
A, I	active, inactive (process status descriptors)	- used to qualify genetic materials and modifying processes with regard to their current state of activity. Active: there is evidence that a modifying process is either operating continuously or is of a recurrent nature at the present time; there is evidence that the process of formation of a genetic material is operative at the present time. Inactive: there is no evidence to suggest that a modifying process is continuing or recurrent; the process of formation of a genetic material has ceased. A process status descriptor is designated for each genetic material and for each modifying process on the basis of their most common state of activity at the present time. (See process status column in Genetic Materials and Modifying Processes above). Process status descriptors are shown in unit symbols on the map only where the current state of activity is contrary to the designated state.

On-Site Symbols



Mapped by :

Fieldwork Completed :

Date of Photography :

Drafted by :

Date :

Table 4: Interpretations provided for each map unit (irrespective of climate).

A. Interpretations for selected uses:

1. Foundations for low buildings
   i) with basements
   ii) without basements
2. Septic tank filter fields
3. Roads and parking
4. Sanitary landfills
   i) trench type
   ii) area type
5. Reservoirs or sewage lagoons
6. Playgrounds.

B. Interpretations for the use of geologic materials as a source of:

i) sand and gravel
ii) top soil

C. Interpretation for soil erosion and mass movement.

survey teams in British Columbia to meet specific regional requirements. Table 5 is an example of a U.S.D.A. modified method. This example, for dwellings with basements, illustrates that the degree of limitations are described as slight, moderate or severe. A *slight* rating means that the site is relatively free of limitations or having easily overcome limitations. A *moderate* rating indicates a limitation(s) which needs to be recognized by can be overcome with good management. A *severe* rating for the particular landuse considered, indicates that the limitations are extreme enough to make the use questionable. In order to rate that part of the landscape defined by the map unit on an overall basis for the landuse considered, a hierarchical system was defined as follows:

High Potential for Intended Use
H (no limitations)

Medium Potential for Intended Use
Number of severe limiting factors allowable.

$M^{1}_{<3}$

Number of moderate limiting factors allowable

Low Potential for Intended Use

L^2 of $L^{<2}_{>3}$

This system allows one not only the ability to provide an overall rating for a particular landuse but also to clearly illustrate those limiting factors which have caused the assigned rating. The limitations considered are listed in Table 6 and are simply those factors considered in the methods used for the interpretations. Following the above procedure,with reference to the numbers beside the limitations illustrated in Table 6, an example would be:

$$L_{2}^{5,\ 4}$$

"a map unit having a selected use severely limited by slope and drainage and having moderate limitations due to flood hazard".

The report to the planning agency provides the methods used to make the various interpretations listed in Table 4. This allows for an understanding of how the results were arrived at so that if certain limitations are not considered important, they may be easily eliminated and a new overall rating produced. It is also important to point out to the planner that the interpretations should be viewed in a relative sense since we are dealing with natural systems. One section of the land must be viewed in isolation from the rest since what happens in one part will certainly affect others. One must then relate the effects of proposed practices on one unit to results on other units.

To illustrate the application of these concepts, Appendix 2 contains examples of the four components provided for each townsite, to be used in conjunction with the maps (from information gathered by G. Singleton and D. Parsons - personal communication). The first table illustrates the *Field Information* described in Table 2, while the second table shows the *Laboratory Information* described in Table 3. The *Terrain Interpretations* for each map unit are shown following the procedure discussed above . To provide a synopsis of this information for the planner, a *Summary Table* is provided which shows those map units rated as moderate or high for each landuse, as well as the total land area (acres) supplied by the total of these map units.

Preliminary Impact Analysis - Prior to completion of the study, a preliminary environmental report was written for the northeast study, part of which was a preliminary environmental impact analysis of the three alternative townsite locations. To illustrate the application, Table 7 reproduces a table from the report *Preliminary Environmental Report* (Environment and Land Use Subcommittee, 1976) stating the impact identified by each resource section. Although extremely brief, the table does point point out the potential environmental problems and indicates that additional more-detailed

Table 5: Soil limitation ratings for dwellings with basements

Item affecting use	Degree of soil limitation[1]		
	Slight	Moderate	Severe
Soil Drainage class[2]	Very rapidly, rapidly well-drained	Moderately well-drained	Imperfectly drained, poorly drained, very poorly drained
Apparent Water Table	Below a depth of 60"	Depth of 30-60"	Above a depth of 30"
Flooding	None	None	Rare, occasional or frequent
Slope	0-8%	8-15%	>15%
Inferred shrink-swell potential	Low	Moderate	High
Unified soil group	GW, GP, SW, SP, GM, GC, SM, SC, CL, with PI (plasticity index)	ML, CL with PI (plasticity index) 15 or more	CH, MH, OL, OH
Potential frost action[4]	Low	Moderate	High
Stoniness class[5]	1	2 & 3	4 & 5
Rockiness class, [5,6]	0	1	2,3,4 & 5
Depth to bedrock[6]	>60"	40-60"	<40"

[1] Some soils given limitation ratings of *moderate* or *severe* may be good sites from the standpoint of esthetics but require more preparation or maintenance.

[2] For class definitions see Can. Soil Surv. Comm., 1974.

[3] Reduce slope limits 50% for those soils susceptible to hillside slippage.

[4] Use this item only where frost penetrates to assumed depth of footings and where soil is moist during freezing weather. See U.S. Dept. of Agriculture, 1974.

[5] For class definitions see appendix.

[6] If bedrock is soft enough so that it can be dug out with light power equipment such as backhoes, reduce ratings of *moderate* and *severe* by one step.

Table 6: Limiting factors considered in the overall rating for the map unit.

1. water table
2. flood hazard
3. perviousness
4. drainage
5. slope
6. stoniness
7. rockiness
8. textural limitation
9. frost heave susceptibility
10. shallow to bedrock or impervious layer
11. unsuitable overburden
12. ground water contamination
13. surface erosion hazard
14. mass movement hazard
15. clay characteristics
16. salinity
17. organic matter content
18. deposit thickness
19. soil reaction (pH)
20. thickness of humified soil horizon
21. possible shrink-swell
22. bedrock type
23. coarse fragment content (3"-10")

information is available for each sector. It also illustrates the other themes considered in the study. To expand on the terrain part of the analysis, maps such as that indicated in Figure 7 were drawn for each townsite alternative. Although it is recognized that an interpretation for one use is not sufficient to base a decision on the land's overall suitability, it does point out the amount of potential land available and its geographic occurrence, which in itself is of utmost importance at this level of planning. This information is presently in the hands of planners and engineers, and is being used to study the features of the terrain which have bearing on their planning activities. It is anticipated that, once the next set of decisions have been made regarding the course of events for the development, there will be further liaison between the earth scientists and the planners.

CONCLUSION

The foregoing discussion and case examples have pointed out that our growing population and increasing use of natural resources carry with them the need to conscientiously plan for the use of land. Landuse planners will continually be expected to solve use conflicts for a commodity which is finite in amount. As such, there will need to be an even increasing effort to make terrain information available, in a usable form, to the planner. It must also be recognized that we are not only trying to conserve natural and aesthetic resources; we must consider hazards and constraints in terms of urban development and hence reduce the risk to the human population of natural disasters. Only when we can communicate this kind of earth science information to the planner and decision-maker can we be sure that we are on the road to ensuring that the land is serving the greatest good for the greatest number in the long-run, and hence meeting the concept of proper landuse management.

ACKNOWLEDGEMENTS

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Table 7: Alternative townsites-environmental assessment matrix.

Townsite / Sector	Tumbler Ridge	Bullmoose	West Flatbed	Dawson Creek	Chetwynd
Climate	Minor problems with inversion and air pollution.	Moderate problems associated with inversion and air pollution; moderate problems associated with severe climate.	Moderate problem associated with severe climate.	No significant problems.	No significant problems.
Terrain & Soils	No significant problems at site; moderate to severe engineering problems with any undertaking along Murray River bluffs.	No significant problems.	Moderate engineering problems associated with till soils.	-------------	No significant problems.
Vegetation	Moderate problems with impact on vegetation diversity. Moderate impacts on adjacent floodplain vegetation.	No significant problems, except moderate fire hazard.	No significant problems.	-------------	-------------
Aquatics	Moderate to severe potential impacts on stream capability and fish utilization in vicinity.	Moderate impacts on Bullmosse and/ or Gwillim Systems.	No significant problems.	-------------	-------------
Wildlife	Severe impacts on wildlife populations on adjacent floodplain. Moderate loss of habitat in an area of high capability.	Minor impact.	Minor impact.	--------------	-------------
Recreation	Minor impacts associated with recreation capability of Murray River.	Minor impact only.	Minor impact.	--------------	-------------
Visual	Moderate impact of townsite itself on landscape.	Minor impact only.	No significant impact.	--------------	-------------
Heritage	Minor to moderate impact on areas of interest.	No known impact.	No known impact.	--------------	-------------

APPENDIX 1

SECTION 1 : *Example of aquatics biophysical data used for terrain suitability analysis (E. Karanka, 1976).*

Aquatics biophysical legend - Scale 1:20,000

Fish Species

1. Sport and Commercial abbreviations

Symbol	Species
Ch	Chinook salmon
Co	Coho salmon
Cm	Chum salmon
Pk	Pink salmon
Sk	Sockeye salmon
Ko	Kokanee salmon
Rb	Rainbow trout
St	Steelhead trout
Ct	Cutthroat trout (coastal)
YCt	Yellowstone Cutthroat trout
EB	Eastern Brook trout
DV	Dolly Varden Char
LT	Lake Trout
GB	German Brown trout
MW	Mountain Whitefish
LW	Lake Whitefish
Gr	Grayling
LMB	Largemouth bass
SMB	Smallmouth bass
NP	Northern pike
WP	Walleye pike (Pickerel)
YP	Yellow perch
Bb	Ling (Burbot)
Cp	Carp

2. OS indicates known but non-sport or non-commercial species. Data bank must be consulted for complete species list.

3. Sp indicates fish observed by not indentified.

4. 0 indicates fish not detected at time and place of sampling.

5. Absence of any fish species symbol indicates that no sampling information was available.

6. (Co) indicates probable but unconfirmed presence.

7. Sk indicates reach used by species for migration only, no resident population.

8. *Note:* no specific symbol exists for a barren stream. When such a condition is suspected, it may be indicated by (0) which is an inference that *if* sampling took place, fish would not be detected.

Channel

1. Cross section

	Symbol	Definition
A. Confined	C	canyon - channel entrenched in bedrock.
	R	ravine - channel entrenched in deep surficial materials.
B. Bounded	B	bounded - channel on narrow valley flat confined by valley walls or high terraces.
	L	flood plain - channel laterally unstable.
	H	flood plain - channel relatively stable.
C. Unconfined	F	fluvial fan - unconfined channel on a fluvial fan.
	W	wash - unconfined channel on a steep slope resistant to entrenchment.
	S	slough - backchannel on a flood plain with major inflow from a tributary or groundwater.

2. Slope - % (elevation gain/reach length)

>3%-to nearest percent
<3%-to nearest tenth percent

3. Channel lateral movement.

	Symbol	Definition
A. Single channel	E	stable - no lateral movement because of entrenchment, vegetation or artificial stabilization.
	M	migration - laterial movement predominately down channel meander migration.
	C	cutoff - lateral movement predominately cutoffs to meanderbends.
B. Multiple channel	D	diversion - laterial movement predominately by diversions and cutting of new channels.
	B	braiding - laterial movement predominately by shifting of channel locations.

Substrate

1. D90 - the average diameter (in cm) of the largest 10% of substrate materials.

2. Composition - Fines, gravels and bedrock are listed in sequence to nearest 10%, expressed as an integer. Larges are inferred. (see example)

1) fines - materials in 0-2 mm size class.
gravels - materials in 2-100 mm size class.
larges - materials >100 mm in size

2) Bedrock percentage indicates by Rn. where integer n represents percentage. R without integer implies 0-10.

3) F, G, L or R used alone indicates 90-100 of a reach is in one category size, fines, gravels, larges or rock respectively.

Example:

Rainbow trout (present) - Chinook (migration)
Coho probable

$$\frac{\text{Rb}\quad\text{Ch}\quad\text{(Co)}}{\text{B2.5}\frac{\text{d}}{\text{g}}\quad 25 - 15\text{R2}}$$

substrate composition 10% fines, 50% gravels, 20% bedrock and 20% large (inferred)

D90 of 25 cm

bounded cross section

2.5% slope

Multiple channel with a combination of diversions and braided lateral movement

Note: 1) where the channel or substrate component is man-made, the symbol is underlined.

2) where channel or substrate data has not been verified the symbol is placed in parenthesis.

Headwater classes

Reaches of streams known or inferred to be barren of fish populations because of steepness and/or ephemeral flow are typed for channel cross section and slope only, with the same symbols as regular streams.

Example:

C30 - a confined channel over bedrock with a 30% slope (inferred to be laterally stable because of entrenchment)

Lakes and Wetlands

1. LAKES

General: $\frac{\text{Fish Species (TDS)}}{\text{Max. depth/Littoral area}}$

- i) Fish species: same as streams
- ii) TDS: total disssolved solids, if avail able
- iii) Maximum depth: measured to nearest meter
- iv) Littoral area: measurement or visual estimate of % of total area <6m. When estimate is made, parenthesis will be used

2. WETLANDS

A.D.: identifies a depressional channel cross section occupied by a permanent or seasonal wetland.

B. area (ha) - wetland area in hectares (omitted if not measured or estimated)

C. class: m - marsh s - swamp
b - bog p - pond
f - fen

e.g. D30m - identifies a 30 hectare marsh.

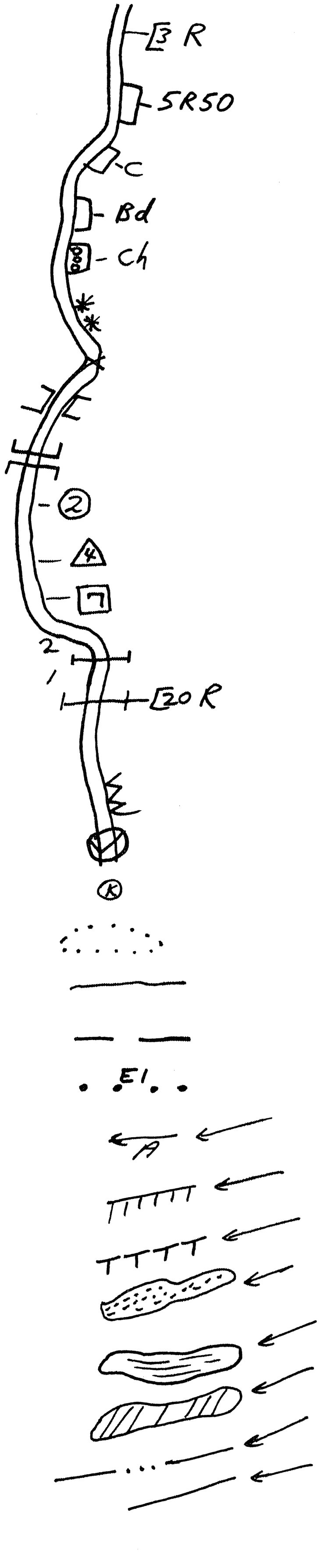
Headwater classes

Reaches of streams known or inferred to be barren of fish populations because of steepness and/or ephemeral flow are typed for channel cross section and slope only, with the same symbols as regular streams.

