Classification of the Visual Landscape for Transmission Planning[1]

Curtis Miller[2/], Nargis Jetha[3/] Rod MacDonald[4/]

Abstract: The Visual Landscape Type Classification method of the Route and Site Selection Division, Ontario Hydro, defines and delineates the landscape into discrete visual units using parametric and judgmental data. This qualitative and quantitative information is documented in a prescribed format to give each of the approximately 1100 Landscape Types a unique description. Utilizing the Landscape Types and evaluation criteria, an assessment can be made of the visual change to the landscape due to the introduction of transmission facilities. This paper elaborates on the effective application of Landscape Types in the Transmission Route Planning Process.

INTRODUCTION

The Visual Landscape Type classification method of the Route and Site Selection Division, Ontario Hydro was developed to define and structure the landscape into discrete visual units for use in a comprehensive Transmission Route Planning Process. The landscape, by virtue of its visual character, can be disaggregated into a hierarchy of visual types determined by identified measurable and perceived visual differences in the landscape at each level. This paper will concentrate on a method designed to operate at a regional level and be influenced by regional concerns in the location of broad band transmission corridors.

Assumptions

There are three underlying concepts associated with the visual impacts of transmission facilities. The first concept is that transmission facilities will change the character of a Landscape Type through which it passes. The degree of change is predictable and a viewer's perception of this change will likely result in a negative emotional response.

The second concept is that the viewer is conditioned to expect certain visual images associated with specific land uses. Transmission facilities often conflict with these expectations and are likely to result in a negative response.

The third concept is that the specific design of transmission towers can result in a negative response from a potential viewer. The degree of' response is a function of the tower size, tower style and number of lines.

These concepts must be integrated to achieve a full understanding of the visual impact of transmission facilities. This paper, however, focuses on the first concept and attempts to demonstrate the degree of change to the character of any Landscape Type caused by a transmission facility. The objective of the overall planning process is to avoid, where possible, those types which would be most severely affected by the imposition of a line or the elimination of a landscape element.

Data Handling

In order to define and delineate the landscape into discrete visual units, parametric and judgmental data ale collected. This information is documented to give each of the 1100 Landscape Types a unique description. For ease of data storage, retrieval and manipulation Ontario Hydro has developed a computer system[5/] to aid in regional siting

---

[1/]Submitted to the National Conference on Applied Techniques for Analysis and Management of the Visual Resource, Incline Village, Nevada, April 23-25, 1979.

[2/]Project Manager, Wirth Associates, Phoenix, Arizona 85016

[3/]Planner, Route and Site Selection Division, Ontario Hydro, Toronto, Ontario M5GIX6

[4/]Principal, Land Plan Collaborative Limited, Guelph, Ontario NIH4E6

[5/] Vaughn, A. V. 1976. Details and Possible Future of the Computer Assisted Route/Site Selection System, Ontario Hydro. Toronto, Ontario. Unpublished Document. 14 p.

studies. A unit area of $4km^2$ defined by a 2km by 2km grid referenced to the Universal Traverse Mercator (UTM) grid system is the basic unit for data classification collected at a scale of 1:250,000.

DEVELOPMENT OF LANDSCAPE TYPES

To circumvent deficiencies inherent in qualitative approaches to land system classification, an inventory process consisting of the systematic recognition, interpretation and analysis of the visual structure of the landscape was developed. In an evaluative method of visual sensitivity and impact analysis which stresses visual relationships between observers, installation and landscape, it becomes imperative that parameters are quantified in an objective manner. The measurable parameters were: landform/relative relief, water cover and forest cover.

Landform/Relative Relief

Landform is the most representative indicator of visual character in the landscape. Landform is the major visual constant, the major space-defining element in the Ontario landscape. Morphological characteristics can be inventoried directly from aerial photographs or, as is undertaken at Ontario Hydro, determined in a systematic manner (MacDonald, 1974).

Relative Relief, as defined in the inventory process, is a measure of the total change in elevation within each 2km by 2km grid cell. To gauge relative relief, measurements are read from 1:50,000 scale topographic maps and are accurate to the nearest 25 feet. The difference between the highest and lowest contour line found in each cell is taken as the measure of relative relief.

Cells of similar relative relief are grouped and unit boundaries are determined. This clustering process results in an objective classification of grid cells based on the relative relief element.

