basin is improved. A natural regime is needed to maximize the available fish habitat for various species, and to maintain the ecological integrity of the lake. It should take precedence over other factors if the ecological integrity of the lake is to be maintained. Attempts to control the water level at a single elevation should be abandoned. The resulting damage to fish passage to and from Wabamun Creek is in contravention of the Fisheries Act. No single level will satisfy all area residents in any case.

Wabamun Creek should be restored to provide fish passage and effective fish habitat in years when water levels are high enough to create outflow. This would also allow the stream to serve as periodic spawning and rearing habitat for fish.

Thermal Effluents

The heated discharge water from the Wabamun Power Plant has been a source of controversy since the plant was built in 1956. The plant effluent enters the lake directly, at temperatures that are about 10 °C above lake temperatures in summer, peaking at about 30 °C in August. In winter the average effluent temperature is about 15 °C above lake temperature, and occasionally as high as 24 °C (Golder Associates 1997). About 5% of the total lake area does not meet the Alberta Surface Water Quality Guidelines (Alberta Environment 1999) which recommends a temperature difference no greater than 3 °C from background to protect aquatic life. In winter, an area of 1.2 to 5.4 km^2 has been kept open by the warm water discharge, representing 1.5 % to 7% of the lake's area. Although the abundance of *Elodea* initially increased as a result of thermal discharge, the species has since declined. The total amount of aquatic plant growth has not increased because of the thermal discharge, however, the distribution and degree of dominance of certain plant species (chiefly *Chara* and *Myriophyllum)* is affected in portions of Kapasiwin Bay (Golder Associates 1999). More detailed information on the impacts of the heated effluent can be found in Beak Consultants Limited (1980) and Golder Associates (1999). The heated effluent will disappear with the decommissioning of the Wabamun Power Plant, so we do not discuss it in detail here, although various effects are mentioned later in discussion of effects on the fisheries of the lake. It should, however, be noted that with the disappearance of the thermal plume, Kapasiwin Bay will freeze completely for the first time in almost half a century. The heated effluent from the Sundance Power Plant is cooled in a cooling pond and does not influence the lake temperature. The temperature of treated water discharged to the lake by the WLWTP is within 3° C of the lake temperature.

Recommendation
With the decommissioning of the Wabamun Power Plant, the heated effluent will disappear. We recommend that a study of Kapasiwin Bay be done to assess the possibility that oxygen depletion under winter ice might occur after the heated effluent disappears. This oxygen depletion may lead to increased release of phosphorus from sediments. Conditions in the lake have changed substantially since the power plant was installed

The Ash Lagoon

The Wabamun Power Plant also has an ash lagoon system, that collects stormwater from the site, wastewater from the facility, ash slurry resulting from coal burning, and drainage from the Whitewood Mine. Effluent is discharged to Lake Wabamun. The discharge sometimes has had a murky appearance, which has elicited public complaints. In a mass-balance study of lagoon inputs and outputs, Golder Associates (2003) found that the lagoon system removed 100% of incoming suspended solids, and over 90% of incoming aluminum, lead, beryllium, cobalt, iron, lead, manganese, silver and titanium. It also removed over 50% of several other trace metals. Its efficiency was lower for arsenic, boron, mercury, molybdenum, selenium and thallium. The discharge has caused levels of some metals to be slightly elevated in Lake Wabamun, particularly in sediments near the outfall from the ash lagoon. Implications are discussed later in the section on metals. Recommendations are made in that section.

Dredging

Recently, dredging has been proposed as an alternative to raising lake levels. It was proposed that dredging certain areas of Lake Wabamun could result in improved navigation, lake circulation and recreational opportunities. An area near the eastern shore of Moonlight Bay was selected as a trial site. It was proposed that removal of 6250 m^3 of sediments would increase an area near shore from 0.6 to 1.1 m in depth, improving navigation. Most effects were estimated to be short-term and local. However, potential damage to fish rearing and spawning habitat could be long-term (Ecomark 2004). It was estimated that several additional studies would be needed in order to consider approval of a pilot dredging permit, including ecological surveys of fish, benthic invertebrates and macrophytes, fish habitat, sediment dewatering, disposal siting and design, fish habitat mitigation plans, and active water quality monitoring during construction.

Recommendation
Given the high costs of dredging, the minimal advantages, and the probability of further damaging a fishery that has already been severely compromised (see below), we recommend not dredging.

Eutrophication

There are no consistent monitoring records for nutrients in Lake Wabamun before the 1980s. However, Hickman et al. (1984) studied the paleoecological record of algal pigments and diatom fossils in lake sediments, establishing that Cyanobacteria (bluegreen algae) have been present throughout the Holocene, and that the lake has varied considerably in productivity and algal composition in the distant past. More recent paleoecological records indicate that for the past century the lake has slowly become more eutrophic, as shown by increasing phosphorus fluxes and changes in diatom species from those indicative of mesotrophic conditions to those indicative of eutrophy.

In the 20th century, sediment records suggest a slow increase in annual phosphorus flux to sediments, generally regarded as an indication that the lake is becoming more eutrophic. The increase is similar to that in other central Alberta lakes that have been subjected to changes in land-use and cottage development (Figure 4). The profiles show accelerated phosphorus deposition in very recent times, but these are not reflected in the contemporary water monitoring record, and it is probable that higher sedimentation rates may be the result of higher concentrations of calcium carbonate caused by evaporation, as discussed below.

After 1980, Wabamun has the most comprehensive monitoring record of any Alberta lake. This record has been recently summarized by Casey (2003a) and Agbeti (2002). There is no evidence in the monitoring record for increasing eutrophication in the past 20 years, either in the form of increased nutrient concentrations or in changes in algal species. In fact, there is a slight suggestion that phosphorus concentrations have decreased since 1998, when the WLWTP began operating. The lake would currently be considered to be highly mesotrophic or slightly eutrophic.

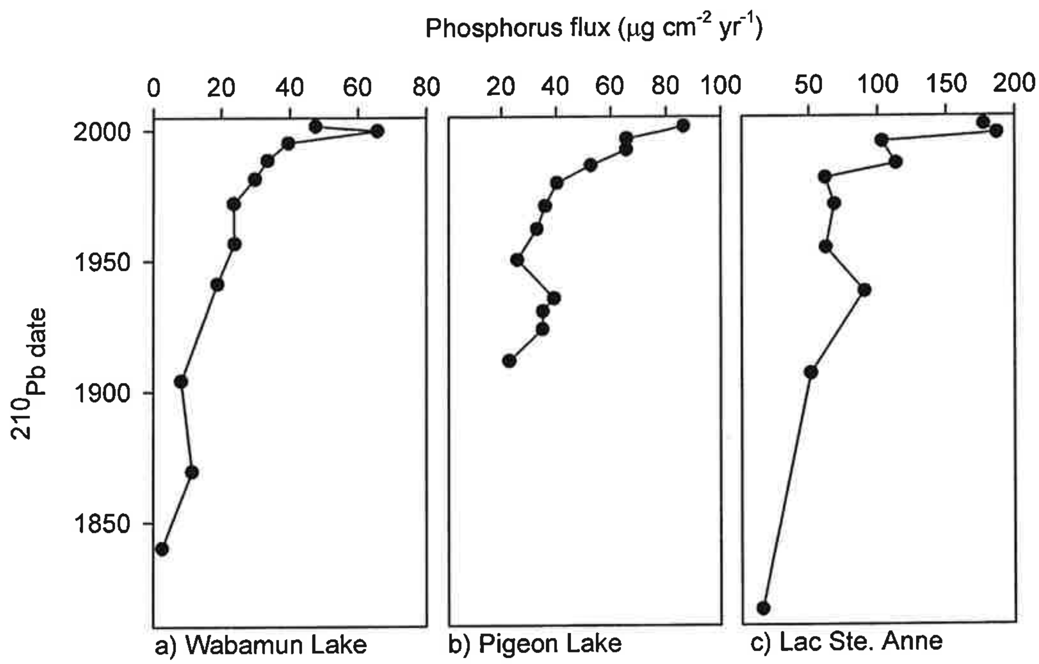


Figure 4. Annual phosphorus flux to the sediments of Lake Wabamun and two other central Alberta lakes that have had land-use changes and cottage development. D. W. Schindler and J. Brzustowski (unpublished data).

Table 2. The present trophic state of Lake Wabamun as compared to "textbook" values.

	Mesotrophic (From Wetzel, 1983)	Eutrophic range	Wabamun in late 90s
TP (µg/L)	11 – 96	16 – 386	30 – 38
Chl a (µg/L)	3 – 11	3 – 78	< 12
Secchi (m)	1.5 – 8.1	0.8 – 7.0	~ 2

TP is total phosphorus concentration. Chl a is the concentration of chlorophyll-*a*, the primary photosynthetic pigment in algae, commonly used as a measure of algal abundance. Secchi is the depth at which a white plate (called a Secchi disk for its inventor) can be seen when lowered into the water on a rope. It is a rough measure of water clarity.

Water from the WLWTP is very low in phosphorus, probably because of efficient flocculation when alum is added during the treatment process. Concentrations in treated water discharged to Lake Wabamun are less than 5 µg/L, similar to values for pristine alpine ecosystems. However, the volume of water replaced each year by the WLWTP is too low for the declining phosphorus in the lake to result entirely from dilution by the WLWTP effluent. It is also unlikely that the phosphorus concentration in runoff from the basin has decreased, because of increased agricultural activity, or that a decline in lake phosphorus is linked to reduced loading due to recent drought conditions, because similar declines are not observed in nearby lakes. More likely, co-precipitation of phosphorus with calcite, which is formed in the water during periods of high productivity as photosynthesizing plants remove carbon dioxide may be partially responsible. Such "whitings" are common in productive lakes in calcareous geological settings. The waters of Wabamun are supersaturated for calcium and carbonate in midsummer, and calcium concentrations have decreased in recent years (Casey 2003a).

There are several likely sources of the increased nutrients observed in cores during the earlier part of the 20th century. Firstly, land use changes, from forests to agricultural land, residential areas, industrial sites and golf courses are well known to increase the runoff of nutrients from watersheds (Dillon and Kirchner 1975, Wetzel 1983). Secondly, a large number of cottages were constructed on the lake, many with septic tanks. Studies in other lakes indicate that septic tanks are often poorly placed, poorly installed, or inadequately maintained, frequently leaking nutrients into lakes. Other common nutrient sources from cottage development are lawn fertilizers, pet excrement, and silt from construction. Four sewage-handling facilities are regulated by Alberta Environment. The town of Wabamun discharges once a year to a creek in the Lac Ste Anne watershed. The summer village of Seba Beach has no discharge. The Sundance power plant discharges to its cooling pond, and the Wabamun Provincial Park discharges to a slough in the Lake Wabamun watershed.

In addition, slowing of water renewal generally causes an increase in lake eutrophication (Vollenweider 1976, Dillon and Rigler 1974, Schindler et al. 1978). The lack of outflow since 1992 indicates that no phosphorus would have been flushed from the lake. The build-up of phosphorus in lake sediments often causes increased release to the water column, generally known as "internal loading." A budget constructed from 1980 and 1981 data indicated that internal loading (sediment release) accounted for 56% of the total phosphorus input to the lake in those years (Figure 5).

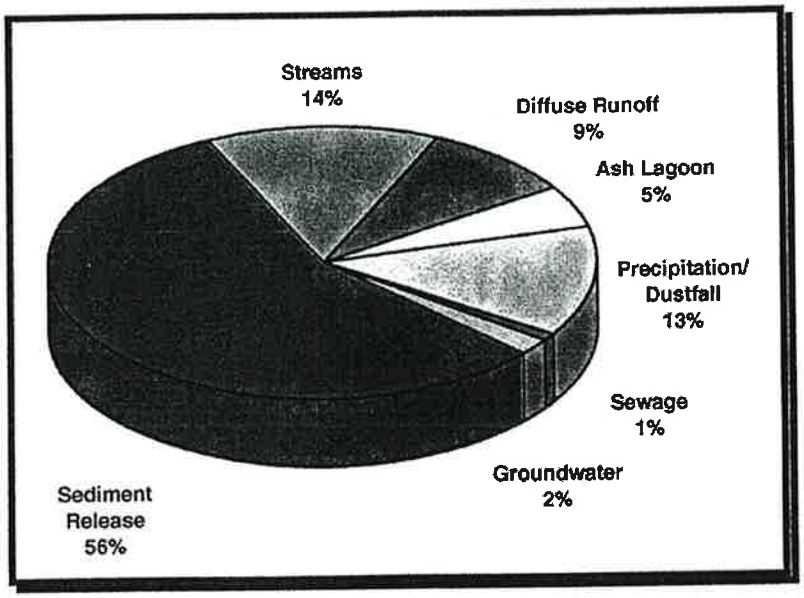


Figure 5. Total phosphorus loading to Wabamun Lake (1980 and 1981). From Golder (1997)- Data are from Mitchell (1985).

Lake Wabamun has ideal conditions for internal loading. It is shallow and windswept, and thermal stratification in summer is weak and transient. Monitoring records indicate that thermoclines form only during still periods on warm summer days. When thermoclines are present, oxygen becomes depleted (anoxia) in near-bottom waters. Phosphorus release from lake sediments is typically high under anoxic conditions. The repeated formation and destruction of stratified conditions (polymixis) promotes algal blooms, because mixing replenishes nutrients to the upper, euphotic zone where algal growth occurs.

A nutrient budget for the lake (Mitchell 1985) indicates that by the early 1980s, Lake Wabamun already has moderate internal loading in midsummer, and to a lesser extent, under winter ice. Internal loading of this magnitude is common in mid-Alberta lakes. It is exacerbated by cottage development and land-use change.

When internal loading becomes large enough to promote large blooms of bluegreen algae (Cyanobacteria), the recovery of a lake becomes difficult. Many European lakes have been studied following reduction in nutrient sources after years of loading. The mean recovery time is about 15 years, but is quite variable (Sondergaard et al. 2000). Because removing internal nutrient sources is an extremely costly and difficult proposition, it would be best to strictly manage the external loading into Lake Wabamun to prevent the lake from becoming more eutrophic than it is at present.

Recommendations:
Because recovery of lakes with high internal loading from eutrophication is difficult, costly and time consuming (decades), all efforts should be made to keep the future inputs of plant nutrients to Lake Wabamun from increasing. Measures should include diversion of all sewage effluents away from the lake, whether they are treated or not. Similarly, storm runoff from urban areas should be prevented from entering the lake. Septic tanks should be replaced with pump-out systems or composting toilets. Fertilizer use on lawns, gardens, and golf courses in the basin should be discouraged. Reclamation of mined land should be to forests, rather than farmland, and fertilizer applied to existing farmland should be strictly regulated. Wetlands and riparian areas in the catchment of the lake should be restored, with emphasis placed on intercepting runoff from agricultural and urban areas.

A study of the potential effects of renewed ice cover in Kapasiwin Bay upon decommissioning of the Wabamun Power Plant should be conducted to evaluate the likelihood for increased phosphorus release from sediments, which might trigger noxious blue-green algal blooms

Other Chemical Considerations

In the period 1982 to 2001, chloride increased by 163%, sulfate by 76% and sodium by 51% (Casey 2003a). Much of the increase occurred after 1992. In contrast, calcium declined, possibly as the result of calcite precipitation, as described later. This precipitation is common in productive prairie lakes, and is why Lake Wabamun is dominated by sodium carbonate rather than calcium carbonate, which is less soluble. If lack of outflow and continuation of chemically treated water from the WLWTP continue, eventually, the lake will be transformed from a sodium bicarbonate lake to one dominated by sodium sulfate, more typical of closed basin lakes in central Saskatchewan. This process will occur very slowly, and while sensitive species of plankton may begin to change, there are no short-term effects expected for fishes.

The rapid increases in sulfate, sodium and chloride of the lake are in part the result of massive amounts of alum and chlorine added as part of the water treatment process, to keep alien species from entering the lake. Furthermore, the Sundance cooling pond, which supplies the treatment plant with source water, has a higher total dissolved solids concentration than the lake. Evaporation, in a system with little outflow, would also contribute to the increases, as discussed above. Chemical additions in water treatment should be kept as low as possible to minimize the increase in conservative ions in the lake, while ensuring that the plant is effective at biological removal. At present, the cost of added chemicals is $2.5 million per year.

Recommendation
If long-term use of the WLWTP is contemplated, the treatment process should be periodically reviewed to determine if chemical additions can be reduced without compromising the plant's effectiveness as a biological "filter." In the long-term, the combination of reduced chemical use at the WLWTP and the measures suggested in the Lake Level and Outflow Regulation section should help to slow the rate of chemical change.

Fisheries

Fishing pressure

Lake Wabamun appears to have been heavily fished since the mid-19th century, when the mission at Lac Ste. Anne is thought to have exploited the fisheries of nearby lakes for food, and to supply customers in Edmonton. Through the latter half of the 20th century, the fishery at Lake Wabamun has attracted huge numbers of sport fishermen. During the 1980s, annual angler effort was 150,000 to 200,000 angler-days. With declining fishing quality, angling effort has also decreased, with approximately 65,000 angler-days on Lake Wabamun during 2001. The commercial fishery has been one of Alberta's largest, in both number of fishermen and amount of fish harvested. In peak years, up to 200 km of gill-nets have been set in Lake Wabamun, with annual harvests often exceeding 100 tonnes of lake whitefish. This commercial fishery has also declined with declining fish stocks, and has been closed for conservation reasons since 2003. The First Nations food fishery (primarily gill-netting by members of the Paul Band) has declined since the early 1990s, likely because of declines in the abundance of whitefish and reductions in the perceived quality of the fish for consumption (Stephen Spencer, personal communication).

The population of walleye in the lake was never large in the 20th century, and the native stock of walleye has now been extirpated, likely as a result of overexploitation by commercial and sport fishing. Extensive efforts to restock the species by Alberta Fish and Wildlife have failed. Continued heavy angling pressure (i.e., a popular walleye sport fishery quickly developed and hooking injuries were commonly observed on sampled walleye), as well as habitat changes because of power plant effluent (i.e. spawning walleye were captured during March in the warm Wabamun Power Plant effluent, approximately 6 weeks earlier than in other area lakes. This may have contributed to the failure of re-establishing walleye in Lake Wabamun.

The northern pike population shows clear signs of over-exploitation. Pike mortality is estimated at 78% per year, far beyond what is sustainable by recruitment and growth. Few fish reach an age of 6 years or a length of over 50 cm. As a result, few fish are large enough to reproduce. In contrast, lightly fished lakes have northern pike of many age classes up to 15 years or more, with large individuals reaching lengths of a meter or more. Although the sport harvest of this species has recently been severely restricted with the imposition of large size limits, the illegal harvest of undersize pike continues to be a significant problem (Patterson 2002). Prior to the closure of the commercial fishery, a large number of northern pike were incidentally taken during the targeted lake whitefish harvest. This incidental commercial harvest typically impacts large, older pike that make up the breeding population and are critical to recovering the population.

Lake whitefish, once supporting the largest commercial and sport whitefish fishery in Alberta, have not adequately reproduced in the past seven years, as evidenced by the lack of young fish caught in test nets. The commercial fishery for whitefish has been temporarily closed to allow the few surviving whitefish to spawn as many times as possible and thereby increase the chances of successful reproduction and recovery of this population.

Yellow perch in the lake do not reach a large enough size to support either a sport or commercial fishery. This size structure is typical of other yellow perch populations in large, eutrophic lakes in central Alberta, such as Lac Ste. Anne and Pigeon Lake.

Changes to fish habitat
Fish habitat has been compromised. As noted earlier, the modifications to the outlet stream and the lowering of lake level have reduced fish habitat, and conversion of shorelines to lawns and beaches has caused an undocumented and therefore unknown loss of shoreline habitat. The transformation of about 300 acres of Goosequill Bay into the Sundance cooling pond also destroyed critical fish habitat. Power plant intakes have affected fish habitat by creating the possibility of fish being "impinged" on intake screens as they attempt to use the habitat near and inside the intake canals. Power plant outflows have affected fish habitat by altering lake temperature and dissolved gas concentrations (see below for further discussion of these issues).

Widespread but undocumented habitat loss along much of the Lake Wabamun shoreline has been caused by cottagers illegally removing fallen trees and weedbeds that are known to be critical habitat for fish. Studies elsewhere indicate that such removals lower fish populations in proportion to habitat availability (Schindler and Scheuerell 2002). Overall, the fish habitat of Lake Wabamun requires drastic protective and restorative action.

Industry-related fish mortalities
While there have been a number of industrially-related causes of fish mortalities, these have not been reflected in the allocation or management of the fisheries of Lake Wabamun.

Throughout the period of TransAlta's operations in the Lake Wabamun area, there have been fish kills that have occurred as result of either normal operating conditions, or plant upsets. TransAlta has been diligent in their attempts to reduce or eliminate these occurrences, however, periodic fish kills still occur. More details are given in Appendix 1.

In February 1973, an unplanned outage at the Sundance power plant (which at that time used the lake as a source of cooling water) caused a rapid temperature decline that resulted in a fish kill due to "cold shock" in the outlet canal of the Sundance power plant. It was estimated that 250 northern pike and 250,000 spottail shiners were killed (Ash et al. 1974). Subsequent to this event, the Sundance cooling pond was constructed and the Sundance plant ceased discharge of cooling water to the lake in 1975.

Fish kills due to thermal stress and gas bubble trauma have also been a periodic occurrence (Golder Associates 1999). These kills have been relatively small in size (limited to less than 100 fish at a time), and have been mostly limited to fish in or near the cooling water outlet canal at the Wabamun power plant. These mortalities have been reduced in recent years by the installation of aerators to reduce gas tension and screens to prevent entry of larger fish into the Wabamun power plant cooling water outlet canal.

Over the fall of 2001 and spring of 2002, the largest documented industrial-related fish kill occurred at Wabamun Lake, involving a combined number of about 3000 lake whitefish, northern pike, and other species. In October 2001, large numbers of dead fish were first noted on the inlet screens of the Wabamun power plant, and a major study was undertaken examine this phenomenon. The primary fish species caught on the screen in the October 2001-Feb 2002 period were lake whitefish with other species such as northern pike and burbot also present, but in far fewer numbers. By March 2002, only a few fish were found on the inlet screens. However, in April of 2002, coincident with their spawning run, northern pike began appearing on the inlet screens in large numbers. This resulted in a large scale fish kill of northern pike in April-May 2002. This pattern was repeated in autumn 2002, but to a lesser extent. After a number of studies were completed, it was deduced that the fish were entering the inlet canal and becoming trapped on the inlet screens of the power plant. There was no indication of toxicity in the fish prior to impingement on the screens. No definitive cause for the behaviour could be determined. However, the behaviour in both northern pike and lake whitefish was coincident with spawning times, leading to the current theory that both species were looking for suitable habitat for reproduction.

TransAlta was proactive in trying to resolve the fish kill problems including 24 hour monitoring of the inlet screens during periods when fish were being trapped on the screens, modifying the inlet screens to reduce fish mortalities, implementing behavioural modification devices such as acoustic and visual deterrents on the inlet screens to keep the fish away and constructing a fish release runway for those fish that did become impinged on the inlet screen. These improvements have reduced the mortalities of fish on the inlet screens to relatively low levels, but have not totally eliminated the problem of industry-related fish kills.

Weed harvesting in Kapasiwin Bay results in the loss of approximately 16,500 fish/year, largely small-bodied fish such as spottail shiner, brook stickleback and Iowa darter (Golder Associates 2000). It is unlikely that weed harvesting is a significant direct source of mortality for these species, although it would remove fish habitat. More details of industry-related fish mortalities are included in Appendix 1.

Recommendations
Industry-related fish mortalities must be taken into account within the management plan for the fishery resource in Wabamun Lake.

The commercial fishing of Lake Wabamun should be ended permanently. Sport fishing should continue to be severely restricted until a natural range of age classes can develop for each target species. Efforts to reduce industry-caused habitat loss and mortality must be continued and industry-related fish mortalities should be included in fisheries management decisions. Existing federal and provincial laws protecting fish habitat should be enforced and illegally destroyed habitat should be restored, including riparian and shoreline areas with cottages. Once the fishery has recovered, it should be cautiously managed to ensure that harvest is no more than annual recruitment, and that a natural age structure is maintained in fish populations.

Any future attempts to reintroduce walleye should be accompanied by total closure to angling of any areas of the lake where walleye congregate until several year classes are established.

Invasive alien species will become more important in the years ahead, for a number of reasons. Voucher specimens of fishes and other organisms that are not easily identified should be kept, and identified by a competent taxonomist to ensure that invasion by alien species is detected early. Regular monitoring for alien species should occur.

Other Organisms

Bottom dwelling animals

Rasmussen (1979) studied the benthic (bottom living) fauna of Lake Wabamun in 1972-1975. He identified nearly 200 taxa of benthic invertebrates, dominated by midges (Chironomini). The number of taxa in the vicinity of heated effluents was similar to in the main body of the lake, although there was a slight switch in taxonomic composition to species associated with aquatic plants.

A November 2002 (Stantec 2003) survey revealed 128 benthic taxa from Lake Wabamun. This result cannot be compared with Rasmussen's because of the lack of seasonal data. Rasmussen also performed more detailed taxonomic analysis, particularly of the Chironomini. Both studies revealed a wide variety of aquatic taxa, including various insect groups (mayflies, caddisflies, true flies, damselflies, midges, beetles, water boatmen, aquatic moths, dragon flies, damselflies), but mites, crustacean, aquatic earthworms, leeches, roundworms, snails, clams, planarians and flatworms, hydras and water bears were also found. The effect of effluent from the ash lagoon was assessed in the 2002 study. A slight difference in invertebrate community composition was shown in the lake between and area near the ash lagoon outfall and a reference location to the west. The difference appears to be a response to mild enrichment, rather than toxicity from the outfall. A slight difference was also noted when comparing invertebrate community composition near the WLWTP outfall with that at a reference location, likely due to the nature of the lake bottom or the influence of treated water.

Zooplankton

Agbeti (2002) analyzed trends in monthly zooplankton data for the open water period in the years 1980, 1988, 1990, 1992 and 1994-2001. There was no evidence of either changes in seasonal patterns, except for a sharp decrease in the abundance of large-bodied crustaceans in 1992. This corresponded with an increase in lake whitefish populations. The populations of large crustaceans have since returned to more typical levels.

Fecal coliform bacteria

In the past there have been periodic beach closures because of concentrations of fecal coliform bacteria in excess of CCME contact recreation guidelines of 200 colonies/100mL of lake water (CCME 2001a). In response to this situation, the Edmonton Capital Health Authority undertook a study in summer of 2004. It involved seasonal surveys of a number of beaches (i.e., Camp YoWoChAs, Fallis, Moonlight Bay Church Camp, Seba, Wabamun Provincial Park, and Village of Wabamun). In general, most water samples had satisfactory fecal coliform counts. However, increases in bacterial counts were noted following rainfall and storm water runoff from land adjacent to the beaches, or following windy periods when lake sediment was re-suspended and lake water became turbid. Beaches that had high numbers of birds in the water, along the shore and on adjacent land often had high fecal coliform counts.

The Capital Health study concluded that the fecal coliform problem at Lake Wabamun is probably caused at least in part by large numbers of birds that use the lake. Some beaches in protected areas away from the main circulation of the lake also tend to have higher fecal coliform counts. There have also been reports of cattle grazing near some of the inlet streams to Lake Wabamun.

Recommendation
Several biomonitoring programs are ongoing (e.g., zooplankton, phytoplankton, fish). These provide an invaluable tool for assessing changes to the aquatic communities as the result of several types of impacts. Their design and suitability for long-term trend assessments need to be reviewed. These programs need to be carried out on an ongoing basis. The need and practicality to incorporate other ecosystem components (benthic invertebrates, macrophytes) needs to be evaluated and, if deemed necessary, a monitoring program designed and implemented. A data analysis and reporting schedule needs to be established.

Monitoring for fecal coliforms needs to be continued. If the current situation persists, a more detailed investigation of sources should be undertaken. Moving some beaches, limiting their use by humans, or further restrictions to human or animal wastes may be needed to correct the situation.

Trace Metals

Metals occur naturally in geological formations. They would be expected to occur in lakes as the result of natural weathering processes in the watershed. Several activities in the Lake Wabamun basin are expected to liberate metals in excess of natural background, including mining, agriculture, transportation and construction. Diversions from mines and ash lagoons, the burning of coal and transportation of coal ash, and emissions from transportation are other potential sources to the lake. Several metals are toxic to humans and aquatic life at low concentrations. The metals do not appear to have caused detectable changes in the aquatic community. Similarly, metals deposited in Wabamun Lake are not a health concern for recreational uses of the lake.

Several studies have been carried out to describe trace metal concentrations in water and sediments from Lake Wabamun. Other lakes in the region were used as reference lakes.

In Lake Wabamun water, metal concentrations in the lake are typically meeting water quality guidelines for the protection of freshwater aquatic life, although some selenium and cadmium measurements are in excess of provincial and Canadian guidelines for the protection of aquatic life (Alberta Environment 1999, CCME 2001a, Casey 2003a). Boron, beryllium, bismuth and molybdenum are also higher than in other lakes of the area (Golder Associates 2002, Anderson 2003).

In sediments of Lake Wabamun and several of the reference lakes, arsenic, cadmium, chromium, copper and zinc exceed Interim Sediment Quality Guidelines for the Protection of Aquatic Life (CCME 2001b). About 25% of arsenic measurements in Lake Wabamun exceed CCME Probable Effects Levels (CCME 2001b), compared to only 4 % of reference lake samples. All samples from Lake Wabamun and reference lakes met the CCME interim Sediment Quality Guideline for mercury (CCME 2001b). Arsenic, cadmium, copper, zinc, mercury, selenium and antimony are higher in Lake Wabamun sediments than in sediments of other lakes of the area.

Metal levels in the vicinity of the ash lagoon outfall tend to be higher than metal levels in similar sediments and at similar depth elsewhere in the lake. This suggests that the ash lagoon has contributed to the metal loading to the lake.

A study of drinking water wells carried out by Alberta Environment in 2002 showed that metal concentrations in all of the wells tested complied with Canadian Drinking Water Guidelines.

At present, none of the metals in Lake Wabamun water and drinking water wells near the lake are at concentrations high enough to be of concern for human drinking water. Metal concentrations in the lake's water are not of concern for aquatic life, but because some metals in sediments were well above interim guidelines for the protection of aquatic live, additional studies were undertaken. These studies showed that the sediments of Lake Wabamun were no more toxic to a range of test species than sediments from reference lakes (HydroQual 2003), and that benthic invertebrates near the ash lagoon outfall, where some metal concentrations are elevated, were as diverse and abundant as in an area away from the ash lagoon (Stantec 2003). Altogether, it seems unlikely that metals in lake sediments have had an acute impact on benthic and planktonic organisms. Further studies would be necessary to determine likelihood of secondary ecological or food-chain effects of trace metals in Lake Wabamun.

Paleoecological studies indicate that some metals have increased since coal mining and burning began in the basin. Metals that have increased include mercury, arsenic, copper, molybdenum, lead, selenium, tungsten and zinc (Donahue et al. unpublished manuscript). All are known to be trace contaminants of coal.