Example:

C30 - a confined channel over bedrock with a 30% slope (inferred to be laterally stable because of entrenchment).

SITE-SPECIFIC STREAM SYMBOLS



An obstruction 3 m high of the following types: R (Rock), L (logs), B (blocks), D (Man-made), Bd (Beaver dam), 0 (Culbert), F (type unknown).

A chute or cascade 5 m high and 50 m long of the above types.

A chute or cascade with details unknown.

A sequence of beaver dams.

Clear evidence (eg: persistent redds of observed spawning adults) of spawning by the indicated species.

A zone of flood and side channels.

A persistent debris acculilation.

A culvert.

A bridge.

A site (point) number with biophysical data available.

A water quality sampling site number.

A water quantity sampling site number.

A reach boundary with reach reference numbers.

A reach boundary which is an obstruction. The obstruction height is not to be included in either adjacent reach for the purposes of reach slope calculation.

A major bank or valley side wall slump zone.

An alluvial sink hole without surface effluent.

A karst pothole.

Persistent snow or ice.

Major watershed boundary.

Sub-watershed boundary.

Minor watershed boundary with reference number.

Avalanche track.

Well defined flood plain boundary (terrace scarp or valley wall).

Poorly defined flood plain boundary.

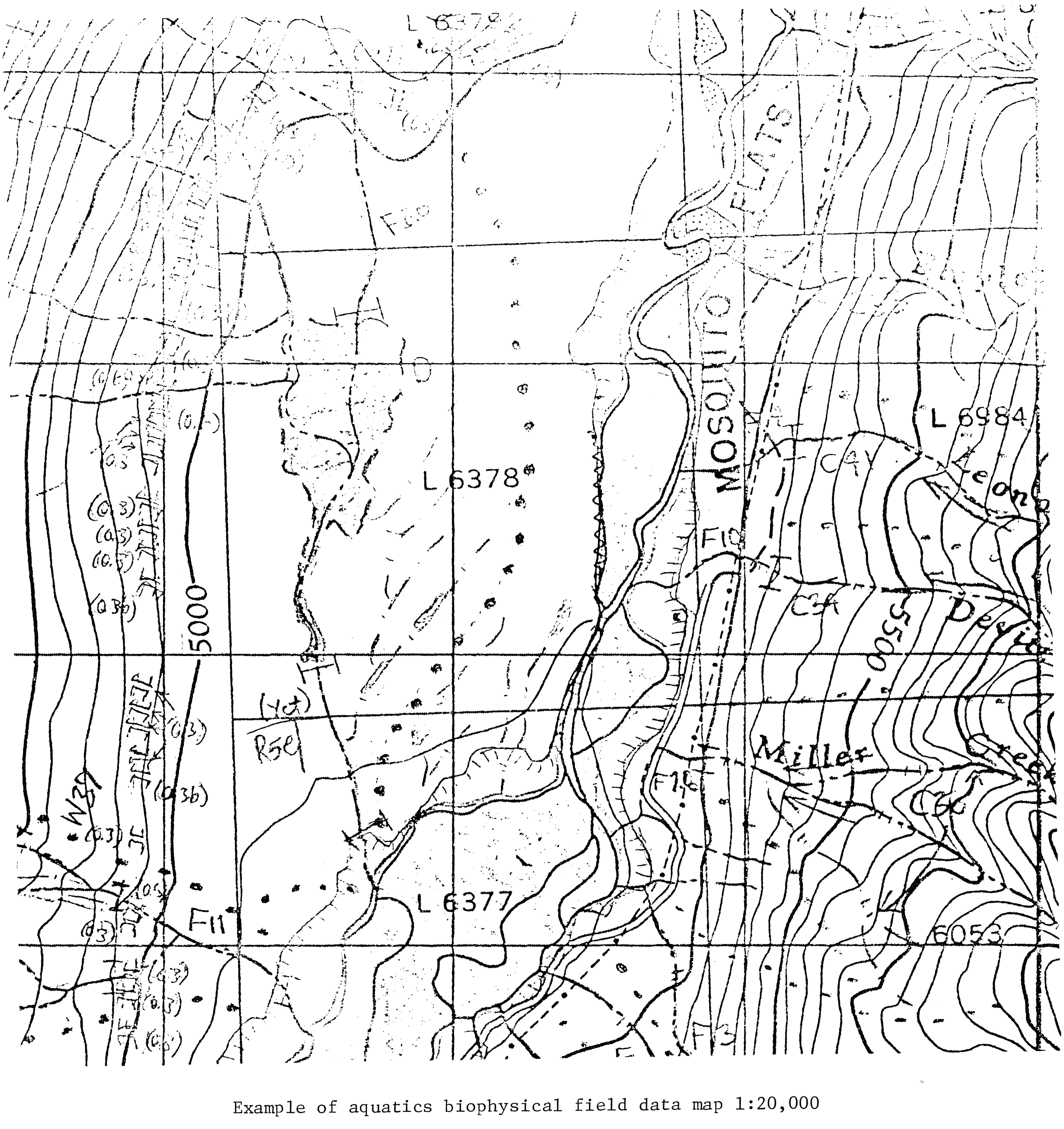
Active channel area 1952 - present.

Active channel (pre 1923 approx.).

Active channel (19th century).

Ephemeral channel.

Permanent flow channel.



Example of aquatics biophysical field data map 1:20,000

Lakes and Wetlands

1. LAKES

General: Fish Species (TDS)
Max. depth/Littoral area

i) Fish species: same as streams.
ii) TDS: total disssolved solids, if available
iii) Maximum depth: measured to nearest meter
iv) Littoral area: measurement or visual estimate of % of toal area <6m. When estimate is made, parenthesis will be used.

2. WETLANDS

A.D.: identifies a depressional channel cross section occupied by a permanent or seasonal wetland.

B. area (ha) - wetland area in hectares (omitted if not measured or estimated)

C. class -

m	marsh	s	swamp
b	bog	p	pond
f	fen		

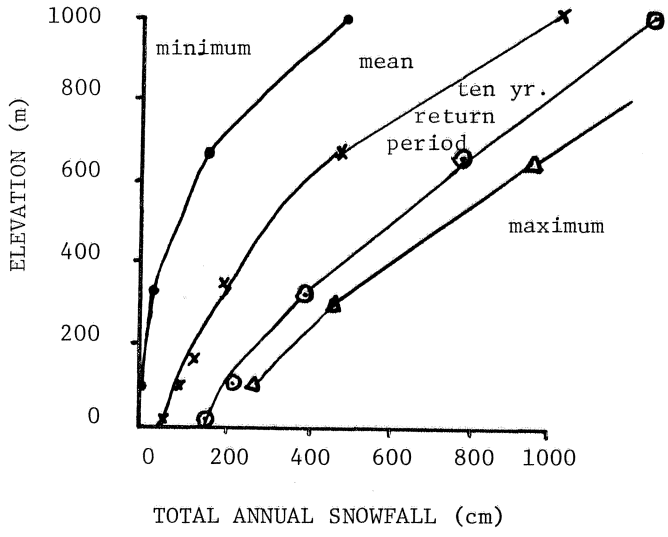
e.g. D30m - identifies a 30 hectare marsh.

SECTION 2

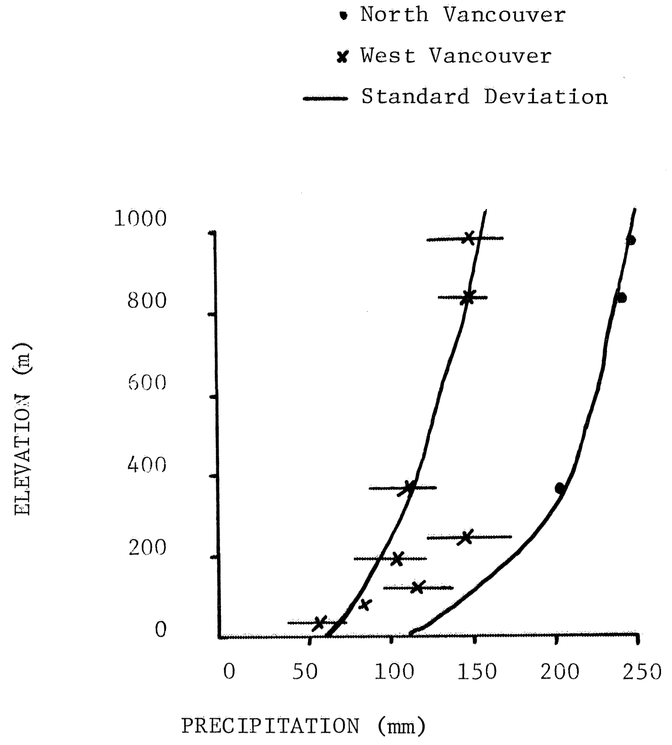
EXAMPLE OF CLIMATE DATA USED FOR TERRAIN SUITABILITY ANALYSIS (R. Bennett, 1976).

TOTAL ANNUAL SNOWFALL VS ELEVATION

Period of record 1954-74



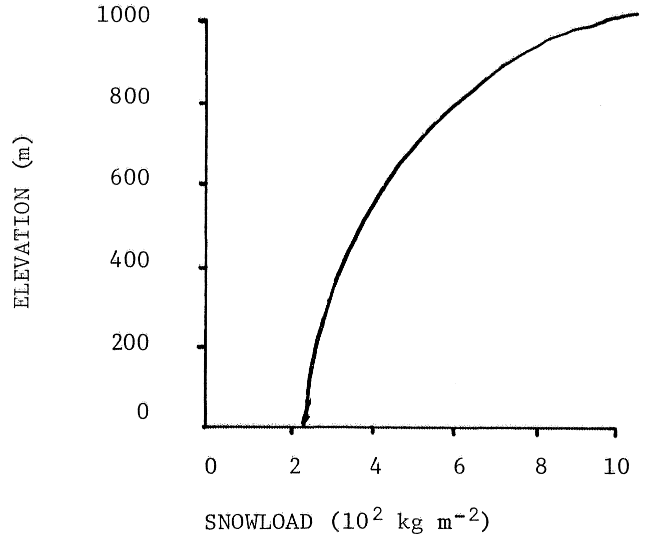
EXTREME ANNUAL 24 HOUR PRECIPITATION



GROUND SNOWLOAD VS. ELEVATION

Period of record 1945-74

SNOWLOAD - 30 year maximum snowdepth (specific gravity of 0.2) maximum 24 hour rainfall.



Error: Rain ±$0.2x10^2$ kg m^{-2}

Snow considering month end snow depth, actual maximum is estimated to be 8% higher than the month end maximum.

Map Symbol	Terrain Classification	Slope Percent	Rockiness Class	Stoniness Class	Coarse Fragments %		Hand Texture	Depth to impermeable Layer	Depth to Apparent Water Table	Soil Moisture Status			Flood Frequency	Sample Number	Area (Acres)	COMMENTS
					3" to 10"	>10"				Regime	Drainage Class	Perviousness Class				
(1)	$sF1-E	0	0	0	0	0	fine sandy loam	N.L.*	N.L.	Humid to Sub-humid	Imperfectly	Moderately	Rare to Occasional	SPMI	352	A pleasant, natural meadow. High water tables for some periods.
(2)	$gF^{G}t$	1	0	0	40	N5	loamy sand	N.L.	N.L.	Sub-humid	Well	Rapidly	None	SPM2	1595	Terrace provides good view of Murray River Valley. Terrace scarp has a slope of 70%
(3)	$\frac{rC}{Rs}$	45-55	3	4	10	40	loamy sand	0.6 to 1.0m	N.L.	Sub-humid (due to Seepage)	Well	Rapidly	None	SPM3	40	
(4)	$\frac{Cvb}{sFa}$	10-15	0	0	0	0	loamy sand	N.L.	N.L.		Well	Rapidly	None	SPN1	282	Landscape position offers good valley views.
(5)	c$F1	0-2	0	0	0	0	sandy loam over clay	N.L.	At or near surface	Aquic	Very poorly drained	$\frac{\text{Moderately}}{\text{Slowly}}$	Occasional	SPN2	103	
(6)	$\frac{s\$F^{A}1 -E// \bar{O}v}{\$sF1}$	0	0	0	0	0	sandy loam	N.L.	0 to 1.6m	Aquic	Poorly	Moderately	Common	SPN3	309	
(7)	$fgF^{A}1$	0-2	N/A	N/A	30	0	gravelly sand	N.L.	2-3m	Aquic	Moderately well	Moderately to rapidly	Frequent	SPN4	11	After deposition of gravels, the area is subject to floods which de-posit fines.