Water Cover

Water is a fairly constant indicator of visual character in the Ontario Landscape. Percentages of water cover in each 2km by 2km grid cell are recorded utilizing a dot screen method[6/]. A dot screen containing 100 evenly spaced dots in each grid cell, at the 1:50,000 scale, is overlaid on a typographic map. Dots that fall within water bodies are counted and the percentage encoded for that cell. Boundaries encompassing areas of similar water cover percentages are drawn.

Forest Cover

Percent forest cover values are calculated for each 2km grid cell utilizing the dot screen method outlined above. Although percent forest cover is a variable indicator of visual character and gives no indication of the distribution or variability of cover within individual cells, it does provide a relative measure for comparing the differences between units. Cells with a similar percentage of forest cover are grouped and boundaries formed to enclose these homogeneous areas.

Aggregation

Landscape Types (Figure I) are created by overlaying the units generated from the above three data maps of relative relief, water cover and forest cover. Where there are questions of boundary location between Landscape Types, aerial photographs, topographic maps, field observations and the collection of further information described below aids in the stabilization of those boundaries.

Non-parametric Data

The collection of non-parametric data may include forest and water patterns, degree of man-modification and openness. This additional information, along with the parametric data, is documented in a standardized format illustrated in Figure 2 Non-parametric data aids in: deciding whether large units can be broken down into smaller units, notes where changes (boundaries) may occur between Landscape Types and how dramatic or self-evident they are, and distinguishes physical features or development patterns which because of cultural/historical associations may make an area unique. In addition, this classification process establishes a consistent nomenclature for inventorying the diverse aspects of the landscape of Ontario.

Aerial photographs and ground surveillance are the primary data sources throughout this portion of the inventory process. Consequently, patterns that are visible from the air often playa major role in determining the description of a given area. Unfortunately, some patterns are not readily discernable at ground level. Regardless of this perceptual handicap, this information provide vital clues to the character of the visual landscape[7/]

[6/]Holt, V. S. 1977. Guidelines for Developing Landscape Units for Visual Impact Assessment. Ontario Hydro, Toronto, Ontario. Unpublished document. 5 p.

[7/]Podealuk, Fred T. 1977. Visual Resources: Definition of Terminology. Ontario Hydro, Toronto Ontario. Unpublished document. 42 p.

