An Analysis of the Ontario Waste Management Corporation's Site Selection Procedure.

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INTRODUCTION

As evidence continues to accumulate which suggests that untreated wastes have deleterious affects on both health and environment, community interest and opposition to the siting of wastes continues to grow. The siting of hazardous waste treatment and disposal plants has, as a result, become an important and controversial issue facing many North American cities and towns. Widespread opposition from both the private and public sectors is continually expressed. Currently, Ontario is faced with a similar dilemma in that plans for the provision of such a facility are being analyzed and implemented. In response to these problems, the Ontario government established the Ontario Waste Management Corporation in 1981. "The prime responsibility of the OWMC is to establish and operate a liquid, industrial and hazardous waste management system for Ontario by properly treating and disposing of all special wastes generated in Ontario that require such treatment and disposal." (Phase 4A Report Summary,OWMC,Sept.1985,p.2).

Presently, a location for the construction of a liquid, industrial and hazardous waste treatment and disposal facility in Ontario has been identified. The selection of this site involved a detailed three and a half year study incorporating the collection and analysis of information on more than forty initial site selection factors and sixty revised factors. Although results indicate this site to be ideal with respect to safety and suitability requirements, widespread community opposition and concern remains. The proposed research will review the locational decisions made by the OWMC and determine if these decisions differ with respect to other literature on site selection methods.

In conducting an analysis of the site selection process of the OWMC with respect to other site selection processes, I am hoping to show how in some instances the site selection procedures are compatible and in others how discrepancies and major differences may exist. Certain internal characteristics within the OWMC's structure can be applied to these other site selection procedures at different levels, providing an effective means for comparison.

Clearly, the OWMC selection process has proven to be a highly detailed, technical and elaborate report which effectively addresses all of the important issues involved in planning for the treatment and storage of hazardous wastes. For the purpose of my report, much of the work has been simplified so as to provide an effective and meaningful base from which extensions of my analysis can be applied. Essentially, a 'bare bones' approach to the OWMC's site selection process will be adopted for both practicality and ease of handling purposes. One must realize however, that within each of the five phases presented by the OWMC in its development process, there is a wealth of information pertaining to environmental, engineering and economic aspects which encapsulate the OWMC's objectives (Appendix fig.1). Furthermore, many of the techniques used within the study such as constraint mapping and suitability analysis have not been included. This omission was intentional in that my thesis addresses aspects of a qualitative nature rather than those which are quantifiable. Specifically, many of the detailed and technical testing procedures utilized by the OWMC are not alluded to because of their limited application to my research goals.

In selecting an ideal site, the Ontario Waste Management Corporation progressively moves from a macro scale (provincial context) down to a micro level (local scale) (Appendix fig.2). In the first step, narrowing the search to a geographic region, the Golden Horseshoe Region was selected primarily for efficiency reasons with respect to transport as 70% of all hazardous wastes in the province are generated here. Within the second step, selecting candidate areas within the Golden Horseshoe, the basic decisions were arrived at through the various engineering options available such as the incineration of waste, physical and chemical treatment of waste and land-fill prospects. The basic physical attributes such as air dispersion, soil types and hydrological aspects effectively determined these sites. The problem of identifying candidate sites within candidate areas embodied the third phase of the OWMC'S site selection procedure. Initial candidate sites were selected based upon existing patterns of industrially designated lands, publicly held lands and privately owned lands. Step four involves the comparison of candidate sites and the selection of preferred site(s) for further analysis. The fifth step involves the testing of site specific factors to ascertain the positive or negative qualities exhibited by each of the sites. Throughout each of these steps, public consultation is carried out to help canvas community feelings and attitudes towards the development of such a facility.

In reviewing other site selection procedures as presented in the literature review, different qualities were sought which would aid in the comparison to the OWMC. Each of the site selection procedures is differentiated from the others because of different goals and objectives which are embodied within them. Each in fact can be applied to different aspects of the OWMC'S site selection procedure and thus used to compare and contrast different things. Specifically, Dobson offers a Regional Screening Procedure which utilizes information of a physical nature and therefore it can be used to discuss many of the physical/environmental criteria which the OWMC itself uses. A Sealed Bid Auction Mechanism as presented by Kunreuther and Kliendorfer will be particularly useful in a economic and social planning context. Aspects of economic and social planning inherent within the OWMC site selection process can be addressed by the Sealed Bid Auction procedure. Service planning problems and issues under the OWMC's service oriented tasks can be viewed in light of a Maximin Criterion (Melachrinoudis and Cullinane). Land Screening Procedures (Anderson and Greenburg) and Site Selection Procedures (Pojasek) are particularly useful in that they offer a combination of planning techniques which incorporate physical, social and service planning aspects. Finally, Pojasek's Site Selection Procedure will provide useful insight in discussing the role of public involvement and participation in the selection process. The level at which the public is involved in the OWMC process is different from that of Pojasek's procedure wherein the public plays an important and integral part. Such differences will be interesting to analyse and discuss.

The OWMC identifies three major aims which it seeks to plan for. The basic categorization which these three aims incorporate will be used as the basis of my argument and will aid in the comparison and discussion of my research goals. Specifically, the OWMC seeks to select a site which minimizes risk to human health as its main goal. Next, once human health has been safeguarded, a site which minimizes environmental impacts will be preferred. Finally, all attempts to minimize financial costs to the OWMC will be examined and implemented.

Clearly, these goals incorporate aspects of social, economic, service, and environmental planning, which will facilitate a comparative analysis between the OWMC and other literature on site selection procedures. Each of these aims/goals is broken down into a series of factors which in turn are broken down into a smaller more precise set of sub-factors which can specifically identify the merits or disadvantages of selecting a particular site over another. It is at this level where most of my proposed research is being conducted. Comparison between the OWMC and other literature on site selection procedures becomes possible at this level (Appendix fig.3).

LITERATURE REVIEW

In response to the problems associated with the management of hazardous wastes in Ontario, The Ontario government established the Ontario Waste Management Corporation in 1981. "The prime responsibility of the OWMC is to establish and operate a liquid, industrial and hazardous waste management system for Ontario by properly treating and disposing of all special wastes generated in Ontario that require such treatment and disposal," (OWMC, Sept 1985. Phase 4A. Report Summary. p.2). Over a period of about three and a half years, the OWMC conducted a detailed study incorporating the collection and analysis of information on more than sixty site selection factors. A five phase facilities development process was designed by the OWMC to present its proposals. A detailed analysis of the report reveals important engineering, environmental, and planning criteria that will influence the selection of an ideal site. In general, the OWMC reports provide relevant information for developing a concise explanation and understanding of the site selection process utilized by the OWMC.

A diversity of noxious facility planning methods are available, many of which can be applied to the problem of locating a hazardous waste disposal site. A review of selected studies with respect to the location of undesirable facilities within the urban landscape will be completed. Such analysis will identify pertinent site selection procedures and techniques used in generating preferred locations. Upon completing the review of OWMC information and other noxious facility planning methods, a basis of comparison will be developed through which differences or similarities in procedures can be analyzed and discussed.

Ontario Waste Management Corporation Site Selection Procedure

In reviewing the OWMC's development plans, valuable information pertaining to the site selection procedure can be obtained. In the Phase 1 report, information pertaining to the assembly and analysis of primary information concerning engineering, environmental and planning issues are discussed. The waste problem in Ontario is viewed by applying principles of supply and demand to determine who the generators of hazardous waste are, and where they are located. Primary information regarding geological and hydrological features in Southern Ontario is presented and initial conclusions regarding suitability requirements for waste disposal sites are made. Analysis of several factors such as land use, engineering infrastructure, archeology, climatology, transportation networks, surface water characteristics and environmentally sensitive areas are presented and discussed with reference to how they might affect the size and location of proposed facilities. Finally, a look at available treatment and disposal technologies is conducted and site requirements for different types of facilities are suggested. Overall, Phase 1 defines the scope of the hazardous waste situation in Ontario, and introduces several factors and criteria which become important in the locational decisions of hazardous waste storage and treatment facilities.

Phase 2 of the OWMC report offers equally important information to the siting of hazardous waste facilities. In this phase, information relating to the progress on the selection of facilities and sites is presented. The bases upon which the OWMC's facilities are being planned is also explained. Aspects such as economic factors relating to industrial growth and recession, the introduction of new technologies, and plans for privately owned and operated waste treatment facilities are reviewed with respect to their importance to the siting issue. Likewise, government regulations affecting the amount of waste requiring special treatment are also considered. Transportation and environmental issues are suggested as reasons to concentrate the search for an ideal site within the geographical region of Southern Ontario.

In Phase 3 of the OWMC report the selection of candidate sites is further discussed and elaborated upon. Specifically, the analysis of facility capacity, design and operation is conducted with reference to the proposed size of facilities, and the processes to be utilized by each of the possible facilities.

