The Stewardship Series

Access Near Aquatic Areas

A Guide to Sensitive Planning, Design and Management

Canada

Province of British Columbia

Foreword

Access Near Aquatic Areas was produced by the Fraser River Action Plan (Fisheries and Oceans Canada) and the Ministry of Environment, Lands, and Parks.

Access Near Aquatic Areas is part of the Stewardship Series, which has been developed to provide guidelines for planning and management of access near sensitive aquatic areas.

Companion documents to Access Near Aquatic Areas include:

- Community Greenways: Linking Communities to Country, and People to Nature (1996)
- Community Stewardship: A Guide to Establishing Your Own Group (1995)
- Naturescape British Columbia, Caring for Wildlife Habitat at Home (1995)
- Stewardship Options: A Guide for Private Landowners in British Columbia (1996)
- Stream Stewardship: A Guide for Planners and Developers (1994)

Access Near Aquatic Areas, as well as the above documents, are available from:

Habitat and Enhancement Branch
Fisheries and Oceans Canada
555 W. Hastings St.
Vancouver, BC
V6B 5G3

Ministry of Environment
Habitat Protection Branch
10334 - 152A St.
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Access Near Aquatic Areas

A Guide to Sensitive Planning, Design and Management

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1.0 Introduction

British Columbia has many lakes, rivers, streams, wetlands and estuaries. These areas, along with their vegetated valleys and floodplains, are critical fish and wildlife habitats as well as being important to our communities and our well being. They provide community water supplies, and valuable fish and wildlife habitat. They also protect adjacent lands from natural flood and drought events, and preserve the unique and scenic character of this region. Many of these features are fragile and easily disturbed and are therefore considered environmentally sensitive areas (ESAs).

Sensitively designed public access protects ecological features and functions

As our population increases, conflict between demands for greater access to these sensitive areas and adequate protection of them is increasing. In rural regions conflicts often arise where these fertile and productive areas are logged or used for grazing, or intensive crop production. In urban areas the problem is becoming more pronounced as these areas are being developed or encroached upon for residential, commercial or industrial use (e.g. sewer and water alignments, roads, mass transit and linear parks). A recently conducted survey shows that natural areas are very important for community recreation. It has been estimated that 1 - 2% of the population in a community regularly use skating rinks, while 5 - 7% routinely use a swimming pool. However, over 50% regularly hike or use foot paths through natural 'greenways' where they exist. (Ed McMahon, Director of American Greenways).

The challenge - protecting aquatic ESAs while accommodating access

Where environmental values are high and encroachment would be particularly damaging, access may have to be controlled, limited or even restricted. Where access to aquatic areas is appropriate, it demands careful planning, design and management.

With increased pressure on these areas, a stewardship approach to public access is needed in order to sustain these fragile ecosystems. Stewardship of these areas requires that all users and managers share responsibility and cooperate in management and conservation of these areas.

This document, another in the *Stewardship Series,* provides a guide to balancing conservation with planning, design and management of access near aquatic areas. It focuses on settlement lands and is intended for use by municipal and regional parks planners and staff, landscape architects, consultants, field staff of environmental agencies, and community conservation groups. It will also be of interest to individual land owners with environmentally sensitive lands who need to manage access issues on private property.

2.0 The Ecological Context for Managing Aquatic ESAs

2.1 What is an Aquatic ESA?

Rivers, lakes, streams, wetlands and estuaries are commonly referred to as aquatic environmentally sensitive areas (ESAs). An aquatic ESA may be perennially wetted or may be an ephemeral wetland; it can be a floodplain, headwater drainage, or ditch. An aquatic ESA could also be a subsurface feature such as an aquifer.

Aquatic ESAs also include the riparian zone. The riparian zone, which is a transition between the aquatic feature and the adjacent upland, is characterized by moist soils and a complex of herbaceous and woody vegetation that is adapted to moist conditions.

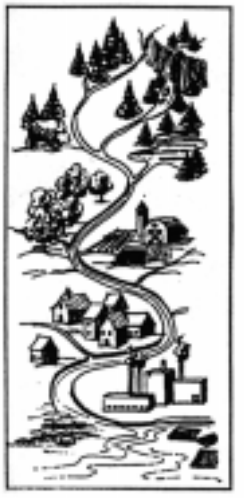
Streams and riparian areas are examples of aquatic ESAs

Sandhill Crane in a wetland

Fish and Wildlife Values of Riparian Zones:

- support the aquatic and terrestrial food webs for fish and wildlife
- provide shelter, cover and temperature regulation for fish and wildlife
- create habitat diversity for songbirds, raptors, small mammals and other wildlife species
- provide wildlife migration corridors and linkages between critical habitats
- buffer aquatic features from pollution
- recharge ground water and aquifers
- stabilize banks and reduce erosion
- dissipate energy of floods
- retain water in soil during droughts

2.2 The Importance of Watershed Planning



Watersheds range in size, but all have the same features. They are catchment areas that drain an area defined by heights of land such as mountains and ridges. Watersheds collect and retain water which is received as precipitation, and slowly release it via seepages or direct discharge into a network of small drainage features. These coalesce to form small first order streams which merge to form second order streams and ultimately rivers. (Diagram from *The Watershed Works*).

Watersheds, like the aquatic ESAs they create, are dynamic systems. They evolve in response to a host of biological, hydrological and geological processes and cycles, all of which can be irrevocably altered by human activities.

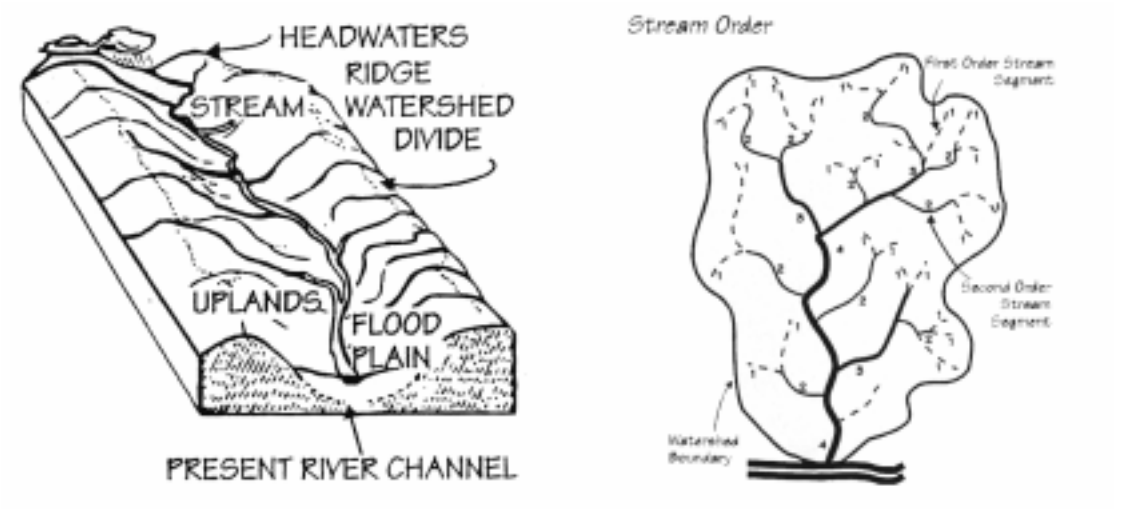


Figure 1 Aquatic ESAs are Products of Watershed Processes
(from *The Streamkeepers Handbook*)

Modification of landscape features and interruption of natural drainage processes have occurred in many watersheds. The result has been a reduction or disappearance of fish and wildlife, increased contamination of surface and groundwater supplies, increased periodicity and magnitude of floods, and a decrease in our quality of life. It has also led to a loss of open space, and a fragmentation of habitats. Over time, it has become clear that the cost of redressing watershed scale impacts significantly exceeds the cost of preventing them in the first place.

Protection of aquatic ESAs requires basic knowledge of watershed processes and an understanding of the consequences of altering these processes.

Watersheds are natural landscape units that integrate many natural processes. As such, they provide a basis for land use and access planning that is sensitive to aquatic protection.

2.3 Ecological Principles for Access Planning

Access plans near sensitive aquatic areas should be based on the following ecological principles:

Ecological Principles:

- Aquatic and riparian areas are critical habitats for fish and wildlife and need to be protected from disturbance.
- Intact wetlands and floodplains are essential for maintaining natural channel morphology, water quality, stream hydrology and natural flood protection.
- Streams, wetlands and other aquatic features are the product of hydrologic, geologic and other processes which often occur in areas well removed from the aquatic feature itself.
- Rivers, streams and riparian areas integrate, express, and accumulate impacts throughout a watershed.

2.4 Establishing Management Objectives

Management objectives for aquatic ESAs need to be established early in all planning processes and should reflect the need to protect (and where possible restore) local environmental values while providing compatible opportunities for access. Management objectives form the basis for planning and design of access to aquatic areas, and as such should be clearly stated in policy and planning documents.

Management Objectives for Aquatic ESAs:

Primary Management Objective:

- to conserve, protect, and restore natural aquatic and riparian habitats and their fish and wildlife populations

Secondary Management Objective:

- to establish a variety of non-intrusive or non-damaging uses in association with largely undisturbed aquatic and riparian habitats

Aquatic ESAs should be principally managed for conservation, protection and restoration

2.5 Determining Compatible Uses

Conservation is necessary to maintain the values in sensitive aquatic areas that make them attractive and scenic. Activities which are compatible with conservation can be encouraged through good planning and design.

Activities Compatible with Protection of Aquatic ESAs Include:

- walking, jogging and hiking
- ecological interpretation
- wildlife viewing
- promotion of environmental awareness
- photography and painting

Incompatible Activities Include:

- livestock grazing
- hunting
- mountain biking
- horse riding
- motorcycle, ATV or snowmobile use

Bird watching - a compatible activity in an aquatic ESA

3.0 Access Planning, Design and Management Principles

Many examples exist in North America where access has been sensitively designed to protect critical habitats. The following planning, design, and management principles have been extracted from several Canadian and American case studies (see Appendix 1), field reconnaissance in the Lower Mainland of B.C., and discussions with government agency and private sector representatives.

3.1 Planning Principles

- Aquatic ESAs need to be isolated from disturbance. This can be accomplished by establishing leave areas (reserve zones) around them[1].
- A buffer adjacent to the leave area is required to:
  - protect the leave area;
  - accommodate recreational trail corridors;
  - prevent conflicting uses next to each other;
  - provide a transition between adjacent land uses.
- The combination of a leave area and a buffer (management zone) permits management for multiple uses (e.g. protection and recreation).
- Impacts must be limited in time and space to very specific locations which are most tolerant to disturbance.
- Where recreational use is proposed, a hierarchy of trails, footpaths, and structures should be planned. These must consider site sensitivities, and should only support compatible uses.
- Nearby residents should be buffered from trail users.
- Interpretive opportunities and public stewardship should be encouraged.
- Penetration into leave areas (e.g. trails, footpaths, livestock crossings, etc.) should be kept to a minimum.
- As site sensitivity and hazards may increase seasonally, access plans must address these issues.

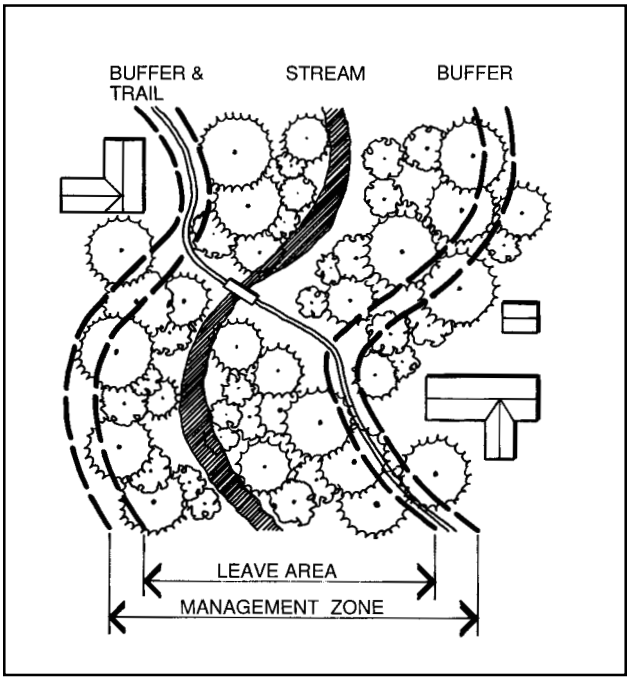


Figure 2 Illustration of Leave Area, Buffer and Proper Trail Alignment

3.2 Design Principles

- Leave areas (reserve zones) should be clearly delineated and protected from any disturbance prior to and during construction.
- Main access should be concentrated in one major corridor located in the buffer area.

[1] Guidelines for establishing leave areas along streams to protect fish habitat are contained in the *Land Development Guidelines for the Protection of Aquatic Habitat*, published by Fisheries and Oceans Canada and the Ministry of Environment, Lands, and Parks (1992).

- Access should be designed to encourage foot traffic and discourage other forms of traffic.
- Barriers should be used as necessary. For example, install:
  - fences to prevent livestock access into leave areas;
  - combination of fences and vegetative barriers to buffer residents from adjacent land uses or trail users;
  - baffles or turnstiles to prevent unauthorized vehicle access onto trails or private property;
  - live barrier blinds along trail boundaries to minimize disturbance to waterfowl.

Fencing is often necessary for human safety

- Structures in leave areas should be designed to separate approaches and traffic either vertically or horizontally from sensitive habitats (e.g. through use of boardwalks, bridges, and railed pathways).

A board walk separates traffic vertically from sensitive habitat

- Soil disturbance, erosion and vegetation removal should be minimized by design and during construction.
- Interpretive signage, kiosks or bulletin boards should be installed at strategic locations (e.g. road crossings, viewpoints, trail heads, etc.) to provide information on environmental values, stewardship initiatives, or to post trail use rules.

3.3 Management Principles

A management plan[2] needs to be developed for these areas which specifies:

- maintenance standards for all structures and trails;
- a schedule for maintenance work;
- trail use rules and guidelines;
- closures of seasonally sensitive or hazard areas (with informational signage and temporary barriers);
- schedule for garbage collection;
- pet management (prohibited/on leash, etc.).

The principle of the *least impact* should always apply when managing or maintaining structures or trails near aquatic ESAs.

Trail use guidelines, barriers and litter control are all part of access management

[2] For additional information on trail planning, design and construction, and maintenance standards, as well as signage and barrier design, refer to the B.C. Parks' *Park Facility Standards Manual, Volumes 1 and 2*, 1992.

4.0 Access Routing Near Sensitive Aquatic Areas

When considering whether public access near aquatic ESAs is appropriate, the following questions must be addressed:

- Is the secured land base large enough to protect leave areas (reserve zones) around sensitive aquatic habitats and provide a buffer for access alignment?
- Can liability, land use conflicts, hazards and potential conflicts with critical environmental features be minimized through skillful site planning and design, and good site management?

Where the answer to both of these questions is yes, detailed site assessments and access planning need to be done in order determine the exact location of trails and access points, and to develop a site plan.

4.1 Site Assessment

Access near an aquatic ESA must be sited in a manner that:

- preserves sensitive features such as riparian and marsh vegetation, unique plants, wetlands, or fish habitat, waterfowl nesting areas, or habitats of endangered or threatened species;
- protects users from hazards;
- minimizes alteration of drainage and disturbance of slopes.

To determine the best location for access, detailed site assessments are needed.

4.1.1 Environmental Sensitivity Assessment

Environmental sensitivity can vary from site to site. The sensitivity of a site is based on:

Biological values:

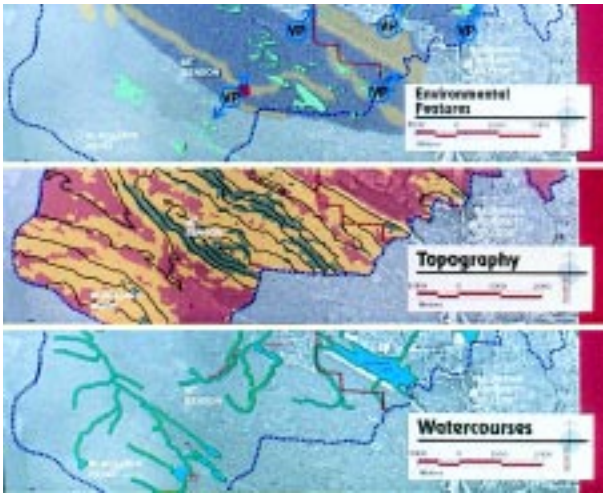
- fish and wildlife use
- location and extent of riparian vegetation
- unique, endangered or threatened plant and animal species[3]

Physical features:

- unstable slopes
- erodable soils
- topography (e.g. escarpments or ravines)
- shallow rooted trees with high windthrow potential
- drainage features (e.g. seeps, springs, ephemeral channels, etc.)
- streams, wetlands, and floodplains

All of the above, as well as local precipitation patterns and adjacent land uses, will influence decisions regarding location and appropriateness of trails, access points or other potential uses near aquatic ESAs.

As all upstream activities in a watershed influence downstream habitats, linkages and cumulative impacts must be considered when assessing sensitivity of a site to further disturbance.



Mapping physical features and biological functions are part of site assessments for access planning
(from *Community Greenways*)

[3] The provincial listing of rare and endangered species is available from the Provincial Conservation Data Centre in Victoria, or via the CDC Web site at www.env.gov.bc.ca/wld/cdc

Existing site specific information should be compiled and where necessary supplemented by site surveys and geotechnical assessments to accurately delineate and map sensitive habitat features, hazard areas, top of bank, leave area boundaries, buffer boundaries, livestock access points, and specific trail routes and alignments.

4.1.2 Safety and Risk Assessment

Consideration of liability and human safety issues at the site assessment stage is important. The location of hazard areas, adjacent land uses and the proximity of proposed access points and alignments to private property must be determined when establishing the management zone around aquatic ESAs and evaluating trail alignment options. Fencing or other types of barriers may be necessary where potential conflicts exist.

Fencing is often necessary for human safety

If an easement has been dedicated by a land owner to a local government, agreements should be developed that indicate responsibilities assumed by each party.

The health and wind firmness of trees, and risks to trail users associated with falling trees need to be assessed. Adequately sized buffers between leave areas and developed areas not only provide a corridor for trail alignment but they also enhance natural successional forest processes. These increase the integrity of the buffer edge and have the added benefit of protecting adjacent property owners' buildings and structures. Dead trees that do not pose a direct hazard should be retained as habitat for wildlife.

4.2 Principles for Planning Public Trails and Access Points

Once suitable sites are identified for public access, an appropriate trail and access system can be developed. Following are principles for planning and design of trails and access points near aquatic ESAs.

4.2.1 Trail System

A *hierarchy of trails* should be established, reflecting the conditions and intended uses near the aquatic ESA:

- *Main or multi-use trails* should be located outside the leave area in a buffer area. These may be multi-use pathways that accommodate pedestrians, cyclists and wheelchairs. These trails can have viewpoints and interpretive signage along their length.
- *Connecting trails* link road ends and residential neighbourhoods to the main trail and to other parts of a greenway.
- *Limited access trails* which penetrate the leave area are used for special purposes. An elevated boardwalk may be used to skirt a wetland; a small footpath may be used to access a particular point of interest such as a salmon spawning area. These minor paths are designed for low volume use.

Fencing is often necessary for human safety

- *Viewpoints* which are often located within the leave area should be set back from the most sensitive areas and/or elevated with railings.
- *Trail heads* should be located in the least sensitive areas of the buffer zone.
- *Trail staging areas* are entry points to the trails system, and should be centrally located within the buffer area.

Each of these trail types will be designed to different standards. Maintenance and spacing requirements for each trail type will vary as well. Barriers may be needed to delineate leave area boundaries or prevent intrusion into particularly sensitive areas. Each of these issues is addressed in subsequent chapters.

4.2.2 Trail Use

Decisions regarding desired trail use should be made at this stage. Trails to be used by both bicyclists and pedestrians have different location and design considerations than trails to be used by pedestrians only. Trail use will dictate locations for vehicle barriers, bicycle racks, hitching posts, fences, and other structures such as trail entrance baffles. These structures should be located at trail heads or in staging areas in the buffer zone. Whenever possible, universal access (including handicapped access) should be accommodated for at least a portion of the main trail.

4.2.3 Location of Limited Access Trails

In order to access specific features that are being showcased, the leave area can be penetrated in specific locations using limited access trails. These trails should be aligned to:

- provide the most direct route to viewing areas, interpretive kiosks and crossing structures;
- avoid areas with high soil compaction potential;
- avoid sensitive or unique vegetation;
- prevent physical intrusion into 'wet areas' such as groundwater seepage areas, small ephemeral wetlands or side channels and floodplains;
- avoid erodable stream banks or other erosion prone areas and/or be elevated above them.

4.2.4 Site Planning Process

Once alignment issues are addressed, specific design can occur. Resource management agencies such as the Department of Fisheries and Oceans and the Ministry of Environment, Lands, and Parks should be consulted early in the planning stages to help define alignments and identify constraints. In the Lower Mainland, application forms for Environmental Reviews and works in and about an aquatic ESA must be completed.[4]

During the site planning phase all proposed trail alignments, leave area and buffer boundaries, locations of barriers and viewing structures need to be accurately surveyed by qualified surveyors or engineers. The precise location of these features can then be identified on-site during final design with stakes and flagging tape.

Before final design and construction commence, the site plan and design should be reviewed and approved by a municipality's environmental officer (or equivalent). The officer can ensure compliance with all environmental regulations and requirements, as well as comment on construction materials and methods.

Instream construction must be carried out during the seasonal 'operating window' when construction impacts to fish and fish habitat are reduced. As these 'windows' vary depending on the fish species present and the location in the province, planners and proponents should contact the nearest Department of Fisheries and Oceans or Ministry of Environment, Lands, and Parks office for information on the approved instream work window for their area.

[4] Application forms for Environmental Reviews in the lower mainland of B.C. are available from Ministry of Environment, Lands, and Parks, Planning and Assessment Branch, 10334-152A St., Surrey.

5.0 Design and Construction Standards for Public Access

This section provides guidelines for the design and construction of public access corridors near sensitive aquatic areas.

Design components of a public access plan near aquatic ESAs generally include:

- trails and viewpoints
- boardwalks and footbridges
- viewing decks and raised platforms
- pedestrian bridges and boardwalks
- barriers (e.g. fences, gated utility service points, hitching posts, bicycle turnstiles or baffles)

5.1 Trail and Structure Construction

In all cases where trails are aligned near an aquatic area, care must be taken to limit vegetation removal and soil disturbance during trail construction. Surface grubbing should be kept to a minimum and trail widths minimized to reduce vegetation removal. Wooden edging or risers can be used to establish trail widths and avoid trail widening over time.

The use of heavy equipment in these areas should be discouraged. Low impact construction techniques should be employed such as small underinflated, rubber tired vehicles, and construction pads, platforms or cranes. Wherever possible prefabricated structures that can be manually assembled on site should be used.

Limited access trails which penetrate the leave area should be constructed manually with materials and equipment that can be easily transported by small work crews.

5.1.1 Trail Construction Materials

Trail surfaces should consist of permeable, non-toxic material. Crushed aggregate with a lightly compacted aggregate sub base is the preferred trail surface for high use or main trails (Figure 3). Bark mulch or hog fuel should not be used on trail surfaces near water as they produce leachate which causes serious water quality problems. Asphalt is not desirable as it is impermeable and accelerates run-off.

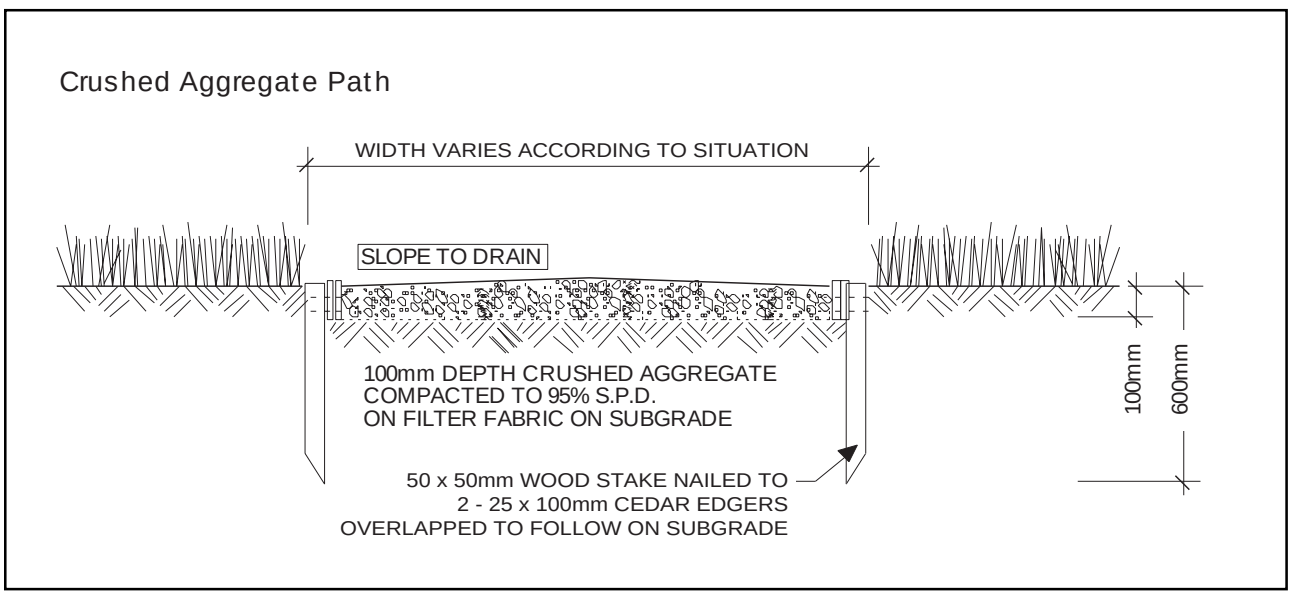


Figure 3 Section Through Crushed Aggregate Path

Example of a crushed aggregate path surface

Aggregate trail mix surfaces usually are comprised of crushed rock and fines. They must be lightly compacted over a sub base to resist erosion, provide drainage, and to be safe. Though satisfactory for more accessible pathways, such surfaces may be impractical for remote trail areas. Compacted granular soil has also been used successfully as footpath surface material. The resulting mix is reasonably permeable, resists flooding and erosion, withstands foot traffic, and requires little maintenance.

Small (limited access trails) should not be over designed. Where possible natural surfaces should be retained and not compacted.

5.1.2 Specific Trail Widths

Main trails

Main trails are typically 2.0 to 3.0 metres in width, and are located in the buffer area.

Connecting trails

These trails should be kept to a maximum width of 1.0 metre and should be designed to link road ends, sidewalks or other access routes to a main trail.

Limited access trails

Limited access trails, used to penetrate or cross leave areas, should be designed as small footpaths and, when necessary, elevated above ground, using boardwalks to avoid intrusion into 'wet' areas or reduce disturbance to sensitive vegetation. The footpaths are narrow: 0.75 - 1.0 metres wide, and may be closed off during sensitive nesting or spawning periods or when seasonal hazards (e.g. high flows) warrant.

In order to limit access into the leave area, portions of the leave area boundary may need to be separated from the trail with a barrier.

5.1.3 Trail Alignment

Design for existing terrain

Typically, trails should be narrow (e.g. 1.0 m or less) over sloping terrain. They can be wider (1.5 - 3.0 m) over flat terrain, particularly if they are multi-use main trails that are located in the buffer. A positive cross-slope should always be maintained to ensure adequate drainage.

Protect existing vegetation

Trails should be routed to protect major tree and shrub groupings.

Recognize safety issues

Trail placement should avoid hazard areas such as steep ravines and bluffs, cliffs and embankments, hazardous trees and snags, undercut stream banks, etc. Conditions such as swift currents, seasonally high waters, or tidal fluctuations should be posted on a current basis, and barriers erected.

5.1.4 Trail Entrance Baffles

Trail baffles or other barriers can be used to discourage access by vehicles, bicycles and horses, or prevent unauthorized use (Figure 4). They can be located at public access staging areas and trail heads leading to sensitive aquatic areas, which may need to be closed at certain times of the year.