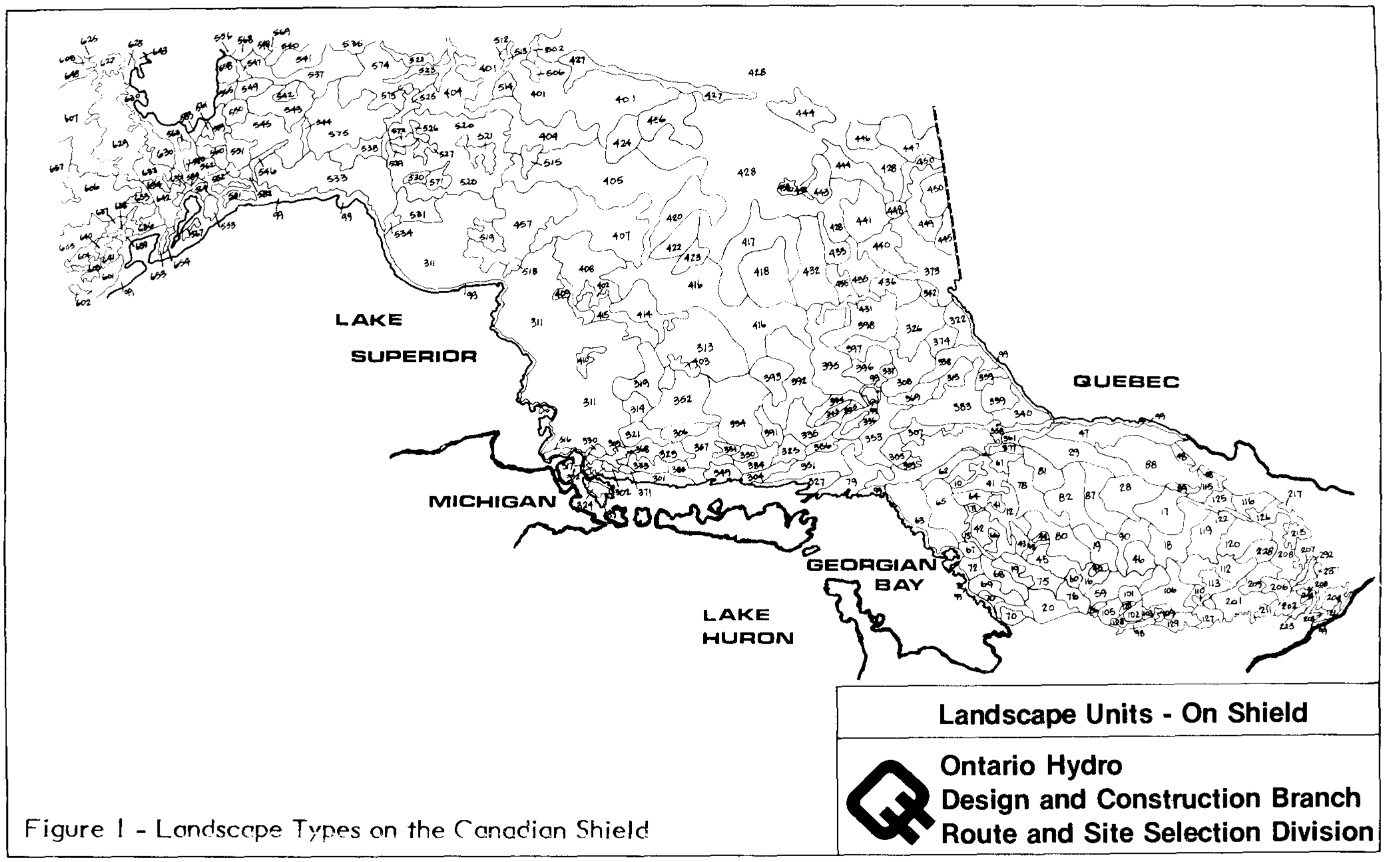

Figure 1 - Landscape Types on the Canadian Shield

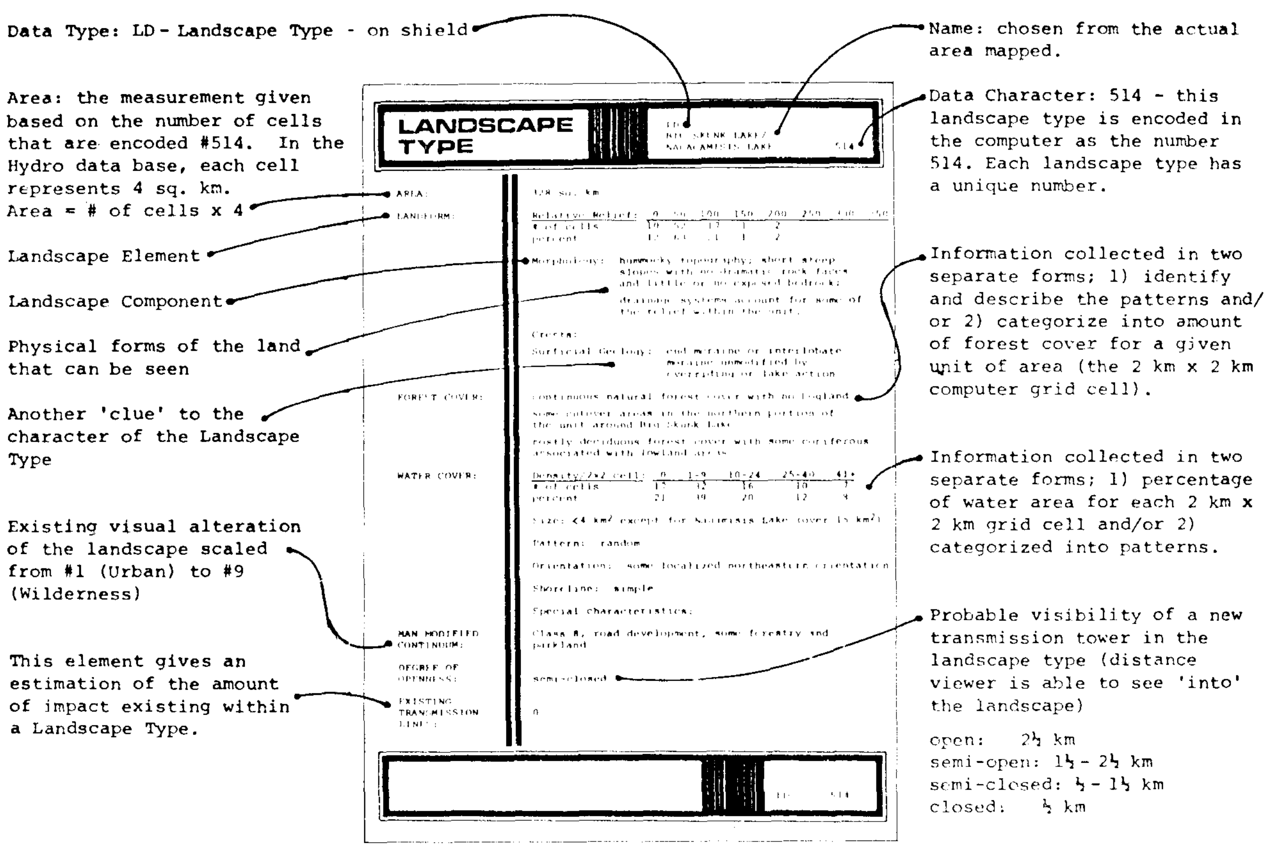

Figure 2 - Standardized Format for Data Documentation

Morphology--is related to the physical form of the landscape that can be seen. In order to achieve some degree of standardization a morphological classification was adopted. The dominant types of landforms that exist in the province include flat, flat with rock-island outcroppings, gently rolling, flat with rock ridges, hummocky, rolling and hilly.

Physiographic features--were identified within each Landscape Type to provide another "clue" as to their visual character. Some of these features found in Ontario include: clay plain, drumlin, escarpment, esker, kame moraine, limestone plain.

Forest Cover Patterns--were identified which cover existing situations throughout the province. Some examples are: checkerboard woodlots, continuous natural forest, continuous woodlots, hedge-rows, isolated woodlots, random bush.

Water Cover--characteristics of pattern, size, orientation and shoreline types were inventoried for two purposes. First, they indicate the contribution of existing lakes to the definition of landscape character and second, they assist in predicting the probability of impacting water bodies. Lakes are classified as either an isolated, integrated, or linear pattern, less than 4 square km, 4-to-16 square km or greater than 16 square km in size. Orientation is a general expression of the alignment of the majority of lakes to one of the major compass points. Shoreline types are either simple, irregular or complex.

Man-modified continuum--inventories the degree of man's alteration of the visual landscape. A comparative nine-point scale was developed which extends as a continuum from the unaltered natural landscape to the totally man-altered urban centers. The conceptual framework behind this landscape element was to provide a basis for identifying Landscape Types which have the greatest potential for or problems of "fit." For Ontario Hydro's purposes, "fit" may be described as the ability of transmission facilities to appear in harmony with various landscapes in the province.