Mercury
Recently, mercury has been a cause for considerable concern in North America, because it is vaporized in combustion and released to the atmosphere in gaseous elemental form that can be carried long distances. There are also some emissions as divalent mercury, probably bound to aerosols and small particulates. Once entering aquatic ecosystems, mercury can be methylated by sulfate-reducing bacteria to methyl mercury. Methyl mercury is biomagnified in aquatic food chains, often to levels that can cause health problems in humans or fish-eating mammals. Such problems have recently been discovered to be particularly acute in developing fetuses and newborn infants (NRC 2000). High mercury concentrations are currently the most common reason for fish consumption advisories in the U.S.A.

The four power plants in the Wabamun vicinity are known to release roughly 600 kg of mercury per year, or about 2/3 of the annual emissions of mercury from electrical production facilities in Alberta (CASA 2003). According to Environment Canada's National Pollutant Release Inventory, in 2002, the Sundance power plant was the second largest industrial aerial emission source of mercury in Canada, with emissions of 275 kg of mercury per year. Other on-site and off-site releases add another 98 kg annually. There are also other sources of mercury to the Wabamun region, including geological formations, forest fires, and long-range transport of the element from sources around the world.

Several studies in North America show that deposition of mercury in lake sediments before the industrial revolution was generally on the order of 4-6 $\mu g/m^2/yr$. In Pigeon Lake, well away from the power plants, current mercury deposition is 6-9 µg/m^2/yr, or 3 to 6 µg/m^2/yr greater than in the early years of the 20th century (Donahue et al. unpublished manuscript). These are similar to current values for mercury deposition for lakes in northern Minnesota and Wisconsin. Current mercury deposition in most pristine areas is about 2-3 times greater than in the mid 19th century. It is believed that this is largely the result of long-range transport of anthropogenically-released mercury in the atmosphere. About half of the atmospheric mercury is believed to be of human origin (Schroeder and Munthe 1998, Mason and Sheu 2002).

A detailed paleocontaminant study of Lake Athabasca, one of the few studies of this kind in western Canada, demonstrated no long-term increase in mercury deposition in northeastern Alberta (Bourbonierre et al. 1996). This, and the small increase in deposition rates in Pigeon Lake, suggests that importance of increases in long-range transport of globally-sourced mercury to Lake Wabamun has likely been minimal when compared to increases in local fluxes to the lake.

Current mercury deposition at Lake Wabamun is somewhat higher, 21-32 µg/m^2/yr. Comparisons with historical values indicate that about 85% of current mercury flux is of anthropogenic origin. Goodarzi (1996) measured mercury deposition at 36 sites in the basin, by analyzing mercury concentrations in cleaned moss pillows taken from the catchment. These indicated an average deposition rate of 7 µg/m^2/yr. While these are lower than lake values, they are more susceptible to re-emission to the atmosphere. Nearby Lac Ste Anne receives 10-15 µg/m^2/yr of Hg. These data clearly indicate that nearby sources as well as long-range transport are affecting the mercury input to the lake. A dated sediment core from Lake Wabamun indicates that the timing of mercury increases above the long-range transport background in Lake Wabamun corresponds well with the installation of power plants (Figure 6). It should be noted that the Lake Wabamun data are from a single dated core, and other sites in the lake may be more variable. However, similar observations were made in Minnesota lakes near to coal-fired power plants (Engstrom and Swain 1997).

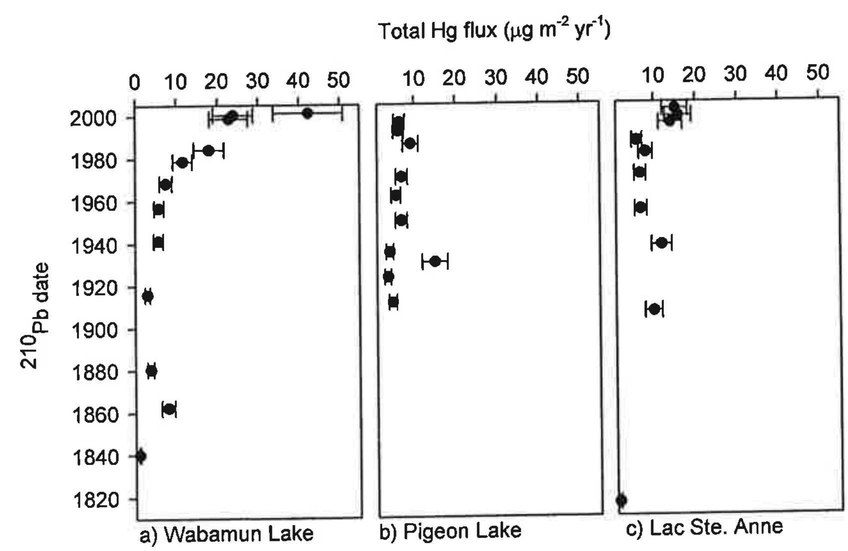


Figure 6. Annual total flux of mercury to the sediments of Lake Wabamun, Pigeon Lake and Lac Ste. Anne. From W. Donahue et al. (unpublished Ms).

Until recently, some claimed that the increase in mercury near the sediment surface could be explained by redox phenomena, as the result of mobilization of iron under anoxic conditions in sediments (Rasmussen 1994). In a recent review of the evidence, Fitzgerald and Lamborg (2003) discounted this theory, pointing out that when atmospheric mercury sources were decreased, concentrations of mercury at surface sediments also decreased. This is not consistent with redox-controlled movement.

Although the current mercury deposition in Lake Wabamun is higher than in other lakes of the area, it does not seem to have contaminated fisheries to a large degree. Northern pike in Lake Wabamun collected in 1996 and 2001 had mercury concentrations that were generally similar to levels recorded in pike from other lakes in the region and fell within the mid-range of Alberta waterbodies, including those in pristine areas (Figure 7). Mercury concentrations in Wabamun pike were below the Health Canada guideline for occasional consumption (0.5 mg/kg). Many northern pike exceeded the subsistence guideline (0.2 mg/kg), and there is some concern for those who eat northern pike regularly. This may be of particular concern for members of the Paul Lake Band. Lake whitefish in Lake Wabamun collected in 1996 and 2001 had mercury concentrations that met both occasional and subsistence consumption guidelines (Golder Associates 2002).

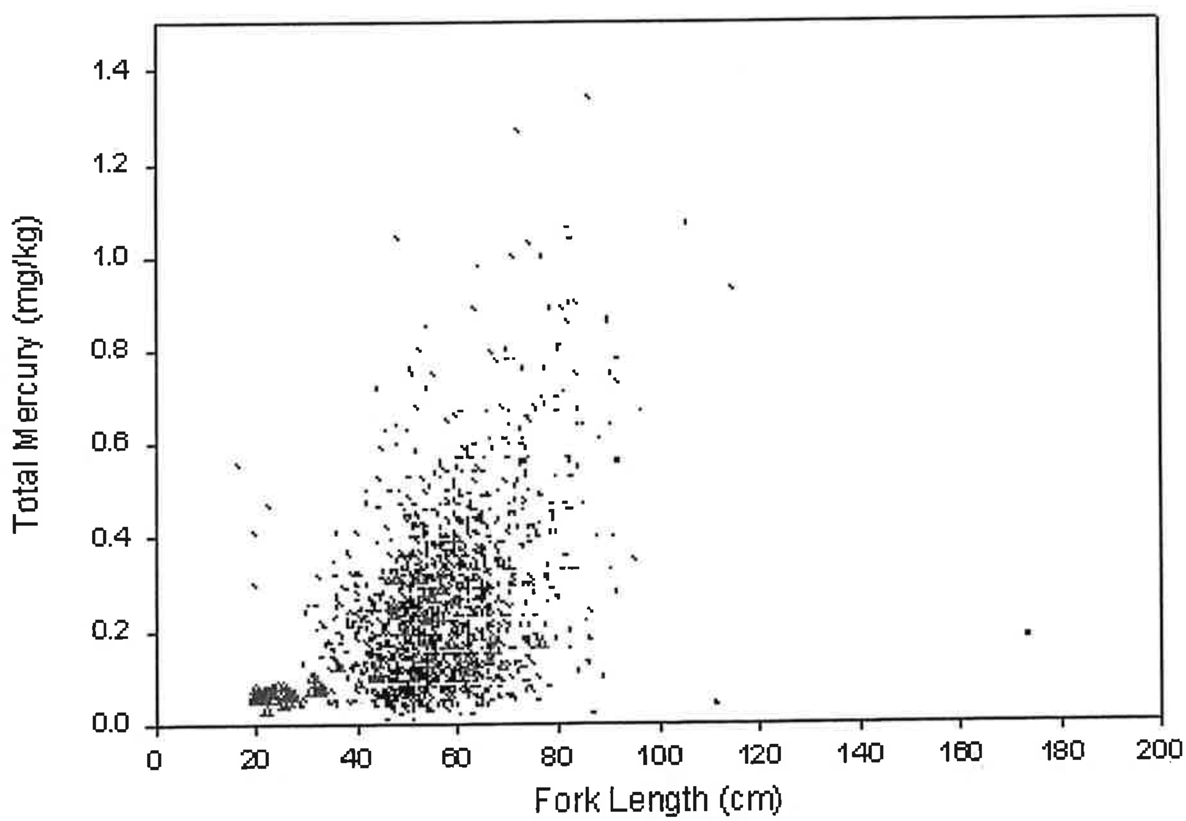


Figure 7. Mercury in northern pike from Alberta waterbodies. Data for Wabamun Lake shown as open triangles, all other locations shown as dots. Data from references provided in the text.

Several factors could change the mercury concentrations of northern pike in the future. Firstly, most of the fish in the lake are very young, as the result of the over-exploitation of fisheries reported above. In general, larger, older piscivorous fish contain the highest mercury concentrations. If the fishery is allowed to recover as recommended, large northern pike could contain concentrations of concern, although data from 1996 and 2001 show that the older, larger fish in the sample were still within regional and Alberta-wide ranges and did not exceed occasional consumption guidelines.

Secondly, methylation of mercury is generally done by sulfate reducing bacteria. In studies of eastern lakes where sulphate concentrations are low, methylation is limited by the availability of sulfate. It is not known if mercury methylation is limited at the 10-fold higher sulfate concentrations found in Lake Wabamun. Sulfate concentrations in the lake are increasing, as the result of the use of alum and thiosulphate in the WLWTP and the lack of flushing.

Recently, CASA has developed a framework for significant reduction of emissions of mercury from thermal generating facilities in Alberta by end of 2009 (CASA 2003). CASA recommends that the requirement for such reductions be part of the operating approvals for all coal-fired plants. For existing facilities, operators will be required to implement mercury emissions controls that are equivalent in performance and cost to fabric filters and activated carbon, at an injection rate to be determined as part of the CASA BATEA review for mercury. New facilities that already have fabric filters would be required to install the equivalent of activated carbon injection. Older facilities that are reaching the end of operation are exempt.

Recommendations:
Implementation of the November 2003 CASA recommendations for reduced emissions. These will be in place by 2009 for all power plants, and involve about 50% reduction in mercury emissions (CASA 2003). This should adequately protect the lake from any future increases in mercury loading, including those that may result from further industrial development in central Alberta.

Our above recommendations for limiting nutrient inputs should be sufficient to protect the fisheries from further increases in mercury as the result of increased biomagnification.
The situation deserves some continued monitoring, especially as older fish age classes recover after the recommendations for fisheries are implemented, although as noted above even larger, older fish are generally within guidelines.

A review of current programs for monitoring trace metals (AENV, TAU/EPCOR, CASA, others) is in order to ensure that objectives are clearly defined and tractable, methods used are comparable and attainable, and redundancy is avoided. In order to assess changes in the relative contribution of industrial activity in the watershed and airshed of the lake, periodic studies of deposition in lake sediments from deeper parts of the lake would be useful, using methods that are well-described in the scientific literature and consistent from study to study.

Organic Contaminants

Disinfection by-products

In the process of treating water to remove organisms, the WLWTP produces halogenated and non-halogenated disinfection by-products, including trihalomethanes, haloacetic acids, aldehydes and several related compounds (Casey 2003b). Concentrations are generally within the limits expected from modern drinking water treatment plants. The plant effluent would be further diluted by the volume of the lake and by the volatilization of compounds. The discharge of treated water to stabilize a lake's level is an unusual situation. Although there should be no concerns for human health, little is known about the toxicity of disinfection by-products to aquatic life.

PAHs

Twenty-one PAHs were identified in near-surface lake sediments from Wabamun. Total fluxes are 73-114 $ug.m^{-2}\ yr^{-1}$, 2 to 6-fold higher than in lakes farther from the coal-fired power plants. Comparisons with deeper sediments and other lakes also indicate that the power plants, coal mining, fossil fuel burning to power engines, and exposed coal seams in or near the lake are the most likely sources. Of the compounds detected, 12 have guidelines. Concentrations of six compounds exceed guidelines. However, the concentrations in sediments are an order of magnitude lower than probable- effects levels. PAHs do not bioaccumulate or biomagnify in food chains, and those in Lake Wabamun currently represent no significant threat to humans. (next to nothing is known about secondary and interactive effects of PAHs on aquatic life).

Recently, concerns have developed over the effects of trace amounts of pharmaceuticals, antibiotics, and personal care products in freshwater (ref). Early studies show that such compounds are numerous, and some are poorly degraded in sewage treatment or septic systems. So far, investigation of toxicity has barely begun. The possible implications for Lake Wabamun should be reviewed in a few years when scientific studies are more numerous. Nonetheless, diversion of all sewage away from the lake, as recommended for reducing nutrient delivery to the lake, should coincidentally limit delivery of these organic compounds.

Recommendations

No current action is recommended for potentially toxic organic compounds. The need for further investigation should be reviewed periodically in view of rapidly increasing scientific understanding of these compounds and their toxicity.

References

Agbeti, M. 2002. An evaluation of long-term phytoplankton and zooplankton communities of Wabamun Lake. Draft.

Alberta Environment. 1993. Wabamun Lake Information Report. 8 pp + figures.

Alberta Environment. 1999. Surface water Quality Guidelines for use in Alberta. Environmental Sciences Division and Water Management Division, Edmonton, Alberta. http://www.gov.ab.ca/env/protenf/publications/SurfWtrQual-Nov99.pdf

Anderson, A.-M. 2003. A survey of metals and trace organic compounds in sediments from Wabamun Lake and other Alberta Lakes. Environmental Monitoring and Evaluation Branch, Alberta Environment. 135pp.

Ash, G.R., N.R. Chymko, and D.N. Gallup. 1974. Fish kill due to "cold shock" in Lake Wabamun, Alberta. J. Fish. Res. Board Canada. 31:1822-1824.

Beak Consultants Ltd. 1980. The effect of thermal discharges on the aquatic plants and other biota of Wabamun Lake, Alberta. Prepared for Calgary Power Ltd.

Bourbonniere R.A., S.L. Telford and J.B. Kemper. 1996. Depositional history of sediments in Lake Athabasca: geochronology, bulk parameters, contaminants and biogeochemical markers. Northern River Basins Project Report No. 72, Edmonton, Alberta.

Canadian Council of Ministers of the Environment (CCME). 2001a. Canadian Water Quality Guidelines. In: Canadian Environmental Quality Guidelines, CCME, Winnipeg. http://www2.ec.gc.ca/ceqg-rcqe/English/ceqg/default.cfm

Canadian Council of Ministers of the Environment (CCME). 2001b. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. In: Canadian Environmental Quality Guidelines, CCME, Winnipeg. http://www2.ec.gc.ca/ceqg-rcqe/English/ceqg/default.cfm

Casey, R. 2003a. Wabamun Lake Water Quality 1982 to 2001. Science and Standards, Alberta Environment, Edmonton. 80pp + Appendices. http://www3.gov.ab.ca/env/water/reports/wabamunsum.html

Casey, R. 2003b. Disinfection by-products in the Wabamun Lake Water Treatment Plant-treated water and Wabamun Lake, July 2002 to March 2003. Science and Standards Branch, Alberta Environment, Edmonton. 28 pp. http://www3.gov.ab.ca/env/water/reports/wabamunsum.html

Clean Air Strategic Alliance (CASA) 2003. An Emissions Management Framework for the Alberta Electricity Sector - Report to Stakeholders. Prepared by CASA http://casahome.org/uploads/Emissions_Mgmt_Framework.pdf

De Menocal, P., J. Ortiz, T. Guilderson and M. Sarnthein. 2000. Coherent high and low latitude climatic variability during the Holocene Warm Period. Science 288: 2198-2202.

Dillon, P.J. and W.B. Kirchner. 1975. The effects of geology and land use on the export of phosphorus from watersheds. Water Research 9: 135-148.

Dillon, P.J. and F.H. Rigler. 1974. A test of a simple nutrient budget model predicting the phosphorus concentration in lake water. J. Fish. Res. Board Can. 31: 1771-1778.

Ecomark 2004. Sediment survey interim report to Alberta Environment. East shore, Moonlight Bay, Wabamun Lake, Alberta. Revision 1.1 16 April.

Engstrom D.R. and E.B. Swain. 1997. Recent declines in atmospheric mercury deposition in the upper Midwest. Environ. Sci. Technol. 31: 960-967.

Fritz, P. and H.R. Krouse. 1972. Wabamun Lake past and present, an isotopic study of the water budget. In: Reinelt, E.R., A.H. Laycock, and W.M. Schultz (eds). Symposium on the Lakes of Western Canada. Edmonton, AB, AEU Water Resources Centre Publication.

Fitzgerald, W. F. and C.H. Lamborg. 2003. Geochemistry of mercury in the environment. In: Lollar, B.S. (ed), Environmental Geochemistry. 9, 107-148. Oxford, Elsevier-Pergamon.

Glover, A.S. 1967. History of Wabamun Lake Outlets. Government of Alberta, Edmonton.

Golder Associates Ltd. 1997. A Synthesis of historical information on the effects of the TransAlta Utilities Wabamun Lake Power Plant using a risk assessment approach. Prepared for TransAlta Utilities, March, 1997. Project 962-2354. Golder Associates Ltd. Calgary, AB.

Golder Associates Ltd. 1999. Investigation of fish mortality in the outlet-cooling canal of the Wabamun Power Plant. Prepared for TransAlta Utilities Corporation. Calgary, Alberta.

Golder Associates Ltd. 2000. Impacts of mechanical weed harvesting on fish in Wabamun Lake, Alberta. Prepared for TransAlta Utilities. Submitted to Department of Fisheries and Oceans.

Golder Associates Ltd. 2002. Water and sediment quality in Wabamun Lake and surrounding lakes, summer 2002. Report prepared for TransAlta Utilities Corporation, Calgary, AB. 22 pp + tables and figures. Submitted to AENV, and shared with public on TAU website.

Golder Associates Ltd. 2003. Wabamun Power Plant ash lagoon treatment system mass balance. Draft report prepared for TransAlta Utilities Corporation, Calgary, AB. Submitted to AENV in September 2003.

Goodarzi, F. 1996. The Impact Of Anthropogenic Activities On The Lake Wabamun Area. Geological Survey Of Canada. Calgary Division, Calgary, Alberta.

Hickman, M., C.E. Schweger and T. Habgood. 1984. Lake Wabamun, Alta: a paleo-environmental study. Can. J. Bot. 62: 1439-1465.

HydroQual Laboratories. 2003. Toxicity Assessment of Wabamun Lake Sediments. Prepared for Alberta Environment, Central Region. Stony Plain. 36pp. http://www3.gov.ab.ca/env/water/reports/wabamunsum.html

Mason, R.P. and G.-R. Sheu. 2002. Role of the oceans in the global mercury cycle. Global Biogeochemical Cycles 16: 1093-

Mitchell, P. 1985. Preservation of Water Quality in Lake Wabamun. Alta. Envir., Poll. Contr. Div., Water Qlty Contr. Br., Edmonton

Mitchell, P. and E. Prepas. 1990. The Atlas of Alberta Lakes. The University of Alberta Press, Edmonton. 676pp

NRC (National Research Council). 2000. Toxicological effects of methylmercury. Committee report, Board of Environmental Studies and Toxicology. National Academy of Sciences, Washington D.C.

Patterson, B. 2002. Status assessment of the northern pike sport fishery, Wabamun Lake, 2001. Alberta Conservation Association, Sport Fish Monitoring Program.

Rasmussen, J.B. 1979. The macroinvertebrate fauna and thermal regime of Lake Wabamun, a lake receiving thermal effluent. M.Sc. Thesis, University of Alberta.

Rasmussen, P.E. 1994. Current methods of estimating atmospheric mercury fluxes in remote areas. Environ. Sci. Technol. 28: 2233-2241.

Seneka, M. 2002. Wabamun Lake Water Balance 1982 - 2001. Alberta Environment, Edmonton. 22pp

Schindler, D.E. and M.D. Scheuerell. 2002. Habitat coupling in lake ecosystems. Oikos 98: 177-189.

Schindler, D.W. and W. Donahue. An impending water crisis in Canada's western prairie provinces. Unpubl. Ms.

Schindler, D.W., E.J. Fee and T. Ruszczynski. 1978. Phosphorus input and its consequences for phytoplankton standing crop and production in the Experimental Lakes Area and in similar lakes. J. Fish. Res. Board Can. 35: 190-196.

Schroeder, W.H. and J. Munthe. 1998. Atmospheric mercury-an overview. Atmospheric Environment 32: 809-822.
Sondergaard, M., E. Jeppeson, J.P. Jensen and T. Lauridsen. 2000. Lake restoration in Denmark. Lakes and Reservoirs: Research and Management 5: 151-159.
Stantec Consulting Ltd. 2003. Benthic Invertebrate Assessment in Wabamun Lake, November 2002. Prepared for Alberta Environment, Edmonton. 49 pp. http://www3.gov.ab.ca/env/water/reports/wabamunsum.html
Vollenweider, R.A. 1976. Advances in defining critical loading levels for phosphorus in lake eutrophication. Mem. Ist. Ital. Idrobiol. 33: 53-83.
Wetzel, R.G. 1983. Limnology. Saunders College Publishing, Harcourt Brace Javonovich College Publishers, Orlando, Florida.

Acknowledgements

Drs. Peter Dillon of Trent University and Dr. Joe Rasmussen of the University of Lethbridge participated in the July Workshop and reviewed the final draft of this report.
Michael Seneka and Richard Casey of AENV provided valuable data and advice on water and nutrient budgets.
Rick Ostertag of WENV provided historical information on power plant development in the Lake Wabamun area.
Stephen Spencer of Alberta Sustainable Resource Development provided Lake Wabamun fisheries data and experience with the fishery.
Gary Ash, Mark Digel, and Richard Robinson of Golder Associates provided reports and a review of an early draft of the report.
Leanne Zrum constructed Figures 1 and 3. She and Elan Gluckie arranged the July workshop, and facilitated the acquisition of information on reclamation of mined areas and bacterial quality of beaches.
Margaret Foxcroft helped assemble the report.

Appendix 1. Lake Wabamun Fisheries

Historical Records
Journals from travelers in Alberta during the 19th century comment on the importance of the fishery at Father Lacombe's mission at Lac Ste. Anne (Kane 1859, Milton and Cheadle 1865, Cheadle 1931). Supplying fish to Fort Edmonton and area must have resulted in extensive local fishing pressure because of the heavy consumer demands of people and, in particular, because of the large population of sled dogs (Southesk 1875). Although not specifically mentioned in these early writings, it is likely that Lake Wabamun was also heavily fished to supply this large demand.

The first published accounting of fish harvests at Lake Wabamun refer to commercial catches from 1915 to 1945 (Miller 1947). Annual commercial fishing records from 1942 to 1976 are presented in Scott (1978).

Fishing Pressure
Angler surveys conducted during the 1980s resulted in estimates of angling pressure of 161,000 angler-days (Berry 1986). Of this effort, approximately 86% occurred during the winter season and 14% during the summer. In 2001, a summer-season creel survey was conducted and angling effort was estimated at 9,464 angler-days (95% CI, 6428 – 12499, Patterson 2002). Based on the winter/summer effort ratio from the 1980s, the total effort during 2001 may have been approximately 65,000 angler-days. Even with this reduction in popularity from the 1980s to 2001, Lake Wabamun receives some of the heaviest angling pressure of any Alberta lake (Sullivan 2003).

Commercial fishing records for Lake Wabamun have been kept since 1915 and repeatedly show periodic high levels of harvest followed by collapse (Figure 1). During the past 20 years, approximately 250 commercial fishermen have been licensed to fish at Lake Wabamun, setting up to 200 km of gill-nets during each fishery.

First Nations fishermen are licensed to fish for food in Lake Wabamun, in accordance to their Treaty rights. Typically, this fishery involves gill-netting for lake whitefish. Records of the numbers of licenses issued since 1980 (Figure 2) show a strong increase during the late 1980s, when whitefish were unusually abundant in Lake Wabamun. Recently, the number of licenses issued has declined. First Nations fishers have complained about the poor quality of fish in Lake Wabamun, although the specific cause of these complaints is unknown (Stephen Spencer, personal communication)

Walleye
A lack of commercial fishery records and only anecdotal reports suggest that walleye were an incidental species in Lake Wabamun. Fishery monitoring (both commercial and sport) failed to record the catch of any walleye during the 1970s and 1980s (Glen Clements, personal communication). During 1983 to 1986 (inclusive), approximately 12 million walleye fry were stocked in Lake Wabamun (Berry 1992). Although the stocked walleye did create a minor, localized fishery (concentrated in the Wabamun Power Plant effluent) for a few years, the fish failed to reproduce and the fishery collapsed (Watters 1991).

Northern Pike
The Lake Wabamun pike population structure was measured during 2001 (Patterson 2002). The age-class density showed evidence of severe growth-overfishing compared to pike from a lightly exploited Alberta lake (Figure 3). Based on the 2001 catch curve, pike total annual mortality at Lake Wabamun was 78%. This high level of mortality will prevent large pike from becoming abundant and will allow reproduction from only 2 or 3 year-classes (compared to more than 15 reproducing year-classes at lightly exploited fisheries). Long-term sustainability of the pike population is reduced with such a truncated age structure.

Following provincial guidelines (Berry 1999), the sport harvest of pike at Lake Wabamun was restricted to fish larger than 63 cm. During the 2001 creel survey, however, 46% of the pike harvested by anglers were illegal (Patterson 2002). This level of illegal harvest is of concern to both fish population management (Sullivan 2002, Post et al. 2003) and from an enforcement and social perspective (Walker 2003).

The commercial fishery harvests large numbers of pike incidental to the lake whitefish fishery. During the past 60 years, the commercial pike harvest has averaged 3000 kgs per year (Figure 4). This harvest is concentrated on large pike that are particularly vulnerable to the large-mesh gill-nets used in this fishery (Figure 5). With the recent restrictions on the sport harvest of smaller pike, the abundance of large pike will likely increase and result in even heavier incidental harvests of pike by the commercial fishery.

Lake Whitefish
Sport angling for lake whitefish in Alberta was initially developed at Lake Wabamun during the 1960s (Paetz and Nelson 1970, Nelson and Paetz 1992) and attracted hundreds of thousands of anglers in the 1980s (Berry 1986). It has been one of Alberta's largest and most important commercial fisheries, both in terms of magnitude of harvest and by participation (Scott 1978).

Although the whitefish fishery at Lake Wabamun has fluctuated greatly over the past century (Figure 1), recent low catches appear to be the result of repeated recruitment failures (Figure 6). A strong year-class of whitefish has not been produced since 1986, and recruitment during the past 7 years (1997 to 2004) has been unusually low. In response to the low catches and poor recruitment, the commercial fishery was temporarily closed in 2003 for conservation reasons (Spencer 2003).

Fish Habitat
Shoreline areas along Lake Wabamun are important for fish habitat. Flooded marshes and emergent weed beds provide spawning and rearing habitat for northern pike (Scott and Crossman 1973). Gravel beaches exposed to naturally-occurring wave action are necessary for lake whitefish spawning (Ash 1974). The importance of these habitats is reflected in the Canadian Federal Fisheries Act, Section 35(1), which states, "No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat." Provincial and municipal acts also recognize the value of these habitats and prohibit unauthorized alterations to shorelines of lakes. In spite of these legal protections, portions of the

shoreline of Lake Wabamun, particularly along cottage subdivisions, has been altered and destroyed. Cottagers have removed weedbeds, dumped sand, dredged channels, and cleared shoreline shrubs. Studies in boreal Canada have shown that removing 50% of the shoreline vegetation can result in a similar 50% decline in pike populations (Mills et al. 1999).

Industrial activities have also resulted in the loss of fish habitat. A large portion of Goosequills Bay, noted for pike spawning, was cut off from Lake Wabamun to create the cooling pond for the Sundance Power Plant (Ash 1974). Strip-mining along the south shore of Lake Wabamun has destroyed much of the Beaver Creek watershed, once used by spawning pike. The near-lake section of Wabamun Creek was destroyed by channel alterations during the construction of the outlet weir, again likely an area that was once important to spawning pike.

Industry-caused Fish Kills

Fish kills attributed to industrial activities have been a recurring problem at Lake Wabamun. Three types of kills have been documented, all associated with the electrical power generating stations. In February 1973, thermal shock associated with an emergency shutdown of the Sundance power plant resulted in an estimated kill of 258,000 spottail shiners and 250 northern pike (Ash et al. 1974).

Gas bubble trauma was documented as a cause of fish kills during the late 1990s near the Wabamun power plant (Golder Associates 1999). Water containing supersaturated gases (formed when cold lake water was heated and discharged during the normal course of plant operations) was concentrated within the effluent stream. Fish caught in this stream were injured and killed as gas bubbles developed in their gills, eyes, skin, and internal organs. TransAlta attempted to reduce this problem by building fish barriers to prevent fish from entering the discharge stream and by mechanically de-gassing the water before it enters Lake Wabamun. Periodic, recurring problems have included fish moving past the barriers and mechanical malfunctions with the de-gassing process.

A third major type of fish kill has been entrainment and destruction of fish in the water intake stream to the Wabamun power plant. Large numbers of dead pike and lake whitefish have been collected from the intake filter screens during each winter since 2001. The direct cause of these deaths appears to be mechanical trauma caused by the rotating filter screen, but the reason for the recent appearance of large numbers of dead and injured fish is not has not clearly ascertained (Greg Goss, personal communication). It is possible that a change in the debris removal procedure on the filter screen has simply resulted in the observations of these fish and similar, but unobserved mortality has been occurring since the plant was built (Stephen Spencer, personal communication).

In each of these instances of large-scale fish kills, the safety of consuming fish from Lake Wabamun been of wide-spread public concern. No evidence of human health risks, however, has been confirmed.

References

Ash, G.R. 1974. The effects of heated water discharge upon lake whitefish (Coregonus clupeaformis [Mitchill]) in Lake Wabamun, Alberta. M.Sc. Thesis. Dept. of Zoology, University of Alberta, Edmonton.

Ash, G.R., N.R. Chymko and D.N. Gallup. 1974. Fish kill due to "cold shock" in Lake Wabamun, Alberta. Journal of the Fisheries Research Board of Canada. 31(11):1822-1824.

Berry, D.K. 1986. Lake Wabamun sportfishery results of creel surveys and sportfish monitoring from 1982 to 1984. Alberta Fish and Wildlife report, Edmonton.

Berry, D.K. 1992. Alberta's walleye stocking program, 1982-1991 and stocking strategy for the 1990s. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division. Pub. No. I/482.

Berry, D.K. 1999. Alberta's northern pike management and recovery plan. Alberta Environment, Natural Resources Service. Pub. No. T/459

Cheadle, W.B. 1931. Cheadle's journal of a trip across Canada 1862 –1863. Hurtig edition reprint, 1971. M.G. Hurtig Ltd., Edmonton.