Trail Baffle

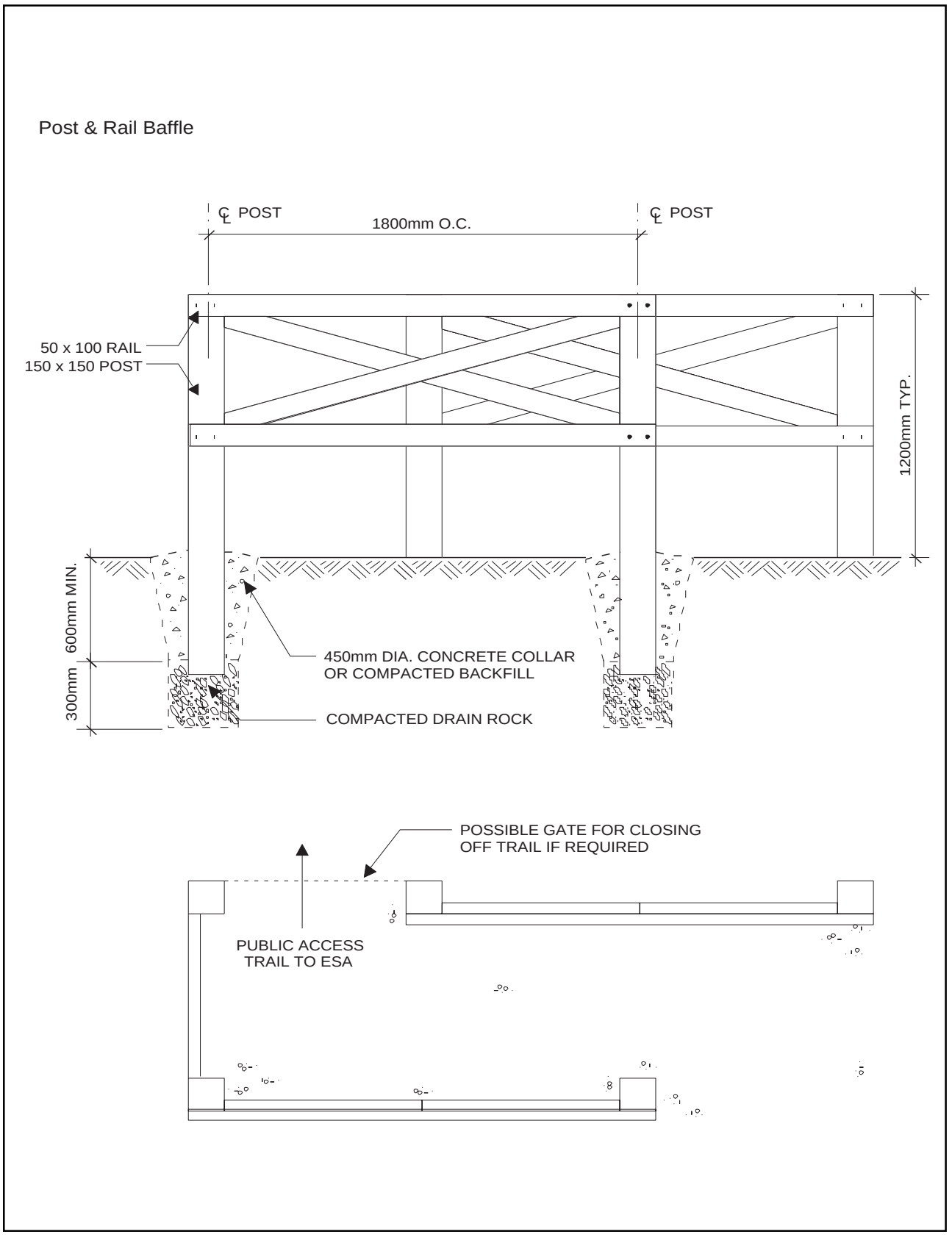


Figure 4 Section and Plan of Post and Rail Baffle

5.1.5 Signage

Well-designed, strategically located signage is an effective way to raise awareness and enhance protection of aquatic ESAs. Signage can be used in conjunction with barriers and should be located in areas where information on critical habitats, maps of public access trail systems, trail use rules, and location of viewpoints, is required.

Example of stewardship signage

5.1.6 Viewpoints

Viewpoints can simply be widened lobes on a connecting trail with durable seating and interpretive signs, or they can be structures that are located at the terminus of a limited access trail. Viewpoints are constructed to separate people from critical fish and wildlife habitat, or areas that are particularly sensitive to disturbance while permitting views into the area of interest.

5.1.7 Trail Staging Areas

Trail staging areas are orientation points, where gates and signs are located and the rules of trail use are clearly posted. Parking spaces, bicycle racks, trash receptacles and washroom facilities are typically situated in staging areas.

Trail staging areas include barriers, signage and other orientation features

5.2 Decks, Boardwalks and Footbridges

These elevated structures (Figures 5, 6 & 7) provide an excellent means of involving the public in ecological viewing and interpretation while preventing physical intrusion into sensitive habitats. An uninterrupted view of a sensitive spawning area or a large wetland can be provided by a bridge if the structure is skillfully sited. Where topography permits, platforms such as viewing towers can be placed at high points in the buffer with views into features in the leave area that are being highlighted. Interpretive signs can be incorporated into the design of viewing platforms or footbridges.

Viewing towers reduce foot traffic in sensitive habitats

Location

Decks and bridges need to be located and constructed with due regard for hydraulic concerns (refer to provincial floodplain requirements). Factors including seasonal fluctuations in water velocity and volume, and debris flow patterns must be considered. Decks and bridges should have enough freeboard to pass debris and high water.

To protect habitat and minimize scour and associated maintenance, deck or bridge footings should be placed outside the wetted perimeter of the aquatic ESA. Where construction creates a footprint within the wetted area, compensation will typically be required.

Materials

Where structures are located in shady or wet locations, use galvanized mesh fastened to the decking with galvanized nails or brackets to prevent slipping. Permit drainage off deck surfaces through 1.5" spacing between planks and a raised bull rail so water does not get trapped.

Pile supported structures are preferred over slabs or floats in aquatic ESAs, except where water is sufficiently deep that floats will not rest on or scour the substrate. The advantage of pile supports is that they have a minimal footprint on the sub-surface and permit currents or tidal movement to occur unimpeded. As well, getting people up and away from the water surface or wetland reduces the potential for trespass and permits better viewing. Piled structures with boardwalks are preferred structures for crossing dunes or other sensitive vegetation zones. Precast concrete pilings or footings should be used where concrete structures are proposed to avoid water quality problems associated with concrete run-off, and to minimize on site construction impacts.

Structures in Contact with Water

Treated wood is often used in structures that are in contact with water since they can be detailed and are generally aesthetically pleasing, less expensive to construct and require limited maintenance. Depending on the treatment however, treated woods can have significant environmental impacts.

To the maximum extent possible, structures in direct contact with water should be inert (e.g. natural untreated cedar, precast concrete or steel) to avoid water quality impacts associated with chemical leaching from treated wood. Steel and concrete have higher initial costs but they are more durable. The low maintenance associated with concrete or steel alternatives can often make them cost-effective over the lifetime of the structure. (Note: These features relate to structures in a fresh water environment. In brackish or marine environments, steel can corrode.) Steel or concrete structures are most suitable where:

- piles must be driven into dense fill or installed in bedrock;
- water depths exceed 15 m and there is considerable tension on the structure;
- applied loads are high;
- maintenance costs and structural integrity are issues.

The selection of preservatives for in-water structures can have significant environmental implications. Many wood preservatives are toxic to attaching or boring aquatic organisms, and do not readily break down.

All treated wood structures should be constructed with material that has been pressure treated off-site at specialized wood preservation facilities (in accordance with best management practices). Wood treated with metallic salts (e.g. Chromated Copper Arsenate (CCA) or Ammoniacal Copper Arsenate (ACA)) using accelerated fixation procedures is preferred for fresh water applications.

Creosote timbers are often used in marine applications because they are particularly resistant to marine borers and attaching invertebrates. However creosote, a complex mixture of polycyclic aromatic hydrocarbons, is very toxic, can bioaccumulate, and persists in sediment for a long period of time. For this reason creosote treated lumber is not preferred for structures that are in direct contact with water. Creosote treated structures are particularly inappropriate in fresh water environments where boring mollusks and other attaching organisms are not a concern.

Construction Practices

All construction debris and materials must be kept away from sensitive habitat areas during construction. Crews must be fully supervised, and the site cleared of debris following construction. Construction should comply with provincial and other building codes. Proposed instream works should be referred to either the Department of Fisheries and Oceans or the Ministry of Environment, Lands, and Parks well in advance of the proposed construction window.

Viewing Decks and Raised Platforms

Raised platforms have an advantage over other viewing decks as they minimize surface disturbance. They also encourage views over streams and wetlands, giving a greater sense of the landscape. Decks need railings for safety reasons as well as to prevent trespass. Larger viewing decks over water should be designed to permit sunlight penetration so that aquatic vegetation is not shaded. In general, timber decks are preferred over concrete as they can be configured to permit additional light penetration between planks.

Methods of reducing shading include orienting platforms and approaches in north-south alignments, elevating structures to maximize distance from the water surface, and reducing the width of approach trestles to a minimum.

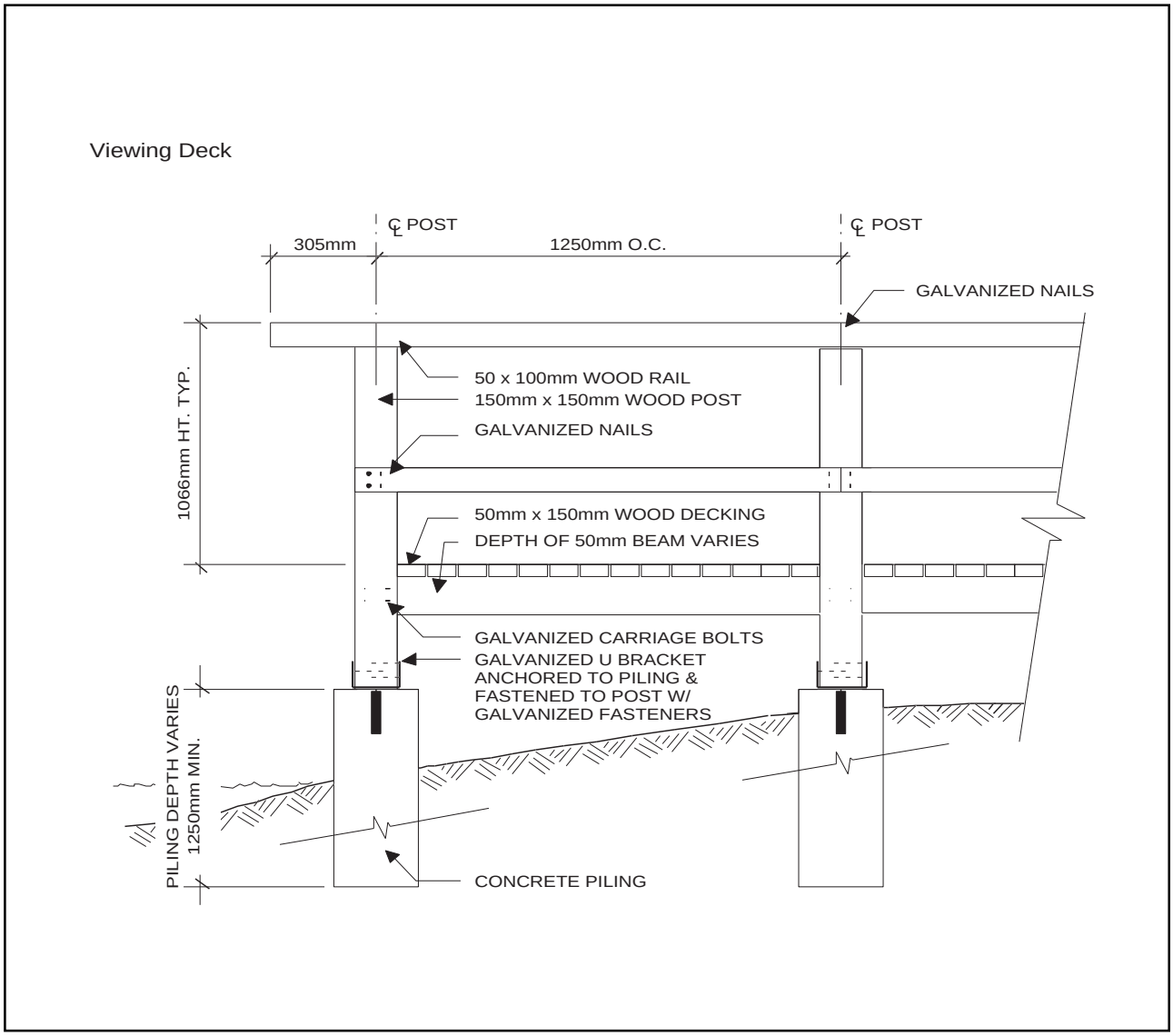


Figure 5 Section Through Viewing Deck

Pedestrian Bridges

Pedestrian bridges can be aligned and constructed in conjunction with proposed utility crossings of watercourses or simply as part of the trail network. Bridges can permit viewing of streams or environmentally sensitive areas with minimal physical disturbance of both stream beds and banks.

Clear span bridges are strongly preferred as they eliminate footprints within the wetted area. These structures also reduce debris accumulation thereby reducing flooding and maintenance concerns that are often associated with culverts and other instream structures. Railings or other barriers should extend beyond the bridge to enhance safety and discourage trampling of the stream bank.

Clear span bridge: footings are located outside the wetted perimeter

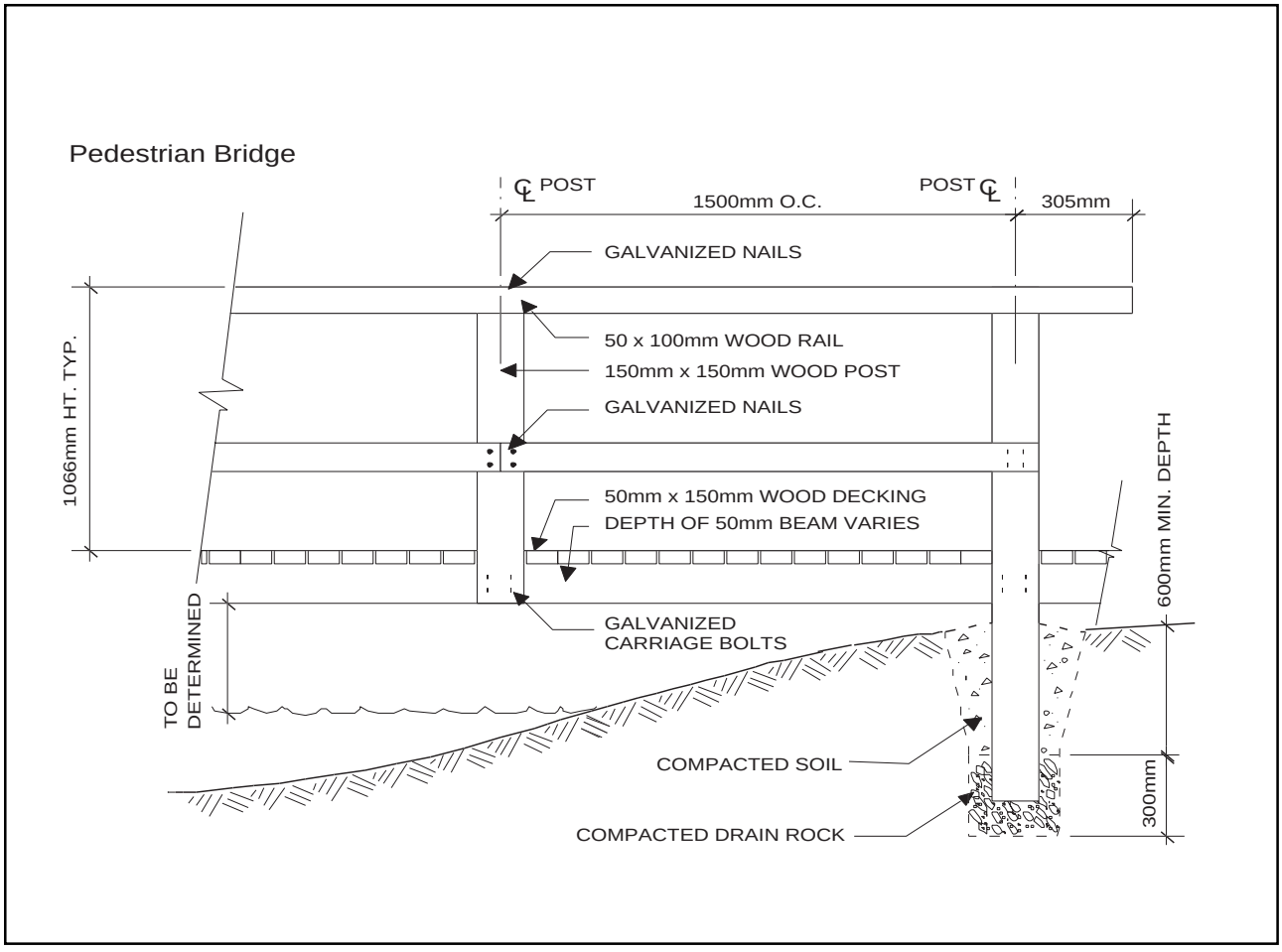


Figure 6 Section Through Pedestrian Bridge

Pedestrian Boardwalks

Boardwalks should be used in damp areas, where the objective is to keep pedestrians on a designated course and lessen compaction of the riparian forest floor or wetland. Boardwalks can be designed with side railings to limit wandering and enhance public safety.

Boardwalk through wetland

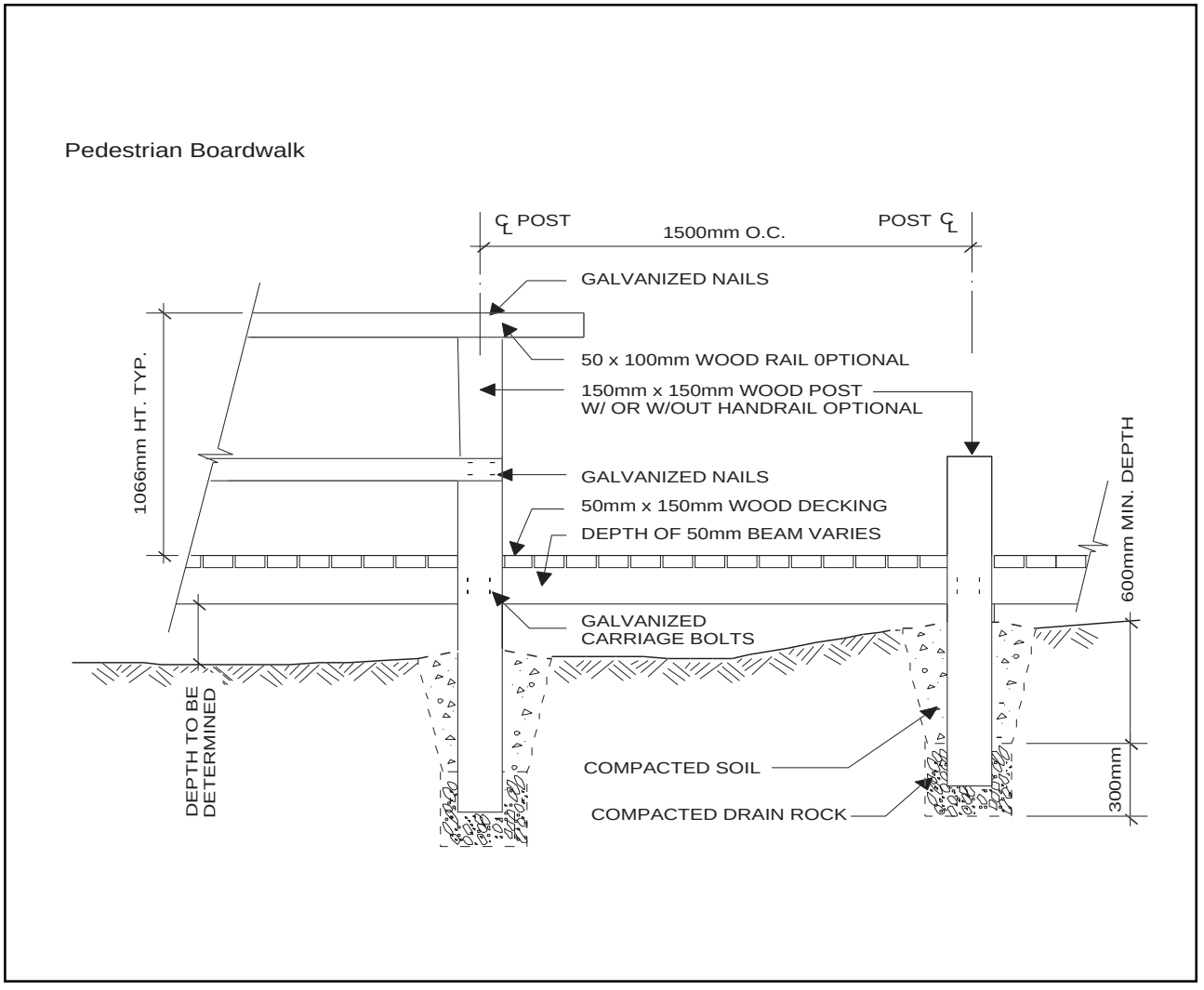


Figure 7 Section Through Boardwalk

5.3 Access from Adjacent Property

Controlling access from large developments backing onto an aquatic ESA can be difficult, but is very important. In many residential subdivisions, including those where the leave area is the subject of a covenant, there are numerous instances where the covenant area has been compromised. Occupants have used these areas as unauthorized dumping grounds for refuse or compost materials, have removed native vegetation to plant lawns, constructed gazebos and other structures, or have built unauthorized trails through the leave area.

In new subdivisions or multi-family housing, barriers are often required between the development and the covenant area. These barriers are now provided with a common access point to the covenanted area, rather than individual gates from private lots. This access point is situated at one or, at most, two points along a fence line or at a street end, to lessen the potential for habitat disruption.

A common easement allows access to a grassed footpath above the ravine

Where gates are installed, they should be narrow (.6 m to .75 m) to discourage wheelbarrow access to the aquatic area and avoid refuse dumping or unauthorized construction in the covenant area.

5.4 Gated Utility Service Points

In some cases historic utility alignments exist within the management zone for aquatic ESAs. In such cases, a municipality or a public utility (e.g. B.C. Hydro, B.C. Telephone) may require access to service existing utility lines, easements or servers. Where the right-of-way is fenced, the entrance to access roads should be securely gated. Surface materials for access roads should be aggregate or grass, not hog fuel or asphalt. Where emergency vehicle access is required, hammerhead designs at access road ends should be used rather than conventional circular turnarounds to minimize surface area disturbance.

5.5 Designing for Public Safety

Natural areas, including aquatic ESAs, are not necessarily any more dangerous than other landscapes, such as parks, commercial sites or residential areas; however, there may be a perception of heightened risk.

Public safety can be incorporated into access design by taking into consideration features such as strategically placed, well marked trail exits and entrances, surveillance site lines, blind spots, lighting and traffic circulation patterns. Surrounding land uses, site layouts, and proximity of parking lots, stores, schools, playgrounds, transit stops, residences, and industrial areas, need to be considered in developing a design that ensures personal safety.

5.6 Costs

The cost of installing trails, decks, viewpoints and other structures is dependent upon specific site conditions, availability of materials and labour.

General cost estimates based on 1995 dollars are noted in Appendix 2. In addition to construction costs, maintenance and management costs must also be considered. For example, edge trees in buffer areas need to be monitored for safety and liability reasons. Signage and barriers need occasional replacement, and structures need to be maintained.

6.0 Trail Management and Maintenance in Aquatic ESAs

6.1 Trail Maintenance Standards

Trail maintenance should reflect the primary management objective of conserving and protecting the natural aquatic environment, including the riparian area. Maintenance activities can have as much impact as original construction unless this management objective is reinforced as part of any maintenance plan and schedule. Following are guidelines for trail management and maintenance in aquatic ESAs.

- Trees and large organic debris falling into streams or onto access trails should be left where they fall unless they are creating a significant erosion concern. In streams this material provides critical habitat for salmon and trout. On access trails it provides a barrier to cyclists or other vehicles and enhances the natural experience for hikers.

Trees should be left where they fall

- Debris removal should be limited to trash and garbage.
- Repairs to trails should not result in additional vegetation removal, infilling of 'wetted' areas or constraining the active channel or floodplain.
- Heavy equipment use should be restricted to main trailhead areas and prohibited in leave areas. Wherever possible hand-held pruning equipment, shovels and wheelbarrows, rather than heavy equipment such as bobcats, backhoes and power mowers, should be used.

Restrict heavy equipment use on trails

- Trails which impinge upon or penetrate the leave area should only be maintained as single file hiking trails, spur trails or footpaths (1.0 m or less in width).
- Where there is a risk of significant property damage or risk to human life, use of heavy equipment is often necessary. In older neighbourhoods where aquatic ESAs are 'multi-use' corridors, a contingency plan for emergency access to sewer and water mains, natural gas pipelines, or power lines which are adjacent to public trails should be developed. The most direct and least damaging approaches to the problem area should be identified. Revegetation and reinstallation of barriers should be undertaken following such works.

- Trail surface edges should be defined with wooden risers or other edging structures which prevent well used trails from widening with foot traffic (trail 'creep'). Edging also delineates the area in which repair work should occur.

Well defined trail edge minimizes trail creep

- Management in the leave area should be passive and restricted to pruning hazard trees and repairing dangerous parts of footpaths or viewing structures.
- Natural drainage and cross drainage on footpaths must be maintained to avoid erosion, ponding, and accelerated trail surface wear.

Poor cross drainage has led to erosion and has accelerated trail wear

6.2 Guidelines for Preventing Trail Proliferation

Over time, where barriers have not been erected or public education programs have failed to prevent inappropriate and damaging use, the number and size of trails near streams have tended to increase. This has resulted in increased vegetation removal, bank damage and erosion. In order to avoid trail proliferation the following guidelines should be adopted:

- Trails should be limited to only one side of an aquatic ESA, and barriers should be erected to direct traffic to designated areas.
- Where trails have increased in number and size over time, consideration should be given to decommissioning a number of the most damaging trails by creating either physical or psychological barriers. These could include:
  - roughening and revegetating trail surfaces;
  - placing boulder clusters or obstacles at strategic locations;
  - providing signage to improve voluntary public compliance; or
  - not maintaining unauthorized trails.
- Structures should be designed for long wear and low maintenance.

Maintenance activities in or about a stream can require approval under the provincial Water Act and federal Fisheries Act. Anyone contemplating such works is advised to contact the nearest Department of Fisheries and Oceans or Ministry of Environment, Lands, and Parks office for assessment forms and for information on construction windows for your location.

7.0 Using Barriers to Protect Aquatic ESAs

As mentioned in previous sections, there are times when barriers are needed in order to adequately protect aquatic ESAs. Simply setting aside a leave area (reserve zone), even if it is placed under covenant and intrusion is restricted by law, does not guarantee that it will be protected. Where damage is occurring, intensity of use is high, or there is considerable risk due to adjacent or associated land use, a barrier may be needed.

Barriers are beneficial because they:

- separate incompatible land uses
- protect fish and wildlife habitat from humans and livestock
- promote physical safety
- improve privacy
- delineate setbacks and covenants
- reduce trespass on private property

Barriers can enhance public safety as well as protect sensitive habitats

7.1 When Is a Barrier Required?

In order to determine the need for a barrier, a risk analysis should be conducted. Among the factors to be considered are ESA values, adequacy of existing protection measures, potential for (and nature of) disturbance, sensitivity to disturbance, existence of viable alternatives, and security and liability issues.

These factors are discussed in greater detail below and are presented in the following decision matrix (Figure 8).

Decision making criteria

Is the ESA high value?

If the aquatic ESA is of high value a barrier may be required.

All ESAs are special areas that require special protection. However, certain aquatic ESAs may be classified as being of particularly high value.

Some factors to consider when ranking an aquatic ESA as high in value include whether the ESA:

- provides on site spawning, incubation or rearing habitat for fish;
- moderates flows, transports water or provides food and nutrients to critical downstream habitats;
- provides critical nesting or forage areas for waterfowl or other wildlife;
- supports rare or endangered fish, wildlife or vegetation species;
- provides corridors or linkages between critical habitats for wildlife;
- includes unique ecological or heritage features.

Is the ESA protected?

If an adequately sized management zone cannot be provided and protected in the long term, a barrier to access will be required.

The leave area or reserve zone along watercourses must be left undisturbed.

The width of this zone should be based on an environmental assessment; however, where this is not practical, the minimum standards prescribed by the *Land Development Guidelines for the Protection of Aquatic Habitat* (1992) should apply. These guidelines presently require leave areas be set back a minimum of 15 - 30 m from top of bank adjacent to low density and high density developments respectively.

Where an adequately sized leave area and buffer cannot be provided, trails should not be entertained. Where 'minimum' standards are met but there are no long term measures in place (e.g. return to crown ownership by conservation organizations) to protect these areas, barriers are required. This often occurs, for example, in redevelopment and infill situations, where lot sizes during subdivision become too small or houses become too large to set aside appropriately sized leave areas and buffers. It may also occur when the developer will not dedicate the management zone.

Is the ESA vulnerable?

A barrier will be required where there is evidence of persistent historic impacts, or current land use activities represent a significant potential for disturbance.

Many urban/suburban streamside areas have historically been impacted either during the development phase or as a result of occupancy. These impacts include bank erosion and vegetation trampling due to pedestrian traffic or livestock use; removal of natural riparian vegetation and soils; dumping of trash/debris; building of structures within the leave area; constraining, dredging, dyking, damming of, or encroachment into, channels. Where such impacts are evident, restoration or rehabilitation efforts and barriers are required.

A high potential for disturbance also occurs where there are high intensity recreational uses or incompatible land uses immediately adjacent to an aquatic ESA, such as heavy industry, high density residential developments, major transportation corridors, livestock grazing areas, or public parks.

Natural riparian vegetation has been removed and the channel suffers from numerous encroachments

Is the ESA particularly sensitive to disturbance?

Where an aquatic ESA is particularly sensitive to disturbance, a barrier will be required.