- TERRAIN ANALYSIS -

FIELD INFORMATION

Sample Number	pH $H_2O/CaCl_2$		Electrical Conductivity (mMho/cm)		Organic Matter (%)	Calcium Carbonate Equivalent %	Coarse Fragments 2mm to 3 in. %	Particular Size Distribution				Liquid Limit	Plastic Limit	Unified Class
	Surface Soil	Parent Material	Surface Soil	Parent Material				% Sand	% Silt	% Clay	Textural Class			
SPM1 (topsoil)	8.5/7.7	----	0.43	----	3.86	6.62	----	57.18	26.75	16.07	sandy loam	----	----	-----
SPM1 (topsoil)	----	8.4/7.7	---	0.40	---	6.54	0	13.66	64.26	22.08	silt loam	31.16	22.23	CL
SPM2 (topsoil)	5.6/4.7	----	0.44	----	1.52	---	----	57.96	29.57	12.47	sandy loam	----	----	-----
SPM2 (subsoil)	----	7.2/6.7	---	0.33	---	---	53.76	---	----	---	--	25.29	21.10	CL
SPM3	----	6.3/5.5	---	0.16	---	---	43.76	54.08	32.74	13.18	sandy loam	NP	NP	SM
SPN1		6.9/5.9		0.01	---	---	0.02	75.78	15.23	8.99	sandy loam	NP	NP	SM
SPN2 (topsoil)	8.1/7.4	----	0.62	---	4.86	2.84	---	---	----	---	--	--	--	--
SPN2	----	7.7/7.3	---	0.91	---	3.45	0	11.31	62.67	26.02	silt loam	40.83	31.10	CL
SPN3 (topsoil)	7.6/7.0	----	0.37	---	4.52	---	---	---	----	---	--	--	--	--
SPN3 (subsoil)	----	8.4/7.7	---	0.37	---	4.06	0	39.08	41.60	19.32	loam	NP	NP	ML or MH
SPN4 (topsoil)	8.1/7.6	----	0.43	---	4.52	13.39	---	---	----	---	--	--	--	--
SPN4 (subsoil)	----	8.1/7.7	---	0.87	---	12.98	68.17	61.33	27.41	11.26	sandy loam	NP	NP	GW - GM
SPN5	8.4/7.7	----	--- ---	0.17	---	14.00	57.83	70.23	18.94	10.83	sandy loam	NP	NP	SW
SPN6	----	6.2/5.2	---	0.17	---	---	64.84	35.32	33.83	30.85	clay loam	30.50	19.71	CL

- TERRAIN ANALYSIS -

LABORATORY INFORMATION

Map units and total area for units with high and moderate potential for designated use

Area in Acres

POTENTIAL USE INTERPRETATIONS								SOURCE INTERPRETATION	
Foundations for low buildings				Sanitary Landfill					
With Basements	Without Basements	Septic Tank Filters Field	Roads & Parking	Trench	Area	Sewage Lagoons	Playgrounds	Sand and Gravel	Topsoil
Moderate	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
2, 4, 9, 10, 12, 13, 15, 19, 24, 25, 28, 30	2, 4, 9, 10, 12, 13, 15, 19, 24, 25, 28, 30	2, 10, 12, 14, 18, 19, 24, 27, 28, 30, 31	1, 2, 4, 7, 9, 10, 11, 12, 13, 15, 17, 18, 19, 28, 30, 33	2, 4, 9, 10, 12, 13, 14, 18, 19, 24, 25, 27, 28, 30, 31	2, 4, 9, 10, 12, 13, 14, 15, 18, 19, 24, 25, 27, 28, 30, 31	9, 12, 25	1, 2, 4, 7, 9, 10, 11, 13, 15, 18, 19, 24, 27, 28, 30, 31	7, 13, 14, 27, 28, 30 31, 33	2, 18, 24 27
area	area	area	area	area	area	area	area	area	area
3027	3027	2596	3994	3521	3895	16	3886	1040	1891
high	**high**	**high**	**high**	**high**	**high**	**high**	**high**	**high**	**high**
14, 27, 31,	14, 27, 31	9	14, 24, 27				12, 14		
area	area	area	area	area	area	area	area	area	area
230	230	5	387	0	0	0	206	0	0

TERRAIN USABILITY INTERPRETATIONS
TERRAIN ANALYSIS

	POTENTIAL USE INTERPRETATIONS								SOURCE INTERPRETATION		POTENTIAL HAZARD	
	Foundations for low buildings				Sanitary Landfill							
Map Symbol	With Basements	Without Basements	Septic Tank Filters Field	Roads & Parking	Trench	Area	Sewage Lagoons	Playgrounds	Sand and Gravel	Topsoil	Surface Erosion Potential	Mass Movement Potential
1	$L^{4,2}_{9}$	$L^{2}_{4,8,9}$	$L^{2}_{4,1}$	$M_{4,2,9}$	$L^{1,2}_{3}$	$L^{2}_{4\;3\;1}$	$L^{2}_{1,17,3}$	$M_{4,1,2}$	L^{8}	$L^{20,19}_{2,4,8}$	L	L
2	M^{4}	M^{4}	M^{3}	M^{4}	M^{4}	M^{3}	L^{3}	M^{4}	L^{8}	$M^{17}_{18,19}$	L	L
3	$L^{5,7,10}_{6}$	$L^{5,7,10}_{6}$	$L^{5,7,10}_{6}$	$L^{5,7,10}_{6}$	$L^{5,7,10}$	L^{5}	$L^{5,6,10}$	$L^{6,5,10}$	L^{8}	$L^{5,6,10}$	$H^{5,10}$	$H^{5,10}$
4	M_{5}	M_{5}	$L^{3,4}_{5}$	M_{5}	M^{3}	M^{3}_{5}	$L^{3\;5}_{8}$	M^{5}	L^{8}	$L^{5,20}$	L	L
5	$L^{2,1,4}$	$L^{2,1,4}$	$L^{2,1,4}$	$L^{2,4}$	$L^{2,1,4}$	$L^{2,1,4}$	$L^{1,2}_{3}$	$L^{2,1,4}$	L^{8}	$L^{4,20,19}_{2}$	L	L
6	$L^{4,1,2}$	$L^{4,1,2}$	$L^{4,1,2}$	$L^{4,2,9}$	$L^{4,1,2}$	$L^{4,1,2}$	$L^{1,2}_{3}$	$L^{1,4,2}$	L^{8}	$L^{4,17,20}_{2,19}$	L	L
7	L^{2}_{4}	L^{2}_{4}	L^{2}	$M_{2\;9}$	$L^{2\;3}_{4}$	$L^{2\;3}$	L^{2}_{3}	M^{2}	M_{8}	$L^{20,19,17}_{2}$	L	L
8	n/a*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9	$M_{4\;9}$	M_{9}	H	M_{8}	$M_{4\;3\;8}$	M_{3}	M_{3}	M_{8}	L_{8}	$L^{20,17}_{19,8}$	L	L
10	M^{4}	M^{4}	M^{3}	H	M^{3}	M^{3}	L^{3}_{8}	M_{5}	L^{8}	$L^{20,17}$	L	L
11	$L^{1,2}$	$L^{1,2}$	$L^{1,2,3}$	M_{2}	$L^{1,2,3}$	$L^{1,2,3}$	$L^{1,2}_{8}$	$M^{1,2}$	L^{8}	$L^{20,17}_{1\;8}$	L	L
12	M_{9}	M_{9}	M^{3}	$M_{8\;9}$	M^{3}	M^{3}	M^{3}	H	L^{8}	$L^{20,17}_{8}$	L	L
13	M^{5}	M^{5}	$L^{3,5}$	M^{5}	$L^{3,5}_{4}$	$L^{3,5}$	$L^{3,5,8}$	M_{5}	M_{8}	$L^{5,20,17}$	M_{5}	M_{5}

WILDLIFE STUDIES IN URBAN AREAS

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ABSTRACT

Evidence exists to suggest that urban dwellers value natural areas in their community, but an education process for residents, developers and planners among others is clearly needed. A number of wildlife studies have been undertaken in cities but little application of the data has occurred.

RÉSUMÉ

De toute évidence, les citadins apprécient les sites naturels de leur milieu, mais l'éducation des résidents, des aménagistes et des planificateurs, entre autres, est sans contredit nécessaire. Un certain nombre d'études de la vie à l'état sauvage ont été entreprises dans les villes, mais leurs données n'ont trouvé que très peu d'applications.

INTRODUCTION

A few years ago, a discussion on wildlife studies in urban environments would have been considered a curious topic. But as everyone well realizes, urbanization is an assumed fact of life, whether or not it happens to fit our philosophical ideals.

Natural environments are frequently a victim of this process; but some urban dwellers, hopefully a substantial segment, possess a keen appreciation of these areas. This appreciation may be a product of urbanization itself through the realization that these environments can help to relieve the stress of urban living

There is evidence to suggest a growing awareness by urbanites of the need for natural environment within their community. Wyman (1975), in a study of residents in a Toronto suburban community adjacent to a natural ravine area, demonstrated the residents' appreciation, awareness and concern for the future of the natural area, both for passive recreational opportunities it provided and for the visual amenity that the site offered to the community. Few were aware of the wildlife that it contained.

McKeating (1975), in a series of public meetings with residents of the same community, noted strong support for the preservation of the ravine in its natural state. As far as they were concerned any proposal for 'development' had to be related to the long-term protection of the site. Concern was frequently expressed regarding the potential for deterioration of the ravine through overuse. A bias is recognized, however, in that the residents may not want their community amenity despoiled by 'outsiders'.

Data from the Tourism and Outdoor Recreation Planning Study (TORPS) demonstrate that a significant percentage of the population is interested in passive activities directly related to natural environments. Using southwestern Ontario as an example, the rate of participation for a large urban area is 18.6 days while in a large non-urban area, it is 12.9 days. These data are significant as they demonstrate the importance of wildlife and natural environments for recreation by urban man. Much of this recreation occurs within or close to urban centres. Within Metropolitan Toronto, the TORPS data illustrate some important evidence. This sample is based on 1,154 interviews with people who participated at least once in the twelve-month period prior to the interview (see Table 1).

From these data, one can observe the high rate of participation in nature-oriented activities within a municipal jurisdiction. While I am well aware of the facts and fallacies of statistical analyses, these studies do indicate a trend and justification for natural areas within urban settings.

In addition, the increased participation and interest by community groups working for the protection of natural environments and urban open space is indicative of increased concern. Examples include the public involvement for the planning of the Toronto central waterfront and attempts by naturalists and ratepayers to pro-

Table 1

Activities	% Participation	Mean Days of Participation	% Participation Home-based	% of Participation in Municipality
Organized Nature Appreciation	49	2.3	80	65
Personal Nature Appreciation	19	6.1	50	42

tect the remaining ravine systems within the city.

Although I am uncertain about how many people equate the loss of natural spaces with the loss of wildlife, the important need is for the protection of natural areas, whether the reasons are social, physical or biological. I believe that urban natural environments are important as a mental resource, providing as they do visual diversity or the opportunity for passive recreation. Perhaps more emphasis should be placed upon natural open space preservation and the roles that it serves rather than on wildlife with its negative connotations or apathetic disinterest that is shared by many. The spring song of a cardinal at 6 a.m. may be a little much for some to take.

With this interest in natural areas and wildlife, it is logical that a number of studies on urban wildlife have been undertaken. However, a paper on the application of wildlife studies to specific issues within the urban environment would be a short one. I know of few examples where a conscientious effort to undertake wildlife studies and to apply the results to a development proposal has been undertaken.

This does not suggest that studies are lacking in urban areas, for there is a large collection of data. Information is not provided in terms that planners, developers, municipal bureaucrats or politicians can accept or understand. Granted, an apathetic if not hostile response can still result, but biologists must be missionaries, not monks, and be prepared to act upon their own intuitive judgement and experience in making their views known.

The advantage of protecting natural environments in urban communities is being recognized by some developers. While not minimizing their efforts to maintain a resemblance of naturalness in their developments, Meadowvale in Mississauga being a good example, they do utilize the natural environment as an opportune marketing tool.

An advertisement in Toronto Calendar magazine speaks eloquently about the benefits of living in Aspen; "to watch the seasons change", "to find peace and quiet in a noisy world" and "a forest of tall trees". It is made to represent the 'good life', an attractive woman hanging demurely upon the arm of a handsome man. Natural settings do have a 'sensual' attraction for they can satisfy many of our senses.

Marketing or not, the approach demonstrates the existence of a practical opportunity to work with land development companies in the protection or provision of wildlife habitat. At the same time, biological knowledge can be utilized to minimize the attraction of species which are normally perceived by the public as undesirable.

A dialogue with developers is clearly required if we are to maximize the opportunity to protect habitat within their developments. A question that must be asked is whether or not biologists are interested in participating in this less glamorous but at least equally important component of wildlife management.

Studies should be undertaken that would attempt to justify in economic terms the advantages of natural environments in urban developments.

WILDLIFE STUDIES IN URBAN AREAS

Geis (1974), over an extended period commencing in 1966, studied the effects of urbanization on bird populations on the 5,400 ha site of the new city of Columbia, Maryland. This development had a wide variety of housing types and it was possible for him to study bird populations before and during the development.

During the first phase, he focussed attention on the impact of urbanization, utilizing the standard survey technique which involves the recording of birds seen or heard during a set time interval at regularly spaced stops. It is confined to the breeding period. Although satisfactory for recording marked population changes, it did not correlate specific habitat conditions with bird populations. To overcome this, transects were established that were divided into 100 yard (91.44 m) long segments. The birds seen or heard within 50 yards (46 m) of the centre were recorded. Thus, an index of bird use was obtained on a linear basis of 100 yard by 100 yard (91.44 m x 91.44 m) blocks or about 2 acres (0.8 ha). Each block was covered on foot in precisely 4 minutes. Following this method, he surveyed the entire City of Columbia.

Some of the results were certainly predictable. Typical farmland species and woodland edge species dramatically declined owing to the shrinking habitat and perhaps increased domestic cat predation. Other populations increased or remained unchanged. Cardinals, house wrens, mockingbirds, chipping and song sparrows increased, no doubt due to the increased planting of shrubs suitable for these species. Geis deals in detail with his results; refer to his paper for further details.

One important observation is that starlings and house sparrows were virtually absent prior to development but were the most common birds after development. The most important factor for this was the style and quality of construction. Widely louvred airvents, unboxed eaves, or otherwise shoddy construction provided excellent nest sites for these birds. An example from Metropolitan Toronto is York University. Some of the buildings were designed in such a way that offered a series of ledges, a situation ideal for pigeons. Pigeons being cliff-dwellers in the 'Old World', York University became the most expensive pigeon coop in the world. These design problems can be avoided if the wildlife information we now possess becomes a component of the design process. At least nuisance values can be minimized, and to some extent, hazards to songbirds.

Erskine (1975) surveyed winter birds of urban residential areas following standard instructions for winter bird population studies. Six complete surveys were made of each of ten study plots. All bird observations were mapped to minimize duplication. The study areas were all in the Regional Municipality of Ottawa-Carleton and varied from open fields to downtown Ottawa and residential areas of varying age. The survey plots were 40-111 ha.

Results indicated that the number of introduced species, (i.e. starling, house sparrow and rock dove), increased in relation to building density. Rock doves, a cliff-dwelling species, appeared unwilling to perch on buildings less than six m in height. High tree density appeared to cancel out starlings and house sparrows which prefer open areas for foraging. To summarize, his results showed that the most favoured areas for native birds were also the most pleasant for humans - areas which have natural vegetation. Surely planners and developers can learn from such basic work.

Thomas and DeGraff (1976) have summarized a wealth of literature regarding wildlife habitats in urban environments. This need not be examined here, but their paper is a good, concise introduction to the topic. An extensive bibliography is included.

The planning that has been undertaken for the Toronto central waterfront is a good example of a project that has given consideration to a wide array of environmental factors. Information has been gathered from a variety of sources and the active participation of interested members of the public was sought. Separate reports were published for vegetation, wildlife, air quality, water, noise, climate and physical geography. This base information was then synthesized to produce planning guidelines based on environmental suitability. Hopefully, existing suitable wildlife habitat will be protected from any proposed development.

In a separate but closely related proposal, Dorney (1973) undertook wildlife studies for the consultants planning the Aquatic Park on the site of the Leslie Street spit. This landfill area has become a superb area for birds. Although the current proposal calls for a wildlife sanctuary at the end of the spit, some important areas are slated for intensive recreation development. Much will be lost if this occurs.

