PRESERVING THE WOODLAND CHARACTER OF RESIDENTIAL DEVELOPMENTS IN RURAL AND URBAN FRINGE AREAS

Submitted by:

M. R. Gardner

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INTRODUCTION

The interface of urban and rural community growth with the forested lands of British Columbia presents a planning, design, and management challenge to urban foresters and other professionals involved in the development process.

Protection of woodlands, wetlands, creek and river floodplains, ravines, and open meadows can contribute to the quality of life by enhancing the aesthetic character of urban development, and providing rich recreational opportunities for inhabitants. Visual screening, separation of conflicting use areas, noise abatement, shade and wind shelter represent some of the other well known attributes of vegetation buffers (Robinette, 1972). Preserving the integrity of the natural hydrological cycle and watershed has both economic benefits and recreational advantages, while recognition of wildlife corridors and habitats can help to maintain an urban ecological diversity.

Much thought has been expressed on the relationship of man to the natural environment, with a common thread suggesting that man has failed to recognize his natural habitat as an all-encompassing entity worthy of a most diligent stewardship. As Simonds (1961) has said, "divorced from his natural habitat, (man) has almost forgotten the glow and exhuberance of being a healthy animal, and feeling fully alive." To maintain and improve the visual quality of our environment is in effect to impress a visual image of our historical identity on the collective mind of society.

This paper will address one component of environmental protection opportunities in the developing urban fringe; the preservation of woodland character. Optimizing woodland retention on development sites entails early identification and analysis of the forest resource, coordinated planning of roads, lots, services, or other land use areas, and demarcation of retention zones or individual trees designated for protection. A critical component in the process is the evaluation of appropriate species for retention, coupled with an assessment of retention zone ecological and physical viability related to windthrow hazard, watertable and drainage considerations, species composition, age-class diversity, density of growth, and the various topographic development constraints placed on the site.

Detailed clearing specifications and drawings depicting retention zone boundaries are critical to the success of forest protection efforts, but additional control through clearing supervision, installation of temporary snow fencing, builders' guidelines, municipal by-laws and other means is essential if the trees are to remain viable throughout the life of the subdivision.

Many well intentioned efforts to preserve woodland character have failed due in part to a lack of understanding of the dynamic nature of the forest resource and the behaviour of individual tree species, but also to a lack of coordinated planning and implementation procedures. Forest retention must be viewed as more than a planning or design component, and treated as part of a holistic landscape management strategy.

The paper describes two subdivision sites within British Columbia communities: Elkford, a new resource town in the coal mining region of Southeastern B. C., and Port Moody, a city expanding into the forests of the Coast Mountain Range. Although the communities are located in different biogeoclimatic zones, and the approach to tree retention reflects the respective forest type, the paper proposes a method of planning, site preparation, clearing, and post-clearing management applicable to a variety of developments on wooded lands.

ELKFORD RESIDENTIAL DEVELOPMENT

The Village of Elkford, established in 1972, is situated on the terraces of the Elk River in the Southeastern Rocky Mountains of British Columbia. The work force is primarily engaged in coal mining and the expected growth of the industry has led to a demand for an additional several hundred housing units required over the next five to ten years. As the community expands into the forested river terraces and mountain slopes the village planners recognize the need to protect the integrity of the woodland character by ensuring controlled selective clearing on development sites.

The most recent subdivision site was established in a mixed second growth stand primarily composed of Pinus contorta (Lodgepole pine), Pseudotsuga menziesii (Douglas-fir), and Picea glauca (White Spruce), with a generally sparse groundcover consisting of Gramineae species, Shepherdia canadensis (Buffaloberry), and Arctostaphylos uva-ursi (Bearberry). The post-fire succession stage is characterised by closely grown Pinus contorta dominating, with the more open xeric slopes and knolls supporting well-formed Pseudotsuga menziesii. Picea glauca are found throughout the site as secondary species in wetter hollows and level areas.

The road and lot lay-out plan recognized the aesthetic value of the Douglas-fir zones and generous parcels were designated for retention throughout the site. The primary retention opportunities to achieve visual screening and functional separation were identified in the back-lot areas of adjacent lots, whereas protection of individual trees other than Douglas-fir, was deemed impractical due to species constraints described below. Following preliminary logging operations to clear road right-of-ways, a detailed site investigation permitted the flagging of retention zones based on an evaluation of views, species windfirmness, tree form and health, and other factors.

The Lodgepole Pine displayed few lower branches on spindly and often decaying trunks, and were not considered windfirm due to a very shallow rooting habit. These factors limited the single tree retention opportunities in pine areas, and only larger contiguous blocks of trees were designated for protection. Younger and well-formed White Spruce were found to be prevalent throughout the site and were evaluated to determine retention potential. However, as White Spruce in mixed stands usually establishes in the shade of the existing canopy, the removal of adjacent vegetation would expose individual trees to sun-induced stress and delayed mortality could occur. White Spruce were, therefore, designated for

retention where they were already relatively open-grown and showed full crown development.

