BRITISH COLUMBIA
MINISTRY OF WATER, LAND AND AIR PROTECTION - 2002

Environmental Indicator: Mitigating Environmental Impacts in British Columbia

Primary Indicator: ***Level of municipal wastewater treatment in British Columbia***

Selection and Use of Indicator: Wastewater treatment is a *response* indicator. It shows the management response to wastewater (also referred to as sewage) disposal in British Columbia. By volume, municipal sewage and combined sewer overflows are one of the largest point sources of pollution to Canadian waters. Wastewater not only consists of human waste, which can carry disease-causing pathogens, it also contains many other substances such as motor oil, paint thinner, antifreeze, pesticide residues, pharmaceuticals and solvents. The main sources of wastewater are households, industrial operations, commercial operations and storm water runoff. In Canada, 80% of marine pollution comes from terrestrial activities, including industrial and agricultural runoff (DFO, 1997).

Toxic pollutants found in sewage effluent can accumulate in fish and other aquatic organisms, working their way up the food chain to include humans. Some of the substances found in sewage are capable of affecting the endocrine systems of fish, birds, reptiles, amphibians and humans. The issue of ecological and human health effects that might result from pharmaceuticals and endocrine disruptors found in wastewater is a subject of ongoing research internationally.

Prior to discharging sewage to the environment, it is treated to remove some impurities and to reduce the biological oxygen demand (BOD) and total suspended solids (TSS). The purpose of wastewater treatment is primarily to protect human health and to reduce stress on the receiving environment. The level of treatment used by a municipality is an indicator of the amount of pollutants being discharged to the environment. It also indicates the sensitivity of the receiving environment because a higher treatment level is required if the receiving environment does not have sufficient purifying ability.

The level of wastewater treatment varies. Preliminary and primary treatment filter out solid material, secondary treatment removes much more fecal material, while tertiary treatment goes beyond this to remove target substances such as contaminants. With each increase in the level of treatment, the BOD and TSS are further reduced. This indicator shows the proportion of the municipal population with sewage treatment that is served by secondary or tertiary wastewater treatment.

Data and Sources:

Table 1. Population of British Columbia Served by Each Level of Waste Treatment Facilities.

Year	[1]Municipal Population with Treatment	Population with Preliminary	Population with Primary	Population with Secondary	Population with Tertiary
1983	1,990,863	142,113 (7%)	1,280,386(64%)	456,684(23%)	111,681 (6%)
1986	2,007,356	141,205 (7%)	1,307,796(65%)	456,418(23%)	101,937 (5%)
1989	2,264,064	159,210 (7%)	1,424,484(63%)	567,247(25%)	113,123 (5%)
1991	2,422,783	150,700 (6%)	1,519,909(63%)	586,332(24%)	165,842 (7%)
1994	2,626,018	162,651 (6%)	1,633,985(62%)	620,928(24%)	208,454 (8%)
1996	2,865,142	219,358 (8%)	1,764,508(62%)	658,175(23%)	223,101 (8%)
1999	2,986,973	201,770 (7%)	874,862(29%)	1,673,134(56%)	237,207 (8%)

[1] This value is the total population served by wastewater treatment facilities. The remaining population (approximately 20%) has on-site sewer systems regulated under the Ministry of Health.
Source: Environment Canada, Indicators and Assessment Branch, Municipal Water Use (MUD) data, 2000. BC Ministry of Water, Land and Air Protection, Pollution Prevention Branch, Summary of Municipal Treatment Facilities, Last updated February 2001.
NOTE: The percentage shown in brackets is the proportion of the municipal population with wastewater treatment that has preliminary, primary, secondary or tertiary treatment for that year.

During the reporting years shown, there has been little change in the population served by preliminary and tertiary treatment. The big shift in 1999 to secondary treatment is due to the upgrade of the Annacis Island Wastewater Treatment Plant from primary to secondary treatment. The plant serves approximately 850,000 people in fourteen GVRD communities before discharging to the Fraser River.

Methodology and Reliability: The data come from Environment Canada's Municipal Water Use Database (MUD) and (former) BC Ministry of Water, Land and Air Protection *Summary of Municipal Treatment Facilities*. Environment Canada's Indicator and Assessment Branch have corrected this version of MUD for problems with the original database. MUD lists a host of water and sewage data for all municipalities that have a population of 1,000 or greater. This includes the population served by primary, secondary (includes ponds and lagoons) and tertiary treatment. One problem with MUD is that it includes preliminary treatment under the primary category. It was considered important, however, to separate preliminary treatment from primary treatment because of the differences in impact on the receiving environment. Data on municipalities served by preliminary treatment were obtained from the BC Ministry of Water, Land and Air Protection *Summary of Municipal Treatment Facilities* or by contacting individual municipalities. Municipalities were also contacted if there were anomalies in the data and the data were corrected accordingly.

The specific definitions for treatment levels are as follows (Sierra Legal Defence Fund, 1999):

Preliminary: Also referred to as pre-treatment, this means that grit and solid material are screened out before the sewage receives further treatment or is released into the environment.

Primary: A physical process, in which the sewage is slowed down and the solids are separated from the liquids. Floatable solids, oil, and grease are usually skimmed off the surface of the wastewater.

Secondary: Also known as biological treatment, this follows primary treatment. It further reduces the amount of solids by fostering the consumption of organic material by organisms in the wastewater. Infiltration ponds and lagoons are included as secondary treatment.

Tertiary: Further treatment is used to reduce TSS and BOD. The particular technologies used in tertiary treatment depend on specific characteristics of the sewage. For example, some advanced forms of filtration can remove some metals, chemicals and other types of contaminants.