Golder Associates Ltd. 1999. Investigation of fish mortality in the outlet cooling canal of the Wabamun Power Plant. Prepared for TransAlta Utilities Corporation. Calgary, Alberta.

Kane, P. 1859. Wanderings of an artist among the Indians of North America from Canada to Vancouver's Island and Oregon through the Hudson's Bay Company's Territory and back again. Hurtig edition reprint, 1968. M. Hurtig, Edmonton.

Miller, R.B. 1947. The effects of different intensities of fishing on the whitefish populations of two Alberta lakes. Journal of Wildlife Management 11:289-301.

Mills, K, A. Salki, D.L. Finlay and D.R. Cruikshank. 1999. Changes in the fish populations of Lake 191, the Experimental Lakes Area, due to macrophyte removal. Paper presented at American Fisheries Society annual meeting, September 1999, Charlotte, North Carolina.

Milton, W.F. and W.B. Cheadle.1865. The north-west passage by land. Prospero Canadian Collection (2001) from the 1865 Cassell, Petter, and Galpin edition. Toronto.

Nelson, J.S. and M.J. Paetz. 1992. The fishes of Alberta. The University of Alberta Press, Edmonton. The University of Calgary Press, Calgary. 437 pp.

Paetz, M.J. and J.S. Nelson. 1970. The fishes of Alberta. The Queen's Printer, Edmonton. 282 pp.

Patterson, B. 2002. Status assessment of the northern pike sport fishery, Wabamun Lake, 2001. Alberta Conservation Association, Sport Fish Monitoring Program Report.

Post, J.R., C. Mushens, A. Paul and M. Sullivan. 2003. Assessment of alternative harvest regulations for sustaining recreational fisheries: model development and application to bull trout. North American Journal of Fisheries Management 23: 22-34.

Scott, C. 1978. Commercial fisheries catch statistics for Alberta, 1942–1975. Fish and Wildlife Division, Alberta Department of Recreation, Parks and Wildlife, Fisheries Management Report 22, Edmonton.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184. 966 pp.

Southesk, J.C. Earl. 1875. Saskatchewan and the Rocky Mountains: a diary and narrative of travel, sport and adventure, during a journey through the Hudson's Bay Company's territories, in 1859 and 1860. Hurtig edition reprint 1969. C. C. Tuttle Company, Japan.

Spencer, S. 2003. Wabamun Lake whitefish closure. Memo/report to Wabamun file. Alberta Fish and Wildlife Division, 12 June 2003.
Sullivan, M.G. 2002. Illegal angling harvest of walleyes protected by length limits in Alberta. North American Journal of Fisheries Management. 22:1053 - 1063.
Sullivan, M.G. 2003. Active management of Alberta's walleyes: dilemmas of managing recovering fisheries. North American Journal of Fisheries Management 23: 1343-1358
Walker, J. 2003. The effects of resource scarcity on the enforcement of recreational fisheries. M.Sc. thesis, Department of Renewable Resources, University of Alberta
Watters, D. 1991. Assessment of stocked walleye and native lake whitefish populations in Wabamun Lake. Alberta Forestry, Lands and Wildlife, Fish and Wildlife, technical report (Wabamun Lake file, Stony Plain).

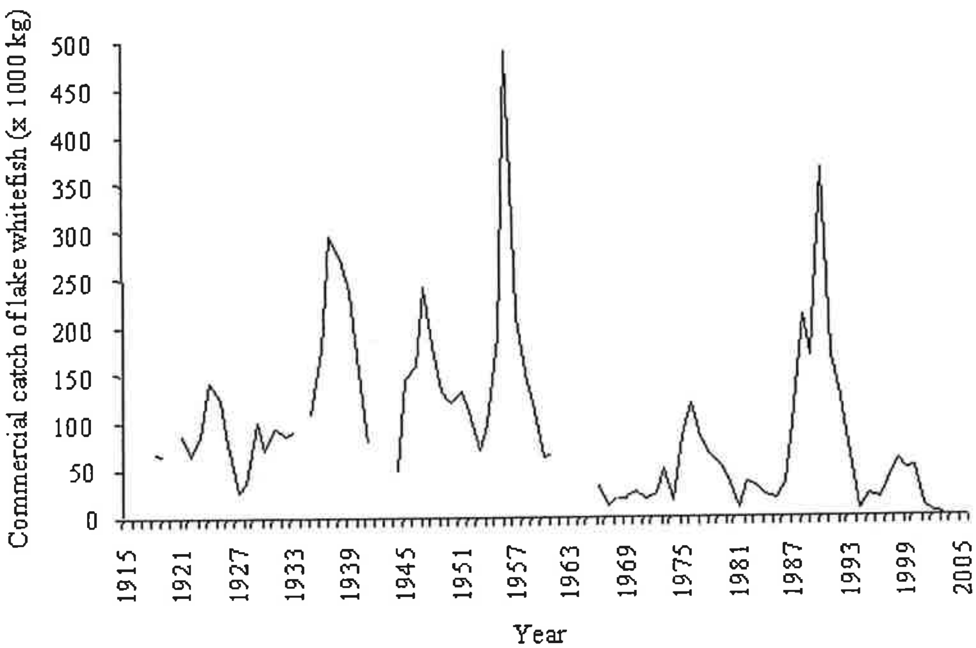


Figure 1. Commercial catches of lake whitefish at Wabamun Lake, 1918 to 2004.

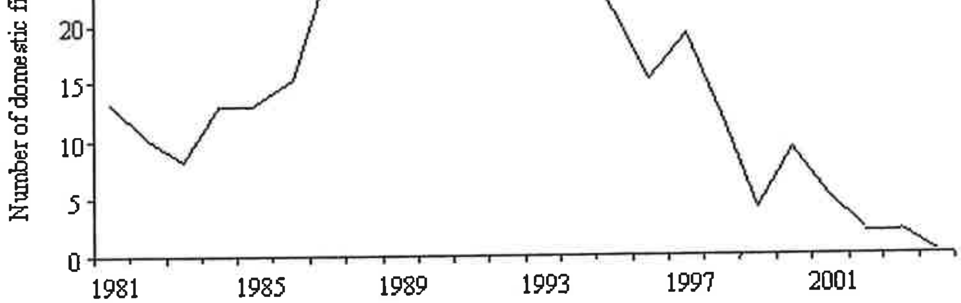


Figure 2. Number of First Nation fishery licenses issued at Lake Wabamun, 1980 to 2004.

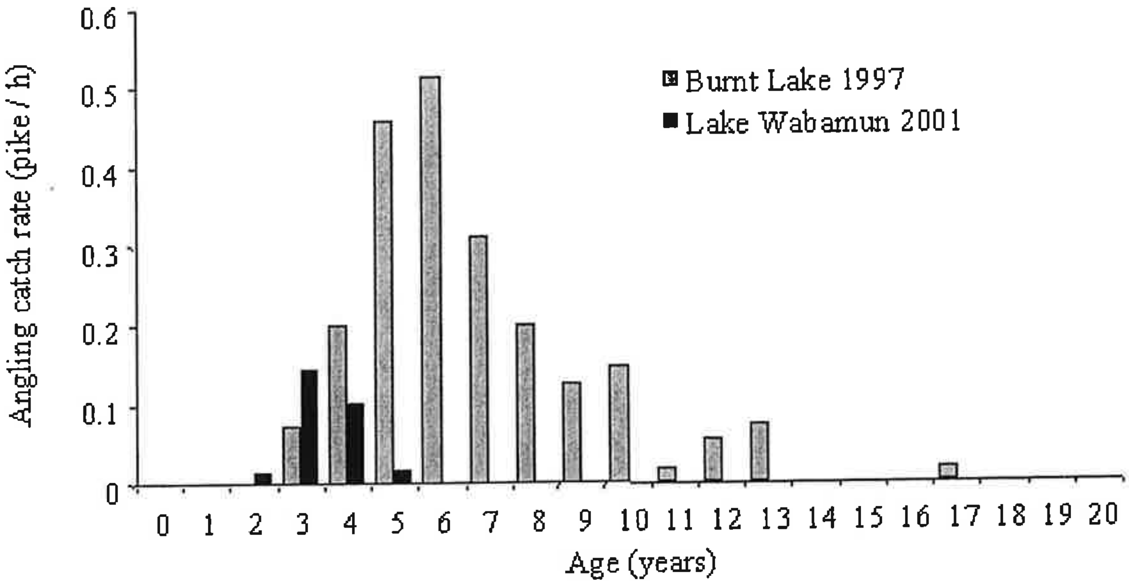


Figure 3. Age-class distributions and densities of angler-caught pike at Wabamun Lake (2001) and Burnt Lake (1997).

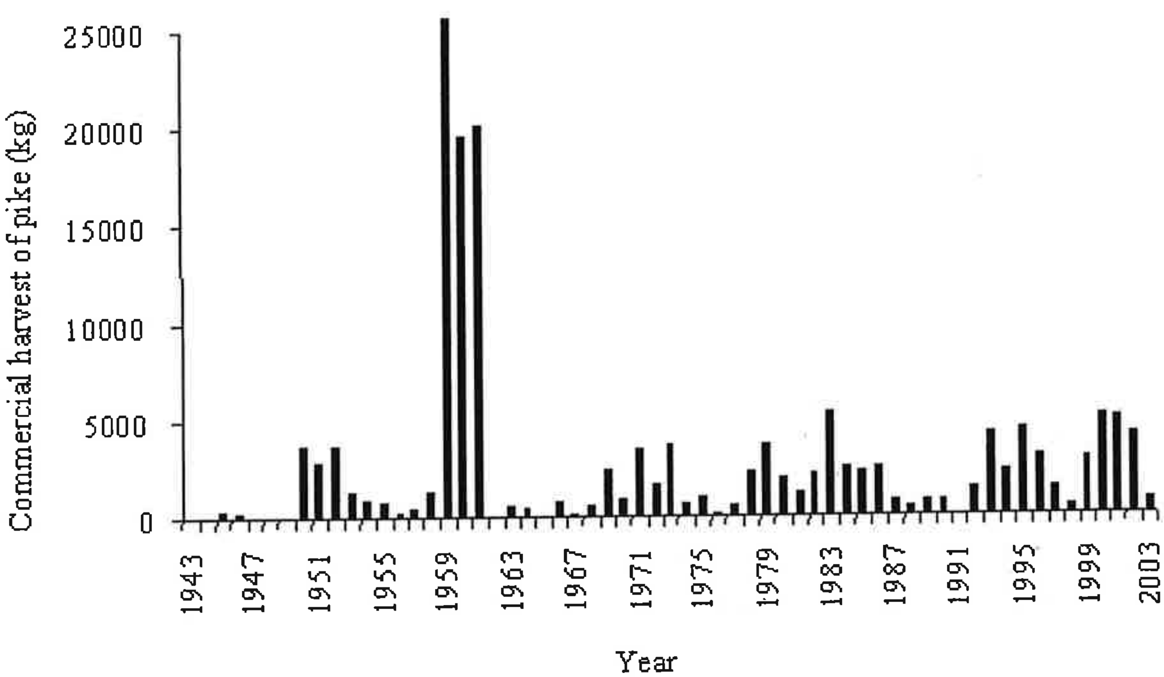


Figure 4. Commercial harvest of northern pike at Lake Wabamun from 1943 to 2003.

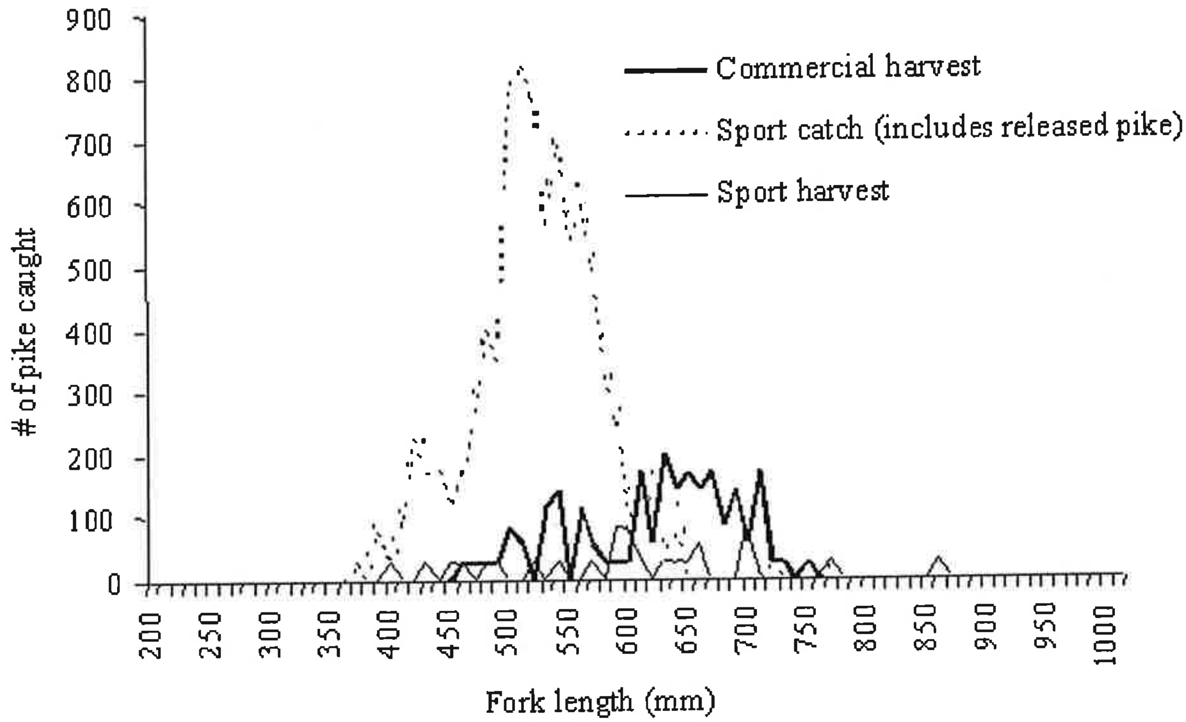


Figure 5. Commercial and sport catches of northern pike at Lake Wabamun, 2001.

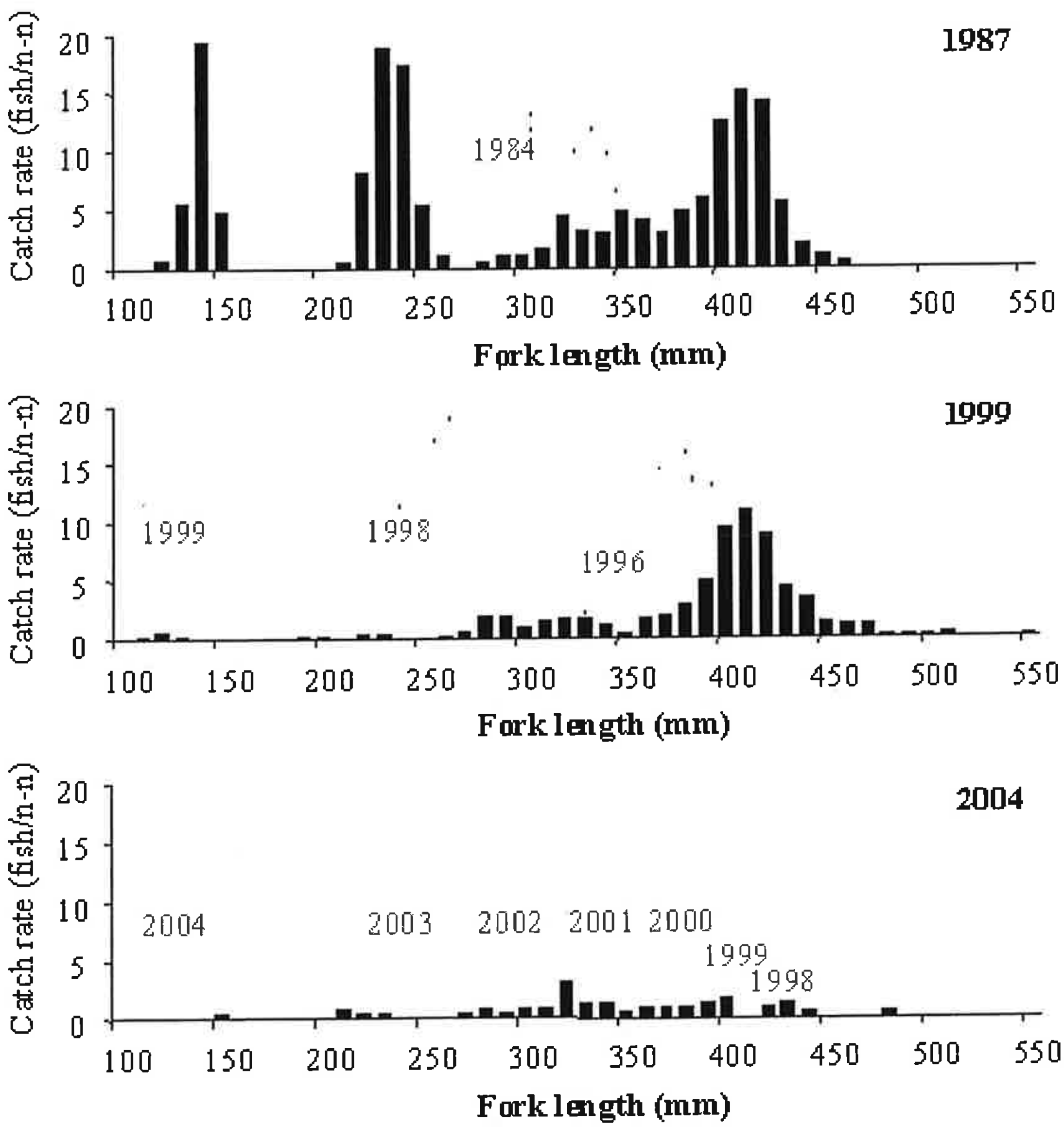


Figure 6. Length frequency distributions of lake whitefish caught in test-nets at Lake Wabamun 1997 to 2004. Density is scaled to commercial catch rate from each year on whitefish recruited to commercial nets (fish larger than 350 mm fork length). Year-classes with unusually low recruitment are marked with the year of birth above the missing size –classes.

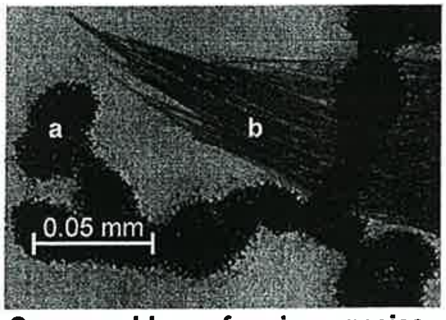
Cyanobacterial Toxicity

Cyanobacterial bloom on Hastings Lake, AB

What are Cyanobacterial Blooms? – Cyanobacteria are a unique group of bacteria that, in the same fashion as algae and plants, utilize photosynthesis to generate the energy required for growth and reproduction. When cyanobacteria grow profusely and congregate, they make lake water look like pea soup. This condition is called a cyanobacterial bloom. Cyanobacteria are natural inhabitants of Alberta's lakes and more than 100 species of cyanobacteria have been recorded.

Why Do Cyanobacteria Make Lakes Toxic? – Of concern is the fact that several common bloom-forming species produce potent toxins. Cyanobacteria have long been known to be toxic. Since the first reports over 100 years ago, numerous cases of animal poisonings have occurred worldwide, including periodic episodes within Alberta. Even reports of human illness and death have been documented in several countries over the years. Continuing research has shown that cyanobacteria can produce different types of toxins. The most common of these globally are the liver toxins called microcystins. Less common are several neuro- (nerve) toxins, including anatoxin-a, anatoxin-a(s) and saxitoxin (otherwise known as paralytic shellfish poison). Furthermore, some cyanobacteria produce mild dermal toxins that act as skin irritants.

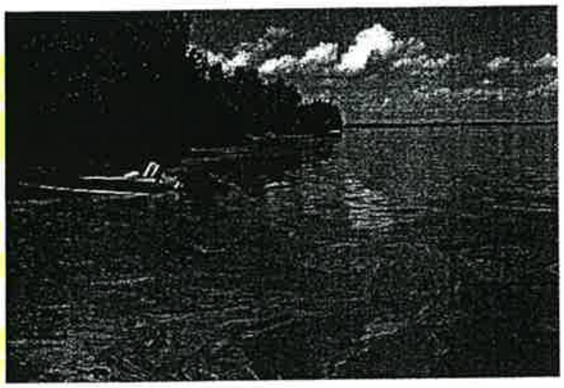
Can Toxicity be Predicted? – Not all species of cyanobacteria produce toxins, yet some species produce several types of toxin. Even within a single species, some strains are toxic while others are not. This makes the prediction of toxicity an arduous task and certainly more difficult than simply predicting bloom occurrence. In most cases, however, toxic and non-toxic strains of a species occur simultaneously. The concentration of toxin(s) is dependent on the density of toxin-producing species in a lake. Intensity and species composition of blooms varies both over time and with location in lakes, as a result so too will toxicity. Lakes that have never had a problem can suddenly become toxic and, conversely, lakes that have shown toxicity in the past may not be for several years. Some parts of the lake could become toxic while others could remain safe. Caution should be exercised at any lakes where blooms have occurred in the past.



Common bloom forming species of cyanobacteria: a) *Microcystis aeruginosa* and b) *Aphanizomenon flos-aquae*.

Toxicity is temporary. Neurotoxins degrade rapidly in the environment. Microcystins, on the other hand, are more persistent, but generally about 90 per cent of the toxin will degrade naturally within two weeks following the collapse of a bloom.

How Do Cyanobacterial Toxins Affect Animals? – When a lake becomes toxic as a result of cyanobacteria, the only sign of a problem may be dead waterfowl or wildlife near the shoreline. Occasionally, domestic animals such as livestock or dogs may be poisoned if they have no other source of drinking water.

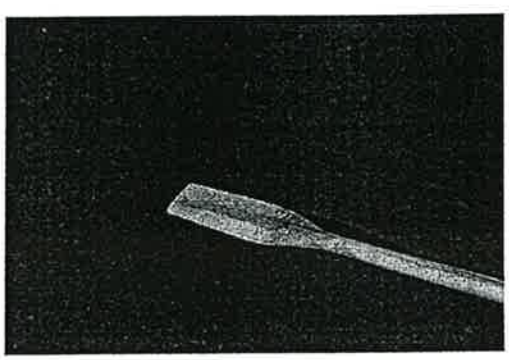


Shoreline bloom on Pigeon Lake, AB.

Microcystins primarily affect the liver and cause a slow death, up to 36 hours following consumption of tainted water. Common symptoms of poisoning are lethargy, pallor, extreme gastro-intestinal pain and diarrhea. This may lead to liver damage and hemorrhaging and in severe cases result in death by shock as much of the body's blood pools in the liver. In contrast, neurotoxins cause a rapid death, often within 30 minutes due to paralysis and respiratory arrest. To confuse matters, several toxins may be present at once and thus symptoms may vary or lack clear definition. The amount of water required to kill an animal generally depends on the density of toxin-containing cyanobacteria and the size and health of the animal. Old, very young, sick or weak animals generally have lower tolerance levels and will be poisoned with much smaller volumes of water consumed.

How Do Cyanobacterial Toxins Affect People? – Humans are just as susceptible to cyanobacterial toxins as animals, but it is unlikely that people would voluntarily drink affected lake water because of its objectionable appearance and odour. This explains the few records of toxicity causing death in humans. However, people can suffer acute discomfort after ingesting or contacting cyanobacteria.

Symptoms of liver or neuro toxicity may include fever, headache, dizziness, stomach cramps, vomiting, diarrhea and sore throat. Dermal toxicity usually includes skin and eye irritation and swelling, sore throat and swollen lips, but may also include other symptoms usually associated with swimmer's itch, such as hives. Symptoms seldom persist for more than two or three days. Children may be more intensely affected because they spend more time in the water than adults. Also, they may accidentally ingest contaminated shoreline water and have lower tolerances to the toxins than adults.



Severe cyanobacterial bloom

How is Toxicity Determined? – Confirming the presence of toxins in lakes and reservoirs is not a routine procedure. If the death or distress of animals is observed near a lake or human illness occurs, several methods, each with their own limitations, can be used to determine whether cyanobacterial toxins are implicated. Currently, laboratories in the Province are able to rapidly determine the concentrations of the liver toxin microcystin and the neurotoxin anatoxin-a.

Trained analysts can determine the presence of potentially toxic cyanobacteria microscopically, but this technique cannot distinguish toxic from nontoxic strains because the strains look alike. However, the presence of toxin-producing species is generally considered an appropriate indicator of the presence of one or more toxins and their density is a reasonable indicator of the degree of toxicity.

What Precautions Can You Take?

- Treat all blooms with caution
- Do not drink water from cyanobacteria laden or bloom-infested lakes and reservoirs
- Do not swim or wade in water containing concentrated cyanobacteria
- When at the lake, watch your children carefully
- Provide alternative sources of drinking water for domestic animals and pets

Who Can You Contact?

If you suspect a health problem related to cyanobacteria, including whether to swim in a lake, contact your regional health authority.

If someone experiences symptoms that may be related to cyanobacteria, **contact a physician** immediately.

If your pet has symptoms, **contact a veterinarian** as soon as possible.

If you have questions about water quality or if you find dead animals in or near a lake, contact your regional Alberta Environment office or the Environmental Monitoring and Evaluation Branch by calling toll-free (310-0000).

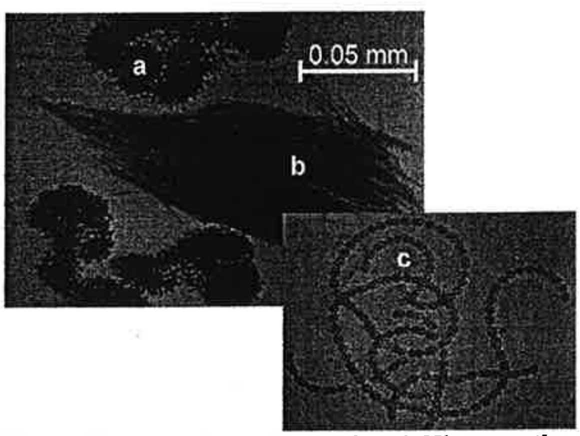
For more information on this issue read about Cyanobacterial Blooms in Surface Waters.

Cyanobacterial Blooms in Surface Waters

What are Blooms? – Many Alberta lakes undergo visible changes during the summer months. Otherwise clear, transparent water may suddenly become soupy in appearance, often turquoise, bright blue, grey, tan or even red in colour. In very rare instances this change is due to the excessive growth of microscopic plants called algae. Typically however, the organisms responsible for these changes are photosynthetic bacteria called **cyanobacteria**. When cyanobacteria grow profusely and congregate, they make lake water look like pea soup. This phenomenon is called a **bloom**.

Cyanobacterial bloom on a Central Alberta lake

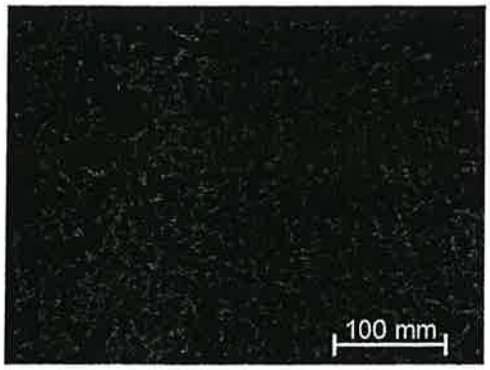
Because cyanobacteria share many similarities in overall appearance, nutrient requirements, and habitat with algae, they were originally classified as algae, and commonly called **blue-green algae**. Even today, many people still refer to them as blue-green algae and their accumulation at the water's surface as a blue-green algal bloom, or simply – algal bloom. We now understand cyanobacteria to be a truly unique group of bacteria capable of photosynthesis. That is, in the same fashion as algae and plants, cyanobacteria convert sunlight and nutrients into energy required for growth and reproduction.



Bloom-forming Cyanobacteria: a) *Microcystis*, b) *Aphanizomenon*, and c) *Anabaena*.

More than 100 species of cyanobacteria have been recorded in Alberta. A typical water sample collected from a lake during the summer can often contain 10 or more species of cyanobacteria. Some are tiny cells that cannot be seen with the naked eye, but for most species found in Alberta lakes, the cells are grouped into larger colonies that may look like fine grass clippings, small shapeless clumps, or spheres. Under the microscope the colonies may look like filaments, strings, bundles or clusters and can reach a size of several millimetres.

Why do Blooms Occur? – Cyanobacteria possess many unique adaptations allowing optimal growth and persistence and the ability to out-compete algae during favorable conditions. For instance, many species produce resting stages or cells that remain dormant until suitable conditions arise. Some possess specialized cells that convert nitrogen gas into forms required for nutrition (nitrogen fixation). And unlike algae, which require carbon dioxide gas for photosynthesis, most cyanobacteria can utilize other sources of carbon, like bicarbonate, which are more plentiful in alkaline or high pH environments (a common characteristic in many Alberta lakes).



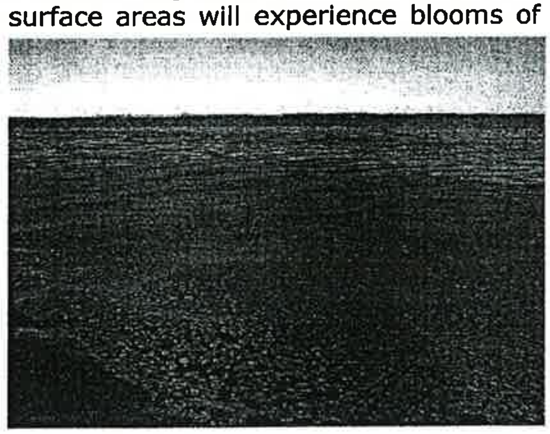
Clumps of cyanobacteria (mainly *Anabaena* and *Lyngbya*) near surface, Pigeon Lake, AB

The adaptation believed largely responsible for the success of cyanobacteria and the formation of blooms, however, is the regulation of buoyancy. Cyanobacteria possess the ability to form gas-filled cavities that reduce cell/colony density making them float to the surface. This allows vertical migration through the water column, affording access to optimal levels of light and nutrients. Once established, cyanobacteria may further alter water conditions to favor their own growth, while reducing growth rates of algae. For instance, cyanobacteria may reduce light availability to algae through shading and may elevate the water's pH by reducing carbon dioxide levels. As a result, many cyanobacteria become particularly visible near the surface of nutrient-rich (eutrophic) lakes, reservoirs and ponds. During windy periods cyanobacteria may produce a large number of gas-filled cavities to counter the downward drag of water currents. When calm stable conditions ensue, the now over-buoyant colonies may rise to the surface en masse creating severe blooms. Conditions can worsen if wind concentrates these scums into bays, or along the shorelines and beaches.

Interestingly, several species of cyanobacteria actually prefer lower light intensities and concentrate as distinct bands at intermediate depths in what is called a metalimnetic bloom. Though less common than surface or epilimnetic blooms, metalimnetic blooms occur periodically in lakes with moderate to low nutrient levels. So, even Alberta's clear-water lakes are susceptible to cyanobacterial blooms, we just can't see them.