Interior Douglas-fir trees generally flourish in open xeric habitats and are characterized by an aesthetic form and acceptable windfirmness attributed to a deep or extensive root system. Large areas of Douglas-fir were designated for protection, while individual trees were also marked for retention in front and side-lot areas.

Selective clearing plans and detailed specifications were prepared and the site was logged, cleared, and grubbed. Control of the contractor's operations was limited and resulted in a number of localized damage to retention zones, although the woodland character of the site remains intact. An evaluation of the project revealed several important elements relating to selective clearing practices and they are summarized as follows:

- retention zone planning should commence concurrently with road and lot layout to ensure optimum tree preservation opportunities are realized.

- flagging of retention zones is expedited by accurate road or lot survey markers to allow accurate boundary demarcation.

- site briefings with contractors should provide a clear outline of retention goals and objectives.

- selection of appropriate equipment is important; for example, bulldozers are not adequate for shaping forest edge areas, and machines with buckets to pull material away from the edge are prefered.

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PORT MOODY; NORTH SHORE DEVELOPMENT

The City of Port Moody is located 30 kilometres south-east of Vancouver and is situated at the head of Burrard Inlet, immediately adjacent to the largely undeveloped Coastal Mountains. Increased demand for housing in the area has led to

rapid subdivision of sloping lands heavily forested with mature second-growth coastal species. The developer and City Council responded to existing planning policies formulated to preserve woodland character within these housing developments, and a report was prepared to evaluate forest retention opportunities and the related concerns of water management, slope stability in relationship to tree removal, and ravine area problems (Gardner & Peepre, 1980). The proposed Villages Development extends over 800 acres of moderate to steeply sloped land and is characterized by mixed stands of Pseudotsuga menziesii (Douglas-fir), Thuja plicata (Western Red Cedar), Tsuga heterophylla (Western Hemlock), and extensive tracts of hardwoods including primarily Alnus rubra (Red Alder), Acer circinatum (Vine Maple) and Acer macrophyllum (Bigleaf Maple). Groundcover and shrub layers are generally dense and represented typically by Polystichum munitum (Western Sword Fern), Gaultheria shallon (Salal), and Rubus spectabilis (Salmonberry). The site is in marked contrast to the dry interior Elkford study area, and is dissected by a large number of creeks, seasonal run-off swales, and springs. The soil structure is characterized by generally thin glacial till over by hardpan clay and bedrock, resulting in shallow rooted species, relatively weak topsoil development, and moist poorly drained conditions.

The initial site investigation included an intensive timber cruise to determine the economic value of the stand and map vegetation boundaries, coupled with a detailed assessment of forest retention constraints.

A comprehensive literature search was completed to develop vegetation species profiles, determine optimum sizes of retention zones, assess windthrow hazard, and gather data on other relevant environmental factors such as prevailing winds, precipitation, soil characteristics, and possible slope instability hazards. The data collected permitted the development of realistic guidelines with respect to the variable tolerance of individual tree species to windthrow, juxtaposition of retention zones relative to road and lot patterns, safe widths for leavae strips and ravine area protection zones. The preliminary plans for the Villages development were evaluated and compared to vegetation retention guidelines and a number of recommendations were outlined to optimize tree retention. Adjustment of road alignments, housing mixes and lot configurations, park locations and size, pedestrian easements, establishment of a "heritage tree" preserve, buffer strips, back lot retention areas, control during construction phases, restoration of forest cover on disturbed lands, and ravine management were addressed in these recommendations.

Following report submission, detailed planning and engineering studies were commenced for Phase I of the project. Road allowances were cleared and detailed site investigations to determine retention zone boundaries were completed, together with plans and specifications. In coastal environments the dominant species are often in excess of 40 m in height and may present a serious hazard to homeowners. Western Hemlock are the least windfirm and are prone to root rot, whereas Douglas-fir and Western Red Cedar are regarded as more windfirm. Removal of the dominant trees from a retention area in order eliminate hazards is not without problems as the suppressed trees are vulnerable to exposure stress as well as being prone to blowdown. Hardwood retention strips particularly Red Alder, are often irregular or unattractive in appearance, and subject to mass windthrow or breakage similar to the instability of narrow Lodgepole Pine stands.

Field identification of appropriate retention zones, and marking of individual trees for protection is, therefore, necessarily a technical decision based on environmental data, rather than solely a design element conceived to improve views or screen use areas. Furthermore, the normal life expectancy of the tree must be weighed against the time horizon normally attributed to urban developments, and some method of management enacted to ensure protection in perpetuity.

