EXECUTIVE SUMMARY

Following consultation with the federal and provincial authorities, the British Columbia Council of Forest Industries has proposed the preparation of a technical guidance document that will develop the framework for design and operation of dry-land log sorts and log yards to manage any potential environmental impact. This document provides background information for use in the development of the technical guidance document. The information is based on literature reviews, site visits and historical background data attained by the author.

The ultimate objective is to ensure that dry-land sorts and log yards to protect fish and fish habitat.

In brief, the background study indicates the following:

- *RE: Environmental issues*
  There are several potential sources of environmental issues at dry-land log sorts and log yards. The issues include:
  - The use of hydrocarbons, including hydraulic and lubricating oil and fuel. Many sites have defined strict management practices for the use of hydrocarbons, as control measures are readily definable.
  - Wood leachates resulting from precipitation on logs and wood debris piles. Management of highly variable runoff volumes containing wood leachates is the largest challenge at dry-land sorts and log yards.

- *RE: Identification of contaminants of concern in wood leachates*
  Studies of stormwater effluents and process discharges from wood processing industries have yielded considerable information on chemicals that are constituents of leachates released from wood.
  The major chemical groups include:
  - Resin acids

- Tannins
- Lignins
- Fatty acids
- Phenols
- Carbohydrates (wood sugars).

The chemical groups listed above have potential for toxicity to aquatic life, if they are at concentrations above specific levels. It is known that factors such as pH and hardness can affect the toxicity of the listed chemical groups, however unexplained disparities in field observations do occur, e.g., low toxicities at elevated chemical concentrations. This report concludes that there is not a full understanding of the exact causes of toxicity of wood leachates to aquatic biota.

- *RE: Studies of log yard and dry-land sort runoff waters*

  Relative to the number of studies conducted on effluents from wood processing operations such as pulp and paper mills, studies on effluents of log yards and dry-land sorts are few. The available data show wide ranges in concentrations of wood leachate chemicals in runoff waters from log yards and dry-land sorts.

  The concentrations of wood leachates and the results of toxicity tests for storm water effluents from at least one dry-land sort have resulted in charges under the Federal Fisheries Act. Federal authorities have issued improvement notices to other sorting operations in British Columbia.

  One study of environmental impacts of a log sorting operation is known to have been conducted. The findings have not indicated evidence of impacts at the marine receiving environment. The degree of environmental impact at any facility would obviously depend upon the size and assimilative capacity of the receiving water as well as the storm water quality.

  Visible impacts of effluents from log sorting and storage sites appear to be localized near the stormwater outlets and result primarily from suspended solids and /or the color associated with wood leachates.

- *RE: Control options*

  Sediment traps and oil-water separators are in use at many BC log sorts and remove much of the larger wood debris and hydrocarbon residues. These systems do not significantly reduce leachate toxicity.

  Additional control options such as wetlands have been used to improve discharge quality. One facility uses an irrigation system as a means of effluent disposal. However a majority of log sorts do not have the necessary space to implement such measures.

  The pollution control issues facing many log yard and dry-land sort operations include:

  - Handling of very large volumes of runoff water that result during precipitation events.
  - Shortage of space at many existing operations to construct possible treatment systems. The shortage of available space at many sites is due to encroachment of developments adjacent to property lines and past practices of siting log sorts directly adjacent to waterways.

  Research efforts are underway to develop possible technologies for runoff treatment. A recent study that evaluated the use of biodegradation and ozonation found that the toxicity was not consistently eliminated. In addition, the practicality, efficacy and costs limit the implementation of such technologies on a large-scale at typical coastal dry-land sorts or interior log yards.

- *RE: Industry trends*

  On recommendation of regulatory agencies, industry has replaced many coastal water log handling and sorting operations with dry-land sorting operations. The industry has paved many of the sites used for sorting to enhance worker safety, reduce soiling of logs, improve wood waste recycling and reduce discharges of suspended solids into adjacent water bodies.

However the paving of log sorts has created additional stormwater issues.

Several companies have formalized environmental management programs that include internal audits and certification under ISO 14000. At several sites, investigations have been conducted and measures have been put into place to minimize wood waste generation and to control the potential impacts of stormwater releases.

- *RE: Assessment of current B.C. operations*

Three studies of B.C. operations are described in the report. A wide variation in practices was noted during the three studies. The studies include:

  - "Environmental Audit Report for Dryland Log Sorting Operations in the Vancouver Island Region" by the B.C. Ministry of Environment, Lands and Parks, April 2001.
  - "The Extent, Causes and Environmental Risk of Logyard/dryland Sort Runoff in British Columbia" by Julie Orban of the University of British Columbia, December 2000 (conducted together with the BC Council of Forest Industries).
  - Assessment of eight log yards and dry land sorts by D. Konasewich, as part of this project (2001).

- *RE: Existing recommended practices*

Three documents have been previously developed in B.C. with several aspects of recommendations for design and/or operation of dry land sorts and log yards. The recommendations are summarized in this report.

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1. INTRODUCTION

The movement of logs from forests to respective process sites (mills) may occur via numerous routes, depending on economics, topography, volumes, season, location and distance.

Along the British Columbia coast, sorting, transportation and log storage have historically occurred in either fresh or salt-water environments. Adverse effects of log handling in the aquatic environment have been documented in reports such as the Fisheries and Oceans publication “A Handbook for Fish Habitat Protection on Forest Lands in British Columbia” (Toews and Brownlee, 1981). The above noted handbook also makes reference to (and supports) a recommendation of a Task Force Report on Log Storage and Rafting in Public Waters that:

> “Dry- land handling and sorting is preferred to water handling and sorting, although the location of dry land facilities should not be in fisheries sensitive zones such as estuaries, salt marshes, herring spawning areas, or shellfish beds”.

In order to meet the above recommendation, the BC forest industry has replaced many coastal water log handling and sorting operations with dry-land operations. However, operators of dry-land sorts may encounter environmental issues relating to surface runoff quality. During rainfall events, wood leachates are inevitably present within the runoff waters, and the concentrations of wood leachates may be at concentrations that are contrary to Section 36(3) of the Canada Fisheries Act.

Key to the assessment of compliance with the Fisheries Act is the Rainbow trout bioassay test. Failure of this test is sufficient grounds for legal charges under the Act. Alternative assessments such as evaluation of environmental impacts, in-situ bioassays or bioassays with more applicable species (e.g. use of salmon instead of trout to test toxicity of waters going to marine waters), and/or modification of bioassay pH’s to reflect ambient conditions, are not at this time, accepted by Federal regulators.

To date, legal charges have been served to one dry-land sort where surface runoff waters have failed to meet the requirements of the bioassay test. Federal challenges (e.g. 60-day improvement notices) have been issued at other coastal dry-land sort operations and interior log yards.

Although wood leachates appear to be the principal chemicals found in runoff waters from dry-land sorts and log yards, other chemicals or products may also be present, including fuel residues and hydraulic oil.

In consultation with federal and provincial authorities, the Council of Forest Industries of B.C. is proposing to develop a technical guidance document to aid in the management of potential water quality issues at dry-land sorts and log yards. This report provides background material for the development of the technical guidance document and is based on: a review of the literature; telephone contacts; and, the results of recent surveys of coastal dry-land sorts and interior log storage yards.

2. DESCRIPTION OF PROCESS

2.1 LOG FLOW PATTERNS

Following the harvesting process, sorting of logs for grade, species and size must occur. Following the sorting process, the logs are then distributed to processing operations such as sawmills, pulp and paper mills. Overall, there are many combinations of procedures within the distribution system.

2.1.1 Coastal log flow patterns

Waelti provided an overview of coastal log flow patterns in British Columbia during 1971 (**Figure 1**). Sorting areas noted in Figure 1 include sorting on land or water. Since 1971, there has been a greater trend toward the use of dry land sorts including:

- Major central sorts that are permanent, usually paved and with sediment/pollution control systems.
- Semi-permanent or temporary sorts which are small, with no pavement, office or maintenance shops, and handle less than 100,000 m^3 annually.

A report by the Council of Forest Industries indicated that by 1981 "despite greater cost, overall 60 percent of the coastal log volume was being sorted on land". The report predicted that the percentage of sorting on land would be increasing, but the lack of suitable land areas in more urbanized areas (for major central sorts) was limited, and topographical constraints in many other areas will require continuation of some degree of water sorting.