All aquatic areas are sensitive. However, local conditions can increase sensitivity to disturbance. Site factors such as complex surface drainage patterns, highly erodable soils and steep terrain will influence the level of disturbance the area can withstand before habitat is significantly altered or destroyed.

The sensitivity of any given area must also be viewed in the context of the overall watershed as previous activities in the watershed (such as deforestation, paving and water withdrawals) may have cumulatively reduced biological productivity to a state where further disturbance or disruption could not be tolerated without irreversible impacts.

Where restoration works (riparian planting, vegetative bank revetment, channel and bank cleanups, etc.) have been undertaken, these areas are considered particularly sensitive and will require immediate protection.

If there is uncertainty about the sensitivity of an aquatic ESA to disturbance, refer to the local ESA study, development permit conditions, or contact the environmental coordinator or planner at City Hall. Environmental consultants, and municipal planning and engineering staff, may also have local information regarding soil types, slope stability and surface or ground water in the area. If additional information is still

required, an environmental impact assessment must be conducted.

Lack of riparian area and highly erodable soils: an extremely sensitive aquatic area

Are there effective alternatives to constructed barriers?

A physical barrier may not be required where effective alternatives exist. The effectiveness of alternatives is dependent upon the nature, frequency, and severity of disturbance.

Alternatives to erected barriers could include:

- incorporating dense vegetative edges into buffer design;
- using natural and abrupt changes in topography in design;
- enhancing perceptions of riparian areas as dark, wet and uninviting places;
- community stewardship initiatives such as signage or land owner contact.

Such alternatives may be effective where impacts are minor (e.g. restricted to trampling or littering), and problems are isolated in time or space. Conversely where the problems are chronic/significant (e.g. construction of permanent structures), an impenetrable barrier is required.

In many cases a combination of approaches is necessary. For example, minor impacts such as littering can be addressed by design (e.g. strategically placed trash receptacles), maintenance (e.g. regularly scheduled garbage collection), monitoring (adopt a stream or adopt-a-wetland programs), and enforcement (rangers to enforce trail use rules, government enforcement of covenant conditions, etc.).

Where design or voluntary measures are being relied upon, the effectiveness of these measures needs to be regularly evaluated. A recent audit has indicated that where restricted access is simply a condition of a covenant, voluntary compliance is often very poor, with an average non-compliance rate of 75% (*Protection of Aquatic and Riparian Habitat on Private Land, 1995*). When these covenant conditions are accompanied by a physical barrier, protection is improved.

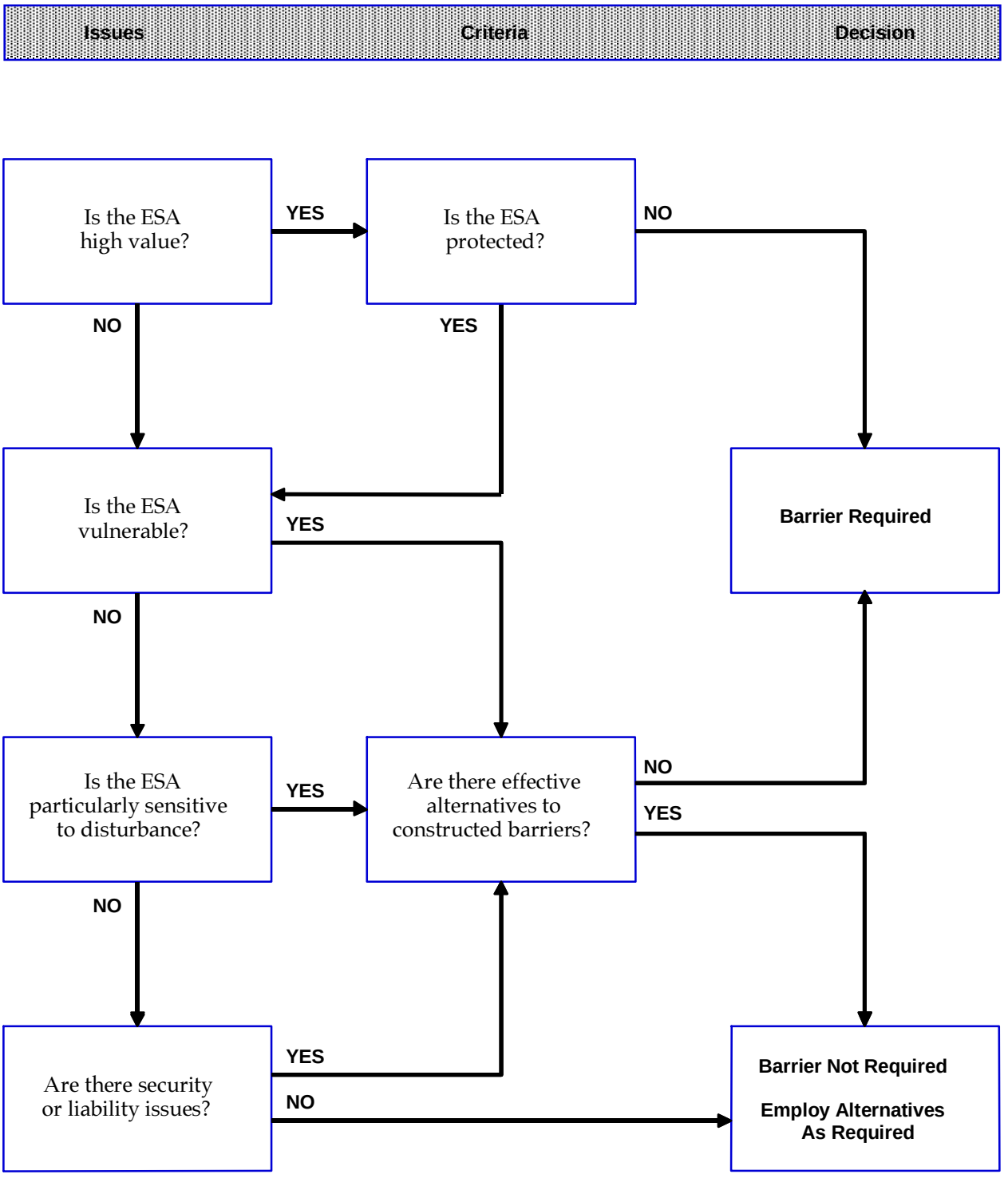
Are there security or liability issues?

Barriers may be necessary where protection of private property and personal safety issues are a concern.

Personal safety and liability concerns may also influence decisions concerning barriers. For example, if trespass onto private property from an adjacent trail is an issue, a barrier may be required. Similarly, where there are vandalism or liability issues associated with existing public utilities within an ESA, a barrier is appropriate. Risks to human safety and security from wildlife or human predators are also a concern, and where other forms of security are considered inadequate, a physical barrier may be necessary. Ensuring public safety often dictates that barriers must be accompanied by good access design and planning, education, community policing and surveillance.

A barrier ensures safety along a trail on steep terrain

Figure 8 Decision Matrix to Determine Barrier Requirements



7.2 Regulations Affecting Barriers

Governments may require barriers where:

- the site is the subject of a Department of Fisheries and Oceans authorization or a compensation agreement respecting the protection of fish habitat;
- Ministry of Environment, Lands, and Parks holds the covenant, requiring boundaries be clearly delineated;

Fence (with signage) on covenant boundary protects sensitive habitat

- local government requires a permanent barrier to protect landscaping, prevent erosion, or to protect riparian vegetation during development.

7.3 Barrier Selection and Implementation

Once it has been determined that a barrier is required, there are a number of factors that will influence the type of barrier that is appropriate. These factors include:

- current and proposed land uses (both on site and adjacent);
- long term site management options;
- area available for barrier construction;
- maintenance requirements;
- safety, security and level of site surveillance available;
- cost.

7.3.1 Contexts for Barriers

Adjacent land use provides a context for determining whether one barrier may be more appropriate than another. For example, in a rural residential site, the use of timber posts or a live barrier, such as a hedgerow, to simply delineate the leave area boundary may be adequate. However, in the same situation, with livestock, a fence would be necessary. For institutional or commercial/ industrial sites, where intrusion and littering is likely and aesthetics are not a concern, a 6 ft. high chain link fence is appropriate. In single family urban residential areas where unmanaged foot traffic is the greatest concern, a 4 ft. high timber fence may be sufficient. Where aesthetic concerns are paramount, a combination of live and hard barriers can be used to maximize both the effectiveness and the visual appeal of the barrier.

7.3.2 Barrier Categories

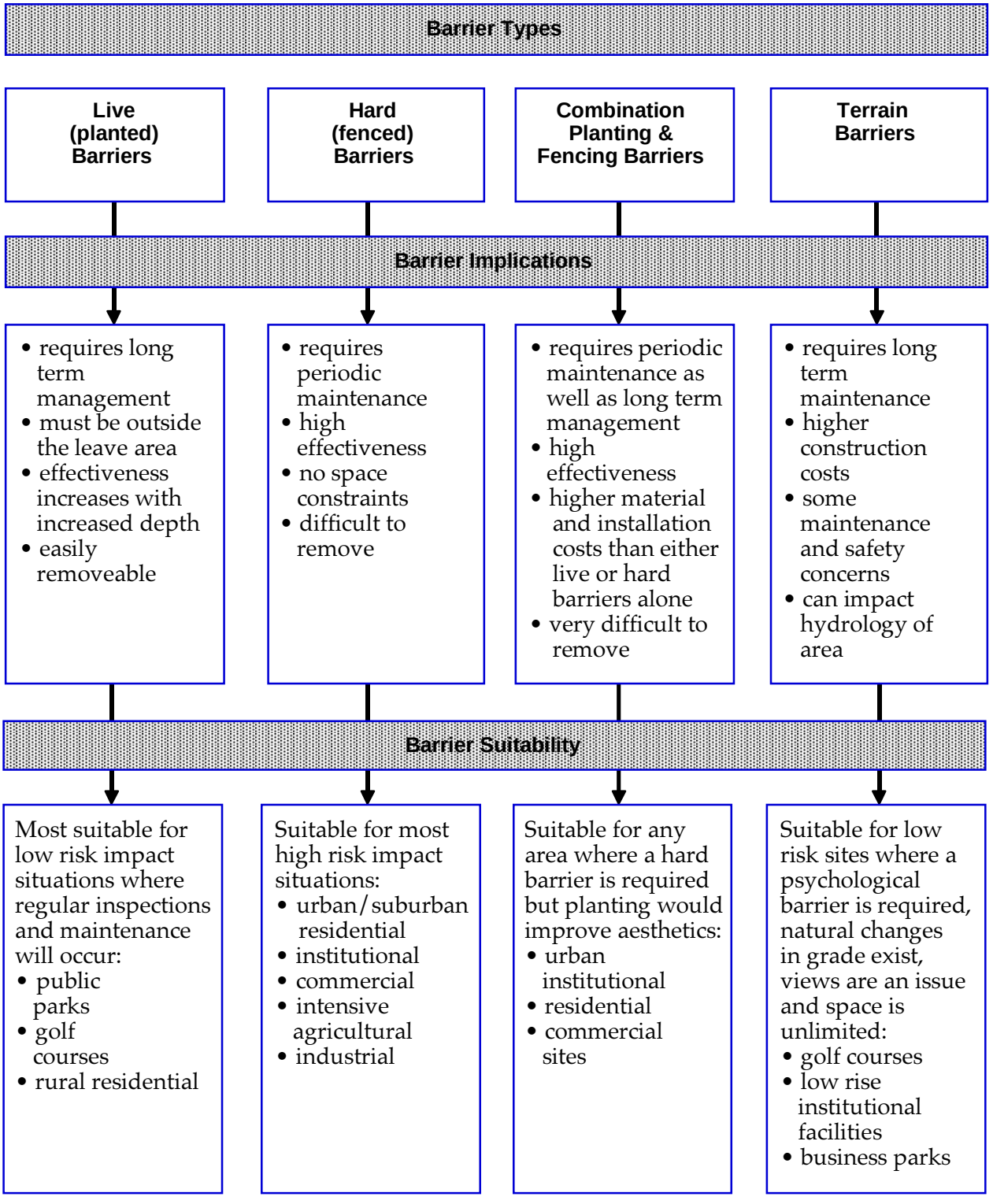
Barriers can be divided into four categories: *Live* (planted), *Hard* (fencing), a *Combination* of live and hard (planting and fencing) and *Terrain* barriers (channels, berms, depressions, and retaining walls). A combination of any of these four barrier types can be used depending on the site. As well, a distinction can be made between *physical* and *psychological* barriers. While a physical barrier such as a fence may prevent access by obstructing passage, a psychological barrier simply provides a deterrence to access. A psychological barrier can be created through a change in terrain (berm), or by using vegetative screening or lighting. A psychological barrier may be preferred for aesthetic reasons where risks are low, and can be designed to enhance desired habitat features.

7.3.3 Location of Barriers

All barriers must be located *outside* leave areas. Where live barriers or combination hard and live barriers are used, the vegetated live barriers can be designed to increase ecotonal edge habitat for wildlife adjacent to but outside the leave area boundary.

Figures 9 and 10 have been developed to assist in selecting appropriate barriers.

Figure 9 Barrier Types, Implications and Suitability



Long term maintenance or management issues should be identified and addressed in planning stages and budgeted for over the required life of the barier.

Figure 10 Barrier Cost and Effectiveness Comparison Chart

Various barrier types have been evaluated on a range of criteria. This chart provides a summary for comparison purposes. Costs are estimates only. Costs vary depending on the scope, location, and timing of the project and are therefore subject to change.

Barrier Type:	Barrier Method	Estimated Cost / l.m.	Longevity	Ease of Installation	Effectiveness of Barrier	Maintenance
Live	Live Barrier (6' High)	$30.-	MODERATE	MODERATE	LOW/MOD.	MOD./HIGH
Combi-nation	Live Barrier with Low Mesh Fence (4')	$45.-	MODERATE	MOD./LOW	MOD./HIGH	MODERATE
Hard	Timber Rail & Mesh Fence 6' High	$20.-	MOD./HIGH	MODERATE	MOD./HIGH	MODERATE
	Low Metal Pipe Rail Fence 4' High	$30.-	HIGH	MOD./LOW	MODERATE	LOW
	PVC Livestock Fence 4' High	$30.-	HIGH	MOD./HIGH	MOD./HIGH	LOW
	PVC Livestock Fence 6' High	$35.-	HIGH	MOD./HIGH	HIGH	LOW
	Timber Fence 4' High	$25.-	MOD./HIGH	MODERATE	MOD./HIGH	MODERATE
	Timber Fence 6' High	$35.-	MOD./HIGH	MODERATE	HIGH	MODERATE
	Timber Posts 4' High (6' on center)	$8.-	MOD./HIGH	HIGH	LOW	LOW/MOD.
	Timber Posts 6' High (6' on center)	$10.-	MOD./HIGH	HIGH	LOW	LOW/MOD.
Terrain	Retaining Walls	$60.-	HIGH	LOW	MODERATE	LOW
	Depressions	$50.-	HIGH	LOW	LOW/MOD.	LOW
	Canals	$70.-	MOD./HIGH	LOW	MODERATE	MOD./HIGH
	Fence and Ditch Combination	$75.-	MOD./HIGH	LOW	MOD./HIGH	LOW/MOD.

7.4 Recommended Barriers

A combination of field reconnaissance, precedent review, and resource agency input was used to identify a series of barrier types for different site conditions.

For many of the barrier options, alternatives are acceptable as long as they conform to height, width, material and structural standards. All barriers should be accompanied by signage.

A. Live Barriers

The primary purpose of live barriers is to provide an aesthetic means of impeding human access to aquatic environmentally sensitive areas. However, live barriers also provide opportunities to:

- design and provide new wildlife habitat (food, cover and travel corridors);
- create or enhance edge or ecotonal conditions;
- provide linkages to other habitats.

The use of flowering and fruiting plants can create a live barrier that is visually pleasing and provides passive recreational activities such as berry-picking or bird-watching. Tree species in the live barrier can enhance aquatic/riparian environments and fish habitat by increasing canopy which shades streams and provides nutrient sources. While hard barriers alone may detract from the landscape design on a development site, live barriers can be incorporated as a new and exciting design element within the surrounding development.

A(i) Conditions for Live Barriers

Live barriers can be applied to a wide range of situations. As indicated in Figure 9, they are best suited for sites where periodic maintenance and some surveillance is possible. Such sites include parks, golf courses, care-oriented institutions, and residential sites. Live barriers are particularly effective when used in combination with a hard barrier and signage.

In a development situation, the most successful barriers are those that make it obvious to a future land owner that the area is sensitive and that the vegetated barrier is not to be removed.

Where a live barrier is to be constructed as a condition of a restrictive covenant, the covenant should state that any trees or shrubs that die during the first three years following planting must be replaced immediately. This is particularly important if the integrity or structure of the live barrier has been compromised (e.g. large gaps). Depending on the risk at the site it may be possible to let opportunistic and rapidly growing natural species colonize and fill the gaps in the live barrier.

A(ii) Plant Material

A row of plant material should be a minimum of 1.5 m thick at the base, and reach a minimum height of 2.0 m when mature. A barrier less than 1.0 m is not effective since this is less than the stride of an average person. The base could be ditched, banked, or leveled to match surrounding landscape, depending on design objectives and site environmental conditions. A 1.5 m barrier width would also allow a .75 m planting zone on either side of a centered hard (fence) barrier.

The plant material for a live barrier or a living fence should be dense (e.g. thick leaves, dense branching) as illustrated in Figure 12, and include 'armoured' or thorny species. The number of species to be used in a live barrier depends on whether the desired outcome is a more 'formal' border (hedge) or a more 'informal' hedgerow or ecotone (Figure 12). Species selection will also be dependent on site conditions, budget, and design criteria. Using a variety of species will help to ensure that plants will always be present in a live barrier, even if there is some mortality. In a monoculture planting, the live barrier will disappear if the chosen species fails to establish, or dies off.

The plant material should be of a height at the time of planting and spaced at a distance such that an immediate barrier is created. When a live barrier is used in conjunction with a hard barrier, smaller and/or younger plant material may be used. The plant material that is used should have a tendency to spread horizontally as well as vertically over time. The plantings should require limited maintenance (pruning, etc.) to perform their intended function as a barrier.

The plants used should be native species. Non-native species may be used where they have the appropriate dense or armoured branching attributes. Other desirable characteristics such as hardiness, drought tolerance, and wind firmness should be considered in order to increase the survival and longevity of the live barrier.

Selection of species for a live barrier will depend upon site environmental conditions, and any design/aesthetic objectives. Suggested species include those listed in Appendix 3. Most of these species are native to coastal British Columbia, and are available through nurseries. When planted in combination, these species will develop into an impenetrable barrier.

Fast growing species can be woven together or used in combination with chain link or mesh fencing to form an attractive impenetrable barrier. Adding vines and trailing shrubs to the live barrier will help to close any gaps left between trees and shrubs.

Existing vegetation on the edge of the riparian area contributes to a live barrier; *however, riparian vegetation must not be removed in order to install a live, landscaped barrier.*

In most instances, the live barrier should be planted immediately outside the leave area. This will effectively increase the depth of the leave area when there is existing vegetation within the leave strip, or at a minimum, provide the physical/ psychological separation required.

In other cases, where the lot size is substantial, a live barrier may be placed further from the leave area boundary in order to increase the distance between the aquatic ESA and the development. This may be appropriate if public safety or liability is a concern—for example, where a steep/deep ravine may be a potential hazard to small children, or where windthrow onto houses or other buildings is an issue.

A(iii) Planting Criteria and Specifications

General Requirements

- It is preferable that there be a mix of deciduous trees (which grow rapidly, stabilize banks, provide shade, and produce leaf litter), and large coniferous trees (which are an ideal source of large organic debris required for fish habitat).
- The soil should be prepared along the intended barrier line by tilling to a depth of 30 cm.
- Material planted during the autumn (September - October) and spring (March - April) has the greatest likelihood of surviving. When necessary, regular watering is advised until the plants are established. Additional advice on planting procedures should be obtained from the nursery supplying the stock.
- Any trees or shrubs that die during the first three years after planting must be replaced immediately if more than a 20% mortality occurs, or if the integrity or structure has been compromised by the creation of gaps in the live barrier. Protection from deer or livestock browsing may be necessary for the first three years of growth.
- Include enough fruit bearing shrubs to provide attractive habitat features to birds and wildlife (up to 25%). The barrier effect is also enhanced through fruit bearing shrubs since they tend to be thorny and dense.

Nursery Grown Stock

- Tree/shrub species should be of guaranteed nursery stock.
- Botanical names should be used when ordering nursery stock to ensure that the correct species are being purchased. Each plant should be tagged with its botanical name, and the tag left on at the time of planting.
- Tree stock must be at least 1.2 m in height when purchased and spaced 2 to 4.5 m apart depending on individual species requirements, the combination of species used, and the overall length of the live barrier.
- Shrub stock must be at least #1 container size or greater. A dense hedge can be established by planting at 25-50 cm intervals.

Salvaged and Transplanted Stock

- During site development, there may be opportunities to rescue or salvage plant materials. Depending on the time of year, these plants may have a lower chance of surviving the shock of transplanting, and thus require a great deal of care to make the effort worthwhile.
- Very small seedlings can be completely dug up with their entire root systems intact. These plants can be potted and readily transplanted to the live barrier site for planting. Regular watering is required if the plants will be kept in containers for any length of time before planting.
- Saplings and trees survive transplanting better if they have been root pruned a year prior to moving. When there is time to root prune, the following steps should be followed:
  - Project a line from the canopy drip line to the ground and dig a narrow trench around the tree, following the line.
  - Sever the roots in the trench with a spade, and back-fill. The severed root ends will put on new growth.
  - When the tree is ready to be transplanted, take a root ball as large in diameter as the root pruning trench, or as large as can be feasibly moved.

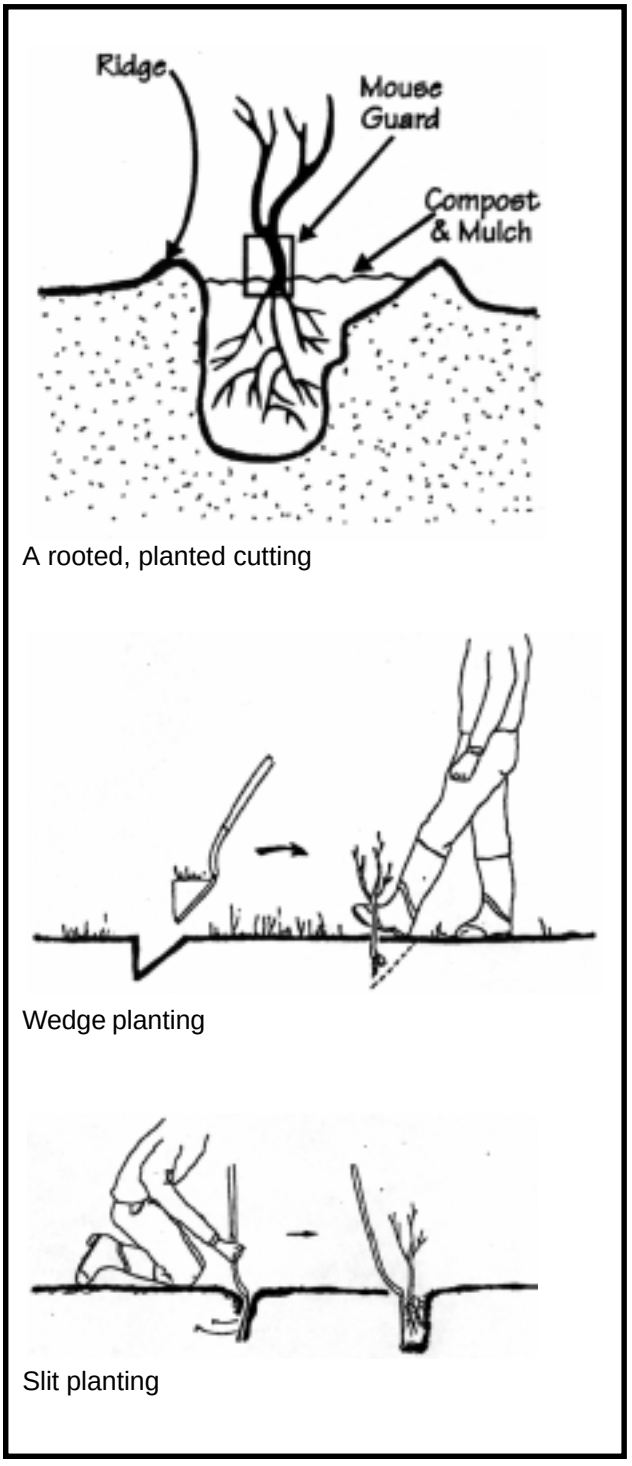


Figure 11 Methods of Transplanting Plant Material

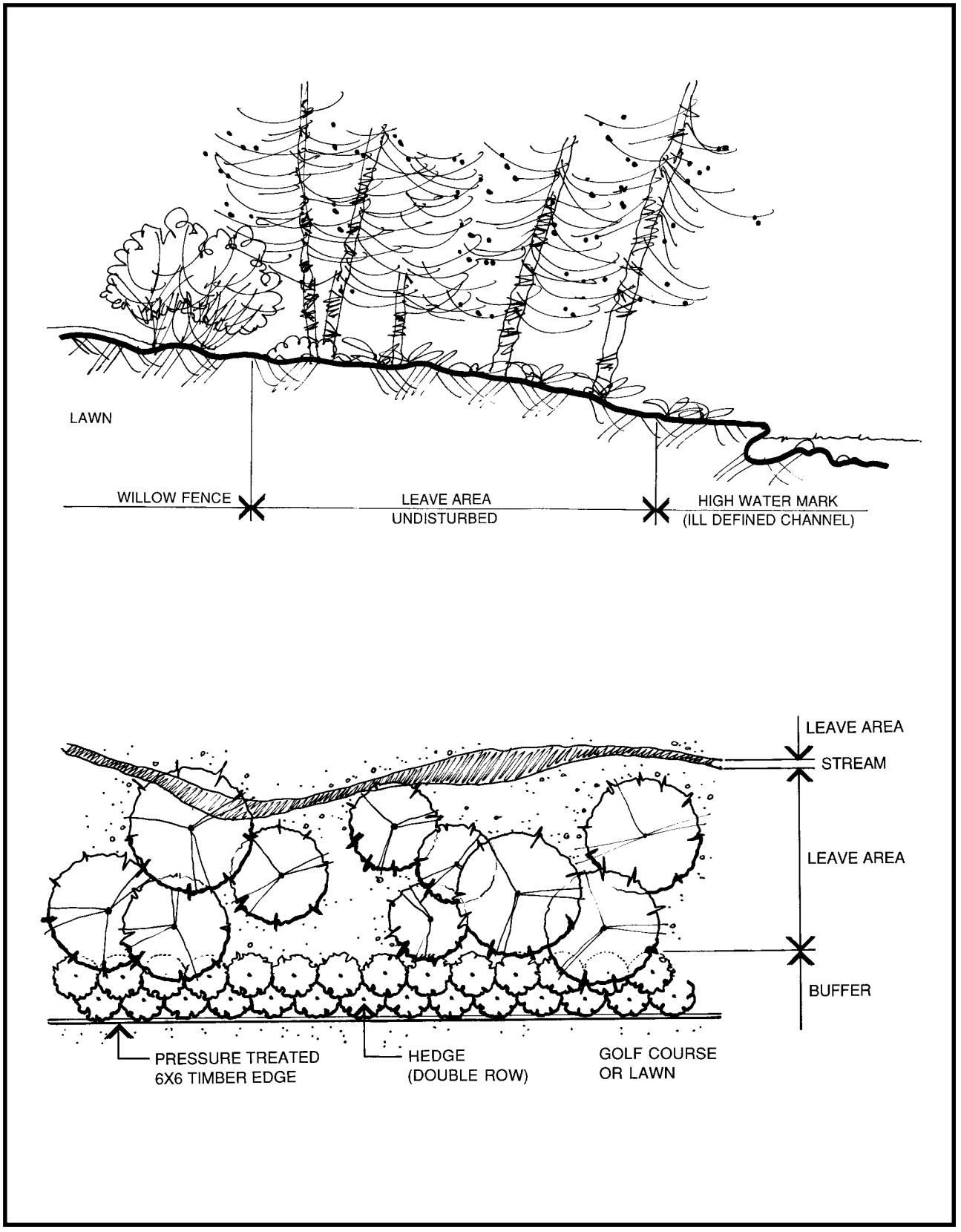


Figure 12 Sketches of Dense Thorny Double Hedge Barriers

B. Hard (Fencing) Barriers

Although hard barriers may not be a preferred option in some cases due to aesthetic considerations, they are effective and necessary in a number of circumstances to protect aquatic ESAs. Recommended hard barriers are described in the following pages.

B(i) Low Metal Pipe Rail Fence

Open rail fences are suitable along paths and walkways where use is low intensity, risk of damage is limited and an impenetrable barrier is not required. They are not suitable for school sites, shopping malls or high density residential developments. Recommended height for such a barrier is 4 ft. (1.2 m). Metal pipe rail fencing can be coated or painted to match the surrounding landscape. Aside from periodic repainting, this fencing alternative requires little maintenance, can be aesthetically pleasing, is durable and has a long life span.