The Port Moody case study illustrated a number of factors which should be considered in the selective clearing process:

- modifications in servicing plans, road gradients, and lot layout may have a pronounced effect on realizing retention opportunities.

- retention zone flagging is improved when lot corners have been surveyed, as individual trees and clumps of vegetation may be more accurately plotted.

- contiguous blocks or strips of trees to remain must be of a size sufficient to resist windthrow.

- large or dangerous trees may be removed from retention areas without adversely affecting the integrity of vegetation to remain.

- protection of retention zones with fencing or other means is critical.

- the retention of single trees in front lot areas is difficult on small city lots as equipment damage and excessive cut or fill may follow during construction period.

DEVELOPMENT OF A WOODLAND RETENTION METHODOLOGY

The examples cited in Elkford and Port Moody, B. C. illustrate several important considerations relevant to the development of a workable methodology to preserve woodland character on development sites. Perhaps the most significant is the realization that some level of commitment to forest and tree protection exists at the professional, developer, and municipal political and civil level, a fact critical to the continued evolution of the process. Secondly, however, it is clear that woodland preservation is not fully integrated with planning and engineering decision making, resulting in frequent and unnecessary failures to optimize retention values.

A system is proposed to ensure that environmental and management factors relevant to woodland preservation are included in the early stages of planning, continued through site preparation and clearing phases, to construction and the operational time horizon of the project. A major conclusion of the two case studies was that planning and implementation phases are only a portion of the process, and that equal attention must be given to post clearing control and landscape management. The method proposed to improve the protection of

WOODLAND RETENTION METHODOLOGY

PLANNING

resource inventory	community ecological variables species composition, species profiles age-class structure, distribution, topography, drainage, edaphic factors Climate.
integration of resource inventory with development plans	road alignment and gradients lot layout & size, servicing requirements building placement, densities, preservation of ecologically viable retention areas protection of landscape character
SITE PREPARATION	road and lot surveys retention zone flagging safety considerations preparation of drawings and specifications
SELECTIVE CLEARING	selection of equipment site supervision
CONTROL DURING CONSTRUCTION	control of builders & subtrades protective fencing builder guidelines municipal by-laws
RETENTION ZONE MANAGEMENT	silvicultural practices municipal policies and by-laws holistic landscape management

woodland character on development sites includes five major areas of concern, each with a number of contributing factors as outlined below:

1. PLANNING

Resource Inventory

Forest retention must take into consideration the ecologically dynamic characteristics of plant communities as well as individual trees. The techniques of inventory may vary from sampling transects to visual observation depending on the scope of project.

Vegetation species composition, and age-class structure and distribution will provide important clues to retention opportunities, but topographic, climatic and edaphic factors are closely associated with a woodland community and should be regarded as controlling elements. Drainage characteristics of a site are important as some tree species are unable to withstand draw-down of the watertable, while certain soil profiles may indicate the dependence of

vegetation on surface recharge. The physiological and structural characteristics of individual plant species on the site should be assessed with regard to potential for retention given the development plans. Certain species are sensitive to sun or wind exposure resulting from clearing, while others may be prone to root rot, pests, or branch decay and breakage.

Integration of Resource Inventory with Development Planning

Forest retention is ideally a planning factor taken into consideration early in the development process, as coordination with road standards and layout, lot sizes and configuration, building placement, service and pedestrian easements, park areas and other open space lands will help to optimize the extent and quality of tree preservation efforts. Alternative development plans with regard to access rights-of-way alignment, or methods of lot servicing may have a marked effect on saving individual specimens, or blocks of desirable trees and other vegetation. Lot size and density are normally economic considerations, but clearly, clustered housing or large single family lots will provide greater flexibility in retention planning. On sloped lands, the expected cut or fill requirements to meet road or lot standards must be weighed against potential impacts on tree root systems,

and necessary remedial measures taken.

The designation of ecologically viable retention units is of considerable importance to facilitate later management in perpetuity, as well as protect the integrity of existing plant communities. A minimum threshold size is, however, difficult to ascertain and varies with site conditions. The full protection of groundcover, shrub layers, and tree canopy over a contiguous area sufficiently large to withstand anticipated development or user impacts may be based on an assessment of water availability, wind, sun exposure, types of plant species, and other established local precedents.

The planning stage will usually involve additional field surveys to ensure that preliminary road centre-lines and other land use boundaries are consistant with tree retention goals, and that the proposed designs reflect or complement the landscape character. A final tree retention plan at this stage in the development process is unrealistic, although general areas should be clearly designated.