Where and When Do Blooms Occur? – The more nutrient-rich (eutrophic) the lake, the more likely it is to sustain surface blooms of cyanobacteria. With the exception of the mountain lakes and those situated in the Canadian Shield in the extreme north east of the province, most of Alberta's lakes reside in glacial till basins comprised of nutrient-rich sedimentary bedrock. Consequently, many Alberta lakes are sufficiently eutrophic to **naturally** support cyanobacterial blooms. Furthermore, the transport of nutrients to lakes may be exacerbated by extensive watershed development (such as, urban, agricultural, and industrial activities) and shoreline disturbance (such as, removal of natural vegetation). In general, lakes with large watersheds in relation to their surface areas will experience blooms of greater magnitude and duration than those lakes of similar size with smaller watersheds.

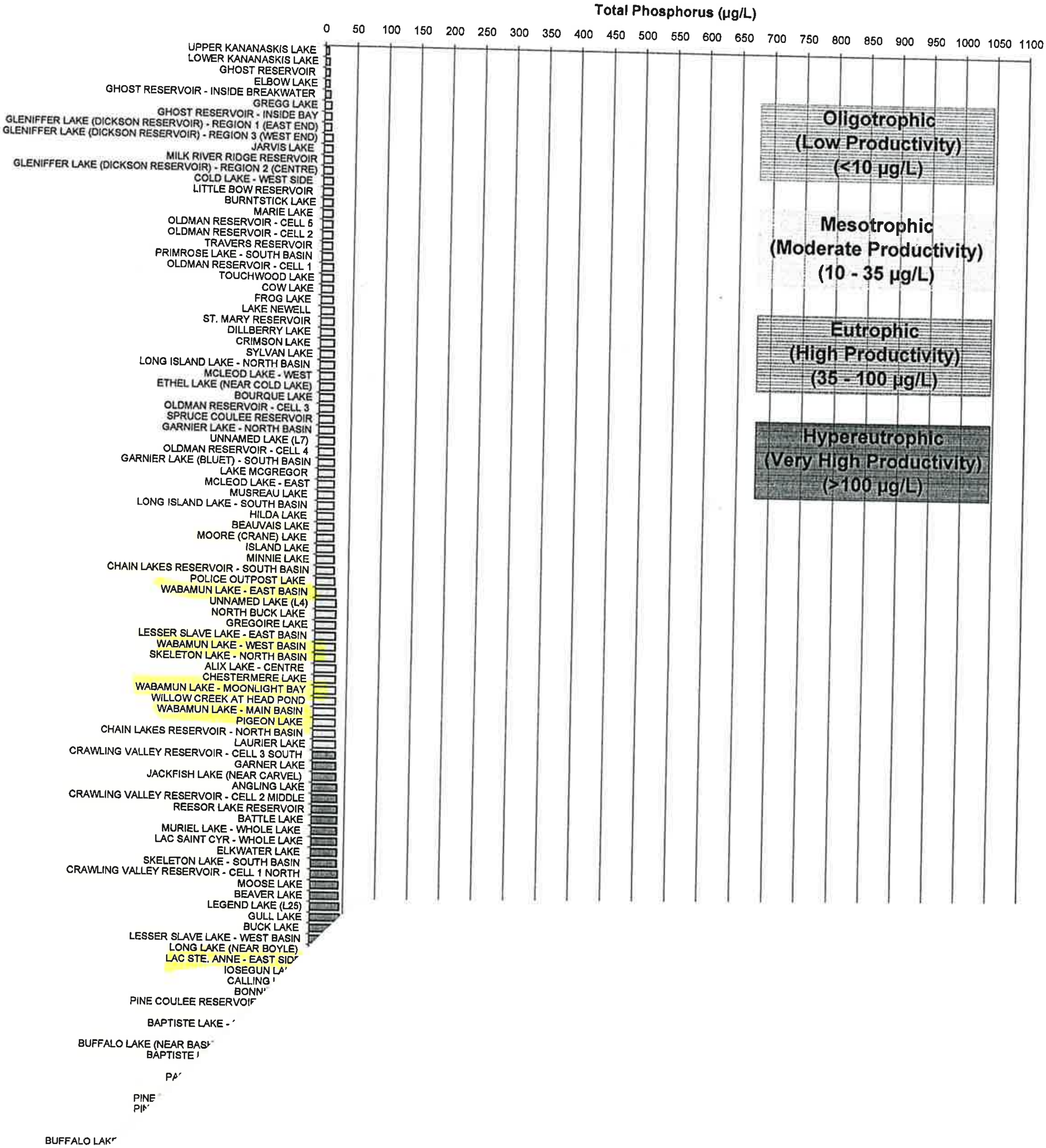
Blooms are most common in Alberta lakes from early July to mid-September. In many lakes, blooms only last for two or three weeks and are characterized by either one prevailing cyanobacterium or several co-occurring species. But in some extremely fertile lakes, cyanobacteria persist throughout summer and into fall as several species dominate the open water in succession (of one another).


Cyanobacteria bloom, Pigeon Lake, AB

Alberta
Environment

Trophic State of Alberta Lakes

Based on Average Summer (May-September) Total Phosphorus Concentrations.



Control phosphorous to save lakes: water expert

SARAH O'DONNELL
Edmonton Journal

University of Alberta water scientist David Schindler has had a rash of calls this summer from people worried about blue-green algae blooms.

On Wednesday, in a paper published in the Proceedings of the Royal Society of London, the internationally respected water researcher renewed his calls to target the nutrient phosphorous in the fight against blue-green algae and its harmful impacts on lakes and wildlife. After reviewing water studies from around the world, Schindler said he is more convinced than ever that eliminating phosphorous is the best way to help restore the health of lakes that have been saturated with run-off filled with livestock excrement or fertilizers.

The paper is directed at scientists. But the message is one that Schindler thinks is important to share with the public and policy-makers, as he has been doing for decades.

It comes at a time when some scientists have argued that nitrogen should be controlled, instead of, or in addition to, phosphorous.

"There is a good news message in my paper based on both my analysis of whole lake experiments and reviewing these histories of successful lake recoveries," Schindler said to the Journal. "That is that we really only need to control the phosphorous."

Schindler acknowledged that there will be some scientists who disagree. "There are a few scientists who have made their careers around nitrogen being controlled who won't be too happy," he said.

Schindler said taking steps to remove nitrogen can be extremely expensive. For example, removing nitrogen and phosphorous from Winnipeg sewage would cost four to eight times more than removing only phosphorous, according to the paper.

And there are no case histories or long-term studies that prove removing nitrogen will help, he said. Blue-green algae can absorb nitrogen from the air, but its only source of phosphorous is the water.

Alberta has seen several blue-green algae warnings this summer. In July, the province issued warnings for popular central Alberta lakes, including Lake Isle, Lac Ste. Anne and Pigeon Lake.

Schindler says cities have done a much better job keeping phosphorous out of Alberta's rivers in recent years, but lakes are still under pressure from several sources. Watersheds continue to be popular for cottage developments and forest is being converted to agricultural land.

"Just a simple conversion from forest to grasslands doubles the amount of phosphorous that runs into a lake," he said. "We've gone downhill in the past 20 years and we have a lot more people and because we have few lakes, we're literally loving our lakes to death."

sodonnell@edmontonjournal.com Twitter.com/scodonnell

January 24, 2013
HUFFPOST ALBERTA CANADA

David Schindler, University Of Alberta, Suggests Phosphorus The Real Enemy When It Comes To Algae

CP | By Tim Cook, The Canadian Press
Posted: 08/22/2012 4:29 pm Updated: 08/23/2012 12:05 pm

THE CANADIAN PRESS

EDMONTON - A University of Alberta ecologist says governments shouldn't be wasting money on controlling nitrogen to stop algae blooms in lakes.

David Schindler says lawmakers should focus instead on controlling phosphorus — something that can be accomplished at only a fraction of the cost.

"There are very few good news stories in ecology these days but this is one," Schindler said Wednesday. "It saves us a lot of money that we can spend for other things."

Numerous studies have linked summer algae blooms to both nitrogen and phosphorus getting into water through sewage and fertilizer.

But in a peer-reviewed paper published Wednesday in Proceedings of the Royal Society of London Series B, Schindler concludes that phosphorus is the real enemy.

Schindler says studies blaming nitrogen for blooms are short-term and do not take into account a lake's entire ecosystem.

"Emperor Nitrogen has no clothes," he said. "The conclusion is we need to rely entirely on whole-lake data ... for reliable environmental policy, not quick-and-dirty surveys with a few small bottles or little containers in lakes."

Schindler reached his conclusions based on studies he did himself on nitrogen in the 1970s and '80s, as well as on a year-long review of about 500 other reports on the subject.

The phosphorus-nitrogen debate has been a huge issue in Manitoba, where the provincial government and the City of Winnipeg had been at odds over the health of Lake Winnipeg.

The province wanted the city to spend millions in upgrades to its sewage treatment plant to remove nitrogen, while the city insisted that phosphorus was the real battle to pick.

Last year, the province released a pollution reduction strategy that backed away from targeting nitrogen.

Schindler says it was the right move.

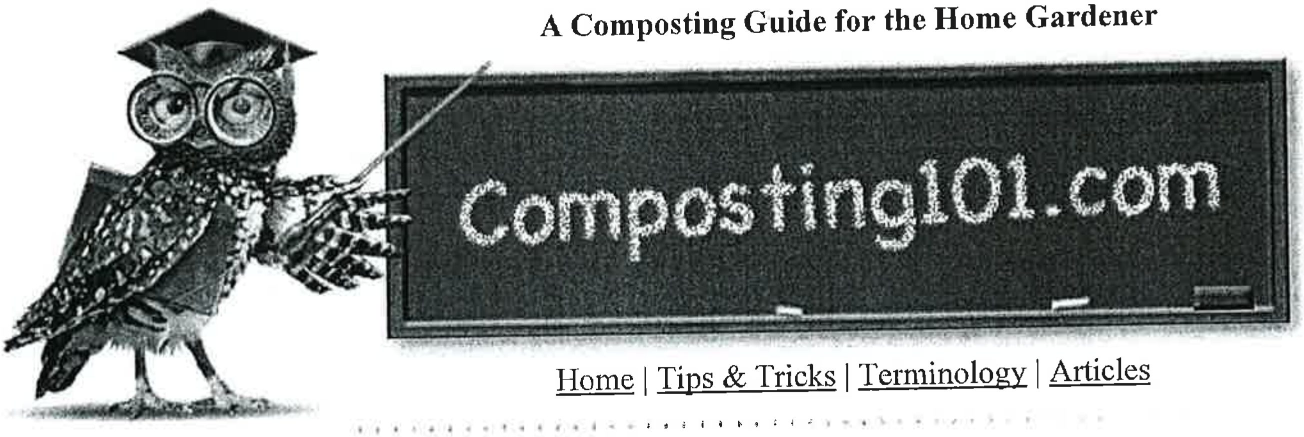
He notes it's much easier to control phosphorus than nitrogen. Phosphorus is removed from water with iron or aluminum or sometimes calcium — a straight-forward process. Getting rid of nitrogen is a two-step deal that relies on "finicky" biological processes.

It's possible focusing on nitrogen may actually make water quality worse — at least when it comes to toxic blue-green algae.

Known scientifically as Cyanobacteria, blue-green algae needs both nitrogen and phosphorus to thrive. It can get the nitrogen it needs from the atmosphere, but the phosphorus has to come from the water.

"By adding phosphorus in a higher amount than nitrogen you actually favour those species that you are trying to get rid of," Schindler said. "Some of us worry that, if you were to tightly control both, we might get fewer algae but might get a higher proportion of blue-green algae."

A Composting Guide for the Home Gardener



Home | Tips & Tricks | Terminology | Articles

COMPOSTING 101

How It Works

What To Use

Carbon-to-Nitrogen Ratio

The Finished Product

A Bevy of Bins

Using Worms

Troubleshooting

A Balancing Act (Carbon-to-Nitrogen Ratios)

All organic matter is made up of substantial amounts of carbon (C) combined with lesser amounts of nitrogen (N). The balance of these two elements in an organism is called the carbon-to-nitrogen ratio (C:N ratio). For best performance, the compost pile, or more to the point the composting microorganisms, require the correct proportion of carbon for energy and nitrogen for protein production. Scientists (yes, there are compost scientists) have determined that the fastest way to produce fertile, sweet-smelling compost is to maintain a C:N ratio somewhere around 25 to 30 parts carbon to 1 part nitrogen, or 25-30:1. If the C:N ratio is too high (excess carbon), decomposition slows down. If the C:N ratio is too low (excess nitrogen) you will end up with a stinky pile.

Below are the average C:N ratios for some common organic materials found in the compost bin. For our purposes, the materials containing high amounts of carbon are considered "browns," and materials containing high amounts of nitrogen are considered "greens."

Estimated Carbon-to-Nitrogen Ratios

Browns = High Carbon	**C:N**
Ashes, wood	25:1
Cardboard, shredded	350:1
Corn stalks	75:1
Fruit waste	35:1
Leaves	60:1

Newspaper, shredded	175:1
Peanut shells	35:1
Pine needles	80:1
Sawdust	325:1
Straw	75:1
Wood chips	400:1
Greens = High Nitrogen	**C:N**
Alfalfa	12:1
Clover	23:1
Coffee grounds	20:1
Food waste	20:1
Garden waste	30:1
Grass clippings	20:1
Hay	25:1
Manures	15:1
Seaweed	19:1
Vegetable scraps	25:1
Weeds	30:1

Note: Many ingredients used for composting do not have the ideal ratio of 25-30:1. As a result, most must be mixed to create "the perfect compost recipe." High C:N ratios may be lowered by adding grass clippings or manures. Low C:N ratios may be raised by adding paper, dry leaves or wood chips.

Many home gardeners prefer to put up with a slight odor and keep some excess nitrogen in the pile, just to make sure there is always enough around to keep the pile "cooking!" Learn more about building a hot compost pile here.

Home | Tips & Tricks | Terminology | Articles

Rats and Mice are very adaptable animals and live near to man and his food supplies. Rats can spread life-threatening disease and cause structural damage to buildings.
The most common species in the UK is the Brown or Norway rat, which is physically strong and has been known to survive two days in open water and can squeeze through a gap of less than 25mm ("1").

They can produce 6-8 young every 22-24 days and are prolific breeders.
Brown rats are omnivorous (they will eat almost anything edible) and consume up to 30g of food per day. Rats produce droppings that are capsule shaped about 20mm long sometimes in small groups or scattered

Rats are more likely to be found outdoors or in buildings such as garages or sheds and rarely invade your home. If rats do enter a house they are likely to be found in cavity walls, lofts and basements and under suspended wooden floors.

In rural areas rats like to live by watercourses and can often be found burrowing into river banks. They are attracted into gardens for either food, shelter or both, so anyone who overfeeds the birds and consequently leaves food out overnight can cause problems. Other attractants are livestock and their food, be it a pet rabbit, pigeons or chickens etc. Rats can often be found living underneath nearby sheds or burrowing nearby to one of these food sources.

Untidy gardens with various types of materials or rubbish piled up in corners are also attractive to rats who may nest there. Compost heaps with their higher temperatures, due to the decomposing of garden waste etc., can also attract them.

Other access points are through various gaps around the external perimeter of your or the adjoining neighbours property. Gaps around pipes, broken airbricks, missing bricks or cement joints, gaps under doors. These are all common faults which the rats and mice take advantage of. They will also climb up pipes, trestles or any type of vegetation that's either growing up or nearby to the property. Once on the roof they enter through gaps in the slates etc.

If you think you may have rats or mice in either your garden or home then you need to act, as they can quickly breed and cause you all sorts of problems.

Rats and mice need to constantly gnaw, in order to maintain their continual growing teeth. This can be particularly troublesome as they chew through all sorts of hard as well as soft materials. They damage floorboards, skirting and joists. They chew through pipes and cables causing leaks and occasional electrical fires, damage is common to items stored in roof-spaces, they will also chew stored items in the garden shed or garage once they manage to get in.

Sometimes the first indication of rodents in the home is when scratching sounds are heard in either the roof-space or the cavity walls during the late evening and nightime. Occasionally birds can also be responsible for these scratching sounds so it's always best to try and distinguish the cause first. Mice usually make their presence known in other ways, such as leaving droppings wherever they have been active, be it in the roof-space or behind items of furniture or equipment in the home. However, rats do not usually start to leave droppings until they are familiar with the area, so when first checking for signs you may not find any. If your property is quite old there is a good chance that there will be plenty of dust in the roof-space, by using a torch it is possible to see footprints in the dust if something has been moving around up there. Other areas to check for signs are the meter cupboard, the cylinder cupboard, behind the bath panel (if it can be taken of), any cellar areas and any other obvious areas around the house.

Once you have identified the problem you can either contact the councils pest control team to carry out a treatment or get poison baits yourself from any of the large d.i.y. stores, garden centres etc. The two most popular baits contain either Bromadiolone or Difenacoum as active ingredients.

If you are decide to attempt the treatment yourself, start by placing a few baits in the roof- space, even if there are no signs or you are not hearing the rodents there. The baits can be placed nearby to the hatch if it's difficult to access. Before you place any baits around the living area make sure small children and pets can't gain access to them. Bait should then be placed in each of the areas you checked earlier.

Additionally for rats, if you were unable to find any obvious access holes around the external perimeter of the building, it is advisable to lift the manhole chamber in the garden or driveway and place some bait on the internal shelving. This will serve two purposes

1. if there are rats in your drainage system they will take the bait and
2. if not, then the drains can be excluded as a possible source of entry.

Rats are very cautious creatures and will sometimes avoid the baits for a number of days before they feel comfortable approaching and eating them. With this in mind you should make sure that alternative food sources are not available to them. Do not leave foodstuffs out overnight including pet food. Once the baits start to be eaten make sure you replace them as necessary, for if there is more than one rat a considerable amount will be consumed.

After they have taken the bait it can be several days before they die. It is also possible that a few days later you may start to experience a smell. If accessible, any bodies should be searched for and buried or burned but occasionally they may die in hard to reach areas and their removal would involve the cost of structural work. The smell can last for a number of weeks depending on the time of year and can be followed by the appearance of Bluebottles some weeks after that.

Try to ensure adequate ventilation for affected rooms, it will help if you could place a number of tissues, cotton wool balls etc. soaked in strong smelling disinfectant etc. as close as possible to the suspected areas.

Break Back traps are available and will ensure the rats bodies are recoverable but they can be dangerous to use and are sometimes permanently avoided by rats, a combination of poison bait and traps would be better for home use.(By law, traps have to be checked at least once every twenty four hours)

If the rats are in the garden, baits can be placed in or around the areas of any sightings. Care must be taken to ensure non- target species like birds and pets cannot reach the bait.

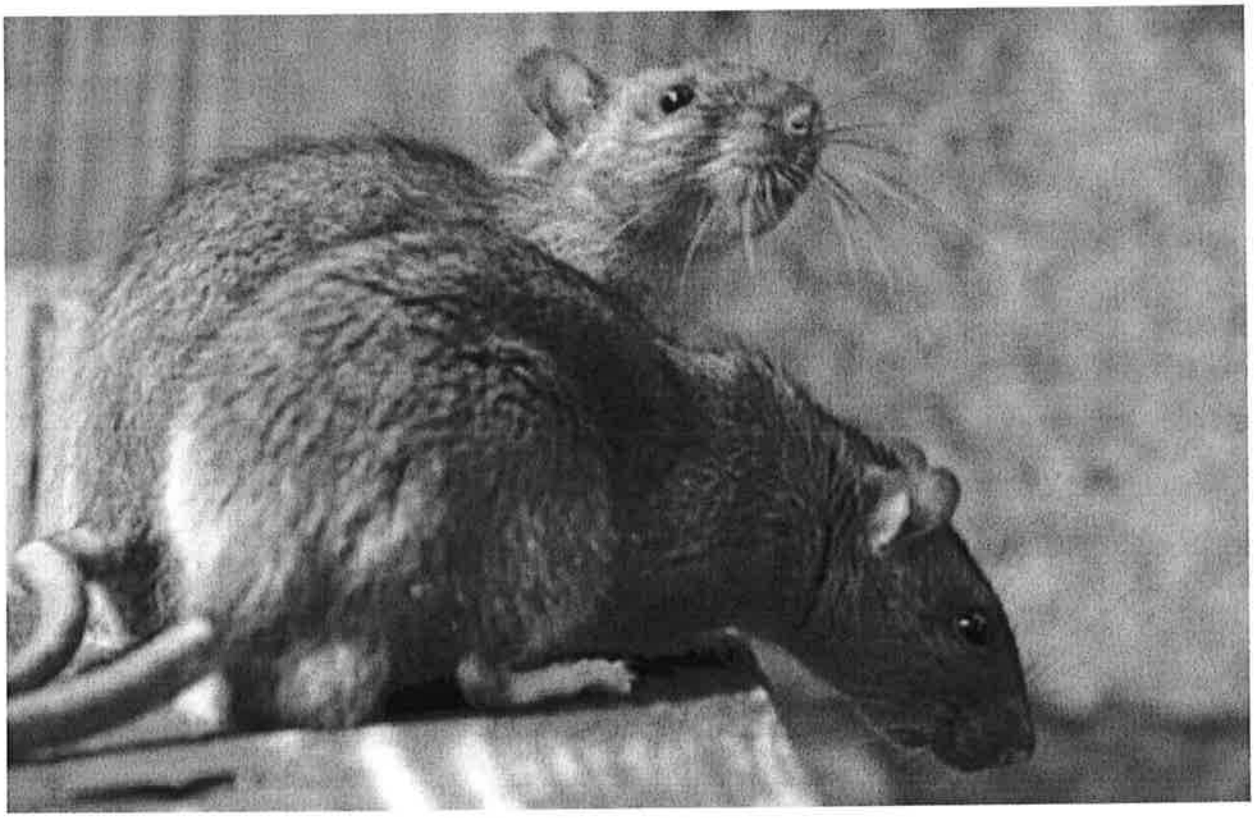
Garden sheds, out-buildings and garages can all be baited. Additionally you can place bait into the middle of lengths of piping from two to four inch diameter and about eighteen inches long. If you don't have any piping you could make tunnel shapes out of bricks, slates, timber etc. and site them around the edges of the garden safe from pets and rain. Again, the rats appearance could be drain related so check around the area of the manhole for signs of holes and if applicable make sure any outside toilets still have their water traps in place. Once baits stop being taken leave them in place for another week or two, just in case there are others in the area, after which time they can be removed and safely disposed of (follow manufacturers recommendations).

MICE

The treatment for mice is much the same as for Rats. Their droppings are obviously much smaller being dark brown/black in colour and about the size of a grain of rice. Mice are not as shy as rats and will quickly start to take any baits, they are also able to squeeze through much smaller gaps (6mm) However, mice will **not** be in the drainage system but usually enter via holes in the external structure sometimes even through the oversized holes in the older types of air-bricks. They can also be brought into the home inside packaging or in boxes that may have been stored in a shed or garage.

Rat patrol steps up war on hundreds of rodents at Medicine Hat landfill

BY SHERRI ZICKEFOOSE, CALGARY HERALD AUGUST 17, 2012



More than 50 rats have now been caught at Medicine Hat's rodent-infested garbage dump.
Photograph by: Screengrab, GI

Hundreds of rats infesting a Medicine Hat landfill have provincial officials scrambling to defend Alberta's rat-free status.

More than 50 rats have been caught and killed at Medicine Hat's garbage dump since the colony was discovered last week.

Single Norway rat sightings were first reported in the area last spring, officials say.

"We're going to estimate that this infestation is small rather than large, and by small we mean several hundred rats as opposed to thousands," said Vaughn Christensen, manager with Alberta Agriculture and Rural Development.

"And we do have it isolated and contained."

The infestation is "one of our larger ones," since the rat eradication program began in 1952, Christensen said.

"Occasionally, we get small investigations around the border."

Agriculture Minister Verlyn Olson vowed to resolve the issue.

"We're up to 52 now, and they've been destroyed," Cypress County agricultural fieldman Jason Storch said Thursday.

Workers are monitoring the site around the clock with infrared digital cameras and bait traps loaded with poisoned food and water. Neighbouring homes and farms have also been outfitted with poisonous traps to prevent the spread of pests.

If needed, bull snakes may be let loose at the landfill.

A single pair of healthy rodents are capable of breeding 15,000 young in a year.

"It's very hard to tell how many are in there. There's no way of knowing. But we're making headway at this point," said Storch.

"We're just monitoring it and that's going to continue until they're all gone," he said.

Dozens of bait stations are set up about every three metres around the landfill.

"We're doing more perimeter baiting to keep ahead on everything. The trick here is to get ahead of them."

Alberta claims to be rat-free, and has only experienced isolated cases of the rodents since the 1950s.

The province, which spends $350,000 a year on its rat-control program, has 11 rat inspectors who patrol the border with Saskatchewan, aiming to prevent the vermin from destroying crops.

Six counties and municipal districts participate in the patrol of the rat-control zone, which is 30 kilometres wide and stretches 390 kilometres from the Montana border to Cold Lake.

Despite the efforts, rodents carried by shipping containers on airplanes, trucks and trains, and some bought by pet owners as snake food, show up in Alberta frequently, officials say.

The City of Calgary fields about 200 rat calls each year, but almost all turn out to be squirrels, muskrats or gophers.

In 2011, four pet rats were discovered in Calgary. Last year, the city located five Norway rats. One came dead in a truck, and the other four were categorized as pets, or fancy rats.

City officials issued a warning that it is illegal to keep rats as pets after three Norway rats were seized from two homes last February.

Possession of a rat can lead to a fine of up to $5,000.

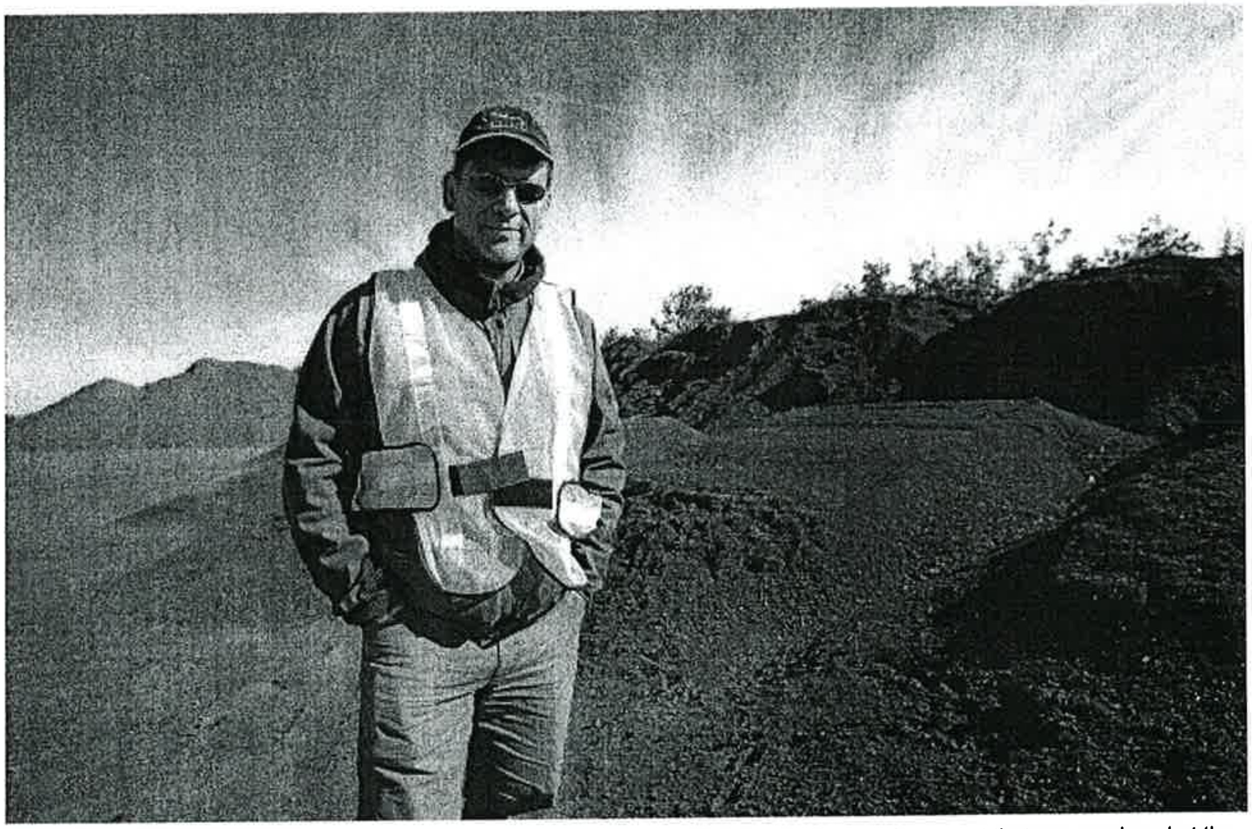
Norway rats can measure up to 25 centimetres long and weigh around half a kilogram.

Provincial law requires that rats discovered in Alberta either be euthanized or removed from the province.

szickefoose@calgaryherald.com

Edmonton compost facility pledges to control pugnacious odour

BY ELISE STOLTE, EDMONTON JOURNAL SEPTEMBER 23, 2012



Marco Castro Wunsch with Advanced Enviro Engineering Limited stands in front of a pile of compost that was produced at the Cleanit Greenit Composting System in Edmonton on Sept. 12, 2012.

Photograph by: Greg Southam, Edmonton Journal

EDMONTON - West-end residents frustrated at the smells coming from a private company's three-storey pile of rotting compost have a glimmer of hope for next year.

The company Cleanit Greenit is testing a new method of forcing air into the piles of decomposing refuse, and has promised to give the city a plan within 30 days on how to reduce the amount of waste it stores on site.

The regional composting facility, at 11304 205th St. in the Winterburn industrial park, is located just two kilometres away from homes. Over its 14-year existence, the company has regularly accepted food and paper waste, yard clippings, oil-contaminated soil, manure and treated human waste, mainly from municipalities around Edmonton.

But this summer, residents to the south and east have complained about an ammonia smell so bad it forced them shut their doors and windows.

Coun. Linda Sloan's office has been inundated with complaints.

"It's reached such a level, we have business owners who have trouble retaining employees," she said. "It's at a stage where closing the facility has to be an option. I want them to be stopped from accepting more waste."

This year's 120 complaints nearly equalled the 130 complaints the province received from 2005 through 2011.

"This is like one mountain manure pile right in the middle of the city," Sloan said.

"Sometimes it smells like an outhouse, sometimes like silage, like rotting and fermenting organic matter," said Belmead resident June McNeil.

"This summer it was really terrible, the worst ever. Nobody could eat outside, sit outside. Summer in our neighbourhood was ruined."

Click here to see pictures of Cleanit Greenit's new aeration system, and read the provincial enforcement orders at Elise Stolte's blog.

The province ordered Cleanit Greenit to stop accepting waste Dec. 13, 2011, when government officials found the company had more than double the amount of compost allowed in its operating plan. There were also concerns run-off was contaminating the soil and surface water.

The site reopened nine days later with requirements for the firm to report every odour complaint, and submit a plan to achieve no net increase in material. They have continued to operate under various enforcement orders and provincial supervision since.

This month, city administrators decided to investigate, too.

Company owner Kirstin Castro-Wunsch admits this summer has been particularly smelly.

The abundant rain was great for green lawns, but filled the facility with heavy, wet grass clippings, she said. The stuff mats together, eliminating oxygen from the pile. Without air, the wrong kind of microbes set to work and produce the worst smells.

"It's been causing all of the composters challenges," Castro-Wunsch said. "It's just really unfortunate."