An introduction to the step by step site selection process as advocated by the OWMC is given. In step 1, the search for a preferred location is narrowed down to a single geographic region in Ontario. The area chosen was that of the

Golden Horseshoe because of its desired hydrogeological, air dispersion and serviceability qualities. Step 2 identifies candidate areas within this predetermined region. Several areas are identified as having desirable characteristics and qualities that would possibly facilitate the development of a hazardous waste treatment and disposal plant. Step three attempts to identify candidate sites within the newly established candidate areas. Specifically, those sites which for a variety of reasons seemed to better suit the development of facility components are identified and further promoted. In step 4, a comparison of the candidate sites is carried out and the best sites are identified. In the 5th and final step, detailed testing of the preferred sites is conducted and the best sites are chosen based upon predetermined criteria. Indepth hydrogeological tests are assessed, soil quality and depth is analyzed, and land use evaluation of on-site and off-site areas is also presented. Overall, salient information pertaining to the acceptability of each particular site is compiled.

. Phase 4 of the OWMC report outlines the reasons behind the selection of site LF-9C (West Lincoln) as the preferred site for locating a waste treatment and disposal facility. A brief explanation is given about the basic acceptability criterion as used by the OWMC (ie. basic reasons for either rejecting or accepting a particular site.) and its corresponding effects upon the final location are discussed.

Literature on Site Selection Procedures

The second part of this literature review analyzes applications or methods of noxious facility planning. Dobson (1979) proposes a Regional Screening Procedure for land use suitability analysis. "His paper discusses the results of a research project designed to develop and apply an automated regional screening procedure to identify the land use suitability of every land parcel within a candidate region." (Dobson,1979,p.224). Dobson's basic methodology is to employ a multiple criteria type of analysis which is used to rate the suitability of each alternative site, to identify trade-offs between various sites, and to consider disparate viewpoints on any siting issue. A data base is assembled, and quantitative siting criteria are created by having qualified personnel (individuals who possess expertise on specific criteria) rank each potential criteria according to its relative importance. Then, compatibility indexes are generated by assessing the criteria's impact upon the site selection as either positive or negative. The data is then arranged into a criteria matrix which conveniently forms an abstracted, qualitative set of criteria that represents the siting priorities and opinions of the respondents. Once applied to a specific geographic region, Dobson's method is capable of isolating potential sites which may be further tested. "Overall, multiple sets of criteria are used for the analysis of substantive siting issues. Possible trade-offs between various siting objectives or identifying the types of impacts that may result from site development are produced." (Dobson,1979,p.234) This approach proves particularly useful when considering a location in a large geographic region where much data is needed.

Another application of noxious facility planning is presented by Kunreuther and Kleindorfer (1986). Together, they propose a Sealed Bid Auction Mechanism for facilitating the siting process of noxious facilities. " They suggest that the hazardous waste facility siting problem arises because there are economies of scale associated with having only one plant to serve the needs of a wide region." (Kunreuther and Kleindorfer,1986.p.295). A compensation arrangement is therefore necessary so that the gains from the winners (those not receiving the facility in their neighborhood) will be shared amongst the potential losers (Those who live in the area of a proposed facility). Next, willingness to accept (WTA) values are generated by the communities independently of the others. They represent how much a community will receive if it is chosen as a site for a noxious facility. It necessarily follows then, if another community is selected as the host site, that all other communities will have to pay a tax to compensate it. " A regional siting agency then assembles all the data, selects the community with the lowest WTA value and uses the tax payments to compensate the host site. By using this procedure the regional agency is guaranteed a balancing budget and a likely surplus."

(Kunreuther and Kleindorfer,1986,p.296). Overall, a Sealed Bid Auction Mechanism must be viewed as a possible alternative to the siting problem because it shows the relative costs and benefits of alternative locations.

Melachrinoudis and Cullinane (1985) suggest yet another alternative approach to noxious facility planning. They acknowledge the importance of placing environmentally hazardous facilities within the environment, and that only after indepth analysis should such a decision be made. They propose a solution to the problem of locating undesirable facilities among several existing facilities within a geographical region through use of a Maximin Criterion. In their methodology, a facility is viewed as occupying a region servicing a circular area, and new facilities cannot be located within these existing or forbidden circles. " An appropriate criterion therefore for the location of an undesirable facility is to minimize its worst effects on existing facilities or to maximize the minimum distance between the new undesirable facility and the existing facilities." (Melachrinoudis and Cullinane,1985.p.115) Overall, the authors suggest that the concept of forbidden circles or regions provides the planner with a great deal of flexibility in that it can handle common location problems and more complicated ones as well.

Anderson and Greenberg (1982) show that there are probably safe places to manage hazardous wastes, and that there are methods of finding them. They present a case study application of a Land Screening Process designed to identify land areas suitable for locating new hazardous waste facilities within the Lower Raritan/ Middlesex county area. Their underlying assumptions are that suitable sites can be found for hazardous waste facilities, that it is impossible to expect no adverse impacts at all, and that it is realistic to assume that some areas will be less prone to adverse effects due to physical, cultural and environmental attributes. To begin, they suggest there should be a clear indication that the geographic region chosen for screening is reasonably suited in terms of marketing and disposal services, and once this is ensured a set of factors defined as siting criteria can be applied. Once applied to a specific region, specific areas can be identified. Finally these areas can be examined at greater detail using field study investigations and laboratory analysis of soils, depth of water table and other factors. In the end a single most suitable location can be isolated and considered as a potential hazardous waste facility location.

According to Pojasek (1980, volume 4) the selection process for hazardous waste involves the following steps: (1) developing site selection criteria, (2) identifying candidate sites best meeting these criteria, (3) initial review and evaluation of candidate sites, (4) selection of sites for final evaluation, (5) evaluation of regional awareness, (6) final evaluation and ranking of sites, (7) public involvement, (8) site selection, (9) public hearing and (10)

review. "He comments that site selection is a complex system integrating public opinion and involvement and existing policy, while evaluating environmental, safety, economic and engineering feasibility. The relative importance of each of these factors depends on the basic selection objectives, services to be provided by the facility and pertinent local and federal regulations and policies."
(Pojasek,1980,V.4,p.6).

ANALYSIS OF THE OWMC

SITE SELECTION PROCEDURE

GOAL #1

TO SELECT A SITE(S) WHICH MINIMIZES RISK TO HUMAN HEALTH

Atop the Ontario Waste Management Corporation's list of importance in providing an equitable and lasting solution to the problem of hazardous waste management is to select a site which minimizes risk to human health and life. Accordingly, the OWMC effectively analyzes all pertinent aspects which may have impacts upon human health under each of the four categories: (1) Site - pathways into the environment. (2) Site - human exposure. (3) Transportation - discharge - pathways into the environment. (4) Transportation - discharge human exposure.

An alternative is sought through a well reasoned and detailed analysis of physical, environmental, and potential man made problems which might disturb human health or pose unacceptable or dangerous risks. Those sites which for a variety of reasons, predispose people to a higher risk associated with the treatment, disposal and movements of hazardous wastes are removed from further consideration and the best or ideal sites are further tested and decided upon. Overall, the OWMC site selection procedure is capable of organizing and manipulating large sets of data, especially those related to environmental and transportation problems which are necessary to consider in minimizing risks to human health.

Ideally, all site selection procedures should seek to protect human interests, and important among those interests should be human health. Unfortunately however, this is not the case. Some selection procedures expect economic gains or efficiency in service provision, thus undermining the importance of safeguarding human health, or else they attempt to translate health problems into monetary terms.

Objective A: Site - Pathways into the Environment.

The Ontario Waste Management Corporation is aware of the importance that the natural environment plays in the transportation of hazardous wastes through ground water movements and air dispersion qualities. It also realizes that the natural movements of contaminants throughout the environment plays an important role in the protection of human health, as they often serve as pathways to the urban or populated environment. Accordingly, the OWMC anticipates such 'pathway' inductions of waste, and seeks to alleviate such problems through appropriate testing of hydrogeologic settings and airsheds to determine the best qualities which would minimize such entrances into environmentally sensitive and populated areas. Much in the same way that Dobson's Regional Screening Procedure seeks to isolate the best site within a region with respect to its physical and environmental attributes, the OWMC also seeks such measures for the provision of human safety. The OWMC seeks to site facility components within hydrogeologic settings which will naturally, or through engineering measures restrict the movements of contaminants and ensure maximum environmental safety and thus protect human health, surface water resources and equatic resources and ecosystems. Through analysis of surface and ground water movements, the natural capability of the receiving environment to disperse, dilute and assimilate liquid wastes is catalogued and used to help determine the most suitable site for the proposed facility. "The OWMC's main objective with respect to the hydrogeological suitability of a site stems from documenting surface water considerations which relate to the natural capability of the surrounding environment to effectively receive treated wastes while avoiding interferences with existing uses and maintaining acceptable standards of human health." (OWMC, Primary Environmental Information, Sept. 1982. p.2).