2. SITE PREPARATION

Retention zone flagging is often scheduled to follow road centre-line clearing, in order to facilitate field location of reference points. Preliminary lot surveys are also advantageously completed at this stage to allow realistic

boundary flagging and demarcation of individual retention trees. A clear system of flagging to designate retention zone edges, selective thinning areas, and protection of individual specimens is essential to control bulldozing or felling operations. Effective flagging would take into account the biophysical constraints identified during the retention phase, and the safety of individual trees, as well as assimilate the site development goals. Feathering of woodland edge areas, marking of dead, diseased, or decadent trees, identification of thinning requirements, opening views, determination of hazards to buildings or rights-of-way, assessment of worthwhile specimen trees, and possible special methods required during clearing operations are some of the important components of the site preparation phase. Clear cutting followed by intensive restoration as opposed to the option of selective cutting should be assessed and decisions made in the context of site and financial constraints. In areas where large trees present a windthrow hazard, selective cutting and careful removal of logs will permit retention of the land base, complete with groundcover and shrub layers. Restoration planting with the dominant species may then follows.

Final contract drawings and specifications should be explicit to avoid unnecessary equipment damage and provide greater control over contractor operations. Clearing or

logging specifications may include statements to ensure the following desired practices:

- environmental protection during construction to avoid spillage of toxic wastes

- appropriate debris disposal methods to avoid dumping on sensitive areas or scorching of foliage from burning piles

- appropriate felling and bulldozing techniques to ensure that retention zones are not damaged or cluttered with clearing debris

- protection of root and trunk areas during clearing

- control over equipment movement, location of burning piles, and decking of logs to protect trees designated for retention

- penalty clauses to enforce protection of retention zones, coupled with clear authority invested in contract supervisor

- selective thinning and clearing along forest edges to ensure an aesthetic and natural appearance

3. CLEARING

Adequate supervision during clearing phases is usually necessary on all sites as equipment operators are normally not familiar with the objectives of environmental protection. Contractor briefings should include the equipment operators and fallers as the field interpretation of flagging will often be done by them rather than foremen. As the forest area is opened, some revision to retention boundaries may be appropriate, particularly in large stands of mature trees where the visual effect of cutting may not be apparent during the flagging stage.

Merchantable timber is normally piled according to species and trucked off the site, although the method of marketing is a matter of preference and depends on local conditions. Required timber marks, fire regulations, permits, and stumpage rates established by the appropriate forestry agency should be investigated and applied as necessary. The returns from the sale of logs may be utilized to finance replanting, or establish a trust fund for long term forest restoration and management.

The completion of initial clearing will result in a freshly exposed forest edge and hence a stabilizing period where blowdown may occur without property destruction should be

allowed. Services and other ground level construction may occur as the trees along edge areas are monitored, assessed, and removed as necessary. Preliminary erosion control measures such as seeding with fast germinating annual grasses or agronomic species will help to prevent soil loss, root exposure, and gully formation on sloping lands. Terracing, retention ponding, wilt traps, wattling, waterbars, and other techniques for water control may be necessary as interim measures in unstable or extreme slope zones.

4. CONTROL DURING CONSTRUCTION

Experience gained from residential development site clearing in both the Elkford and Port Moody case studies, suggests that successful woodland retention is accomplished as much through control during the construction phases, as control during the logging operations.

Soil compaction caused by heavy equipment movement over root zones, excessive cut or fill around individual trees or along the leading forest edge, abrasion of trunks, branch breakage, and disruption of water supply are a few of the factors popularly known as "contractor's disease". Although remedial measures such as tree well construction, corrective tree surgery or application of wound dressing are relatively

well known, the methods for effective control and prevention during construction are less evident in the literature (Pirone, 1972). Building siting and the relationship to adjacent lots may be modified to minimize the potential interference of root systems with service trenches, as well as permit stockpiling of soil away from tree drip-lines. Temporary snow fencing may also be effectively utilized to protect forest edges from equipment movement, sub-soil dumping, or spillage of toxic wastes.

However, these measures will only be followed if contractors are either informed and responsive to the relationship between the forest and development site, or if rules are rigidly enforced through contract specifications and penalties. Builder guidelines are a useful tool for provision of information, yet developer control is often relinquished after lot sale, and the site supervision opportunity negated.

Municipal tree cutting by-laws, if enforced, may be effective against outright destruction of trees during construction, but are impractical to mitigate stress related mortality caused by clearing.