At the University of Toronto, studies have been undertaken in urban wildlife, through the Faculties of Zoology and Forestry. The most intensive is that undertaken by Jean Pierre Savard under the supervision of Dr. Bruce Falls. In this study, emphasis is on *urban* environments rather than natural areas in urban situations. About 30 study plots were extensively sampled with data from about 6 plots being carefully interpreted. Although the data analysis has not been completed, the study compared different methodologies in population census techniques used to determine the nature of urban bird communities, and what habitat features such as building structures and vegetative physiognomy affect populations. Several species have been selected for thorough study on the factors influencing nest site selection.

Other studies include waterfowl surveys and a study of the population dynamics and social behaviour of squirrels in Mt. Pleasant cemetery.

The presence of 'desirable' species can be enhanced by allowing for their habitat requirements and level of tolerance of human disturbance. Nasmith (1975) in a study of a Toronto ravine measured the changes in breeding densities of certain species against the impact of human activity. He found that some species were more tolerant than others. McKeating and Creighton (1974), Dorney, and others have outlined suggestions that homeowners could undertake to attract wildlife to their backyards thereby expanding available habitat.

Other studies exist; Dagg and Campbell, Gill & Bonnett, Craig in St. Catharines, Webber in Vancouver among others. Conclusions can be drawn from the foregoing.

1. Style, design, quality of construction and spacing can minimize the attraction of species normally perceived as nuisance. Adequate design can also reduce hazards to birds.

2. Appropriate landscaping of public areas, institutional lands or private backyards can provide habitat for wildlife. Alternative management should be explored to avoid the sterility of institutional property.

3. Retention of natural environments within urban areas provides wildlife habitat but other amenity values should be better emphasized.

4. Urban development can minimize its impact on the natural environment. More pleasant surroundings for humans would result and woulld at the same time provide wildlife habitat if a broader approach was taken.

Citizen groups have become constructively involved with the identification of natural environments that should be protected. Two groups will serve as examples: The Toronto Field Naturalists' Club and the Calgary Field Naturalists' Society. Unlike many groups, these organizations have attempted to systematically evaluate natural areas; they have conducted biological surveys, have published their findings and have attempted to translate their results into action to obtain protection for important natural areas.

The Toronto group, for example, prepared a questionnaire as a guide for the use of its members in the evaluation of areas; they have shared their expertise and techniques with local community groups and have provided substantial input into the official plan exercise for the Metropolitan Toronto area. Their questionnaire is outlined in a paper by Cranmer-Byng(1975). The studies have been printed in a series of inexpensive publications. Proposals regarding the Official Plan are contained in *Toronto the Green* (Toronto Field Naturalists' Club, 1976). Most importantly, their information has been forwarded to a variety of decision makers.

The group in Calgary has been similarly active. Their actions in conjunction with other concerned groups have resulted in the establishment of natural area parks within the city. In addition, their publication, *Calgary's Natural Areas (1976)*, is a good example of what citizen organizations can accomplish. Spalding (1975) has reviewed similar activities in other Alberta cities.

In my view, there is little doubt that the 'alleged' amateur can play an effective role in the protection of natural areas within urban complexes.

This is especially true in providing input for official plans. Local residents usually know their area best. Their knowledge when combined with ecologically sound planning processes can result in official plans having at least some resemblance of sympathy toward natural environments. The Regional Municipalities of Waterloo and Hamilton-Wentworth are examples. Municipalities under the Planning Act do not have the mandate to protect natural areas even if they were sympathetic to the objective. As most habitat is lost at the municipal level, major efforts should be exerted to obtain amendments in this legislation.

While not exactly a wildlife study, an example of government action was the symposium sponsored by the University of Guelph, the Ontario Ministry of Natural Resources and others, on the topic, Wildlife in Urban Canada. The purpose of the symposium was to bring together people from across Canada to discuss the broad problem of people and wildlife living together, its benefits and costs and to make recommendations for the solution of problems. The resulting recommendations can do much to enhance wildlife values in urban settings if translated to planners, decisions makers and others who have direct impact upon the land base in terms that they can understand and appreciate.

I have forwarded the proceedings to the Urban Development Institute, Ontario Association of Architects, Metro Planning Department and others. Little dialogue has occurred thus far.

It is difficult to achieve protection of natural environments solely on altruistic grounds. One must be able to demonstrate the social and economic benefits to a community and to illustrate the environmental impact that may occur should they be destroyed. We should emphasize more the functionary role played by natural environments and their resultant benefits to the human population. These functions require no elaboration here.

To achieve the protection of natural processes will require new dimensions in thought by the public and by decision makers. The innovative planning that will be required will necessitate adjustment of existing priorities and traditions by planners, geographers, biologists and others in a multi-discipline approach to problem solving. Planning for urban wildlife habitat must also include man as a biological component of that habitat.

This brings us to a key question. How many people really care about wildlife in cities? Is it really important or are those of us concerned about wildlife in urban areas merely talking to ourselves and the dedicated few?

A fundamental need is to be able to identify the perceptions and attitudes or urban people toward nature in their communities. If we are to 'manage' wildlife in urban centres, we must be able to answer the question--managing for whom and for what?

A number of benefits are apparent to those of us who appreciate nature, but it is a reflection of individual attitudes and priorities and not of urban man in general.

Until we are able to better quantify these needs, we will continue to have a difficult time in the protection of natural habitats in municipal jurisdictions.

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USE OF ECOLOGICAL (BIOPHYSICAL) INFORMATION

UTILISATION DES CONNAISSANCES ÉCOLOGIQUES (BIOPHYSIQUES)

THE USE OF BIOPHYSICAL INFORMATION — B.C. LAND COMMISSION OVERVIEW

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INTRODUCTION

The B.C. Land Commission's prime target, the long-term preservation of agricultural land, has evolved basically as a planning function that takes us in many directions all at once. As we often find ourselves in the center of politically sensitive issues, the Commission might be described as being on the 'firing line' with regards to biophysical information. This information is the basis of our agricultural zoning and the basis of our everyday decisions regarding applications under the Land Commission Act and changes to the Agricultural Land Reserve. In this paper, I will attempt to give some idea of our experiences related to the use of biophysical information.

Information related to the natural characteristics of the land and its climate is unquestionably critical as far as consistency in Commission decision-making is concerned. At the same time, we have a very small staff of our own and there is rarely any time to collect new information. We therefore rely fairly heavily upon provincial and federal agencies involved in natural resources or lands management, and we have to try to use the information they provide in whatever form and scale it is available at the present time.

USE OF BIOPHYSICAL INFORMATION IN ESTABLISHING THE AGRICULTURAL LAND RESERVES

In April 1973, the Land Commission Act was passed through the B.C. legislative assembly, and the subsequently appointed Land Commission was asked to proceed with agricultural zoning for the province. The long-term intent in establishing Agricultural Land Reserves was to establish a zone based upon biophysical parameters rather than the variables of market and other socioeconomic considerations. The first problem, therefore, was to decide upon a technical base for such zoning that would weather all storms, politically and otherwise, and be as fair as possible to everyone. We turned to the CLI agricultural capability interpretations that had been derived for the most part from basic soils and climate data.

The choice of the CLI information of course was pragmatically motivated, in that it was the only uniform province-wide classification of the land resource available at the time - a very necessary requirement in order to fairly and equitably apply a province-wide zone. Without this basic biophysical inventory, the scheme of agricultural zoning would have been very difficult if not impossible to implement.

Under the Land Commission Act, the regional level of government was required to submit an Agricultural Land Reserve plan to the Commission for consideration. To aid the Regional Districts and to provide a guideline, B.C. Department of Agriculture prepared "suggested" Agricultural Land Reserve Maps for each district, which identified those lands having the soil/climate combination to support agriculture and not already urbanized or irreversably alienated in some manner. These maps were essentially a generalized second stage interpretation of the CLI agricultural capability data.

While basing the agricultural zoning upon the land's inherent characteristics was the only sensible route to go - given the long-term intention of the legislation - the route was not without its problems. Because we were dealing with a zoning concept, the end product of which would be administered and utilized by existing public agencies, problems quickly arose related to the administrative need for legally definable boundaries and the technical data of course being based upon the natural characteristics of the land. First, therefore, all natural boundaries had to be converted to essential straight line legal boundaries for Land Registry identification purposes, etc. This was a long, tough, frustrating job and a not altogether successful one. The whole problem of natural versus legal boundaries is one that I feel prospective users of biophysical information as well as those who are collecting such information should be made more aware of. By having to define agricultural areas by straight lines, we are forced to generalize still further biophysical data that, for the purposes we were attempting to use it, were already being pushed to the limit. Partly because of this, the credibility of the Agricultural Land Reserves has sometimes been brought into question, especially by non-technical people who may be looking at one or two properties and noting that the agricultural portions seem to bear little resemblance to the actual Agricultural Land Reserve boundary.

The second main problem we encountered, and of course are still grappling with, is the scale of mapping. This was especially a problem in the metropolitan area, along the urban fringe, where the fragmentation of parcels was already quite advanced. Capability data were available to us at a scale of 1:50,000 and yet, in the drawing of the Agricultural Land Reserve line and in considering applications under the Land Commission Act, we must attempt to apply information mapped at this scale to lots of 2, 5 and 10 acres. Anyone in the business of collecting and interpreting biophysical data certainly appreciates the fallacy of such an exercise. On an aside comment, I find that there are advantages and disadvantages to being aware of the weakness of technical data and being in a decision-making position as well. At times, getting across the problems related to scale, natural boundaries, limitations of the classification system, or whatever, is difficult when dealing with local government politicians or occasionally even my fellow Commissioners.

Despite such problems, however, Agricultural Land Reserves were finally established throughout the province. The Reserves are a unique kind of zone. Being based upon the biophysical or ecological attributes of the land, they are regarded as relatively permanent, not subject to rezoning to a 'higher' use - or as I might better describe it, a lower and worse use if out of agriculture - as in standard zoning bylaws.

USE OF BIOPHYSICAL INFORMATION IN MANAGEMENT OF THE AGRICULTURAL LAND RESERVES

Much of our time and efforts on a day-to-day basis are devoted to processing applications under the Land Commission Act. Appeal provisions fall into two basic catagories: applications for exclusion from the Agricultural Land Reserve and applications to subdivide or carry out some non-agricultural activity within the Agricultural Land Reserve. During consideration of these applications, detailed on-site information is often required. While our small staff handles a limited amount of this work, we also have arrangements with Soils and Property Management branches of the B.C. Department of Agriculture to conduct on-site inspections on our behalf.

We are also continuously refining the agricultural reserve line, especially in areas where the scale of the original biophysical information was inadequate for zoning purposes. The first step to this, what we call *fine tuning* process, is the refinement of the biophysical data base through field work; adjustment to the Agricultural Land Reserve follows if and when necessary.

Our efforts to minimize the impact upon the Agricultural Land Reserve of non-agricultural uses (transmission lines, highways and pipelines, etc.) require variable amounts of biophysical information. In one instance, soil stability may be the concern; in another, it may be a matter of identifying natural landscape breaks so as to encourage the service facility along the route of least impact upon present agricultural operations.

As time permits, the Commission also becomes involved in special projects, often in cooperation with municipalities or Regional Districts. Such projects usually relate to directing growth away from agricultural lands through planning, while creating and encouraging a positive environment for agriculture within the Agricultural Land Reserve. A wide range of biophysical data may be utilized in such projects, from bedrock information, detailed soils information and climate data to parcel size analysis, urban suitability studies, wildlife habitat requirements, recreation capability, and visual impact and landscape sensitivity analysis.

Where do we get this information? As well as leaning heavily on the original CLI data, we request that various government agencies provide us with the best biophysical background information that they have available. These agencies include: the B.C. Environment and Land Use Committee Secretariat; Provincial Ministries of Agriculture, Forestry, Housing & Municipal Affairs, Economic Development, and Environment (which includes Water Resources and Lands Services); Federal agencies such as the Lands Directorate and the Fisheries and Marine Service; and local government planning staffs.

All this information is critical, and I doubt that we could have carried out the Agricultural Land Reserve zoning without the CLI information and related biophysical base. However, biophysical information, no matter how good, will not make decisions for us. Decision makers can very easily fall into the trap of regarding biophysical data as gospel; when mistakes emerge and errors are made, they then lose confidence in the information altogether. We must remember that any land classification system is incomplete and inadequate if used beyond the limited purposes for which it was established.

At the same time, we must recognize that there are still great gaps in our information base. As more information is gathered, we face the additional problem of coordinating it with existing information. If we expect decision makers to utilize all these data we are so busily collecting, we must strive to present to them an integrated package, otherwise the decisions will suffer.

In this way, also, there is more likelihood that biophysical information will come to be used not only as a basis for initial planning decisions but also for management and follow-up program.

It appears to me that many people feel that users are generally unable to understand the technical information that is made available to them. I strongly feel that social norms change, and with time the public becomes aware of the existence of this information and learns how to use it. In fact, if this process is not happening, I feel we really *are* in trouble. If we are to be successful in selling the concept that land use decisions must be based upon biophysical parameters, this base information must eventually be able to work its way through the political system. If biophysical information is not understandable to the politicians and other non-technical persons in its present form, then it is our job to change it into a form that is palatable and credible enough for the politician to accept and defend.

THE NATURAL-ENVIRONMENT COMPONENT IN ONTARIO'S MUNICIPAL PLANS

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INTRODUCTION

Heightened environmental concern, a phenomenon of the Sixties and Seventies, reflects a growing awareness that environmental deterioration is not just a product of large-scale projects in remote areas such as James Bay or the MacKenzie Valley. Nor is it attributable only to massive application or misapplication of technology, such as the widespread use of DDT or the testing of nuclear weapons. Environments are equally degraded by numerous, incremental and seemingly minor changes which accompany land use and 'development', in turn generated by urban industrialization, concentrated population growth and a high-consumption lifestyle. Some observers see urbanization as the *main* source of current environmental problems:

> ...*urbanization, with its concomitant maze of decisions affecting the use, development, maintenance and redevelopment of land, is perhaps the most important determinant of environmental quality, particularly the quality of the urban environment where the vast majority of our citizens live* (Kaiser *et al.*, 1974, p. 31).