Another trend since the 1971 schematic shown in Figure 1, is the increasing use of trucks to deliver wood to large central sorting areas. At the four coastal dry land sorts visited during this study, almost all wood was delivered by truck for sorting. The sorted wood was then bundled for transport via water to processing facilities.

2.1.2 Interior log flow patterns

Although no statistics were obtained during this review, it appears from the visits to four Interior log storage areas during the course of this study that:

- The degree of handling logs between the harvest areas and the processing plants is less than at coastal operations, i.e., the need for sorting is generally less at Interior log storage areas.
- Mixed species of wood are less likely to be transported together.
- Land transport directly from the source area to the processing plant is more likely.
- In addition to transport of logs via truck, transport via water (lake or river) also occurs.

2.2 DESCRIPTION OF PROCESS- COASTAL DRY LAND SORTS AND INTERIOR LOG STORAGE AREAS

As noted in **Figure** 1 and as discussed in Section 2.1, both major centralized and semi-permanent/temporary sorts are used for collection, sorting and distribution of coastal logs. Interior log yards are usually located next to a particular processing plant and serve to sort and store wood for that particular plant. However, there are Interior sorting yards that function much like the major centralized coastal dry land sorts (i.e., distribution of logs to more than one facility occurs).

A BC Ministry of Forest report (1999) describes the activities at a sorting operation:

> "Once the yard receives delivery of the logs they are unloaded and arranged in rows so that all the log butts and tops are facing the same direction in order to facilitate the grading, merchandizing and sorting process. The logs are piece scaled and sorted in one operation, in order to reduce the handling operations. On the basis of species and specific sales attributes such as top diameter, taper, knot characteristics, butt flare and other factors, scalers establish the merchandizing cuts to maximize the value of the logs and fill specific order requests. Each day the scalers meet with the log yard manager to discuss the market values and sales activity to ensure the highest yield are obtained from the logs while still being able to satisfy their clients."

FIGURE 1 COASTAL LOG FLOW PATTERNS IN BRITISH COLUMBIA

When sorting on land, front-end loaders, log stackers and cranes are used to separate the logs into various sort categories.

A dry land sort or log storage yard must have the following features:

- A central location: in the case of log yards, proximity to the point of use (sawmill, OSB, chipping operation, etc.); in the case of dry land sorts, proximity to a transportation system- highways and/or water.
- Convenience for transfer of logs to and from the yards to enable easy in and out of trucks. In the case of many dry land sorts, proximity to water with the ability to locate the appropriate transfer equipment has been essential.
- There must be sufficient space for storage of logs.
- There must be sufficient space for corridors for movement of logs.
- There must be sufficient space for sorting and grading of logs.
- There must be adequate ground preparation to enable operation of heavy equipment.
- Rapid drainage of stormwater must occur.
- Surfaces should have minimal potential for contaminating logs and wood debris by soil.
- Availability of disposal options for bark and waste wood.

Other factors such as economics (land costs, transportation costs, etc.) also have a major role in the development of dry land sorts and log yards.

2.2.1 Coastal dry land sorts

A conceptual diagram showing typical features of a coastal dry land sort is shown in **Figure 2**. All features may not be present at all sorts and different approaches for water management may be in place.

Unsorted logs would be brought to a site by truck or by water. Typically logs brought in by truck are unloaded by large front-end loaders (e.g., Wagner or LeTourneau) with a capacity to remove the entire truckload at one time. This procedure reduces the amount of log handling and generally reduces losses of bark. The loads are then carried to a sorting area where they are arranged in rows for sorting. Loads that cannot be sorted immediately are placed in a storage area. Following the sorting process, the logs are placed in bins, then bundled and transported via water or land to process areas or export terminals.

Associated with each coastal dry land sort would be:

- Fuelling facilities for heavy equipment and boom boats.
- Storage areas for bark and waste wood.
- A means to control drainage and provision of a treatment system for point source effluent discharges. Many coastal dry land sorts have some provision for suspended solid removal and, oil and grease removal.

2.2.2 Interior log storage areas

Overall, the schematic in **Figure 2** could represent Interior log storage areas with the exception that:

- Interior log storage areas may be significantly larger than coastal dry land sorts.
- Interior log storage areas are less likely to be paved, and drainage of precipitation via infiltration into ground rather than as a point discharge is common.
- Storage areas for bark and waste wood are minimal. Most interior log storage areas are associated with operations such as sawmills and OSB mills (oriented strand board mills.) Such operations as part of their processes, have power boilers, wood burners and/or landfills, hence options for waste wood disposal are more readily available to Interior log yard sites.

FIGURE 2: SCHEMATIC OF A TYPICAL DRY LAND SORT

3. ENVIRONMENTAL ISSUES

The most common potential stormwater pollutants at dry-land sorts and log yards are: those generated during the leaching of logs and debris; soil erosion; ash wastes; and, leaks and spills of hydraulic and lubricating oils from equipment used at the site. The Washington State Department of Ecology (1995) provided further identification of the source areas as:

- Log storage, rollout, sorting, scaling and cutting areas.
- Log and liquid loading and unloading areas.
- Truck, rail, ship, stacker and loader access areas.
- Debarker, bark bin, and conveyer areas.
- Bark, ash, sawdust and wood debris piles and other solid wastes.
- Log trucks, stackers, loaders, forklifts and other equipment.
- Maintenance shop and parking area.
- Cleaning areas for vehicles, parts and equipment.
- Storage and handling areas for hydraulic oils, lubricants, fuels, paints, liquid wastes, and other liquid materials.
- Metal salvage areas.
- Application of herbicides for weed control.
- Contaminated soil.

The major potential pollutants from the above source areas are as follows:

- Specific wood extractives such as resin acids, tannins and lignins, and phenols;
- Substances causing biochemical oxygen demand; and,
- Suspended solids.

Pollutants that may occur on occasion include:

- Hydrocarbons, and
- Metals.

A brief discussion of the pollutants is provided in this section to enable an overview of potential environmental issues at dry-land sorts and log yards. More detailed reviews of the pollutants are referenced in this section.

3.1 SPECIFIC WOOD EXTRACTIVES (RESIN ACIDS. TANNINS AND LIGNINS, PHENOLS)

Rainfall percolating through logs in storage, hog fuel piles and wood chip piles will leach naturally occurring chemicals from wood. The leachate is often characterized by color, elevated carbon content, and measurable concentrations of resin acids, lignins, and phenolic compounds. Excellent reviews of wood chemistry and log yard runoff chemistry provided by McDougall (2001) in a report sponsored by Alberta Environment and by Samis et al. (1999) in a report by Environment Canada. Other reviews of note are provided in documents by Orban (2000) and by Taylor et al. (1996).

Table 1 provides a summary of wood constituents as provided by McDougall (2001). The table also provides concentrations of specific chemicals and pollution parameters (such as BOD) found within effluents from various log yards located in Alberta.

Overall there have been few studies that have focused on the characterization and toxicity of runoff waters from dry-land sorts and log yards. However the chararacterization and impact of wood constituents has been the subject of considerable research, with the first major program being the Cooperative Pollution Abatement Program (CPAR) of the Canadian federal government and the Canadian pulp and paper industry during the years 1970 to 1979 (Jones, 1980). Although the CPAR program focused on pulp and paper effluents, many of the studies provide insights to the possible impacts of log yard runoff waters, because many of the chemicals found in pulp and paper effluents are also found in log yard runoff waters. Other individual studies have since been conducted and an extensive database is available. **Table 2** summarizes some of the findings of the CPAR program and selected other studies that are relevant to the characterization of log yard runoff waters.