Openness--inventories the degree to which a viewer is able to see into a landscape unit. To promote consistency of application, numerical values were assigned each openness category as follows: Open - greater than 2½ kms. ; Semi-open - ½-to-2½ kms . ; Semi-closed - ½-to-1½ kms ; and Closed - less than½ km.

Existing Transmission Lines--is an inventory of the number of existing transmission rights-of-way and the areal extent of their visual sphere of influence through each Landscape Type.

EVALUATION/ANALYSIS OF LANDSCAPE TYPES

The criteria used for evaluating to what degree the Landscape Types are affected by the introduction of a transmission facility evolved around specific characteristics of those Landscape Types. The evaluation focuses on what response there would be to a change in those characteristics. The charac teristics are:

- visibility in the landscape type
- spatial definition of the landscape type
- color of the landscape type
- naturalness of the landscape type
- complexity of the landscape type
- uniqueness of the landscape type
- historical significance of the landscape type
- preference for the landscape type.

These characteristics cannot all be quantitatively described, but can be demonstrated by various graphics and descriptive techniques to provide the planner, public, special interest groups or any other decision-maker with a rationale for 'why' a specific Landscape Type should be avoided.

Visibility in the Landscape Type

The degree of openness of a landscape type dictates the visibility of the transmission line. The capacity of a Landscape Type to screen a transmission line is a function of the amount of forest cover, relative relief and water cover. Experience in Ontario has shown that flat, forested landscapes with few lakes provide the best potential for screening a transmission line.

Spatial Definition of Landscape Type

A transmission facility can dominate the spatial characteristics of a Landscape Type. Spatial definition is a function of space defining objects and features such as landform, vegetation and builtform. Landscapes characterized by small intimate spaces, e.g., terminal morraine landscapes, can be severely impacted by major transmission lines.