The data in the summary table and graph are derived by dividing the population served for each treatment type by the total population serviced by wastewater treatment and converting to percentage. The total population is an aggregation of all those served by preliminary, primary, secondary and tertiary treatment for all the listed municipalities. If a municipality did not have wastewater treatment data, the population of that community was not part of the calculation. These calculations were made for each of the survey years.

Because the indicator is a response indicator, it is subject to changes in management effort and policy. Another possible indicator for wastewater treatment is the amount of treated wastewater discharged (Average Daily Flow, or ADF) to the environment, however, the data were not suitable for separating ADF values by treatment type. There is only one ADF value for each municipality while there are several municipalities served by more than one sewage treatment plant using different levels of treatment. For this reason, population served by wastewater treatment has been selected as the indicator.

This indicator provides a relative trend as opposed to an absolute one. Since individual municipalities report to MUD, sometimes values are estimated or figures from a previous year's report will be carried over.

References:

DFO. 1997. Cited in: Commission for Environmental Cooperation. 2001. *The North American Mosaic: A State of the Environment Report*. pg. 47.

Environment Canada. 2000. Municipal Water Use (MUD) data. Ottawa: Indicators and Assessment Branch. http://www3.ec.gc.ca/MUD

BC Ministry of Water, Land and Air Protection. Last updated February 2001. *Summary of Municipal Treatment Facilities*. Victoria: Pollution Prevention Branch.

Sierra Legal Defence Fund. 1999. *The National Sewage Report Card (Number Two): Rating the Treatment Methods and Discharges of 21 Canadian Cities*. A Sierra Legal Defence Fund Report.

<u>Secondary Measure</u>: ***Across-Canada comparison of wastewater treatment.***

<u>Selection and Use of Indicator</u>: This indicator compares British Columbia's performance in wastewater treatment to the performance of other provinces and to the country as a whole. Looking at the population served by the different levels of wastewater treatment as a percentage of the provincial population allows for direct comparisons between provinces of different sizes.

<u>Data and Sources:</u>

Table 2. Wastewater Treatment Across Canada in 1999[1]

Jurisdiction	Population Served by Sewers	Population Served by Secondary	Percent served by Secondary	Population Served by Tertiary	Percent served by Tertiary	Percent served by Secondary or better
Saskatchewan	668,301	226,610	33.91	439,340	65.74	99.65
Alberta	2,278,310	484,274	21.26	1,778,760	78.07	99.33
Manitoba	811,334	797,242	98.26	0	0.00	98.26
Ontario	8,887,900	2,042,363	22.98	6,346,319	71.40	94.38
Canada	22,603,438	8,484,546	37.54	9,073,640	40.14	77.68
British Columbia	2,999,515	1,662,040	55.41	236,301	7.88	63.29
New Brunswick	393,085	243,713	62.00	0	0.00	62.00
Quebec	5,700,439	2,801,795	49.15	268,670	4.71	53.86
Nova Scotia	459,314	174,402	37.97	4,250	0.93	38.90
PEI	60,071	11,876	19.77	0	0.00	19.77
Newfoundland	345,169	40,231	11.66	0	0.00	11.66

Source: Environment Canada. Municipal Water Use Database. 2001.
[1] These data refer to the proportion of the total municipal population served by a municipal wastewater system.
Notes: Secondary treatment includes waste stabilization ponds. Insufficient data exist to adequately assess the degree of treatment in NWT, Yukon or Nunavut, therefore the data for Canada do not include the Territories. The MUD database is based on a survey of municipalities across Canada conducted every 3 years.

Table 3. Trends in Wastewater Treatment across Canada, 1983-1999

Jurisdiction	Treatment Type	Percent of Population Served by Each Treatment Type						
		1983	1986	1989	1991	1994	1996	1999
British Columbia	No treatment	0	1	1	0	0	0	0
	Preliminary	7	7	7	7	7	8	7
	Primary	65	65	63	63	62	62	30
	Secondary	23	22	24	23	23	22	55
	Tertiary	6	5	5	7	8	8	8
Alberta	No treatment	0	0	0	0	0	0	0
	Preliminary		0	0	0	0	0	0
	Primary	6	0	0	0	0	0	0
	Secondary	89	66	65	62	62	31	21
	Tertiary	4	34	35	37	37	68	78
Manitoba	No treatment	0	0	0	0	0	0	0
	Preliminary							
	Primary	3	3	2	2	2	2	2
	Secondary	97	97	98	98	98	98	98
	Tertiary	0	0	0	0	0	0	0

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Jurisdiction	Treatment Type	Percent of Population Served by Each Treatment Type						
		1983	1986	1989	1991	1994	1996	1999
New Brunswick	No treatment	29	29	30	8	10	8	9
	Preliminary							
	Primary	1	1	2	23	25	26	29
	Secondary	70	70	67	69	64	66	62
	Tertiary	1	1	1	0	1	0	0
Newfoundland	No treatment	83	82	81	84	83	83	80
	Preliminary							
	Primary	2	2	5	8	11	4	8
	Secondary	15	16	14	8	7	12	4
	Tertiary	0	0	0	0	0	0	0
Nova Scotia	No treatment	73	74	68	70	69	57	55
	Preliminary							
	Primary	0	0	0	1	1	6	6
	Secondary	25	24	32	29	31	36	38
	Tertiary	2	2	0	0	0	1	1
Ontario	No treatment	0	0	0	0	0	0	0
	Preliminary							
	Primary	14	13	15	13	6	6	6
	Secondary	18	19	18	14	16	18	23
	Tertiary	67	67	68	73	77	76	71
PEI	No treatment	0	0	2	0	0	0	3
	Preliminary							
	Primary	77	82	83	82	82	74	77
	Secondary	23	18	15	18	18	26	20
	Tertiary	0	0	0	0	0	0	0
Quebec	No treatment	88	88	59	44	16	12	3
	Preliminary							
	Primary	1	1	19	20	41	42	43
	Secondary	10	10	20	27	34	40	49
	Tertiary	0	0	2	9	10	7	5
Saskatchewan	No treatment	0	0	0	0	0	0	0
	Preliminary							
	Primary	33	35	36	35	36	5	0
	Secondary	32	29	29	30	28	59	34
	Tertiary	35	36	35	36	36	35	66