Table 1 Wood Chemistry and Log yard Runoff Chemistry (from McDougall, 2001)

Table 2: Summary of previous research relating to potential impacts of log yard runoff waters

General Research Finding	More Detailed Finding and Reference
Pulp mill effluents were generally toxic and many studies suggested that the majority of the toxicity in effluents from processing of soft woods was attributed to the wood constituents- resin acids	• Toxicity of a kraft mill effluent was attributed to wood extractives, i.e., 82% due to resin acid soaps, and 18% to unsaturated fatty acids (CPAR #11, BCResearch). • Pulp mill effluent toxicity could be directly related to the wood constituents- resin acids. Other compounds (juvabione) were also found to be toxic (CPAR #149, BC Research).
Other studies suggest that resin acids are not consistently the major source of toxicity for softwood.	• A hardwood debarker effluent from an Ontario mill had no detectable concentrations of resin acids and was very toxic (LC50 of 5%) (CPAR #148, BC Research). • Toxicants in effluents from processing of red cedar indicated that resin acids and fatty acids were not major contributors to toxicity. The most toxic component was derived from lignin (CPAR #711, PPRIC, Pointe Claire, Quebec).
Hardwood trees such as aspen produce dark and acutely toxic leachates that contain elevated concentrations of phenols.	• Piles of aspen logs cut in winter have been observed to produce leachates known as "blackwater" during snowmelt. Phenols to 30 mg/L may be present (Taylor et al., 1996)
Toxicity is affected by pH.	• The toxicity of resin acids increased significantly by decreasing pH from 7.0 to 6.4 (CPAR #149, BC Research) • It was recommended that bioassays be conducted at pH of receiving water (CPAR #402, BC Research). • Pease (1974) showed that wood leachates were more toxic to pink salmon in freshwater than in seawater.
Toxicity may be affected by hardness.	• Toxicity of pulp mill effluent appears to decrease with increases in hardness. The LC50 at 40 ppm hardness was 25% and LC50 at 150 ppm hardness was 60%. (CPAR #330, Eco-Research, Pointe Claire, PQ).
Bark leachates are a major source of toxicity	• Wastewaters from hydraulic debarking systems, wet and dry drum barking systems are very toxic (i.e., LC50's <10% volume) (CPAR #148, BC Research) • Effluents from kraft pulping of wood containing high concentrations of bark (e.g. 15%) were of higher toxicity than effluents from systems not using bark. (CPAR #513, PPRIC, Pointe Claire, PQ).
Wood species vary in release rates of wood extractives.	• Black liquor from fir had higher quantities of toxic components than black liquors from hemlock or cedar (CPAR #10, BC Research). • Effluent from a thermomechanical pulp plant showed that western spruce resulted in an effluent that was of higher BOD and toxicity than effluent from the use of western hemlock. • Hardwoods have low concentrations of resin acids relative to soft woods. (CPAR#148, BC Research). • Pease (1974) indicated the following sequence of leaching rates for various woods: red cedar>yellow cedar>hemlock>spruce. Spruce leachate was the most

	toxic in fresh water, while yellow cedar was the most toxic in 20 ppt seawater.
Correlations of operating factors with toxicity were not evident.	• No discernible correlations between woodroom operating variables and effluent quality were found (CPAR #148, BC Research)
It is difficult to treat effluents with high amounts of wood extractives so that the effluents are no longer toxic.	• Biological oxidation of waste waters from wood room wastes did not always remove toxicity although BOD reductions were >80%. Chemical flocculation was generally ineffective. (CPAR #148, BC Research). • Tests with pulp mill effluents indicated that biotreatment results 39 to 98% toxicity removal. DHA was the most biodegradable resin acid (CPAR #408, BC Research).
Contact of wood waste leachates with soil results in decreased toxicity.	• Lysimeter and field tests showed that leachates from active log yards, sawdust piles and hog fuel piles were toxic at surface levels and nontoxic after passing through quantities of soil or gravel. (CPAR #363, Econotech, New Westminster, B.C.)
Aging of wood waste results in leachates of lower toxicity.	• Leachates from "old hogfuel piles" were less toxic (CPAR #363, Econotech, New Westminster, B.C.) • However, although fatty acids and resin acids were found at decreased concentrations in blow liquor from aged wood chips, no decreases in toxicity were observed.
When bark is finely-ground and mixed with water, a mixture results that is highly toxic to fish.	• Envirosphere (1981)

- CPAR studies were identified by project numbers. Extended abstracts of the studies are found in the publication by Jones (1980) and final reports are available at the University of British Columbia library.

3.1.1 Overview of information on releases of specific wood extractives from log yard operations

Typically, coastal operations monitor their effluents for general parameters such as oil and grease, and suspended solids (Bunce, personal communication). As an example, of the four coastal dry land sort yards visited during this study and the two other yards known to the author, only two had data on releases of specific wood chemicals such as resin acids or tannins and lignins. Of the four interior log yards visited during this study, only one operation had analyzed its runoff waters for wood extractives.

Sporadic information on wood extractive concentrations in runoff waters from dry-land sorts and log yards is available in the literature, e.g., NCASI (1992) and Zenaitis et al. (2001). However for the sake of illustration, three sources of information are used in **Tables 3 and 4** to provide a general overview of information relating to the presence and impacts of releases of wood chemicals from log yard operations. The purposes of Tables 3 and 4 are to show that wood extractives are indeed found in runoff waters from dry-land sorts and log yards at concentrations above background levels found in forested areas, and at concentrations that may cause toxicity.

Table 3: Overview of Presence and Impacts of Resin Acid/Tannin and Lignin Releases from Log Yard Operations

Study	Wood chemicals: resin acids		Wood chemicals: tannins/lignins	Toxicity LC_{50}- 96 hr	Notes
Compilation of information from BC coastal log yard and dry-land sorts with paved surfaces (Author's files)	Total resin acids	N=19 Range: <1 –8.1 mg/L Median: <1 mg/L	N=15 Range: 5-660 mg/L Median: 83 mg/L	N=22 Range: 12->100 Median: 22%	- results were highly variable for a given discharge point over a several months - studies at one site showed no receiving environment impact via dive survey, sediment and receiving water bioassays. -changes in operating practices were not effective in achieving "non-toxicity". -toxicity was pH dependent
	Dehydro-abietic acid	N=3 Range: 0.19-0.73 mg/L Median: 0.64 mg/L			
	Abietic acid	N=3 Range: 0.07-0.5 mg/L Median: 0.42 mg/L			
BC coastal yard with unpaved surface (Author's files)				N= 6 All results LC50 >100%.	
Alberta Environ. survey of 5 log yards (McDougall, 2001)	Resin Acids: N=24 Range: <0.01- 15.5 mg/L Median: 0.54 mg/L		N=56 Range: 3.8-345 mg/L Median: 30.3 mg/L	N=17 Range: 7.1%->100% Median: 100%	-no paved surfaces
Alberta Environ. survey of control areas (forest areas near above 5 log yards) (McDougall 2001)	Resin Acids: N=3 Range: <0.01-0.053 mg/L Median: <0.01 mg/L		N=10 Range: 0.7-3.1 mg/L Median: 1.5 mg/L	N=2 Both non-toxic	
BC Environment survey of Vancouver Island Dryland Sorts (Bunce, 2001)	Not measured,		Not measured.	Microtox EC50:* N=18 Range: 2-100% Median: 16%	

* The EC50 was said by Bunce to be comparable to a LC50 for Rainbow trout "if the toxicants were dissolved".

Table 4: Summary of phenol concentrations in stormwaters releases from log yards

Study	Phenol concentrations (mg/L)	Toxicity	Notes
BC OSB mill (aspen storage)	N=27 Range: <0.01-3.02 Median: 0.12	Microtox; N= 12 Range EC50: 5.1%-46.2%	Phenol concentrations have been decreasing at this mill because of improved storage practices and reduced storage of hogfuel on the site.
Alberta Environment-survey of 5 log yards (McDougall, 2001)	N=95 Range: <0.001-29 Median: 0.33	LC50 Rainbow trout N=17 Range: 7.1%->100% Microtox: EC50 N=59 Range: 1.5%->100%	
Alberta Environment-survey of control areas (forested areas) (McDougall 2001)	N=12 Range: <0.001-0.023 Median: 0.002	Microtox: EC50 N=2 Non-toxic	

3.1.2 Environmental objectives for specific wood extractives

As noted in **Table 1**, wood extractives consist of a large number of individual chemicals. The identification of all chemicals is unlikely, given that natural products may yield many isomers and congeners within a same family of compounds. Confirmed identification will require synthesis of each compound, for verification by gas chromatography and mass spectrometry.

As a result, the specific chemicals identified in the earlier 1970 studies are commonly used to evaluate the potential impacts of wood leachates. Those chemicals are:

- Resin acids, namely abietic and dehydroabietic acid;
- Fatty acids;
- Tannins and lignins; and
- Phenolic compounds.