Color of the Landscape Type

The color of the right-of-way can contrast dramatically with the surrounding landscape. Since the vegetation in the right-of-way is consistently managed to a specific height or type, its color in both summer and winter can be very different from the landscape adjacent to the right-of-way. This is particularly true in coniferous forested landscapes where the leaf color of early successional species in maintained rights-of-way contrasts with the coniferous forest color and winter snow contrasts dramatically with the green forests surrounding the right-of-way.

Naturalness of the Landscape Type

A transmission facility is closely associated with an industrial image. Its structural design reflects man-made built forms and contrasts dramatically with visual images of natural, pristine landscapes. The visual character of wilderness landscapes or landscapes in a near-natural state can be severely impacted by a major transmission facility.

Complexity of the Landscape Type

Transmission lines tend to be a simplistic built form. Their alignment is as near a straight line as possible. They are structurally homogeneous. They are continuous for long distances and visually monotonous. When located in complex landscapes with variable relief, variable vegetation types and patterns and variable land uses, a feature as simplistic and overwhelming as a transmission line contrasts dramatically with the surrounding landscape.

Uniqueness of the Landscape Type

It is assumed that a transmission line located in a unique landscape will be more easily perceived because of the viewers increased awareness of his surroundings. Landscapes which are dominated by lakes, special landforms, unique vegetation are examples of those types.

Historical Significance of the Landscape Types

Some Landscape Types have intentionally or unintentionally been preserved as remnants of cultural heritage. They visually reflect a period in history by the character of the buildings they hold, by the character of the lot and road pattern, and by the woodlot and hedge pattern. Transmission facilities impose an image of the industrialized 20th century and contrast dramatically with historical images. The potential viewer is likely to be aware of and sensitive to the visual intrusion of a transmission facility in this landscape.

Preference for the Landscape Type

Certain Landscape Types contain features or have characteristics which have traditionally attracted people. Water has always been an attraction. Landscapes dominated by lakes and rugged coastlines have long been a visual stimulus to people. Mountainous landscapes, landscapes which change dramatically with season and which have unusual or ever changing climatic situations have always attracted people. A transmission line located in these areas will likely affect the viewer's perception and long standing preference for such Landscape Types.

This visual analysis method utilizes the visual typology described in the previous section, to determine which characteristics in terms of complexity, spatial definition, etc. are most prevalent in each Landscape Type. The landscapes exhibiting the strongest characteristics are to be avoided where possible by transmission facilities. The weighting system, which determines the importance of the changes to the visual character of various types, is a combined attitudinal/value and best professional judgment analysis made through the use of a public Citizen's Committee and Transmission Route Planning Staff. The following section briefly describes the Transmission Route Planning Process.

THE PLANNING PROCESS

The Ontario Hydro Transmission Route Planning Process[8/] which determines the location and types of facilities in the landscape, entails a stepwise elimination of possible alternatives. At the initial phase, the entire study area is examined to determine continuous pathways or bands for a transmission facility which attempts to avoid areas of economic and environmental concern. These bands are then evaluated and compared and some alternatives are eliminated from further consideration. In a subsequent route selection phase, the remaining bands are studied in greater detail to identify specific routes and sites.

A current project, the East-West Interconnection Study (Miller 1978) illustrates the sequence of steps (Figure 3) used in recommending bands for further study. The following is a brief description of each of these steps illustrating the incorporation of Landscape Types into this planning process.

Data Inventory and Storage

Environmental data, collected from a variety of sources and mapped at a scale of 1:250,000, are inputted into Ontario Hydro's computer system.

Environment Divided Into Factors

Members of a public Citizens Committee are divided into Factor[9/]. Working Pups to discuss specific environmental objectives[10/] best related to their expertise and interest.

[8/] Vaughn, A. V. 1977. A Planning Alternative-The "Situation" Approach. Ontario Hydro, Toronto, Ontario. Unpublished document. 52 p.

[9/] A major resource heading (e.g., Agricultural Production, Recreation, Visual, Wildlife, etc).

[10/] A two-part statement consisting of: (i) a directive to "avoid" a particular environmental situation characterized by specific descriptive information contained within the data inventory, and (ii) an appended "because" clause outlining reasons why a situation should be avoided, in terms of the changes which could be expected if transmission facilities were located there and the perceived significance of those changes.