Source: Environment Canada. Municipal Water Use Database. 2001.
Notes: For all jurisdictions, except British Columbia, preliminary treatment is not separated from primary treatment data. To determine the proportion of the population served by preliminary and primary treatment, it would be necessary to contact each jurisdiction and possibly each municipality within each jurisdiction.

References:

Environment Canada. 2001. Municipal Water Use (MUD) data. Ottawa: Indicators and Assessment Branch. http://www.ec.gc.ca/water/mud/

Secondary Measure: ***Liquid manure storage capacity.***

Selection and Use of Indicator: In livestock operations, ability to manage livestock manures in an environmentally responsible manner is a key to environmental sustainability. Manure is a nutrient resource and can be used to provide all or part of the nutrient supply of growing crops, but inappropriate storage or use of manure can result in contamination of surface or groundwater.

Provisions under the Waste Management Act authorize farmers to use manure without a permit where it is used as a crop fertilizer or soil conditioner. A measure of environmentally responsible use of manure is the ability to store manure during the winter months when rainfall is heavy. This preserves the nutrients in the manure and prevents runoff of nutrients into surface and groundwater. In coastal BC, the months when manure should not be applied to land, are November, December and January.

One hundred days of storage capacity is considered a minimum to avoid manure applications to land during the 'no spread' months, while 150 days storage is recommended.

Data and Sources:

Table 4. Liquid Manure Storage Capacity in British Columbia, 1998

Farm Type	Storage Capacity (percent of BC farms)				
	<100 days	101-150 days	151-200 days	201-250 days	>250 days
Dairy	12%	47%	27%	9%	4%
Hog	15%	46%	24%	6%	9%

Source: State of Resources Report, Ministry of Agriculture, Food and Fisheries, 2002.

Methodology and Reliability: The data were collected for the State of Resources Report (2002) prepared by the BC Ministry of Agriculture, Food and Fisheries. Statistics Canada surveyed livestock producers by telephone in October/November of 1998, to collect baseline data on a range of farm activities, including manure and fertilizer management. The survey is to be repeated every three to five years.

Farms surveyed were those reporting gross returns greater than $25,000 in 1995 and operated by the same operator as in 1995. The dairy and hog farms that were surveyed were located in the Lower Fraser Valley. Data were received and used for analysis from 166 dairy farms and 37 hog farms.

References:

BC Ministry of Agriculture, Food and Fisheries. 2002. *State of Resources Report*. Resource Management Branch, Abbotsford, BC
http://www.agf.gov.bc.ca/resmgmt/SoR_Rep/SoR_Report.htm

Secondary Measure: ***Shellfish growing area sanitary closures.***

Selection and Use of Indicator: Bivalve shellfish (e.g., clams, mussels, scallops and oysters) are good indicators of the health of the marine environment because of their method of obtaining food. As filter feeders, bivalves pass large volumes of water through their bodies to remove suspended food particles. This can concentrate bacteria, viruses and toxic substances in their bodies.

Stringent standards are applied to waters in which shellfish are grown, and harvesting may be prohibited in certain areas due to sewage contamination or dangerous levels of toxins and pathogens, both natural and human produced. The presence of fecal coliform (FC) bacteria in the water is used as an indicator of the presence of human or animal wastes and the possible presence of disease causing organisms. Shellfish growing waters are considered polluted when the tests for fecal coliforms show that densities exceed a median of 14FC/100 mL (based on 15 data points). In comparison, the standard for drinking water is 0 FC/100 mL, while the swimming water standard is 200 FC/100mL.

Pollution sources that lead to sanitary closures of shellfish growing waters include urban run-off, sewage discharges (including defective foreshore sceptic systems and direct marine sewage discharge from boats) and agricultural drainage.

Data and Sources:

Table 5. Shellfish Growing Area Sanitary Closures for British Columbia

Year	Yearly Cumulative Total Closure Area (hectares)
pre-1976	58,107
pre-1990	75,945
1991	76,124
1992	77,485
1993	78,249
1994	98,569
1995	98,569
1996	100,376
1997	101,029
1998	102,749
1999	104,399

Source: Environmental Protection Branch, Environment Canada, Pacific and Yukon Region, 2000.

Methodology and Reliability: British Columbia has approximately 26,000 km of coastline. Along this coast, Environment Canada surveys 2,400 ha of shellfish aquaculture lease area and 750,000 ha of wild harvesting area. Survey results are presented to the Pacific Shellfish Classification Committee, which designates shellfish growing areas as either Approved, Conditionally Approved or Closed (classifications described below). Harvesting for any reason is prohibited within Closed areas.

Approved

- The area is not contaminated with fecal material, poisonous or deleterious substances or marine biotoxins to the extent that consumption of the shellfish might be hazardous.
- The median or geometric mean fecal coliform Most Probable Number (MPN) of the water does not exceed 14FC/100 mL using the five-tube, decimal dilution test (a standard fermentation technique involving culturing serial dilutions of water samples in test tubes of bacterial growth media)

Conditionally Approved

- During those time when harvesting is permitted, the area meets all of the requirements of an "Approved" area.
- Conditions that preclude harvesting in areas designated "Conditionally Approved" must be: easily identified by routine measurement and reporting; and predictable and/or controllable.