She said she's been trying to improve the smell since the province got involved last year.

"It's Murphy's law (the grass overload) had to happen this year," she said. "I'm really sorry. We're just trying to do a good job. I wish we didn't have any odour complaints and we'll get to that." Residents are invited to call the office directly when the smell is particularly bad at 780-488-7926.

Castro-Wunsch said most of her raw material comes from the curbside composting programs in Stony Plain, Spruce Grove and Sherwood Park. She tries to include in each contract a requirement to take the finished compost product back, but Strathcona County declined this year. That's been one reason why material has been building up.

This month, Cleanit Greenit started a $40,000 research and development trial that could drastically reduce the smell even if the facility gets overloaded with grass again, she said.

The project, paid for through the federal Industrial Research Assistance Program, runs pipes through piles of compost to force air through. It's more efficient than the current practice of mixing wood chips into the piles to passively let air filter through.

Getting air flow means "you're having the right kind of bugs working on the compost," said Marco Castro-Wunsch, Kirstin's husband and a technician.

The system lets him cover the whole pile with another layer of wood chips to further filter the smell. "You're going to see a big difference," he said.

However, the pilot project is being applied to just 10 per cent of the property for now. The company has plans to expand it, but "it all costs money," he said.

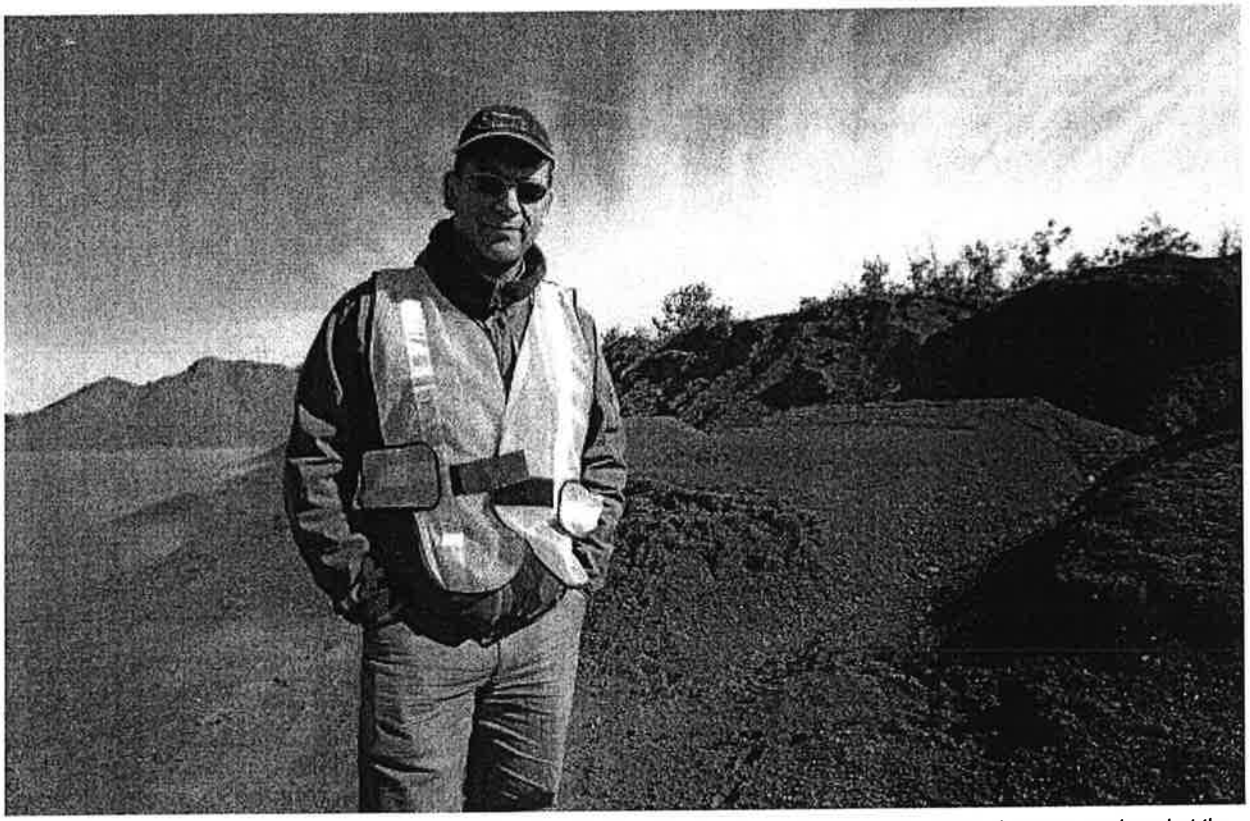
If anyone wants to help reduce the amount of compost on site, they can buy compost from Jils Landscape Supply or Canar Rock and Landscape Supplies for about $25 a cubic yard, Kirstin Castro-Wunsch said. "That would really help a lot."

estolte@edmontonjournal.com

twitter.com/estolte

See pictures of Cleanit Greenit's new aeration system, and read the provincial enforcement orders at edmontonjournal.com/edmontoncommons.

Previous Next



Marco Castro Wunsch with Advanced Enviro Engineering Limited stands in front of a pile of compost that was produced at the Cleanit Greenit Composting System in Edmonton on Sept. 12, 2012.

Photograph by: Greg Southam, Edmonton Journal

STANDARDS FOR

COMPOSTING FACILITIES IN ALBERTA

Alberta Environment
Environmental Assurance
Environmental Policy Branch

July 2007

FOREWORD

Until the updated regulatory revisions are legislated, these *Standards* will only apply to new composting facilities or lateral expansions as required by the Director issuing approvals or reviewing applications for registration. It is expected that those responsible for composting facilities, including consultants, will use the *Standards* to prepare approval and registration applications and improve composting facility design, operation, and closure measures.

Existing composting facilities operating under an approval or registration shall follow the conditions of their approval or registration. However, facility owners and operators should begin updating their operations plan, monitoring plans, and other requirements of the *Standards* in preparation for legislation changes.

The use of the standards does not absolve a composting facility owner from Alberta Environment or other ministries regulatory requirements. The composting facility owner should consult agencies such as the local development authority, the Energy and Utilities Board if accepting oilfield wastes, and Federal Ministries such as Environment Canada to determine other applicable regulatory requirements.

Any comments or concerns with the content of the Standards should be submitted in writing to:

Waste Policy Advisor, Environmental Policy Branch
Alberta Environment
10th Floor Oxbridge Place
9820-106 Street
Edmonton, Alberta T5K 2J6

For copies of this report, contact:

Information Centre
Alberta Environment
9820-106 St.
Edmonton, Alberta
T5K 2J6

Pub. No: I/XXX
ISBN: 0-7785-XXXX-X Printed Edition
ISBN: 0-7785-XXXX-X On-line Edition
Web Site: www.gov.ab.ca/env/

ACKNOWLEDGEMENT

Alberta Environment acknowledges with gratitude the guidance and direction provided by the participants in developing this document. The members willingly participated in the process by volunteering their time to attend meetings and review documents. The participants and Alberta Environment staff members included the following.

Steering Committee

Salim Abboud, Ph.D.	Alberta Research Council
Susan Antler, MBA	Composting Council of Canada
Donna Chaw, Ph.D.	Alberta Environment
Andy Cumming, B.Sc Eng	Natural Resources Conservation Board
Gordon Dinwoodie	Alberta Environment
Jennifer Fisher, B.A.I.E., C.Tech	Alberta Energy and Utilities Board
Scott Gamble, P. Eng	CMH2Hill
John Hastie, M.Sc. P.Ag.	Valdrew Environmental Services Ltd.
Steve Johnson, M. Eng. P. Eng.	Alberta Environment
Brian Koberstein	Alberta Agriculture and Food
Jim Lapp, Civil Tech	City of Edmonton
Janet Mclean, M.Sc.	Alberta Environment
Molly Morse, Compost Dip	City of Calgary
Virginia Nelson, M.Sc., P. Eng	Alberta Agriculture and Food
Natasha Page, M.Sc., A. Ag.	Alberta Environment
Stephen Parker	Alberta Health
Mary Stewart, P. Eng.	Regional Services, Alberta Environment
Bruce Taylor, Ph. D., P. Ag.	Solid Waste Association of North America
Jodi Tomchyshyn, M. E.Des.	Alberta Environment
Allan Yee, CD, M.Sc., P. Eng	City of Edmonton/Composting Council of Canada

Facilities Siting and Design Working Group

Ken Armstrong, P. Eng	Consulting Engineers of Alberta
Andy Cumming	Natural Resources Conservation Board
Steve Johnson, M. Eng. P. Eng	Alberta Environment
Brian Koberstein	Alberta Agriculture and Food
Doug Munro, B. Ed	Flagstaff Regional Solid Waste Management
Natasha Page, M. Sc., A. Ag.	Alberta Environment
Jason Price, M. Sc.	Alberta Agriculture and Food
Kate Rich, M.Sc., P. Geol.	Alberta Environment
Mike Sandford, B.A. (Special)	Alberta Municipal Affairs and Housing
Mary Stewart, P. Eng.	Regional Services, Alberta Environment
Bruce Taylor, Ph. D., P. Ag.	Solid Waste Association of North America

Facilities Operations Working Group

Abimbola Abiola, Ph.D, R. M., P. Ag.	Olds College
Marie Beliveau, C.P.H.I. (C)	Alberta Health and Wellness
Doug Everett, C.P.H.I. (C)	Alberta Health and Wellness
Scott Gamble, P. Eng	CMH2Hill
Matt Haghighi, P.Eng.	Alberta Environment
Jim Lapp, Civil Tech	City of Edmonton
Dean Litzenberger	Alberta Environment
Doug Munro, B. Ed.	Flagstaff Regional Solid Waste Management
Natasha Page, M. Sc., A. Ag.	Alberta Environment

Brian Sexton	Alberta Agriculture and Food
Mike Sandford	Alberta Municipal Affairs and Housing
Bill Symonds	Alberta Municipal Affairs and Housing
Jodi Tomchyshyn, M. E.Des.	Alberta Environment
Robin Vogelesang	Alberta Municipal Affairs and Housing

Final Product Working Group

Mohamed Amrani, Ph. D., P.Ag.	Alberta Agriculture and Food
Susan Antler, MBA	Composting Council of Canada
Donna Chaw, Ph.D.	AMD Organics Inc
Gordon Dinwoodie	Alberta Environment
Matt Haghighi, P. Eng.	Alberta Environment
John Hastie, M.Sc. P.Ag	Valdrew Environmental Services Ltd.
Cody Jackson	Top Spray div. of Spray Lake Sawmills
Tanya Moskal-Herbert	Alberta Agriculture and Food
Natasha Page, M. Sc., A. Ag.	Alberta Environment
Jason Price, M. Sc.	Alberta Agriculture and Food
Elston Solberg, M.Sc.	Agri-trend
Allan Yee, CD, M.Sc., P. Eng	City of Edmonton/Composting Council of Canada

INTRODUCTION

Alberta Environment is updating its waste management regulatory requirements. The *Standards for Class II & Class III Composting Facilities in Alberta* (*Standards*) is one initiative in upgrading waste management regulatory requirements. The *Standards* outline the minimum requirements for development, operation, monitoring, and closure of a Class II & Class III composting facility.

These standards were built on the following outcomes:

Alberta's composting facilities are designed, constructed, operated and closed in a manner that is protective of air, land, water, biodiversity, human health, and human quality of life.

Facilities will meet local land use planning requirements, and not create a risk to the local community.

Compost quality meets minimum requirements to not adversely affect the land, plants, or crops.

These standards outline the requirements for Class II and Class III composting facilities. Persons responsible for composting facilities affected by these standards should consult with Alberta Environmental prior to commencing the construction and operation of a composting facility.

The classifications for composting facilities are as follows:

Class I composting facilities are facilities that accept more than 20,000 tonnes of feedstock per year. Persons responsible for Class I composting facilities should contact Alberta Environmental for more information regarding regulatory requirements.

Class II composting facilities are facilities that accept 500 to 20,000 tonnes of leaf and yard waste feedstock per year, or up to 20,000 tonnes of feedstock per year. Acceptable feedstock for Class II facilities includes: animal bedding, brewery/winery waste, cardboard and paper products, food waste, manure, milk processing waste, paunch manure, hatchery waste, source separated organics, wastewater sludge, and vegetative matter. Additional feedstock may be received at a Class II facility, pending approval by Alberta Environment.

Class III composting facilities are facilities that accept 100 to 500 tonnes of leaf and yard waste feedstock per year.

These standards do not apply to composting facilities accepting less than 100 tonnes per year of leaf and yard waste.

TABLE OF CONTENTS

DEFINITIONS

For the purposes of these Standards,

(a) "Act" means the *Environmental Protection and Enhancement Act.*, R.S.A. 2000 c. E-12, as amended;

(b) "Active Composting Area" means the area where windrows or piles of feedstock are placed for active composting;

(c) "Aerobic conditions" means an environment which is conducive to the microbial degradation of organic solid waste in the presence of oxygen

(d) "Amendments" means a supplemental material mixed with compostable feedstock in preparation for composting to create a favorable condition for composting, either by adjusting the moisture content, or the carbon to nitrogen ratio;

(e) "Animal bedding" is absorbent material that is used for covering the floor of livestock confinement areas, and includes straw, wood shavings, and associated manure and urine;

(f) "Animal Mortality" means a deceased animal, not including hatchery waste

(g) "Animal Part" means any part of an animal that is not food waste or hatchery waste;

(h) "Background groundwater quality" means the groundwater quality prior to the start of composting operations;

(i) "Brewery/winery waste" means non-hazardous organic waste from beer and wine manufacturing. This includes materials such as: spent grain, yeast, and grape marc;

(j) "Bulking agent" means a material that is added to compostable feedstock to enhance porosity and airflow;

(k) "CCME" means the Canadian Council of Ministers for the Environment;

(l) "Class I composting facility" means a waste management facility which accepts 20,000 tonnes or more per year of feedstock for composting, for composting, but does not include:
   a. a residential composter, or
   b. a manure storage facility as defined in the *Agricultural Operation Practices Act*;

(m) "Class II Composting Facility" means a waste management facility that accepts under 20,000 tonnes /yr wet weight of feedstocks for composting, but does not include
   a. a residential composter;
   b. a Class I composting facility;
   c. a Class III composting facility; or,
   d. a manure storage facility as defined in the *Agricultural Operation Practices Act*.

(n) "Class III Composting Facility" means a waste management facility accepting between 100 and 500 tonnes per year of leaf and yard waste feedstock for composting, but does not include
   a. a residential composter;
   b. a Class I composting facility;
   c. a Class II composting facility; or,
   d. a manure storage facility as defined in the *Agricultural Operation Practices Act*.

(o) "Certified Operator" means a person who holds qualifications recognized by the Director;

(p) "Compost" is a solid mature product resulting from composting;

(q) "Composting" is a managed process of bio-oxidation of a solid heterogeneous organic substrate including a thermophilic phase;

(r) "Contaminant" means a substance that is present in an environmental medium in excess of natural background;

(s) "Curing Area" means the area where composting materials are placed to stabilize to reach maturity;

(t) "Day" means any period of 24 consecutive hours unless otherwise specified;

(u) "Design Capacity" means the processing capacity of the composting facility in tonnes (w/wt) of feedstock accepted per year;

(v) "Expanding Facility" means a facility that applies to increase the registered design capacity;

(w) "Feedstock" means all materials that are accepted at the composting facility and used in the composting process, including amendments and bulking agents;

(x) "Feedstock Preparation Area" means the area where feedstocks are temporarily placed for processing prior to active composting;

(y) "Food waste" means food and food preparation wastes from residences and commercial establishments such as grocery stores, restaurants, produce stands, institutional cafeterias and kitchens, and industrial sources like employee lunchrooms;

(z) "Foreign matter" means any matter over 2mm in dimension that results from human intervention and has organic or inorganic components such as metal, glass, synthetic polymers (for example plastic and rubber) and that may be present in the compost including metal, glass, plastic, rubber and other synthetic polymers, but excluding mineral soil, woody material and pieces of rock;

(aa) "Final Closure" means the period after all feedstock acceptance has ceased;

(bb) "Groundwater" means all water under the surface of the ground whether in liquid or solid state;

(cc) "Groundwater contamination" is defined as a change in water quality that produces a noticeable or measurable change in groundwater characteristics;

(dd) "Hatchery waste" means broken or unhatched eggs, unhatched chicks, membranes, embryonic fluids and egg shell;

(ee) "Hydraulic conductivity" means the ease with which a fluid can be transported through a material;

(ff) "ISO 17025" means the international standard, developed and published by International Organization for Standardization (ISO), specifying the management and technical requirements for laboratories;

(gg) "Leaf and yard waste" means vegetative matter resulting from gardening, horticulture, agriculture, landscaping or land clearing operation, including materials such as tree and shrub trimmings, plant remains, grass clippings, leaves, trees and stumps;

(hh) "Liner" means a continuous layer constructed of natural or man made materials, beneath or on the sides of a structure or facility, which restricts the downward or lateral migration of the contents of the structure or facility;

(ii) "Mature compost" means a stable compost that has little or no organic phytotoxic substances that can cause delayed seed germination when used as a soil amendment, and meets maturity compost quality requirements, as set out in the Guidelines for Compost Quality, published by CCME, as amended;

(jj) "Manure" means excreta in liquid or solid form from livestock, poultry, pets, animals in zoological facilities, and aquaculture;

(kk) "Manure storage facility" means a manure storage facility as defined in the *Agricultural Operation Practices Act*;

(ll) "Milk processing waste" means sludge or biomass from treatment of milk or fluid milk;

(mm) "Monitoring well" means a well drilled at a site to measure groundwater levels and collect groundwater samples for the purpose of physical, chemical, or biological analysis to determine the concentration of groundwater contaminants;

(nn) "Natural protective layer" means a continuous layer of natural materials, beneath or on the sides of a structure or facility, which restricts the downward or lateral migration of the contents of the structure or facility;

(oo) "Pathogens" means organisms, including some bacteria, viruses, fungi, and parasites, that are capable of producing an infection or disease in a susceptible human, animal or plant host;

(pp) "Paunch manure" means undigested stomach contents of ruminants;

(qq) "Positive slope" means a slope that encourages positive drainage of water and minimizes ponding;

(rr) "Process water" means a combination of storm water run-on, leachate, equipment wash down water and any other wastewater generated on site;

(ss) "Processing area" means the combination of the feedstock processing and the active composting area;

(tt) "Receiving area" means the area used to receive incoming feedstocks;

(uu) "Registered Design Capacity" is the design capacity that has been registered with Alberta Environment;

(vv) "Retention Pond" means a pond that is designed to store process water and run-off from storm events;

(ww) "Run-off" means any rainwater or meltwater that drains as surface flow from the receiving, processing, curing and associated storage areas of a compost facility;

(xx) "Run-on" means any rainwater or meltwater that drains as surface flow onto the receiving, processing, curing and associated areas of a compost facility;

(yy) "Sharp foreign matter" means any foreign matter over 3mm dimension that may cause damage or injury to humans and animals during or resulting from its intended use, and may consist of, but is not limited to the following: metallic objects or pieces thereof; glass or porcelain or pieces thereof;

(zz) "Source separated organics" means the organic fraction of municipal solid waste, that has been accumulated and presorted by the generator, and collected separately from household hazardous material and non-compostable material;

(aaa) "Spring" means an area where groundwater flows naturally onto the earth's surface at an identified location;

(bbb) "Storage area" means the area used to store mature compost;

(ccc) "Storage capacity" means the storage area size that is capable of storing one year's worth of compost production for a period of eight months;

(ddd) "Subsoil" means the layer of soil directly below the topsoil, to a maximum depth of 1.2 metres below the topsoil surface, that consists of the B and C horizons as defined in The System of Soil Classification for Canada, Agriculture and Agri-Food Canada, 1998, Publication 1643, 3rd Edition, as amended or replaced from time to time;

(eee) "Topsoil" means the uppermost layers of soil that consist of the L, F, H, O, and A horizons as defined in The System of Soil Classification for Canada, Agriculture and Agri-Food Canada, 1998, Publication 1643, 3rd Edition, as amended or replaced from time to time;

(fff) "Trace elements" are chemical elements present in compost at a very low concentration;

(ggg) "Wastewater sludge" means the accumulated wet or dry solids that are separated from wastewater during treatment, including the precipitate resulting from the chemical or biological treatment of wastewater;

(hhh) "Water body" means a water body as defined in the *Water Act*.

(iii) "Water table" means the upper level of groundwater: the level below which the pore spaces in the soil or rock are saturated with water;

(jjj) "Water well" means an opening in the ground, whether drilled or altered from its natural state, that is used:

a. for the production of groundwater for any purpose;
b. obtaining data on groundwater; or
c. recharging an underground formation from which groundwater can be recovered, and includes any related equipment, buildings, structures and appurtenances;

(kkk) "Working surface" means a surface that can withstand the wear and tear of composting equipment and forms the base of the receiving, feedstock preparation, active composting, screening, and curing areas of a composting facility;

(lll) "Vegetative matter" means source-separated organics that consist of plant matter, including but not limited to non-treated wooden material, leaf and yard waste, agricultural crop residues, vegetable processing plants, and pre-consumer meat-free food wastes;

(mmm) "Year" means a calendar year.

CLASS II COMPOSTING FACILITIES

1. Registration

1.1. Registration Application

In addition to any information required by the Director under the Approvals and Registration Procedure Regulation (A.R. 113/93), an application for registration of a newly proposed or an expanding composting facility shall contain at a minimum the following documents:

a) a registration application form;
b) a composting facility checklist;
c) a facility design plan and specifications;
d) a topsoil stockpile plan;
e) an operations plan;
f) an odour management program;
g) a groundwater monitoring program; and
h) a background groundwater quality report.

1.2. Facility Design Plan and Specifications

(a) Unless authorized in writing by the Director, the Facility Design Plan and Specifications shall be prepared by a professional registered with the Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA).

(b) The Facility Design Plan and Specifications shall include, as a minimum, all of the following:

(i) An engineering design report that provides a description of proposed:

- a. feedstocks;
- b. composting methods;
- c. design capacity, including:
  - i. processing area capacity;
  - ii. storage area capacity; and
  - iii. curing area capacity.
- d. environmental control measures included in the design; and
- e. monitoring systems.

(ii) Engineering maps and plans that include:

- a. soils investigation report;
- b. topographic site plans showing the overall site development and setbacks;
- c. cross-sections showing based grades and elevations;
- d. a description and interpretation of groundwater elevations, flow, patterns and composition;
- e. details of components of the composting facility;
- f. a design for liner for receiving areas, feedstock storage, active composting areas, curing areas, and process water retention ponds;
- g. a working surface that has a positive slope and capable of withstanding wear through normal operations;
- h. a run-on control system to prevent flow of water onto developed areas of the composting facility for events of up to

at least the peak discharge from a 1 in 25 year – 24 hour duration storm event;

i. run-off control system to collect and control the volume of process water run-off for a 1 in 25 year – 24 hour duration storm event; and

j. a groundwater monitoring system, unless authorized in writing by the Director.

(iii) Soil Conservation Plan, that includes:

a. provisions to conserve all topsoil and subsoil for reclamation;
b. the location of the stockpiles;
c. the content of the stockpiles;
d. the volume of the stockpiles; and
e. provisions to stockpile the soil as follows:
   i. to locate all soil stockpiles at the facility;
   ii. on stable foundations; and
   iii. on undisturbed topsoil.

1.3. Operations Plan

The Operations Plan shall include, at a minimum, the following:

(a) a list of feedstock accepted at the composting facility;
(b) feedstock acceptance policies and procedures;
(c) prohibited waste handling procedures;
(d) site security and public access control procedures;
(e) working surface maintenance program;
(f) liner maintenance program;
(g) a composting process plan, including:
   (i) a description of composting technology used;
   (ii) procedures for maintaining aerobic conditions;
   (iii) a pathogens reduction plan;
   (iv) a composting temperature monitoring program;
   (v) quality assurance and quality control program;
   (vi) procedures for curing compost to meet maturity requirements;
   (vii) procedures for storage and management of final product; and
   (viii) procedures for preventing pathogen re-growth in final product;
(h) an odour management program;
(i) process water management procedures;
(j) environmental monitoring program;
(k) compost quality monitoring plan;
(l) procedures for handling and disposal of residual materials;
(m) a site safety and emergency response plan;
(n) contingency plan for reasonably foreseeable events;
(o) nuisance management plan; and
(p) reporting procedures.

1.4. Odour Management Program

The Odour Management Program shall include all the following components:

(a) a description of odour control technology;
(b) best management practices to mitigate offensive odours;
(c) a method to detect odours;
(d) a procedure to track and document public complaints regarding odours from the composting facility;

(e) a procedure to respond to public complaints regarding odours originating from the composting facility; and
(f) an odour contingency response plan to minimize or remedy offensive odours.

1.5. Groundwater Monitoring Program

Unless authorized in writing by the Director, the groundwater monitoring program shall include, at a minimum, the following:

(a) a program to establish background groundwater quality prior to the start of composting operations;
(b) a detailed program for groundwater sample collection and analysis, that includes, at a minimum, the following:
  (i) retrieval of representative samples from each groundwater monitoring well at least once per year;
  (ii) laboratory analysis of the samples for parameters as set out in Table 1; and
  (iii) monitoring the depth to water at each monitoring well at time of sampling.

TABLE 1
Groundwater Parameters for Routine Monitoring

Dissolved Metals
Arsenic
Barium
Boron
Cadmium
Chromium
Copper
Iron
Lead
Manganese
Mercury
Vanadium
Other Parameters
Total phosphorus
Ammonia
Nitrate-Nitrogen
Total Kjeldahl Nitrogen
pH
Total dissolved solids
Electrical conductivity
Chemical oxygen demand
Total organic carbon
Calcium
Magnesium
Sodium
Potassium
Chloride
Sulphate
E. coli
Total coliform

1.6. Background groundwater quality report

A background groundwater quality report shall include analysis of:

(a) routine groundwater chemistry;
(b) trace elements;
(c) total coliform, fecal coliform, and *E. coli*; and
(d) the Director may, by notice in writing, require the registration holder to test additional background groundwater parameters.

2. Environmental Setbacks

Unless authorized in writing by the Director, no person shall construct or operate a composting facility within any of the following distances:

(a) within 100 metres from a spring;
(b) within 100 metres from a water well; and
(c) within 30 metres from a water body.

3. Construction Specifications

3.1. Facility Construction

(a) The construction of the composting facility shall comply with the Design Plan and Specifications.

(b) Any deviations from the construction requirements outlined in 3.2 through 3.3 must be authorized in writing by the Director.

3.2. Liner System

(a) The liner system included in the Design Plan and Specifications shall include, as a minimum, the following construction criteria:
   (i) the liner system must be placed under all active areas of the facility, including the receiving, feedstock preparation, active composting, and curing areas;
   (ii) the liner system must have a separation of at least 1 metre between the seasonally high water table and the bottom of the liner;
   (iii) the liner system must have a positive slope to avoid ponding; and
   (iv) the liner system must be constructed of a clayey material:
      a. with a thickness of at least 0.5 metres measured perpendicular to the liner surface; and
      b. with a hydraulic conductivity of 1×10^{-9} m/sec or less
   or alternative material that provides equivalent protection.

(b) Not withstanding 3.2 (a) the liner system shall be comprised of a natural protective layer only where all the following conditions are met:
   (i) the liner system prevents the lateral movement and downward migration of process water;
   (ii) the natural protective layer is comprised of 2 metres or more of a material that has a hydraulic conductivity of 1×10^{-8} m/sec or less;
   (iii) there is at least 1 metre of a material between the bottom of natural protective layer and the seasonally high groundwater table; and
   (iv) the natural protective layer has a positive slope to avoid ponding.

3.3. Retention Pond Liner

(a) The retention pond liner included in the Design Plan and Specifications must include, as a minimum, the following construction criteria:
   (i) a separation of at least 1 metre between the seasonally high water table and the bottom of the liner; and
   (ii) construction of a clayey material:
      a. with a thickness of at least 1 metre measured perpendicular to the liner surface, and
      b. that has a hydraulic conductivity of 1×10^{-9} m/sec or less
   or alternative material that provides equivalent protection..

(b) Notwithstanding 3.3 (a), the retention pond liner shall be constructed of a natural protective layer only where all the following conditions are met:
   (i) the retention pond liner prevents the lateral movement and downward migration of process water;
   (ii) there is 5 metres or more of a clayey material that has a hydraulic conductivity of 1×10^{-8} m/sec or less; and,
   (iii) there is at least 1 metre of a clayey material between the bottom of natural protective layer and the seasonally high groundwater table.

3.4. Groundwater Monitoring System

(a) Unless authorized in writing by the Director, the registration holder shall install a groundwater monitoring system for the composting facility.

(b) The groundwater monitoring system for the composting facility shall consist of
   (i) at least one monitoring well up gradient of the facility;
   (ii) at least two monitoring wells down gradient of the facility; and
   (iii) a type of well that is appropriate to monitor for contaminants.

3.5. Soil Conservation Plan

The registration holder shall:
(a) stockpile soil according to the soil conservation plan;
(b) take all steps necessary to prevent erosion, including but not limited to, all of the following:
   (i) revegetating the stockpiles; and
   (ii) any other steps as authorized in writing by the Director.
(c) immediately suspend conservation of soil when wet or frozen field conditions will result in mixing, loss or degradation of soil; and
(d) recommence conservation of soil only when wet or frozen field conditions in 3.4 (d) no longer exist.

4. Facilities Operations

4.1. Facility Maintenance

The registration holder shall maintain the composting facility to comply with the Design Plan and Specifications.

4.2. Certified Operator

The day to day operations of a Class II composting facility shall be supervised by a Certified Operator in accordance with the Waste Control Regulation, as amended.

4.3. Signage

The registration holder shall
(a) post; and,
(b) maintain
signs at the composting facility entrance providing, at a minimum, the following information:
(i) name of registration holder or person responsible;
(ii) telephone numbers for:
a. 24hr emergency contact;
b. the local fire department; and
c. Alberta Environment (1-800-222-6514); and,
(iii) hours of operation.

4.4. Feedstock list

Unless authorized in writing by the Director, the registration holder shall accept only the following feedstock for composting:
(a) animal bedding;
(b) brewery/winery waste;
(c) cardboard and paper products;
(d) food waste;
(e) hatchery waste;
(f) manure;
(g) milk processing waste;
(h) paunch manure;
(i) source separated organics;
(j) wastewater sludge; and
(k) vegetative matter, including those derived from processing plants.

4.5. Operations Plan

The registration holder shall:
(a) implement; and
(b) update
the Operations Plan in compliance with the composting facility Design Plan and Specifications, as specified in section 1.3.

4.6. Odour Management Program

The registration holder shall:
(a) implement; and
(b) update
an Odour Management Program.

4.7. Odour Complaints

Upon receiving a complaint regarding an offensive odour allegedly resulting from the composting facility, the registration holder shall:
(a) investigate the complaint;
(b) record the following information regarding the complaint:
(i) the place, date and time of the complaint;

(ii) the name, and address of the complainant;
(iii) the nature of the complaint; and
(iv) a summary of all measures and actions that were taken to address the complaint.