5. WOODLAND MANAGEMENT

Development in lands peripheral to towns and cities often incorporates the previously contiguous and natural forest environment into the urban fabric, and contributes to what has been called the urban forest (Jorgensen, 1967). As an integral component of the urban landscape, these wooded areas must be managed effectively to optimize both human use, and life expectancy of the resource. Although urbanization drastically modifies the naturally occuring forest community, sensitive subdivision planning and designation of retention zones may allow new ecological balances to evolve. Larger tracts of woodland left undisturbed may be sufficiently resilient to user impacts and represented by a plant population diversity capable of maintaining a long term ecological stability. However, in most urban forest lands, and in particular the small residential retention areas described in this paper, natural processes of regeneration can be improved through sound silvicultural practices such as thinning or underplanting.

The urban forest presents a unique challenge in landscape management as elements of the natural resource with its varying composition and distribution, administrative and legal jurisdictions and practices, and user impacts must be assessed and formulated into a workable plan.

The initial step in management must be a public education and information program to gain support from users, elected municipal officials, and administrative staff. Only after a political commitment has been made can the necessary policy infrastructure to support a woodland and tree management plan be set in place. Municipal tree cutting by-laws, zoning, tax incentives, and restrictive covenants are a few of the avenues worthy of consideration, while on privately owned or strata-title lands strict tree preservation and management guidelines may be established.

The management plan should include goals and objectives for particular land units which reflect the composition and use of the wooded resource. Capital and operational costs, scheduling, and other factors must be considered on public lands, while mechanisms for enforcement of tree cutting and planting by-laws on private lots should be addressed.

Technical factors related to management of woodland retention areas may include selective thinning to obtain healthy growth of individual trees or allow diverse groundcover and shrub layer development, replacement of dead or decadent trees, restoration of disturbed sites by replanting native species mixes, or in smaller parcels, pruning and other

arboricultural practices. Woodland path maintenance, fire prevention, public education or interpretation monitoring and assessment of the management plan effectiveness, are other important components of a woodland management plan.

CONCLUSION

The paper has addressed the preservation of woodland character in urban development areas with a view to evolving a methodology that encompasses resource assessment, retention zone planning, site preparation, clearing, control during construction, and the critical management phase. Two project sites were examined initially to provide a documentation of existing techniques and areas of concern, while illustrating the different approaches required in dissimilar forest types.

The second part of the paper introduced an approach to woodland retention which may be applicable to a wide variety of development conditions. The planning stage, including a resource inventory and the subsequent integration with land use proposals was suggested as an important initial step, although early political commitment was envisaged as indispensable to the long term viability of preservation efforts. The technical aspects of site preparation, clearing, and control must reflect a sound analysis of environmental data, and a thorough

knowledge of resultant clearing impacts on individual plant species or communities, as well as fully incorporate site design criteria.

Retention area management during the operational time horizon of the development constitutes an important element of an overall landscape resource utilization plan, although the level of required or desirable sophistication may vary considerably depending on site conditions.

Land use patterns and expected time horizons for developments must be taken into account. For example, in resource towns similar to Elkford, the eventual depletion of coal resources may well lead to a decrease in population and a subsequent need to restore portions of the built-up landscape to a naturalized condition. Effective forest retention planning and management in the present could provide a basis for future restoration efforts.

Preservation of woodland character on development sites is, therefore, something more than aesthetic enhancement or a means to derive increased return on lot sales; rather it is a component of holistic landscape planning and management with long term human and environmental benefits.

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rapid subdivision of sloping lands heavily forested with mature second-growth coastal species. The developer and City Council responded to existing planning policies formulated to preserve woodland character within these housing developments, and a report was prepared to evaluate forest retention opportunities and the related concerns of water management, slope stability in relationship to tree removal, and ravine area problems (Gardner & Peepre, 1980). The proposed Villages Development extends over 800 acres of moderate to steeply sloped land and is characterized by mixed stands of Pseudotsuga menziesii (Douglas-fir), Thuja plicata (Western Red Cedar), Tsuga heterophylla (Western Hemlock), and extensive tracts of hardwoods including primarily Alnus rubra (Red Alder), Acer circinatum (Vine Maple) and Acer macrophyllum (Bigleaf Maple). Groundcover and shrub layers are generally dense and represented typically by Polystichum munitum (Western Sword Fern), Gaultheria shallon (Salal), and Rubus spectabilis (Salmonberry). The site is in marked contrast to the dry interior Elkford study area, and is dissected by a large number of creeks, seasonal run-off swales, and springs. The soil structure is characterized by generally thin glacial till over by hardpan clay and bedrock, resulting in shallow rooted species, relatively weak topsoil development, and moist poorly drained conditions.

The initial site investigation included an intensive timber cruise to determine the economic value of the stand and map vegetation boundaries, coupled with a detailed assessment of forest retention constraints.