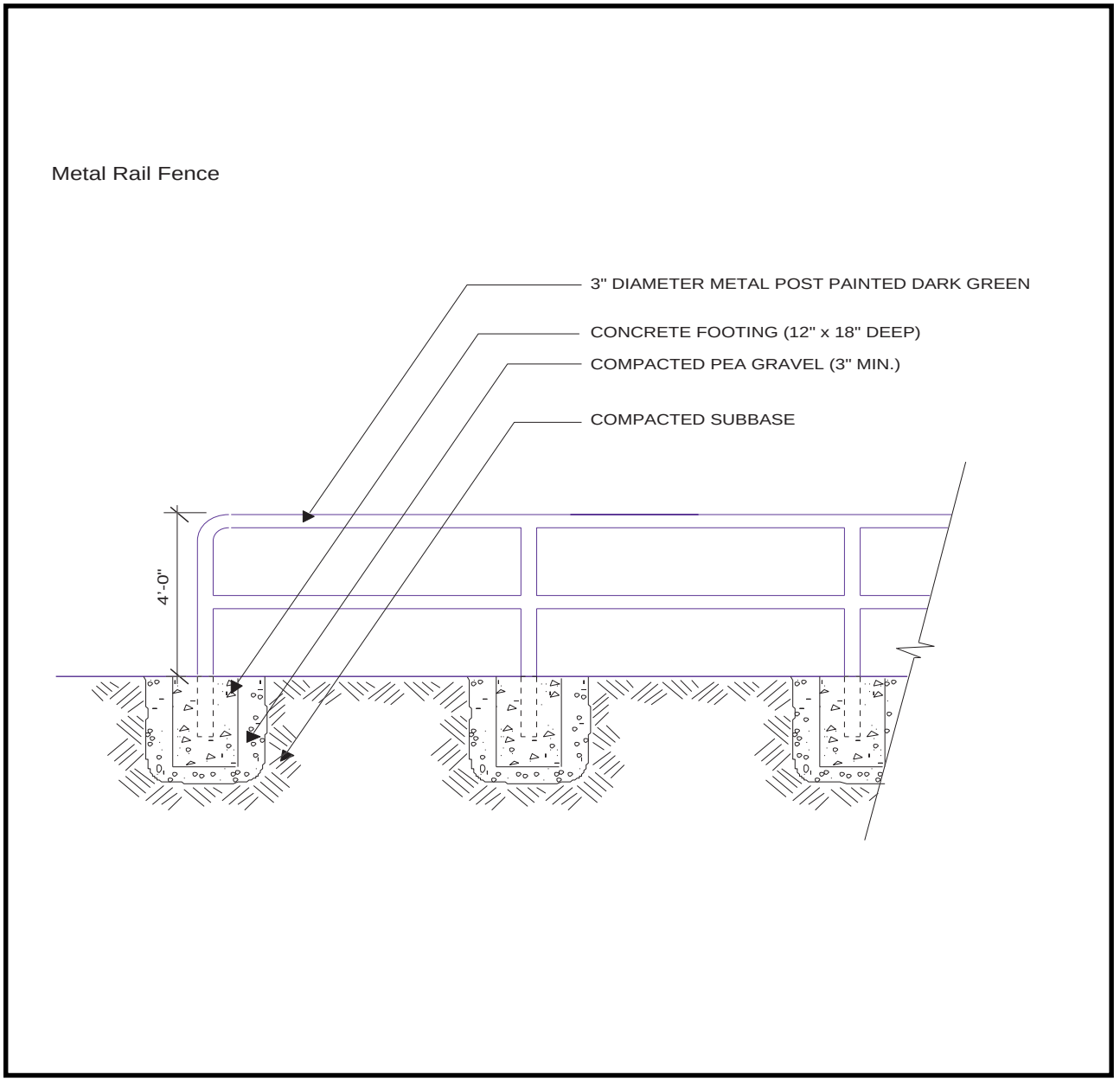


Figure 13 Detail of Metal Rail Fence

B(ii) Timber Rail and Mesh Fence (Page Wire Fence)

Recommended heights for this barrier are 4 ft. (1.2 m) and 6 ft. (1.8 m). Timber rail and mesh fencing is an aesthetically pleasing alternative for low or medium density housing applications. In addition, timber fencing provides opportunities for site specific wood detailing. It is easy to install and has a moderate maintenance level. Posts and cross members may need replacement every ten to fifteen years. Periodic maintenance might include a weather proof stain and minor repairs. All hardware (nails, etc.) should be rust proof galvanized. Rails should be made of pressure treated wood (Hemfir) or cedar. Mesh must be galvanized wire.

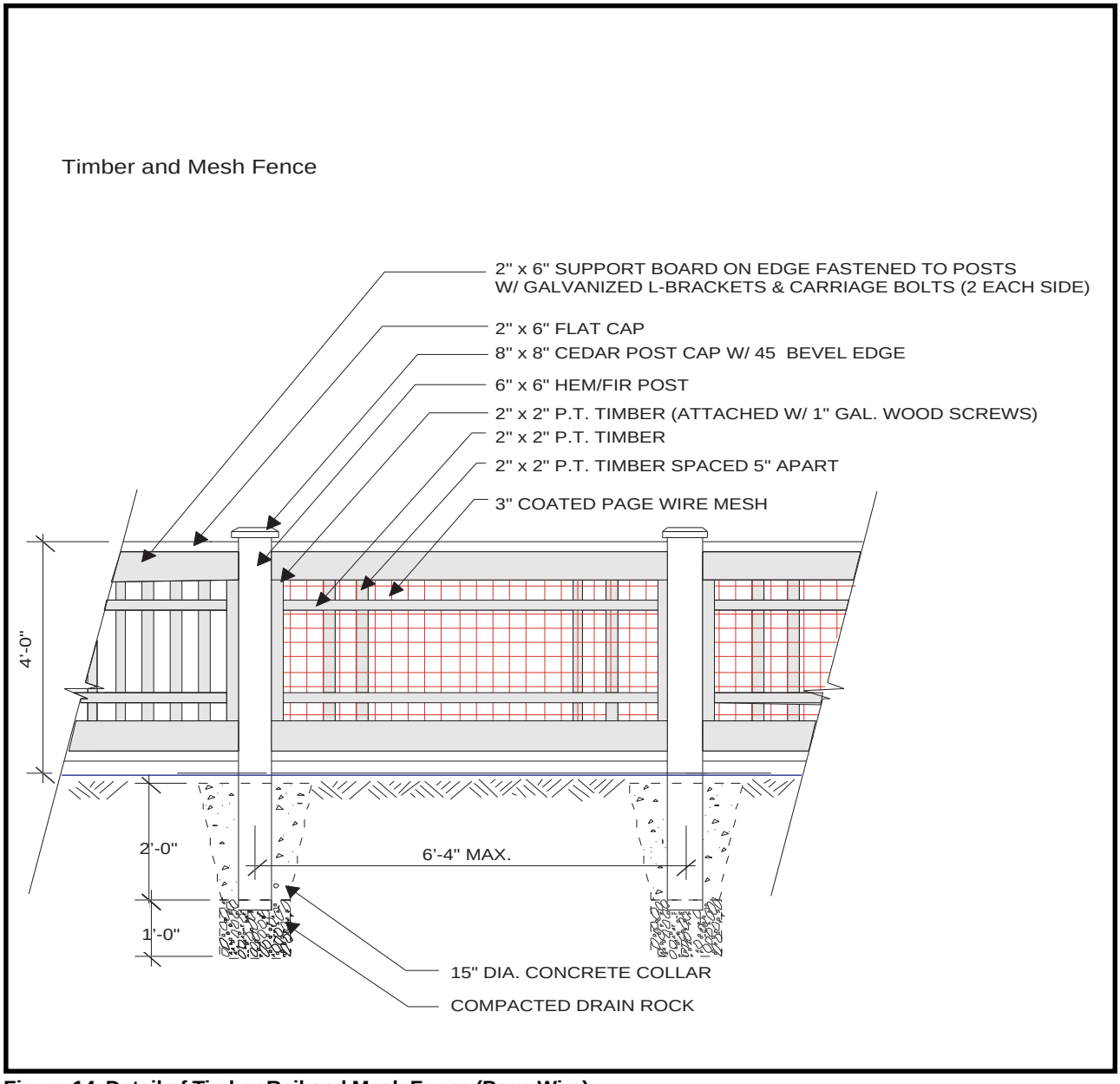


Figure 14 Detail of Timber Rail and Mesh Fence (Page Wire)

B(iii) Plastic PVC Pipe Fencing

This is a new fencing alternative composed of plastic PVC pipe. It is strong, durable, requires little maintenance and is easy to install. It is effective for urban, suburban or rural residential applications where a durable physical barrier is required. This form of fencing is also aesthetically pleasing in rural or 'hobby farm' applications or other applications where a 'ranch' effect is desirable. Presently, colours are limited to the colour of the plastic and the plastic cannot be painted. PVC fencing is recyclable where facilities exist.

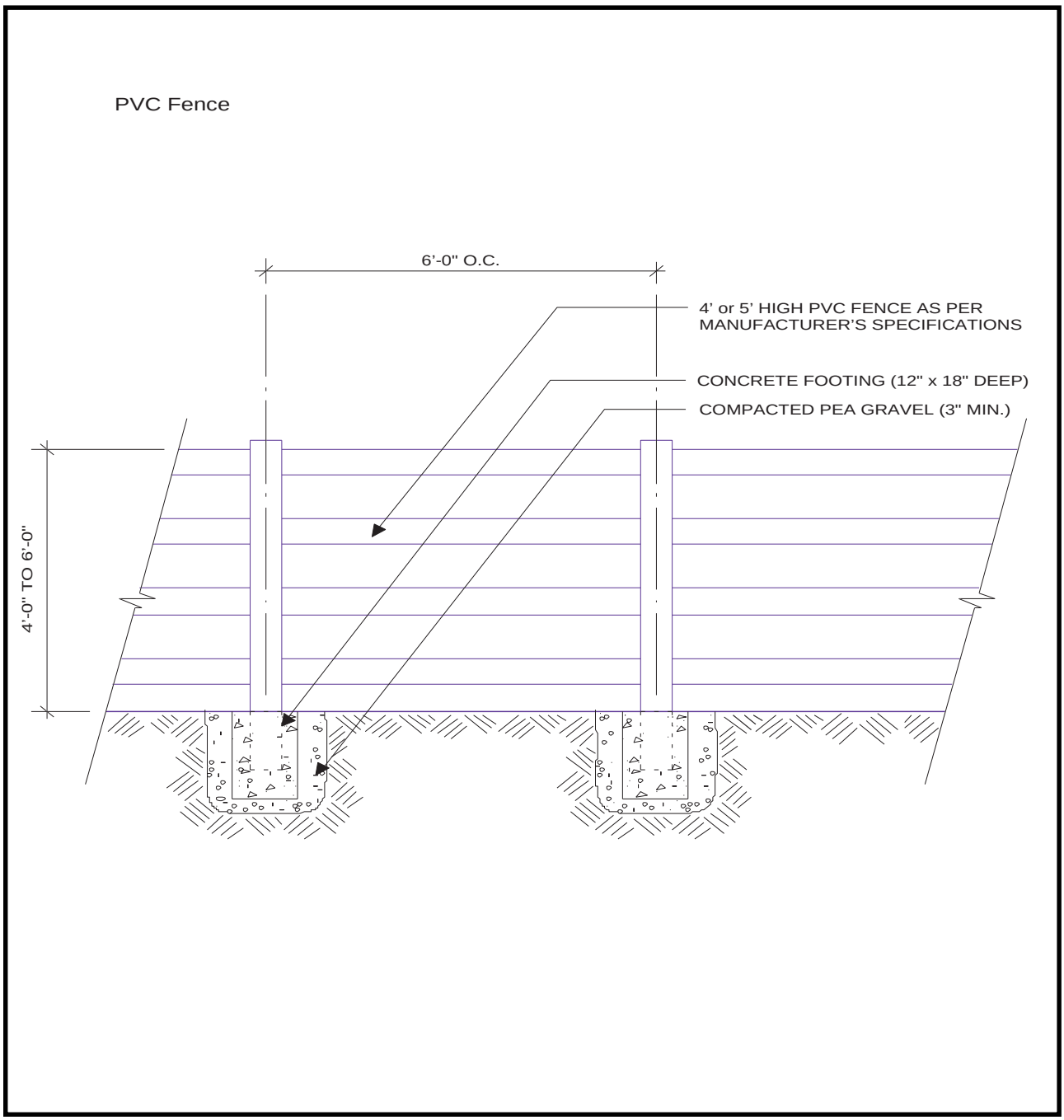


Figure 15 Detail of PVC Fence

B(iv) Smooth or Barbed Wire Fence and Log Fence

For ranching or farming applications where preventing livestock access into an aquatic ESA is key, galvanized smooth, barbed or PVC wire fence can be used. Page wire fencing can be used to confine small animals such as sheep, calves, and foals. Log fences, made from pressure treated wood (Hemfir) or cedar, may be more practical in some situations.

Where barbed wire is used, a top rail or wildlife visibility tape is recommended to prevent injury to wildlife. Where log fences are used, wildlife passage can be ensured by providing adequate clearance at the bottom of the fence, and by developing game jumps, where the fence height is lowered at regular intervals to permit unimpeded wildlife migration.

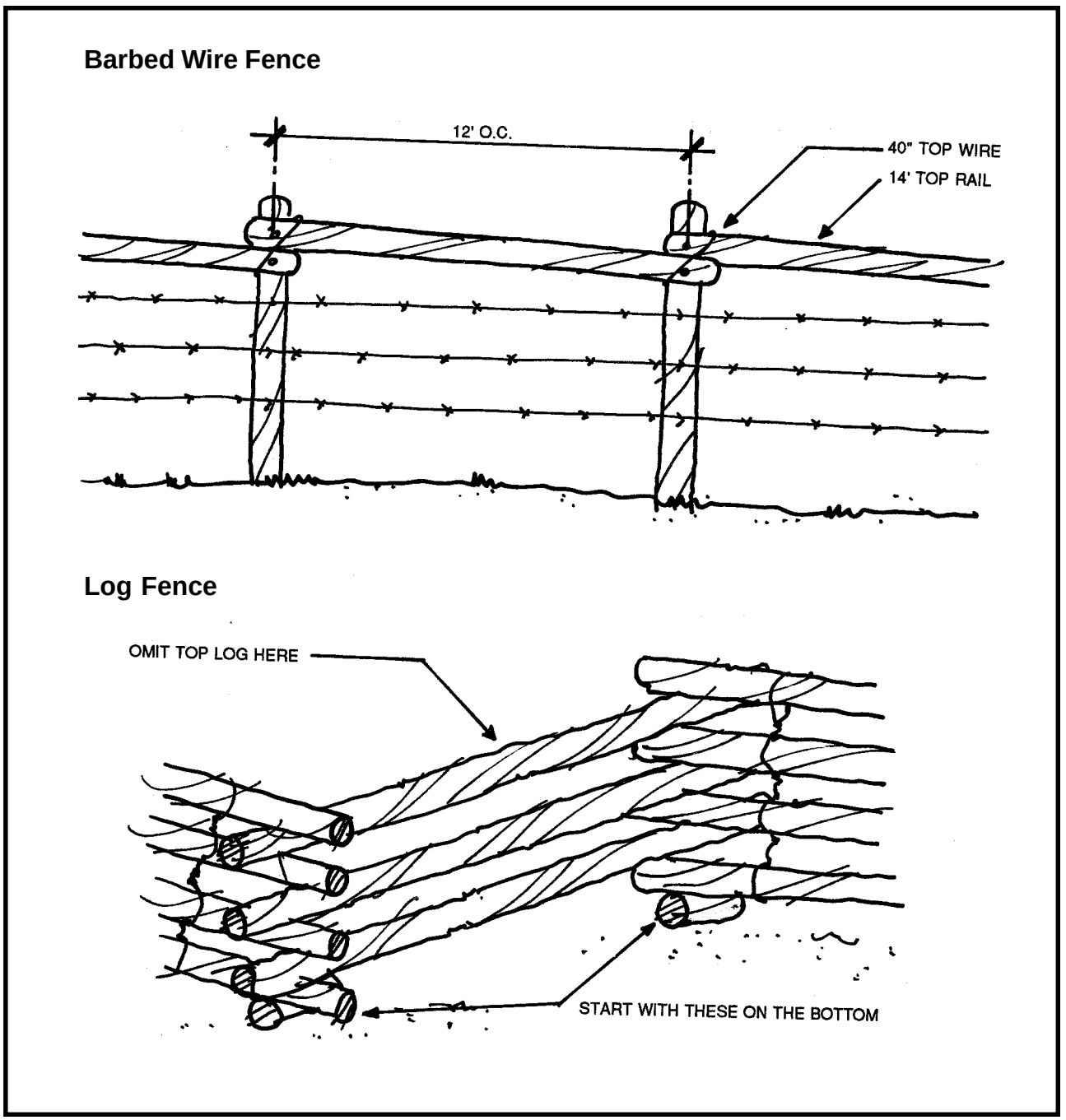


Figure 16 Sketch of Barbed Wire Fence and Log Fence Adapted for Wildlife

B(v) Coated Chain Link Fencing

Chain link fencing forms a very effective barrier. It is most appropriate for locations where there are significant risks of damage from high volume pedestrian use or heavy equipment, or where littering exists. Examples include school yards, high density residential sites, commercial or industrial sites. Vinyl coating in a natural colour such as green or black can blend the chain link fencing into the surrounding landscape. It can also be combined with plantings, such as shrubs and vines, to improve aesthetics. If properly installed, chain link fencing can have low maintenance and a long life span.

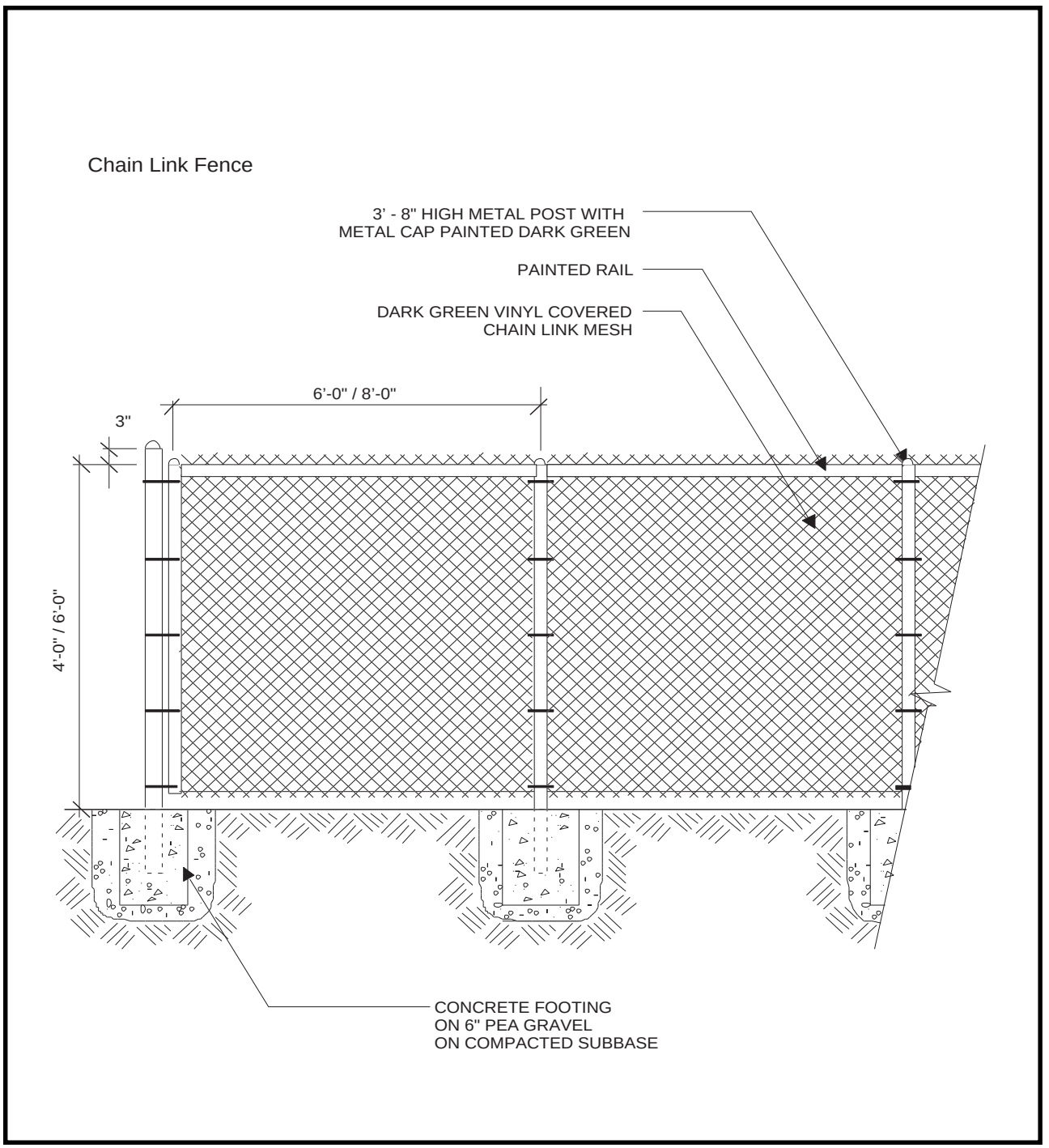


Figure 17 Detail of Chain Link Fence

B(vi) Timber Fencing

Timber fencing can be very aesthetically pleasing and lends itself to many variations in the detailing. It is most appropriate in a residential context. It is easy to install and with periodic maintenance can last many years.

In the dry and cold north and interior, the life span of wooden structures will be longer. Maintenance includes periodic weather proof stain and minor repairs. All hardware (nails, etc.) should be galvanized (rust proof). Timber should be pressure treated wood (Hemfir) or cedar.

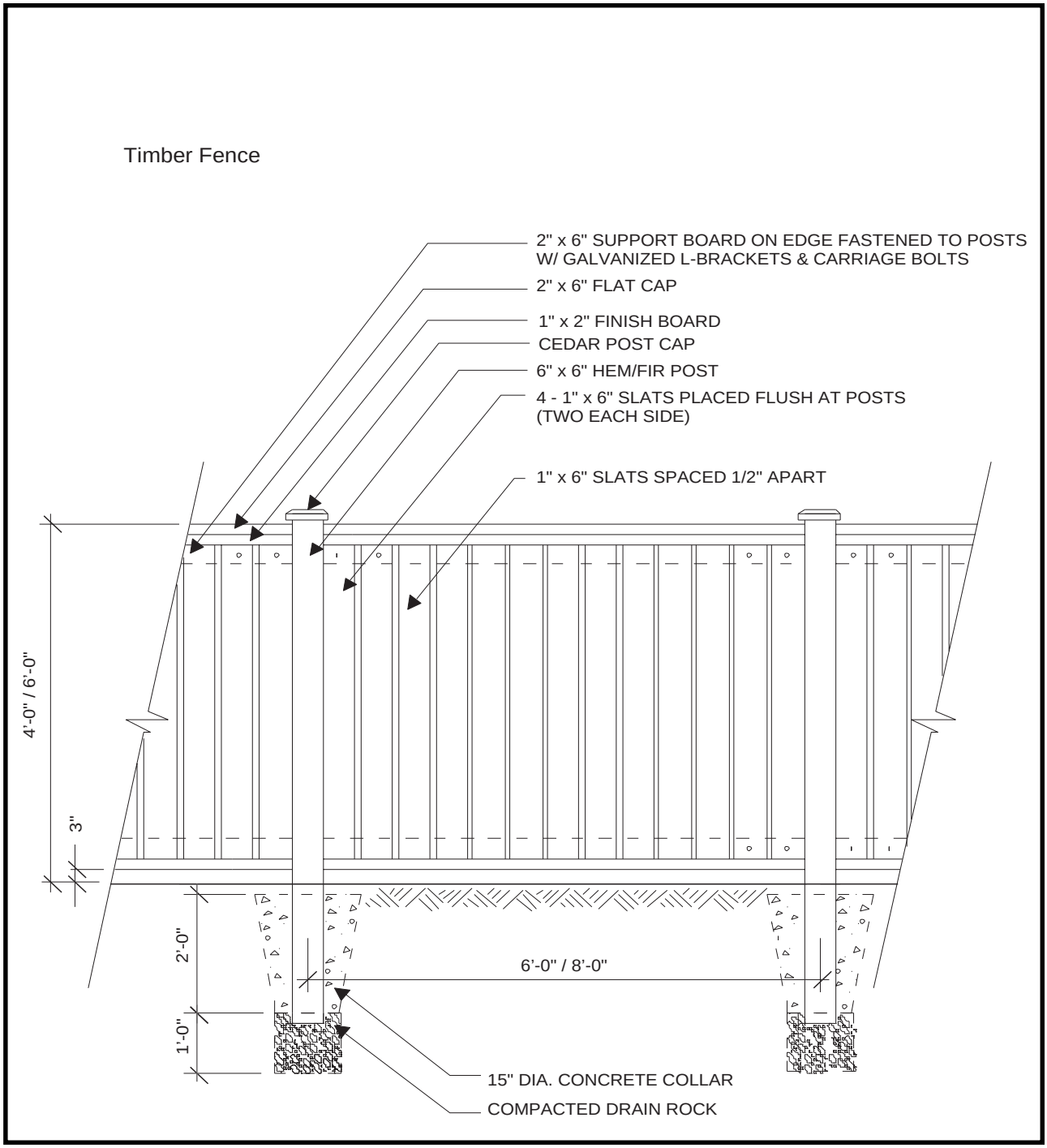


Figure 18 Detail of Timber Fence

B(vii) Timber Marking Posts

Timber marking posts are appropriate where an impenetrable barrier is not necessary or a simple means of delineating a covenant boundary is all that is required. Timber marking posts may be used in conjunction with a vegetative barrier in some cases to produce an aesthetically pleasing barrier to separate land uses or create wildlife habitat. Some examples of appropriate uses are rural residential (non-hobby farm) or rural/ suburban properties near wildlife migration corridors. This barrier type will demarcate a covenanted area and provides a mounting post for signage. It is possible to install a temporary electric wire for seasonal livestock containment if required. Periodic maintenance might include a weather proof stain and minor repairs. All hardware (nails, etc.) should be galvanized (rust proof). Timber should be pressure treated wood (Hemfir) or cedar. Post spacing can vary depending on the length of the boundary and the number of properties involved.

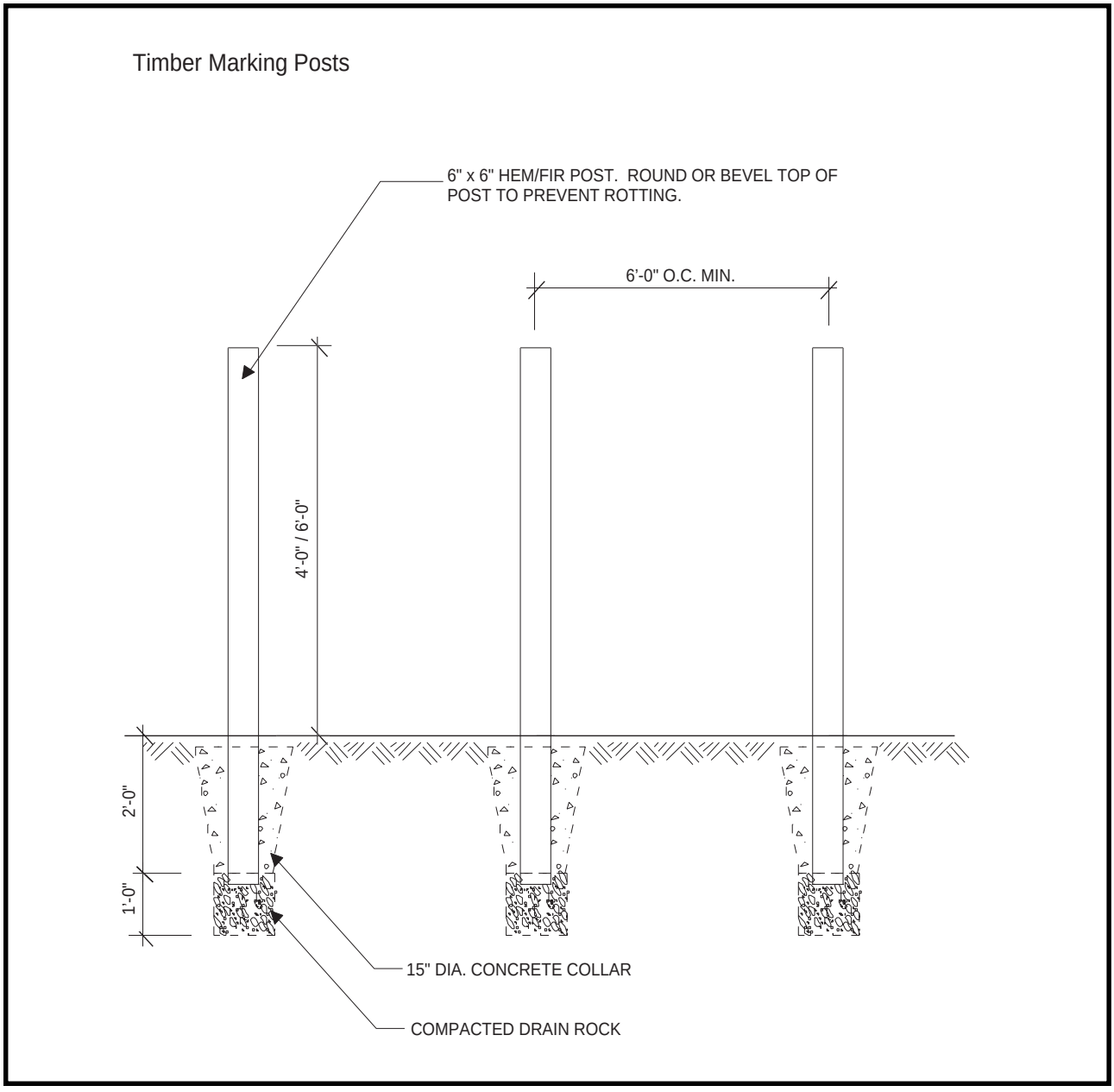


Figure 19 Detail of Timber Marking Posts

C. Live Barriers in Conjunction with Fencing

Where the visual effect of a live barrier is desired, but site influences suggest a 'hard' barrier (e.g. high potential of intrusion into an ESA), a fence may be used in conjunction with live plant material.