4.8. Offensive Odours

Upon discovery of an offensive odour resulting from the composting facility, the registration holder shall:

(a) implement the Odour Contingency Response Plan, which shall include:
  (i) procedures to minimize or remedy the cause of the offensive odour, which may include:
    a. monitor, measure, contain, remove, destroy or otherwise dispose of the substance or thing causing the offensive odour or control or prevent the offensive odour from occurring again;
    b. install, replace or alter any equipment or thing in order to control or eliminate the offensive odour;
    c. construct, improve, extend or enlarge the facility, structure or thing if that is necessary to control or eliminate the offensive odour; or
    d. mitigate the odour in accordance with the Odour Management Program;
(b) record the:
  (i) date of the occurrence of the offensive odour;
  (ii) actions done to minimize or remedy the offensive odour; and
(c) take any action deemed necessary by the Director, in addition to any other duties imposed under the Act or the regulations under the Act.

4.9. Facility capacity

(a) The amount of feedstock accepted each year to a composting facility must not at any time exceed the registered design capacity of the facility.

(b) The registration holder must not, at any time, exceed the registered compost curing area and storage capacity area.

4.10. Nuisance Management

The registration holder shall control nuisances such as, but not limited too, litter, fires, disease vectors, and dust, by:

(a) establishing and maintaining litter controls that include:
  (i) minimize the escape of litter from the composting facility;
  (ii) implementing controls to prevent litter to be washed, blown, or transported onto adjacent properties; and
  (iii) retrieving litter that has been washed, blown, or transported onto adjacent properties, provided the consent of the owner of the adjacent property is first obtained.
(b) managing the feedstock storage and the composting process to minimize disease vectors;
(c) applying weed controls to prevent accumulation of weeds at the facility and in compost products;
(d) managing feedstock storage and composting process to prevent the occurrence of fires; and

(e) set up or construct artificial barriers, utilizing natural barriers, or other effective measures to control access to the site to prevent the uncontrolled depositing of wastes or other materials.

5. Environmental Monitoring Standards

5.1. Sampling and Analytical Standards

(a) With respect to any sample required to be taken pursuant to these standards, all samples shall be:
- (i) collected;
- (ii) preserved;
- (iii) stored;
- (iv) handled; and
- (v) analyzed

in accordance with:

- (vi) the *Standard Methods for the Examination of Water and Wastewater*, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation, 1998, as amended; or
- (vii) the *Methods Manual for Chemical Analysis of Water and Wastes*, Alberta Environmental Centre, Vegreville, Alberta, 1996, AECV96-M1 as amended; or
- (viii) the *Guidelines for Compost Quality*, published by the CCME, as amended; or
- (ix) The *Test Methods for the Examination of Composting and Composts*, published by the United States Department of Agriculture and the United States Composting Council, as amended; or
- (x) a method authorized in writing by the Director.

(b) The registration holder shall analyze all samples that are required to be obtained by these standards in a laboratory accredited pursuant to ISO 17025 standard, as amended, for the specific parameter(s) to be analyzed, unless otherwise authorized in writing by the Director.

(c) The term sample as used in 5.1(b) does not include samples directed to continuous monitoring equipment, unless specifically required in writing by the Director.

(d) The registration holder shall comply with the terms and conditions of any written authorization issued by the Director under 5.1(b).

5.2. Groundwater Monitoring Program

(a) Unless otherwise authorized in writing by the Director, the registration holder shall
- (i) implement; and
- (ii) maintain;

a groundwater monitoring program.

(b) Unless otherwise authorized in writing by the Director the registration holder shall ensure that each groundwater monitoring well is:

(i) protected from damage; and
(ii) locked, except when samples are taken.

(c) If a groundwater sample cannot be collected because the monitoring well is damaged or is no longer capable of producing a representative sample
   (i) the groundwater monitoring well shall be cleaned, repaired or replaced; and
   (ii) a representative groundwater sample shall be collected prior to the next scheduled sampling date, unless otherwise authorized in writing by the Director.

(d) If at any time throughout the operational and final closure period groundwater contamination occurs at the composting facility, the registration holder shall:
   (i) immediately notify the Director in accordance with the Act and the regulations under the Act,
   (ii) identification of the source that is adding contaminant mass to the groundwater;
   (iii) remove or control of the source to prevent further contamination;
   (iv) construct, repair, or replace the structure or thing, if that is necessary, to prevent further contamination;
   (v) conduct additional groundwater monitoring; and
   (vi) any other duties imposed under the Act or the regulations under the Act.

(e) Throughout the operational and final closure period of the composting facility, the groundwater quality at each of the monitoring wells shall not exceed the numerical criteria published in Table 3 of the *Alberta Tier 1 Soil and Groundwater Remediation Guidelines*, published by Alberta Environment, as amended, unless otherwise authorized in writing by the Director.

5.3. Process Water Disposal Procedures

Process water from the retention pond shall be disposed of only in the following manner:
(a) at an Alberta Environment approved wastewater treatment facility;
(b) by irrigation in accordance with the safe limits "Guidelines for Municipal Wastewater Irrigation" published by Alberta Environment, as amended; or,
(c) as otherwise authorized in writing by the Director

5.4. Retention Pond Sediments

Retention pond sediments shall be disposed of only in the following manner:
(a) At an Alberta Environment approved waste management facility authorized to accept such waste;
(b) by land application in accordance with "Guidelines for the Application of Municipal Wastewater Sludges to Agricultural Lands", published by Alberta Environment, as amended; or,
(c) as otherwise authorized in writing by the Director.

5.5. Compost Quality Monitoring

The registration holder shall not give away or sell compost unless the compost meets:

(a) the compost quality requirements, as set out in the *Guidelines for Compost Quality*, published by CCME, as amended, for the following criteria:
   (i) maximum concentrations for trace elements;
   (ii) foreign matter;
   (iii) sharp foreign matter;
   (iv) maturity/stability;
   (v) pathogen reduction requirements; and
(b) any other requirements as specified in writing by the Director.

(c) The registration holder shall collect, at a minimum, 1 sample from each 1000 tonnes (wet weight) of compost produced per year for compost quality monitoring.

(d) The registration holder shall collect sample(s) collected under 5.6 (b) so that the samples are representative of the batch of compost.

(e) The registration holder shall dispose of all finished products that do not meet the compost quality requirements set out in 5.6 (a):
   (i) at an Alberta Environment approved waste management facility authorized to accept such waste; or,
   (ii) as otherwise authorized in writing by the Director.

6. Reporting and Record Keeping

6.1. Operating Record

(a) The registration holder shall establish and maintain an Operating Record for a composting facility until the end of the final closure period.

(b) The Operating Record shall contain, at a minimum, the following information:
   (i) a copy of the Registration document;
   (ii) a current organizational chart of the operating company;
   (iii) operation/procedures logbook;
   (iv) the most recent version of the design plan for the composting facility;
   (v) public issues and complaints;
   (vi) nuisance management;
   (vii) monitoring reports;
   (viii) inspection reports;
   (ix) maintenance records;
   (x) records of contraventions;
   (xi) tonnage reports; and
   (xii) all annual reports for the composting facility.

6.2. Monitoring Records

The registration holder shall record and retain all the following information in respect of any sampling conducted or analyses performed in accordance with these standards for a minimum of ten years, unless otherwise authorized in writing by the Director:
   (a) the place, date and time of sampling;
   (b) the dates the analyses were performed;
   (c) the analytical techniques, methods or procedures used in the analyses;

(d) the names of the persons who collected and analyzed each sample; and
(e) the results of the analyses.

6.3. Tonnage Report

(a) Each year the registration holder shall prepare a Tonnage Report for the composting facility covering the calendar year reported on.

(b) The registration holder shall submit the Tonnage Report to the Director by March 31 of the year following the year on which the report is based.

(c) The Tonnage Report shall contain, at a minimum, the following information:
  (i) total tonnes (wet weight) of feedstock accepted;
  (ii) total tonnes (wet weight) of amendments and bulking agents used;
  (iii) total tonnes (wet weight) of compost produced; and
  (iv) total tonnes (wet weight) of compost used, sold, or given away.

6.4. Reporting of Contraventions

(a) In addition to any other reporting required pursuant to the Act or the regulations, the registration holder shall immediately report to the Director by telephone any contravention of the terms and conditions of these Standards at 1-780-422-4505.
(b) The registration holder shall submit a written report to the Director within 7 days of the reporting pursuant to 6.4 (a).
(c) The report required in 6.4 (b) shall contain, at a minimum, all of the following:
  (i) a description of the contravention;
  (ii) the date of the contravention;
  (iii) an explanation as to why the contravention occurred;
  (iv) a legal land description of the location of the contravention;
  (v) the name of the registered owner or owners of the parcel of land on which the contravention occurred;
  (vi) a summary of all measures and actions that were taken to mitigate any effects of the contravention;
  (vii) the Registration number provided by the Director for the composting facility, and the name of the person who held the Registration number at the time when the contravention occurred;
  (viii) the names, addresses, telephone numbers and job titles of all persons operating the site at the time that the contravention occurred;
  (ix) the names, addresses and telephone numbers of all persons who had charge, management or control of the site at the time that the contravention occurred;
  (x) a summary of proposed measures that will prevent future contraventions including a schedule of implementation for those measures;
  (xi) any information that was maintained or recorded under these Standards, as a result of the contravention; and
  (xii) any other information required by the Director in writing.

6.5. Annual Report

(a) During each year of operation of the composting facility, the person responsible shall prepare an Annual Report for the facility covering the calendar year reported on.
(b) The person responsible shall place the Annual Report in the Operating Record by March 31 of the year following the year on which the report is based.
(c) The Annual Report shall contain, at a minimum, the following information:
  (i) any changes in persons responsible;
  (ii) any changes made to the operations plan;
  (iii) the types and quantities of feedstocks processed at the composting facility;
  (iv) the amount of compost permanently removed from the facility or used on site;
  (v) records demonstrating pathogen reduction;
  (vi) compost quality records, including:
    a. pathogen analysis;
    b. sharp foreign matter analysis; and
    c. trace element analysis;
  (vii) the following environmental monitoring records and their interpretations:
    a. process water monitoring;
    b. table or graphical presentation of yearly groundwater monitoring records;
    c. quality and quantity of process water removed from the composting facility for irrigation or disposal; and,
    d. quality and quantity of sediments removed from the composting facility for land application or disposal.
  (viii) any remedial actions taken;
  (ix) a summary of non-compliance issues;
  (x) a summary of nuisance management issues;
  (xi) a summary of complaints received, and the action or actions taken as a result of the complaints; and
  (xii) adjustments to financial security necessary for final closure, if applicable.

6.6. Record Keeping

(a) The registration holder shall immediately provide any records, reports, documents or data required to be created under these Standards to the Director, or a representative of the Director, upon request.

(b) The registration holder shall place the Annual Report in the Operating Record by March 31 of the year following the year on which the report is based.

(c) The registration holder shall record and retain all the following information regarding each contravention of these standards or complaints from the facility for a minimum of 10 years:
  (i) the place, date and time of the contravention/complaint;
  (ii) the name, and address of the contravention/complainant;
  (iii) the nature of the contravention/complaint; and
  (iv) a description of the contingency plan implemented.

7. Final Closure

7.1. Final Closure Plan

(a) The registration holder shall notify the Director of the closure of the composting facility by submitting a Final Closure Plan within 6 calendar months after the final acceptance of feedstock at the composting facility.

(b) The Final Closure Plan shall include, at a minimum, the following:
- (i) schedule for completion;
- (ii) description of the final use of the closed areas;
- (iii) description of site restoration procedures, including:
  - a. drainage;
  - b. soil replacement;
  - c. erosion control;
  - d. revegetation, where applicable;
- (iv) compost removal;
- (v) waste disposal;
- (vi) maintenance and operations of contaminant monitoring systems until performance measures are met for soil and groundwater, if applicable.

(c) The Final Closure Plan shall be implemented in accordance with written authorization of Director.

7.2. Final Closure Report

(a) The registration holder shall file a copy of the Final Closure Report in the Operating Record for the calendar year in which Final Closure will be complete.

(b) The Final Closure Report shall include, at a minimum, the following:
- (i) the date of completion of the final closure;
- (ii) a statement including supporting evidence that the final closure has been completed in accordance with the final closure plan;
- (iii) a description of any deviations to the final closure plan and the reasons for the deviations; and
- (iv) a description of how the following elements (if applicable) have been, or will be dealt with
  - a. the final use of the closed areas;
  - b. drainage restoration;
  - c. soil replacement;
  - d. erosion control; and
  - e. re-vegetation.
- (v) a groundwater report with supporting evidence to show that groundwater has not been contaminated.

CLASS III COMPOSTING FACILITIES

1. Notification

1.1. Notification Form

(a) The person responsible for a Class III composting facility shall submit the following to the Director prior to commencing construction and operation of the composting facility.
- (i) a Notification form;
- (ii) a Composting Facility Checklist; and
- (iii) an Operations Plan.

1.2. Operations Plan

(a) The Operations Plan shall include, at a minimum, the following:
- (i) feedstock acceptance policies and procedures;
- (ii) site security and public access control procedures;
- (iii) working surface maintenance program;
- (iv) a composting process plan, including:
  - a. procedures for maintaining aerobic conditions;
  - b. corrective measures for excessive odours;
  - c. a pathogens reduction plan;
  - d. a composting temperature monitoring program;
  - e. quality assurance and quality control program, based on regulatory requirements;
  - f. procedures for curing compost to meet maturity requirements;
  - g. procedures for storage and management of final product;
  - h. procedures for preventing pathogen re-growth in final product;

(b) process water management procedures;
(c) procedures for handling and disposal of residual materials (compostable and non-compostable); and
(d) nuisance management plan.

2. Facility Design Requirements

2.1. Facility Design

The receiving, feedstock preparation, active composting, curing and storage areas must:
(a) have a working surface that is capable of withstanding the wear and tear from normal operations;
(b) be located on a liner or natural protective layer to prevent the release of process water into the environment;
(c) have a separation of at least one meter above the seasonally high water table; and
(d) be graded for positive drainage to prevent ponding of water.

2.2. Run-off, Run-on Control

The entire composting facility must have run-on and run-off controls that:
(a) prevents the flow of surface waters on to the composting facility; and
(b) prevents process water from contaminating groundwater and surface water.

3. Facility Construction

The person responsible shall construct the composting facility in accordance with the design specified in 2.1 and 2.2.

4. Environmental setbacks

Unless authorized in writing by the Director, no person shall construct or operate a composting facility:
(a) within 100 metres from a spring;
(b) within 100 metres from a water well; or
(c) within 30 metres from a water body.

5. Composting Facility Capacity

The amount of leaf and yard waste accepted each year to a Class III composting facility must not at any time exceed 500 tonnes per annum, wet weight.

6. Facilities Operations

6.1. Person Responsible

The person responsible must notify the Director within 30 calendar days of a change of ownership.

6.2. Signage

The person responsible shall
(a) post; and
(b) maintain
signs at the composting facility entrance providing, at a minimum, the following information:
- (i) name of registration holder or person responsible;
- (ii) telephone numbers for:
  - a. 24hr emergency contact;
  - b. the local fire department; and
  - c. Alberta Environment (1-800-222-6514); and,
- (iii) hours of operation.

6.3. Operations Plan

The person responsible shall:
(a) implement; and
(b) update
the Operations Plan in compliance with the composting facility design plan and specifications.

6.4. Nuisance Management

The shall control nuisances such as, but not limited to, litter, fires, disease vectors, and dust, by:
- (a) establishing and maintaining litter controls that include:
  - (i) minimize the escape of litter from the composting facility;
  - (ii) implementing controls to prevent litter to be washed, blown, or transported onto adjacent properties; and
  - (iii) retrieving litter that has been washed, blown, or transported onto adjacent properties, provided the consent of the owner of the adjacent property is first obtained.
- (b) managing the feedstock storage and the composting process to minimize disease vectors;
- (c) applying weed controls to prevent accumulation of weeds at the facility and in compost products;
- (d) managing feedstock storage and composting process to prevent the occurrence of fires; and
- (e) set up or construct artificial barriers, utilizing natural barriers, or other effective measures to control access to the site to prevent the uncontrolled depositing of wastes or other materials.

7. Environmental Monitoring Standards

7.1. Sampling and Analytical Standards

(a) With respect to any sample required to be taken these guidelines, all samples shall be:

(i) collected;
(ii) preserved;
(iii) stored,
(iv) handled; and
(v) analyzed

in accordance with:

(vi) the *Standard Methods for the Examination of Water and Wastewater*, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation, 1998, as amended or
(vii) the *Methods Manual for Chemical Analysis of Water and Wastes*, Alberta Environmental Centre, Vegreville, Alberta, 1996, AECV96-M1 as amended; or
(viii) the *Guidelines for Compost Quality*, published by the CCME, as amended; or
(ix) The *Test Methods for the Examination of Composting and Composts*, published by the United States Department of Agriculture and the United States Composting Council, as amended; or
(x) a method authorized in writing by the Director.

(b) The person responsible shall analyze all samples that are required to be obtained by these standards in a laboratory accredited pursuant to ISO 17025 standard, as amended, for the specific parameter(s) to be analyzed, unless otherwise authorized in writing by the Director.

(c) The term sample as used in 7.1(b) does not include samples directed to continuous monitoring equipment, until specifically required in writing by the Director.

7.2. Compost Quality Monitoring

(a) The person responsible shall not give away or sell compost unless the compost meets the compost quality requirements, as set out in the Guidelines for Compost Quality, published by CCME, as amended, for the following criteria:

(i) maximum concentrations for trace elements;
(ii) foreign matter;
(iii) sharp foreign matter;
(iv) maturity/stability; and
(v) pathogen reduction requirements;

(b) The person responsible shall collect a minimum of one composite sample for compost quality monitoring per calendar year if the compost is transferred to third parties.

(c) The person responsible shall collect sample(s) collected under 7.2 (b) so that the samples are representative of the batch of compost.

(d) The person responsible shall dispose of all finished products that do not meet the compost quality requirements set out in 5.6 (a):
(i) at an Alberta Environment approved waste management facility authorized to accept such waste; or,
(ii) as otherwise authorized in writing by the Director.

8. Reporting and Record Keeping

Annual Report

(a) During each year while the composting facility is operational, the person responsible shall prepare an Annual Report for the composting facility covering the calendar year reported on.

(b) The person responsible shall provide the Annual Report to the Director upon a request in writing.

(c) The Annual Report shall contain, at a minimum, the following information:
 (i) any changes of ownership or persons responsible;
 (ii) any changes made to the operations plan;
 (iii) water quality testing, if done
 (iv) compost quantity records;
 (v) the amount of compost permanently removed from the facility;
 (vi) the amount of compost stored at the facility;
 (vii) records demonstrating pathogen reduction; and
 (viii) compost quality records.

9. Final Closure Notification

The person responsible shall notify the Director of the closure of the composting facility by submitting a Final Closure Notification within 6 calendar months after the final acceptance of feedstock at the composting facility.

Appendix A

COMPOSTING FACILITY CHECKLIST

(TO BE SUBMITTED WITH REGISTRATION/ NOTIFICATION FORM)

Purpose of checklist:

The purpose of this checklist is to ensure the person responsible for the siting and construction of a newly proposed or laterally expanding compost facility has taken the necessary measures to suitably locate the facility according to the most recent version of the AENV Standards and Guidelines for composting facilities. This includes consultation with municipal planning staff regarding planning and development approvals.

NOTE: This checklist is not intended for composting facilities that are proposed at landfills or wastewater treatment plants where land use is already designated.

Name of proposed facility: ______________________________

Name of applicant: ______________________________

Address: ____________________ **Email:** ____________________**(optional)**

____

____

Phone number: ____________________ **Fax:** ____________________

Project Location: ______________________________

Legal Land Description: ______________________________

Facility Street Address: ____________________ **Parcel Size:** ____________________

____

____

Tentative construction start date: ____________________ **Tentative Facility Start up Date:** ____________________

1) List any provincial registrations, approvals or municipal permits that will be needed for your proposal, e.g. Composting facility registration, development permit, road side development permit, etc. and provide the names of local officials you are working with. If you need more space please attach a separate sheet.

   Permit: ____________________ Officer/Planner's Name: ____________________

   Permit: ____________________ Officer/Planner's Name: ____________________

   Permit : ____________________ Officer/Planner's Name: ____________________

   Permit: ____________________ Officer/Planner's Name: ____________________

2) Attach a site plan, vicinity map, and/or topographic map of the proposed location, if reasonably available.

3) How much land (hectares) will be leased/purchased for your proposal?

4) How much of that land will be used by the composting facility (facility footprint)? If possible please provide the size of the area designated for receiving, processing, curing, the retention pond, and buffer zones.

5) Give a brief description of the type and quantity of organic materials that will be composted at this facility. Please included all primary feedstocks and amendments.

6) Does this facility require financial security in accordance with Part 4, section 27 - 33 of the Waste Control Regulations? YES NO

7) Do you plan on doing a public consultation process? If so, please describe. YES NO

8) What general types of soils are found on the site (for example, clay, sand, gravel, peat)?

9) What is the current use of the site?

10) What is the current land use designation of the site?

11) Is the facility within 450 metres from schools, residential housing, and Food Establishments? YES NO

12) Is there a hospital within 450 metres from the site? YES NO

13) Identify existing roads or highways serving the site. Show on site plans, if any. Permits are required if the facility is within 300 metres of a highway and 800 metres of an intersection of a controlled highway.

14) What designated and informal recreational opportunities are in the immediate vicinity?

15) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, rivers, lakes, ponds, wetlands)? If yes, describe type and provide names (if applicable). YES NO

16) Will the project require any work within 30 metres of the described bodies of water? YES NO
If yes, please describe

17) Is there a drinking water well within 450 metres from the site? YES NO

18) Is there a spring within 100 metres from the site? YES NO

19) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan. Flood risk maps are available from Alberta Environment `http://www3.gov.ab.ca/env/water/flood/index.html`) YES NO

20) Will any wastewater be discharged to surrounding land? If so, please provide a general description and indicate the area on the site plan. YES NO

21) How deep is the seasonal high water table from the surface?

22) Have you included the information required in Section 1of the standards? YES NO

The above answers are true and complete to the best of my knowledge.

Signature: ....

Date Submitted: ....

Government
of Alberta ■

Code of Practice for Compost Facilities

Made under the Environmental Protection and Enhancement Act, RSA 2000, cE-12

Queen's Printer Bookstore
5th Floor, Park Plaza
10611 - 98 Avenue
Edmonton, AB T5K 2P7
Phone: 780-427-4952
Fax: 780-452-0668

E-mail: qp@gov.ab.ca
Shop on-line at www.qp.alberta.ca

CODE OF PRACTICE FOR COMPOST FACILITIES

ALBERTA ENVIRONMENTAL PROTECTION

TABLE OF CONTENTS

CODE OF PRACTICE FOR COMPOST FACILITIES

ALBERTA ENVIRONMENTAL PROTECTION

PREFACE

1(1) The Code of Practice for Compost Facilities is incorporated by the *Waste Control Regulation* (A.R. 192/96), under the authority of section 36 of the *Environmental Protection and Enhancement Act*. Persons responsible for Class I compost facilities accepting 20,000 tonnes or less of waste per year must meet all its requirements to ensure that their activities are in compliance with Alberta's environmental laws. In addition to the requirements of this Code of Practice, these persons responsible must comply with all requirements of the *Environmental Protection and Enhancement Act*, its associated regulations, the *Subdivision and Development Regulation* (A.R. 212/95), and all other applicable laws.

(2) Persons responsible for compost facilities affected by this Code must register with Alberta Environmental Protection prior to commencing the construction and operation of a compost facility. Section 4 of this Code deals with registration in greater detail.

INTRODUCTION

2(1) This Code of Practice outlines minimum requirements for the design, construction, operation, and reclamation of Class I compost facilities that accept 20,000 tonnes or less per year of waste, and promotes environmentally sound management practices at those facilities. The *Guidelines for Compost Quality* published by the Canadian Council of Ministers of the Environment provide the compost quality objectives required by this Code.

(2) Compost facilities that accept more than 20,000 tonnes of waste require an approval under the *Environmental Protection and Enhancement Act*. Persons responsible for these facilities should consult the *Activities Designation Regulation* (A.R. 211/96) to determine whether their activities will require an approval.

(3) Questions or concerns regarding the application or contents of this Code of Practice can be made to:

Alberta Environment
Northeast Boreal & Parkland Regions
Regional Director
5th Floor, 9820 - 106 Street
Edmonton, AB T5K 2J6
Phone: (780) 427-9562
Fax: (780) 422-5120

or:

Alberta Environment
Northwest Boreal & Northern East Slopes Regions
Regional Director
Provincial Building
203, 111 - 54 Street
Edson, AB T7E 1T2
Phone: (780) 723-8395
Fax: (780) 723-8542

or:

Alberta Environment
Southern East Slopes & Prairie Regions
Regional Director
201 Deerfoot Square
2938 - 11 Street N.E.
Calgary, AB T2E 7L7
Phone: (403) 297-7605
Fax: (403) 297-5944

DEFINITIONS

3(1) In this Code of Practice,

(a) "active life" means the period of operation of a compost facility beginning with the initial receipt of waste and ending at completion of reclamation activities;

(b) "aerated static pile system" means a composting system in which a heap of feedstock is formed and subjected to forced or passive aeration to provide the aerobic biological decomposition of the organic matter;

(c) "compost" means the stable humus-like material that

(i) results from the biological decomposition and stabilization of organic materials under aerobic and thermophilic conditions,

(ii) is potentially beneficial to plant growth, and

(iii) is sanitized to a degree that protects human health;

(d) "compost facility" means a Class I compost facility that accepts 20,000 tonnes or less of waste per year;

(e) "disease vectors" means animals capable of transmitting disease to humans;

(f) "feedstock" means waste that contains organic materials which decompose biologically;

(g) "in-vessel system" means any compost system in which feedstock is contained in a vessel or reactor;

(h) "leachate" means liquid that has percolated through and drained from feedstock or compost and has extracted dissolved or suspended materials;

(i) "MPN" means most probable number;

(j) "operation procedures" means the activity of processing and producing compost, and may include blending of materials, agitation and mixing of materials, addition of moisture, stabilization of compost and storage of product;

(k) "points of compliance" means the location or locations where measurements of groundwater quality are taken to assess the performance of the compost facility;

(l) "run-off" means any rainwater or meltwater that drains as surface flow from the processing, curing and associated storage areas of a compost facility;

(m) "run-on" means any rainwater or meltwater that drains as surface flow onto the processing, curing and associated areas of a compost facility;

(n) "uppermost formation" means a continuous water-saturated geological stratum or strata, including but not limited to sand lenses and aquifers, that is projected to be the most probable pathway or pathways for lateral transport of leachate;

(o) "windrow system" means a compost system in which feedstock is placed in elongated piles of triangular or trapezoidal cross-section that are turned in order to enhance convective airflow, to control temperatures and to blend the feedstock.

(2) Terms defined in section 1 of the *Environmental Protection and Enhancement Act* and in the *Waste Control Regulation* (A.R. 192/96) are incorporated into and become part of this Code of Practice, unless otherwise defined or modified within this Code of Practice.

REGISTRATION

4 In addition to any information required by the Director under the *Approvals and Registration Procedure Regulation* (A.R. 113/93), the person responsible shall complete the registration form attached to this Code of Practice and submit the completed form to the Director, prior to commencing construction of a compost facility.

PERSON RESPONSIBLE'S DUTY

5 The person responsible for a compost facility shall comply with all requirements of this Code of Practice.

DESIGN AND CONSTRUCTION

6(1) The person responsible shall construct a compost facility that is designed in accordance with the following requirements:

(a) there shall be a design plan which defines and describes

(i) the operating capacity of the compost facility to receive feedstock, and to produce and store the compost and non-compostable materials,

(ii) the structures and equipment required for the operation of the compost facility, and

(iii) the structures, facilities and equipment for control of emissions of offensive odours and contaminated liquids;

(b) there shall be a composting pad

(i) constructed of at least 0.5 metres of clayey material having a permeability less than 5×10^{-8} metres per second, or an alternative material that provides equivalent protection, and

(ii) constructed with a minimum slope of 2 percent in order that the pad does not collect water or leachate;

(c) there shall be a run-on control system that prevents the flow of surface water onto the storage, processing and curing areas; and

(d) there shall be a run-off control and management system that provides protection of surface water quality in accordance with section 7(4).

(2) In addition to the requirements set out in section 6(1), a compost facility that is enclosed within a structure or vessels shall include an air pollution control system to control emissions of

(a) offensive odours,

(b) airborne microbials, and

(c) airborne particulates so that the opacity from all air emission sources does not exceed an opacity of 40 percent over a period of 6 consecutive minutes per hour.

(3) The Director may, by notice in writing, require the person responsible to construct and maintain a groundwater monitoring system where

(a) the compost facility is not enclosed within a structure or vessel;

(b) the volume of feedstock exceeds 5,000 tonnes per year;

(c) the compost facility is located on a natural geological material with a hydraulic conductivity that is greater than 5×10^{-7} metres per second and within 5 metres vertically of an unconfined aquifer; or

(d) the base of the composting pad is less than 1 metre above the seasonally high water table.

(4) The person responsible shall comply with any notice given under section 6(3) in accordance with its terms.

OPERATING REQUIREMENTS

7(1) The person responsible shall develop, maintain and implement an operations plan that is consistent with the compost facility design and includes as a minimum:

(a) a description of the source and types of feedstock to be composted;

(b) operation procedures for feedstock preparation, aeration, moisture control, and temperature control;

(c) feedstock acceptance procedures and policies;

(d) an emergency response plan to deal with fires, releases, or medical emergencies;

(e) a plan for the management, detection and mitigation of offensive odours; and

(f) a plan for minimizing dust.

(2) The compost shall meet the following requirements:

(a) fecal coliforms shall be less than 1000 MPN per gram of total solids calculated on a dry weight basis; and

(b) salmonella sp. shall be less than 3 MPN per 4 grams of total solids calculated on a dry weight basis, where the Most Probable Number method of analysis is used, or otherwise non-detectable by other generally accepted methods of analysis.

(3) Notwithstanding subsection (2), where the feedstock does not include materials that may include high levels of human pathogens, including but not limited to food scraps and fecal matter, the processing shall meet the following requirements:

(a) in an in-vessel or aerated static pile system, the compost shall be maintained at operating conditions of 55°C or greater for 3 days;

(b) in a windrow system, the compost shall attain an internal temperature of 55°C or greater for at least 15 days, and during this stage, the windrow shall be turned at least 5 times.

(4) The person responsible shall prevent the release of leachate or run-off from the composting pad to the surrounding watershed unless the leachate or run-off meets the least stringent of the following parameters:

(a) surface water background quality,

(b) the most recent edition of *Alberta Ambient Water Quality Interim Guidelines*, published by Alberta Environmental Protection, or

(c) the most recent edition of *Canadian Water Quality Guidelines*, published by the Canadian Council of Ministers of the Environment.

(5) The person responsible shall establish and maintain litter controls to minimize the escape of wastes from the compost facility, and shall retrieve waste that is washed or blown onto adjacent properties or accumulates on the compost facility and shall properly dispose of such waste.

(6) Non-compostable materials that result from preparation of the feedstock or from the screening of compost shall be removed from the compost facility and properly disposed of when the amount of non-compostable materials exceeds the storage capacity specified in the design plan required in section 6(1).

(7) The person responsible shall establish controls to prevent the propagation, harbourage or attraction of disease vectors and noxious weeds at the compost facility.