The only water quality guidelines for specific wood leachates, are those for resin acids developed by the Ontario Ministry of Environment in 1995 and those for “phenols” as developed by the Canadian Council of Ministers of Environment (CCME).

Guidelines for resin acids

In the supporting documentation for development of guidelines for resin acids, the Ontario Ministry (Taylor et al., 1988) undertook an extensive literature review, which indicated the following:

- Studies of acute toxicities of resin acids showed that the LC50’s for various species of fish ranged from 0.5-2.1 mg/L dehydroabietic acid (DHA) and 0.2-2.1 mg/L for other resin acids.
- Toxicity was dependent on pH, and the guidelines for resin acids had to account for the pH of the ambient water in which biota resided.
- Although DHA was not the most toxic resin acid, it was found to be predominant among resin acids in wood processing effluents. It was also considered to be persistent.
- The toxicity of mixtures of resin acids was additive.

Based on the assumption that resin acids bioaccumulate in biota, the Ministry applied a 100 fold safety factor to the reported 96-hr LC50 values for coho salmon (0.75 mg/L) and sockeye salmon (0.79 mg/L), hence the guidelines of 0.008 mg/L (8 μg/L) for dehydroabietic acid. The guidelines recommended by the Ministry were as follows:

Receiving water pH	DHA guideline (ug/L)	Total resin acids guideline (ug/L)
5.0	1	1
5.5	2	3
6.0	2	4
6.5	4	9
7.0	8	25
7.5	12	45
8.0	13	52
8.5	14	60
9.0	14	62

The Ministry emphasized that the guidelines are set at a level of water quality, which is protective of all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure to the water (i.e., the guidelines represent a concentration that would be protective of aquatic biota in receiving waters such as lakes and rivers). The policy of the Ministry is that "water which presently does not meet the Provincial Water Quality Objectives shall not be degraded further and all practical measures shall be taken to upgrade the water quality to the Objectives."

The Ontario guidelines for resin acids have been adopted as "working guidelines" by the BC Ministry of Water, Land and Air Protection (2001), i.e., they have not been fully assessed and have not been formally endorsed by the Ministry. Along with many other chemical parameters listed in the working guidelines, the guidelines for resin acids would be reviewed by the Ministry on a priority basis for formal approval and use in British Columbia.

The British Columbia Pollution Control Objectives for the Forest Industry (1977, revised in 1989) indicate that outside of an "initial dilution zone", there should be only a "negligible increase" in resin acids and wood waste leachates. Under industry guidelines, for point discharges to lakes, estuaries and marine waters, the initial dilution zone may extend up to 100 meters horizontally in all directions, but shall not exceed 50 per cent of the width of a water body. For point discharges in rivers and streams the zone may extend up to 100 metres downstream of the discharge point, but shall not exceed 50 percent of the width of the river or stream. The term "negligible increase" is defined as "one which does not lead to a polluted condition in receiving water quality and can therefore be disregarded." It could be inferred that log yard runoff should not cause the receiving waters to exceed ambient guidelines outside of the prescribed "initial dilution zone."

<u>Guidelines for phenols</u>

The Canadian Water Quality Document of the CCME indicates that the 96-hr LC50 toxicities of phenol to various species of fish ranges from 8.3 to 68 mg phenol/L. Chronic toxicity to trout occurs at levels of 0.07 to 0.12 mg phenol per litre of water. The CCME review found that the most sensitive species was the embryo-larval stage of the leopard frog, which is sensitive to phenol at a level of 0.04 mg/L. With the application of a ten-fold safety factor to this observation, CCME then derived an ambient guideline of 0.004 mg phenol per litre of water. CCME found that phenol was the most toxic of all sensitive of all phenolic compounds, and the guideline is applicable to all phenols.

CCME guidelines are reviewed at a provincial level for consideration of adoption within a province. In a draft document dated September 17, 2001, the B.C. Ministry of Water, Land and Air Protection proposed an ambient water quality guideline for phenol. The document provides the following alternative to the CCME guideline:

- 0.002 mg/L for hydroxy-phenol
- 0.0125 mg/L for 3-hydroxy-phenol, and
- 0.050 mg/L for all other phenols (exclusive of chlorinated phenols and the above noted phenols).

3.2 BIOCHEMICAL OXYGEN DEMAND

Wood contains carbohydrates, which in accordance to Table 1 include cellulose and water soluble wood sugars. The compounds are susceptible to biological degradation during which oxygen may be depleted. Although other organic compounds in wood are also susceptible to biological degradation, carbohydrates are most readily degraded. Depending on: the volume of discharge; the amount of biodegradable and soluble carbohydrates in the discharge; and, the physical characteristics of the receiving environment (e.g., temperature, water currents, etc.), there may be potential for oxygen depletion in the receiving environment due to releases of log yard runoff waters.

Biochemical oxygen demand (BOD) is used to assess the potential for oxygen depletion by aerobic organisms. Other parameters such as TOC (total organic carbon) and COD (chemical oxygen demand) may also be used. General relationships among BOD, COD and TOC may be inferred for particular effluents however reliable relationships are rare.

Table 5 indicates that natural waters from forest areas have "background" BOD's, and assumptions of impacts from log yards require careful analyses of properly obtained field data.

3.2.1 Summary of current information on releases of oxygen demanding substances from log yard operations

Examples of available data on BOD, COD or TOC from BC log yards and dry-land sorts, as well as data from the study by Alberta Environment are summarized in **Table 5**.

Table 5: Summary of information on quantities of oxygen demanding substances in runoff waters from log yards.

Information source	**Parameter**	**Number of samples**	**Concentration Range (mg/L)**	**Median Value (mg/L)**
BC Sawmill	BOD	20	<2-790	8
BC OSB mill	TOC	24	31-109	61
BC Log Sort	COD	5	157-3930	559
Alberta Environment- 5 log yards (McDougall, 2001)	BOD	72	23-1800	157
	COD	95	160-3500	608
	TOC	46	62-1080	264
Alberta Environment- Background (McDougall, 2001)	BOD	9	0.9-7.6	2
	COD	12	<5-71	45
	TOC	11	8-23.2	17.8
BC Environment (Bunce, 2001)	BOD	16	14-725	306

3.2.2 Environmental objectives for oxygen depleting substances

British Columbia specifications for releases of oxygen depleting substances state the effluent quality objectives on unit of production for hydraulic debarkers and pulping processes (e.g., kg BOD per unit; or kg BOD/t), and concentrations for saw, planer, shingle, wood preserving and plywood mills (e.g., 50 mg BOD/L).

BC Water Quality Guidelines (2001) specify that a 30-day median of ambient organic carbon (TOC) in waters subject to a discharge should be within +/- 20% of the median background concentration. It is inferred the condition would apply outside of the "initial dilution zone" as discussed in page 17 of this report.

3.3 PARTICULATES

Releases of wood, bark and soil particles from a site may impact the receiving environment. The releases may result in physical impact on fauna residing in or on the sediment of the receiving environment. As well, a chemical impact may occur, whereby decomposition of organic material may result in a detrimental loss of oxygen and/or releases of hydrogen sulfide.

3.3.1 Summary of current information on releases of particulate concentrations in runoff waters from log yard operations

Table 6 provides an overview of actual concentrations of particulate (suspended solid) concentrations in effluents from BC and Alberta log yards.

Table 6: Summary of information on particulate concentrations in log yard runoff waters

Information Source	Number of samples	Range (mg/L)	Median (mg/L)
BC log sorts (author's files)	25	22-2820	314
Vancouver Island sorts (Bunce, 2001)	26	8-4010	309
Alberta- 5 sawmill sites (McDougall, 2001)	89	<0.4-3015	85
Alberta- 5 control sites (McDougall, 2001)	12	<0.4-19	3

3.3.2 Environmental objectives for suspended solids

As in the case of BOD, the BC Environment Pollution Control Objectives for total suspended solids in effluents are based on production volumes in hydraulic barkers and pulping processes, and concentrations (60 mg/L) for effluents from saw, planer, shingle, wood preserving and plywood mills.

The BC Approved Water Quality Guidelines (2001) specify that the maximum induced suspended solids should be no more than 25 mg/L in 24 hours when the background is less or equal to 25 mg/L. Again, it is inferred this condition applies to water outside the "initial dilution zone".