Using a fence in combination with a live barrier will help to prevent removal of plant material, and if plant mortality occurs, the covenant/ESA remains clearly delineated. As well, information signs can be mounted on the fence posts. If visual impact of the fencing material is a concern, a page wire fence placed between or behind planting can be used. Fence and vegetation height can vary depending on aesthetic, security and protection considerations.

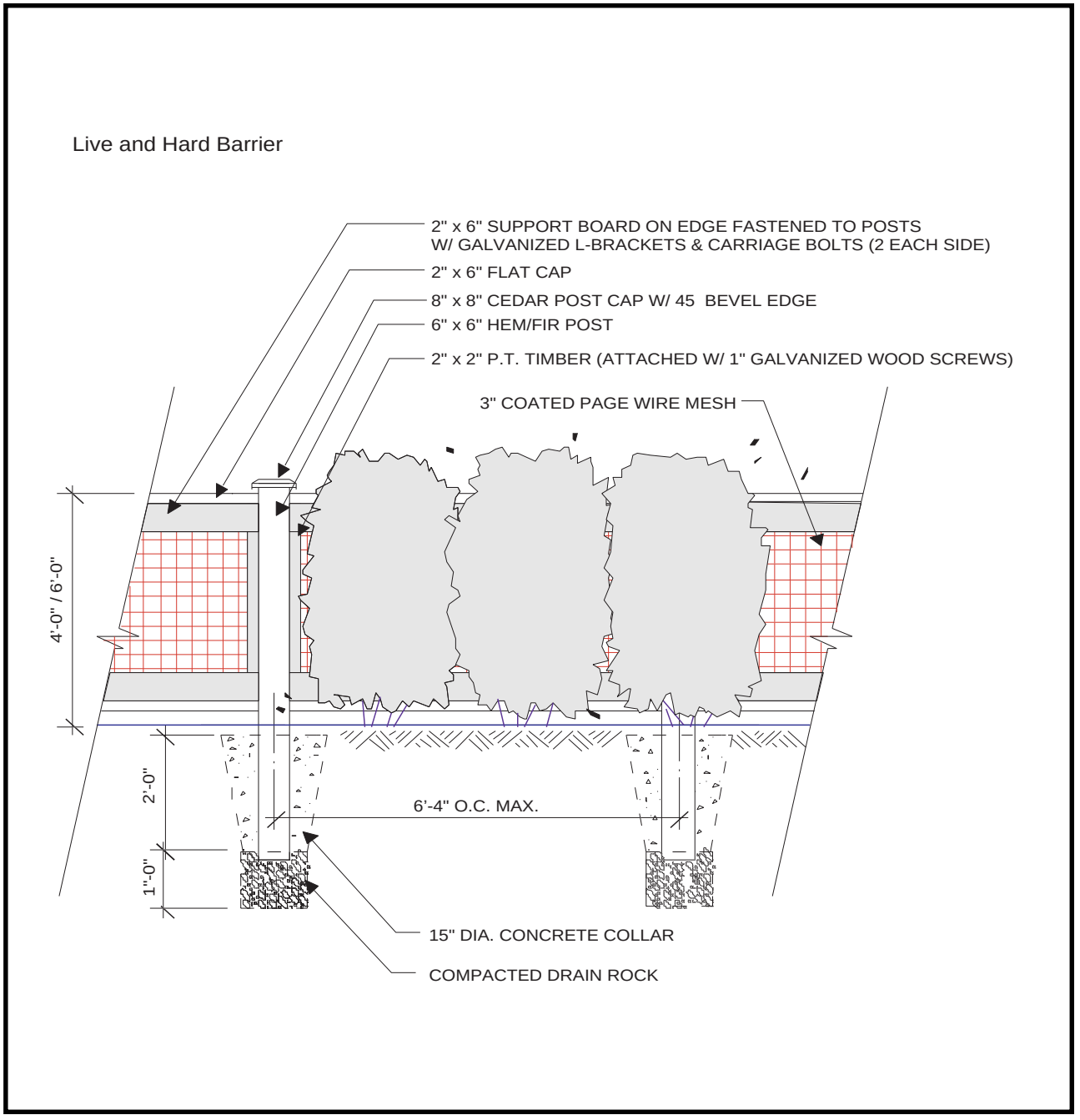


Figure 20 Detail of Combination Live and Hard Barrier

D. Terrain Barriers

A terrain barrier is a change in grade or elevation that discourages pedestrian, livestock, and vehicular trespass. This category includes channels, depressions, berms and retaining walls. When installing terrain barriers, existing topography and run-off patterns need to be taken into account — natural drainage patterns should not be interrupted. Terrain barriers are effective on flat land where there are natural changes of grade, or where ditches or drainage structures exist that could be enhanced. As terrain barriers may require more space and can be more costly to construct, particularly where required changes in elevation are significant, they are most suitable for large institutional care facilities, golf courses, within a large park and locations where there are existing changes in grade. Terrain barriers can also be used in combination with planting or fences. The following are a list of terrain barrier alternatives.

D(i) Retaining Walls

These barriers are most effective when the grade difference between top of bank and the leave area is greater than 4 ft. (1.2 m). Retaining walls are only useful for sites with a natural and abrupt change in elevation. Retaining walls are most useful for inhibiting trespass; however they do not prevent littering, unless they are used in combination with a fence. They are very effective psychological barriers and do not obstruct views into the ESA.

As most retaining walls also serve a bank stabilization function, they must be structurally designed and approved by a registered professional engineer. Retaining walls adjacent to public areas generally require a railing. Pressure treated timber or lock-block walls are preferred. All construction materials should be pretreated. Use of concrete on site must be managed very carefully to prevent runoff as concrete runoff and wash water is toxic to fish and aquatic invertebrates. Retaining structures should be set back a minimum of 1.0 m from the leave area boundary to prevent disturbance of the leave area vegetation during construction and maintenance of the retaining wall.

Retaining Wall Barrier

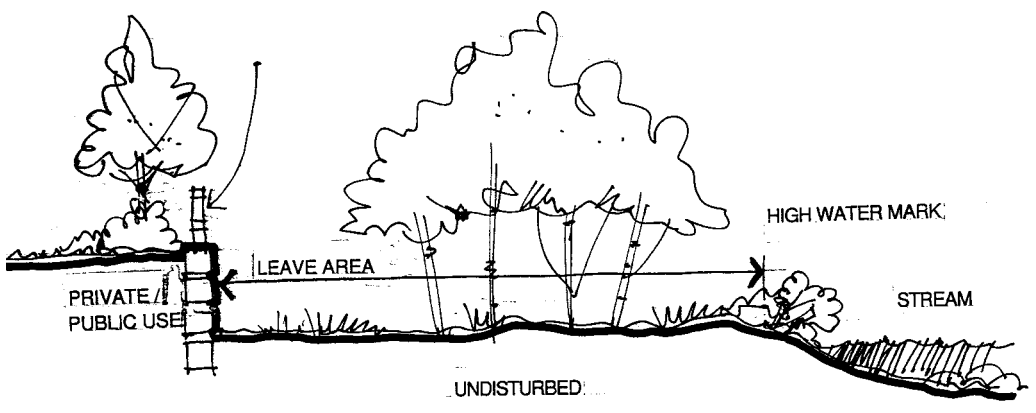


Figure 21 Sketch of Live Barrier in Combination with Fencing and Retaining Walls

D(ii) Berms

A berm is a raised mound of land, usually created by filling a portion of a site. Where the surrounding terrain is level, a berm can provide both visual and physical separation between an aquatic area and an adjacent land use. The berm must be constructed within the development site. The toe of the slope should be located outside of the boundary of the leave strip or covenanted area. Plantings can be used on the berm to augment its effectiveness as a barrier and to enhance bird and wildlife habitat. As one possible drawback of berms is that they can block views, they are most appropriate in areas where viewscapes or aesthetics are not issues.

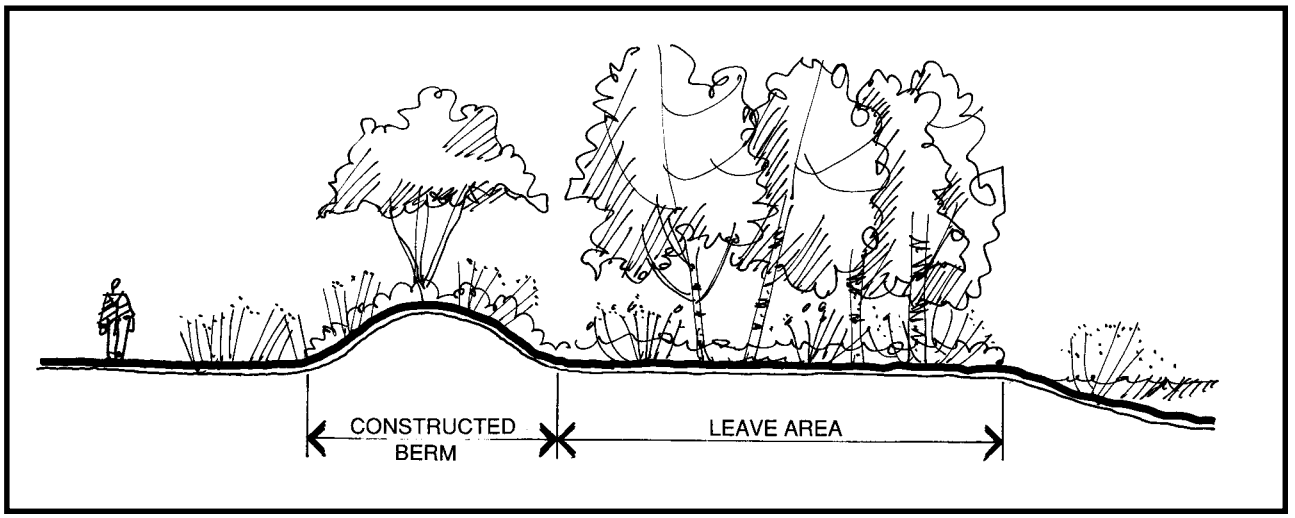


Figure 22 Sketch of Constructed Berm

D(iii) Depressions

Depressions can be effective for large nature parks, golf courses and rural residential areas. However, unless the natural topography is suitable, the construction costs might not make this a feasible alternative. When using only a depression as a barrier, the width and depth should be sufficient to deter pedestrians, bicycles, and motor vehicles. Depressions should be a minimum of 2 ft. deep and 3 ft. wide in order to be most effective. Excavation for depressions could also be to a depth appropriate for establishment of natural aquatic vegetation such as sedges and rushes. Where foot traffic is expected, signage should be provided. A depression in conjunction with a fence (known as a 'ha ha') is very effective and if seen from a distance provides no break in the view.

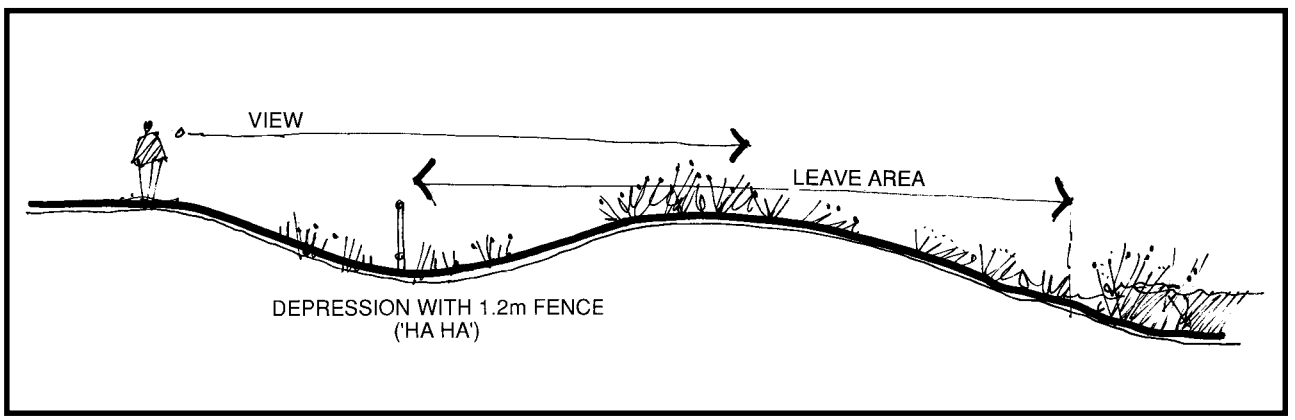


Figure 23 Sketch of Depression in Combination with Fencing ('ha ha')

D(iv) Channels

A channel is a depression containing flowing water, and includes drainage ditches. While channels can be effective for inhibiting trespass, they can be expensive to construct and may require routine maintenance. Where channels or ditches are an existing site feature, they should be incorporated into the site plan or designed as natural barriers. As there may be some liability concerns associated with channels, their use is most appropriate for very specialized applications - to separate, for example, public parks, intensive agriculture and golf courses from ESAs. Fencing in conjunction with a channel may be required as well to enhance safety. To be effective as a barrier, channels should be greater than 4 ft. (1.2 m) wide.

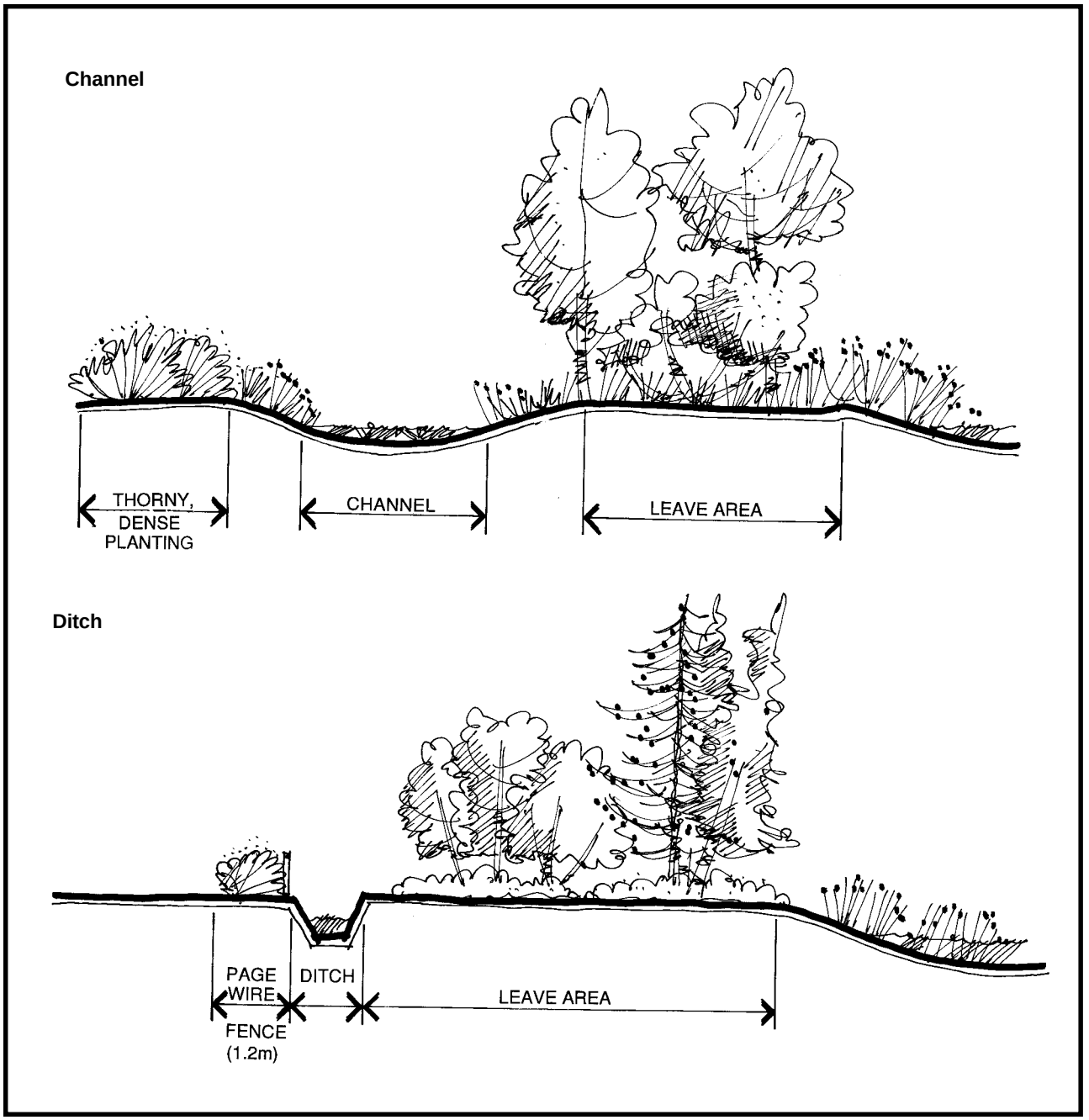


Figure 24 Sketch of Channel and Ditch in Combination with Fence/Plant Material

7.5 Case Examples: Using Barriers to Protect Aquatic ESAs

This section presents a series of examples where barriers have been used to protect sensitive aquatic areas. The settings range from rural to urban. The success or shortcomings of each example is reviewed, including potential improvements and possible alternatives. Many of these examples illustrate the importance of adequate planning to prevent conflicts. In many of these cases, restoration and rehabilitation is also required.

A. Rural Agricultural Site

A feasible solution is found to curtail habitat destruction by cattle

Farming is the mainstay of a rural township close to the Vancouver metropolitan area. The farmer on this site runs forty to fifty head of cattle that he sells each spring. A salmon bearing stream traverses the property. Prior to the installation of a livestock barrier, the riparian vegetation and the streambanks were being destroyed by trampling and grazing. The streambanks became severely eroded, causing increased sedimentation of the stream. Manure from an upland slope was also leaching into the creek.

The solution included the installation of a galvanized barbed wire fence to restrict cattle access to the creek. This fence has circular pressure treated timber posts, rugged strands of barbed wire and a galvanized access gate for maintenance. An important feature of this project is a stream crossing/watering area for cattle composed of an aggregate sub base and gravel surface. The material selected for this crossing is of a size which does not pose a tripping hazard to livestock. A low galvanized barrier across the stream permits cattle access to the stream at the preferred crossing/watering site, without inhibiting fish passage and waterflow in the stream. A riparian shrub and tree replanting program has also been implemented. This will provide stream bank stabilization and improve cover for fish as well as reduce summer stream temperatures, all of which were identified as concerns. The manure on the slope has been removed and the corral has been relocated so that livestock wastes do not enter the stream.

A galvanized barrier prevents livestock from entering the stream

This rugged galvanized wire fence also protects vegetation that has been planted

A gravel surfaced crossing allows livestock direct but managed access to stream

B. Single Family Housing

B(i) Timber walls and fences help to protect a stream corridor

A recent development on sloping terrain features large single family homes of 300 square metres. Views of the stream and ravine are an important marketing amenity. Skillful siting and grading has helped to maintain many native trees and shrubs on site. In all instances, leave areas were established; however, few were adequately set back from top of bank. As a result the stream corridor (which is fish bearing) required greater protection from disturbance.

Timber crib walls in combination with timber fences have been used to accomplish this objective. In most locations, where elevation differences were slight, curb walls were constructed without any fencing. Where elevation differences were significant, walls were combined with either timber or rail fencing. Thus far the combination of retaining walls and fencing has been successful in limiting intrusion into the stream and remnant leave area while allowing generous views.

Timber retaining walls with rail fencing can be effective barriers

Timber fencing atop a timber retaining wall prevents disturbance of leave area

B(ii) In single family housing, barriers have varied results

Several attempts at stream protection using primarily ornamental plantings have occurred in an older single family subdivision near Vancouver.

One resident has planted rows of pyramidal cedar to create a barrier adjacent to the stream bank. The choice of vegetation, the density, and scale are too small to be effective. As well, large gaps in the planting invite trespass.

Upstream, a double row of dense shrubs is more effective. At the top of the bank, one row of flowering shrubs is planted in front of another row of dense, thorny vegetation. This has been effective in reducing foot traffic into the small ravine and stream. However, these plantings occurred in the leave area, and necessitated natural vegetation removal. Use of native plant species could have compensated for lost fish and wildlife riparian habitat.

This row of cedars is not effective in preventing stream disturbances

B(iii) Timber fencing in residential settings offers choices

Timber fencing can be adapted to a variety of settings. If well built and maintained, timber fencing is aesthetically pleasing and effective against intrusion into sensitive areas such as streams and wetlands.

A rugged 6 ft. timber fence with vertical slats is aesthetically pleasing and has been successful in preventing trespass into a ravine and stream corridor

In a large hobby farm setting, open rail fences are compatible with the image of the semi rural landscape and equestrian activity

C. Multi-Family Housing

Chain link fencing and natural landscaping combine to protect a small tributary

A rapidly developing Lower Mainland community faces the challenge of protecting fish bearing streams and other ESAs from degradation. As it grows, the conflict between accommodating people and protecting natural areas has become critical.

This site includes a mixture of condominiums and rental town housing. A small stream that is a tributary to the Fraser River runs through the property. The stream is important for coho salmon production despite upstream portions having been culverted. The stream had historically been a dump site for trash and derelict shopping carts.

A chain link fence has been constructed along the top of bank. Since the fence was installed native vegetation has re-established itself, vigorously growing through and over the fence. As a barrier the fence has been very effective in precluding intrusion and littering. The vegetation partially conceals the fence and improves the aesthetics.

Unfortunately, however, the fence was constructed within the leave area. On the opposite bank, natural riparian vegetation was removed and replaced with sod to accommodate maintenance access to a utility corridor. Clearing of vegetation and utility corridor alignment within the leave area must be discouraged.

Chain link fencing and natural vegetation combine to form an effective barrier

D. Suburban High School Site

The need for a fenced barrier becomes urgent

A large secondary school is located adjacent to a steep wooded ravine and a fish bearing stream. Students use the ravine slope to sit and have lunch and people traverse the ravine regularly to reach the stream. As well as being unsafe, serious erosion has been triggered. The slope is also extensively littered with rubbish.

This situation warrants a strong, durable barrier. A live barrier would not be sufficient to curtail trespass. A low fence would be easily vaulted. Therefore, a vinyl coated chain link fence, with supports set in concrete, 6 ft. high, is the preferred choice. If desired, vines could be planted to reduce its visual impact. Trash receptacles should be installed and a

designated outdoor sitting/eating area established with tables and/or benches.

The eroded portions of the ravine should be replanted with native vegetation. Cooperation between the school board and the municipality is required. Volunteers, service clubs, environmental or student groups could assist in constructing the fence and replanting the slope.

This large high school lacks barriers and invites students to congregate in a ravine adjacent to an ESA

The results are litter, safety problems and habitat disturbance

E. Industrial/Commercial Setting
Industrial / commercial site beside an ESA creates problems

This light manufacturing and commercial site has an inadequate setback from a fish bearing stream. Building uses include warehousing, fast food restaurants, discount retail outlets and automobile dealerships. The site is littered and there is ongoing trespass into the ESA. As well, pre-load sand is sloughing into the ESA. Riparian vegetation has been removed and the small tributary is infilling.

At a minimum, a silt fence should be installed at the base of preload fill slopes to curtail sediment migration. Additional measures could include placing lock-blocks or hay bales along the outside of the silt fence to retain preload material on site and to increase stability of the fence. A fence along the top of bank is needed to discourage trespass and reduce litter. A combination barrier would offer visual relief to this predominantly paved area.

Fencing options include a 4 ft. chain link or timber fence with plantings. The fencing should be continuous since it is at road crossings and other openings that most of the impacts occur. Riparian vegetation should be re-established along the banks.

Previously disturbed habitat and a compromised setback warrants a durable fence or a combination barrier

This open fence design is not effective in preventing trespass and litter into the stream

A properly installed silt fence is needed on this site to prevent migration of preload sand into the leave area and permanent fencing needs to be maintained

F. Urban Park

An important stream is protected and access is accommodated

A history of severe erosion, accidents and intrusion into a stream corridor has resulted in a program of barrier installation and trail realignment in a heavily used urban park. Prior to this, some park visitors were scrambling over steep slopes to reach viewpoints or to enter the stream at dangerous locations. As well, trails were aligned within rather than outside of the desired leave area.

The municipality's parks department has embarked on an education program and has installed vinyl coated chain link fencing along the most vulnerable and hazardous sections of the setback to discourage intrusion at these locations. In addition, trails that were routed along the bank or ravine edge have been re-aligned beyond the leave area. Boardwalks were installed across sensitive and periodically flooded lands and stairs were used to replace eroding trails.
In specific locations, seasonal access is permitted to the stream edge.

A fence, railing and timber stairs are designated to keep pedestrians on the path

A vinyl coated chain link fence separates an ESA from a heavily used aggregate surface trail

8.0 Tools for Protecting Aquatic ESAs

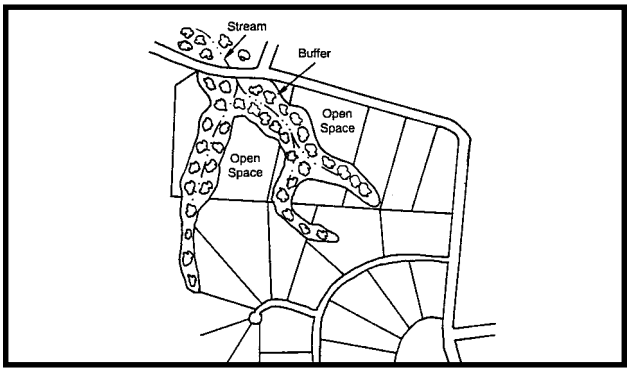
8.1 Greenways

Greenways[1] are 'linkages' between environmentally sensitive areas, utility right-of-ways, roadways, street boulevards, abandoned rail lines, neighbourhood parks and other privately and publicly owned open spaces. Done sensitively, community greenways planning can often accommodate both protection of the aquatic ESA and areas of public access.

Greenways require:

- Documentation in Neighbourhood Community Plans (NCPs) and Official Community Plans (OCPs)

Documentation of greenways, which may include environmentally sensitive areas such as streams, wetlands, and other aquatic features in local land use plans and in Official Community Plans, helps to ensure recognition and protec-tion of these areas during subsequent land designation or development.



(from *Riparian Buffer Strategies for Urban Watersheds*)
Incorporate leave and buffer areas into local land use plans

- Proactive planning and coordination with other land uses

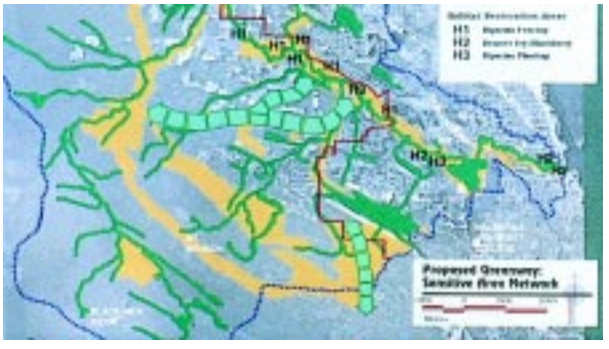
  By planning the 'green infrastructure' first, before lands are zoned or designated for use, greenways of an adequate size to protect natural processes can be delineated. Greenways should include adequate buffers and leave areas (reserve zones) around aquatic ESAs.

- Developing recreational objectives for sections of the greenway that are compatible with surrounding land use

  Not all greenways are trailways. Elements of a greenway such as roads, community parks, or right-of-ways may be designated for active recreation whereas ravines, floodplains, crop lands, or privately owned dykes can be designated as areas where no access is permitted.

- Biophysical analysis and mapping

  Greenways planning requires terrain and aquatic biophysical analysis and mapping in order to establish different levels of sensitivity and to identify locations of specific habitat value. Analysis of potential hazards and other conditions are necessary to identify both resource protection areas and locations that are appropriate for public access.



(from *Community Greenways*)
Terrain and aquatic mapping provide the basis for greenways planning

[5] Please refer to *Community Greenways: Linking Communities to Country, and People to Nature* (1996) for comprehensive guidelines on greenways planning.