Closed

- The area is contaminated with fecal material, poisonous or deleterious substances to the extent that consumption of the shellfish might be hazardous.
- The median fecal coliform MPN of the water exceeds 14FC/100 mL, for five tube decimal dilution test.

References:

Environment Canada. 2001. Shellfish Closures. Pacific and Yukon Region Environmental Indicators. http://www.ecoinfo.ec.gc.ca/env_ind/region/shellfish/shellfish_e.cfm

Secondary Measure: ***Mitigation of metal leaching and acid rock drainage at mine sites.***

Selection and Use of Indicator: The location of mine sites with metal leaching and acid rock drainage (ML/ARD) issues is a *state* or *condition* indicator, because it identifies areas where there are potential risks to ecosystem health due to mining activities. ML/ARD is a matter of stewardship and is a provincial priority since mining is important economically, socially and environmentally for British Columbians.

ML/ARD are naturally occurring processes that can have significant negative impacts on the receiving environment if not adequately mitigated. The main cause for both is the exposure of elevated concentrations of sulphide minerals or their weathering products to the weathering effects of oxygen and water. Acidity is produced by the oxidation of sulphur and the hydrolysis of ferric iron in iron sulphide minerals. ARD occurs if these acidic compounds become dissolved in water and there are insufficient neutralizing minerals present. Elevated metal leaching is associated with ARD due to the high solubility of many metals under acidic conditions. Most metals are more soluble in acidic drainage, however, environmental impacts can occur from metal leaching under neutral or alkaline drainage conditions. This is especially the case for materials with elevated levels of arsenic, antimony, selenium, zinc or molybdenum.

Dissolved metals can be highly toxic and are more readily absorbed by living organisms than metals in their solid forms. Metals that are absorbed by plant and animal tissue (*bioaccumulation*) can be passed from one organism to another through the food web. Concentrations of metal contaminants in tissue increased with the trophic level in the food web (*biomagnification*).

ML/ARD is a concern at metal and coal mines because of the potentially high concentrations of sulphide minerals and trace metals. In addition, mining greatly increases the amount of rock surface exposed to oxygen and water. In North America, ML/ARD has caused significant ecological damage and resulted in multi-million-dollar cleanup costs for the mining industry and government. Once conditions conducive to ML/ARD have been created, significant environmental impacts can persist for hundreds of years and be very expensive to mitigate.

The causes of ML/ARD are not limited to mining; any human activity that disturbs mineralized materials can be a concern. For example, forestry road building has resulted in significant ML/ARD on northern Vancouver Island and the Queen Charlotte Islands, while the construction of the Okanagan connector highway resulted in ML/ARD impacts on the Pennask Creek fishery (in this case, a lime treatment plant was installed to remediate the effects).

There are many strategies for avoiding environmental impacts from ML/ARD. Key among these are:

- Flooding in a constructed impoundment, old mine workings, or from natural water bodies to limit the oxidation of reactive wastes.
- Use of soil and other engineered cover technologies to reduce the input of water and oxygen to mining wastes.
- Blending waste materials to create a benign composite.

Other practices that have proven beneficial in the mitigation of ML/ARD include:

- avoiding problematic materials;
- segregating waste;
- diverting upstream drainage;
- using lime amendments during processing;
- changing mine processing;
- selectively timing drainage discharge;
- locating facilities to assist drainage collection, minimizing leaching and maximizing natural dilution and attenuation; and
- various forms of drainage treatment.

Often sites use a combination of different mitigation strategies, either for the purpose of primary protection or as a backup for contingencies.

Mitigation has a number of challenges, including cost and the required longevity of the process. ML/ARD mitigation can be very expensive, with capital costs of more than $10 million and operating costs up to $1.5 million per year. Longevity is an issue since most mitigation measures must be designed, constructed and operated in a manner that allows them to perform indefinitely. Successful long-term operation requires conservative design criteria and comprehensive monitoring and maintenance. To be effective, the selected mitigation strategies must also be compatible with the mine site and its surrounding environment and land uses.

Another challenge in mitigation is the large number of factors to manage. Not only are there are a large number of processes controlling ML/ARD, but many of the most important processes, such as weathering, water movement and ecological changes, are in a state of flux as a result of the changes introduced by the mining. At most sites, the full extent and potential cost of ML/ARD mitigation is as yet unknown. Consequently, detailed monitoring, regular review and an adaptive management strategy are key components of successful ML/ARD mitigation.

Each mitigation strategy has associated strengths, limitations and monitoring and maintenance requirements. ML/ARD mitigation is relatively new and there are many uncertainties regarding future performance and maintenance requirements. For example, the long-term effectiveness of soil covers may be diminished by climatic extremes, erosion, freeze/thaw cycles, burrowing of animals, and roots of vegetation, whereas the long-term security of reactive wastes in a flooded impoundment depends on climatic factors and the ability to maintain a water retaining dam in perpetuity.

Flooding is the most common mitigation strategy at the newer mines, while the collection and treatment of drainage is the most common strategy at older properties. Chemical treatment of water to remove metals is an effective, yet costly, mitigation solution. Other drawbacks of collection and treatment include the detailed monitoring and maintenance requirements, alienation of much of the land on the site from alternate use and secondary waste production.