The same study, for the United States but applicable in its conclusions to Ontario, goes on to say (p. 32):

> *Most of these decisions are made at the local level... the effective participation of local urban government is crucial but its role is weak, underutilized and poorly understood. Without both a concern for and a capacity to incorporate environmental goals at the local and regional levels within states, a major portion of public policy and its influence on urban decisions will be void of purposeful, systematic and explicit concern for environmental quality.*

Interest and concern are one thing; however, action and results can be quite another. That is one reason why, in fall 1975, the Ontario Planning Act Review Committee commissioned a study (one of several) to examine the natural-environment component in Official Plans.[1] The study, which Audrey Armour and I conducted over the next nine months[2], was to formulate an alternate concept of planning and municipal management capable of greater sensitivity to environmental considerations, and suggest practical improvements. The focus was deliberately narrowed to the natural environment (a parallel study was to be done of social considerations) and to municipal government (although we extended it to provincial-municipal relationships). Our work included: a survey of 133 of Ontario's 362 Official Plans (a considerably higher proportion were for urban municipalities so that we were able to examine the Plans that apply to most of the population and the urbanizing part of Ontario); a questionnaire survey of municipal planning directors (29% of the 69 responded) and the chief planners or resource managers of Conservation Authorities which play a key role in planning and development of natural environments in southern Ontario (26% responded), followed up by a one-day workshop attended by 50 of these planners; perusal of provincial Ministries' review procedures for Official Plans; a look at provincial and regional planning and policy frameworks which affect local planning; a limited survey of the attitudes of mayors toward the natural environment; and an examination of relevant documentation from and experience of other jurisdictions in Canada and the United States (see Lang and Armour, 1976).

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[1] These are legally adopted guides to the municipality's physical development, under the Planning Act; also called, in other provinces, Municipal Development Plans, Community Plans, etc.

[2] An 86-page summary of our study, *Municipal Planning and the Natural Environment*, is expected to be published in summer 1977 (Ontario Government Bookstore, 880 Bay St., Toronto $1.20) along with the Planning Act Review Committee's "Green Paper". The summary may be consulted for extensive backup statistics, direct quotations from planners and plans, and other supporting evidence.

KEY FINDINGS OF THE STUDY

1. *Official Plans are weak in their treatment of natural environment concerns.* Our survey revealed seven environmental concerns at the municipal level, listed below in the order of frequency in which they appeared in the Plans surveyed:

1. Safeguarding residents and property from environmental hazards such as flooding, soils unstable for foundation purposes, etc. (found in 48% of the sample).

2. Minimizing pollution of land, water and air (in 46% of the sample).

3. Protecting and promoting the aesthetic qualities of the municipality (in 43% of the sample).

4. Managing water resources to protect and conserve municipal water supplies and maintain water quantity and quality (in 20% of the sample).

5. Protecting unique (to the area) and/or irreplaceable natural resources such as wildlife and special tree stands (in 19% of the sample).

6. Protecting agricultural land as a natural resource (in 11% of the sample).

7. Conserving resources such as timber and minerals for purposes of economic production (in 5% of the sample).

'Natural environment', to most municipalities, means three things: natural hazards, especially flooding; pollution; and aesthetics. Goal statements in Plans reflect this narrow set of concerns, leaving out altogether issues such as energy use and conservation and giving only passing attention to the preservation of agricultural land. Official Plans often fail to relate these ends to feasible means by which they may be achieved. Plans rely heavily on land use control but environmentally oriented land use categories tend to be left implicit (which, in cases of conflict with other objectives, means environmental considerations are likely to be traded off); also, the range of environmental land use categories is quite limited (the old standbys of open space and hazard lands prevail; environmentally sensitive areas appear only infrequently). Moreover, Plans give little attention to the specific effects of permitted uses on the natural environment (few require environmental analysis, for example) and only marginally address the inherent conflicts between natural environment and economic/assessment motivated development; rather than providing guidelines for the unavoidable resolution of these conflicts, Plans tend to ignore them or wish away conflict in general statements of planning goals.

Municipalities pass much of the environmental buck to Conservation Authorities whose mandate is limited with respect to the natural environment. Their focus too is narrow (e.g. strong emphasis on flood protection), whether by choice or by necessity (budget constraints), and their operation raises questions of accountability and public involvement. Conservation Authorities can be expected to continue to play a valuable role in the protection and enhancement of the natural environment, but the main impetus for improvement must come from the municipal and provincial governments.

2. *Emerging plans of the regional municipalities do not fit the foregoing pattern.* They display a considerably higher level of environmental concern, innovation in environmental analysis, and policy formulation related to means. In short, they show considerable promise. But, because none of the Plans has yet been adopted officially, it remains to be seen whether their environmental provisions will survive the tests of political feasibility and the provincial review process, and how effective the resulting plans will be in protecting environmental resources.

3. *Municipal planners demonstrate environmental concerns considerably stronger than and different from those found in Official Plans.* Whereas Plans take a narrow view of natural environment, planners appear to recognize a wider range of concerns - water resource management, protection of natural environment features and economic resources, and promotion of air quality - that differ from the environmental priorities indicated by Official Plans. Obviously, Plans lag rather than lead. The environmental movement peaked six years ago, time enough for plans to catch up; yet even the more recent, post-Earth-Day Plans rarely exhibit more concern than their earlier counterparts.

4. *Planners cite a number of roadblocks to more environmentally oriented municipal planning.* Heading the list are: inadequate municipal powers to acquire and protect environmentally sensitive areas; conflicts and lack of cooperation among jurisdictions; failure of the Province to provide the necessary provincial-regional planning frameworks; provincial insensitivity to local solutions to environmental problems; and the usual shortages of time, staff, data and money. Not often mentioned but nonetheless prominent in the list of barriers to environmental planning is the primitive state of the art; the level of knowledge and the available methods for such planning, especially those relating planning and ecology, are weak and un-

certain. Little research is being done to correct this deficiency.

5. *The problems go deeper than this, however, to the nature of the planning process itself (both municipal and provincial-regional).* Pro-development and urban biases lead to natural environment (and countryside generally) being viewed as 'unused', 'vacant', 'raw' land and a reservoir for development[3]. The planning process, therefore, tends to filter out environmental concerns. And, input-oriented, it tends to rely strongly on the Plan for criteria to judge the validity of development proposals. Given inevitable shortcomings in the inputs (data, perceived goals/problems), and in planners' analytic and predictive capabilities especially where complex environmental systems enter the planning agenda, this reliance on the Plan is both unrealistic and hazardous (see Lang, 1976). Needed instead is an approach that looks for the best possible environmental inputs but *also* subjects the outputs of planning (plans themselves, policies, programs, projects) to environmental evaluation before commitment to action. Such evaluation would consider both the objectives of the Plan and the reality of the current community condition. To bring about such an environmental planning approach would require a three-part innovation at the municipal level.

6. *The first improvement would be in the environmental content of Official Plans.* It would remove some of the roadblocks cited earlier and, in particular, create new opportunities for the identification, acquisition, control and management of environmentally sensitive areas.

7. *Environmental assessment offers a means by which to introduce the second element, pre-action evaluation, to the municipal planning process.* Imminent proclamation of the Environmental Assessment Act offers the opportunity[4]. Six years of American experience with environmental assessment have demonstrated that it has considerable potential as a means of forcing environmental considerations into a higher profile in public and private decision-making processes, and of minimizing short and longer term adverse environmental effects of public and private actions[5]. Environmental assessment, as well, has shown itself to be feasible administratively at all government levels.

Environmental assessment and municipal planning in Ontario, however, appear to be heading in divergent directions. Competition often appears to overshadow cooperation among the relevant provincial Ministries. And the apparently parallel processes of review and approval for municipal planning and environmental assessment (as proposed)[6] could result in unacceptable delays and costs and, ultimately, damage to the credibility of both processes.

It is essential that municipal planning and environmental assessment be made complementary and mutually reinforcing, and that eventually they be integrated into a single component of municipal management. Both would benefit thereby. Environmental assessment would bring to planning a necessary means for adding the evaluative component it lacks, specifically for assessing the environmental effects of proposed

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[3] Kaiser, whose 1972 study covered 200 municipal planning agencies in the United States, concluded (Kaiser *et al.*, 1974, pp. 81 & 105): *Environmental planning, to local and metropolitan planning agencies, is interpreted as the integration of man-made and natural systems. This interpretation suggests an inclination towards searching for a balance among multiple objectives, only some of which are environmental, and a disinclination to give up the traditional bias toward urban values altogether.*

Local planners are saying that they are adding environmental factors and goals to the list of other factors in this land use planning program; but not establishing specific environmental planning approaches separate from their already established planning values and activities.

[4] Recently, parts of Ontario's Environmental Assessment Act were proclaimed, first, to create the Environmental Assessment Board, then to apply the Act to designated undertakings of designated provincial ministries and agencies. The Act, its regulations, and a newsletter, *EA Update*, are available from the Ministry of the Environment, Environmental Approvals Branch, 135 St. Clair Avenue West, Toronto M4V 1T5.

[5] Refer to the Council on Environmental Quality's report *Environmental Impact Statements: An Analysis of Six Years Experience by Seventy Federal Agencies*, March 1976, together with its Annual Reports (Council on Environmental Quality, 722 Jackson Place N.W., Washington DC 20006).

[6] A special provincial-municipal working group has devised draft regulations for applying the Environmental Assessment Act to designated municipal undertakings, probably in 1977 (the Act is then to be applied to designated private actions). Copies of the draft regulations are available from the Ministry of the Environment (footnote 4).

actions; it would also provide a vehicle for improving environmentally the various functional planning processes (transportation, sewer and water, recreation, housing, etc.) and for bringing these more effectively under central municipal control. On the other hand, long-range comprehensive planning would compensate for environmental assessment's short-range and project-by-project emphasis.

8. *The third element, needed to realize the full potential of environmental assessment in planning and to complement the use of more environmentally oriented plans, is an 'environmental audit'.* This would involve: the establishment of environmental data bases, probably at the regional municipality or county scale; the carrying out of post-action evaluations to determine actual effects of implemented plans, policies, programs, and projects, and to identify unforeseen and cumulative effects that warrant corrective action; regular monitoring of the changing environmental quality of the municipality, and changing perceptions of that quality, focusing on activities, environments, effects and affected groups of concern; and an annual state-of-the-environment report as a benchmark against which to measure change and as a means for public information and education.

9. *The three elements - environmentally oriented Official Plan, environmental evaluation and environmental audit - would form the basis for introducing a new process of municipal environmental management.* Such a process is essential, for the real concern is not so much with the quality of plans but rather with the quality of subsequent actions and their effects. And that is the business of municipal management of which planning is but one part.

The impact approach applicable to environmental issues has equal validity to other aspects of municipal management - e.g. impacts of proposed actions on municipal finance and municipal services, social impacts, energy impacts, and so on. Most of these fields are rapidly developing at the present time; models exist elsewhere for their application here[7].

10. *The Province holds the key to bringing about the environmental-management innovation.* However, there is a lot of improvement needed at the provincial end first. The Planning Act presently gives scant attention to environmental concerns. Nor are Ministry of Housing policies and review procedures with respect to municipal planning environmentally oriented; environmental matters are left to the Ministries of the Environment and Natural Resources, but they perform only an advisory role in municipal plan review. Official Plans are supposed to relate to provincial and regional planning strategies but these deal only superficially with the natural environment and provide no framework within which to conduct municipal environmental planning. Jurisdiction over environmental matters is fragmented and ambiguous. And finally, the Province lacks an explicit holistic identification of province-wide interests with respect to natural environment systems and trends in their quality and functioning, the dependence of people of this province on certain man/environment relationships for their well-being, and how they value the natural environment - all as background to determining how the provincial government and municipalities, each with defined jurisdictions, may effectively plan and manage their affairs with respect to environmental matters.

Coordinated provincial-municipal action is at the heart of effective environmental planning and management. The Province holds the key to such action, and the responsibility to initiate the needed improvements.

RECOMMENDATIONS OF THE STUDY

1. *Role of the Official Plan.* The Province should indicate clearly to municipalities that the role of the Official Plan is limited to guiding Council decisions with respect to (a) the spatial land-use aspects of the municipality's functions, and (b) the exercise of its control over physical development. Natural environment considerations should be explicitly contained in all Official Plans (Recommendation 2) as part of the larger social and environmental framework upon which such Plans are based; but achieving the desired level of environmental quality is a result of initiatives within the process of municipal management, including but not limited to Official Plans. An environmentally oriented approach to municipal management in Ontario would comprise: environmentally oriented Official Plans and functional plans utilizing environmental data bases; the designation of environmentally sensitive areas; the incorporation of environmental assessment to evaluate the effects of proposed actions before they are taken; new forms of development control; and an ongoing 'environmental audit' to improve each municipality's understanding of its existing environmental condition, to monitor environmental effects, and to maintain a watch over their cumulative consequences.

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[7] In particular refer to the work of the Urban Institute (2100 M Street N.W., Washington DC 20037) which recently published a series of five reports on environmental, social and fiscal impacts of physical urban development.

2. *Environmental Content of Official Plans.* The Planning Act should be amended to require, or the Minister should require by regulation, that all Official Plans *explicitly* give consideration to and include provisions related to the natural environment, including:

a. The municipality's definition of 'the natural environment'; a full description of the natural-environment systems and processes in the municipality and their relationships to those in adjoining municipalities; and an evaluation of the existing and projected condition of the natural environment with and without Plan proposals.

b. Explicit statements of policy concerning the conservation, preservation, use and enhancement of the natural environment with respect to those matters over which the municipality (i) has direct jurisdiction and control, (ii) shares control with other municipalities or with intermunicipal agencies such as Conservation Authorities, and (iii) actively suports, in fields of provincial or federal jurisdiction.

c. Environmental policies explicity related to feasible means available or proposed for achieving the Plan's stated environmental objectives.

d. Environmental Protection Areas identified along with the criteria for their identification; and an indication of how the municipality, using new legislation (see recommendation 4), intends to acquire the development rights affected, control the use of such Areas, and otherwise manage their environmental functioning.

3. *Environmental Data Bases.* The Province should encourage and support financially and technically the building-up of environmental data bases at the municipal level. Regional municipalities, Counties and Conservation Authorities are appropriate levels at which to create and administer environmental data bases. Data collected should be related directly to the functioning of natural-environment/human-activity systems in each 'region', and to the decision capability of municipal governments.

4. *Environmental Protection Areas.* Special legislation regarding Environmental Protection Areas, based on the four-part definition suggested in Section 3, should be drafted for consideration and comment by municipalities, provincial agencies, Conservation Authorities and interested groups and individuals. The legislation should include general criteria for identification of Environmental Protection Areas, the basis for their management (acquisition, protection and control, and ongoing functioning) and related powers and processes for use by municipalities with Official Plans. The legislation should also clarify existing jurisdiction and control between municipalities and Conservation Authorities with respect to floodplains; it should provide new municipal powers to prevent development in key Environmental Protection Areas such as those headwater and aquifer recharge zones of vital concern to the well-being of the people of the municipality; and it should allow municipalities to exercise interim controls to prevent destruction of environmental resources in areas intended for Environmental Protection Area designation.