Example of a greenway that protects aquatic ESAs - North Vancouver

An example of an approach to greenway designation and protection can be found in the District of North Vancouver's upland planning. Stream corridors and other ESAs have been mapped as part of the District's data base, accompanied by stringent controls for soil handling, vegetation protection, erosion control and water quality maintenance. Stream corridors have been established and vegetation retained. Trails are sited outside these corridors, in a zone that buffers the ESA from development. Pedestrian bridge crossings afford opportunities for viewing streams while minimizing intervention with aquatic habitats. District staff, agency and environmental consultants are engaged to review and monitor all developments including community parks to assure compliance with aquatic ESA protection requirements. Remedial measures are required in the form of restoration planting and other mitigation procedures for any disruption such as a utility crossing within the greenway.

8.2 Legislation, Guidelines and Resource Materials

Legislation is another tool used to protect ESAs. Access plans, trails and structures need to be designed in a way that protects fish and wildlife habitat, and may need to be referred to senior agencies.

In some cases, regulations have been promulgated, or guidelines have been produced, which interpret the legislation for specific land use activities.

Statutes, regulations, guidelines and resource materials relevant to aquatic resource protection and public access are listed and summarized in Appendix 4.

8.3 Covenants

Restrictive Covenants[5]

The Ministry of the Environment, Lands, and Parks currently requests that a restrictive covenant be placed on that portion of privately owned property that is considered fish habitat according to the federal Fisheries Act. In many instances, these boundaries are surveyed to comply with leave areas as defined in the *Land Development Guidelines for the Protection of Aquatic Habitat.* The Ministry of the Environment's Water Management Branch also requires restrictive covenants in floodplain areas under sections 82 and 215 of the Land Title Act.

In redevelopment situations, covenants are often the only means of protecting aquatic riparian areas. When large tracts of land are being rezoned or subdivided, proactive planning approaches should be encouraged to secure and protect 'leave areas'.

Conservation Covenants

A new legal option for protection of ecologically sensitive areas has been created under recent amendments to section 215 of the Land Title Act which allows conservation groups to hold covenants. These 'conservation covenants' are now being established throughout B.C. by several non-government organizations (NGOs). However, due to logistics and NGO resources, conservation covenants are generally used where environmentally sensitive areas are contained in large private property holdings.

For further information on conservation covenants the reader is referred to *Leaving a Living Legacy: Using Conservation Covenants in B.C.* (West Coast Environmental Law Association, 1996).

[6] Covenants are a written agreement between a landowner and government, whereby the owner agrees to specified limits on the use of the land. This agreement is registered on title under s.215 of the Land Title Act, and is commonly referred to as a restrictive covenant.

8.4 Voluntary Stewardship

In addition to the planning and regulatory tools that can be used by government, ESAs can also be protected through voluntary stewardship initiatives undertaken by the public. There are many examples of voluntary stewardship for aquatic habitat and watershed protection in the Lower Mainland.

One example of community stewardship is the Township of Langley's Environmental Partners Society (L.E.P.S.). In conjunction with other groups, such as the Aldergrove Downtown Business Association, L.E.P.S. has initiated habitat enhancement programs along both the Salmon River and Bertrand Creek.

In addition, L.E.P.S. has established good working relationships with environmental agencies and the Township of Langley. It has been successful in securing funds and equipment donations to enhance stream and riparian habitats throughout Langley. L.E.P.S. has also been involved in trail planning along sections of Bertrand Creek.

In another setting, naturalist groups and community interests in the Village of Harrison Hot Springs are playing an active role in enhancing Miami Creek, which flows into Harrison Lake. As a part of the planning process they are involved in determining locations for boat launching, and nature paths and will be involved in trail construction.

Community stewardship initiatives can include:

- participating in local land and water use planning processes (NCP, OCP and zoning reviews);
- identifying sensitive aquatic features through aquatic ESA inventories;
- voluntary conservation of aquatic ESAs on private property;
- land owner contact to encourage stream stewardship or compliance with covenants;
- education programs to address specific issues (e.g. human access, littering, vegetation removal);
- restoration and enhancement programs for degraded areas;

Volunteers clear wood debris from an estuarine marsh

- stream stewardship programs (signage for habitat, storm-drain marking; Streamkeepers training; 'adopt-a-trail'/ 'adopt -a-stream' programs);
- helping develop 'sensitive' access plans and assisting with trail construction.

Well designed, well located signage raises awareness of sensitive aquatic ecosystems

8.5 Cooperative Management

As aquatic ESAs often cover large areas or flow over long distances, their management presents an opportunity for cooperation across jurisdictional boundaries. Case studies (Appendix 1) illustrate that effective sharing of management and funding responsibilities is often accomplished through partnerships between different levels of government as well as institutions, industry and the public.

Cooperation among different levels of government as well as between local governments can also help to assure the continuity of greenways.

A portion of the Sea to Sky trail corridor that runs through the District of North Vancouver (and the forest through which it extends) is included within the District's Lynn Canyon Park as well as the Greater Vancouver Regional District's Lynn Headwaters Regional Park. Despite limited financial resources, cooperative planning between these governments has protected important habitats yet assured reasonable access to Lynn Creek and the Seymour River. Improvement of visitor safety, environmental protection and creation of trails and signs are key parts of this program.

8.6 Funding

The cost and responsibility for developing and managing environmentally sensitive access plans can sometimes be shared among different government levels, surrounding communities and the private sector. Land for park and school dedications (between 5 and 10% of the parcel) at the time of subdivision, development cost charges, provincial cost sharing programs, land trusts, direct local government investment, and corporate sponsorship can help pay for land acquisitions.

The recent formation of partnerships between public and private sectors to raise capital for greenway development involving aquatic ESAs and related amenities has considerable potential. Changes in the federal Income Tax Act in 1995 and 1996 respecting donations of ecologically sensitive land can also play a role in land dedication with potential tax benefits to the property owner *(Stewardship Options for Private Landowners in B.C.,* 1996). Contributions in kind, such as equipment loans or volunteer labour, are equally important elements of many successful cost effective projects. The Township of Langley and City of Port Coquitlam are two municipalities that have benefited from including the private sector in community greenway and trail corridor development.

Volunteers will often assist with planting riparian vegetation

9.0 Case Example

Planning for Public Access in a Residential Area With Sensitive Aquatic Features

The following case example involves a site with several streams and wetlands, and various adjacent land uses in a suburban community (Figure 25). It illustrates a wide range of opportunities for providing public access to sensitive aquatic areas.

Community Background

The subject community is located within a rural block, which is part of a municipality characterized by primarily suburban and rural land uses. The existing neighbourhood has been zoned single family residential, with most development having occurred in the 1960s. There are several viable market farms adjacent to the stream. On the south west corner there is a commercial development and public market. Streams, tributaries, wetlands, and associated riparian areas border or flow through almost every farm or residential area in this suburb. Residents enjoy the feeling of being in a rural area and being surrounded by natural features.

Access Issues for Streams and Wetlands

A parcel of land has been designated for residential development in the northwest corner. Recently, a developer expressed interest in purchasing the lot, and applying for rezoning and subdivision. The lot has two creeks running through it, both tributaries to a large stream. A number of residents wish to preserve the sensitive natural features on the proposed development site, particularly those associated with the streams. Coho salmon and cutthroat trout are the main fish species found in the creeks. Several species of raptors and songbirds are found in the bordering riparian areas. Residents are accustomed to walking along the creek system on a small footpath, and would like to retain access to this amenity. They conduct a survey of residents and bring their concerns regarding protection and access throughout the neighbourhood to the municipal planner, who suggests that an access and management plan for riparian and aquatic areas be developed for the whole area.

Planning Process for Public Access

A team consisting of community members, a municipal planner and an engineer, a habitat biologist, and the developer interested in the undeveloped lot, is formed.

Step 1: Assessing Current Conditions

First, the access planning team develops an overview of issues affecting streams and riparian zones in the area.

They find that the current Official Community Plan (OCP) does not contain any direction on protecting environmentally sensitive areas (ESAs). The Neighbourhood Concept Plan (NCP) does not have an inventory of ESAs, but the municipal engineering department has a map of the watercourses in this area.

A review of conditions in the neighbourhood shows that there are many concerns for streams and riparian areas. In the existing residential area, the stream and riparian zone have been significantly compromised. The stream has been constrained within a narrow channel and storm sewers transport high flows away from the stream. The original forest that covered this area was cut down long ago, and a two to three metre width of shrubs and small deciduous trees is now all that remains of the riparian area. The bank is riddled with many paths down to the water, causing problems such as bank instability and sedimentation. Remaining wetlands and floodplain areas, which serve as natural stream flow regulators and water purification systems, are being compacted through unmanaged human access to the area.

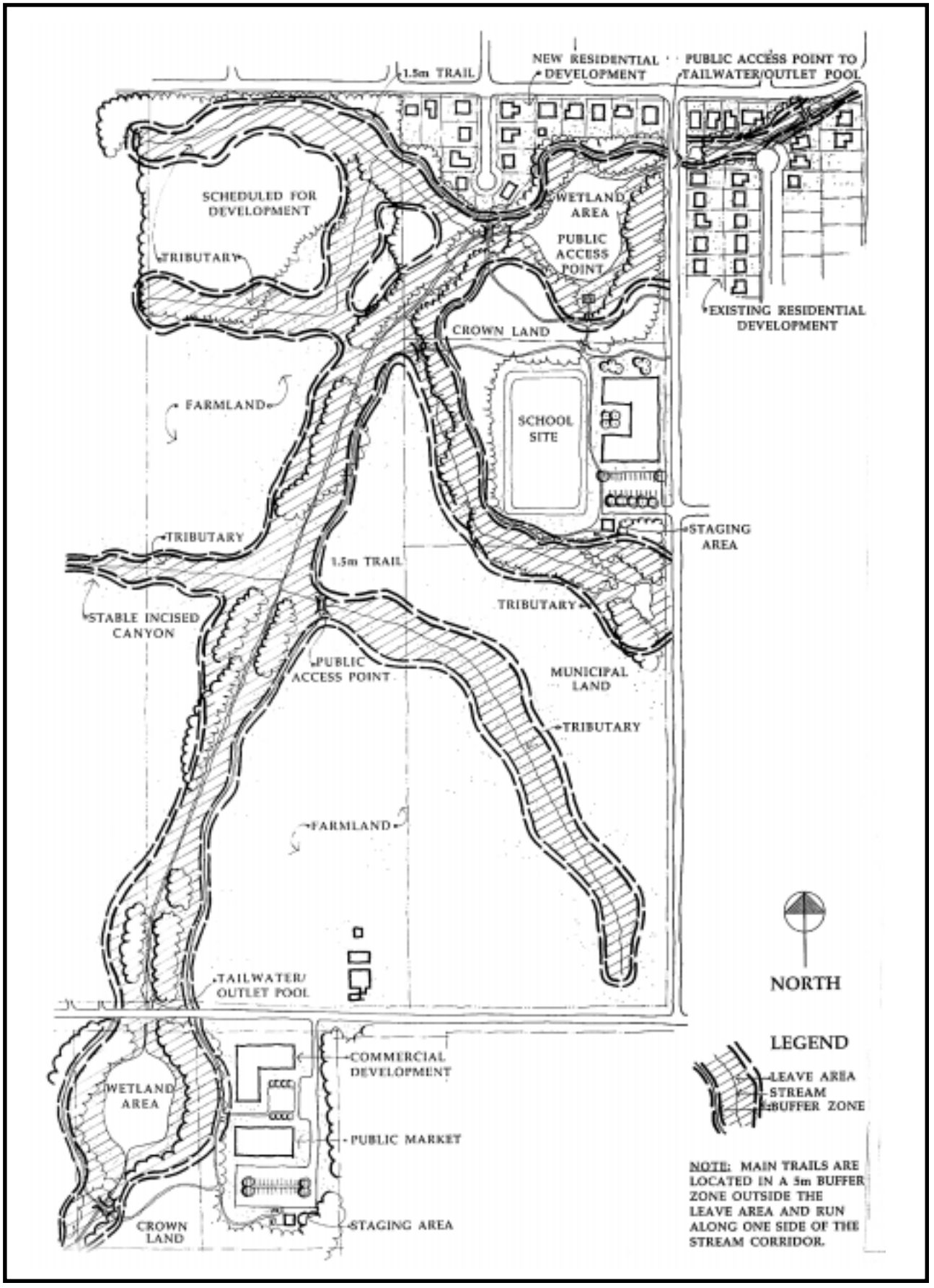


Figure 25 Access Planning Case Example

Flooding has become a common problem in low lying residential areas and farmers' fields. The capacity for water absorption in this watershed has been decreased through an increase in impervious surface area due to development, wetland compaction and riparian removal.

During the summer, water flows have decreased or even disappeared in some sections of the watershed. Impervious surface area in the watershed has reduced natural groundwater recharge, thereby reducing the amount of water available to streams in dry months. Water withdrawal for irrigation has also decreased stream flows.

As a result of extremes in water flows, some streams in this area have lost the ability to support fish. Other impacts to fish habitat include increased siltation, a decrease in spawning gravel and large organic debris, an increase in water temperature, and high concentrations of fecal coliforms and nutrients in small tributaries.

Step 2: Inventory and Mapping of ESAs

The next step taken by the access planning team is to conduct an ESA inventory. Then the aquatic component of the ESA inventory is used to update the existing watercourse map, and additional layers of information including adjacent land uses, proposed land uses and lot boundaries are developed and overlayed.

The biophysical analysis indicates that several of the streams and wetlands in this community's 'backyard' still support populations of coho salmon and cutthroat trout. The riparian area is found to be home to the endangered water shrew, as well as to many species of waterfowl and raptors, including the red-tailed hawk, which had been on the endangered species list, but has recently been making a comeback in the area.

Step 3: Developing Public Access Policies

In the next stage of planning, public access policies, various protection measures recreational management objectives, and trail design standards are developed, all of which have protection of the aquatic ESA as the primary objective.

Step 4: Establishing Adequate Leave Areas

Recognizing watershed processes, and the need for watershed planning, management zones are established along watercourses and around wetlands throughout the catchment. The management zones are intended to be large enough to include a leave area (reserve zone), as well as a buffer zone within which compatible uses such as trails can be accommodated. Based on topographic information and advice from the biologist, management zones are set at 50 m on either side of all aquatic features and designated as Development Permit Areas for the protection of the natural environment.

Detailed field inspections are then conducted to identify critical habitat features, geotechnical concerns, local surface drainage patterns, etc. Refined leave area (reserve zone) boundaries are then determined, based on site sensitivity, habitat values and risk. The purpose of the leave area is to protect the functions required for long-term stream or wetland maintenance. At this scale, leave area boundaries are established at 50 m on either side of the main channels and floodplains; 30 m around wetlands; and 5 - 7 m (for geotechnical protection) on the top of a ridge where a small tributary flows through a high relief and geotechnically stable ravine.

A leave area reclamation policy is also developed for those properties where there are historic footprints that are completely included within the recommended leave area. While activities will obviously continue within these areas, they are nonetheless mapped for future reference in the event that during rezoning or subdivision, there may be opportunities to acquire the property or create a new footprint that is more sensitive to the required leave area.

Step 5: Dedication of Leave Areas

In the undeveloped lot where multi-family residential housing is proposed, the leave area along one of the main tributaries will be placed under strata control and will become common property, subject to strata rules which the local planner will help define. In addition, a small area of the subdivision is dedicated by the developer to create park land. In order to maintain a continuous leave area along the tributary, an arrangement is made for a transfer of development rights. The developer is ceded an adjacent parcel of municipal land in exchange for setting aside sufficient land to create a leave area with an adjacent buffer for a trail system.

Areas around wetlands have been dedicated back to the crown in the past and cannot be developed. These areas are incorporated into the greenways plan. The municipality purchases the area where public access to the wetland has been proposed. Covenants are applied to privately owned areas around the wetland within the site to protect the remaining habitat features.

The municipality and community recognize that in the undeveloped area owned by the municipality, where two tributaries to the main stream flow parallel to each other, an excellent opportunity exists to preserve a large area for ecological viewing purposes. This area, which is municipally owned, is scheduled for rezoning to commercial. The community expresses a strong desire to see this area remain undeveloped and designated as a park. A local stewardship group offers to assist by building a boardwalk and viewing tower. Local businesses make a commitment to donate building materials. Senior government agencies will sponsor kiosks and signage. A local service organization offers a financial incentive to the municipality to compensate for revenues lost as a result of not selling the property for commercial development. Due to the high degree of community, corporate, and government support, the municipality decides to designate the area as a municipal park.

Step 6: Recreation Corridor Designation

The next step in the public access plan is to designate land adjacent to the leave areas (reserve zones) for a buffer zone, where trails will be located. A 5 m strip adjacent to the leave area is recommended in areas where good recreational potential exists along the aquatic ESAs. The 5 m strip includes 3 m for a main trail, and 2 m for vegetative screening.

Step 7: Barrier Implementation

All access planning is done with consideration of possible barrier requirements and designs. At sites where the aquatic ESA is especially sensitive and subject to historic deterioration, barriers are installed.

Where rushes and sedges have been planted as part of a constructed wetland, a temporary silt fence is installed along the edge of the wetland to protect the fragile emergent vegetation.

At one section of stream where a spawning area is regularly disturbed by people walking up to and through the stream, a combination hard and planted fence is installed to prevent unmanaged access to the stream, and a boardwalk is planned to provide a view of the spawning bed.

For the lot that is to be developed, the municipality sets landscaping requirements specifying that the developer retain the natural vegetation in the leave area along the stream. In addition, the developer is required to install a hard barrier on the outer edge of the buffer area to prevent trespass onto private property and to provide a screen between houses and trail users.

Implementing the Public Access System

Step 8: Trails and Public Access Points

A hierarchy of trails is established. A main trail is located in the buffer area outside the leave area (Figure 26), and limited access trails are identified at certain locations along the aquatic ESA. The main trail is designated for high intensity use, and can accommodate walkers and joggers. Portions of the main trail are wider and barrier free so that they

are accessible to bicycles, wheelchairs and parents with strollers, particularly along sections adjacent to neighbourhoods and the principal staging area.

Limited access trails are aligned to access viewing points within the aquatic ESA. Limited access trails and a footbridge run between the two residential subdivisions. (Figure 28). Routing is direct and trail width is limited to less than 1.0 m. Viewing sites are carefully chosen for their educational potential and ecological value. Extremely sensitive sites are not chosen since it was determined they would be very difficult to protect.

Step 9: Trail Staging Areas

Two staging areas are situated in central locations: one in conjunction with the school site, and another in conjunction with the public market. The staging areas incorporate the following amenities:

- Parking is shared with the school site on weekends, when maximum main trail use is experienced and when the school is not in session. Bicycle racks are also installed.
- Portable compost washrooms are provided. They are maintained and monitored on a regular basis by the municipality's parks department.
- Signs provide information regarding direction/orientation of the trail system, salmonid enhancement initiatives on the stream, ecological interpretive programs and acceptable recreational uses.

Step 10: Viewing Decks (figures 27 & 29)

Viewing decks are provided at each of the wetlands, and over culverts with fish passage baffles (providing views to these baffles to demonstrate their function). The viewing decks are located in areas determined to be the least sensitive to disturbance, and vegetative barriers are provided in conjunction with fencing at certain locations along either side of the trail leading to the decks. The boardwalk leading to the wetland viewing platform has handrails for safety and to protect the public wetland from intrusion.

Step 11: Integrating Access Planning with Municipal Planning

In order for the municipality to support the implementation of the access plan, surrounding land use planning needs to be dovetailed with it. Policies for the protection of aquatic ESAs are adopted into the Official Community Plan. In addition, the aquatic ESA access plan becomes an integral part of the Neighbourhood Concept Plan. The Development Permit Area boundaries around the aquatic features are indicated on the land use map in order to alert municipal staff, landowners and developers to aquatic areas of concern.

In addition, the access planning exercise has heightened awareness of watershed issues affecting the neighbourhood, including waterflows in streams, siltation, storm water detention, water quality, and impervious surface area. The municipality begins to address these concerns.

In the community, stream stewardship initiatives are introduced including a habitat restoration program (riparian vegetation planting and bank stabilization); guided interpretive walks; a land owner contact program; and a 'salmonids in the classroom' incubation program.

Step 12: Access and Community Greenways Planning

The Aquatic ESA Access and Management Plan will become part of the municipality's Greenway plan. The protected riparian areas and associated buffer zones with trail systems will become part of a green space network, connecting other parcels of private and publicly owned green open spaces throughout the municipality. These protected areas will also be linked to stormwater detention ponds and constructed wetlands as part of subdivision approval.