A comprehensive literature search was completed to develop vegetation species profiles, determine optimum sizes of retention zones, assess windthrow hazard, and gather data on other relevant environmental factors such as prevailing winds, precipitation, soil characteristics, and possible slope instability hazards. The data collected permitted the development of realistic guidelines with respect to the variable tolerance of individual tree species to windthrow, juxtaposition of retention zones relative to road and lot patterns, safe widths for leavae strips and ravine area protection zones. The preliminary plans for the Villages development were evaluated and compared to vegetation retention guidelines and a number of recommendations were outlined to optimize tree retention. Adjustment of road alignments, housing mixes and lot configurations, park locations and size, pedestrian easements, establishment of a "heritage tree" preserve, buffer strips, back lot retention areas, control during construction phases, restoration of forest cover on disturbed lands, and ravine management were addressed in these recommendations.

Following report submission, detailed planning and engineering studies were commenced for Phase I of the project. Road allowances were cleared and detailed site investigations to determine retention zone boundaries were completed, together with plans and specifications. In coastal environments the dominant species are often in excess of 40 m in height and may present a serious hazard to homeowners. Western Hemlock are the least windfirm and are prone to root rot, whereas Douglas-fir and Western Red Cedar are regarded as more windfirm. Removal of the dominant trees from a retention area in order eliminate hazards is not without problems as the suppressed trees are vulnerable to exposure stress as well as being prone to blowdown. Hardwood retention strips particularly Red Alder, are often irregular or unattractive in appearance, and subject to mass windthrow or breakage similar to the instability of narrow Lodgepole Pine stands.

Field identification of appropriate retention zones, and marking of individual trees for protection is, therefore, necessarily a technical decision based on environmental data, rather than solely a design element conceived to improve views or screen use areas. Furthermore, the normal life expectancy of the tree must be weighed against the time horizon normally attributed to urban developments, and some method of management enacted to ensure protection in perpetuity.

The Port Moody case study illustrated a number of factors which should be considered in the selective clearing process:

- modifications in servicing plans, road gradients, and lot layout may have a pronounced effect on realizing retention opportunities.

- retention zone flagging is improved when lot corners have been surveyed, as individual trees and clumps of vegetation may be more accurately plotted.

- contiguous blocks or strips of trees to remain must be of a size sufficient to resist windthrow.

- large or dangerous trees may be removed from retention areas without adversely affecting the integrity of vegetation to remain.

- protection of retention zones with fencing or other means is critical.

- the retention of single trees in front lot areas is difficult on small city lots as equipment damage and excessive cut or fill may follow during construction period.

DEVELOPMENT OF A WOODLAND RETENTION METHODOLOGY

The examples cited in Elkford and Port Moody, B. C. illustrate several important considerations relevant to the development of a workable methodology to preserve woodland character on development sites. Perhaps the most significant is the realization that some level of commitment to forest and tree protection exists at the professional, developer, and municipal political and civil level, a fact critical to the continued evolution of the process. Secondly, however, it is clear that woodland preservation is not fully integrated with planning and engineering decision making, resulting in frequent and unnecessary failures to optimize retention values.

A system is proposed to ensure that environmental and management factors relevant to woodland preservation are included in the early stages of planning, continued through site preparation and clearing phases, to construction and the operational time horizon of the project. A major conclusion of the two case studies was that planning and implementation phases are only a portion of the process, and that equal attention must be given to post clearing control and landscape management. The method proposed to improve the protection of

WOODLAND RETENTION METHODOLOGY

PLANNING

resource inventory	community ecological variables species composition, species profiles age-class structure, distribution, topography, drainage, edaphic factors Climate.
integration of resource inventory with development plans	road alignment and gradients lot layout & size, servicing requirements building placement, densities, preservation of ecologically viable retention areas protection of landscape character
SITE PREPARATION	road and lot surveys retention zone flagging safety considerations preparation of drawings and specifications
SELECTIVE CLEARING	selection of equipment site supervision
CONTROL DURING CONSTRUCTION	control of builders & subtrades protective fencing builder guidelines municipal by-laws
RETENTION ZONE MANAGEMENT	silvicultural practices municipal policies and by-laws holistic landscape management

woodland character on development sites includes five major areas of concern, each with a number of contributing factors as outlined below:

1. PLANNING

Resource Inventory

Forest retention must take into consideration the ecologically dynamic characteristics of plant communities as well as individual trees. The techniques of inventory may vary from sampling transects to visual observation depending on the scope of project.

Vegetation species composition, and age-class structure and distribution will provide important clues to retention opportunities, but topographic, climatic and edaphic factors are closely associated with a woodland community and should be regarded as controlling elements. Drainage characteristics of a site are important as some tree species are unable to withstand draw-down of the watertable, while certain soil profiles may indicate the dependence of

vegetation on surface recharge. The physiological and structural characteristics of individual plant species on the site should be assessed with regard to potential for retention given the development plans. Certain species are sensitive to sun or wind exposure resulting from clearing, while others may be prone to root rot, pests, or branch decay and breakage.