(8) The person responsible shall post signs at the compost facility entrance providing the following information:

(a) the name of the person responsible for the compost facility,

(b) any waste restrictions, and

(c) telephone numbers for

(i) the person responsible,

(ii) the local fire department,

(iii) Alberta Environmental Protection, Pollution Emergency Response Team (1-800-222-6514), and

(iv) the local police department.

(9) The person responsible shall provide artificial or natural barriers at the compost facility to control public access and prevent unauthorized vehicular traffic and illegal dumping of wastes.

MONITORING

8(1) The person responsible shall establish a program to monitor and record the temperature of the composting process.

(2) Where a groundwater monitoring system is required by the Director under section 6(3), the person responsible shall

(a) obtain and analyze representative samples from the groundwater monitoring system on an annual basis, or at a frequency approved in writing by the Director, and

(b) analyze such samples for the parameters set out in section 8(3).

(3) Throughout the active life of a compost facility, the groundwater quality shall meet the performance standards listed in Table 1 in the uppermost formation or formations at the points of compliance. The person responsible may apply in writing to the Director where the person responsible seeks to use alternate performance standards, providing justification for the use of the proposed alternate performance standards.

Table 1 – Performance Standards for Compost Facilities

CHEMICAL	CONCENTRATION (mg/L)
Chloride (Cl)	250
Nitrate - nitrogen	10
pH	6.5 to 8.5 units

(4) The Director may, by notice in writing to the person responsible,

(a) require that groundwater samples be analyzed for parameters other than those set out in section 8(3),

(b) change the frequency of groundwater monitoring and analysis required under section 8(2), or

(c) require the person responsible to install additional groundwater monitoring wells,

where the Director is of the opinion that it is necessary due to

(d) the character of feedstock received at the compost facility,

(e) changes in groundwater quality at the compost facility, or

(f) other evidence that suggests an impact on groundwater quality.

(5) The person responsible shall comply with any notice given under section 8(4) in accordance with its terms.

(6) Where groundwater at the compost facility fails to meet the performance standards set out in section 8(3), the person responsible shall notify the Director and shall implement a groundwater remediation plan.

(7) Where groundwater monitoring is require the person responsible shall

(a) protect all groundwater monitoring wells from damage,

(b) keep all groundwater monitoring wells locked, except when being sampled, and

(c) clean, repair or replace groundwater monitoring wells which have been damaged or are no longer able to produce representative groundwater samples prior to the next scheduled sampling date.

(8) The person responsible shall conduct analyses of samples collected in the following manner:

(a) for water and leachate samples, in accordance with

(i) the most recent edition of *Standard Methods for the Examination of Water and Wastewater*, published by the American Public Health Association, American Water Works Association and the Water Environment Federation,

(ii) the *Methods Manual for Chemical Analysis of Water and Wastes* (1987), published by Alberta Environmental Protection, as amended from time to time, or

(iii) any other equivalent method accepted by the Director in writing;

(b) for feedstock and compost samples, in accordance with

(i) the most recent edition of *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, published by the United States Environmental Protection Agency,

(ii) the most recent edition of *Manual on Soil Sampling and Methods of Analyses*, published by the Canadian Society of Soil Science, or

(iii) any other equivalent method accepted by the Director in writing

COMPOST QUALITY

9 The person responsible shall produce a compost that meets the standards established in the most recent edition of *Guidelines for Compost Quality*, published by the Canadian Council of Ministers of the Environment.

RECLAMATION

10 Before reclaiming the compost facility, the person responsible shall notify the Director in writing of the intent to close the compost facility.

RECORD KEEPING

11(1) The person responsible shall establish and maintain an operating record for the compost facility, and shall provide the operating record and its contents to Alberta Environmental Protection upon request.

(2) The operating record shall include the following information:

(a) a copy of the registration for the compost facility,

(b) the current versions of the design and operations plans for the compost facility, and

(c) annual reports as required by section 11(3).

(3) Throughout the active life of the compost facility, the person responsible shall prepare an annual report for the compost facility for the calendar year from January 1 to December 31, and shall place the report in the operating record by March 31 of the following year. The annual report shall contain the following information:

(a) the type and volume of feedstock received and processed in the calendar year;

(b) the amount of compost produced, stored, and shipped from the compost facility in the calendar year;

(c) the operating temperatures recorded in accordance with section 8(1);

(d) the surface water monitoring data;

(e) the groundwater monitoring data, where groundwater monitoring is required in writing by the Director under section 6(3);

(f) an analysis of the compost where it is intended for an unrestricted use as defined in the most recent edition of *Guidelines for Compost Quality*, published by the Canadian Council of Ministers of the Environment;

(g) any remedial action taken in relation to clauses (c), (d) and (e).

REPORTING

12 The person responsible shall immediately report any contraventions of this Code of Practice by telephone to the Director of Pollution Control Division at (403) 422-4505. The Director of Pollution Control Division may require the person responsible to provide a further written report of any contravention.

CODE AMENDMENT

13 This Code of Practice will be reviewed every 5 years beginning in 2001. Alberta Environmental Protection will accept and compile written comments on the contents of this Code at any time, and will review all comments received at the next review. The Director may institute a review and amendment of this Code of Practice at any time. All proposed amendments to this Code of Practice will be reviewed by government, industry, and the interested public. The Director shall have the final decision on amendments made to this Code of Practice. Amendments to this Code of Practice shall become effective when published by Alberta Environmental Protection.

Alberta
Environment

CODE OF PRACTICE FOR COMPOST FACILITIES
REGISTRATION FORM
SMALL COMPOST FACILITIES
(<20,000 tonnes/year of feedstock)

1. GENERAL INFORMATION:

Applicant Name: ______________________

Mailing Address: ______________________

Legal Land Description
for Compost Facility: ______________________

Contact Person: ______________________

Phone Number: ______________________

Fax Number: ______________________

2. TECHNICAL INFORMATION:

(a) Please provide the following information as specified in the Code of Practice for Compost Facilities ("the Code"):

(i) copies of the site investigation, compost facility design and groundwater monitoring system as specified in sections 6(1) to 6(3) inclusive of the Code where applicable; and

(ii) a copy of the operations plan as specified in Section 7 of the Code.

(b) If applying for alternate groundwater quality performance standards, as specified in Section 8(3) of the Code, please provide documentation supporting the request for alternate performance standards.

3. OTHER INFORMATION

Please provide:

(a) a copy of the development approval issued by the local municipal authority;

(b) an overview of the public's involvement in the siting and planning of the compost facility.

(c) where appropriate, a copy of the field approval issued under section 19(1)(c) of the Public Lands Act; and

(d) the rationale for the compost facility, in writing.

I acknowledge that I have reviewed a copy of the Code of Practice for Compost Facilities, and that I am bound by the provisions of the Code and any subsequent amendments to it.

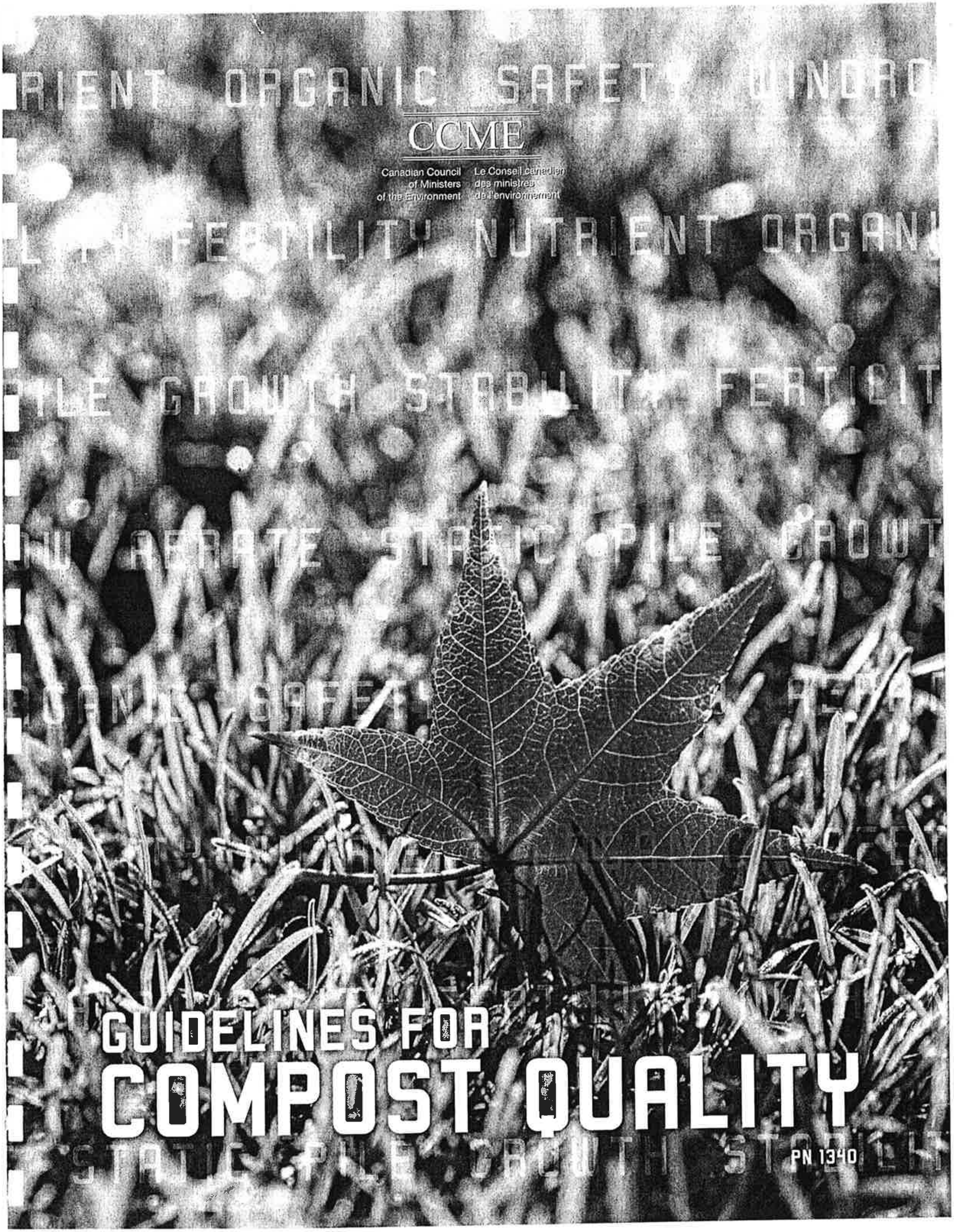
______________________ ______________________
Applicant Signature Date

For Office use only:

Date Received:______________________________

Registered by:____

______________________ ______________________
Director's Signature Date



CCME

Canadian Council of Ministers of the Environment

Le Conseil canadien des ministres de l'environnement

GUIDELINES FOR COMPOST QUALITY

PN 1340

CCME

Canadian Council of Ministers of the Environment

Le Conseil canadien des ministres de l'environnement

Guidelines for Compost Quality

PN 1340

Canadian Council of Ministers of the Environment

The Canadian Council of Ministers of the Environment (CCME) is the major intergovernmental forum in Canada for discussion and joint action on environmental issues of national, international and global concern. The 14 member governments work as partners in developing nationally consistent environmental standards, practices, and legislation.

Canadian Council of Ministers of the Environment
123 Main St., Suite 360
Winnipeg, Manitoba R3C 1A3
Ph: (204) 948-2090 Fax: (204) 948-2125

For additional copies, contact:

CCME Documents
Toll free: 1 (800) 805-3025
www.ccme.ca

Aussi disponible en français

La présente publication est également offerte en français sous le titre *Lignes directrices pour la qualité du compost.* PN 1341

ISBN 1-896997-60-0

Abstract

The benefits of compost to aid plant growth and add stability and fertility to soils are well demonstrated. Based on these attributes, the composting industry in Canada has become a vibrant industry that continues to grow in size and strength.

In order to ensure a consistent, high quality product that is safe for all uses, early in the 1990s CCME established a committee to develop quality guidelines for compost that is sold or given away. CCME, the Bureau de normalization du Québec (BNQ) and the Canadian Food Inspection Agency (CFIA) agreed to coordinate efforts and developed compost standards that provide a significant level of consistency, while being flexible enough to accommodate different (e.g. regional) interests and issues. This joint effort led to the development of the first edition of the CCME Compost Quality Guidelines in 1996.

Since 1996, the industry has grown to what it is today. During that growth, new science and technologies have improved our understanding of composting and compost. Thus, a revision to the 1996 guidelines was necessary. These revised guidelines reflect our new understanding while still providing the same level of protection that was intended in the first version.

The CCME Guidelines for Compost Quality are based on the following four criteria for product safety and quality: foreign matter, maturity, pathogens, and trace elements. The guidelines attempt to integrate the concept that exposure is an integral part of risk by establishing two grades of material (Category A - unrestricted and Category B - restricted). The guidelines will help protect public health and the environment and help composting continue to develop as an important resource/waste management solution.

CCME produced its first Guidelines for Compost Quality in 1996. In 2003, CCME directed the Compost Guidelines Task Group to review the 1996 CCME Compost Guidelines since the Canadian voluntary standard (BNQ) was also being revised. The BNQ public consultations and standard revisions have led to the development of these revised CCME Guidelines for Compost Quality.

1.2 Objectives

The objectives of *Guidelines for Compost Quality* are to:

- Protect public health and the environment across the country;
- Promote harmonization with the Canadian Food Inspection Agency (CFIA) and Bureau de normalisation du Québec (BNQ);
- Encourage source separation of municipal solid waste (MSW) to produce a high quality compost product;
- Produce compost standards that are consistent across the country, while accommodating different interests and issues;
- Incorporate the experience of industry and regulators in applying the guidelines and to ensure that the national guidelines reflect new science and technology advances;
- Discourage the application of untreated organic wastes to land; and,
- Ensure consumer confidence through consistent nationwide product quality standards.

1.3 Scope and Applicability

These guidelines apply to compost produced from any organic feedstock as determined by regulatory agencies. They apply to compost that is sold, given away or used on-site. Specific definitions and regulatory information on on-site composting can be obtained from federal, provincial and territorial authorities.

These guidelines do not apply to compost-based products, e.g., potting soil mixes, although jurisdictions may wish to apply or modify the guidelines for these products.

Due to the diversity of regulatory approaches that exists in Canada, these guidelines generally apply to the quality of compost rather than the composting process. Jurisdictions will develop individual siting and operating guidelines to accommodate jurisdictional needs.

In response to special concerns, a jurisdiction may decrease or increase the number of parameters to be analyzed based on monitoring data, changes in the waste stream or processing techniques, effectiveness of source separation programs, or the potential presence of toxic substances.

These guidelines only come into effect if adopted, in whole or in part, by an authority having jurisdiction. Where this guideline has been adopted, in whole or in part, by an authority having jurisdiction, it is subject to any restrictions or conditions added by the regulatory authority.

Readers of this guideline are advised to check with the federal, provincial, or territorial authority having jurisdiction to establish whether this guideline applies in their area of interest.

Table of Contents

Glossary

aerated static pile: a heap of compostable materials formed to promote the aerobic decomposition of the organic matter. Ventilation is either provided by passive or forced aeration, rather than through frequent agitation (turning). French: ***tas statique aéré***

biosolids: organic product obtained from the physico-chemical and/or biological treatment of wastewater. Biosolids result from primary wastewater treatment (primary biosolids), or from secondary wastewater treatment (secondary biosolids), and these two types of biosolids are often combined (mixed biosolids). These biosolids can be derived from the treatment of either municipal wastewater or industrial wastewater. French: ***biosolides***

compost: solid mature product resulting from composting. French: ***compost***

composting: managed process of bio-oxidation of a solid heterogeneous organic substrate including a thermophilic phase. French: ***compostage***

contaminant: element, compound, substance, organism, or form of energy which through its presence or concentration causes an adverse effect on the natural environment or impairs human use of the environment. French: ***contaminant***

foreign matter: any matter over 2 mm in dimension that results from human intervention and has organic or inorganic components such as metal, glass, synthetic polymers (for example plastic and rubber) and that may be present in the compost but excluding mineral soil, woody material and pieces of rock. French: ***corps étranger***

in-vessel composting: diverse group of composting methods in which composting materials are contained in a reactor vessel; the purpose is to maintain optimal conditions for composting. French: ***compostage en milieu fermé***

mature: term used to designate a compost that, when used as an organic soil conditioner, does not have phytotoxic effects arising from, for example, nitrogen immobilization or anaerobioses. NOTE — The opposite of "mature" is immature. French: ***mature***

micronutrient: plant nutrient (for example boron, copper, molybdenum, manganese, iron and zinc) required in lesser quantities than major (for example nitrogen, phosphorus and potassium) and secondary (for example calcium and magnesium) plant nutrients, having essential physiological functions in plant metabolism. French: ***oligoélément***

municipal biosolids: biosolids obtained from municipal wastewater pretreated to remove gravel and coarse solid waste. French: ***biosolides municipaux***

municipal solid waste (MSW): solid non-hazardous refuse that originates from residential, industrial, commercial, institutional, demolition, land clearing, or construction sources. French: ***déchets solides municipaux***

pathogens: organisms, including some bacteria, viruses, fungi, and parasites, that are capable of producing an infection or disease in a susceptible human, animal, or plant host. French: ***organismes pathogènes***

sharp foreign matter: any foreign matter over a 3 mm dimension that may cause damage or injury to humans and animals during or resulting from its intended use.
NOTE — Sharp foreign matter may consist of, but is not limited to, the following: metallic objects or pieces of metallic objects, for example utensils, fixtures, electrical wiring, pins, needles, staples, nails, bottle caps; glass and porcelain or pieces of glass and porcelain, for example, containers, dishes, glass panes, electric light bulbs and tubes, mirrors. French: ***corps étranger tranchant***

source separation: separation of wastes into specific types of material at the point of generation. French: ***tri à la source***

thermophilic phase: biological phase in the composting process characterized by the presence of micro-organisms which grow optimally in a temperature range of 45°C to 75°C. French: ***phase thermophilic***

trace element: chemical element present in compost at a very low concentration. French: ***élément trace***

volatile solids: solids in water or other liquids that are lost on ignition of dry solids, generally above 500°C. French: ***solides volatils***

windrow: elongated piles of triangular or trapezoidal cross-section that are turned in order to aerate and blend the material. French: ***andain***

yard waste: vegetative matter resulting from gardening, horticulture, landscaping, or land clearing operations and includes materials such as tree and shrub trimmings, plant remains, grass clippings, and chipped trees. French: ***résidus de jardin***

Acronyms

AAFC	Agriculture and Agri-Food Canada
BNQ	Bureau de normalisation du Québec
CCC	Composting Council of Canada
CCME	Canadian Council of Ministers of the Environment
CFIA	Canadian Food Inspection Agency
CRIQ	Centre de recherche industrielle du Québec
MPN	most probable number
MSW	municipal solid waste
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
SCC	Standards Council of Canada

Preface

Guidelines for Compost Quality, 2005, is published by the Canadian Council of Ministers of the Environment (CCME) and replaces the previous version – *Guidelines for Compost Quality*, 1996.

This document was prepared by the CCME Compost Guidelines Task Group. Membership of the Task Group was representative of provincial, territorial, and federal governments.

Compost Guidelines Task Group

Barry Friesen, Chair	Nova Scotia Environment and Labour
Jack Bryden	British Columbia Ministry of Water, Land and Air Protection
Gordon Dinwoodie	Alberta Environment
Jim Ferguson	Manitoba Conservation
Marc Hébert	Ministère de du Développement durable, de l'Environnement et des Parcs
Brad Guglietti	Ontario Ministry of the Environment
Ken Hall	Northwest Territories Resources, Wildlife and Economic Development
Dennis Jackson	Environment Canada
Don Jardine	Prince Edward Island Environment and Energy
Heather Valsangar	New Brunswick Environment and Local Government
Pat Paslawski	Yukon Environment
Marie Ryan	Newfoundland and Labrador Environment and Conservation
Kim Yee	Saskatchewan Environment
Anjanette Tomac	CCME Secretariat

Acknowledgements

The Compost Guidelines Task Group acknowledges the following individuals and organizations that have contributed to the production of these guidelines:

Sylvain Allard	Bureau de normalisation du Québec
Susan Antler	Composting Council of Canada
Ian Gardiner	Canadian Food Inspection Agency
Kate Billingsley	Canadian Food Inspection Agency

Section 1

Introduction

Canadians have long understood that organic matter, when composted, is a valuable product. Compost provides many benefits, returning nutrients and organic matter to the soil, making it a valuable amendment for landscaping, horticulture, and agriculture.

In 1996, CCME developed guidelines for compost products, at a time when the composting industry was still relatively young. Since then, many industries and municipalities have implemented large-scale composting operations.

By setting standards for the quality of compost material, the guidelines helped protect public health and the environment, as well as ensured that compost products were used beneficially. The composting industry also benefited since the guidelines helped secure compost as a beneficial soil amendment, increased the demand for organic materials, and encouraged source separation of organic wastes. In short, the guidelines helped organic materials to be regarded as a resource.

As is often necessary, updates to guidelines and standards are necessary in order to recognize advances in new technologies and science. This 2005 revision is meant to reflect these advances and to provide even better use of organic resources in Canada and to protect the environment and human health.

1.1 Background

Several standard-setting organizations across Canada are mandated to regulate compost and write standards concerning compost. These include the federal government, provincial and territorial governments, and the Bureau de normalisation du Québec (BNQ), acting on behalf of the Standards Council of Canada (SCC)[1].

Within the federal government, the Canadian Food Inspection Agency (CFIA) regulates compost when it is sold either as a soil amendment or as a product with plant nutrient claims under the *Fertilizers Act*. The provinces and territories regulate the disposal and beneficial use of wastes on land, and therefore, the production and use of compost. In its role, acting on behalf of the SCC, the BNQ establishes voluntary industry standards for adoption by the SCC and endorses products that meet their standards.

Since 1993, CCME, BNQ and CFIA have aimed to coordinate efforts in an attempt to develop compost standards that provide a significant level of national consistency, while being flexible enough to accommodate different interest (e.g., regional) and issues.

[1] The SCC coordinates voluntary industry standardization activities in Canada and represents Canada in the International Organization for Standardization (ISO). Four standard-development organizations are accredited by the SCC, one of which is the BNQ. Within the SCC, BNQ is primarily responsible for standardizing fertilization, organic fertilizers, and soil supplements. As such, the BNQ is the only standard-writing organization of the SCC accredited to write industry standards for compost.

Section 2

Product Safety and Exposure

Products must be safe for sale or use. However, by the same token, "safety" (or "risk") is the function of exposure. When assessing the safety of a product, exposure must also be considered; if there is no exposure there can be no "risk". Ultimately, exposure is a function of the quantity, the intended use, and the users of a product. The question then becomes whether a product is "safe enough" for "use as intended". It should be recognized that a product may be safe for one type of use and user, but not for another use in which the product may be further exposed to the public, water, environment, or plants in the food chain. These guidelines attempt to integrate the concept that exposure is an integral part of the risk by establishing different grades of material (Category A - unrestricted and Category B - restricted) on the basis of safety.

Section 3

Compost Product Guidelines

These compost guidelines are based on the following four criteria for product safety: foreign matter, maturity, pathogens and trace elements.

The standards for compost quality are summarized in this section. For additional information on the limits recommended, please refer to the "Support Document for Compost Quality Criteria [National Standard of Canada CAN/BNQ 0413-200, Canadian Council of Ministers of the Environment (CCME) Guidelines and Agriculture and Agri-Food Canada (AAFC) Criteria]".

3.1 Categories

Two compost categories have been developed for trace element concentrations and sharp foreign matter. These categories (A and B) are based on the end use of the compost material.

Unrestricted Use

Category A – Compost that can be used in any application, such as agricultural lands, residential gardens, horticultural operations, the nursery industry, and other businesses.

Category A criteria for trace elements are achievable using best source separated MSW feedstock or municipal biosolids, or pulp and paper mill biosolids, or manure.

Restricted Use

Category B – Compost that has a restricted use because of the presence of sharp foreign matter or higher trace element content. Category B compost may require additional control when deemed necessary by a province or territory.

Please note that for a compost to meet the unrestricted use category, it must meet the unrestricted (Category A) requirements for all trace elements and sharp foreign matter. If the compost fails one criterion of the guideline for unrestricted use but meets the criteria for restricted (Category B) use, then it is classified as a Category B product. Products that do not meet the criteria for either Category A or B must be used or disposed of appropriately.

3.2 Trace Elements

Trace elements, for example, mercury, cadmium, lead, may be present in raw materials from which compost products are produced. Excessive accumulation in soils over the long term may result in toxicity to plants, animals and humans. However, copper, cobalt, molybdenum and zinc (and possibly nickel and selenium) are plant micronutrients, and their presence may be useful in compost. Also arsenic, cobalt, chromium, copper, molybdenum, nickel, selenium, and zinc are micronutrients required by animals and humans (Webber and Singh, 1995). Cadmium, mercury and lead are of no known value to either plants or animals. Compost applied repeatedly in large quantities to land without monitoring trace element concentrations could theoretically cause adverse effects on human health or the environment over the long term.

The concentrations of trace elements in finished compost (Category A and B) and the cumulative additions to soil (Category B) shall not exceed those levels provided in Table 1 as calculated on a dry weight basis.

Background information about trace elements are provided in Annexes A and B.

Table 1 **Concentrations of Trace Elements in Compost and Cumulative Trace Element Additions to Soil**

	CATEGORY A	CATEGORY B	
Trace Elements***	Maximum Concentration within Product (mg/kg dry weight)	Maximum Concentration within Product* (mg/kg dry weight)	Maximum Cumulative Additions to Soil* (kg/ha)
Essential or beneficial to plants or animals			
Arsenic (As)	13	75	15
Cobalt (Co)	34	150	30
Chromium (Cr)	210	**	**
Copper (Cu)	400	**	**
Molybdenum (Mo)	5	20	4
Nickel (Ni)	62	180	36
Selenium (Se)	2	14	2.8
Zinc (Zn)	700	1850	370
Other			
Cadmium (Cd)	3	20	4
Mercury (Hg)	0.8	5	1
Lead (Pb)	150	500	100

* These concentrations are the existing standards under the Canadian Food Inspection Agency's Standards for Metals in Fertilizers and Supplements, September 1997 (Trade Memorandum T-4-93).

** Limits for copper and chromium are not established in the Trade Memorandum. Calculated in the same manner as limits for the other nine elements, the trace element additions to soil for chromium and copper would be: chromium = 210 kg/ha and copper = 150 kg/ha for the trace element concentrations within the compost product , chromium = 1060 mg/kg and copper = 757 mg/kg. Details of these calculations are in the "Support Document for Compost Quality Criteria [National Standard of Canada CAN/BNQ 0413-200, Canadian Council of Ministers of the Environment (CCME) Guidelines and Agriculture and Agri-Food Canada (AAFC) Criteria".

*** Concentrations of other elements may eventually be regulated in certain provinces to accommodate regional and national concerns.

3.3 Foreign Matter in Compost

Foreign matter detracts from good quality compost. As most compost feedstocks and products contain foreign matter, the following quality criteria are important to protect human health, and to be an incentive for source separation of residuals or sorting out of foreign matter in the final product.

a) Sharp Foreign Matter

Category A - Compost shall not contain any sharp foreign matter of dimension greater than 3 mm per 500 ml.

Category B - Compost shall have a sharp foreign matter content less than or equal to three (3) pieces of sharp foreign matter per 500 ml, and the maximum dimension of the sharp foreign matter shall be 12.5 mm. However, this compost shall not be used in pastures, parks or for residential purposes.

b) Other Foreign matter

Category A - Compost shall contain no more than one (1) piece of foreign matter greater than 25 mm in any dimension per 500 ml.

Category B - Compost shall contain no more than two (2) pieces of foreign matter greater than 25 mm in any dimension per 500 ml.

3.4 Maturity/Stability of Compost

Characteristics of mature and stable compost include biostabilization and humus formation. Guidelines for compost maturity are necessary as unstable/immature product has the potential to cause adverse effects on plants when applied in large amounts or attract vectors, such as flies, and to cause odours.

Compost shall be mature and stable at the time of sale and distribution. To be considered mature and stable, a compost shall be cured for a minimum of 21 days and meet one of the following three requirements:

a) the respiration rate is less than, or equal to, 400 milligrams of oxygen per kilogram of volatile solids (or organic matter) per hour; or,

b) the carbon dioxide evolution rate is less than, or equal to, 4 milligrams of carbon in the form of carbon dioxide per gram of organic matter per day; or,

c) the temperature rise of the compost above ambient temperature is less than 8 °C .

3.5 Pathogens in Compost

As pathogenic organisms may be present in the compost feedstock, the compost itself may also contain pathogenic organisms and, as a result, may pose a risk to human health. To adequately reduce these health risks, the compost shall conform to the criteria outlined in either a) or b) depending on the feedstock source.

a) When compost contains ***only yard waste*** the following criteria shall be met:

1. The compost shall undergo the following treatment or other process recognized as equivalent by the relevant province or territory.

   Using in-vessel composting method, the material shall be maintained at operating conditions of 55°C or greater for three days.

   Using the windrow composting method, the material shall attain a temperature of 55°C or greater for at least 15 days during the composting period. Also, during the high temperature period, the windrow shall be turned at least five times.

   Using the aerated static pile composting method, the material will be maintained at operating conditions of 55°C or greater for three days. The preferable practice is to cover the pile with an insulating layer of material, such as cured compost or wood chips, to ensure that all areas of the feed material are exposed to the required temperature.

   OR

2. Organism content shall meet the following:

   Fecal coliforms[2] < 1000 most probable number (MPN)/g of total solids calculated on a dry weight basis,

   AND

   No *Salmonella* sp. with a detection level < 3 MPN/4g total solids calculated on a dry weight basis.

---

[2] Preliminary research suggests that some composts may have high fecal coliform counts due to bacteria of environmental origin and not of fecal origin. Thus, fecal coliforms may not be a reliable indicator of pathogen levels under all circumstances. In cases where high levels of fecal coliforms are suspected to be due to environmental contamination, additional analysis for *Escherichia coli* should be conducted. Use of *Escherichia coli* content as a direct indicator of pathogen levels is not yet supported by all regulatory agencies in Canada, but it may be used to help verify the reason for the high fecal coliform levels.

b) When compost contains ***other feedstock***, the following criteria shall be met:

1. Undergo a treatment (described in a),

   AND

2. Organism content shall meet the following:

   Fecal coliforms < 1000 MPN / g of total solids calculated on a dry weight basis,

   OR

   No *Salmonella* sp. with a detection level < 3 MPN / 4g total solids calculated on a dry weight basis.

3.6 Organic Contaminants in Compost

Organic chemicals enter waste streams from a variety of industrial and domestic sources. While many degrade or volatilize during waste collection, treatment (including composting) and storage, some of these organic chemicals persist.

Some compost feedstocks may contain trace amounts of persistent[3] or bio-accumulating organic contaminants, such as dioxins, furans, pesticides, polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbons (PAH) or herbicides (e.g. clopyralid). The manufacturer should pay special attention to raw materials that might contain such contaminants. To this effect, it is recommended that the composting of raw materials with high contents of these contaminants be avoided.

However, given the low content of dioxin and furans in compost feedstock (Webber, 1996) and in composts produced in Canada (Groeneveld and Hébert, 2004), routine analysis under the CCME Guidelines is not considered necessary. The same also applies to PCB and PAH. For specific sampling requirements in each province or territory, contact the provincial or territorial authority having jurisdiction.