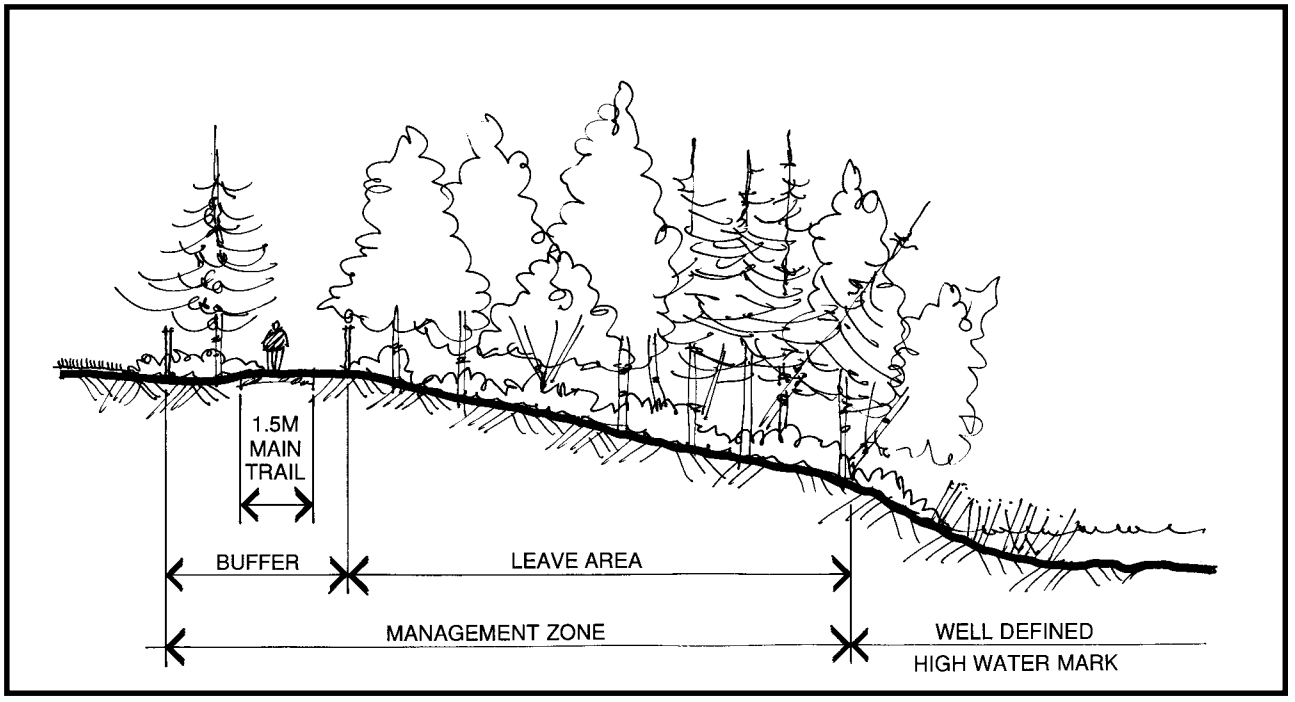


Figure 26 Section Through Aquatic ESA with Main Trail in Buffer

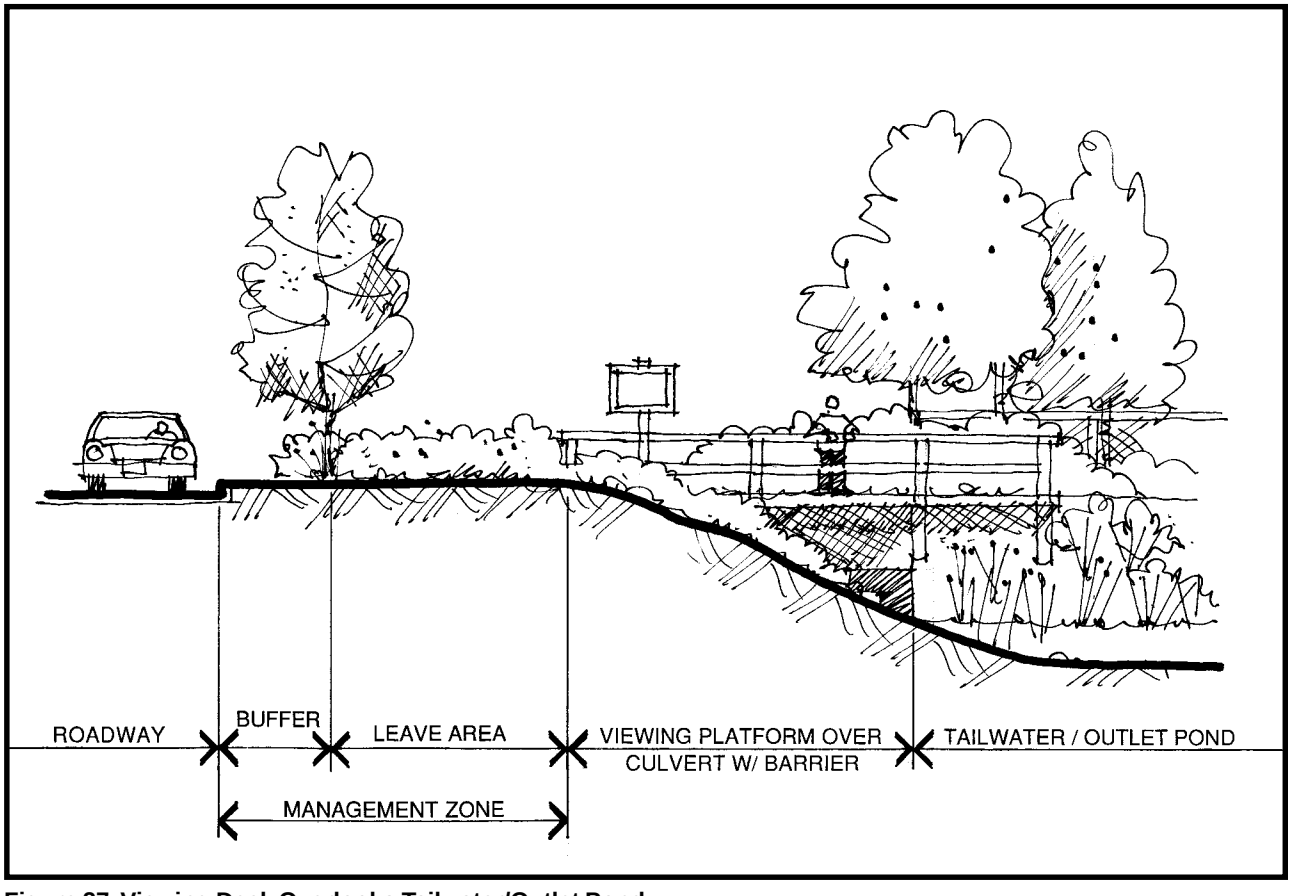


Figure 27 Viewing Deck Overlooks Tailwater/Outlet Pond

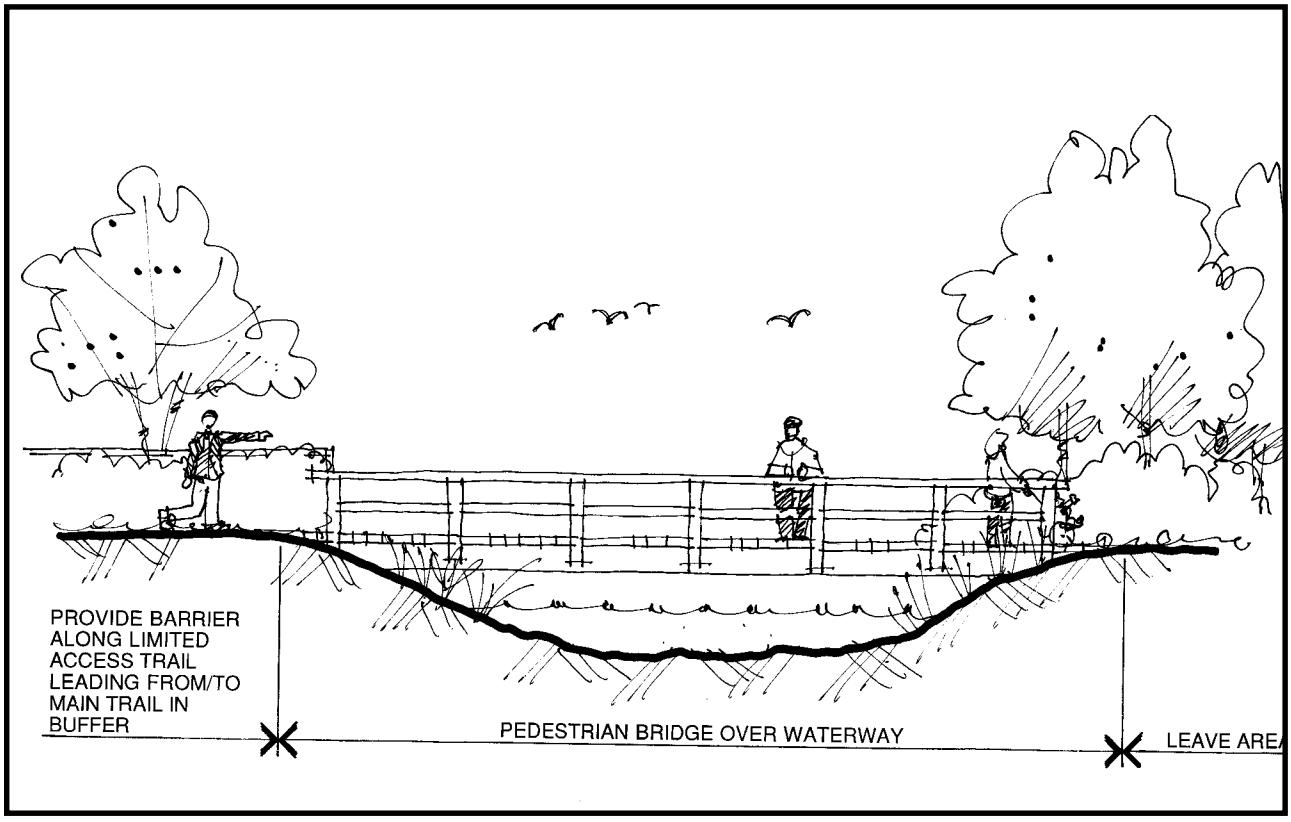


Figure 28 Limited Access Trails Lead to Footbridge Overlooking Wetland

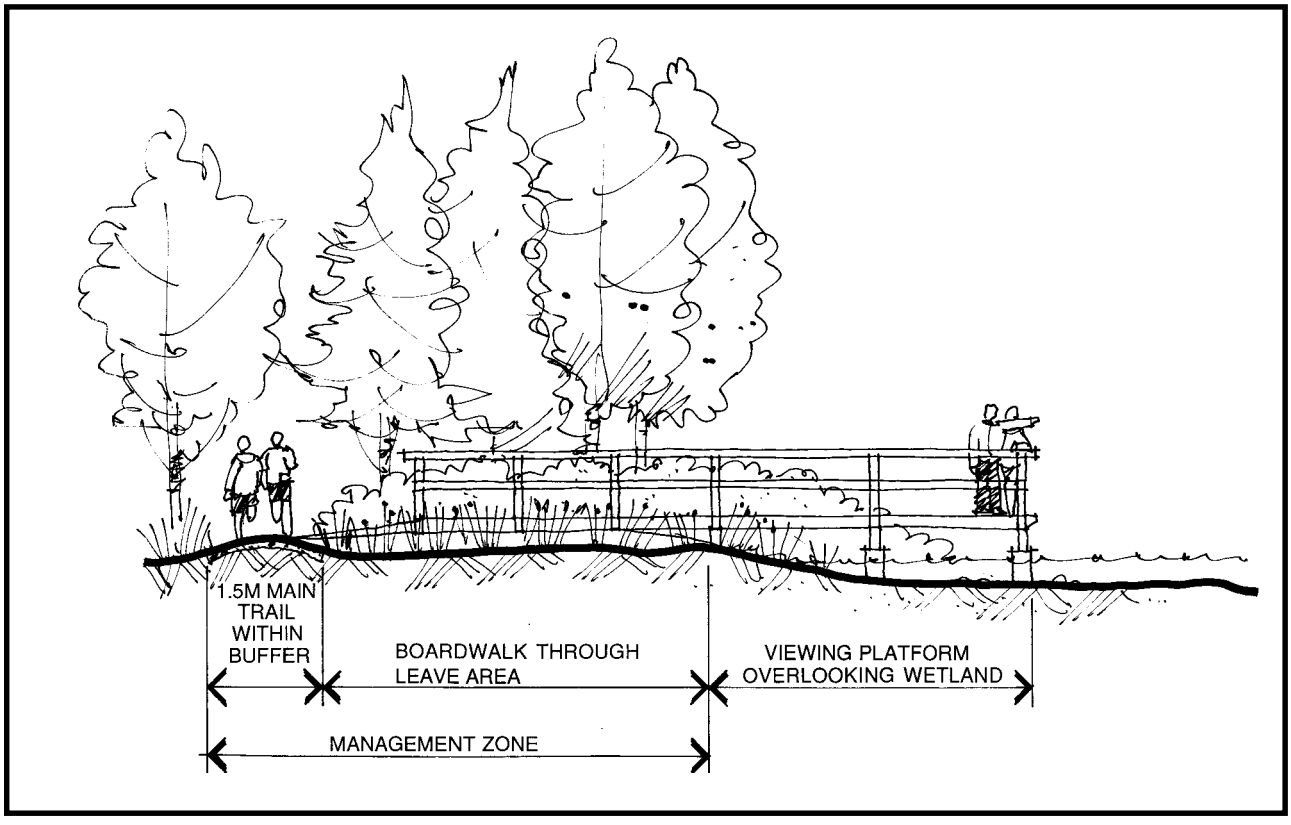


Figure 29 Limited Access Trail Leads From Main Trail to Viewing Deck

Appendices

Appendix 1: Case Studies in Access Planning

This appendix summarizes a number of projects in Canada and the U.S. northwest where access planning near sensitive aquatic areas is a significant issue.

A. Oregon Coastal Zone Management and Shorefront Access

Department of Lands, Conservation and Development; Oregon, U.S.A.

Oregon has defined an extensive Coastal Zone which extends from three miles off shore to the western summits of the Coast Range Mountains. Its comprehensive Coastal Management Program includes regulations for all types of land uses within it. As well as identifying detailed protection measures for significant habitats (ESAs), the program and its supporting legislation has a provision requiring that coastal private lands not be sold unless an easement permitting public access to the beach is provided.

Through the use of this permanent easement, the public has access to the dry sand beach as far up to the property as the actual vegetation line. The *Oregon Beach Bill* (defended successfully against several court challenges) guarantees the unobstructed public use of such beaches, even those that are privately owned. These rights are managed jointly by the State Parks System and by the Lands, Conservation and Development Commission. Public access points must be provided along the entire coast, usually at one mile intervals for footpaths and at three mile intervals for parking, bicycle racks and portable washrooms.

Oregon has established special measures for protecting sensitive areas such as wetlands, headlands and dunes. Under State law, special rules are required by county, local governments and other agencies to preserve these resources through devices such as 'overlayzoning'. This technique adds a layer of special standards which govern uses permitted within and adjacent to ESAs. Included are conditions for public access. For example, access across dunes except in very limited circumstances is permitted only by boardwalk, with strict adherence to the defined path. Emphasis is placed on establishing view points with interpretive signs for fragile resources such as wetlands or wildlife habitats.

The State Park Land/Conservation Acquisition Program has several specific measures for access and protection of beaches and coastal resources. It acquires lands which contain unique natural qualities, scenery, water access or park resources for special recreational or educational activities not available within the current park or natural reserve system. The program also acquires lands adjacent to existing parks for protection/buffer of sensitive areas.

With respect to riparian areas, particularly along coastal streams, removal of vegetation is restricted to alleviation of direct hazards only. There are strict setbacks, varying in distance, for any structures and paths. As well, riparian woodlands on private property can qualify for tax deferral if approved by the state's Department of Fish and Wildlife. Once approved, they are set aside by legal agreement as a protected zone.

Despite the State's progressive role in coastal management, resource protection and assuring public access, the beauty of Oregon's coast is threatened by the tremendous growth in water oriented recreation. This pressure could outstrip the State's capacity to successfully continue its lead in planning for human use while preserving its unique natural heritage.

Close to the Edge

The shoreline, the land at the water's edge, is the essence of the coastal zone. These lands are a delicate fringe of habitat critical to almost all types of wildlife that inhabit the coastal zone.

Lands at the water's edge are also a critical human habitat. Shorelands have been a magnet for human settlement since the beginning of time. Even now, access to water, both physical and visual, draws human settlement to the shores of oceans, lakes and estuaries. Many uses, like ports and marinas, must have access to the water, while others, such as restaurants, motels and houses, sometimes benefit from closeness to the water.

Planning for shorelands has two major objectives: setting aside lands for uses that need to be located along the shoreline and protecting the natural fringe between land and water. To accomplish these objectives, each plan includes a shorelands boundary and special zoning requirements for lands within the boundary.

What are "shorelands" ?

Each comprehensive plan includes a coastal shorelands boundary. Lands between the high water mark and that boundary are coastal shorelands.

The shorelands boundary is usually a minimum of 50 feet landward from the shoreline. (It may be less if there is a road within 50 feet of the shoreline.) The boundary extends further inland wherever one of the resources listed in the chart to the right is present.

Shoreland Zoning

Each coastal comprehensive plan includes special zoning restrictions to recognize and protect special shoreland values. Most zones include either an overlay zone or additional standards to regulate uses within the shorelands boundary. The special restrictions are described in the chart to the right.

Resource Included

- **Sites Especially Suited for Water Dependent Uses** (ESWD)
- **Mitigation and Restoration Sites**
- **Dredged Material Disposal Sites** (DMD)
- **Riparian Vegetation**
- **Coastal Hazard Areas**
- **Significant Habitats**
- **Public Access**
- **Exceptional Aesthetic Resources**

Lands Included	Special Requirements
Sites with deep water close to shore and with access to supporting facilities, such as rail lines and highways that are suitable for water dependent uses, such as port facilities, marinas etc. (Most "ESWD" sites are in developed estuaries.)	Only water-dependent uses are allowed. (These are uses which must have access to the water in order to function, such as marinas, port facilities etc.) Uses that are "in conjunction with water dependent uses" or which don't interfere with water dependent uses may also be permitted.
When dredging or filling is permitted in tidal marshes or flats their effects must be offset by creating or improving another part of the estuary. Mitigation and restoration sites are lands that have potential, if modified, to create, restore or enhance biological or habitat values. Breaching of dikes to restore tidal action is a typical mitigation technique.	Temporary uses and other uses which don't interfere with eventual use of a site for mitigation or restoration are permitted. Continuation of existing uses is typically allowed.
Sites for future development or marginal farmlands that are close to navigation channels. Wetlands and good farm land are generally not designated as DMD sites.	No interfering uses are allowed until the site has been fully used for dredged material disposal. After disposal is complete, any use permitted by zoning may be allowed.
Trees, shrubs and other vegetation along the shore stabilize the shoreline, provide habitat, and help buffer coastal waters from adjacent development. Riparian vegetation usually extends 25-50 feet inland depending on the waterway and the steepness of the shoreline.	Removal of vegetation is restricted. Except for water-dependent uses, structures must be set back from riparian vegetation. Riparian areas can qualify for property tax deferral if they are approved by the Oregon Department of Fish & Wildlife.
Areas subject to natural hazards that are related to coastal waters, including erosion and flooding.	All development within identified hazard areas is reviewed by the city or county — see Natural Hazards discussion on page 14. Vegetative stabilization is preferred over riprap to control shore erosion.
Large, valuable or relatively unique habitats and wetland areas as identified in the comprehensive plan (and as updated at periodic review).	Resource values of the wetland or habitat are protected by the plan. Development must occur outside designated resource areas or be consistent with protection of identified values. (Alterations to wetlands in coastal shorelands require state and federal permits even if they aren't designated as major marshes in the comprehensive plan.)
Public lands, rights of way and easements which provide physical or visual access to coastal waters.	Lands may not be sold unless some public access or potential for access across the property is retained.
Areas with outstanding views of the coastal water or of the coastal landscape or of a particular coastal feature. (Mostly public viewpoints, public lands, and state parks.)	Alterations or development which would interfere with or detract from the view are not permitted.

(from *Oregon's Coastal Management Program: A Citizen's Guide*)

B. Columbia River Gorge National Scenic Area Management Plan

Columbia River Gorge Commission, USDA Forest Service; Washington and Oregon, U.S.A.

The *Columbia Gorge National Scenic Area Act* (1986) contains an innovative system for enhancing and protecting the Columbia River Gorge. This law recognizes the need for environmental protection, public access and economic development.

The Act establishes a management partnership between a newly created Columbia Gorge Commission, the U.S. Forest Service, state and local governments, Native American tribes and private land owners.

While thirteen urban areas have been exempted (with local planning controls), 90% of the Gorge has been identified for resource protection. The legislation stipulates that a comprehensive management plan be developed for the Scenic Area, a 140 km stretch of river which harbours wetlands, tributary streams, islands, forests and steep bluffs. As well, there are numerous sites of heritage and cultural value, which have been designated as Special Management Areas within the Gorge.

The overall approach toward providing public access to aquatic ESAs within the corridor is to divert access to specific points outside the sensitive areas (for recreational uses such as boat launching) and to emphasize viewing in preference to actual contact or trails through the aquatic ESA.

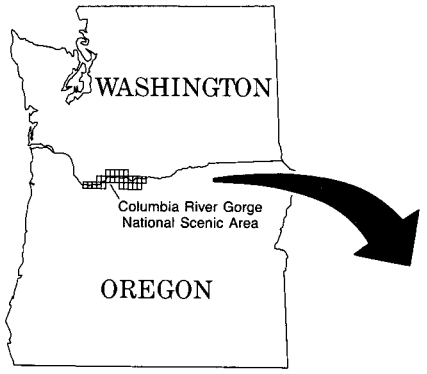
Substantial buffer zones are required around wetlands and other high value habitats for any permanent use. For example, a 60 metre (200 ft.) buffer zone is stipulated for riparian areas around wetlands and fish bearing perennial streams, while a 15 metre (50 ft.) buffer is required for intermediate streams.

Loop trails with an emphasis on soil or compacted aggregate surface are being developed in conjunction with scenic viewpoints and to provide access into U.S. Forest hinterlands for hikers. Day use areas for activities such as picnicking and boat launching are sited at less sensitive locations along the scenic corridor where terrain permits.

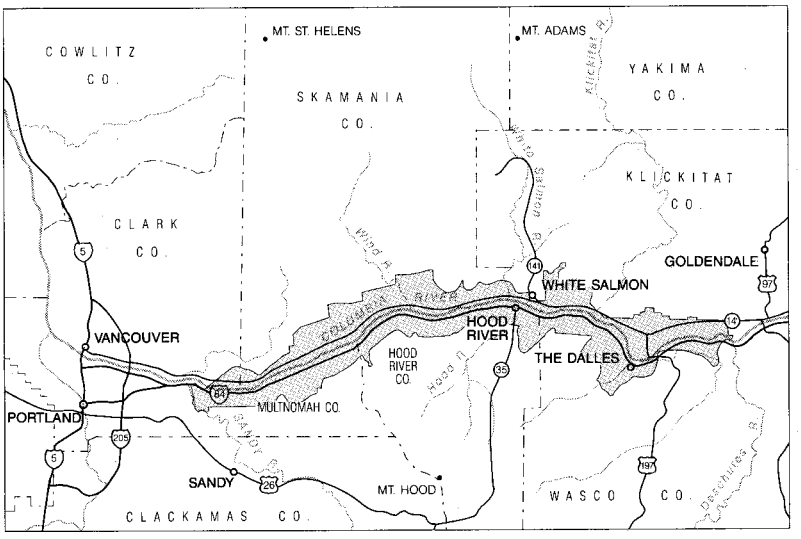
An inventory has been conducted of all significant natural areas within the Gorge, noting the unusual qualities of each one. Many of these offer refuge to endangered or threatened wildlife and fish.

While some of these ESAs are relatively inaccessible to people owing to their location (such as islands in the Columbia River), others are highly vulnerable. In response, the public access procedure has been to:

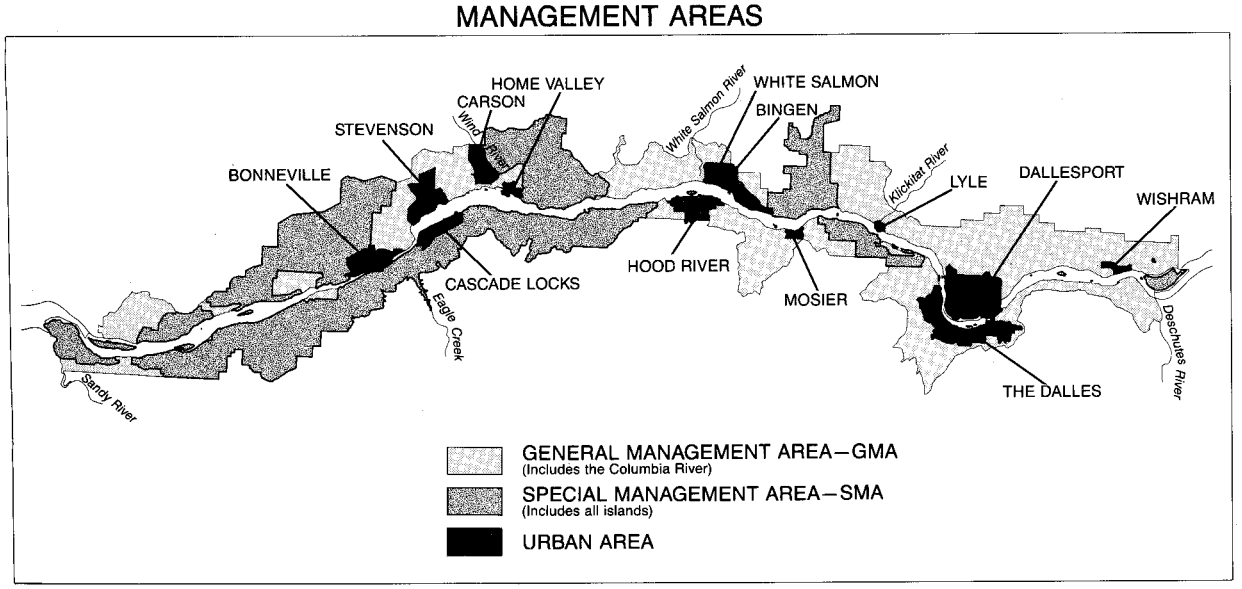
- provide new viewpoints that highlight the particular ESAs and their features with accompanying interpretive signs;
- create or restore view openings along the Historic Columbia River Highway through selective tree thinning and pruning in a manner consistent with resource protection;
- establish walking and bicycle paths along segments of the Historic Columbia River Highway, giving high priority to links which provide views into or which skirt sensitive areas, scenic vistas and culturally significant sites;
- stipulate through legislation that all such sites must also include assessment of aquatic and other natural resources as well as a management plan that details their protection during construction and after they become actively used.



LOCATION MAP



MANAGEMENT AREAS



The Columbia River Gorge Management Plan involves historic, scenic and natural attributes. Public access must be carefully planned and sited

(from *Management Plan for the Columbia River Gorge National Scenic Area)*

C. Lake Ontario Greenway Strategy

Lake Ontario Waterfront Regeneration Trust

The Lake Ontario Waterfront Regeneration Trust's mandate is to help restore and protect sensitive areas along Lake Ontario's shoreline. Rapid urbanization, industrial uses and other activities such as transportation have severely impacted Lake Ontario's waterfront.

The Waterfront Regeneration Trust is oriented toward developing a sense of community and economic vitality for a region stretching from Niagara to Kingston. Working with different government agencies and the private sector, the Trust is presently in the process of establishing a continuous waterfront trail, knitting together urban and rural lakefronts and wetlands, extending from Hamilton to Kingston.

While parts of this public trail system are already in place, others will have to be acquired through dedication or purchase. The involvement of all government levels, community groups and the private sector is considered vital to this effort.

Through the Trust, ESAs along the lake shore corridor have been identified and mapped. The size, condition, surrounding land use patterns and significance of each ESA have been fully documented. Objectives for the enhancement and protection of individual sites, which include marshes, bays and streams, have been developed. Sites with maximum interpretive potential are highlighted, emphasizing the unique attributes of each one. This data helps to determine the degree of public access advisable and the specific methods which are most appropriate such as interpretive trails, viewpoints or boardwalks.

A major feature of the plan is enhanced public access through a *Greenway Interpretation Masterplan*, which emphasizes resource interpretation, including educational paths, signs and viewpoints. Its central theme is "Nature of Change", linking the natural and cultural heritage of the corridor and individual sites to the regeneration of the waterfront.

Trail routes include sections which expose the public to the value of ESAs. Interpretive paths and boardwalks, viewing platforms, bridges and signs are critical elements of the access management plan. The responsibility for constructing and managing particular portions of these trails lies with municipal and regional governments and with other agencies such as Ontario's Conservation Authorities which oversee watersheds within certain regions of the province.

In conjunction with the Waterfront Regeneration Trust, the *Great Lakes Wetlands Conservation Action Plan*, a cooperative effort among government and non-government interests, is active in conserving and restoring wetlands of the Great Lakes. A list of priority ESAs within the corridor has been developed with specific protection or restoration strategies for each one. Many of these sites have been identified as having provincial significance and have also been included in local community plans as protection areas. As well, land owner contact programs have been initiated which encourage private interests to protect significant habitats within the Lake Ontario Greenway.

To help ensure that the Greenway and Trail Plan receives public support, the Regeneration Trust has been holding a series of on site workshops along the trail corridor. As each section of trail is opened, it is strongly publicized through local events and the media.

Following are two examples where public access to aquatic ESAs has been accommodated within the Lake Ontario Greenway Corridor.

C(i) Second Marsh Wildlife Area
Oshawa, Ontario

This 121 hectare (303 acre) wetland is one of the few remaining Lake Ontario marshes adjacent to an urban centre. It supports numerous fish, reptile, bird and plant species. Deterioration, however, has prompted a Management Plan for Second Marsh. One key mandate of the plan is to incorporate public involvement and public access. Provisions for access have been coupled with a Rehabilitation Program, including clean up and habitat restoration. Public access and education/interpretation components of the plan feature a new hierarchy of trails, notably:

- primary trail with compacted aggregate surface for multi-use (part of the Waterfront Trust Trail Linkage System);
- secondary aggregate surfaced trails, typically 1.5 metres wide, leading to viewpoints and interpretive nodes—primarily for use by naturalists and supervised school groups. Portions of these trails are raised boardwalks;
- two viewing platforms and four viewing towers capable of accommodating groups to facilitate bird and wildlife interpretation;
- closure of certain sections of trail system during key waterfowl nesting and fish spawning periods.

C(ii) The Duffins Creek Project
Pickering, Ontario

Duffins Creek meanders through a series of marshes near Pickering, a suburb east of Toronto. A cooperative management and joint-funding agreement involving the towns of Ajax and Pickering, Ontario Hydro, the Provincial Government, local service organizations, naturalist clubs, the Metro Toronto Conservation Authority and the Waterfront Regeneration Trust strives to reduce environmental impacts while encouraging public appreciation of these important wetlands.

A pathway system has been developed that encourages viewing and interpretation of wildlife habitat, while at the same time avoiding public intrusion upon it. The trail is innovative in its construction, utilizing raised boardwalks made of prefabricated steel and wood. As well, a recently developed 'hardened' soil, using an organic hardener, is being tested. Using this type of soil provides a path surface which resists erosion, while remaining permeable. The trail will serve as a basis for the design of public access of other aquatic ESAs along the Lake Ontario Corridor.

Duffin Creek at Lake Ontario

D. Swan Lake/Christmas Hill Nature Sanctuary

Capital Regional District; Victoria, B.C.

The Swan Lake Nature Sanctuary contains a hierarchy of trails developed with consideration of habitat sensitivity. The trail plan intentionally directs traffic away from sensitive habitats, with trail access to viewpoints in selected areas. Main trails are situated away from the lake, while a floating boardwalk and two docks provide access out onto the lake. At the same time, trails provide continually changing vistas since they are never constructed as a straight line. Where trails do penetrate the riparian area, they are unobtrusive footpaths and do not obstruct riparian functions. Thorny bushes are used as live barriers along the trail to prevent pedestrians from accessing aquatic ESAs. Signage notifying the public of wildlife activities, such as nesting, is also used to protect sensitive habitat areas.

A boardwalk through the Swan Lake Nature Sanctuary wetland

E. Galloping Goose Trail

Capital Regional District; Victoria, B.C.

Part of the Galloping Goose trail lies adjacent to the Swan Lake/Christmas Hill Sanctuary. This trail is being developed as part of a larger network of pathways to provide public access to a community greenway. Trail alignment adheres to an old railway corridor. Two former railway trestles have been made pedestrian friendly with wood planking and handrails. Since these improvements required instream work, the Ministry of Environment, Lands, and Parks regional habitat protection office was contacted and provided advice on material handling and timing in order to minimize impact on fish and fish habitat. The railway trestles provide ideal viewpoints and vertical separation in the trail. Thus, intrusion into the wetland is discouraged and pedestrians are restricted to the designated trail. Improvements to the habitat and drainage basin are being undertaken by community volunteers. Included is the removal of non-native plant species and plantings of indigenous species. The Galloping Goose trail will include urban and non-urban sections. Once complete, the trail will be 60 km long. Where it is not converted railway track, much of the trail is a narrow footpath with dense vegetation immediately adjacent to the trail.

F. South Dyke Trail, London's Landing

Richmond, B.C.

Richmond's South Dyke affords flood protection from the Fraser River's South Arm. Significant sections of its shoreline include 'red zone' habitat—valuable wetland and intertidal vegetation which is of particular importance to fish and waterfowl.

The recently constructed South Dyke trail is part of the City of Richmond's overall trail network which encourages public access along its dykes. At London Farm and London's Landing, two important heritage sites, there are also significant habitats. Through skillful design, protection of the aquatic ESA has been achieved while permitting compatible access and enjoyment.

Along London Farm's waterfront, there was a serious problem of vehicular intrusion upon the beach and upper wetland. This conflict has been eliminated through grade separation, a stepped wall, rugged bollards and a galvanized drain. The footpath is set back from the marsh and is situated at top of bank, while motor vehicles are restricted to an access road situated at a higher elevation. Steps lead to the beach and wetland.

At London's Landing, the site of an historic ferry landing, an old pier has been renovated to create a platform for viewing the wetlands and river. As well, a system of paths, signs and picnic tables are provided. Vertical separation between this system and the aquatic ESA is achieved through elevated decking. This design has effectively integrated habitat protection with public viewing and appreciation of the area.

The pier and seating area at London's Landing along the South Dyke Trail in Richmond, B.C.

G. Boundary Bay Regional Park

Greater Vancouver Regional District; Delta, B.C.

Boundary Bay Regional Park, which covers 38 hectares along the western shore of Boundary Bay, was officially opened in 1989. The Bay is one of North America's most significant waterfowl habitats and a major migratory midpoint stopover on the Pacific Flyway. In 1995, as part of the Provincial Lower Mainland Nature Legacy Program and the Vancouver International Airport Wildlife Habitat Compensation program, additional lands were acquired to expand the Regional Park to 127 hectares in size. The Park has a variety of natural landscape features, including marine, sand dune, savannah and wetland ecosystems which provide important habitat for shore birds, song birds, blue herons and raptors. Mudflats immediately offshore are a critical resting and feeding stop for migratory birds.

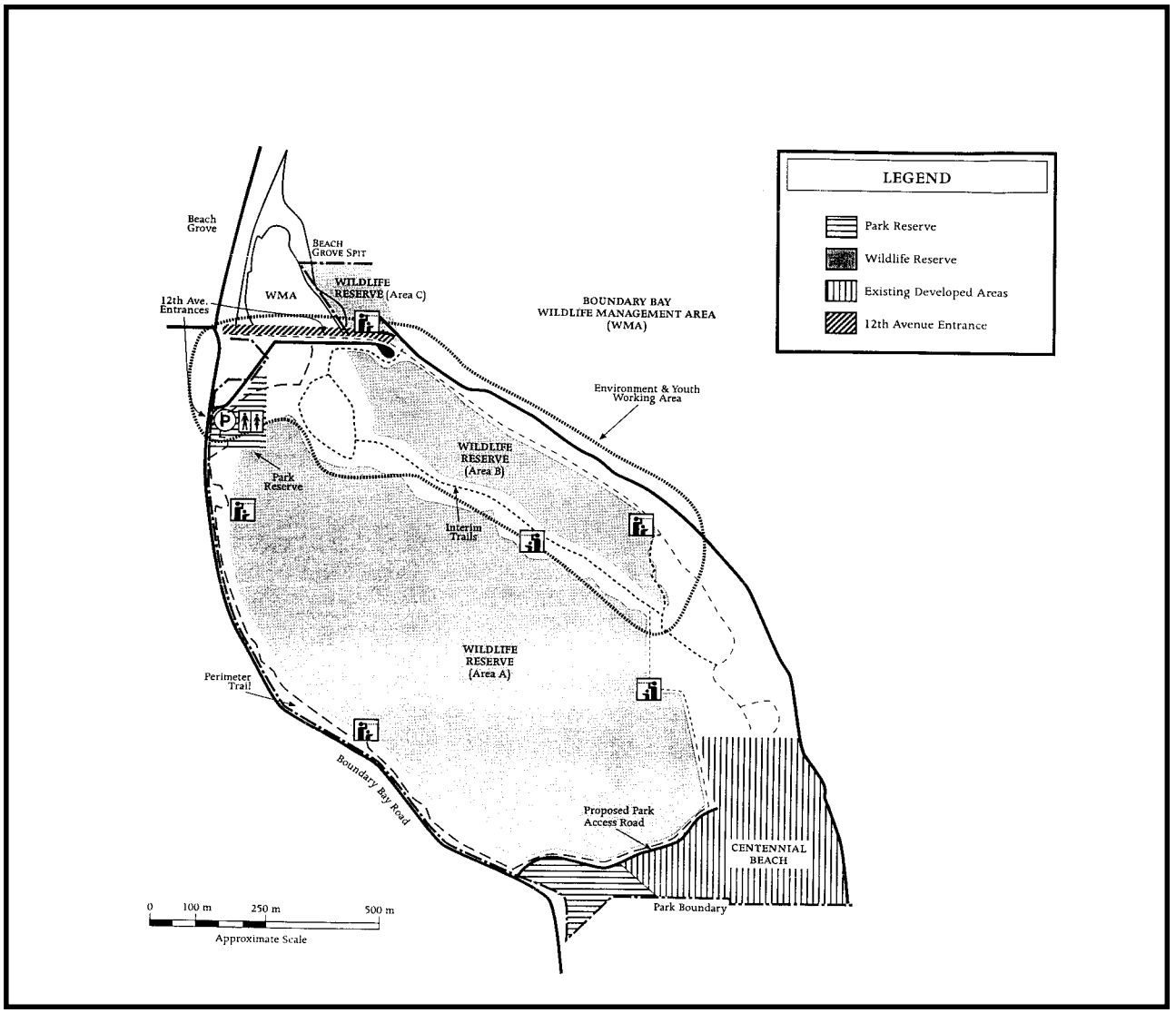
An elevated boardwalk leads to the raised viewing deck at Boundary Bay Regional Park

As one of only three public ocean beaches south of the Fraser River in the Lower Mainland, Boundary Bay Regional Park has become extremely popular as a destination for walking, jogging, cycling, beach oriented activities and nature appreciation, with approximately 396,000 visitors in 1995 alone. A 2 km dyke running through the Park along the foreshore is part of a 9 km dyke network which protects Delta's low-lying farmland and residential areas from flooding. The dyke is popular for walkers, joggers, cyclists, naturalists and equestrians. The potential for conflict between wetland habitat protection and visitor use is clearly evident.