3.4 METALS

A review of the literature, suggests that metals are not a major issue at log sort and storage yards. An exception is the finding of zinc in stormwater effluents, the source being nearby buildings with galvanized siding and roofing (Bailey et al., 2000). Such releases are unlikely from a dry-land sort or log yard operation per se. .

3.5 PETROLEUM HYDROCARBONS

Except in areas where vehicle fueling and maintenance occur, hydrocarbon releases are usually not an issue at log yard sort and storage yards. The exception would be the occurrence of spill such as a rupture of a hydraulic fluid line. The Alberta study found that in 66 samples of stormwater runoff, the range in oil and grease concentrations was <0.02 to 29.7 mg/L with a median value of 2.9 mg/L.

4. REVIEW OF ENVIRONMENTAL IMPACT STUDIES AT LOG YARDS

Few environmental studies are known to have been conducted at log yards. The studies available have addressed one or more of: stormwater runoff quality; environmental impacts; and, the effects of management practices at log yards. The results are important to the development of a technical guidance document, and perhaps illustrate the difficulties that may be encountered to achieve "non-toxic" discharge effluents.

4.1 NORTH COAST TIMBER, PRINCE RUPERT, B.C.

A large majority of a 60 ha area was paved to provide facilities to sort and store logs for an adjacent sawmill. The area was paved to replace a log yard that generated large quantities of sediment releases during rainfall events. The pavement minimized contact of logs with soil and hence enabled more ready acceptance of the resulting hog fuel for combustion. Lower maintenance of sawmill equipment resulted. Worker safety was enhanced by the ability to maintain a clean yard surface. The site had four outlets from the paved area and three discharges from ditches that drained the unpaved area. A ditch was located up-gradient of the log yard to minimize the amount of water draining through the pavement area.

Effluents from the discharge points at the paved area were found to be "toxic" using the Rainbow trout 96-hr bioassay procedures. Efforts were then made to find a means of minimizing toxicity. Studies of the effluents indicated that:

- There is a high variability of resin acid and, tannin and lignin concentrations over time, and that the reasons for the variability could not be determined. Except in the cases where very low volumes of wood were in storage, the study could not definitively discern any relationships between effluent quality and factors such as volumes of wood in storage, time of the year and housekeeping practices.
- Toxicity identification evaluation (TIE) studies suggested that tannins and lignins were the main source of toxicity observed in effluents.
- pH modifications of effluents were noted to reduce toxicity, providing the tannins and lignins were not at excessive levels.

- Toxicity was absent in effluents directed to the dirt ditches.

Based on the effluent studies, a receiving environment study was conducted. No evidence of an environmental impact to the receiving water was noted:

- A bioassay on sediments in direct contact with the discharge showed no toxicity to an amphipod test species.
- A dive survey of the receiving environment showed no differences in the biological community compared to a control area several kilometers away. The exception was an small area where wood debris from historical booming operations was present.
- A water sample taken directly adjacent to the area of discharge of stormwater had no toxicity to sticklebacks.
- Avoidance by salmon fry was not noted in the receiving environment during discharge of stormwater effluents.

During the study, modifications of operating practices had occurred, including:

- The purchase of a street sweeper to clean the paved yard surface at frequencies of approximately twice per day.
- Log bundles placed on the paved area after removal from the marine water, were no longer “pushed” to their sorting or storage locations. Pushing of logs on the pavement was observed to cause the formation of a wood “flour” that enhanced wood leachate concentrations. The bundles were now “lifted” for transport.
- Hog fuel piles were minimized by ensuring frequent removal from the site. The hog fuel piles were covered by a tarp to minimize the percolation of precipitation.

Despite the changes in operating practices, the effluents were still found to be “toxic” using the Rainbow trout 96-hr LC50 bioassay test. The relationship between the results of the fresh water Rainbow trout bioassay test and the potential impacts on marine fish was not pursued in this study.

Part of the program included an assessment of effluent treatment options. Site topography, area requirements and costs excluded options such as biological and physical/chemical treatment.

4.2 ASSESSMENT OF LOG YARD RUNOFF IN ALBERTA

In a study sponsored by Alberta Environment, runoff waters from five log yard test sites and three forested areas were monitored over a two and one-half year period. The study attempted to address the following questions:

I. *Are runoff waters from log yards any different from runoff waters obtained at undisturbed forested areas (control sites)?*

   Significant differences were found in pH, BOD, COD, phenol, total suspended solids and, tannin and lignin concentrations. As examples, the maximum BOD in log yards was found to be 983 mg/L versus 7.6 mg/L at the control sites. Phenol was found at a maximum of 6.22 mg/L at the log yards, versus 0.023 mg/L at the control sites. Tannins and lignins were a maximum of 165 mg/L in log yard runoff waters versus a maximum of 3.1 mg/L in the control forest areas.

II. *Is there a relationship between the volumes of wood in storage versus the quality of the runoff waters?*

   The expectation is that the higher the number of logs stored on a site, the more log yard leachate generated. Generally this assumption was found to be true, however the yard with the lowest volume of logs per unit area, was found to have the highest concentrations of tannins and lignins, suspended solids and COD. The tree species at this log yard were 100% conifers. One other test site, which also consisted of 100% conifers, had approximately 5 times more logs per unit area. However the concentrations of COD and phenols were much less at the latter site than the former site. The authors of the study concluded "other factors must therefore play a more important role for these two test sites than the ratio of logs stored to the storage area". However a study by Orban et al. (2001) indicated that log yards with the highest potential risk to the environment were primarily associated with larger sorting yards, i.e., those that processed more than 329,000 m^3/year; had a runoff more than 20 days per year; and had runoff of a color "darker than yellow."

III. *What impact do tree species have on runoff quality?*

Definitive conclusions on this question could not be made, partially because of differences in soils that constituted runoff pathways (e.g., collection of samples on clay surfaces versus muskeg/clay surfaces).

Runoff waters from a yard containing mostly spruce, had the lowest organic content (i.e., BOD, COD, phenol, tannin and lignin). However it is also noted that the runoff path consisted of a muskeg/clay surface. Phenols were highest in a log yard that stored deciduous trees (poplar), and tannin and lignin concentrations were highest in a yard with 100% conifers.

IV. *Do soil characteristics of a log yard impact runoff quality?*

The results were inconclusive, however the statement is made that "a clay surface may result in higher levels of organics in the runoff compared to a site with a silty/sandy soil." A conclusion of the report states " "statistical analysis indicated that the runoff from log yards with clay soils, storing pine or aspen logs and having a defined runoff path tended to have higher organic and TSS levels compared to a log yard storing only spruce on a muskeg/clay surface".

V. *What is the effectiveness of retention ponds?*

Statistical analysis of data for one plant, indicated that there were significant differences between influent and effluent waters for the parameters pH, COD and phenol (i.e., 69% reductions in concentrations had occurred).

The main conclusion of the report is that "based on the monitoring results and the data analysis done, runoff control measures are necessary at log yard sites where runoff releases to a receiving water body".

VI. *What impact do management practices have on runoff quality?*

Although this question was stated as one objective for this study, the investigators could not find a relationship between management practices and runoff quality due to the complexity of the issue.

5. ASSESSMENT OF DESIGN AND OPERATION OF BRITISH COLUMBIA LOG YARDS

For the purpose of this study, three recent reviews of British Columbia log yards are summarized to provide an overview of their existing status with respect to environmental controls. The reviews are:

- *"Environmental Audit Report for Dryland Log Sorting Operations in the Vancouver Island Region"* April 2001, by Hubert Bunce, Ministry of Environment, Lands and Parks, Nanaimo, B.C.

  Forty one of 101 dry land log sorting operations in the Vancouver Island Region were inspected during the spring of 1999. The program provided a preliminary assessment of the potential environmental impact of each site.

- *"The Extent, Causes and Environmental Risk of Logyard/Dryland Sort Runoff in British Columbia", December 2000.* A Master of Science research paper by Julie Loughlin Orban, University of British Columbia.

  This paper provides a detailed overview of the chemistry, toxicology and control measures for log yard runoff. As well a survey administered through the Council of Forest Industries was distributed to log yard/dry land sorts throughout British Columbia.

- For the purpose of this study, the author visited four coastal dry land sorts and four interior log yard operations. The results of his visits along with his previous work at two large coastal dry land sorts are also used in this assessment.