5. *New Ways to Control Land Use and Human Activities.* The Ministry of Housing and the Ministry of the Environment should sponsor an investigation to identify feasible new methods of regulating land use and human activities in direct relation to the capacities of natural systems and processes to accommodate development; of particular promise is *impact zoning* (see Rahenkamp *et al.*, 1977). Ways should also be sought for municipalities with Official Plans to protect environmental resources (e.g. trees, natural habitat) on privately owned lands earmarked for urban development.

6. *Environmental Evaluation.* Environmental evaluation, based on an integration of environmental assessment into the processes of municipal planning and management, should be acknowledged as a vital component of the adaptation of those processes to natural-environment considerations. Environmental assessment and municipal planning must be made complementary and not allowed to become competitive. A specific study, which should be initiated by the Planning Act Review Committee, is urgently required to design and test guidelines and procedures, under a range of typical municipal circumstances, for coordinating environmental assessment, municipal planning and development control.

7. *Local Control of Environmental Assessment.* Regulations currently being prepared for application of the Environmental Assessment Act to municipalities should accept as a principle that the Province will minimize its intervention into municipal planning and management in this regard. Municipalities should be permitted flexibility in the manner of incorporating environmental assessment into their operations, in conformity with provincial guidelines and with the Minister of the Environment approving each municipality's general approach (see Armour, 1977). The Working Group preparing the regulations should give special attention to deriving methods for coordinating the hearing, appeal and approval processes under the Environmental Assessment

Act and the Planning Act.

8. *Environmental Assessment and Housing.* When the Environmental Assessment Act is proclaimed with respect to provincial undertakings, housing should not be exempt (see Brooks, 1976). Instead, attention should be given to overcoming the potential problem of additional delay in processing development applications. The Ministries of Housing and the Environment should give priority to assisting municipalities to establish processes and procedures that coordinate municipal development control and municipal environmental assessment as they relate to housing (Recommendation 6).

9. *Class Studies.* Current work being done by the Ministry of the Environment on class studies for environmental assessment purposes should be expanded to include classes of municipal activities affecting the natural environment and classes of environmentally sensitive areas.

10. *Environmental Assessment Information.* The Ministry of the Environment should establish a program to generate, disseminate and facilitate the sharing of information and knowledge with respect to environmental assessment at the municipal level in Ontario.

11. *Environmental Audit.* By amending either the Planning Act or the Municipal Act, the Province should require each municipality (or group of adjoining municipalities) to undertake, with provincial support, the preparation of an 'environmental audit' as a further essential element in the proposed environmentally oriented municipal planning and management process. An environmental audit would include a municipal environmental data base (Recommendation 3); post-action environmental evaluation; special-purpose evalutations concerning secondary and cumulative effects; and an annual state-of-the-environment report. Municipal environmental audits would be coordinated with similar audits carried out by the Province at the regional and provincial levels. Sweden has demonstrated the feasibility of such environmental monitoring at the national level (see Emmelin, 1977).

12. *Provincial-Municipal Relationships.* In its relationship to municipalities with respect to planning, the Province should reorient its approach, based on a clear identification of Province-wide interests concerning the natural environment. The Province should express these interests in its provincial-regional planning frameworks and policies, and require municipal conformance in the preparation of Official Plans. The Province should delegate to municipalities those functions of direct concern at the local level (e.g. subdivision control, zoning bylaw amendment), and it should redirect much of its effort toward monitoring of the results of municipal actions, with selective provincial intervention only when the Province's interests appear to be threatened.

13. *Review of Plans and Related Measures.* In the short run, the Ministry of the Environment, the Ministry of Natural Resources and the Ministry of Housing should prepare and publish a single set of environmental guidelines for the review of Official Plans, their amendment and related measures (including consents) under the Planning Act. Use of these guidelines should be adopted as a policy of the Ministry of Housing which carries primary responsibilities for such review and which would request the advice of the other two Ministries with regard to detailed interpretation of the application of the guidelines to specific cases. In addition, in relation to municipal actions affecting the natural environment, the Minister should make it mandatory for municipalities to consult Conservation Authorities, in the early stages of Official Plan preparation, plan amendment, the preparation of development control measures, and the administration of these measures including relevant consents and minor variances.

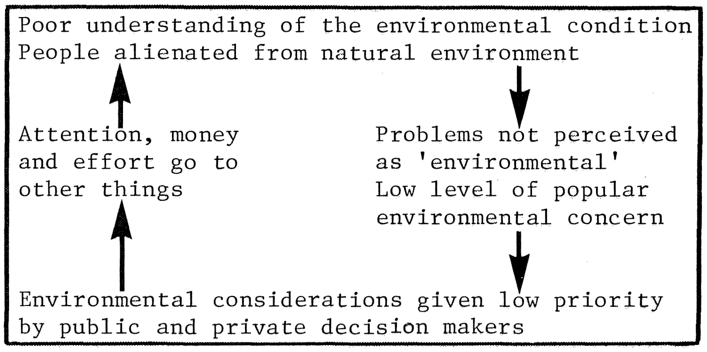
SUMMARY

We found municipal plans to be weak and narrow in their treatment of natural environment concerns, though emerging regional municipality plans may not follow this pattern. Municipal planners demonstrate environmental concerns considerably stronger than and somewhat different from those found in adopted municipal plans. This is due in part to a number of significant barriers to environmentally oriented municipal planning: inadequate local powers to acquire and protect environmentally sensitive areas; conflicts and lack of cooperation among jurisdictions; failure of the Province to provide the necessary provincial-regional policy frameworks for municipal planning; some provincial insensitivity to local solutions to environmental problems; and the usual shortages of time, staff, data and money. And, compounding all of these problems, the primitive state of the environmental planning art. The problems go deeper, however, to the nature of the planning process itself, both municipal and provincial. Pro-development biases lead to natural environment and countryside being seen mainly as unused, not-yet-urbanized, 'raw' land, a reservoir for urban development. Environmental concerns, undervalued, get filtered out and traded off. Considering the enormous environmental demands of our high-consumption lifestyle based on urban industrialization, these same environmental concerns ought to be front and centre on the public decision agenda. They are not, however.

It is tempting here to call for an environmental ethic. No doubt one is needed, but how is it to be achieved? Likely it will be a result of environmental living rather than as a prerequisite to it. I prefer a 'linked-incremental' strategy to reach the kind of lifestyle that is more environmentally sound (the Conserver Society, for example), an approach which ties together a wide range of specific, often marginal, improvements within a concept of urban environmental management, an approach that proceeds simultaneously to make necessary changes and to do the necessary educating, especially of those directly involved in making the key decisions. Environmental assessment has a role to play here, provided that it is carefully worked into the management process, not merely tacked onto its backside. Evaluation before-the-fact, however, has to be complemented by monitoring and evaluation after-the-fact, recognizing that we cannot evaluate everything just as we cannot foresee all environmental effects. Opening these evaluation processes to public participation, especially by those directly affected by the proposed actions, would help (and force) a better understanding of the consequences of individual and collective actions. And it would create public pressure on the responsible agencies to act accordingly.

The key to bringing off a more environmental form of municipal operation inevitably rests with the provincial government. The Province has to define legitimate provincial interests with respect to the natural environment, then concentrate on taking care of these adequately and staying out of what are legitimately local decisions except to monitor municipal actions and conditions in order that selective provincial intervention (justified by environmental needs rather than mere political expediency) may be made. Environmental issues will always be too pervasive to be neatly assigned to government levels, but that does not justify automatically assigning them to the 'higher' level. Rather, taking a page from ecosystems, it suggests a model of 'cooperative autonomy'.

The Province also needs to lead in the establishment of the data base that is essential to environmental planning and the management of environmental change. It is incredible that the people of Ontario (or any province or the nation for that matter) do not know for sure how much agricultural land there is left and how fast it is disappearing, whether we are mismanaging our forests to the extent that timber will soon be a non-renewable resource, what's really happening to the Great Lakes, what the quality of the air and water is in each municipality, and so on. Everyone by now knows that we depend on our environment for our well-being. And yet our knowledge of the state of that environment and how it is changing, and our knowledge of the nature of that dependency, is at an abysmal level. Small wonder municipal environmental planning leaves so much to be desired. It is simply part of a larger dilemma:



Poor understanding of the environmental condition
People alienated from natural environment

Attention, money
and effort go to
other things

Problems not perceived
as 'environmental'
Low level of popular
environmental concern

Environmental considerations given low priority
by public and private decision makers

A major overall review of a province's planning legislation offers a unique, once-in-25 years opportunity to break into, and out of, this kind of vicious circle. Let's hope that Ontario does not let this opportunity slide by. There may not be too many more of them left.

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RÉSUMÉ

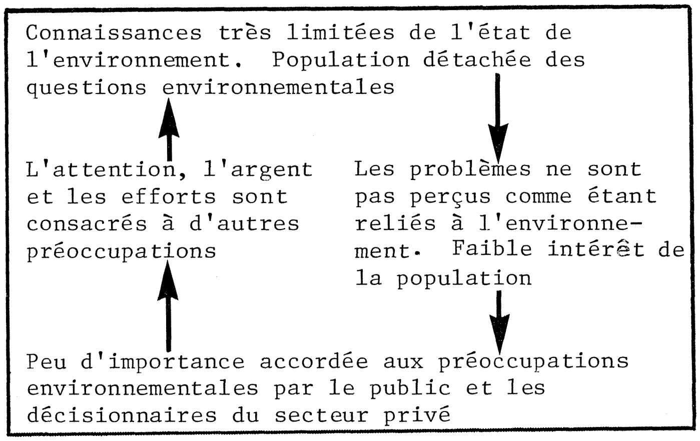
Nous estimons que les plans municipaux trahissent un manque de dynamisme et une certaine étroitesse d'esprit dans la façon de traiter les questions relatives à l'environnement naturel, bien que les plans municipaux régionaux nouvellement élaborés s'écartent peut-être de cette tendance. Les planificateurs municipaux se soucient des questions environnementales de façon beaucoup plus manquée et sensiblement différente de celle qui se dégage des plans municipaux qui ont été adoptés. Cela est dû en partie à la présence d'un nombre important de facteurs qui font obstacle à la planification munipipale en matière d'environnement: pouvoir local insuffisant pour faire l'acquisition et protéger les secteurs environnementaux menacés; conflits et manque de collaboration entre les diverses autorités; échec des provinces à offrir un ensemble de politiques provinciales et régionales indispensables à la planification municipale; certaine indifférence de la part des provinces à l'égard des solutions locales aux problèmes de l'environnement; et les difficultés habituelles qui résultent du manque de temps, de personnel, de données et de fonds. Et pour envenimer le problème, signalons le stade primitif où se situe encore l'art de la planification environnementale. Mais le problème est encore plus profond et remet en cause la nature même du processus de planification à l'échelle municipale et provinciale. Toutes les influences qui s'exercent en faveur de l'aménagement des terres amènent à ne plus considérer l'environnement naturel et la campagne autrement qu'en termes de terres inutilisées, non encore urbanisées, de terres "brutes", véritable réservoir propice à l'aménagement urbain. Les préoccupations environnementales, sous-estimées, sont mises de côté et éliminées en faveur d'autres préoccupations. Mais, compte tenu des fortes pressions exercées sur l'environnement en raison de notre haut niveau de vie basé sur l'industrialisation en milieu urbain, il faut envisager les inquiétudes que nous causent ces questions et les placer au centre des préoccupations soumises aux décisions du public, chose qui ne se fait cependant pas à l'heure actuelle.

Le présent document appelle l'élaboration d'un code d'éthique en matière d'environnement. Nul doute que cela s'impose, mais comment y arriver? On y parviendra probablement en adoptant un mode de vie adapté à l'environnement plutôt que par la création préalable d'un code d'éthique. Je préfère l'adoption d'une méthode où les facteurs seraient interdépendants pour atteindre le genre de vie le mieux adapté aux ressources environnementales disponibles (une sorte de société d'économie, par exemple), une méthode d'approche qui réunit une vaste gamme de projets d'amélioration particuliers, souvent marginaux, dans le cadre d'un concept de gestion environnementale des milieux urbains, une méthode qui veille à effectuer simultanément les changements qui s'imposent et à éduquer la population en conséquence, et plus particulièrement ceux qui participent directement à la prise des décisions clés. L'évaluation environnementale a un rôle à jouer en ce sens, à condition que cette activité soit parfaitement bien articulée au processus de gestion et qu'elle ne soit pas simplement à sa remorque. Il faudra cependant procéder à des évaluations avant la réalisation du projet par l'exercice d'un certain contrôle et à l'évaluation du projet une fois terminé, conscients du fait que nous ne pouvons tout évaluer, de la même façon qu'il est impossible de prévoir tous les effets environnementaux. Permettre au public de prendre part au processus d'évaluation, surtout ceux qui sont directement touchés par les mesures proposées, aiderait à mieux comprendre les répercussions possibles des mesures prises par les particuliers et les collectivités (et forcerait cette prise de conscience). Par ailleurs, cela permettrait au public d'exercer des pressions auprès des organismes responsables afin qu'ils prennent les mesures qui s'imposent.

Il incombe inévitablement aux gouvernements provinciaux de faire en sorte que les municipalités se soucient davantage des questions environnementales. La province doit définir ses intérêts légitimes à l'égard de l'environnement naturel, puis concentrer ses efforts à les protéger de façon appropriée sans se mêler des décisions qui reviennent de droit aux localités, sauf pour surveiller les mesures prises par ces dernières et leurs conditions d'application, de manière à pouvoir intervenir de façon sélective (dans l'optique d'un souce réel pour l'environnement et non à des fins purement politiques). Les questions environnementales demeureront toujours trop vastes pour n'être traitées qu'à certains niveaux de gouvernement, mais cela ne veut absolument pas dire qu'il y a lieu de les confier au niveau le plus élevé. Bien au contraire, à l'image de l'écosystème, on propose plutôt l'"autonomie coopérative".

Il incombe en tout premier lieu aux provinces de rassembler les données fondamentales indispensables à la planification des ressources du milieu et à la gestion des changements apportés à l'environnement. Il est inconcevable de penser que les citoyens de l'Ontario (de toute province ou du pays) ignorent encore la quantité de terres agricoles encore disponibles

et à quelle vitesse elles tendent à disparaître, si nous gérons nos forêts et façon à ce point médiocrement que le bois deviendra bientôt une ressource non renouvelable, ce que se passe réellement dans les Grands lacs, le niveau de qualité de l'air et de l'eau dans chaque municipalité, etc. Chacun sait que notre bien-être dépend de l'environnement. Et pourtant, nos connaissance de l'état de cet environnement, des transformations qu'il subit et nos connaissances de la nature même de cette dépendance sont encore au stade primitif. Le peu d'importance accordée à la planification de l'environnement des municipalités laisse tellement à désirer. Cela fait tout simplement partie d'un dilemme plus vaste encore:



Connaissances très limitées de l'état de l'environnement. Population détachée des questions environnementales

L'attention, l'argent et les efforts sont consacrés à d'autres préoccupations

Les problèmes ne sont pas perçus comme étant reliés à l'environnement. Faible intérêt de la population

Peu d'importance accordée aux préoccupations environnementales par le public et les décisionnaires du secteur privé

Une revue d'ensemble en profondeur des lois provinciales sur la planification offrirait l'occasion unique, pour la première fois en 25 ans, de rompre avec cette espèce de cercle vicieux. Espérons que l'Ontario ne laissera pas passer une telle occasion. Qui sait si pareille occasion se présentera encore!