Proper planning of new mining developments can reduce the land alienation, environmental risks and costs associated with ML/ARD. In British Columbia, regulations for managing mine wastes are included in the BC *Waste Management Act* (administered by BC WLAP), BC *Mines Act* (administered by BC MEM) and federal *Fisheries Act* (administered by DFO). BC Ministry of Energy and Mines permits require that metal and coal mines predict the ML/ARD potential of all wastes produced and, where mitigation is necessary, provide reasonable assurance of environment protection and the costs of future mitigation. BC Ministry of Water, Land and Air Protection sets conditions for discharge to the environment and pollution abatement. Under BC's Waste Management Act, the Province can include previous owners of mines in a cleanup order.

Data and Sources:

Table 6. Mitigation Measures for One or More Component[1] at Permitted[2] Mines and Selected Sites in British Columbia.

Permitted Metal Mines with Acid Rock Drainage (ARD) Concerns	
Mitigation Measure Employed or Planned	**Mines**
Drainage Treatment	Bell, Equity Silver, Eskay Creek, Gibraltar, Granisle, Island Copper, Myra Falls, Premier, Samatosum, Sullivan
Underwater Disposal	Coast Copper, Equity Silver, Eskay Creek, Goldstream, Huckleberry, Kemess, Island Copper, Jedway, Johnny Mountain, Kitsault, Mount Polley, Myra Falls, Premier, QR Gold, Samatosum, Summit Lake, Snip, Tasu
Blending	Elk, Samatosum
Dry Covers	Equity Silver, Gibraltar, Myra Falls
Other Forms of Mitigation	Lawyers, Monteith Bay, Shasta, Texada
Further Assessment Required	Baker, Boss Mountain, Coast Copper, Dome Mountain, Endako, Equity Silver, Eskay Creek, Giant Nickel, Goldstream, Huckleberry, Island Copper, Jedway, Kitsault, Kemess, Lawyers, Monteith Bay, Myra Falls, Premier, Red Mountain (Rossland), Summit Lake, Snip, Taurus, Texada Trout Lake, Venus
Permitted Metal Mines with Neutral pH Drainage Concerns	
Drainage Treatment	Brenda, Nickel Plate
Underwater Disposal	HB, Pinchi Lake
Dry Covers	Candorado
Further Assessment Required	Candorado, Cassiar, Endako, Golden Bear, Highland Valley, Mount Polley, Pinchi Lake, Similco
Permitted Coal Mines with ARD Concerns	
Underwater Disposal	Quinsam
Blending	Quinsam, Quintette
Further Assessment Required	Quinsam, Tulameen
Permitted Coal Mines with Neutral pH Drainage Concerns	
Further Assessment Required	Fording River, Greenhills, Line Creek, Elkview, Coal Mountain
Selected Advanced Exploration and Historic Sites with ARD Concerns	
Drainage Treatment	Bluebell (for waste moved to Sullivan), Brittania, Tulsequah
Underwater Disposal	Anyox, Aurora-Guindon, Bluebell, Brittania, Mount Washington, Sulphurets
Dry Covers	Cirque
Diversion of Groundwater	Duthie
Further Assessment Required	Anyox, Duthie, Kutcho Creek, Mount Washington, Red Mountain (Stewart), Tulsequah

Source: Mines Branch, British Columbia Ministry of Energy and Mines. 2002.

[1] Waste rock, tailings, open pit or underground mine workings.

[2] Refers to a *British Columbia Mines Act* permit, approving work system and reclamation program at major mines.

Methodology and Reliability: The list of mines was derived from the site knowledge of experts at the Mines Branch, British Columbia Ministry of Energy and Mines (MEM), and is based on company reclamation reports and mine assessments by MEM.

Classifying mine sites according to their ML/ARD potential is a difficult undertaking at mine sites where there is no impact at present and considerable uncertainty regarding the potential for ML/ARD to cause impacts in the future. At other sites, only a small amount of waste rock, sections of underground workings or portions of pit walls produce acidic drainage and there is little impact on the downstream environment.

References:

Price, W.A., and J.C. Errington. 1998. *Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia*. BC Ministry of Energy and Mines. 86 pp. http://www.em.gov.bc.ca/Mining/MinePer/ardguide.htm

BC Ministry of Energy and Mines and BC Ministry of Environment, Lands and Parks. 1998. Policy for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia, July 1998. 17 pp. http://www.em.gov.bc.ca/Mining/MinePer/ardpolicy.htm

Secondary Measure: ***Amount of municipal solid waste disposed of and recycled per person in British Columbia.***

Selection and Use of Indicator: The annual amount of solid waste disposed of per capita is a *pressure* indicator; it shows the stress on the environment from human activities. The disposal of solid waste directly reflects consumption patterns and wasted resources. Although landfills are managed to mitigate impacts on the environment, there is still potential for contamination of groundwater, soil and air. In addition, landfills use large tracts of land, which in densely populated areas are becoming a rare commodity. Incinerators require less land but cause the depreciation of the surrounding land value due to lowered air quality.

Most importantly, disposal of municipal solid waste indicated wasted resources. Over-packaging is one example where energy is spent on material that is used briefly, then enters the waste stream. It is estimated that residential waste accounts for 45% of the municipal waste stream, with the remaining 55% coming from industrial, commercial, and institutional sources (BC MELP 1993).

In 1989, the Government of British Columbia established a goal for 2000 of reducing by 50% the per capita amount of municipal solid waste disposed of (as compared to 1990). In accordance with this target, the Government of British Columbia amended the *Waste Management Act*, requiring regional districts to submit Solid Waste Management Plans (SWMPs) to the then Ministry of Environment, Lands and Parks for approval by the Minister.

As of 1992, the *Waste Management Act* defines municipal solid waste (MSW) to mean (a) refuse that originates from residential, commercial, institutional, demolition, land clearing or construction sources, or (b) refuse specified by a manager to be included in waste management. The definition of MSW implicitly excludes sewage sludge, agricultural waste and industrial wood waste.