With respect to air dispersion qualities, the OWMC tries to incorporate sound engineering measures to ensure minimal emissions of potentially hazardous or health threatening air-borne pollutants. " It is important to avoid areas which are known to be subject to atmospheric conditions which inhibit good dispersion of emissions to the atmosphere. The selection of sites which avoid adverse dispersion qualities or conditions is perhaps one of the most effective avoidance measures that can be used. In so doing, both the frequency and intensity of periods of potential impacts are minimized, and the risk to human health is also reduced." (OWMC, Atmospheric Dispersion Influences, July 20, 1983, p.13).

Major problem areas where air dispersion characteristics become important within the OWMC's study area are urban areas with a population size greater than 40,000, land sites within

5 km of Lake Ontario and Lake Erie, and land near the base of the Niagara Escarpment. Information relating to wind direction during different times of the year, topographic features down wind which might act to retard dispersal, and urban heat island phenomena relating to urban developments is collected and analyzed. Furthermore, with respect to pathways into the environment, the OWMC analyzes potential sites which may exhibit such hazards as flooding, potential susceptibility to seismic disturbances, slope failures and other natural occurrences. It is strongly suggested that such sites be able to facilitate environmental monitoring and be susceptible to the application of pertinent counter measures when the need arises.

Overall, this area of OWMC planning is most consistent to physical approaches to planning wherein detailed environmental information is utilized and decided upon. The same such analysis is incorporated within Dobson's analysis and several parallels in methodology can thus be identified. Clearly, environmental issues play a large role in minimizing risks upon human health.

Objective B: Site - Human Exposure.

Perhaps the best way to minimize the risk to human health in locating a particular site is to reduce the amount of exposure people around the site will have. Clearly, risk to human health will be lowest at sites with a minimum of people living nearby, and highest where there are pockets or concentrations of people living close by. In addressing such a problem, the OWMC analyzed the three aspects of land use, land use planning and land ownership. Various categories of land use on or near a particular site such as residential land use, commercial, and industrial will all have important impacts upon the duration and extent of exposure that people will experience. Also, future developments within the area through land use planning are important and worth consideration if human health is to be ensured. Land ownership is also of prime importance because people need compensation if they are to be displaced, and it is easier to move fewer as appossed to larger sets of people. "This objective has the greatest relevance to landuse, land use planning and ownership. All categories of land use; residential, industrial, and commercial involve concentrations of people who could for all, or part of the day be exposed. The variations in population concentrations in proximity to facilities and the length of visit or occupancy in each land use and in different locations will bear greatly on the selection of a site."(OWMC, Phase 3B, Jan. 3, 1985. p.4).

Also, in terms of human exposure, existing land uses will have to be safeguarded. Possible water resources used for human or animal consumption will have to be strictly monitored and tested on a regular basis. Also, populations sensitive to exposure and/or are difficult to evacuate will merit special consideration on the part of the OWMC.

Overall, this area of the site selection procedure is consistent to forms of social planning in that people receive the most consideration and are paramount with respect to the selection of a particular site.

Objective C and D: Transportation and Discharge.

The transportation of hazardous wastes is an important issue of consideration when trying to minimize the potential risks to human health. Clearly, the movement of hazardous wastes to treatment and disposal facilities will have significant influences on annual operating costs, public acceptance and perhaps most importantly upon human health. The potential risks of transporting such dangerous substances through the environment has raised questions about human safety in the event of a possible accident or release. For the OWMC, analysis of possible pathways into the environment and human exposure as related to the transportation of hazardous material, has been conducted in attempts of identifying the best alternatives for ensuring human safety.

In general, the transportation issue has proven to be a complex problem which encapsulates many different important planning aspects (Appendix. fig.4). Paramount among these issues however, is safety and the risk associated with public health in the event of any difficulties or problems associated with the transportation of wastes. Accordingly, the OWMC has adopted methods to ensure that the sites selected will be well suited in terms of their ability to properly facilitate the movements of such wastes. Analyzed were the transportation routes available in the form of railways and highways. Initial conclusions favored highway systems in Ontario because major routeways were on the periphery of large urban centers whereas railway routes often dissected major urban areas thus increasing the risks of possible accidents. Furthermore,provincial highways provide a continuous linkage of roadways between all cities and towns, whereas railways are more restrictive. "Current inspection procedures on highway systems throughout the province are in place for truck inspection. ... Vehicles transporting waste will be suspect to the inspection so that minimum levels of safety are monitored and regulated." (OWMC, Primary Information. Transportation, August. 1982. p.4). By maximizing the use of the 400 series highways, and other routes which avoid populated areas, the number of people who might be exposed to a spill is minimized.

GOAL #2

TO SELECT A SITE(S) WHICH MINIMIZE ENVIRONMENTAL IMPACT

One hundred years of industrialization and the production of industrial and domestic waste has created difficulties and problems which are becoming noticeable at the natural environment. Accordingly, the Ontario Waste Management Corporation has attempted to select a site which minimizes environmental impact while addressing all important factors which may have possible effects upon the natural environment under each of the following five categories: (1) Physical and Biological. (2) Resources. (3) Land Use Conflict. (4) Social. (5) Economics.

Clearly, a best site is sought which will minimize negative impacts to both the natural environment and the man made or developed environment, all possible attempts have been taken to ensure that important safeguards are implemented, such that all physical and biological features of the environment are not damaged nor altered significantly. To the man made environment, similar provisions are taken such that minimal disturbances and difficulties are caused.

Objective A: Physical and Biological.

Various possible accidents or difficulties stemming from the location of a hazardous waste treatment and disposal site may have devastating effects upon the physical environment. In attempting therefore to maintain acceptable safety measures and thus safeguarding the natural environment, the OWMC analyzes various physical and biological factors which it feels are important.

Specifically, the siting of facility components should be such that all, or most of the negative impacts upon the environment are avoided with respect to the present as well as the future. Analysis of natural wildlife habitats for example have provided the OWMC with a list of areas unsuitable for the construction of their proposed facility. Areas too close to the Great Lakes are obviously omitted for their potential of causing extensive damage to Ontario's water ways, and the associated fish, vegetation and water fowl which depend on these water ways. Furthermore, rivers which seem geologically well suited for the hydrogeological transportation of treated wastes, may not be suitable in terms of the potential damage to wildlife. Various rivers off of Lake Ontario and Lake Erie were isolated for this reason, and eliminated from further study because of their importance to wildlife and maintenance of a balanced biological ecosystem. The Bronte Creek area for example, received early recognition in the study because of the annual salmon run which occurs here. As a result, it was considered unsuitable in terms of wildlife preservation and management. In comparison however, site LF-9C (the chosen West Lincoln site), did not exhibit any known disturbances to valued wildlife species or to important natural vegetation, and as a result it was further promoted as a valued location.

Also important in a physical context are natural landforms and physical features which for a variety of reasons are valued by society. For this reason, two initial sites located near Niagara Falls which were identified as being geologically secure, were omitted. The possibility of any accidents which might negatively effect the 'beauty' of the Falls was considered too great to allow any facility developments. The detrimental impacts to the built environment, be it the city of Niagara Falls, and especially to the tourist industry which relates to millions of people who visit here each year, were too important to overlook. Clearly then, in some instances the environmental and economic aspects associated with facility siting may overlap.

Finally, the introduction of liquid treated hazardous wastes into rivers and streams may cause problems by increasing the rate of flow, possibly interfering with wildlife, natural fauna or by causing problems associated with sedimentation in shallow areas. Through geological surveys, such places can be avoided, given that adequate information can be collected.

Objective B: Resources

Natural resources are a prime consideration of the Ontario Waste Management Corporation. The potential losses of commercially valuable resources as a result of any contaminants or problems arising from a particular facility have caused extensive analysis of agricultural capabilities and land uses, as well as present and future resource identification. Safeguarding areas with natural resources which are presently being used, as well as areas which exhibit high potential for future resource development, are the ultimate goals.

In terms of resources which occur naturally throughout the environment, such as mineral aggregates, the OWMC seeks to minimize the displacement and disruption to current uses, and to take effective measures to ensure that such resources, once identified, can be utilized when the need arises. In effect then the OWMC must practice and implement effective resource management schemes to ensure that negative effects upon the environment are minimized.

Other important resources include heritage and archeological resources as well as economically and/or recreationally important biological resources. Accordingly, the OWMC takes into consideration all important historical and cultural enclaves which exist in Ontario as well as any economically or recreationally important areas which stand out as worthy of preservation. In so doing, all possible efforts are taken to minimize both displacement and disruption to such resources.