Integration of Resource Inventory with Development Planning

Forest retention is ideally a planning factor taken into consideration early in the development process, as coordination with road standards and layout, lot sizes and configuration, building placement, service and pedestrian easements, park areas and other open space lands will help to optimize the extent and quality of tree preservation efforts. Alternative development plans with regard to access rights-of-way alignment, or methods of lot servicing may have a marked effect on saving individual specimens, or blocks of desirable trees and other vegetation. Lot size and density are normally economic considerations, but clearly, clustered housing or large single family lots will provide greater flexibility in retention planning. On sloped lands, the expected cut or fill requirements to meet road or lot standards must be weighed against potential impacts on tree root systems,

and necessary remedial measures taken.

The designation of ecologically viable retention units is of considerable importance to facilitate later management in perpetuity, as well as protect the integrity of existing plant communities. A minimum threshold size is, however, difficult to ascertain and varies with site conditions. The full protection of groundcover, shrub layers, and tree canopy over a contiguous area sufficiently large to withstand anticipated development or user impacts may be based on an assessment of water availability, wind, sun exposure, types of plant species, and other established local precedents.

The planning stage will usually involve additional field surveys to ensure that preliminary road centre-lines and other land use boundaries are consistant with tree retention goals, and that the proposed designs reflect or complement the landscape character. A final tree retention plan at this stage in the development process is unrealistic, although general areas should be clearly designated.

2. SITE PREPARATION

Retention zone flagging is often scheduled to follow road centre-line clearing, in order to facilitate field location of reference points. Preliminary lot surveys are also advantageously completed at this stage to allow realistic

boundary flagging and demarcation of individual retention trees. A clear system of flagging to designate retention zone edges, selective thinning areas, and protection of individual specimens is essential to control bulldozing or felling operations. Effective flagging would take into account the biophysical constraints identified during the retention phase, and the safety of individual trees, as well as assimilate the site development goals. Feathering of woodland edge areas, marking of dead, diseased, or decadent trees, identification of thinning requirements, opening views, determination of hazards to buildings or rights-of-way, assessment of worthwhile specimen trees, and possible special methods required during clearing operations are some of the important components of the site preparation phase. Clear cutting followed by intensive restoration as opposed to the option of selective cutting should be assessed and decisions made in the context of site and financial constraints. In areas where large trees present a windthrow hazard, selective cutting and careful removal of logs will permit retention of the land base, complete with groundcover and shrub layers. Restoration planting with the dominant species may then follows.

Final contract drawings and specifications should be explicit to avoid unnecessary equipment damage and provide greater control over contractor operations. Clearing or

logging specifications may include statements to ensure the following desired practices:

- environmental protection during construction to avoid spillage of toxic wastes

- appropriate debris disposal methods to avoid dumping on sensitive areas or scorching of foliage from burning piles

- appropriate felling and bulldozing techniques to ensure that retention zones are not damaged or cluttered with clearing debris

- protection of root and trunk areas during clearing

- control over equipment movement, location of burning piles, and decking of logs to protect trees designated for retention

- penalty clauses to enforce protection of retention zones, coupled with clear authority invested in contract supervisor

- selective thinning and clearing along forest edges to ensure an aesthetic and natural appearance

3. CLEARING

Adequate supervision during clearing phases is usually necessary on all sites as equipment operators are normally not familiar with the objectives of environmental protection. Contractor briefings should include the equipment operators and fallers as the field interpretation of flagging will often be done by them rather than foremen. As the forest area is opened, some revision to retention boundaries may be appropriate, particularly in large stands of mature trees where the visual effect of cutting may not be apparent during the flagging stage.

Merchantable timber is normally piled according to species and trucked off the site, although the method of marketing is a matter of preference and depends on local conditions. Required timber marks, fire regulations, permits, and stumpage rates established by the appropriate forestry agency should be investigated and applied as necessary. The returns from the sale of logs may be utilized to finance replanting, or establish a trust fund for long term forest restoration and management.

The completion of initial clearing will result in a freshly exposed forest edge and hence a stabilizing period where blowdown may occur without property destruction should be

allowed. Services and other ground level construction may occur as the trees along edge areas are monitored, assessed, and removed as necessary. Preliminary erosion control measures such as seeding with fast germinating annual grasses or agronomic species will help to prevent soil loss, root exposure, and gully formation on sloping lands. Terracing, retention ponding, wilt traps, wattling, waterbars, and other techniques for water control may be necessary as interim measures in unstable or extreme slope zones.