STUDY GROUP SESSIONS

SESSIONS DE GROUPES D'ÉTUDE

STUDY GROUPS

For the evening session of the Workshop, three study groups were organized. Each group was given two questions, one of which was common to each group. A chairperson was appointed for each group and was requested to present the group's results in the afternoon session of the following day. The chairpersons were asked to outline the results under the major headings: *Answers*, *Group Discussion*, and *Recommendations*. These results are provided below. Since full agreement on all points was not possible, the results should be taken as a consensus of the particular group.

STUDY GROUP A

M. Romaine (Chairman)	P. Gimbarzevsky
M. Jurdant	E. Mackintosh
M. Roed	G. Wickware
N. Ward	M. Walmsley
L. May	C. Selby

QUESTIONS

1. Would it be desirable to have a biophysical survey program for urban or urbanizing areas in Canada?

2. Many methods of securing basic data on natural resources are available. Some are single disciplinary in their approach while other are multidisciplinary; for the latter, the approach may be integrated or nonintegrated. As a means of providing biophysical information in urban or urbanizing areas, what do you consider are the merits of these individual methods? You may wish to consider the merits in relation to:

a) the normal limitations of funding and manpower,

b) the information desired for the various levels of planning,

c) the intensity of various land uses,

d) the efficiency of the method(s), etc.

Answers

The answers to both questions are reflected in our recommendations.

Group Discussion

It was agreed that integration is needed. However, there are several kinds of integration:

a) *The synthesis of environmental characteristics to understand the environment and its processes* - There is a need for common base maps which would serve as building blocks to achieve the objective of synthesis. The questions of logistics and timing also were discussed. With some sectors, such as with surficial geology maps, it may be necessary to proceed independently. This is often advantageous in terms of timing and funding. As maps of this kind surface, the preparation of other maps which require them as a pre-planning or assimilation tool can commence.

b) *The coordination of agencies' efforts* - Discussion centered around the location of existing biophysical information. It was felt that there is certainly no need for a 'super' agency (e.g. central data bank for the country) to carry out this function. The real problem is in collecting existing information from various agencies so that the information is convenient and accessible to regional or local governments.

c) *The relation and synthesis of existing information* - This is a question of logistics and the state of the art. This is especially true considering that over time, various disciplines have different objectives. The need for some type of resource data bank was also discussed.

In trying to respond to the questions provided, the group discussed data needs. This certainly depends on the objectives and the time frame. Confusion over defining what was actually meant by 'urban' and 'urbanizing' areas made it difficult to provide specific answers. The group also discussed the various levels of information and data needs. A small-scale reconnaissance level is perhaps where you can have the major influence on preplanning (e.g. in locating townsites). There is obviously a need for intermediate scales and detailed or site-specific scales. Papers presented at this Workshop have adequately expressed the data needs. Many of the 'hot areas' can only be resolved at the detailed level, but it is difficult to conceive that any government could launch a major program to deal with these issues, at least not in a short time frame.

Perceived possible goals:

(a) To foster and develop ecologically sound principles for urban-type programs.

b) To develop interim guidelines and manuals for planners with regards to the use of ecological principles.

c) In cooperation with urban planners, to work towards the incorporation of (a) and (b) into land use programs (e.g. like that demonstrated by the B.C. Land Commission).

d) To develop and test systematic approaches to deliver to urban planners 'packages' that would demonstrate the above. These would include directions as to what information is important, and how to obtain and use it.

To achieve these goals, two prerequisites or underlying principles are apparent: (1) The information must be legally defensible. (2) Research and development are needed in a number of areas.

Recommendations

1) A mechanism should be established for integrating efforts of line agencies, especially in terms of information and programs.

2) Program packages, which include guidelines, classifications and evaluations for delivery to urban and urbanizing areas, should be developed.

3) Urban environment problems, the adequacy of existing information, and future survey needs should be assessed.

4) A framework for program planning should be implemented.

5) Ecological processes and values need to be recognized and understood.

STUDY GROUP B

P. Archer (Chairwoman)	J. Coleman
T. Oke	R. Seypka
J. Nowland	V. Gerardin
E. Oswald	R. Bennet
P. Dean	D. Lacate

QUESTION 1

Would it be desirable to have a biophysical survey program for urban or urbanizing areas in Canada?

Answer

It was agreed that a biophysical survey in urban or urbanizing areas would be desirable.

Group Discussion

The group was not too concerned with the capabilities to do this type of work, as the basic expertise and techniques for such a program are available. The group felt that it might be more appropriate to provide guidelines for all agencies involved in the implementation of this type of work throughout Canada.

Data collection should stress those types of data which are not likely to change significantly over time. Surveys should also stress basic or descriptive collections rather than derivative maps. Also discussed were problems of reliability, particularly the overlay technique and its probability of inaccuracy when dealing with a number of overlays. Although this question is directed to biophysical information, the importance of socioeconomic data is also recognized.

Recommendations

1) Fisheries and Environment Canada should encourage the provinces to enact legislation which would require that environmental impact statements be prepared prior to development.

2) All relevant biophysical terms should be fully defined to avoid misinterpretation.

3) Biophysical survey programs should be regionally flexible to account for differences in natural settings throughout Canada.

QUESTION 2

Is there sufficient biophysical information in urban or urbanizing area to support sound planning?

Answer

Although biophysical information exists for urban areas, it is by and large insufficient in the areas covered and even what is available is not always readily usable. Thus, it is largely inadequate for sound environmental planning and development.

Discussion

Needs in urban planning vary. No one scale of expressing biophysical detail is appropriate for all needs. The provision of information should utilize telescoping levels, with each level being appropriate for particular levels of planning needs. The group attempted to order the biological and physical characteristics in terms of the ways that they should be presented. This order, however, depends on location.

Where biophysical information is not available, the various governments should attempt to assist planning agencies by providing technical advice. This would help to bridge situations until the information is collected and translated for planning needs. However, even where biophysical information does exist, it may be incomprehensible to planners or they may not even know it exists. Governments should therefore assist planners in the interpretation of the information, or at least help them to locate the information. To bypass at least half the problem, information which is available should be in a form that is comprehensible to as wide a variety of users as possible.

Existing biophysical information is largely reconnaissance. Appropriate biophysical information is most deficient at the intermediate and detailed levels of planning.

Recommendations

1) The Canada Committee on Ecological (Biophysical) Land Classification should create a methodology for evaluating the compatibility of the natural environment with a range of urban land uses.

2) A workshop should be held to discuss the evaluations and methodologies.

STUDY GROUP C

J.I. Sneddon (Chairman)
M. Fenger
E. Jorgensen
H. Hirvonen
J. Chibuk
J. Thie
R.S. Dorney
J.E. Harrison
G.A. Hills
A.N. Boydell
R.J. Planck
D.W. Guscott

QUESTION 1

Would it be desirable to have a biophysical inventory program for urban and urbanizing areas in Canada?

Answer

The study group felt that at this time it would not necessarily be desirable to establish a national biophysical program for urban and urbanizing areas in Canada.

Any comprehensive and systematic national program would have to be preceded by selected pilot studies in areas where urban biophysical problems are both identifiable and immediate. The objectives of such studies would be determined through interdisciplinary dialogue between scientists and planners.

Group Discussion - Major Points

- There is a case for implementing biophysical programs where this type of information can still make a contribution to the planning process.
- Biophysical studies of core areas would be of questionable value unless major renovation and design is proposed.
- Urban planners need to be consulted as to where problems are occurring and as to where the best point of entry is in relation to biophysical-oriented studies having the greatest impact.
- It has to be recognized that in certain areas there is only a limited amount of lead time available for biophysical studies to be completed and have an input into the planning process.
- In many urban and urbanising areas, planning decisions and development trends have been established to the point where biophysical information would be of limited value.

Recommendation

Through dialogue with planners, critical areas where biophysical information would have the greatest impact should be identified and biophysical studies should be conducted in these areas on a selective basis. Based on the success of these studies, the need for more comprehensive programs should be evaluated.

QUESTION 2

Urban planners often remark that ecological (biophysical) information is not readily understandable. How would you improve the communication of this information?

Answer

This is a valid comment that arises due to the lack of communication between the scientist and the planner.

The scientist is often not fully aware of how the planner will use his information, at the planning stage and subsequently when he goes before politicians, the public and, increasingly, before the courts. With an increased awareness, the scientist can present his information in a manner that satisfies the planner's requirements and, at the same time, point out the assumptions made and the limitations of the information being provided.

The planner should be aware of his own requirements and how he is going to use the information supplied. This can be achieved by constant communication at all stages of the ecological (biophysical) survey and evaluation.

An outline indicating an integrated and interdisciplinary approach to the ecological (biophysical) survey and evaluation of a planning project that should lead to a better understanding by planners and a better presentation of ecological (biophysical) information by scientists follows:

APPOINTMENT OF INTERDISCIPLINARY TEAM (includes representatives for all disciplines involved in the planning project)

⬇

DEFINITION OF GOALS AND OBJECTIVES

⬇

DEFINITION OF INFORMATION REQUIREMENTS AND DATA-GATHERING METHODOLOGIES DEVELOPED ACCORDING TO CRITICAL PATH TECHNIQUES

⬇

DATA COMPILATION AND SYSTEMATIZED APPROACH TAKEN TO DATA ANALYSIS, INTERPRETATION AND INITIAL ENVIRONMENTAL EVALUATION

⬇

FINAL PRESENTATION FORMATS DEVELOPED

⬇

PRESENTATION OF FINAL ECOLOGICAL (BIOPHYSICAL) REPORT (includes a statement of the utility and limitations of the information provided)

⬇

CONTINUED INTERDISCIPLINARY DIALOGUE (in pre-planning, impact assessment, final planning, implementation, operational and environmental monitoring phases of a project)

Group Discussion - Major Points

- Ecological (biophysical) information has to be collected, stored and written up in a technical format. This provides a reference point for justification of evaluations and also provides a data base for further evaluations and research.
- Technical terms are used in technical reports to preserve the integrity of the information and of the professionals involved.
- To meet the requirements of the planner and the project there is often a case for providing information at:

  a) a technical level
  b) a user level
  c) a level suitable for digestion by the layman

- The scientist has to establish the credibility and usefulness of his information. This involves the education of the user and the optimum presentation of information. The user beyond the immediate user has to be considered.
- The users' requirements have to be well-understood for effective presentation of information.
- Some presentation formats result in user difficulties (e.g. computer output is entirely unsuitable for presentation purposes to decision makers.)

Recommendation

In providing guidelines for ecological (biophysical) surveys, it is important that integrated interdisciplinary dialogue between the scientists and the users be established at all stages of a project from inception through implementation and beyond. Through improved communications, the scientist will have a greater awareness of the user's requirements, and the planner will develop a greater awareness of the value of ecological information. The use of ecological information will be optimized to society's benefit.

Post Presentation Comments

- The outline of the integrated and interdisciplinary approach was presented as being passé. However, whether any biophysical surveys have been undertaken following this type of approach was questioned.

  A major concern was expressed that in this presentation and throughout the Workshop too much emphasis has been placed on the survey phase of the biophysical. The system analysis, interpretation and application aspects of biophysical programs had been virtually ignored.

GROUPES D'ÉTUDE

GROUPES D'ETUDE

Trois groupes d'étude ont été formés pour la séance du soir de l'atelier. Chacun s'est vu assigner deux questions, dont une était donnée à tous. On a demandé au président désigné de chaque groupe de faire le compte rendu de ce qui est ressorti des échanges de vues, le lendemain après-midi. Il fallait pour ce, grouper les conclusions, qui sont exposées ci-après, sous trois rubriques principales: Réponses, Échange de vues et Recommandations. Comme il a été impossible d'obtenir l'unanimité sur tous les points, il faut considérer ces conclusions comme étant le consensus sur un point donné chez les divers groupes.

GROUPE D'ÉTUDE A

M. Romaine (président)
M. Jurdant
M. Roed
N. Ward
L. May
P. Gimbarzevsky
E. Mackintosh
G. Wickware
M. Walmsley
C. Selby

1. Souhaitez-vous la création d'un programme de levés biophysiques pour les zones urbaines ou les secteurs en voie d'urbanisation du Canada?

2. Il existe un grand nombre de modes d'acquisition des données de base sur les ressources naturelles. La méthode d'approche de certains d'entre eux est unidisciplinaire, tandis que pour d'autres, elle est multidisciplinaire; dans ce dernier cas, elle peut être intégrée ou non. Selon vous, quels avantages présente chacune de ces méthodes pour l'acquisition de renseignements biophysiques sur les zones urbaines et les secteurs en voie d'urbanisation? Comme critères, vous pouvez utiliser:

a) les restrictions normales de financement et de main-d'oeuvre;

b) les renseignements requis pour les divers stades de la planification;

c) l'intensité des diverses utilisations des terres;

d) l'efficacité des modes, etc.

Réponses

Nos recommandations répondent à ces deux questions.

Échange de vues

Nous avons convenu que l'intégration est nécessaire. Il y a toutefois plusieurs types d'intégration:

a) *La synthèse des caractéristiques du milieu afin de comprendre l'environnement et ses processus* - Il faudrait des cartes uniformes, qui serviraient d'outils pour atteindre les objectifs de la synthèse. On s'est également entretenu de questions ayant trait à la logistique et au calendrier. Sur certains plans, par exemple les cartes de géologie de surface, il peut se révéler nécessaire de concentrer ses efforts chacun de son côté. C'est souvent avantageux du point de vue du temps et du financement. Au fur et à mesure de l'établissement de ces cartes, on pourra entreprendre la préparation des autres cartes, auxquelles les premières sont nécessaires comme outil de planification préliminaire ou d'assimilation.

b) *La coordination des efforts des organismes* - Les échanges de vues ont tourné autour des sources actuelles de renseignements biophysiques. On estime que l'on n'a certainement pas besoin d'un "super-organisme" (par ex. une banque centrale de données pour tout le pays) pour remplir cette fonction. Le véritable problème, c'est de rassembler les renseignements dont disposent les divers organismes afin que l'information soit appropriée et accessible aux administrations locales et régionales.

c) *La relation et la synthèse des renseignements existants* - Il s'agit ici de logistique et de situation. C'est particulièrement vrai si l'on considère qu'avec les années, les objectifs de diverses disciplines se sont modifiés. Il a également été question de la nécessité d'un certain type de banque de données-ressources.