Agricultural resources have also merited sufficient study on the part of the OWMC. Much of Ontario, specifically within the Golden Horseshoe, contains areas of prime agricultural land which are economically productive and environmentally sensitive. The introduction of a possible facility in any of these prime agricultural locations could foreseeably have detrimental consequences on both the farmers involved and upon their farmlands. "Overall, agriculture is a multi-faceted human activity that occupies most of the natural landscape in arable regions, it is part of a larger biological production system, it is a source of employment, adds to the gross national product and it is a distinctive way of life. Consequently, there are numerous points in the agricultural production system where farm enterprises and groups of enterprises could be effected by major non-agricultural developments in rural areas." (OWMC, Site Selection Procedure Phase 3B: Agriculture. 1985.p.2)

Perhaps importantly then, the selection of factors for use throughout the site selection process of the OWMC was governed by the following categories of impact upon agricultural production systems and to agricultural resources: (1) Impact on land productivity, both present and future. (2) Impact on local and regional agricultural economic systems. (3) Impact on agricultural communities. Such factors were developed so as to minimize the displacement of prime agricultural soils, the displacement and disruption on existing farm enterprises and productive areas. A classification system was therefore developed where in all agricultural land uses could be analyzed and ranked according to productivity. (Appendix. fig. 5a and 5b.)

Accordingly, such agricultural factors helped to eliminate certain sites which did not possess very good natural characteristics for the development of facility components. For example, site LF-11W (Town of Ancaster) was removed from further consideration for a variety of reasons. The number of land holdings of less than 20 hectares was seven, and non-farm houses numbered six. Therefore, if the site were to be considered an important location, then the displacement of numerous farmers and non-farmers would have to occur. Furthermore, this area had the potential of supporting very good class 1 agricultural lands on 93% of its site area, for this reason then, site LF-11W was overlooked primarily because of its potential of being an agricultural resource of high value in the future. Site LF-9C (West Lincoln site) was selected based upon similar criteria. Perhaps most important was the fact that no farm houses, nor non farm houses would have to be evicted off of the proposed site. Furthermore, site LF-9C has a land use designation of rural as opposed to agricultural, and only 69% of the present site could foreseeably be transformed into any form of productive agricultural lands.

Objective C: Land Use and Land Ownership.

According to the OWMC, it is evident from the broad brush considerations that few if any land use factors will be wholly exclusive for either the choice of a system or the location of a facility. Apart from the obvious desirability of avoiding recreational features, residential areas etc., it is unlikely that land use and character will be determinative in themselves. Rather, they will be one of a series of factors which will be weighed together to produce an optimum choice.

A wide range of factors were considered relating to urban areas, industrial parks, special areas, Indian reserves, associated facilities and other factors , relating to the presence of airports and major route ways. With respect to urban areas, the OWMC notes that they pose both advantages and disadvantages for siting in that they frequently contain residential and other areas where physical avoidance may be desired. On the other hand, they may also contain existing industrial areas and servicing capabilities needed for facilities and particularly, with respect to the Golden Horseshoe region, many of the prime generators of waste. In terms of site PI-1A1 (city of Brampton) for example, the existence of a nearby residential land use, and the prospects for future residential developments in this area proved to be unsatisfactory in terms of safeguarding the environment, and as a result it was dropped from further consideration.

Overall, in attempting to minimize environmental impacts, the OWMC seeks to minimize conflict with existing, committed, proposed and planned land uses. By attempting to change as little as possible with respect to land uses both present and future, the OWMC believes that the environment will benefit the most. Furthermore, attempts to minimize conflict with federal, provincial, municipal and native communities, will go along way in ensuring a minimum of disruption to the natural environment and the built environment as a whole. Also, by maximizing the potential for the establishment of facility components in locations characterized by similar industrial uses such as in industrial parks or with associated facilities, potential negative impacts to the environment may be avoided. Finally, wherever possible, the OWMC seeks to minimize the total amount of private property required to develop its facility options while keeping the disruption to land use patterns to a minimum.

Objective D: Social.

In attempting to safeguard the natural environment, various social factors and objectives become apparent. Clearly, every environment is made up of a number of characteristics, among those, social characteristics can be considered an integral proportion. Accordingly, the OWMC seeks to locate a facility for the treatment and disposal of wastes which will best suit the social characteristics and attitudes which make up the environment.

In minimizing environmental impact, a logical starting point with respect to social criteria would be to minimize the displacement of people, particularly those groups or individuals who for a variety of reasons are vulnerable to change. Furthermore, public acceptance on behalf of those people in effected communities will also be useful in reducing possible perceptions or realities of negative environmental impact. All attempts are taken by the OWMC to ensure proposed facility components are compatible with the image, character, traditions and lifestyles of the affected area. In so doing, environmental impacts upon the social aspects of the area will be minimized.

The OWMC also feels that once safeguards are implemented to ensure that the affected peoples are accounted for, that other measures should be taken to reduce the negative impacts related to the built environment. For example, all efforts should be taken to minimize any conflicts between proposed and existing facilities, and the use of areas for enjoyment which may suffer from visual intrusions or noise. Furthermore, losses or damage to buildings or features of archeological, cultural, symbolic or historical significance should also be minimized in attempts of reducing environmental impacts.

Overall, disturbances to people within the environment as a result of the siting of a hazardous waste facility are related to many different issues. Whether it is related to transportation, noise, pollution or the destruction of significant places, environmental impacts can have lasting affects upon the people who live within that community, and perhaps upon the natural environment itself. With respect to the chosen site LF-9C in West Lincoln for example, there is a minimum of disturbances which directly affect those people living within the area. The number of actual residents who must be displaced is lower than many of the other proposed sites, while the percentage of dwellings which are privately owned is greater, allowing for much simpler financial dealings and compensation in the event of displacement. Likewise, most of the affected residents have not established long lasting ties with the area, so any relocation of people would not be as difficult perhaps as it would in longer lived areas.

Objective E: Economics.

In safeguarding the environment from potential impacts, economic factors must be taken into consideration by the OWMC. Clearly, economic affects within the local area will have either positive or negative impacts upon the community and directly upon both the urban and natural landscape.

Accordingly, local businesses and economic institutions receive prime importance and consideration by the OWMC in trying to reduce environmental impacts. Specifically, all attempts are taken to maximize local employment opportunities associated with the development of the waste treatment and disposal site. Furthermore, measures are taken to minimize the displacement of local businesses, and wherever possible, the disruption of the operations of local businesses is avoided.

With respect to the built environment, environmental impacts are avoided by the OWMC which seeks to minimize property value depreciation and to maintain the local and regional character of the affected area. The provision of public and private services is monitored to ensure that adverse affects do not cause environmental problems.

GOAL #3

TO MINIMIZE FINANCIAL COSTS TO THE OWMC

A third important goal which the Ontario Waste Management Corporation seeks to plan for is to minimize its financial costs associated with the development of a hazardous waste treatment and disposal facility. Final costs for the OWMC will undoubtedly be very high. All attempts therefore must be taken to ensure that the most cost effective yet safety oriented options are implemented.

Objective A: To Hold Financial Costs to the Lowest Level.

Clearly, in developing an appropriate treatment and disposal facility which will be able to accept wastes from throughout Ontario, many potential costs can be minimized. Attempts at minimizing costs relating to approvals and site acquisition, for example are made. Site LF-9C in West Lincoln was partially based upon the fact that there were a minimum of land holdings which would have to be compensated. Accordingly then, site acquisition costs to the OWMC would be substantially minimized.

Costs related to on-site and off-site developments are also important when determining the best or ideal site. With respect to on-site developments, costs related to clearing, drainage, grading, screening and other engineering modifications can be minimized. Certain sites for example may predispose themselves to development whereas others will need specific alterations and changes which could prove to be very expensive. Likewise, off-site developments and costs could run very steep if existing service extensions, and road improvements are necessary. The existence or absence of various on-site and off-site characteristics therefore will go a long way in either increasing or decreasing financial costs for the OWMC.

Development and/or operations costs associated with facility components and necessitated by site or area characteristics may prove to be expensive as well. The location of certain sites will predetermine special remedial or monitoring measures which will protect human health and environment. The need for such measures will be based upon different factors relating to existing features in and around the selected site. Areas where human health is particularly at risk, or where the natural environment may be somewhat more ecologically sensitive, will require more monitoring equipment, and perhaps highly engineered and expensive containment equipment to ensure minimum standards of safety.

Furthermore, operating costs relating to the transportation of hazardous materials to and from the waste facility components will have to be analyzed such that possible cost efficient alternatives can be identified. In particular, the 400 series offers good accessibility and safety considerations to much of Ontario's producers of toxic substances. Other provincial highways and municipal roads offer reasonably good transport capabilities with only a minimum of upgrading or improvement required.