Table 7 provides an overview of the information from the three above noted reviews. More details of the reviews by Bunce (2001) and Konasewich (2001) are provided later in this section.

Table 7: Overview of BC Logyard/Dryland Sorts

Question or Aspect	**Orban (UBC/COFI)**	**Bunce (BC Ministry of Environment)**	**Konasewich (COFI)**
Is the facility a log yard?	N=64 Yes: 58% No: 42%		N=4
Is the facility a dry land sort?	N=64 Yes: 59%	N=41	N=4
How long has the facility been in operation?	N=21 Average: 21 years		
What is the annual volume? M3	N=64 The average is 413,000 The median is 329,500		N=8 Median: 300,000
What is the total area of the facility? ha	The average is 17.4 ha. The median is 5.4 ha..		N=8 Median: 10 ha.
What is the ground surface?	N=104 (survey of 64) Concrete: 5.8% Asphalt: 19.2% Dirt: 22% Gravel: 36.5% Mulch: 2.9% Other: 13.5%	N=41 50% were all paved.	N=4 Coastal yards All were paved N=4 Interior yard. None were paved.
Visible runoff?	N=72 Yes: 89% No: 11%		N=8 Yes: 75% No: 25%
Runoff a point source or non-point source?	N=64 Point: 36% Nonpoint: 63%		Point at 4 of 4 coastal sorts. Point at 2 of 4 interior log yards
When does runoff occur?	N=119 (64 surveys) 24% when it rains 28% during heavy storms 37% during snow melt 11% when sprinkler is operating		
Where does runoff terminate?	N=95 (64 surveys) River: 8.4% Stream: 3.2% Lake: 5.3% Ditch: 15.8% Ocean: 31.6% Ground: 30.5%	N=41 All coastal	N=4 Coastal yards 3 to ocean 1 to pond N=4 Interior Yards Lake : 1 Ground: 3 (including irrigation pond)
Does logyard/dryland sort slope towards nearest body?	N=17 Yes: 47% No: 53%		N=4 Coastal yards 3 of 4 slope to ocean 1 of 4 slopes to pond N=4 Interior 2 of 4 have no detectable slope 1 of 4 slopes to a lake 1 of 4 slopes to irrigation pond

What is the color of the runoff?	N=64 Clear: 11% Light yellow: 34% Dirty yellow: 22% Tea: 23% Black: 9%		
Has the runoff ever been analyzed?	N=62 Yes: 31% No: 61%		N=8 Yes: 3 facilities No: 5 facilities
Is the runoff collected? (into a drainage system)	N=64 Yes: 55% No: 45%		N=4 (coastal sorts) Yes: 4/4 N=4 (Interior yards) Yes: 2/4
Is the collected runoff treated? (any type of treatment)	N=64 Yes: 45.3% No: 54.7%	N=41 Yes: 63%	N=8 Yes: 75%
How is the collected runoff water treated:	N=37 (30 surveys) Oil separator: 16% Sediment trap: 73% Marsh: 8.1% Treatment lagoon: 0 Other: 5.4%		N=8 Oil separator: 7/8 at fuelling stations Sediment trap/settling ponds: 5/8 Marsh: 1/8 Irrigation: 1/8
Is water applied to control dust?	N=64 Yes: 75%		N=8 At all 4 coastal sorts
How is the ground surface cleaned?	N=83 (64 surveyed) Not cleaned: 5% Front end loader: 46% Power sweeper: 1.2% Sweep log: 39% Other: 10%		N=8 Sweep log: 4/4 coastal Front end: 4/4 Interior
How often is the ground cleaned?	N=64 Never: 6.3% Continuously: 64% Daily: 14% Weekly: 6.3% Monthly: 1.6% Annually: 1.6% As required: 4.7%		N=8 Continuously: 4/4 coastal After each sort: 1 of 4 Interior As required: 3 of 4 Interior
How are wood wastes stored?			
How are wood wastes disposed?			N=8 Boiler: 5 Teepee Burner:1 Landfill:8 Mulch: 2
Does open burning of waste wood occur?		N=41 Yes: 42%	
Do petroleum storage facilities have sufficient containment?		N=41 Yes: 61% No: 39%	

5.1 DETAILS FROM ASSESSMENT BY BUNCE (2001) AND KONASEWICH (2001)

During the spring of 1999 the Ministry conducted an inspection of 41 of the 110 dry land sorting operations located in the Vancouver Island Region (Bunce, 2001). In addition, for the purpose of this report, evaluations of four dry land sorting and four log storage areas were conducted (Konasewich, 2001). Also to the information provided in Table 6, the reviews also provide information that could be used in the development of a technical guidance document. It is noted many of the observations by Bunce, were also observed by Konasewich. For the sake of brevity, written repetition of observations is minimized.

RE: *Management of log yards*

Konasewich, 2001 (Coastal dry land sorts and interior log storage yards)

- There is an industry trend towards more formalized procedures for environmental protection (documentation, training and implementation) at log yards and dry land sorts, particularly through ISO 14000 certification.
- Internal audits of environmental protection programs are routinely conducted at several operations.
- There is a trend towards more sorting and grading at the source areas. Particularly for Interior log yards, loads of logs may be brought to the process areas as single species and further sorting and handling requirements are minimized. Grading for OSBs, chipping and, pulp and paper production is not necessary and less handling of wood occurs.
- There appears to be a greater trend to trucking of logs from source areas to the process sites.
- There is a trend to minimize handling of logs at sorting operations by investment in heavy equipment that can carry larger loads of logs (e.g., the ability to unload a log truck in one operation). As well as enabling a faster through-put for log trucks, the equipment reduces the losses of bark during handling. The cost of a typical unloader is said to be in the order of $1.5 million..

RE: *Pavement of sites and drainage*

<u>*Bunce (2001) (Coastal dry land sorts)*</u>

- Paved sites allow refuse to be more easily, frequently and completely removed from the high use areas.
- Paved surfaces are generally sloped so that runoff water is directed away from the site quickly.
- Bunce stated that "Most unpaved sites were noted to have low spots where runoff water and wood waste could collect, hence creating the potential for a wood waste 'stew'".
- Drain rock berms at paved sites become plugged and collect mixtures of water and wood.
- Wood fines are generated on paved sites by the movement of heavy equipment over wood debris and by the abrasion of a sweep log when it is used to clear a surface.
- Paved sites result in lower landfill volumes since less soil-contaminated waste wood is generated.
- A paved DLS site may result in reduced equipment maintenance and operating costs.

<u>*Konasewich, 2001 (Coastal dry land sorts and interior log storage yards)*</u>

- Pavement is the surface of choice by operators of dry land sorts.
- In addition to advantages listed by Bunce, the ability to clean a pavement enhances worker safety considerably.
- Costs of paving a dry land sort are very high, e.g., into the millions of dollars. Asphalt is only a minor cost, relative to the costs for base preparation to enable the operation of heavy equipment on the surface.
- Managers of paved dry land sorts are disappointed that the issue of runoff quality has arisen, given that previously; the sorts were sources of large releases of suspended solids from unpaved surfaces.
- As mentioned by Bunce, wood fines are generated on paved sites by the movement of heavy equipment over wood debris. Konasewich (2001)

obtained a sample of sprinkler runoff water from a site that used a "sweep log" to clear the yard surface. The sample contained 1,050 mg/L tannins and lignins, and 5,660 mg/L suspended solids, and had a pH of 5.0. Alternative procedures to clean surfaces need to be assessed.

- Of the four Interior log yards visited and the many observed enroute, none had paved surfaces. Relative to coastal dry land sorts, the Interior log yards had the following generalized features:

    - Interior log yards were generally much larger in area. **Photograph 1** shows a portion of one Interior log storage yard and **photograph 2** shows a typical coastal log yard.
    - Rainfall levels were generally much less, e.g. 205 mm precipitation at Ashcroft and 413 mm at Williams Lake versus 1100 mm at Nanaimo and 3200 mm at Port Alice. The potential of runoff waters from several interior log yards is considerably less than for coastal mills. Some yards may experience runoff only during infrequent heavy rainfall events.
    - Drainage patterns at two of the four interior log yard sites were not generally well defined, with water releases at occurring via seepage into the ground and drainage via low spots surrounding the yard. Drainage to ground may lead to designation of the property as a "contaminated site" if a groundwater standard for resin acids is incorporated within the Contaminated Sites Regulation.