In 1993 the Greater Vancouver Regional District (GVRD), in partnership with the Friends of Boundary Bay and the Environmental Partnership Fund, initiated an interpretation and trail improvement program. The program included formalizing a trail through sensitive dune habitat to consolidate several informal trails, a self guided dune interpretive walk complete with signs and an elevated boardwalk around the perimeter of a freshwater wetland. The boardwalk, with controlled access points and strategically placed signs leads to a viewpoint where visitors can overlook the marshland and Boundary Bay tidal flats. The viewpoint and low level viewing tower were installed in 1995 as a joint project between GVRD Parks and B.C. Ministry of Environment, Lands and Parks. Interpretive signs about the environmental importance of the Bay are affixed to the structures and at key points around the dyke.

To educate park visitors about ground nesting birds such as savannah sparrows which can easily be disturbed by visitors and dogs, GVRD Parks annually posts information signs during nesting season requesting visitors to stay on the trails with their pets on leash.

A major initiative in 1996 was the update of the Boundary Bay Regional Park Concept Plan, jointly undertaken by GVRD Parks and Environment Canada. The updated Plan will focus on maintaining and enhancing wildlife values while providing outdoor recreation opportunities and promoting environmental awareness and interpretation. Components of the Plan include designating large Wildlife Reserves within the Park solely to be managed as wildlife habitat (no public access), while concentrating intensive outdoor recreation in the Centennial Beach area. Habitat improvements for raptors, passerines and great blue herons are proposed in the Wildlife Reserves with funding provided by the Wildlife Habitat Compensation Program. Passive recreation such as walking will be provided along trails next to the Wildlife Reserves, the foreshore dyke and around the perimeter of the Park. The perimeter trail will be dual use to permit cycling.



Boundary Bay Regional Park Plan Map

Appendix 2: Sample Unit Costs for Construction Materials

Examples of construction costs (labour and material) for typical access structures are summarized in 1995 dollars. It should be cautioned that these are estimates only. Costs can vary significantly according to site, location, distance from suppliers, ease of access, labour rates, availability of materials and other considerations. As well, municipalities and other agencies often purchase materials in bulk, resulting in different costs than to private developers or land owners.

Aggregate Trail, including 15 cm sub-base / 15 cm compacted surface	$18 /$m^2$
Timber Deck / Boardwalk (pressure treated Hemfir)	$200 /$m^2$
Signs (timber or metal)	$300 each
Timber Benches	$800 each
Bicycle Racks (metal)	$700 each
Timber Gate (1 m width)	$200 each
Metal Gate (1 m width)	$400 each
Timber Fence (1.2 m)	$25 / l.m.
Timber Fence (1.8 m)	$35 / l.m.
Chain Link Fence (1.2 m)	$25 / l.m.
Chain Link Fence (1.8 m)	$30 / l.m.
Page Wire Timber Fence (1.8 m)	$20 / l.m.
Double Row of Thorny Shrubs (1.2 m)	$30 / l.m.

Appendix 3: Suggested Live Barrier Species for Coastal British Columbia (native plants)

Species	Features	Height	Light/Soil Require-ments	Comments
Trees				
Acer macrophyllum Big-leaf maple	large leaves, yellow autumn colour, provides shade	to 30m	sun/shade, mesic [7]	Large deciduous tree, use with other smaller species
Alnus rubra Red alder	fast growing, nitrogen fixer	to 25m	sun, mesic to wet- mesic	Large deciduous tree, use with other smaller species
Betula papyrifera Paper birch	fast growing, yellow autumn colour, peeling white bark	to 30m	sun, mesic	Large deciduous tree, use with other smaller species, hardy
Populus balsamiferassp. trichocarpa Black cottonwood	fast growing, fragrant leaves	to 50m	sun, mesic to wet- mesic	Large deciduous tree, use with other smaller species, hardy
Populus tremuloides Trembling aspen	fast growing, silver grey bark, trembling leaves, yellow autumn colour	to 20m	sun, mesic to dry- mesic	Large deciduous tree, use with other smaller species, hardy
Prunus emarginata var. *mollis* Bitter cherry	rapid growing, white flowers, red fruits, attracts birds	to 15m	sun to part-sun, mesic	Large deciduous tree, use with other smaller species
Pseudotsuga menziesii Douglas fir	rapid growing evergreen	to 75m	sun, mesic	Large coniferous tree, use with other smaller species
Thuja plicata Western red cedar	rapid growing evergreen, drooping foliage	to 60m	sun to part-sun, mesic	Large coniferous tree, can be hedged or use with other smaller species
Tsuga heterophylla Western hemlock	rapid growing evergreen, dense **twiggy**	to 60m	sun to part-sun, mesic	Large coniferous tree, can be hedged or use with other smaller species
Small Trees				
Acer circinatum Vine maple	showy autumn colour	to 7m	sun/shade, mesic	select multistems or coppice to encourage denser branch system, use with other species
Acer glabrum Douglas maple	showy autumn colour	to 10m	sun/part-sun, mesic	select multistems or coppice to encourage denser branch system, use with other species
Corylus avellana Hazelnut	edible nuts, large leaves, yellow autumn colour	to 6m	sun/part-sun, mesic	Introduced species, can be hedged or coppiced to make a dense branch system, suckers, fast growing, can be interwoven with hard barrier (chain link)
Corylus cornuta var. *californica* Beaked hazelnut	edible nuts, large leaves, yellow autumn colour	1-4m	sun, mesic	can be hedged or coppiced to make a dense branch system, suckers, fast growing can be interwoven with hard barrier (chain link)
Crataegus douglasii Black hawthorn	**thorns**, white flowers, purplish-black fruit	to 10m	sun, mesic	numerous sharp, nasty 3 cm long thorns
Malus fusca Pacific crabapple	**thorns**, showy fragrant pink-white flowers, small yellow edible fruits	to 10m	sun, mesic	sharp, nasty spur shoots
Prunus virginiana Western chokecherry	white flowers, edible red fruit, attracts birds	to 10m	sun, mesic to dry- mesic	use with other species

[7] Intermediate, i.e. in relation to temperature, moisture, or decomposition.

Species	Features	Height	Light/Soil Require-ments	Comments
Salix lucida ssp. *lasiandra* Pacific Willow	fast growing, new growth is showy yellow	to 12m	sun, mesic to wet- mesic	cuttings root readily, can be interwoven with hard barrier, tolerates flooding
Salix scouleriana Scouler 's willow	fast growing, soft velvety leaves	2-12m	sun to part-sun, mesic to wet-mesic	cuttings root readily, can be interwoven with hard barrier, tolerates flooding
Salix sitchensis Sitka willow	dense, **twiggy** , fast growing, bright green leaves	1-8m	sun, mesic to wet- mesic	cuttings root readily, can be interwoven with hard barrier, tolerates flooding
Sambucus cerulea Blue elderberry	showy glossy blue fruit clusters, large compound leaves, attracts birds	to 6m	sun, mesic to dry- mesic	can be open in the ground layer, use with other species, needs good drainage
Sambucus racemosa Red-berry elder	white flower clusters, showy red fruit, large compound leaves, attracts birds	to 6m	sun/part-sun, mesic to wet-mesic	can be open in the ground layer, use with other species, aggressive once established
Shrubs				
Amelanchier alnifolia Serviceberry	showy white flowers, edible purple-black fruit, red-orange autumn colour, attracts birds	to 5m	sun, mesic	upright, spreading, can be a small tree.
Cornus sericea(syn. *stolonifera*) Red-osier dogwood	showy red twigs, white flowers and fruit	to 3m	sun, mesic	spreads by stolons, fast growing, hardy, can be hedged
Holodiscus discolor Oceanspray	**twiggy** , showy creamy-white flowers	to 4m	sun, mesic to dry- mesic	drought tolerant, use with other ground covering species to close gaps
*Mahonia (*syn. *Berberis) aquifolium* Oregon grape	**prickly,** evergreen, yellow flowers, edible blue fruit	to 2m	sun to part-sun, mesic to dry-mesic	can be spindly in shade, suckering, drought tolerant, use with other species to keep gaps closed
Oplopanax horridus Devil 's club	branches and stems covered with numerous 1cm **thorny** spines, spines on leaves	1-3m	shade/part-sun, mesic to wet- mesic	needs well-drained soils, particularly nasty and will stop anyone
Philadelphus lewisii Mock orange	fragrant white flowers	to 3m	sun to part-shade, mesic	spreading, fast growing
Physocarpus capitatus Pacific ninebark	**twiggy** , white flower clusters	to 4m	sun/part-sun, mesic to dry-mesic	use with other species, can be hedged
Potentilla fruticosa Shrubby cinquefoil	dense and **twiggy** , showy yellow flowers	to 1m	sun, mesic to dry- mesic	good for formal live barrier, can be used as ground layer with other trees and shrubs
Ribes lacustre Black gooseberry	**thorns,** reddish-maroon flowers, edible fruits	to 2m	sun to part-sun, mesic to dry-mesic	erect to spreading, branches covered with numerous prickles and larger spikes at leaf nodes
Ribes sanguineum Red-flowering currant	dense and **twiggy** , showy red flowers, attracts hummingbirds	1-3m	sun/part-sun, mesic	can be hedged
Rosa acicularis Prickly rose	**thorns,** pink flowers, red hips	to 1.2m	sun, mesic	hardy, fast growing, suckering
Rosa gymnocarpa Baldhip rose	**thorns,** pink flowers, red hips	to 1.2m	sun, mesic	hardy, fast growing, spreading
Rosa nutkana Nootka rose	**thorns,** pink flowers, red hips	to 3m	sun to part-sun, mesic	hardy, fast growing, spreading
Rosa pisocarpa Clustered wild rose	**thorns,** clustered pink flowers, red hips	to 2.5m	sun to part-sun, mesic	wetland margin plant, hardy, tolerates flooding, fast growing, suckering

Species	Features	Height	Light/Soil Require-ments	Comments
Rubus discolor Himalayan blackberry	**thorns,** white flowers, edible blackberries, attracts birds	to 10m	sun, mesic	erect to sprawling and trailing. Introduced and naturalized species.
Rubus idaeus Red raspberry	**thorns,** red edible berries, attracts birds	to 1.2m	sun, mesic	rapid growing, suckering
Rubus leucodermis Black raspberry	**thorns,** red-black berries, attracts birds	to 2m	sun, mesic	rapid growing, suckering
Sorbus sitchensis Sitka mountain ash	twiggy, white flower clusters, showy red fruit, red autumn colour, attracts birds	1-4m	sun, mesic	use with other species, can be hedged
Spiraea douglasii Hardhack	dense, **twiggy** , showy pink flowers	1-2m	sun, mesic	can be hedged
Vaccinium ovatum Evergreen huckleberry	glossy evergreen leaves, white flowers, edible black fruit	to 2m	shade to part-shade, mesic	use with other species
Vaccinium parvifolium Red huckleberry	edible red fruit, attracts birds	to 2m	part-shade, mesic	use with other species
Viburnum edule Highbush cranberry	white flower, edible orange-red fruit, red autumn colour, attracts birds	to 3.5m	sun/part-sun, mesic	twiggy, can be hedged
Vines and Climbing Species				
Clematis columbiana Columbia clematis	blue flowers, climbing and twining vine, showy seed clusters in autumn	to 12m	sun, dry-mesic to mesic	can climb along live barrier plants, or along top of hard barrier fences
Clematis ligusticifolia Western clematis	white flowers, climbing and twining vine, showy seed clusters in autumn	to 12 m		can climb along live barrier plants, or along top of hard barrier fences
Lonicera ciliosa Western trumpet honeysuckle	orange-yellow flowers, climbing vine, hummingbird plant	to 10m	sun, mesic	can climb along live barrier plants, or along top of hard barrier fences
Ground Layer Species				
Juniperus communis Common juniper	**very prickly** leaves (needles)	to 2m	sun, dry-mesic	Low spreading
*Mahonia (*syn. *Berberis) nervosa* Cascade Oregon grape	evergreen, **prickly** leaves, yellow flowers, blue fruit	to 1m	shade to part-shade, moist	Low spreading
Rubus ursinus Trailing blackberry	**thorns,** white flowers, purple-black berries, attracts birds	to .5m	sun/part-sun, mesic	creeping and mounding, rapid growing

Appendix 4: Legislation, Guidelines and Resource Materials

The following tables list key legislation, guidelines and resources that assist managers of public land and private landowners to maintain the important functional roles of aquatic features at both the local and regional level.

A. Legislation

Legislation	Administering Body	Applicability of Act to Access Planning
Fisheries Act	Fisheries and Oceans Canada; Environment Canada; Ministry of Environment, Lands and Parks	This Act contains enforceable measures to prevent the disruption, alteration or destruction of fish habitat, or the deposit of deleterious substances into fish habitat. The *Land Development Guidelines for the Protection of Aquatic Habitat*, described in the next section, interprets this legislation for proponents. Proposals for work in areas adjacent to aquatic ESAs should be compliant with these guidelines.
Policy on Wetland Conservation	Environment Canada	This Policy seeks to preserve wetland functions in Canada. Projects on federal land, or supported by federal money must achieve no net loss of wetland function. For other projects, the federal government encourages proponents to maintain wetland function.
Canada Wildlife Act	Environment Canada	This Act and its regulations enable the federal government to participate in wildlife conservation, research and interpretation. It permits the establishment of National Wildlife Areas to preserve wildlife habitat areas of national significance.
Migratory Birds Convention Act	Environment Canada	This Act and its regulations empower the federal government to manage migratory bird populations. The Act and regulations contain provisions that regulate hunting of migratory birds, and prohibit the deposition of oil, grease and other deleterious substances into waters frequented by migratory birds.
National Parks Act	Heritage Canada	Parks Canada, under Heritage Canada, can, through the National Parks Act, designate an area as a National Marine Conservation Area, which includes the seabed, water column and upland area. Zoning and management plans are implemented in agreement with DFO/DOE and/or the province. Type of public access depends on designated use.
(B.C.) Wildlife Act	Ministry of Environment, Lands and Parks	Among other things, this Act requires the identification and protection of the nest sites of herons and certain raptors.
Municipal Act	Municipalities & Regional Districts	Under this Act, municipalities can develop OCPs which contain policies for environmentally sensitive areas, parks and greenway systems, erosion control, tree cutting, stormwater management, and cooperation with other agencies and government. Municipalities can also use zoning and subdivision bylaws and other provisions such as Development Permits to protect aquatic features.
Water Act	Ministry of Environment, Lands, and Parks	The Water Act and the Section 7 Regulations (1995) deal with the administration of water licenses and define provincial requirements for conducting works in and around watercourses.
Waste Management Act	Ministry of Environment, Lands, and Parks	The Waste Management Act requires permits be issued for litter, effluent, refuse and special wastes, and includes provisions for permit enforcement.
B.C. Parks Act	Ministry of Environment, Lands, and Parks	This Act gives MELP the mandate to establish and maintain parks in B.C. Responsibilities of MELP under this Act include the property, rights, interests of the Crown on or in park and recreation areas, the natural resources within those areas, and the presentation, development, use and maintenance of parks. Regulations may be established to govern the human use of these areas as well as for the administration, protection and development of the land.
Ecological Reserves Act	Ministry of Environment, Lands, and Parks	Sites are chosen to protect ecologically significant examples of ecosystems, wildlife habitat, and special features for the purposes of conservation, scientific study and research. Level of access depends on the purpose of the reserve.

Agricultural Waste Control Regulation	Ministry of Environment, Lands and Parks (under the Waste Management Act)	This regulation and the Code of Agricultural Practice for Waste Management outline how agricultural waste must be managed to reduce impacts to groundwater and surface waters. They can be used to require the relocation of manure to minimize toxic or nutrient rich leachate from being discharged into streams and watercourses, and to require fencing to exclude livestock from aquatic habitats.
Farm Practices Protection Act	Ministry of Agriculture, Fisheries and Food	This Act amends the *Municipal Act* and *Land Title Act* to encourage improved planning for agriculture by local governments. In conjunction with the new act, specific farm management standards are being developed which will address among other things setbacks for farm buildings and farm activities from watercourses.

B. Guidelines and Resource Materials[8]

Guidelines and Resources	Developed for:	Application to Access Planning
Land Development Guidelines for the Protection of Aquatic Habitat (current edition: 1992)	municipal or private developers, landowners	These guidelines protect fish populations and their habitats by outlining approaches to erosion control, storm water management, and leave strip designation and maintenance. These guidelines are designed to achieve "no net loss" of productive capacity of fish habitat.
Stream Stewardship: A Guide for Planners and Developers	municipal staff, private developers	This planning guide illustrates land planning principles and tools available to local government to protect streams, streamside vegetation and water quality.
Stewardship of the Aquatic Environment: A Guide for Agriculture	farmers, ranchers and farm communities	This guide presents recommendations and guidelines for good stewardship of streams, lakes, and wetlands associated with agricultural activities.
Stewardship Options : A Guide for Private Landowners in B.C.	property owners	This book helps landowners identify natural features on their property and provides both practical and legal options for private stewardship, in order to protect and restore wildlife and fish habitat.
Streamkeepers Handbook	volunteers committed to protecting and restoring stream habitats	The Streamkeepers Handbook provides specific suggestions for the protection and restoration of streams, wetlands and associated habitats. Includes training modules.
Wetlandkeepers Handbook	property owners, restoration and protection volunteers, municipal staff	This handbook provides background information on wetland ecology, law, and instructions on wetland activities. Includes training modules.
Protecting British Columbia's Wetlands - A Citizen's Guide	volunteers committed to protecting and restoring wetlands	This handbook provides specific suggestions and resources for the protection and restoration of wetlands and associated habitats.
Community Greenways: Linking Communities to Country, and People to Nature	municipal staff developers, property owners	This document integrates land management tools to create networks of green spaces linking human development with natural areas. Protection of environmentally sensitive areas and access planning are fundamental aspects of greenways planning.
Lake Care (BC Environment)	property owners	This manual provides a guide to conserving fish habitat in lakes.
Naturescape Series (1, 2, 3)	property owners	This series is a landowner 's resource for landscaping and wildlife habitat enhancement in the Georgia Basin; it also contains an overview for the whole of B.C.

[8] Sources of these materials are identified in the Resources section.

Glossary

Aquatic Habitat: Areas associated with water which provide food and shelter and other elements critical to completion of an organism's life cycle. Aquatic habitats include streams, wetlands, marshes, bogs, estuaries, and riparian areas, as well as large fresh and salt water bodies

Aquifer: Underground water bodies. There are two types of aquifers. Open aquifers have permeable materials overlying them, e.g. soil with underlying loose gravel. Closed aquifers are capped with an impervious layer of material, such as clay, which prevents water from penetrating from the soils directly above. The water level in aquifers rises and falls in response to water removal and infiltration.

Barrier: A structure installed to protect an environmentally sensitive area. A barrier can be hard (i.e. fence); live (i.e. planted); a combination of hard and live; or a terrain feature (i.e. berm). A barrier can be physical (obstructing passage) or psychological (deterring access).

Buffer: The portion of a management zone that is adjacent to the leave area. The buffer area protects the leave area. It is within the buffer that recreational trail corridors are accommodated. Buffers also provide a transition between adjacent land uses.

Deleterious Substance: Substance harmful to fish or fish habitat (Canada Fisheries Act, sec. 36.3)

Development Permit Area: An identified area that is 'designated' on an OCP map. Development in these areas requires a permit before construction can proceed. Typically, development must meet special requirements due to the unique nature of the site.

Ecosystem: The terms used for the sum total of vegetation, animals and the physical environment in which they interact. Ecosystem is derived from the Greek term *oikos*, which means home.

Environmentally Sensitive Area (ESA): Areas requiring special management attention to protect fish and wildlife resources and other implicit natural systems or processes. ESAs have also been broadly defined to include other scenic, historic or cultural values.

Estuary: A partially enclosed body of water freely connected to the ocean, within which the seawater is diluted by mixing with freshwater and where tidal fluctuations affect river water levels. The estuary is a dynamic system typified by brackish water, variable and often high nutrient levels and by shallow water conditions often associated with marsh plants in upper tidal zones and eelgrass in lower tidal zones.

Fish: Fish are defined as: shellfish, crustaceans, marine animals, the eggs, spawn, spat and juvenile stages of fish, shellfish, crustaceans, and marine animals. (Canada Fisheries Act, sec.31.5)

Fish Habitat: Spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes. (Canada Fisheries Act, sec. 31.5)

Fishery Operating Window: The time periods of reduced risk for important commercial, sport, and resident fish species, based on life histories. The fishery operating window is the time of year during which there are no fish eggs or alevins present in the substrates of the local rivers. This is the preferred period for instream work or development. Prior to commencement of any instream work and with sufficient lead time, proponents should contact DFO/MELP for information regarding species timing windows for their area.

Floodplains: Relatively flat, low-lying areas adjacent to watercourses. Floodplains are formed of fluvial sediments and are periodically flooded and modified when streams flow over the tops of banks. Stream channels meander within unconfined floodplains, alternately creating and isolating habitats.

Groundwater: Water that infiltrates through the ground surface and accumulates in underground water bodies in porous rock or gravels.

Headwater: The area in the upper reaches of a watershed typified by unconfined surface water flows. Headwaters can coalesce to form rivulets or first order streams with distinct channels. Headwaters can often be ephemeral (wetted only part of the year). Hydrologic processes such as those that occur in headwaters affect the entire downstream structure of the watercourse.

Hydrology: The study of the occurrence, circulation, and distribution of the waters of the earth. Local hydrologic regimes and processes need to be taken into account in water and land use planning. These processes include precipitation, interception, run-off, infiltration, percolation, storage, evaporation, and transpiration.

Impervious: The inability of a material (usually a substance used in road, parking lot and driveway surfacing) to permit the relatively rapid passage of water through into the ground.

Leave Area (reserve zone): The area of land and vegetation adjacent to an aquatic area that is to remain in an undisturbed state, throughout and after the development process. Leave areas are required around all aquatic features that flow into or contain fish or fish habitat. This may include wetlands, ponds, swamps or other intermittently wetted areas, as well as small streams side channels and ditches which may not flow throughout the entire year (ephemeral). The leave area (reserve zone) together with the buffer comprise the management zone.

Management Zone: The area around sensitive aquatic features that includes the leave area (reserve zone), and a buffer. The dimensions of the management zone are ideally dictated by topography, vegetative communities, hydrologic, and geomorphic features and processes.

Marsh: A mineral wetland that is permanently or seasonally inundated up to a depth of two metres by standing or slow moving water. The waters are nutrient rich and the substrate is usually mineral soil. Marshes are characterized by communities of emergent rushes, grasses and reeds, and submerged or floating aquatic plants in areas of open water.

Mitigation: Actions taken during the planning, design, construction and operation of works and undertakings to alleviate potential adverse effects on the productive capacity of fish habitats. (*DFO Policy for the Management of Fish Habitat*, 1986)

No Net Loss: A working principle which strives to balance unavoidable habitat losses through avoidance, mitigation and habitat replacement on a project-by-project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented. (*DFO Policy for the Management of Fish Habitat*, 1986)

Productive Capacity: The maximum natural capability of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depend. (*DFO Policy for the Management of Fish Habitat*, 1986)

Riparian Area: The land adjacent to the normal high water level in a stream, river, lake or pond and extending to the portion of land that is directly influenced by the presence of adjacent ponded or channeled water. Riparian areas typically exemplify a rich and diverse vegetative mosaic reflecting the influence of available surface water.

Run-Off: That portion of rain fall or snow melt which flows off the surface.

Salmonid: Fish belonging to the family *salmonidae*, including Pacific salmon, trout, char, whitefish, and related species.

Sedimentation: Deposition of material carried in water; usually the result of a reduction in water velocity below the point at which it can transport the material.

Spawn (verb): To produce or deposit eggs - usually used in reference to aquatic organisms such as fish, crustaceans and oysters. (noun) eggs of fish or invertebrates.

Stormwater Detention: The collection and containment of run-off from impervious surfaces. Detention is intended to maintain, as closely as possible, the natural predevelopment flow pattern and water quality of development sites in the watershed. Increases in impervious surfaces reduce detention and retention, causing significantly higher peak flows and reduced base flows in streams.

Top of Bank: The point at which the bank shows a significant or abrupt change in slope. In flat landscapes it could be the normal high water mark, but more typically, it is the top of the slope leading down to the water.

Water Quality: The chemical, physical and biological characteristics of water.

Watershed: The total region defined by height of land draining into a given waterway, lake or reservoir; a drainage basin.

Wetlands: Areas of permanent or temporary standing water, characterized by the absence of channel flow and the presence of vegetation which is distinct from that in neighboring, freely drained areas. The most common types of wetlands are swamps, marshes and bogs, fens and shallow water.

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- Capital Regional District Parks (Victoria). Tel: (604) 478-3344
- Greater Vancouver Regional District, Parks Department. Tel. (604) 432-6350
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- Marine Trail Association. Tel: (604) 266-6715
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- Pacific Streamkeepers Federation (North Vancouver). Tel: (604) 986-5059
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"This document can provide a valuable reference for local government in planning, builing, and renovating trails and other forms of public access in and around environmentally sensitive areas. Details on siting, surfacing and construction materials are particularly valuable."

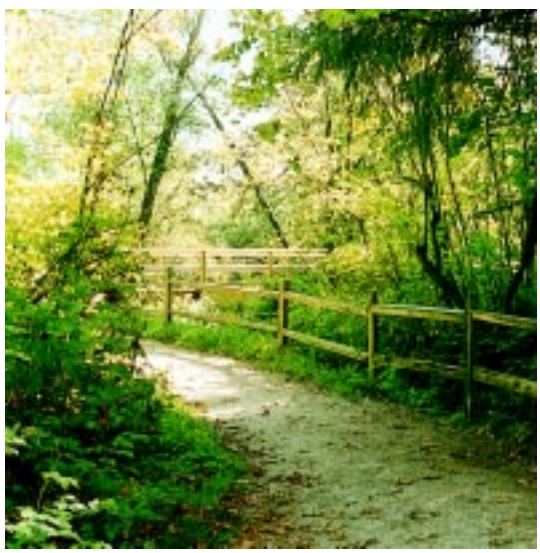
Harriet Ruggeburg
Environmental Planner
City of Nanaimo

"The challenge everywhere now is to enjoy - not destroy - natural places and sensitive habitat, essential to fish and wildlife but extremely attractive to humans. The planning and design principles given in the Access Planning Guide are really clear and practical first steps towards a balance that works."

Richard Hankin
Manager, Regional Parks
Greater Vancouver Regional District

"Public access to ESAs is important in achieving long term appreciation, protection and stewardship of such areas. This guide provides an easy-to-follow, detailed approach to trail building in sensitive areas. It will be a useful tool to Trails BC as well as to other local groups, landowners, planners and developers."

Janine Robinson,
Chair, Southwest Regional Council
The Trails Society of British Columbia



"This guide, another important addition to the excellent Steward Series, tackles the challenging issue of harmonizing habitat protection with public use of the natural landscape. It is a user-friendly compendium documenting a range of access problems and solutions, well-illustrated with local and national cas studies to assist in making good planning, design and management decisions."

Moura Quayle
Professor and Director,
UBC Landscape ARchitect Program
Chair, City of Vancouver Urban Landscape Task Force
"greenways advocate"

"The Pacific Streamkeepers Federation heartily endorses the access-within-limited-interference philosophy that is promoted in this manual. We see the planning and management of access near aquatic areas as an extremely important aspect of protecting and ecosystem within a watershed. Hopefully the document can be put into "active use" by a wide range of people as soon as possible."

Zo Ann Morten
Dr. Jutta Rickers-Haunerland
The Pacific Streamkeepers Federation

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