Data and Sources:

Table 7. Amount of Municipal Solid Waste Generated[1] in British Columbia (tonnes)

Year	Population	Total disposed to landfills and incinerators	Total recycled	Disposed per capita
1990	3,289,259	2,890,516	659,764	0.879
1996	3,880,593	2,448,741	1,363,721	0.641
1997	3,958,217	2,650,108	1,493,022	0.670
1998	3,996,030	2,423,524	1,771,813	0.606
1999	4,026,657	2,504,667	1,790,666	0.622
2000	4,062,270	2,509,112	1,837,381[2]	0.618

Sources: British Columbia Ministry of Water, Land and Air Protection. 2002. *Municipal Solid Waste Tracking Report, 2002*. Population statistics are from BC STATS.
[1] Generated = Disposed + Recycled.
[2] In 2000, material recycled through industry stewardship programs and provincial initiatives was included in the survey. This accounts for 8.9% by weight of the total amount of recyclables reported in BC.

Methodology and Reliability: The Municipal Solid Waste tracking program was established in 1990 by the then Ministry of Environment, Lands and Parks to monitor progress towards meeting British Columbia's MSW reduction goal. Each of BC's 27 regional districts was required to record and submit the amount of waste disposed and recycled in their districts. The data submitted by regional districts vary in accuracy; data collection depended on the number of staff available to record the information and the availability of scales near landfills and incinerators.

Waste disposal data are more accurate than recycling data, as most regional districts have the means to measure and record the amount of waste disposed of in municipal landfills or incinerators. Recycling data are *underestimated* in most, if not all, regional districts, which gives an underestimate of the total waste generated. The underestimation of recycling is a result of several factors, including: private recycling facilities that did not divulge the amount recycled; material trucked to recycling facilities outside the regional district's jurisdiction; and lack of information about waste recycled in the commercial and institutional sectors, which is often kept private by companies. The 1999 and 2000 data collection sheets were modified from previous years to include industry stewardship programs and provincial initiatives. Paints, residuals and beverage containers collected by Brewer's Distributor, Ltd. are not included in the stewardship program data because these programs use a volumetric unit (i.e., number of containers) that cannot easily be converted to weight.

From 1990 to 1995, regional districts that did not submit disposal reports were not included in the provincial total. In the 1996 report, missing data for regional districts were calculated using the population of the regional district and the provincial disposal rate for that year. This method was changed in the next report because it was more likely to overestimate the disposal rate of these regional districts, which were often rural and generated a small amount of waste. To improve accuracy in the 1997/98 and 1999 reports, the rate for any regional districts that did not submit a report was estimated by looking at trends from previous submissions along with the rates of regional districts with similar waste generation and demographic characteristics. In the 2000 report, calculations for the three regional districts that did not supply disposal data (their combined population totaled 1.5% of the provincial total) were based on the assumption that there was no change in the regional waste disposal rate between 1999 and 2000. Accordingly, the 1999 rate was multiplied by the 2000 population to give the 2000 waste generation rate.

This indicator is limited to one aspect of the waste stream: municipal waste. It does not address hazardous, bio-medical or other wastes that may be considered part of the larger waste stream generated at the societal or individual level.

References:

British Columbia Ministry of Water, Land and Air Protection. 2002. *Municipal Solid Waste Tracking Report, 2002*. Environmental Management Branch, Victoria, BC.

British Columbia Ministry of Environment, Lands and Parks. 1993. *Program for Participation: How British Columbia is managing solid waste.* Municipal Waste Reduction Branch, Environmental Protection Division, Victoria, BC.

Secondary Measure (not included in *Environmental Trends 2002* report) ***Geographic distribution of per capita disposal rates in British Columbia.***

Selection of Indicator: This indicator highlights the waste disposal behaviour of the average individual in different parts of the province, which means that this is a *response* indicator. The disposal rate is generally a function of the waste reduction plans put in place by each regional district, as well as the recycling facilities and programs available to residents in that regional district. Regional districts in areas with high population density are under the most pressure to reduce the per capita disposal rates of municipal solid waste. Areas with high populations generate a relatively large amount of solid waste per area, yet there is less land available to set aside as landfill for this waste. Thus, in these areas, regional districts have actively pursued recycling initiatives and education programs to reduce the per capita amount of waste generated.

The geographic distribution of waste is classified by ecoprovince, as defined within the ecological classification system commonly used in British Columbia (Demarchi 1993).

<u>Data and Sources</u>:

Table 8. Per Capita Municipal Solid Waste Disposal Rates, by Ecoprovince, 2000

Ecoprovince	Regional District	Disposed (tonnes)	Recycled (tonnes)	Population	Per Capita Disposal Rate (kg/person/yr)
Boreal Plains	Peace River	44,100	1,947	57,726	764
Boreal Plains Total		**44,100**	**1,947**	**57,726**	**764**
Central Interior	Bulkley-Nechako	26,964	3,866	44,204	610
Central Interior	Cariboo	26,466	No data	73,549	360
Central Interior Total		**53,430**	**na**	**117,753**	**970**
Coast & Mountains	Alberni-Clayoquot	17,358	1,202	34,000	511
Coast & Mountains	Central Coast	1,516	No data-	4,332	350
Coast & Mountains	Kitimat-Stikine	21,982	No data	46,870	469
Coast & Mountains	Mount Waddington	7,952	415	15,058	528
Coast & Mountains	Skeena-Queen Charlotte	13,800	1,269	25,514	541
Coast & Mountains	Squamish Lillooet	29,655	11,982	45,523	651
Coast & Mountains Total		**92,263**	**na**	**171,297**	**3,050**
Georgia Depression	Capital	136,654	93,310	334,940	408
Georgia Depression	Comox-Strathcona	40,588	9,176	105,439	463
Georgia Depression	Cowichan Valley	28,088	22,786	76,819	366
Georgia Depression	Fraser Valley	121,983	149,812	243,008	502
Georgia Depression	Greater Vancouver	1,433,383	1,198,861	2,011,035	713
Georgia Depression	Nanaimo	55,682	53,194	137,003	406
Georgia Depression	Powell River	5,283	3,482	21,060	251
Georgia Depression	Sunshine Coast	11,611	3,877	27, 438	423
Georgia Depression Total		**1,833,272**	**1,534,498**	**2,956,742**	**3,532**
Southern Interior	Central Okanagan	97,775	17,445	152,000	643
Southern Interior	North Okanagan	43,542	9,222	79,047	551
Southern Interior	Okanagan-Similkameen	84,921	No data	80,448	1,056
Southern Interior	Thompson-Nicola	75,747	69,044	130,192	582
Southern Interior	Kootenay Boundary	16,134	9,287	34,065	474
Southern Interior Total		**318,119**	**na**	**475,752**	**3,306**
Southern Interior Mtns	Central Kootenay	18,600	4,018	61,790	301
Southern Interior Mtns	Columbia Shuswap	21,623	7,203	52,973	408
Southern Interior Mtns	East Kootenay	44,677	12,347	56,366	718
Southern Interior Mountains Total		**84,900**	**23,568**	**171,129**	**1,427**

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Ecoprovince	Regional District	Disposed (tonnes)	Recycled (tonnes)	Population	Per Capita Disposal Rate (kg/person/yr)
Sub-Boreal Interior	Fraser-Fort George	76,027	13,108	106,933	711
Sub-Boreal Interior Total		**76,027**	**13,108**	**106,933**	**711**
Taiga Plains	Northern Rockies	7,000	2,000	6,434	1,088
Taiga Plains Total		**7,000**	**2,000**	**6,434**	**1,088**
Total British Columbia		**2,509,111**	**na**	**4,062,270[1]**	**618**

Source: British Columbia Ministry of Water, Land and Air Protection. 2002. *Municipal Solid Waste Tracking Report, 2000*.
[1] This population total is from BC STATS and does not equal the sum of the population figures in the rest of the table, which were provided by regional districts.

Methodology and Reliability: Data from this indicator were taken from the *Municipal Solid Waste Tracking Report 2000.* This reporting system was established in 1990 to track progress towards the goal of reducing the amount of waste disposed of per person. Each regional district reports on the amount of municipal solid waste that is sent to landfills or incinerated in the region.

For consistency with the other environmental indicators, the regional districts have been assigned to ecoprovince. In cases where a regional district is divided between two ecoprovince, the entire regional district is assigned to the ecoprovince in which the majority of the regional district's population is located.

Not all individuals in BC are represented by this data set. The Stikine region in north-eastern BC, which is part of the Northern Boreal Mountains ecoprovince, does not have regional district status and contains no municipalities. Therefore, no data from this region were collected.

References:

British Columbia Ministry Water, Land and Air Protection. 2002. *Municipal Solid Waste Tracking Report, 2000.* Victoria, BC.

Demarchi, D. 1993. *Ecoregions of British Columbia*. Ministry of Environment, Lands and Parks, Victoria, BC.

Secondary Measure: ***Waste oil received at Mohawk's North Vancouver re-refinery.***

Selection and Use of Indicator: Waste oil is defined in the *Special Waste Regulation* as lubricating oil, cutting oil, fuel oil, gear oil, hydraulic oil or any other refined petroleum-based oil or synthetic oil that has been contaminated or become unsuitable through use, storage or handling for its intended purpose. The definition also includes materials (such as soil, water, equipment, etc.) that contain greater than 3 percent oil by weight. These oil contaminated materials are not included in this indicator.

Waste oil is classified as a “special waste” in British Columbia and, as such, must be managed in a responsible manner in order to protect human health and the environment.

Mohawk Lubricants Limited operates a waste oil re-refinery in North Vancouver. Impurities contained in waste oil can be separated through the re-refining process. The result is recycled lubrication oil, which is a marketable product.

The following table shows the amount of waste oil originating in British Columbia that is recycled at the Mohawk Lubricants Limited re-refinery in North Vancouver.

Data and Sources:

Table 9. Waste Oil Received at Mohawk's North Vancouver Re-refinery from 1995 to 2000.

Year	Source and Quantity (litres) of Waste Oil		
	All of BC	Lower Mainland only	Vancouver Island only
1995	24,374,789	11,336,300	4,756,671
1996	27,552,164	12,039,757	6,382,318
1997	29,024,389	11,698,115	7,600,992
1998	28,128,755	10,930,458	8,098,356
1999	21,364,643	12,451,494	3,743,824
2000	30,441,562	16,451,345	8,230,891

Source: Environmental Management Branch. 2002. BC Ministry of Water, Land and Air Protection.
Note: Approximately 50-60 percent of waste oil collected in BC during 1999 and 2000 was re-fined.

Methodology and Reliability: This information represents all manifested shipments of waste oil from BC sources to Mohawk as recorded in the ministry's Special Waste Information System data base. Waste oil shipments received by Mohawk from Alberta and Washington State are not included in the table above.

References:

British Columbia Ministry of Environment, Lands and Parks. 1999. Vancouver Island used oil facilities improve compliance. Press Release: November 5, 1999.