PHOTOGRAPHS 1 AND 2

RE: Runoff treatment systems

Bunce (2001) (Coastal dry land sorts)

- Twenty six of 41 inspected log handling facilities had some form of treatment works to remove suspended solids and to contain hydrocarbons. It was noted that the facilities were typically retrofitted to an existing site and designed to fit available space rather than to meet specific discharge criteria. Bunce stated "sampling indicates many of the treatment facilities do not meet discharge quality generally attributable with these kinds of works". Treatment facilities at some sites were compromised in their ability to collect oil during peak flows. Peak flows were noted to flush any collected hydrocarbons.
- Many treatment works were found to be full of solids, hence resulting in poor suspended solid and hydrocarbon removal. Cleanout must occur as part of a regular preventative maintenance schedule.
- Examples of effective treatment systems were found including:
  - Systems that were properly sized and maintained. Features included: high length to width ratios; operation of ponds in series.
  - Systems that have been designed to enable easy cleanout of ponds.

Konasewich, 2001 (Coastal dry land sorts and interior log storage yards)

- Operators of three of four coastal dry land sorts stated that "if they had to build a new sort", they would not slope the sort towards the receiving environment. Rather, the sorts would slope towards a "back area" where a retention pond or marsh could be constructed. The fourth operator's sort was located on a man-made island built specifically for the sort and no "back area" would be available.
- The availability of land for a treatment system at a coastal dry land sort is generally "tight" because of geography or limited property lines. Land surrounding a typical Interior log yard is usually abundant, however there are exceptions such as sorts with narrow property lines that are located along rivers.

- Coastal dry land sorts are subject to extreme rainfall conditions whereby the volumes of runoff waters can be very high. Collection sumps observed during the visits were said to be able to handle runoff water >95% of the time (for sediment and hydrocarbon removal). Control and/or treatment of runoff waters during peak conditions (i.e., < 5 % of the time) would be very difficult or would require significantly larger systems. By-pass systems are desirable under such circumstances.
- Effective collection and treatment systems for runoff waters are in place at some sites. Examples of proven and possible systems are as follows:

  - A majority of runoff water from the Weyerhaeuser Northwest Bay dry-land sort is directed to a man-made marsh. The water from the marsh is used as a source of water for dust control at the sort, hence the concept of recycling of water. The marsh appears to have an active biological population with respect to wildlife and vegetation. A sample of water obtained from the marsh (at the pumping station for the dust control water) had a pH of 6.5, tannins and lignins at 2.7 mg/L, and suspended solids of 8.5 mg/L.

  - The Ainsworth OSB mill at 100 Mile House uses a series of ponds to collect runoff water from the log storage yard. A large central collection pond (**Photograph 3**) is used as a distribution point for spray irrigation of a nearby alfalfa field. The log storage area is located on a hillside, which facilitates transfer of the runoff water from the satellite ponds to the main pond by gravity. Emergency storage areas are available to handle any unusual peak flows. A large area is available for log storage and a stormwater collection system.

    In accordance to the Ministry of Environment permit, Ainsworth is to monitor soil and water quality, and monitor and record runoff and irrigation water quantities. Water quality monitoring includes water from the leachate collection and irrigation ponds and water from the nearby creek. EvEco Consultants of Vancouver designed the system.

As well, the plant has instigated additional practices to improve leachate quality including the storage of logs on supports to reduce contact of the logs with runoff water, and the minimization of the quantities of hog fuel in storage.

- The West Fraser Mills Ltd. Fraser Lake Sawmill uses a terraced log storage area located on a hillside. A ditch is located in-between each terraced area within which a single row of logs is stored on supports (**photograph 4**). Wetland vegetation has developed within each ditch. The ditches drain to a collector ditch that drains to a sediment collection system. The sediment collection system consists of 3 chambers in series. Although, monitoring data for the system are not available, the concept is of interest. The storage area required installation of a 1-metre base of gravel to enable operation of heavy equipment. The location of the site is advantageous to such a system – i.e. the log yard is located on a slope to enhance drainage and a large area is available.

- Other technologies have been recently developed and assessed in British Columbia.

  - A sand filter system for treatment of runoff water is being evaluated by Microbial Technologies Inc. The filter removes colloids, which are claimed to be a source of toxicity to log yard runoff waters to fish. Pilot plant scale tests suggest that the approach may be effective at some log yard sites. The approach may not be effective for sites with elevated concentrations of dissolved wood leachates.
  - An "article in press" by Zenaitis et al. (2001), describes the results of bench scale tests conducted at the University of British Columbia

to treat log yard run-off by combined biological and ozone treatment. Batch biological treatment reduced tannins and lignins by 90%. Acute toxicity was reduced, however not to levels that would meet regulatory standards, i.e., compliance with the 96-hr LC50 Rainbow trout bioassay was not consistently achieved. Ozonation also reduced toxicity but not to regulatory objectives. No further improvements in toxicity reduction were observed for combined biological treatment and ozonation.

- Overall there likely is no common solution that can be applied to all log yard operations. Approaches for runoff remediation are actively under investigation by Dr. Sheldon Duff of UBC in conjunction with COFI, and obviously by groups such as Microbial Technologies Inc.

- The main issues are related to:
  - Handling of peak flows;
  - Space of limitations at many sites;
  - Economics; and
  - The lack of adequate understanding as to causes in variations of leachate quality.

PHOTOGRAPHS 3 AND 4

RE: Discharge of effluents

Bunce (2001) (Coastal dry land sorts)

- Of the sites inspected Bunce stated that "the sites impact a variety of receiving environments ranging from, ecologically valuable, productive and sensitive estuaries to steep sided inlets with well-flushed foreshores having a lower ecological value".
- The report recommends diversion to less sensitive receiving environments. Further study is required to determine the possible impacts of these discharges.
- Of the 41 sites visited, runoff waters were sampled from 13. In total 16 samples were obtained (more than one discharge was sampled at three sites). Thirteen of 16 samples showed toxicity using the Microtox test. Bunce stated "in most cases the flows are low enough such that there is sufficient dilution in the receiving environment to prevent negative effects". He stressed that this is a preliminary observation based on limited data.
- Low pH's (4.6-5.3) were found in all effluents.

Konasewich, 2001 (Coastal dry land sorts and interior log storage yards)

- Data for effluent quality, particularly for wood leachates and toxicity, were minimal. Only three of 10 sites, known to the author, had any information on toxicity and wood leachate indicators such as concentrations of resin acids and, tannins and lignins. .
- Of the four coastal sites visited during 2001, none had any notice of regulatory concerns related to stormwater runoff quality from their facilities. All coastal dry land sorts were aware of litigation regarding stormwater quality at another dry land sort on Vancouver Island. Runoff from one of four Interior sites was controlled by a provincial permit.

RE: Refuse management

Bunce (2001) (Coastal dry land sorts)

- Wood waste was observed at the foreshore or diversion ditches at most sites.
- Lower impact ratings were provided to sites where wood waste was stored furthest from the foreshore.
- Subsequent processing of wood debris requires minimal contamination by dirt and rock. A greater volume and higher value recovery was achieved at paved DLS sites.
- Several systems were noted to be in place to extract higher value chips from waste. Others use wood wastes to reclaim logging roads and rock quarries.
- Relative to wood waste management, Bunce recommended that:

- Dry land sort operators should maintain a clean work site that minimizes the generation of wood waste and wood fines.
- Dry land sort operators should pursue alternatives for wood waste, such as increased use of soil conditioner for road reclamation where site conditions are appropriate or for use as organic material to reclaim denuded sites such as quarries, gravel pits and side cast areas.

Konasewich, 2001 (Coastal dry land sorts and interior log storage yards)

- Particularly for dry-land sorts, there is frustration with the lack of options for disposal of wood debris or “hog”. Although options such as bark mulch are used, the volumes of ”hog” generated are such that a more reliable disposal means is required (e.g., co-generation). Pulp and paper mill demands for “hog” in power boilers, are not consistent. The need for co-generation facilities was frequently mentioned by operators as a preferable option for disposal of wood waste.
- Log yards with unpaved surfaces are dependent upon the availability of landfills for disposal of wood debris. The wood debris is contaminated with

inorganic material (soil/gravel etc) and is thus unacceptable for use in power boilers.