[3] The term "persistent" is used to indicate resistance to transformation (i.e. breakdown or degradation) in the environment. A compound is considered persistent in soil or aquatic systems when its half-life (T ½) or its time for 50% decline or disappearance is greater than 180 days.

Section 4

Sampling and Analytical Methods for Testing Compost Quality

The following documents can be used as a basis for sampling and analytical test methods.

CAN/BNQ 0413-200-2005 – Organic Soil Conditioners – Composts. (Amendements organiques – Composts.)

CAN/BNQ 0413-210-2005 – Organic Soil Conditioners – Composts – Determination of Foreign Matter Content – Sieving Method. (Amendements organiques – Composts – Détermination de la teneur en corps étrangers – Méthode granulométrique.)

CAN/BNQ 0413-210-2005 – Organic Soil Conditioners – Composts – Determination of Respiration Rate – Respirometric Method. (Amendements organiques – Composts – Détermination du taux de respiration – Méthode respirométrique.)

These publications are available at the Bureau de normalisation du Québec (BNQ).

> **Bureau de normalisation du Québec**
> Customer Service
> 333, rue Franquet
> Sainte-Foy (Québec) G1P 4C7
> Telephone: (418) 652-2238
> Toll-free: 1 800 386-5114
> Fax: (418) 652-2292
> E-mail: bnqinfo@bnq.qc.ca
> http://www.bnq.qc.ca/

CENTRE D'EXPERTISE EN ANALYSE ENVIRONNEMENTALE DU QUÉBEC, Dénombrement des salmonelles ; méthode par tubes multiples. MA. 700 – Sal-tm 1.0, Ministère de l'Environnement du Québec, 2003, 19 p. http://www.ceaeq.gouv.qc.ca/methodes/pdf/MA700Saltm10.pdf

Compost sampling and analysis protocols can also be found in *Test Methods for the Examination of Composting and Compost* (TMECC).

US COMPOSTING COUNCIL RESEARCH AND EDUCATION FOUNDATION (CCREF), and UNITED STATES DEPARTMENT OF AGRICULTURE (USDA), *Test Methods for the Examination of Composting and Compost.* http://www.tmecc.org/tmecc/

Maximum Acceptable Trace Element Contents in Category A Compost — No Net Degradation and Best Achievable Approach Concepts[4]

The **no net degradation** and the **best achievable approach** concepts are two different concepts that were considered for the determination of the maximum acceptable trace element contents in **Category A** compost.

The **no net degradation** concept referred to in *An International Survey of Composting Criteria* (Waste Conversion Incorporated, 1992) requires that the use of compost not change the regional background levels of trace elements in the receiving soils. In the *Review and recommendations for Canadian interim environmental quality criteria for contaminated sites* (1991), Environment Canada defines **background level** as "the concentration of a chemical substance occurring in a media removed from the influence of industrial activity at a specific site and in an area considered to be relatively unaffected by industrial activity."

The **no net degradation** concept generally recognizes that the maximum acceptable trace element contents in compost should be established by taking the arithmetic mean of measured background levels in a defined region and adding three standard deviations from the mean. For ***normal distributions***, 99 % of all trace element content results for samples from a region considered to be uninfluenced by industrial activities shall be below these maximum acceptable contents.

At the time of the first edition of this guideline (1996), measurements of background levels of trace elements were available only for the agricultural soils of Alberta, Ontario and Québec. Requirements based on the **no net degradation** concept were thus established using the highest values of background levels of soils obtained from these three provinces.

The **best achievable approach** concept favours the use of the best available technology to produce an end product. This concept is based on the fact that the best available technology (such as source separation) to produce the desired end product should be used to establish the requirements for maximum acceptable trace element contents in compost.

At the time of the first edition of this guideline (1996), data based on the **best achievable approach** concept was available in British Columbia's *Production and Use of Compost Regulation* (1993). The data specified in this regulation were derived from municipal solid waste residue and source separation management programs. In 2004, numbers for Cu and Zn were derived to allow composting of other feedstocks. For Cu, the value was raised from 100 to 400 mg/kg in order to allow composting of hog manure and municipal biosolids. Environmental justifications of trace element contents are found in Hébert and

[4] Adapted from Bureau de normalisation du Québec (2005)

Groeneveld (2003). For Zn, the concentration limit was raised from 500 to 700 mg/kg to allow composting of poultry and hog manure, and vermicomposting. The limits for poultry manure were based on CRIQ (1994) database values for manure and manure composts. It is important to note that both the **no net degradation** approach and the **best achievable technology** standards are policy-based criteria for compost products and are not based on risk assessment associated with local soil quality.

The following table presents maximum acceptable trace element contents for **Category A** compost established using the highest value derived from **no net degradation** and **best achievable approach** concepts.

Table 2 Maximum Acceptable Trace Element Contents for Category A Compost Using the Highest Value Derived from No Net Degradation and Best Achievable Approach Concepts.

Trace Element	**Mean of Background Levels + 3 Standard Deviations**			***No Net Degradation* Concept (1996)**	***Best Achievable Approach* Concept**	**Maximum Acceptable Trace Element Content in Category A Compost**
	Alberta	**Ontario[1]**	**Québec[2]**			
As		10		10	13[3]	13
Cd	1.6	3	2.5	3	2.6[3]	3
Co	14	25	34	34	26[3]	34
Cr	30	50	121	121	210[3]	210
Cu	29	60	48	60	400[4]	400
Hg	0.1	0.15	0.09	0.15	0.8[3]	0.8
Mo		2		2	5[3]	5
Ni	36	60	62	62	50[3]	62
Pb	20	150	68	150	150[3]	150
Se		2		2	2[3]	2
Zn	124	500	144	500	700[5]	700

NOTE — All results are expressed in milligrams per kilogram (dry weight basis).

1. Reference: Ontario Ministry of the Environment, 1989
2. Reference: Giroux, Rompré, Carrier, Audesse & Lemieux, 1992
3. Reference: British Columbia, 1993
4. Reference: Hébert and Groeneveld, 2003
5. Reference: Centre de recherche industrielle du Québec, 1994

Maximum Acceptable Trace Element Contents in Category B Compost as outlined in Trade Memorandum T-4-93 [5]

Maximum acceptable trace element contents for **Category B** compost ensure that the cumulative trace element additions to soil will not exceed the requirements shown in the table below, assuming a wet basis annual application rate of 11,000 kg/hm² (1 hm² = 10,000 m² = 1 ha) of compost at 60% moisture content (equivalent to an oven-dried mass of 4,400 kg/hm² containing up to 5% total nitrogen) for a period of 45 years.

No maximum trace element content for Cu or Cr was retained for **Category B**, which corresponds to the absence of values indicated in "Trade Memorandum T-4-93" (CFIA, 1997).

Note that these values, except for As and Pb, are lower than «Exceptional quality» criteria derived by US EPA (1995) for municipal biosolids compost from a risk-based analysis.

Table 3 Maximum Acceptable Trace Element Contents for Category B Compost

Trace Element	Maximum Cumulative Trace Element Addition to Soils* Based on *Table I* in "Trade Memorandum T-4-93", kg/hm² (kg/ha)	Maximum Acceptable Trace Element Content in Type *B* Compost Based on *Table II* in "Trade Memorandum T-4-93", mg/kg (dry weight basis)
Arsenic (As)	15	75*
Cadmium (Cd)	4	20
Cobalt (Co)	30	150
Lead (Pb)	100	500
Mercury (Hg)	1	5
Molybdenum (Mo)	4	20
Nickel (Ni)	36	180
Selenium (Se)	2.8	14
Zinc (Zn)	370	1,850

* The maximum arsenic content in a compost in milligrams per kilogram is calculated as follows:

$$\frac{15\ \mathrm{kg}/\mathrm{hm}^2}{4400\ \mathrm{kg}/\mathrm{hm}^2\mathrm{a} \times 45\ \mathrm{a} \times 1\ \mathrm{g}/1000\ \mathrm{mg} \times 1\ \mathrm{kg}/1000\ \mathrm{g}}$$

[5] Adapted from Bureau de normalisation du Québec (2005)

Webber, M.. (1996). Compilation, Review and Evaluation of Organic Contaminants in Compost and Compost Feedstock Materials. Burlington, Water Technology International Corporation.

Webber, M. and S.S. Singh. (1995) Contamination of Agricultural Soils. In D.F. Acton and L.J. Gregorich (Eds.), *The Health of Our Soils: Toward Sustainable Agriculture in Canada*. (chap. 9). Centre for Land and Biological Resources Research, Research Branch, Agriculture and Agri-Food Canada. http://res2.agr.gc.ca/publications/hs/chap09_e.htm


FERTILITY
STATIC
WINDROW AERATE

Province of Alberta

ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT

WASTE CONTROL REGULATION

Alberta Regulation 192/1996

With amendments up to and including Alberta Regulation 31/2012

Office Consolidation

Alberta Queen's Printer
5th Floor, Park Plaza
10611 - 98 Avenue
Edmonton, AB T5K 2P7
Phone: 780-427-4952
Fax: 780-452-0668

E-mail: qp@gov.ab.ca
Shop on-line at www.qp.alberta.ca

Note

All persons making use of this consolidation are reminded that it has no legislative sanction, that amendments have been embodied for convenience of reference only. The official Statutes and Regulations should be consulted for all purposes of interpreting and applying the law.

(Consolidated up to 31/2012)

ALBERTA REGULATION 192/96

Environmental Protection and Enhancement Act

WASTE CONTROL REGULATION

Table of Contents

Definitions

1 In this Regulation,

(a) "Act" means the *Environmental Protection and Enhancement Act*;

(b) "agricultural waste" means waste generated by a farmer;

(c) "biomedical waste" means waste that is generated by

(i) human health care facilities,

(ii) medical research and teaching establishments,

(iii) clinical testing or research laboratories, and

(iv) facilities involved in the production or testing of vaccines,

and contains or may contain pathogenic agents that may cause disease in humans exposed to the waste;

(d) "certified operator" means a person who holds a valid certificate of qualification issued in accordance with the Act and this Regulation;

(e) "Class I compost facility" means a waste management facility where waste, not including hazardous waste, is decomposed through a controlled bio-oxidation process, including a thermophilic phase, that results in a stable humus-like material, but does not include

(i) a residential composter,

(ii) a compost facility that receives only sludge as defined in the *Wastewater and Storm Drainage Regulation* (AR 119/93),

(iii) a Class II compost facility, or

(iv) a manure storage facility as defined in the *Agricultural Operation Practices Act*;

(f) "Class II compost facility" means a waste management facility where only vegetative matter or manure is decomposed through a controlled bio-oxidation process, including a thermophilic phase, that results in a stable humus-like material, but does not include

(i) a residential composter, or

(ii) a manure storage facility as defined in the *Agricultural Operation Practices Act*;

(g) "Class I landfill" means a landfill for the disposal of waste that has

(i) 2 liners of which at least one is a synthetic liner,

(ii) a leachate collection and removal system,

(iii) a leak detection system between the 2 liners, and

(iv) a groundwater monitoring system;

(h), (i) repealed AR 162/2005 s2;

(j) "Class II landfill" means a landfill for the disposal of waste, not including hazardous waste;

(k) "Class III landfill" means a landfill for the disposal of inert waste;

(l) repealed AR 162/2005 s2;

(m) "container" means any portable device which is or was used to store or hold hazardous waste or dangerous goods;

(m.1) "dangerous goods" means a product, substance or organism that is by its nature or by the regulations under the *Transportation of Dangerous Goods Act, 1992* (Canada) included in any of the classes listed in the Schedule to that Act;

(n) "Director" means the person designated as Director for the purposes of this Regulation;

(o) "dispersible form" means any of the following or a mixture of them:

(i) a liquid;

(ii) a solid that can pass through a 9.5 mm mesh opening;

(iii) a friable solid that can be reduced by grinding in a mortar and pestle to a particle size that can pass through a 9.5 mm mesh opening;

(p) "dispose", when used with respect to waste at a landfill or by deepwell injection, means the intentional placement of waste on or in land as its final resting place;

(q) "empty container" means a container that contains less than 2.5 centimetres of the original contents or less than 3% of the original contents, whichever is the lesser amount;

(r) "farmer" means a person engaged in an agricultural operation as defined in the *Agricultural Operation Practices Act*;

(s) "Federal Regulations" means the *Transportation of Dangerous Goods Regulations* (SOR/2001-286) made under the *Transportation of Dangerous Goods Act, 1992* (Canada);

(t) "hazardous recyclable" means a recyclable that has one or more of the properties described in Schedule 1;

(u) "hazardous recyclable facility" means a facility for storing or processing hazardous recyclables;

(v) "hazardous waste" means waste that has one or more of the properties described in Schedule 1, but does not include those wastes listed in Schedule 2;

(w) "hazardous waste management facility" means a facility for the collection, storage, treatment or disposal of hazardous waste, but does not include an on-site facility;

(w.1) "inert waste" means solid waste that, when disposed of in a landfill or re-used, is not reasonably expected to undergo physical, chemical or biological changes to such an extent as to produce substances that may cause an adverse effect, and includes, but is not limited to, demolition debris, concrete, asphalt, glass, ceramic materials, scrap metal and dry timber or wood that has not been chemically treated;

(x) "internal volume" means the nominal capacity of a container;

(y) "land treatment" means

(i) the controlled application of a substance on the land surface and the incorporation of the substance into the upper soil zone,

(ii) the controlled application of soil containing hydrocarbons on the land surface, with or without incorporation of the soil containing hydrocarbons into the upper soil zone, or

(iii) the controlled application of soil containing hydrocarbons onto a man-made surface or containment system, in such a manner that physical, chemical or biological removal or degradation of the substance or hydrocarbons takes place, but does not include

(iv) the controlled application to land of sludge as defined in the *Wastewater and Storm Drainage Regulation* (AR 119/93), or

(v) the controlled application of a substance to land where that activity constitutes an agricultural operation as defined in the *Agricultural Operation Practices Act*;

(z) "landfill" means a waste management facility at which waste is disposed of by placing it on or in land, but does not include a land treatment facility, a surface impoundment, a salt cavern or a disposal well;

(aa) "liquid", when used with respect to waste, means a waste that has free liquids;

(bb) "oil production site" means the field production facilities for recovering oil or oil sands by drilling or other in-situ recovery methods, including any injection or pumping facilities, and any associated infrastructure, where the site is located within the area illustrated in the guideline entitled *Guide for Oil Production Sites* published by the Department;

(cc) "oilfield waste" means an unwanted substance or mixture of substances that results from the construction, operation, abandonment or reclamation of a facility, well site or pipeline within the meaning of the *Oil and Gas Conservation Act* and the regulations under that Act but does not include an unwanted substance or mixture of substances from such a source that is received for storage, treatment, disposal or recycling at a facility authorized for that activity pursuant to the *Environmental Protection and Enhancement Act*;

(dd) "oilfield waste management facility" means a facility that is approved under the *Oil and Gas Conservation Act* and the regulations under that Act to process, treat, dispose of, store or recycle oilfield waste;

(ee) "on-site facility" means a facility that is used solely to deal with wastes or recyclables generated on property that is owned, rented or leased by the person responsible for the facility;

(ff) "person responsible" for a facility of any kind under this Regulation means

(i) the owner or previous owner of the facility,

(ii) every person who has or has had charge, management or control of the facility or any portion of the facility,

(iii) any successor, assignee, executor, administrator, receiver, receiver-manager or trustee of a person referred to in subclause (i) or (ii), and

(iv) a person who acts as a principal or agent of a person referred to in subclauses (i), (ii) or (iii);

(gg) "recyclable" means a substance or mixture of substances that is intended to be recycled;

(hh) "residential composter" means a composter that

(i) is located at a residence,

(ii) is used to decompose manure, food scraps or vegetative matter resulting from gardening, horticulture, landscaping or land clearing, and

(iii) uses a controlled bio-oxidation process that results in a stable humus-like material;

(hh.1) "soil containing hydrocarbons" means soil that is contaminated with only gasoline, kerosene, jet fuel or diesel fuel, or any combination of them;

(ii) "storage site" means a waste management facility, where waste, other than hazardous waste, is

(i) stored,

(ii) sorted, compacted, shredded, ground or processed, or

(iii) collected and held for removal to another waste management facility;

(jj) "surface impoundment" means a facility that consists of an excavation or diked areas that is formed primarily of earthen material and is used for the storage of waste;

(jj.1) "TEQ" means dioxin toxic equivalent with respect to the following toxicity equivalency factors:

Congener	Toxicity equivalency factor
2,3,7,8-tetrachloro-dibenzo-p-dioxin	1.000
1,2,3,7,8-pentachloro-dibenzo-p-dioxin	0.500
1,2,3,4,7,8-hexachloro-dibenzo-p-dioxin	0.100
1,2,3,6,7,8-hexachloro-dibenzo-p-dioxin	0.100
1,2,3,7,8,9-hexachloro-dibenzo-p-dioxin	0.100
2,3,7,8-tetrachloro-dibenzofuran	0.100
1,2,3,7,8-pentachloro-dibenzofuran	0.050
2,3,4,7,8-pentachloro-dibenzofuran	0.500
1,2,3,4,7,8-hexachloro-dibenzofuran	0.100
1,2,3,6,7,8-hexachloro-dibenzofuran	0.100
1,2,3,7,8,9-hexachloro-dibenzofuran	0.100
2,3,4,6,7,8-hexachloro-dibenzofuran	0.100

(kk) "unrinsed empty container" means an empty container that previously held a hazardous waste

(i) that has not been rinsed 3 times, using for each rinse a clean solvent that is in an amount equal to 10% of the container volume and that is capable of removing the previously contained hazardous waste, or

(ii) that, in the opinion of the Director, has been rinsed or cleaned by a method that does not produce results equal to or better than those produced by the method set out in subclause (i);

(ll) "waste" means any solid or liquid material or product or combination of them that is intended to be treated or disposed of or that is intended to be stored and then treated or disposed of, but does not include recyclables;

(mm) "waste management facility" means a facility for the collection, storage, treatment or disposal of waste.

AR 192/96 s1;272/2003;162/2005

Part 1
Hazardous Waste

Definitions

2 In this Part,

(a) "carrier" means a person who accepts hazardous waste for transport or who transports hazardous waste;

(b) "consignor" means a person who consigns hazardous waste for storage, transport, treatment or disposal;

(c) "receiver" means a person who receives hazardous waste for storage, treatment or disposal.

Personal identification numbers

3 An application for a personal identification number under section 188(2) of the Act must be submitted to the Director in a form and manner acceptable to the Director.

AR 192/96 s3;251/2001

Generator's duties

3.1 A person who generates hazardous waste or hazardous recyclables shall

(a) characterize, and

(b) classify

the hazardous waste or hazardous recyclables prior to consignment for transportation.

AR 162/2005 s3

Exemption

4 Sections 188 and 191 of the Act do not apply to the consignor or carrier of hazardous waste when the hazardous waste is transported to on-site facilities if the operation is carried out in compliance with the Federal Regulations.

AR 192/96 s4;251/2001;162/2005

Form of manifest

5 The manifest referred to in section 191 of the Act must be in the form for the manifest set out in the Federal Regulations.

AR 192/96 s5;251/2001

Manifest completion

6 The consignor, carrier and receiver of hazardous waste shall complete the applicable parts and copies of the manifest to the satisfaction of the Director.

Generator's and consignor's manifest duties

7(1) A consignor, on consigning a hazardous waste, shall

(a) sign all copies of the manifest, and ensure that the carrier certifies receipt of the hazardous waste,

(b) mail the first copy of the manifest to the Director within 2 days, excluding Saturdays and holidays, after consigning the hazardous waste,

(c) retain the 2nd copy for at least 2 years following the consignment, and

(d) deliver the 3rd, 4th, 5th and 6th copies to the carrier.

(2) The consignor of hazardous waste that is shipped out of Alberta shall ensure that a copy of the manifest completed by the out-of-province receiver is given to the Director, the carrier, the consignor and, if the waste is shipped out of Canada, to the Department of Environment (Canada).

Carrier's manifest duties

8 A carrier, on accepting hazardous waste for transportation, shall

(a) sign all copies of the manifest,

(b) return the first and 2nd copies of the manifest to the consignor,

(c) ensure that the 3rd, 4th, 5th and 6th copies accompany the hazardous waste during transportation, and

(d) deliver the 3rd, 4th, 5th and 6th copies to the receiver.

Receiver's manifest duties

9(1) A receiver, on accepting hazardous waste for storage, treatment or disposal, shall

(a) sign the 3rd, 4th, 5th and 6th copies of the manifest and return the 4th copy to the carrier,

(b) mail the 3rd copy to the Director within 2 days, excluding Saturdays and holidays, after receiving the hazardous waste,

(c) retain the 5th copy for at least 2 years after receiving the hazardous waste, and

(d) mail the 6th copy to the consignor within 2 days, excluding Saturdays and holidays, after accepting the hazardous waste.

(2) The receiver of hazardous waste generated outside of Alberta shall ensure that the Director and, if the waste was generated outside of Canada, the Department of Environment (Canada), receive a copy of the manifest.

(3) The consignor shall retain the 6th copy of the manifest referred to in subsection (1)(d) for at least 2 years following its receipt from the receiver.

Multiple carriers' manifests

10(1) If multiple carriers are used for a consignment of hazardous waste,

(a) the consignor shall complete a separate manifest and comply with section 7 with respect to each carrier;

(b) each carrier, on accepting hazardous waste for transportation, shall

(i) sign one manifest form and return the first and 2nd copies of that form to the consignor, and

(ii) deliver the remaining copies and remaining manifest forms to the receiver or next carrier;

(c) the receiver shall, on accepting the hazardous waste for storage, treatment or disposal,

(i) sign the 3rd, 4th, 5th and 6th copies of all manifest forms,

(ii) cross-reference all of the manifests,

(iii) mail the 3rd copy of each manifest form to the Director within 2 days, excluding Saturdays and holidays, after accepting the hazardous waste,

(iv) mail the 4th copy of the appropriate manifest to each carrier,

(v) retain the 5th copy of each manifest for at least 2 years after receiving the hazardous waste, and

(vi) mail the 6th copy to the consignor within 2 days, excluding Saturdays and holidays, after accepting the hazardous waste.

(2) The consignor shall retain the 6th copy of the manifest referred to in subsection (1)(c)(vi) for at least 2 years following its receipt from the receiver.

Storing hazardous waste

11(1) A person who stores hazardous waste shall store it in an amount and in a manner so that

(a) it will not cause an adverse effect,

(b) any leakage is contained and prevented from entering into the remainder of the hazardous waste management facility and places beyond, including sewers and the ground underneath the site,

(c) at least secondary containment is provided for liquid hazardous waste, and there are no openings in the secondary containment system that provide a direct connection to the area surrounding the system,

(d) the hazardous waste is adequately labelled, stating the identity of the hazardous waste that is being stored,

(e) incompatible hazardous wastes are stored in such a manner that there will be no contact between them, even in the event of a release, and

(f) routine inspections of the site can be performed.

(2) A person who stores hazardous waste shall ensure that the hazardous waste is stored in a place that

(a) is secure from entry by unauthorized persons,

(b) is prominently identified as a hazardous waste management facility where hazardous waste is being stored,

(c) is equipped with suitable equipment to handle emergency situations,

(d) is provided with operators trained to respond to emergency situations specific to the hazardous waste stored, and

(e) is designed and maintained so that surface run-off water cannot enter the secondary containment system.

(3) Subsection (2)(b) applies only to a hazardous waste management facility whose only function is the storage of hazardous waste, and does not apply to a hazardous waste management facility that is located in or is part of a manufacturing, processing or other operation.

Storage of PCBs

12(1) In this section,

(a) "PCB" means any chlorobiphenyl that has a molecular formula of $C_{12}H_{10-n}Cl_n$, in which "n" is greater than 2;

(b) "PCB equipment" means any equipment, machinery or similar manufactured item, including but not limited to a capacitor or an electrical transformer, that contains a PCB liquid, PCB solid or PCB substance;

(c) "PCB liquid" means a liquid that contains more than 50 mg of PCB per kilogram of the liquid;

(d) "PCB solid" means a solid that contains more than 50 mg of PCB per kilogram of the solid;

(e) "PCB substance" means a substance, other than a PCB liquid or a PCB solid, that contains more than 50 mg of PCB per kilogram of the substance;

(f) "PCB waste" means any PCB liquid, PCB solid, PCB substance or PCB equipment that is stored as hazardous waste.

(2) In determining the quantity, volume or weight of PCB waste for the purposes of subsection (3), the total amounts stored in or around one site that is under the responsibility of the same person shall be added together.

(3) Subject to the terms and conditions of an approval, a person who stores PCB waste in the following amounts shall advise the Director in writing in accordance with subsection (4) and keep and provide records in accordance with subsections (5) and (6):

(a) PCB liquids in an amount of 100 L or more;

(b) PCB solids or PCB substances in an amount of 100 kg or more;

(c) PCB liquids, PCB solids or PCB substances or a combination of them, in an amount less than that referred to in clause (a) or (b), that contain 1 kg or more of PCB;

(d) PCB equipment that contains an amount of PCB, PCB liquids, PCB solids or PCB substances referred to in clauses (a) to (c).

(4) The person who stores PCB wastes

(a) must advise the Director in writing no less than 30 days after that person first stores PCB waste in amounts referred to in subsection (3), and

(b) must disclose the name of the person, the location of where the PCB waste is being stored and a description and inventory of the PCB waste that is stored at the site.

(5) The records referred to in subsection (3) must contain the following information:

(a) with respect to each item of PCB waste received at the site,

(i) the date of receipt of the PCB waste,

(ii) the quantity of PCB waste received,

(iii) a description of the PCB waste, including, where applicable, the nameplate description, the serial number and the PCB registration number,

(iv) the condition of the PCB waste,

(v) the source of the PCB waste,

(vi) the name of the carrier of the PCB waste, and

(vii) the name of the individual who received the PCB waste;

(b) with respect to each item of PCB waste removed from the site,

(i) the date of removal of the PCB waste,

(ii) a description of the PCB waste, including, where applicable, the nameplate description,

(iii) the condition of the PCB waste,

(iv) the name of the carrier of the PCB waste,

(v) the destination of the PCB waste, and

(vi) the name of the individual authorizing the removal of the PCB waste;

(c) the results of any inspections conducted and any action taken as a result of those inspections.

(6) A person who is required to keep the records referred to in subsection (3) shall provide a copy of the records to the Director on January 1 and July 1 of each year containing the required information for the preceding 6-month period.

Landfills

13(1) No person shall dispose of hazardous waste into a landfill.

(2) Despite subsection (1), the following solid hazardous waste may be disposed of in a Class I landfill:

(a) solid hazardous waste containing one or more halogenated organic compounds in a combined concentration less than 1000 milligrams per kilogram, of which no more than 50 milligrams per kilogram is polychlorinated biphenyl;

(b) solid hazardous waste containing one or more of the following compounds in a combined concentration less than 1000 milligrams per kilogram:

(i) acetone;

(ii) benzene;

(iii) n-butyl alcohol;

(iv) carbon disulphide;

(v) cresol and cresylic acid;

(vi) cyclohexanone;

(vii) ethyl acetate;

(viii) ethyl benzene;

(ix) ethyl ether;

(x) isobutanol;

(xi) methanol;

(xii) methyl ethyl ketone;

(xiii) nitrobenzene;

(xiv) 2-nitropropane;

(xv) pyridine;

(xvi) toluene;

(xvii) xylene;

(c) solid hazardous waste that ignites, reacts or corrodes according to a test method set out in the Alberta User Guide for Waste Managers, 1996, published by the Department, as amended from time to time, that describes ignitable, reactive or corrosive hazardous waste, provided that those substances or mixtures of substances are not liable to ignite, propagate combustion, react or corrode under the conditions of disposal;

(d) solid hazardous waste producing a waste extract in which the concentration of each of the following substances, if present, is less than the following value:

(i)	arsenic:	500 mg/L;
(ii)	beryllium:	100 mg/L;
(iii)	cadmium:	100 mg/L;
(iv)	chromium (VI):	500 mg/L;
(v)	lead:	500 mg/L;
(vi)	mercury:	20 mg/L;
(vii)	nickel:	500 mg/L;
(viii)	selenium:	200 mg/L;
(ix)	silver:	100 mg/L;
(x)	thallium:	200 mg/L;

(e) solid hazardous waste with a pH greater than 12.5.

(3), (4) Repealed AR 162/2005 s5.

AR 192/96 s13;162/2005

Codes of practice

14(1) The Codes of Practice listed in Column B of Schedule 4 to this Regulation are adopted pursuant to section 38 of the Act and form part of this Regulation.

(2) A person who, pursuant to a registration, carries on any activity referred to in Column A of Schedule 4 to this Regulation shall comply with the corresponding Code of Practice referred to in Column B of that Schedule in the carrying on of that activity.

(3) Notwithstanding subsection (2), where the Director issues an approval in respect of the activity pursuant to section 6(3) of the *Activities Designation Regulation* (AR 276/2003), the approval holder

(a) is not required to comply with the Codes of Practice in Schedule 4, and

(b) shall comply with the terms and conditions of the approval.

AR 192/96 s14;162/2005

Importation

15(1) No person shall knowingly import any hazardous waste into Alberta for the purpose of storage for a period exceeding 30 days without first obtaining written authorization from the Minister.

(2) No person shall knowingly import hazardous waste into Alberta for the purpose of disposal.

(3) Subsection (2) does not apply to the disposal of residues resulting from the treatment of imported hazardous waste.

Dilution or division

16(1) No person shall mix hazardous waste with any solid or liquid for the primary purpose of dilution or of avoiding the requirements of this Regulation.

(2) No person shall divide a hazardous waste for the purpose of avoiding the requirements of this Regulation.

Part 1.1
Hazardous Substances

Hazardous substances

16.1 Any chemical or combination of chemicals that was used in or arose from the production of methamphetamine is designated as a hazardous substance.

AR 87/2007 s2

Part 2
Hazardous Recyclables

Application

17(1) Section 169 of the Act does not apply to a person consigning for shipment less than 205 litres, or less than 205 kilograms, of hazardous recyclables.

(2) Section 169(b) of the Act does not apply to a hazardous recyclable that is being consigned for shipment to an oilfield waste management facility.

AR 192/96 s17;251/2001;272/2003

Storage

18(1) A person who stores a hazardous recyclable shall store it in an amount and in a manner so that

(a) it will not cause an adverse effect,

(b) any leakage is contained and prevented from entering into the remainder of the hazardous recyclable facility and places beyond, including sewers and the ground underneath the site,

(c) at least secondary containment is provided for liquid hazardous recyclables, and there are no openings in the secondary containment system that provide a direct connection to the area surrounding the system,

(d) the hazardous recyclable facility is adequately labelled, stating the identity of the hazardous recyclable that is being stored,

(e) incompatible hazardous recyclables are stored in such a manner that there will be no contact between them, even in the event of a release, and

(f) routine inspections of the hazardous recyclable facility can be performed.

(2) A person who stores hazardous recyclables shall ensure that the hazardous recyclables are stored in a place that

(a) is secure from entry by unauthorized persons,

(b) is prominently identified as a hazardous recyclable facility where hazardous recyclables are stored,

(c) is equipped with suitable equipment to handle emergency situations,

(d) is provided with operators trained to respond to emergency situations specific to the hazardous recyclables stored, and

(e) is designed and maintained so that surface run-off water cannot enter the secondary containment system.