Overall then, the reduction of financial costs is an important consideration in the site selection procedure of the OWMC. The implementation of various extra safety measures on particular sites will however represent an additional drain on OWMC funds which may result in the reduction of other components which might be desired but no longer economically feasible. Clearly, the reduction of financial costs must be conciliatory to the reduction of risks to human health, and to minimizing environmental impacts. Yet, at the same time, they are very much inter related. The OWMC is therefore faced with the task of developing the best possible alternatives while trying to remain within economic constraints.

COMPARATIVE EVALUATION OF OTHER LITERATURE

ON SITE SELECTION PROCEDURES

Dobson: A Regional Screening Procedure For Land Use Suitability Analysis.

Dobson (1979) offers a Regional Screening Procedure to identify the land use suitability of every land parcel within a candidate region. "His procedure requires a geographical base file of relevant and easily accessible information, a screening algorithm for application to the stored data, and one or more sets of siting criteria for each type of land use or facility." (Dobson, 1979, p.225). In general, a variety of environmental data is necessary for most applications. Dobson's basic methodology is to employ a multiple criteria type of analysis which is used to rate the suitability of each alternative site, to identify trade-offs between various sites, and to consider disparate viewpoints on any siting issue.

To obtain quantitative siting criteria, respondents who may include members of the user organization, carefully selected experts, or any other sample group, are presented a description of the facility under consideration and asked to determine the importance each variable should have in the siting decision. Each variable in the data base is then ranked by the respondents on a scale 0 through 10, and this is called its importance weight. Respondents are then asked to consider each value that a variable might take as either a positive or negative influence. If the value is highly compatible with the facility, it is assigned a 10, if it is incompatible it is assigned 0, and neutral aspects are given a 5. These numbers are called compatibility indexes. "When the variable is of great importance and when the category or the value is highly repulsive, a negative compatibility index may be assigned to indicate that cells possessing the characteristic must be excluded from the final selection regardless of the attractiveness of other characteristics." (Dobson,1979,p.225). Effectively then, a criteria matrix of importance weights and compatibility indexes forms an abstracted, quantitative set of criteria that represents the siting priorities and opinions of the respondents.

Dobson's selection procedure can best be described as a physical approach to hazardous waste facility planning, and as such, several parallels to the OWMC site selection procedure can be identified. Clearly, Dobson's approach recognizes the importance of maintaining acceptable levels and safeguards for the protection of human health and the preservation of the natural environment, much in the same way that the OWMC does. On a more elaborate level than the OWMC however, Dobson is capable of assessing the suitability of an entire region on a parcel by parcel basis, thus providing what is truly the best alternative for the location of hazardous waste facilities. Through construction of a data base utilizing a multiple criteria type of analysis, both physical and environmental aspects can be taken into consideration. A series of preferred sites can eventually be isolated which possess the most positive attributes and which merit further consideration and detailed testing. Clearly then, by predetermining the site selection criteria, and by placing emphasis on these criteria to minimize risks to health and environment, Dobson is capable of selecting sites which will be most advantageous in terms of maintaining certain levels of health and ensuring acceptable environmental standards both in the short and long term.

Overall, Dobson's Regional Screening Procedure differs from that of the OWMC's site selection procedure because of several salient features. Perhaps most importantly, is the fact that Dobson does not incorporate such a wide range of variables as the OWMC does. Factors relating to the urban environment, economics and social conditions are absent whereas the OWMC incorporates such analysis into its site selection procedure. Simultaneously then, Dobson has supplied additional information on the need for more detailed analysis of the socio-economic and ecological impacts of the facility design in certain candidate areas. Furthermore, Dobson's procedure is restricted or limited in areas that do not have a geographical information system. The cost for developing such a system is excessive for most single applications. The OWMC procedure on the other hand is capable of developing acceptable alternatives in the absence of such a system, or else without strict reliance upon their existence.

Clearly, Dobson's technique could have been applied within the OWMC framework. In particular, Dobson's technique would have proven useful in analyzing much of the environmental data that the OWMC had collected.

Kunreuther and Kliendorfer: Sealed Bid Auction Mechanism.

Kunreuther and Kliendorfer propose a Sealed Bid Auction mechanism for facilitating the siting process of noxious facilities. Their procedure perhaps is most indicative of an economic or social approach to the issue of hazardous waste facility siting. "They suggest that the hazardous waste siting problem arises because their are economies of scale associated with having only one facility to serve the needs of the wide region. The community that hosts the plant absorbs all of the environmental costs, while the rest of the region enjoys the benefits of the facility. One reason that these facilities have been so strongly opposed by communities is that they generate little new employment and provide limited additional taxes in relation to their perceived negative impact." (Kunreuther and Kliendorfer,1986,p.295). Appropriately then, a compensation arrangement is therefore necessary so that the gains from the winners (those not receiving the facility in their neighborhood) will be shared amongst the potential losers (those who live in the area of the proposed facility). In a sense, the siting of hazardous waste facilities is a mixture of a public good and a private bad. The positive externalities associated with the facility in community 'A' yield positive value to all other communities in the area. Community 'A' however, receives negative value from hosting the development.

Next, willingness to accept values (WTA) are generated by the communities individually from one another, which represent how much a community will expect to receive for hosting such a facility. Correspondingly, if another site is chosen as the host site, then all the other communities will have to pay a tax defined as their willingness to pay (WTP) value in order to compensate it. "A regional siting agency then assembles all the data, selects the community with the lowest WTA value and uses the tax payments to compensate the host site. By using this procedure the regional agency is guaranteed a balancing budget and a likely surplus." (Kunreuther and Kliendorfer, 1986,p.296)

Overall, a Sealed Bid Auction Mechanism must be viewed as a possible alternative to the siting problem because it shows the relative costs and benefits of alternative locations. "The Low Bid Auction procedure must therefore be viewed as one of a set of policy tools for dealing with the hazardous waste facility siting process. It offers the possibility of clarifying the relative costs and benefits of alternative locations and appropriate monitoring and control procedures for implementing changes from the current system"(Kunreuther and Kliendorfer, 1986,p.297). Furthermore, it introduces economic and community opposition as important site selection factors, whereas the OWMC fails to address such aspects related to community viewpoints. The interaction between rival communities is also seen to be an important ingredient in the final selection of a preferred site, while within the OWMC site selection procedure, no such interaction between rival sites occurs nor is promoted. Clearly, the discretionary role ascribed to individuals within the Sealed Bid Auction Mechanism supersedes the roles and functions attributed to individuals within the OWMC's site selection procedure, wherein the community members assume non-participating roles as opposed to active ones.

Finally, certain standards may have to be implemented within the Sealed Bid Site Selection procedure so that residents in all possible sites are convinced that they are safe against potential environmental effects such as pollution. The possibility of compensating people along transportation routes is a feasible situation that the OWMC fails to address. According to the OWMC, compensation will be payed to those people and households who are directly effected as a result of actual relocation.

Perhaps Kunreuther and Kliendorfer's procedure could be applied to the OWMC site selection in that the selected areas within the Golden Horseshoe region could have produced WTA and WTP values. Perhaps, such a procedure would be helpful to the OWMC in identifying areas of acute opposition to the siting of hazardous wastes. Reasonable assumptions could then be made with respect to the suitability of a particular site in terms of its social acceptability.

Melachrinoudis and Cullinane: Maximin Criterion

Melachrinoudis and Cullinane (1985) offer yet another alternative approach to noxious facility planning. Their approach is somewhat service based, and relates to the location of a facility so as to take advantage of the present distribution of existing facilities to provide an effective and equitable service network. They propose a solution to the problem of locating undesirable facilities within a geographical region through use of a Maximin Criterion. The objective of this technique is to maximize the smallest distance between existing facilities or to minimize the worst effects upon presently developed facilities. Accordingly then, the notion of forbidden circles develops, within which no two facilities can locate together. Ultimately, the arrangement of hazardous waste facilities will take on a hexagon type of distribution throughout the landscape with equal areas being serviced.

"Overall, the most desirable feature of this model is that the existing facilities are assumed to have a region around them in which the new facility is not allowed to be placed. This concept of a forbidden circle or region provides the modeler with a great deal of flexibility in terms of building realism into his model." (Melachrinoudis and Cullinane, 1985,p.123). Furthermore, common location problems and more complicated ones as well can sufficiently be addressed through such a procedure.