Tentant de répondre aux questions posées, le groupe a discuté les besoins en données. Ceux-ci dépendent sûrement des objectifs et du calendrier. Il a été difficile de fournir des réponses précises en raison d'une certaine confusion lors de la définition précise de zone urbanisée et de secteur en voie d'urbanisation. L'échange a également porté sur les divers niveaux d'information et de besoins en données. C'est peu-être un niveau de reconnaissance réduit qui permet la plus grande incidence sur la planification préliminaire (par ex. lorsque l'on détermine l'emplacement des lotissements urbains). Il est évident que l'on a besoin d'échelles intermédiaires et d'échelles détaillées ou spécifiques à un lieu. Les documents présentés lors de l'atelier ont bien démontré les besoins en données. Bon nombre de "sujets délicats" ne peuvent être résolus qu'au niveau de détail, mais il est difficile de concevoir qu'un gouvernement puisse entreprendre un programme important afin de s'occuper de ces questions, à tout moins pas à brève échéance.

Objectifs possible perçus:

(a) Favoriser et élaborer des principes écologiques sûrs pour les programmes urbains.

(b) Produire des lignes directrices et des manuels provisoires à l'intention des planificateurs relativement à l'utilisation des principes écologiques.

(c) En collaboration avec les planificateurs urbains, travailler à l'intégration des objectifs (a) et (b) dans les programmes d'utilisation des terres (comme l'a fait la Commission des terres de la Colombie-britannique).

(d) Mettre au point et tester des méthodes systématiques en vue de fournir aux planificateurs urbains des ensembles documentaires prouvant ce que précède. Ces ensembles comporteraient des instructions relativement aux renseignements importants et aux façon de les obtenir et de les utiliser.

Deux prérequis ou principes sous-jacents semblement nécessaires pour atteindre ces objetifs: (1) les renseignements doivent satisfaire toute analyse juridique; et (2) divers domaines commandent un effort de recherche et de mise en valeur.

Recommandations

1) On devrait établir un mécanisme afin d'intégrer les efforts des organismes d'exécution, particulièrement en ce qui a trait à l'information et aux programmes.

2) On devrait élaborer des ensembles documentaires sur le programme comportant des lignes directrices, des classifications et des évaluations à l'intention des zones urbaines et des secteurs en voie d'urbanisation.

3) On devrait évaluer les problèmes de l'environnement urbain, la convenance des renseignements existants et les besoins futurs en matière de levés.

4) On devrait mettre en application un cadre destiné à la planification du programme.

5) Il faut reconnaître et comprendre les processus et les valeurs écologiques.

GROUPE D'ÉTUDE B

P. Archer (présidente)	J. Coleman
T. Oke	R. Seypka
J. Nowland	V. Gerardin
E. Oswald	R. Bennet
P. Dean	D. Lacate

PREMIÈRE QUESTION

Souhaitez-vous la création d'un programme de levés biophysiques pour les zones urbaines ou les secteurs en voie d'urbanisation au Canada?

Réponse

Il est convenu qu'un levé biophysique dans les zones urbaines ou dans les secteurs en voie d'urbanisation serait souhaitable.

Échange de vues

Le groupe ne voit pas de lacune au chapitre des capacités de faire ce genre de travail; les techniques et les connaissances techniques de base pour un tel programme existent. Le groupe estimait qu'il pourrait être plus approprié de fournir des lignes directrices à l'intention de tous les organismes qui participent à la mise en oeuvre de ce genre de travail dans tout le Canada.

La collecte des données devrait surtout porter sur les types de données qui ne sont pas susceptibles de subir d'importants modifications au cours des années. De plus, les levés devraient porter davantage sur la collecte de données de base ou de données descriptives plutôt que sur l'établissement de cartes générales. On s'est également entretenu des problèmes de fiabilité, en particulier que ce qui est de la technique des calques de superposition et des probabilités d'inexactitude lorsque l'on a affaire à un grand nombre de calques. Bien que la question porte sur les renseignements biophysiques, on a également reconnu l'importance des données socio-économiques.

Recommandations

1) Le ministère des Pêches et de l'Environnement devrait inciter les provinces à adopter des lois qui obligeraient à dresser un état des répercussions sur l'environnement avant le début des travaux.

2) Afin d'éviter les fausses interprétations, on devrait donner une définition complète de tous les termes biophysiques utiles.

3) Les programmes de levés biophysiques devraient pouvoir être adaptés aux besoins régionaux afin de tenir compte des différences entre les caractéristiques naturelles des diverses parties du Canada.

DEUXIÈME QUESTION

Dispose-t-on de suffisamment de rensiegnements biophysiques sur les zones urbaines ou les secteurs en voie d'urbanisation pour appuyer uen planification valable?

Réponse

Il existe des renseignements biophysiques sur les zones urbaines, mais ils sont en général insuffisants dans les régions couvertes; qui plus est, ceux dont on dispose ne sont pas toujours facilement utilisables. Ils sont donc largement insuffisants pour permettre une planification et un développement environnementaux sûrs.

Échange de vues

Les besoins varient en matière de planification urbaine. Aucune façon d'exprimer les détails biophysiques n'est appropriée à tous les besoins. Pour fournir les renseignement, on devrait se servir de niveaux télescopiques, chacun étant approprié à des niveaux de besoins particuliers en matière de planification. Le groupe a tenté de donner aux caractéristiques physiques et biologiques l'ordre que l'on devrait adopter pour leur présentation. Cet ordre dépend toutefois de l'emplacement.

Lorsque l'on ne dispose pas de renseignements biophysiques, les divers gouvernements devraient essayer d'aider les organismes planificateurs en leur fournissant des conseils techniques. Ils pourront ainsi faire face aux situations qui se présenteront jusqu'à ce que les rensiegnements soient rassemblés et interprétés aux fins des besoins en planification. Toutefois, même lorsque des renseignements biophysiques sont disponibles, les planificateurs peuvent ne pas les comprendre ou même ne pas savoir qu'ils existent. Les gouvernements devraient donc aider les planificateurs à interpréter les renseignements ou du moins à les localiser. Afin de contourner ou moins la moitié du problème, les renseignements disponibles devraient être exprimés de façon à être compris par le plus grand nombre d'usagers possible.

Les renseignements biophysiques existants ont en grande partie été recueillis lors de travaux de reconnaissance. C'est aux stades de la planification intermédiaire et détaillée que le manque est le plus marqué.

Recommandations

1) Le Comité canadien de la classification écologique (biophysique) du territoire devrait élaborer une méthodologie en vue d'utilisation des terres urbaines.

2) On devrait organiser un atelier afin d'étudier les évaluations et les méthodologies.

GROUPE D'ÉTUDE C

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PREMIÈRE QUESTION

Souhaitez-vous la création d'un programme de levés biophysiques pour les zones urbaines et les secteurs en voie d'urbanisation au Canada?

Réponse

Le groupe d'étude estime qu'à l'heure actuelle, il n'est pas urgent de mettre sur pied un programme national de levés biophysiques pour les zones urbaines et les secteurs en voie d'urbanisation au Canada.

Tout programme national exhaustif et systématique devrait être précédé d'études pilotes sélectionnées, menées, dans les régions où les problèmes biophysiques urbains sont à la fois indentifiables et immédiats. On déterminerait les objectifs de ces études par des échanges interdisciplinaires entre spécialistes et planificateurs.

Échange de vues - Principaux points

- Il y a lieu de mettre en oeuvre des programmes biophysiques lorsque ce genre de renseignements peut encore être utile au processus de planification.
- Les études biophysiques du centre-ville seraient d'une utilité douteuse, à moins que l'on propose d'importants travaux d'aménagement et de rénovation.
- On doit consulter les planificateurs urbains relativement aux endroits où il se pose des problèmes et relativement au moment qui conviendrait le mieux aux études à caractère biophysique qui ont la plus grande incidence.
- On doit reconnaître que, parfois, on a peu de temps pour réaliser les études biophysiques pour qu'elles puissent être utiles au processus de planification.
- Dans beaucoup de zones urbaines et de secteurs en voie d'urbanisation, on a pris les décisions concernant la planification et établi les tendances du développement en se disant que les renseignements biophysiques seraient d'utilité limitée.

Recommandation

Par des échanges avec les planificateurs, on devrait identifier les secteurs critiques où les renseignements biophysiques seraient le plus utile et faire des études biophysiques de façon sélective. Ensuite, en se fondant sur les résultats de ces études, on pourrait évaluer la nécessité de programmes plus exhaustifs.

DEUXIÈME QUESTION

Les planificateurs urbains disent souvent que les renseignements écologiques (biophysiques) sont difficiles à comprendre. Comment feriez-vous pour améliorer la transmission des renseignements?

Réponse

C'est une observation valable. Le problème, c'est d'abord le manque de communication entre les spécialistes et les planificateurs.

Souvent le spécialiste ne sait pas très bien de quelle façon le planificateur utilisera les renseignements qu'il lui fournit lors de la planification même, et, par la suite, devant les autorités politiques, le public et, de plus en plus, devant les tribunaux. Une connaissance accrue des besoins permettrait aux spécialistes de présenter leur information d'une façon qui satisfasse les planificateurs et, par le fait même, de signaler les hypothèses faites et les limites de l'information fournie.

Le planificateur devrait connaître ses propres besoins et l'usage qu'il fera des renseignements obtenus. Il peut y arriver par des communications constantes à toutes les étapes du levé et de l'évaluation écologiques (biophysiques).

Ci-après, un schéma indiquant une méthode intégrée et interdisciplinaire de levé d'évaluation écologique (biophysique) d'un programme de planification qui devrait mener à une meilleure compréhension par les planificateurs et à une meilleure présentation de l'information écologique (biophysique):

FORMATION D'UNE ÉQUIPE INTERDISCIPLINAIRE (compte des représentants de toutes les disciplines qui participent au programme de planification

▼

ÉTABLISSEMENT DES BUTS ET OBJECTIFS

▼

DÉFINITION DES BESOINS EN MATIÈRE D'INFORMATION ET DE MÉTHODOLOGIES DE COLLECTE DES DONNÉES MISES AU POINT D'APRÈS LES TECHNIQUES DU CHEMINEMENT CRITIQUE

▼

COMPILATION DES DONNÉES ET MÉTHODE SYSTÉMATISÉE APPLIQUÉE À L'ANALYSE ET À L'INTERPRÉTATION DES DONNÉES ET PREMIÈRE ÉVALUATION ENVIRONNEMENTALE

▼

PRÉSENTATION FINALE DES FORMATS MIS AU POINT

▼

PRÉSENTATION DU RAPPORT ÉCOLOGIQUE (BIOPHYSIQUE) FINAL (comporte un exposé sur l'utilité et les limites de l'information fornie)

▼

ÉCHANGES INTERDISCIPLINAIRES CONTINUS (lors des étapes de la planification préliminaire, de l'évaluation des répercussions, de la planification finale, de la mise en oeuvre et du contrôle opérationnel et environnemental d'un programme)

Échange de vues - Principaux points

- On a rassemblé, emmagasiné et rédigé l'information écologique (biophysique) sous une forme technique. On dispose ainsi d'un moyen pour justifier les évaluations ainsi que d'un stock de données pour d'autres recherches et évaluations.

- On utilise des termes techniques dans les rapports techniques afin de préserver l'intégrité de l'information et de profiter au maximum des connaissances des professionnels en cause.

- Afin de répondre aux besoins du planificateur et du programme, il y a souvent lieu de fournir des renseignements:

  a) à un niveau technique
  b) au niveau de l'utilisateur
  c) à un niveau que puisse comprendre le profane.

- Le spécialiste doit prouver la crédibilité et l'utilité de son information. Il doit pour ce faire éduquer l'usager et présenter le plus de renseignements possible. Il faut tenir compte de ceux qui viennent après l'usage immédiat.

- Les besoins des usagers doivent être bien compris pour que la présentation de l'information soit valable.

- Certains modes de présentation posent des difficultés à l'usager (par ex. les imprimés d'ordinateur ne sont absolument pas acceptables aux fins de présentation à ceux qui prennent les décisions).

Recommandation

Lors de la fourniture de lignes directrices sur les levés écologiques (biophysiques) il est important d'établir un dialogue interdisciplinaire intégré entre les spécialistes et les usagers à toutes les étapes d'un projet, de son point de départ à sa mise en oeuvre et même au-delà. De meilleures communications permettront au spécialiste de mieux connaître les besoins de l'usager, et au planificateur, de mieux connaître la valeur de l'information écologique. On maximisera l'utilisation de celle-ci à l'avantage de la société.

Observations ultérieures à la présentation

- On a présenté la méthode interdisciplinaire et intégrée comme étant une chose désuète. On a cependant mis en doute qu'il y ait eu des levés biophysiques faits selon ce type de méthode.

  On s'est dit préoccupé du fait que, dans cette présentation et tout au long de l'atelier, on a trop insisté sur l'étape des levés dans la biophysique. On n'a pratiquement pas tenu compte de l'analyse systémique et des aspects interprétation et application des programmes biophysiques.

ECOLOGICAL LAND CLASSIFICATION SERIES

* No. 1. CANADA COMMITTEE ON ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION, 1977. Ecological (Biophysical) Land Classification in Canada: Proceedings of the first meeting of the Canada Committee on Ecological (Biophysical) Land Classification, 25-28 May 1976, Petawawa, Ontario. Ed. by J. Thie & G. Ironside. 269pp. Includes abstracts and some text in French.

** No. 2. M. JURDANT, J. BÉLAIR, V. GERARDIN & J. DUCRUC, 1977. L'Inventaire du Capital-Nature (Inventory of Capital-Nature): A method of ecological land classification and mapping. Text in English. (In preparation).

No. 3. CANADA COMMITTEE ON ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION, 1977. Ecological (Biophysical) Land Classification in Urban Areas: Proceedings of a workshop, 23-24 November 1976, Toronto, Ontario. Comp. & ed. by E. Wiken and G. Ironside. 167pp. Includes abstracts and some text in French.

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SÉRIE DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE

* No. 1. COMITÉ CANADIEN DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE, 1977. Classification Écologique (Biophysique) du Territoire au Canada: Compte rendu de la première réunion du Comité canadien de la classification écologique du territoire, 25-28 mai 1976, Petawawa, Ontario. Éd. par J. Thie & G. Ironside. 269pp. Comprend des résumés et du texte en français.

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No. 3. COMITÉ CANADIEN DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE, 1977. Classification Ecologique (Biophysique) du Territoire dans les Régions Urbaines: Compte rendu d'un atelier, 23-24 novembre 1976, Toronto, Ontario. Comp. & éd. par E. Wiken & G. Ironside. 167pp. Comprend des résumés et du texte en français.

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