- At Interior log yards, wood refuse with minimal soil contamination (e.g. during the winter period) is commonly used in power boilers. Pieces of broken logs are stored separately and may be chipped for use in power boilers or sold as firewood.
- Bark losses at log yards are particularly high during the spring when the sap content of the wood is very high. Interior yards also experience high losses of bark from trees that have been infested by beetles. Control of incidental losses of bark during the sorting and grading of such logs is be difficult.
- There is an effort to reduce the amount of wood handling at the log yards. Pre-sorting may have occurred (with respect to species and/or size) prior to arrival at the log yard. Sorting at the log yard may occur at an area where logs are unloaded, rather than additional movement to another area. The sorted wood is placed in bins, bundled and/or carried directly to appropriate storage areas by use of log loaders (such as a Wagner) that can carry the entire bundle without further separation of logs (**Photograph 5**).
- As mentioned previously, techniques to collect wood debris from paved surfaces without generation of fine material need to be developed.
- At one Interior log yard, bark is removed from the yard surfaces after each sort. Removal was found to be easier and in the long run less time-consuming than removal at monthly (or greater) intervals.

RE: Burning of wood waste

<u>Bunce (2001) (Coastal dry land sorts)</u>

- Open burning was conducted at 17 of the 41 sites inspected. . Eight of the 17 did not adequately remove fines (organic and inorganic) prior to ignition, resulting in low temperature combustion and poor emission quality.
- Paved DLS sites generate less inorganic fine material than unpaved sites, therefore open burns at paved DLS sites have better emissions.

- Fourteen of the seventeen sites where open burning occurred, gave no consideration to weather conditions prior to initiation of open burning, i.e., venting indices were not considered.
- Locations of some open burn sites in enclosed valleys may lead to the trapping of air emissions.

Konasewich, 2001 (Coastal dry land sorts and interior log storage yards)

- All Interior log yards visited had on-site boilers or teepee burners to dispose of wood refuse.
- Only one of four Interior log yards burned yard debris on a regular basis. Debris at the other yards was too soiled for burning except during the winter.

PHOTOGRAPH 5

RE: Landfills

<u>Bunce (2001) (Coastal dry land sorts)</u>

- Overall, compliance with regulatory requirements relating to refuse disposal was good. Failure to meet the landfill covering requirements was the most frequent deficiency (six sites).
- Better attention to landfill management practices was suggested to minimize leachate generation.

<u>Konasewich, 2001 (Interior log storage yards))</u>

- Landfills were essential components of log storage yards as places to dispose of soiled waste wood.
- Availability of a space for Interior landfills was much greater than for coastal dry land sorts.

RE: Petroleum product management

<u>Bunce (2001) (Coastal dry land sorts)</u>

- Sixteen of 41 sites were observed to have deficient containment for petroleum storage facilities.
- Commonly, undersized oil/water separators were installed.
- A large number of separators were found to be full of solids and overloaded with collected hydrocarbons.
- Peak flow rainfalls may not be accommodated in sizing of oil/water separators.
- There is acceptable awareness of spill reporting requirements. Only 5 of 41 DLS operators did not have spill contingency plans.
- Many facilities have proactive attention to petroleum product management, with many installations of double walled fuel storage tanks and built-in containment systems.

Konasewich, 2001 (Coastal dry land sorts and interior log storage yards)

- Fuelling facilities for sites visited were contained. Procedures for spill control and reporting were available.
- The Spill Reporting Regulation (B.C. Reg. 263/90) has caused operations to be cognitive of fuel and hydraulic fluid handling precautions. All eight facilities visited during this study have equipment and training for response to spills. **Photograph 6** provides an example of one fuelling facility.
- At two sites, spill kits were installed inside cabs of heavy duty equipment to enable rapid response to hydraulic line breakage.

RE: Special Waste Management

Bunce (2001) (Coastal dry land sorts)

- Hydrocarbon stained soils were noted at 21 sites.
- Non-compliance was associated with collection, storage or containment of special waste requirements of SWR.
- There was confusion at some sites with regard to classification of wastes. Special wastes are identified by Bunce as: antifreeze; oil filters and used oil containers with more than 3% oil (by weight); bilge water, and, waste paint and paint cans.

RE: Watering (Placement of sorted logs into water for transport)

Konasewich(2001) (Coastal dry land sorts)

- Hydraulic lines for bins should be protected and contained.
- Debris in vicinity of bins should be regularly cleaned.
- Bank stability and shoreline erosion control should be assured.

PHOTOGRAPH 6

6. EXISTING RECOMMENDED PRACTICES

Three documents have been developed in British Columbia with recommendations for design and operation of dry-land sorts and log yards. **Table 8** provides a brief overview of the recommendations.

Table 8: Overview of recommended practices for use in British Columbia

ASPECT	**ENVIRONMENT CANADA (1996)**	**CFLA (1997)**	**BC ENVIRONMENT (VANCOUVER ISLAND DIVISION) (2001)**
Runoff water	-surface runoff should be diverted from wood residue piles.		-should be directed away from active and temporary wood waste storage sites -treatment for solid and hydrocarbon removal -treatment should accommodate major storm events -discharge to less sensitive portions of receiving environment
Yard surfaces			-should enable efficient, effective and regular removal of wood waste -pavement suggested for high volume, large DLS sites
Wood waste reduction	-hydraulic debarkers should not be used unless effective treatment works are available.		-volume of potential wood waste transported to DLS should be minimized -recovery of wood waste should be undertaken where practicable. - recovery of wood waste for alternative uses such as chips, hog fuel, firewood, compost or as a soil conditioner is encouraged. -alternative uses for purposes such as plant mulch, soil conditioner, animal bedding is authorized subject to certain conditions.
Wood waste storage	-good housekeeping must be practiced with frequent removal of wood residues in areas of high generation. -a buffer strip is required between wood residue storage areas and water bodies.	-dry land sort debris should not be placed in bundles or introduced into the water and must be disposed of in an approved manner.	-regular removal of wood waste from high generation areas should be conducted -temporary storage areas should be as far from fish bearing and other sensitive receiving environments as possible.

	–base of wood waste pile must be minimal, i.e. cone shaped. -wood residue loading facilities should assure no wind blown deposits occur.	-foreshore must be clear of debris.	-the volume of wood waste in storage should be minimized.
Open burning			-adequate air supply systems should be utilized. -fines should be excluded as much as possible -frequency of burns should be minimal.
DLS landfills	-landfill should be sited, designed, operated and monitored in accordance to requirements in referenced document.		-should be sited to minimize impact on receiving environment -metal waste should be recycled as much as possible
Receiving environment			-all staff should be aware of environmental issues -new sites should take into account sensitive receiving environments. -existing sites should consider relocation of effluent discharges to less sensitive areas
Petroleum management			-all storage facilities must be equipped with complete spill containment. -maintenance areas must be located in impervious areas and include collection systems with oil/water separators
Special waste management			-all requirements of the special waste regulation should be met.
3 r's			Reduction, reuse and recycling is suggested.
Watering of logs		-logs to be watered must be well-limbed and clean. -bundled logs should be watered in defined alley ways. -bundle wires must be secured tightly around logs to prevent escape, breakage or excessive shifting of logs during all handling phases.	

7. CONCLUSIONS

Based on the information provided in this report, the following conclusions are prepared:

- There are a variety of environmental management practices at B.C. dry land sorts and log yards.
- There is a trend towards the formalization of environmental practices within the industry by use of internal audit procedures and by ISO 14000 certification.
- The issue of runoff quality is more prevalent at large dry land sorts and log yards that handle >300,000 m^3/year and have runoff more than 20 days per year. At some operations, such as those in the Interior, runoff issues would be minimal.
- The source of potential toxicity of log yard runoff waters is definitely associated with wood leachates. However all factors that result in increased or decreased toxicity are not understood.
- No operating practices or treatment systems have been defined that will assure continuous compliance of log yard runoff water with the 96-hr LC50 Rainbow trout bioassay test. Several operating practices to reduce possible environmental impacts have been defined.
- Many existing operations are at a disadvantage in the implementation of alternative design and operation practices, generally due to space limitations.
- Constraints to the application of treatment systems for runoff waters from log yards include the availability of reliable technology, space limitations and the associated costs.
- The actual environmental impact of runoff waters is site specific and studies known to date suggest the impacts may be minimal.

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