With respect to the OWMC's site selection procedure only limited comparisons can be made to the Maximin Criterion. Although the OWMC seeks to locate its facility components within a large geographic region, it does so having initially predetermined a region which exhibits the greatest need for serviceability. In terms of the Ontario context that the OWMC is operating, this region is the Niagara Horseshoe area within which 70% of all the toxic wastes in the province are produced. Clearly then, in the case of the OWMC site selection procedure there is no overlapping circles or regions to determine siting options. Furthermore, within the OWMC site selection framework, emphasis is not placed upon minimizing the effects upon neighboring facilities, but rather upon minimizing the detrimental effects upon human health and the natural environment. Perhaps an obvious shortcoming of the Maximin Criterion is that too much emphasis is placed upon service issues as opposed to environmental and human safety considerations.

In the OWMC site selection framework, a Maximin Criterion would have limited use. It could be used quite effectively however, to isolate the serviceable area within the region, and to indicate which remaining areas will pose service problems. Areas for example which are isolated and do not possess very good transportation alternatives could be identified and perhaps eventually improved.

Anderson and Greenburg: A Land Screening Process

Anderson and Greenburg (1982) suggest a Land Screening Process for the development of a hazardous waste treatment and disposal facility, which can be seen to be a combination of physical, social and service planning. They present a case study application of a Land Screening Process designed to identify land areas suitable for new hazardous waste facilities within the Lower Raritan / Middlesex county area. The screening process presented is designed to screen small geographic areas through a set of factors defined as siting criteria. The underlying assumption is that suitable sites do exist for hazardous waste management facilities, that possible adverse impacts can be expected, and that some sites because of their cultural, physical and marketing characteristics are better suited for such developments. An analysis of these criteria will result in the identification of the relative suitability of the areas examined.

Initially, measures are taken to ensure that the region considered is appropriate in terms of marketing alternatives. "An effective marketing strategy might suggest a centrally located site, or one in close proximity to the major hazardous waste generators. Next, the screening process is applied to the chosen region, resulting in the identification of certain areas that have the least apparent physical or cultural conditions conducive to environmental contamination or public health threats." (Anderson and Greenburg, 1982,p.207). Finally, these areas can be examined in greater detail with respect to laboratory analysis and field tests. Eventually, the most suitable location can be put forward as a potential hazardous waste facility location.

In terms of comparison to the OWMC, the Land Screening Process as offered by Anderson and Greenburg has several parallels in methodology. The first such comparison is related to the fact that both site selection procedures begin by isolating a centralized and serviceable region within which the facility must be located. A second such comparative analysis can be based on the fact that both procedures incorporate data of a social nature. That is to say that information relating to the cultural and social makeup of the candidate sites is important in the selection of a preferred site. Finally, environmental attributes as tested through detailed and scientific testing procedures have important determinative influences upon the selection of an ideal site within both site selection procedures. Through evaluation of the economic impacts upon various sites, the OWMC site selection procedure differs from that of Anderson and Greenburg's approach in that it analyses both costs and benefits of particular sites, and bases its site selection on the most beneficial site in terms of environmental, cultural/social and economic attributes.

Pojasek: Site Selection Procedure.

In Pojasek's Site Selection Procedure, a well defined series of steps are identified. Each of these steps involves the collection and analysis of relevant information. The following steps are used: (1) Developing site selection criteria. (2) Identify candidate sites best meeting these criteria. (3) Initial review and evaluation of candidate sites. (4) Selection of sites for final evaluation. (5) Evaluation of regional awareness. (6) Final evaluation and ranking of sites. (7) Public involvement. (8) Site selection. (9) Public hearing and (10) review.

Pojasek states that the site selection procedure for a hazardous waste facility is a complex system which combines public involvement and opinion. Accordingly, the public is given an important role in the site selection procedure. Pojasek advocates a type of planning partnership wherein planning responsibilities are shared through joint policy boards or committees. Such a partnership could be instrumental in involving the community in the planning process, and in resolving possible impasses by community votes.

Within the OWMC selection framework, the public is not given such an important role. Citizens are given surveys and asked to attend public meetings where they are given the opportunity to be heard. Through use of public consultation in the selection process, the OWMC attempts to obtain only the views of the citizens.

Perhaps, the OWMC could profit from giving people more power within the selection procedure. "Clearly, the citizens are a primary source of information about the problems that are being experienced by the community, about the impacts of proposed solutions, and about the values and aspirations of community members. The politicians and planners on the other hand, know the resources that are available to solve problems, the limits of knowledge about project impacts, and the institutional and procedural avenues that must be observed." (Hodge, 1986,p.341). Overall, effective and full participation would involve more than just one way flows of information, it would imply some citizen influence on subsequent developments in the plan, with final responsibility resting with the politicians and planners.

CONCLUSIONS

Two sets of conclusions can be drawn from this paper. The first pertains to the OWMC Site Selection Procedure, and the second relates to the other literature on hazardous waste facility siting procedures.

With respect to the OWMC, the site selection procedure has proven to be a comprehensive and detailed planning initiative which has taken about seven years to develop and implement. The actual procedure has attempted to integrate social, physical and environmental, service considerations and economic aspects in selecting the ideal site. In a sense, the OWMC has provided a multi-disciplined selection procedure which can identify acceptable sites for the development of a hazardous waste facility based upon a variety of information.

In terms of the West Lincoln site (LF-9C) which has been proposed for the development of facility components, it is an efficient selection. Clearly, in terms of land use it is a desired site. Likewise, with respect to serviceability, the site is centrally located and provides good transportation alternatives and accessibility. Furthermore, the proposed site is consistent to the environmental and physical conditions which were identified as being important. Also, site LF-9C has proven to be an equitable selection in that it represents a cost efficient site in term of acquisition costs, and it poses a minimum of disturbances to both the urban and natural environments. Overall, the OWMC Site Selection Procedure has been a reasonable response to the need for developing a hazardous waste treatment and disposal facility.

With respect to other literature on site selection procedures, most of the techniques seek to plan for a single objective with reliance on only one type of information. This is evident in Dobson's physical approach to site selection wherein only information pertaining to environmental qualities and attributes is utilized. As a result, most of the procedures are not as comprehensive nor as complete as the OWMC procedure. They do however, provide sufficient detail within their particular area of specialization, which in some cases is necessary given the huge amount of special data required.

Other techniques (Anderson and Greenburg and Pojasek) combine different aspects into their site selection procedures in attempts of addressing all the site requirements for a hazardous waste facility. None of the procedures presented within this paper, however, approach the level of integration at which the OWMC operates. With the exception of Pojasek's approach, all of the procedures presented are inadequate in that they would not produce and equitable or efficient site in terms of all the possible considerations that would need to be incorporated.

Clearly, in comparison to the OWMC approach, these other site selection techniques point out the importance of including a variety of information in the site selection process. Possible attempts of combining selection techniques to plan for a variety of requirements can be seen as an alternative. Complexity and data requirements have obvious cost constraints, but if human and environmental safety is to be ensured, such constraints will assume secondary roles.