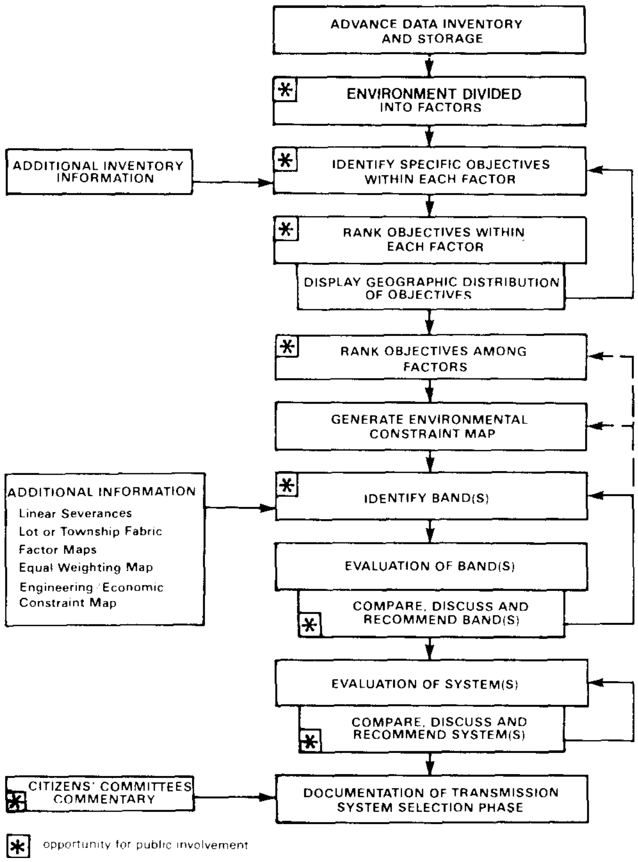

Figure 3 - Transmission System Selection Process

Identify Specific Objectives within Each Factor

Specific environmental objectives are identified and developed with respect to each factor of concern with the help of the Factor Working Groups. The geographical context used by the Visual Factor is the Landscape Types. The visual analysis method utilizes the visual typology discussed in the previous section to determine which characteristics in terms of complexity, spatial definition, etc. the most prevalent in each landscape type. The landscape: exhibiting the strongest characteristics are separated out as situations to be avoided by the transmission line.

Rank Objectives within Each Factor

The objectives within each individual factor are ranked in order to their relative priority by the members of each Factor Working Group. The ranking, a collective judgment by the group, reflects the relative importance of avoiding each environmental situation and is determined by considering the potential changes and significance of those changes to both the human and natural environment. The following example demonstrates the end product of a Factor Working Groups importance ranking of visual resources within the Visual Factor.

EXAMPLE: EAST/WEST TIE STUDY

First Ranked--Avoid viewsheds of the shorelines of Lake Superior, Lake Nipigon and the North Channel.

Second Ranked--Avoid landscapes characterized by high relief (greater than 400 ft.) ;see Figure 4.

Third Ranked--Avoid landscapes dominated by water; with more than 40 pct. water cover.

Fourth Ranked--Avoid major "U" and "V" shaped valleys, gorges and scenic waterfalls.

Fifth Ranked--Avoid areas designated as an "edge"

Sixth Ranked--Avoid landscapes moderately dominated by water; 20-to-40 pct. water cover.

Rank Objectives Among Factors

It is not possible to locate transmission facilities which avoid all identified significant environmental concerns. Therefore, it is necessary to establish a basis for making "trade-offs." A listing of all objectives in rank order provides the required guidance for any routing decision. Figure 5 illustrates this ranking process.