Secondary Measure: ***Number of lead-acid battery units recycled.***

Selection and Use of Indicator: Lead-acid batteries must be disposed of correctly to avoid becoming a hazard in the communities in which they are deposited. Over time, batteries exposed to the elements slowly degrade, releasing lead into the ground and water sources. Lead accumulation in body tissue can be lethal, therefore it is important that lead-acid batteries and other household hazardous wastes are recycled or disposed of carefully. In the early 1990's, the Government of British Columbia developed a Product Stewardship strategy, which involved industry and consumers in taking responsibility for waste from products they produce or use. The lead-acid battery stewardship program was initiated in 1991. Stewardship programs initiated since that time are primarily funded and managed by industry. Other product examples include: pharmaceuticals; solvents, flammable liquids, poisonous domestic pesticides and gasoline; paint products; beverage containers; and scrap tires.

Data and Sources:

Table 10. Number of Lead-acid Battery Units Recycled in BC

Year	Battery Units Recycled
1991 (10 months)	589,362
1992	779,433
1993	747,120
1994	720,835
1995	668,716
1996	416,734
1997	520,374
1998	778,002
1999	799,055
2000	758,670

Source: Environmental Management Branch. 2002. BC Ministry of Water, Land and Air Protection.
Notes: Data are collected by fiscal year. Each year in the table represents the start date for the fiscal year (e.g., 1995 represents fiscal year 1995–96). With the exception of 1991, data were collected over the full 12 months of each fiscal year.

Methodology and Reliability: The BC Lead-Acid Battery Collection Program was established by the then Ministry of Environment, Lands and Parks in June 1991. It is an incentive-based program supported by a point-of-sale levy of $5 on new lead-acid batteries.

The program target is to "capture" all of the scrap lead-acid batteries generated each year and ensure that they are recycled, rather than being disposed of in landfill sites. The 1998–99 program capture rate was approximately 89 percent. It is important to note, however, that there is a commercial market for reconditioned batteries, so a large number of batteries that are returned are suitable for reconditioning and thus are not included in the capture data. This means that the actual capture rate is closer to 100 percent.

The data for this indicator were taken from the waste manifests submitted to the Battery Collection Program for processing and payment of incentives. While data inaccuracies could arise from entry errors or intentional misrepresentation, the risk of this is considered low.

Secondary Measure (not included in *Environmental Trends 2002* report) ***Number of contaminated sites remediated.***

Selection of Indicator: This indicator looks at progress in remediating (cleaning up) sites with existing contamination. Contaminated sites are locations where commercial or industrial activities have resulted in spills or the deposit of chemicals onto land. Toxic substances, such as PCBs (polychlorinated biphenyls), lead and cadmium, may remain in the soil, surface water or groundwater at levels posing a threat to human health, environmental health or underground services, such as telephone lines. These types of sites are considered contaminated if they are unsuitable for specific land or water uses.

The potential effects on humans range from minor physical symptoms to life threatening diseases, such as cancer. Children are often most at risk from exposure to contaminated soil, air, water and food. Even if a site does not pose a threat to humans, it can still have a significant negative impact on plants and animals living there. Contaminated sites can release substances that kill fish, impair the reproduction of birds and disrupt local food webs. Infrastructure impacts are also a concern and several instances of damage to underground services have been reported. In one case, corrosion of wire insulation by gasoline from a leaking underground tank caused street lighting to short circuit.

Heavy metals, such as lead, arsenic, cadmium and mercury, are common at contaminated sites in British Columbia. Organic chemicals, including benzene and toluene in gasoline, occur at about two-thirds of the sites. Chlorophenols were commonly used as wood preservatives at wood treatment operations and though their use has greatly diminished, historically contaminated sites remain. Benzo[a]pyrene and naphthalene from creosote are still common at wood treatment operations that produce pilings for docks and floats. Polychlorinated biphenyls (BCBs) often occur at sites where electrical equipment has been used.

Data and Source:

Table 11. Number of Contaminated Sites Remediated in British Columbia.

Year	Yearly Total	Cumulative total
1988	3	3
1989	19	22
1990	45	67
1991	57	124
1992	96	220
1993	106	326
1994	146	472
1995	118	590
1996	64	654
1997	88	742
1998	134	876
1999	164	1040
2000	152	1192

Source: Environmental Protection Branch, Ministry of Water, Air and Land Protection
Note: Year indicates the beginning of the fiscal year for which data were collected (e.g., 1988 represents fiscal year 1988/89).

Methodology and Reliability: Each data point represents a site that the Ministry of Water, Land and Air Protection has officially signed off on as being:

- cleaned up in accordance with Ministry standards or guidelines of the day, or
- reported as remediated to the Ministry by a site owner.

The data are entered into the Ministry's computer system by headquarters and regional ministry staff on a daily basis, as time allows. The data in the computer system are considered accurate, and have been checked several times. Some data on remediated sites may be missing because they have not yet been entered into the system, or because, before April 1, 1997, persons cleaning up sites independent of ministry involvement were not required to inform the ministry of their cleanup activities.

References:

British Columbia Ministry of Water, Land and Air Protection.. Nov. 1998. Fact sheets on contaminated sites No. 1: *Facts on Contaminated Sites: BC Environment's Contaminated Sites Program.* Can be accessed on the Internet at: http://wlapwww.gov.bc.ca/epd/epdpa/contam_sites/fact_sheets/1.html

British Columbia Ministry of Water, Land and Air Protection. Jan. 1997. Fact sheets on contaminated sites No. 2: *Facts on Contaminated Sites: Why Clean Them Up?* Can be accessed on the Internet at: http://wlapwww.gov.bc.ca/epd/epdpa/contam_sites/fact_sheets/2.html