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APPENDIX

Figure 1

FACILITIES DEVELOPMENT PROCESS

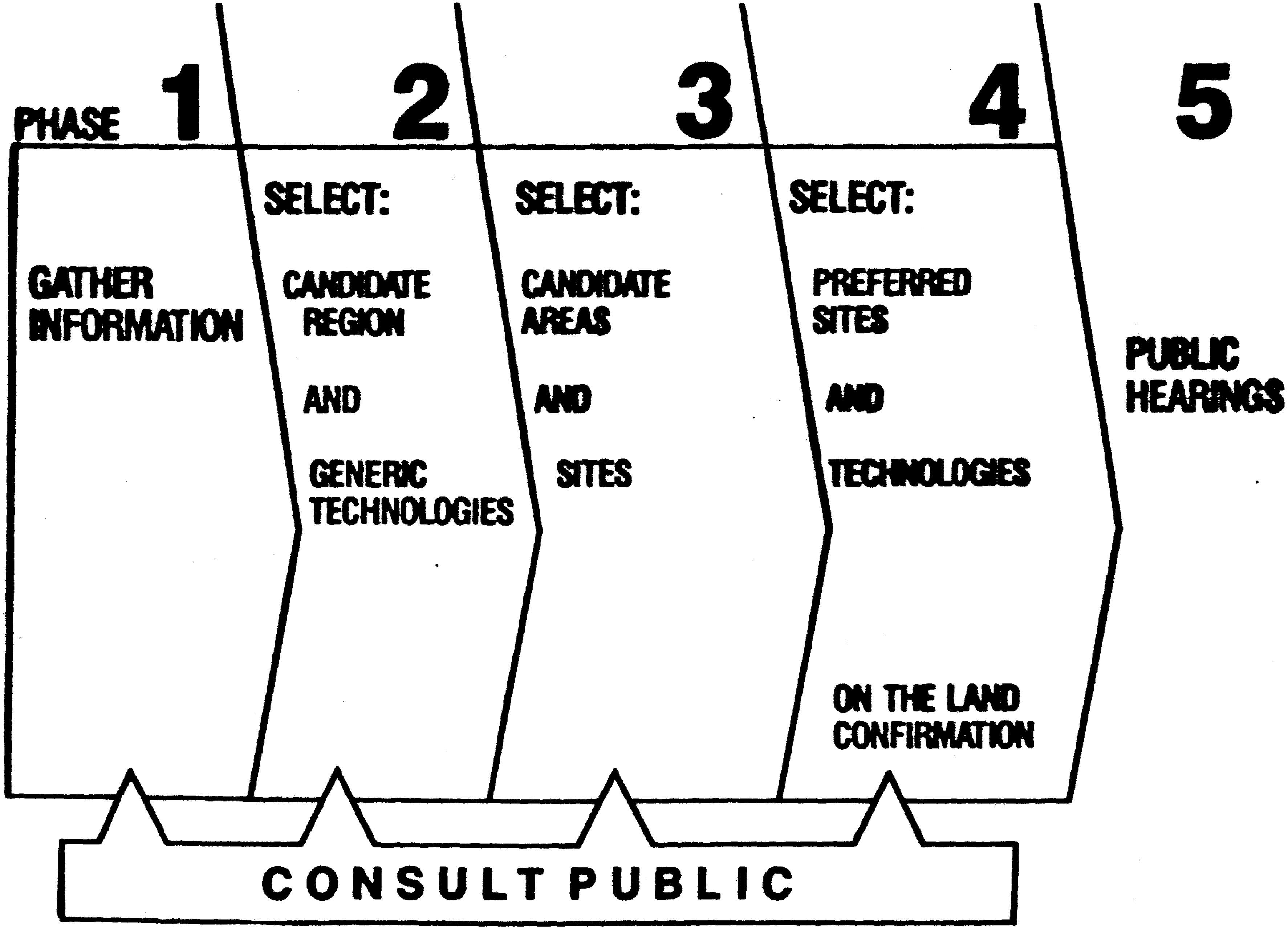

Figure 2.
Step-by-Step Approach to Site Selection
Source: OWMC, 1986

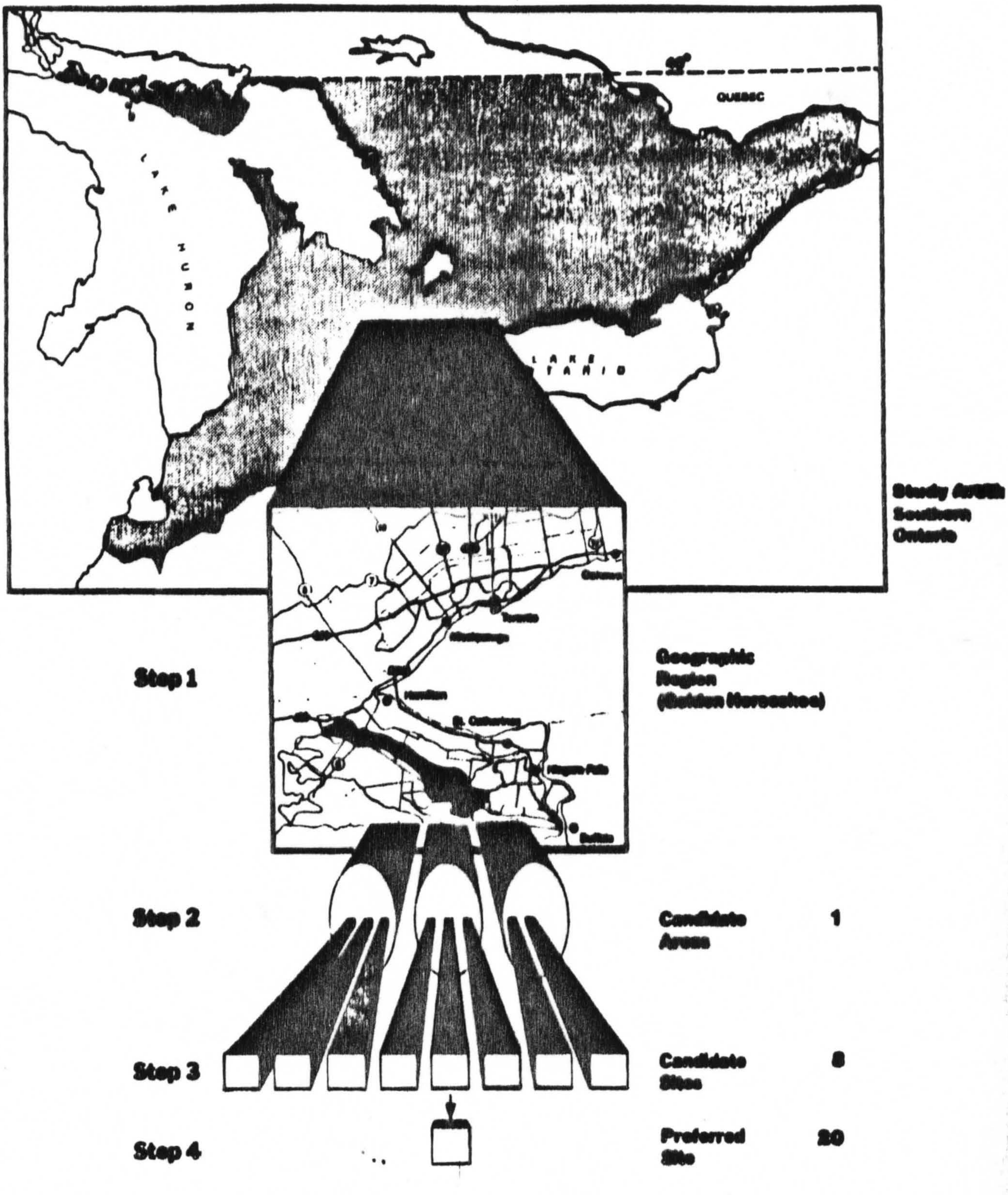

fig.3

Site Selection Objectives

I GOAL:

To select a site(s) which minimizes risk to human health.

Objectives:

A. Site - "pathways" into the environment

1. To site facility components in hydrogeologic settings that will naturally restrict the movement of contaminants and protect groundwater resources and to utilize engineering measures where required to ensure maximum environmental safety.

2. To site facility components in hydrogeologic settings that will naturally restrict the movement of contaminants and protect human health, surface water resources and equatic ecosystems.

3. To site facility components in airsheds that have atmospheric dispersion characteristics which will protect air quality and aquatic and terrestrial ecosystems.

4. To site facility components in settings which minimize the hazards to the site as a result of such conditions as flooding, potential susceptibility to seismic disturbance, slope failures and to utilize engineering measures where required to ensure maximum environmental safety.

5. To site facility components in settings which facilitate monitoring as well as the application of countermeasures, including backup emergency services.

6. To site facility components to minimize potential contamination of food chains.

7. To site facility components to minimize hazards to the site from other uses which might contribute to the likelihood or severity of a release of contaminants.

8. To locate discharge locations (if required) with dispersion characteristics that will protect human health, surface water resources and aquatic ecosystems.

B. Site - human exposure

1. To site facility components to minimize the number of people who might be exposed as well as the duration of their exposure to contaminants in the event of a release.

2. To site facility components to minimize the potential for the contamination of existing wells and other sources of water for human or animal consumption.

3. To site facility components to minimize the potential for exposure of populations who are sensitive to exposure and/or are difficult to evacuate.

C. Transportation Discharge - pathways into the environment

1. To select transportation routes and modes which minimize the likelihood of a release of contaminants during transit.

2. To site facility components such that the physical settings along the access routes to the site(s) naturally restrict the movement of contaminants and protect human health, terrestrial and aquatic ecosystems.

D. Transportation Discharge - human exposure

1. To site facility components to minimize the number of people who might be exposed and the duration of that exposure to contaminants along the access routes to the site(s) in the event of a release.

2. To site facility components to minimize the potential for exposure of populations who are sensitive to exposure and/or are difficult to evacuate along access routes to the site(s).

II GOAL

To select a site(s) which minimizes environmental impact

Objectives

A. Physical and Biological

1. To avoid destruction and minimize disruption of significant natural ecosystems.

2. To avoid destruction and minimize disruption of significant vegetation or wildlife.

3. To avoid destruction and minimize disruption of rare or uncommon species of plant and animal life.

4. To avoid destruction and minimize disruption to significant landforms and other physical features.

5. To minimize physical impacts on surface water such as sedimentation and changes in base flow.

6. To minimize impacts on surface water quality from emissions.

B. Resources

1. To minimize the amount of land required to safely construct and operate the facility component(s).

2. To minimize displacement of prime agricultural land.

3. To minimize displacement and disruption of existing far enterprises.

4. To minimize disruption to productive agricultural areas and to stable agricultural communities.

5. To minimize displacement and disruption to other natural resource such as mineral aggregates.

6. To minimize disruption of economically and/or recreationally important biological resources.

7. To minimize displacement of and disruption to heritage and archaeological resources.

8. To minimize displacement of areas with a high potential for resource development.

C. Land Uses and Land Ownership

1. To minimize conflict with existing, committed, proposed and planned land uses.

2. To maximize the potential for the establishment of the facility components in locations characterized by similar industrial uses.