4. CONTROL DURING CONSTRUCTION

Experience gained from residential development site clearing in both the Elkford and Port Moody case studies, suggests that successful woodland retention is accomplished as much through control during the construction phases, as control during the logging operations.

Soil compaction caused by heavy equipment movement over root zones, excessive cut or fill around individual trees or along the leading forest edge, abrasion of trunks, branch breakage, and disruption of water supply are a few of the factors popularly known as "contractor's disease". Although remedial measures such as tree well construction, corrective tree surgery or application of wound dressing are relatively

well known, the methods for effective control and prevention during construction are less evident in the literature (Pirone, 1972). Building siting and the relationship to adjacent lots may be modified to minimize the potential interference of root systems with service trenches, as well as permit stockpiling of soil away from tree drip-lines. Temporary snow fencing may also be effectively utilized to protect forest edges from equipment movement, sub-soil dumping, or spillage of toxic wastes.

However, these measures will only be followed if contractors are either informed and responsive to the relationship between the forest and development site, or if rules are rigidly enforced through contract specifications and penalties. Builder guidelines are a useful tool for provision of information, yet developer control is often relinquished after lot sale, and the site supervision opportunity negated.

Municipal tree cutting by-laws, if enforced, may be effective against outright destruction of trees during construction, but are impractical to mitigate stress related mortality caused by clearing.

5. WOODLAND MANAGEMENT

Development in lands peripheral to towns and cities often incorporates the previously contiguous and natural forest environment into the urban fabric, and contributes to what has been called the urban forest (Jorgensen, 1967). As an integral component of the urban landscape, these wooded areas must be managed effectively to optimize both human use, and life expectancy of the resource. Although urbanization drastically modifies the naturally occuring forest community, sensitive subdivision planning and designation of retention zones may allow new ecological balances to evolve. Larger tracts of woodland left undisturbed may be sufficiently resilient to user impacts and represented by a plant population diversity capable of maintaining a long term ecological stability. However, in most urban forest lands, and in particular the small residential retention areas described in this paper, natural processes of regeneration can be improved through sound silvicultural practices such as thinning or underplanting.

The urban forest presents a unique challenge in landscape management as elements of the natural resource with its varying composition and distribution, administrative and legal jurisdictions and practices, and user impacts must be assessed and formulated into a workable plan.

The initial step in management must be a public education and information program to gain support from users, elected municipal officials, and administrative staff. Only after a political commitment has been made can the necessary policy infrastructure to support a woodland and tree management plan be set in place. Municipal tree cutting by-laws, zoning, tax incentives, and restrictive covenants are a few of the avenues worthy of consideration, while on privately owned or strata-title lands strict tree preservation and management guidelines may be established.

The management plan should include goals and objectives for particular land units which reflect the composition and use of the wooded resource. Capital and operational costs, scheduling, and other factors must be considered on public lands, while mechanisms for enforcement of tree cutting and planting by-laws on private lots should be addressed.

Technical factors related to management of woodland retention areas may include selective thinning to obtain healthy growth of individual trees or allow diverse groundcover and shrub layer development, replacement of dead or decadent trees, restoration of disturbed sites by replanting native species mixes, or in smaller parcels, pruning and other

arboricultural practices. Woodland path maintenance, fire prevention, public education or interpretation monitoring and assessment of the management plan effectiveness, are other important components of a woodland management plan.

CONCLUSION

The paper has addressed the preservation of woodland character in urban development areas with a view to evolving a methodology that encompasses resource assessment, retention zone planning, site preparation, clearing, control during construction, and the critical management phase. Two project sites were examined initially to provide a documentation of existing techniques and areas of concern, while illustrating the different approaches required in dissimilar forest types.

The second part of the paper introduced an approach to woodland retention which may be applicable to a wide variety of development conditions. The planning stage, including a resource inventory and the subsequent integration with land use proposals was suggested as an important initial step, although early political commitment was envisaged as indispensable to the long term viability of preservation efforts. The technical aspects of site preparation, clearing, and control must reflect a sound analysis of environmental data, and a thorough

knowledge of resultant clearing impacts on individual plant species or communities, as well as fully incorporate site design criteria.

Retention area management during the operational time horizon of the development constitutes an important element of an overall landscape resource utilization plan, although the level of required or desirable sophistication may vary considerably depending on site conditions.

Land use patterns and expected time horizons for developments must be taken into account. For example, in resource towns similar to Elkford, the eventual depletion of coal resources may well lead to a decrease in population and a subsequent need to restore portions of the built-up landscape to a naturalized condition. Effective forest retention planning and management in the present could provide a basis for future restoration efforts.

Preservation of woodland character on development sites is, therefore, something more than aesthetic enhancement or a means to derive increased return on lot sales; rather it is a component of holistic landscape planning and management with long term human and environmental benefits.

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