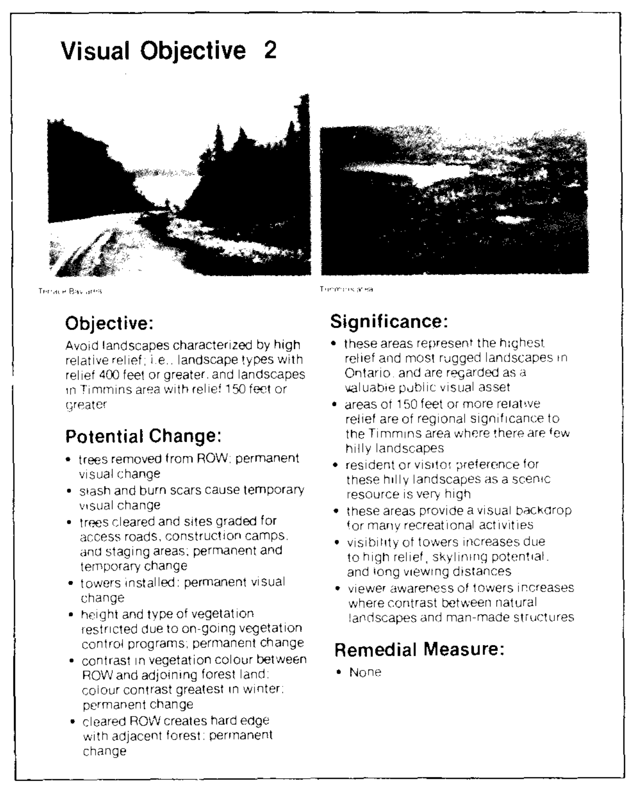

Figure 4 - Typical Objective Card

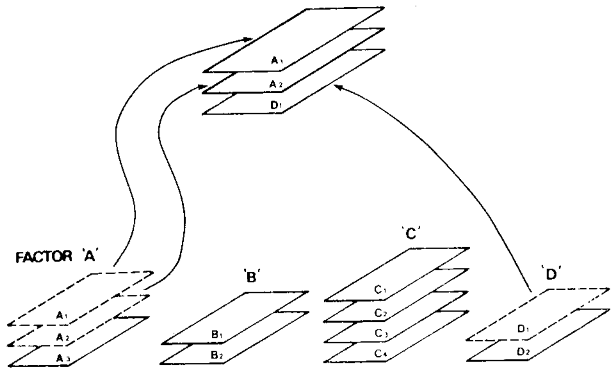

Figure 5 - Objective Ranking Process

Each major factor - or deck of cards - is ordered so that the highest priority objective is at the top of each factor - or deck. The decks are then presented to the citizen committee members, who are asked to discuss, compare and select the top card having the highest priority. This card is then removed from its deck and the next card in that deck is displayed. The process of review, comparison and selection is repeated. (In this second round, the committee members are examining the second card in one of the decks and re-examining the top cards in all the other decks.) This process is repeated until all the cards - or objectives - are ranked in order of their overall priority.

Produce an Environmental Constraintment Map

After completion of the ranking process, the computer is used to search and identify the highest rank objective for each 2 km x 2 km cell in the study area. This information is then depicted on a Constraint Map.

Identify Bands

Bands or pathways which avoid areas of greatest constraint are delineated to accommodate the system alternatives.

Evaluate and Compare Bands

Probable environmental implications expressed in terms of length of right-of-way, area of each band, width of right-of-way and environmental situations impacted are tabulated for each of the bands. Bands likely to have the best combination of least total environmental effect and maximum avoidance of the highest ranked situations are selected for more detailed routing studies.

CONCLUSION

The Visual Landscape Type Classification method of Ontario Hydro places a major emphasis on understanding the visual relationship between a transmission facility and the character of each Landscape Type in which a proposed installation might be located. An understanding of this relation ship provides the basis for the development of location and design criteria which minimize overall visual impact.

A method has been developed which systematically inventories the elements which constitute landscape character. The inventory process relies heavily on key measurable data, i.e., relative relief, forest and water cover, to identify each visual type. In addition, non-parametric data are collected for each type in a consistent manner. The quantitative data and descriptive information are combined to identify and describe each Landscape Type.

Opportunities for continuous and constructive public participation is provided in the planning process throughout the lifetime of a study. A Citizens Committee is established in a study area to gain public acceptance of the study method and the contents of the data base, to identify regional concerns and to establish an overall ranking of those concerns.

In conclusion, Ontario Hydro's visual analysis process consists of three phases:

- *inventory of the visual landscape
- assessment of the visual resources (including public preferences)
- integration into a holistic planning process.

This method has been effectively applied in four Regional Siting Studies and is currently being utilized in a major study in Northern Ontario. Ontario Hydro planners have found this method appropriate at the level of decision-making necessary for the delineation of broad band corridors.

LITERATURE CITED

MacDonald, Rod, et al.
1974. Location Hydro. Interdisciplinary Research, Centre for Resources Development, University of Guelph, Guelph, Ontario. 166 p.

Miller, Curtis and Alan Buck
1978. East-West Interconnection: Outline of Transmission System Selection Phase. Ontario Hydro, Toronto, Ontario. 23 p.