3. To minimize the amount of private property required and the disruption to land ownership patterns.

4. To minimize conflict with federal, provincial, municipal and native communities, policies, programs and plans.

D. Social

1. To minimize the displacement of people, particularly those groups and individuals vulnerable to change.

2. To minimize conflict between the facility components, operations and the use and enjoyment of properties in the vicinity of the site(s), as a result of visual intrusion, noise, etc.

3. To minimize losses or impacts on buildings and features of archeological, historical, symbolic, cultural or social significance.

4. To maximize compatibility between the facility components and the character, image, traditions and lifestyle of the affected area.

5. To establish the facility components, to the extent possible, in areas in which the local communities can adapt to the type of change which might result from the project.

6. To maximize community acceptance of the facility components.

7. To maximize compatibility with the visual character and appearance of the landscape in the vicinity of the facility location.

8. To minimize conflict between the transportation of hazardous wastes to the facility components and the use and enjoyment of properties along access routes to the site(s).

9. To minimize conflict between facility-related traffic and local traffic by ensuring that access routes provide an acceptable level of service.

E. Economics

1. To maximize local employment opportunities.

2. To minimize the displacement of businesses.

3. To minimize property value depreciation.

4. To minimize disruptions to the operations of local businesses.

5. To maximize compatibility with the local and regional economic character of the affected area.

6. To minimize adverse effects upon the provision and use of public and private community services and facilities.

7. To minimize the burden upon municipal services and finance.

III GOAL

To minimize financial costs to the OWMC.

Objectives

A. To hold financial costs to the lowest level consistent with the other goals of the site selection process.

1. To minimize approvals costs.

2. To minimize site acquisition costs.

3. To minimize on-site development costs, e.g. clearing, drainage, grading, screening and other engineering modifications.

4. To minimize off-site development costs, e.g. service extensions, road improvements.

5. To minimize development and/or operations costs associated with the construction and operations of the facility components.

6. To minimize development and/or operations costs necessitated by site or area characteristics, e.g. special remedial or monitoring measures to protect human health and the environment.

7. To minimize on and off-site development and/or operations costs associated with effluent dispersion, if any, e.g. pipelines.

fig. 4

EXHIBIT A1 - CLASSIFICATION OF TRANSPORTATION ISSUES

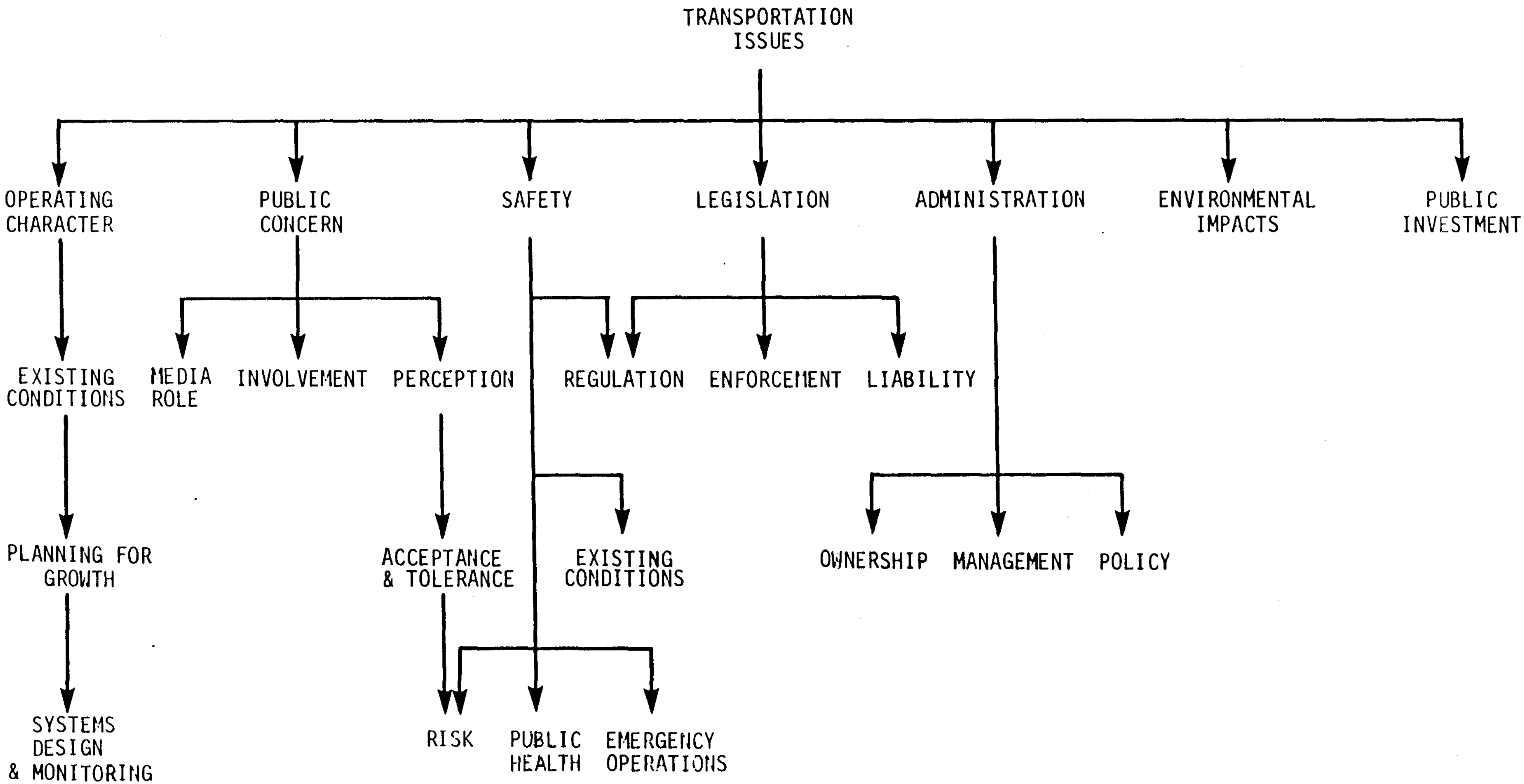

fig. 5a

TABLE 2-11

REVISED CONSTRAINT RANKING OF AGRICULTURAL INDICATORS

HIGH IMPACT	Existing specialty crops
	Class 1 or 2 with row crops or corn-wheat
	Class 1 or 2 with mixed, cereal grain, hay-grain or hay (good quality)
	Class 3 with row crops or corn-wheat
	Class 3 with mixed, cereal grain, hay-grain or hay (good quality)
	Class 1 or 2 with hay (poor quality), pasture or grazing
	Class 4 with row crops, corn-wheat
	Class 4 with mixed, cereal grain, hay-grain or hay (good quality)
	Class 3 or 4 with hay (poor quality), pasture or grazing
	Class 1 or 2 with non-agricultural land use
	Class 3 or 4 with non-agricultural land use
	Class 5, 6 or 7 with any use
LOW	Urban shadow, designated industrial and residual urban land, and publicly owned land with any soil capability and land use.

fig.5b

TABLE 4-3

RELATIVE SENSITIVITY OF CROPS TO INJURY BY CONTAMINANTS

Field Crops

Forages

Alfalfa	High
Clover	High
Corn	Intermediate
Grass	Intermediate

Grains

Barley	Intermediate
Buckwheat	Intermediate
Corn	Intermediate
Oat	Intermediate
Rye	Intermediate
Wheat	Intermediate

Other Seeds

Bean	High
Soybean	High
Sunflower	Intermediate

Specialty Crops

Leafy Crops

Asparagus	Low
Cabbage, Cauliflower Broccoli	Intermediate
Lettuce	High

Root Crops

Beet	Intermediate
Carrot	Intermediate
Onion	Intermediate
Potato	Intermediate

Vegetable Fruits

Snap Bean	High
Sweet Corn	Intermediate
Cucumber	Intermediate
Pea	Intermediate
Tomato	Intermediate

Fruit

Apple	Intermediate
Apricot	Intermediate
Cherry	Intermediate
Grape	Intermediate
Peach	Intermediate
Pear	Intermediate
Plum, Prune	Intermediate
Strawberry	Intermediate

Source: "SITE SELECTION PROCESS - PHASE 3B: SELECTION OF CANDIDATE SITES - Sensitive Crops," Ecologistics Limited. 1984.